

nutrición clínica

y

Dietética Hospitalaria



Nutr Clín Diet Hosp. 2024; 44(3)





CUIDAMOS DEL JARDÍN EN EL QUE VIVIMOS

*Todo jardín necesita un jardinero que lo cuide y lo defienda.
Y en Central Lechera Asturiana llevamos más de 50 años
protegiendo el nuestro, Asturias. Somos más de 7.000 familias
ganaderas que con nuestra forma de vida y nuestra forma de hacer
las cosas contribuimos a hacer del mundo un lugar más verde.*

Ayúdanos a cuidarlo.



La revista **Nutrición Clínica y dietética hospitalaria** está indexada en las siguientes Bases de datos:

- Emerging Sources Citation Index (ESCI)
 - Citefactor
 - REDIB
 - Google Scholar
 - CAB Abstracts
 - Chemical Abstracts Services CAS
 - Índice Bibliográfico Español en Ciencias de la Salud IBECS
 - Índice Médico Español IME
 - Índice MEDES
 - DOAJ
 - CABI databases
 - LATINDEX
 - SCOPUS
-

Edición en internet: ISSN: 1989-208X

Depósito Legal: M-25.025 - 1981

Publicación autorizada por el Ministerio de Sanidad como Soporte Válido. S.V. nº 276

MAQUETACIÓN: Almira Brea, S.L. - Madrid

© Copyright 2012. Fundación Alimentación Saludable

Reservados todos los derechos de edición. Se permite la reproducción total o parcial de los trabajos contenidos en este número siempre que se cite la procedencia y se incluya la correcta referencia bibliográfica.

LORTAD: usted tiene derecho a acceder a la información que le concierne y rectificarla o solicitar su retirada de nuestros ficheros informáticos.

EDICIÓN

Fundación Alimentación Saludable. Madrid

REMISIÓN DE ORIGINALES

Utilizando el área de envío de originales de la web
Revisión por pares de los originales remitidos
(normas disponibles en la web de la revista)

DIRECCIÓN POSTAL

Prof. Jesús Román Martínez Álvarez
Facultad de Medicina, 3ª plta.
Sociedad Española de Dietética y Ciencias de la Alimentación
Dpto. de Enfermería
Ciudad universitaria - 28040 Madrid

ESPECIALIDAD

Alimentación, Nutrición y Dietética. Áreas declaradas de interés:

- NUTRICIÓN BÁSICA
- NUTRICIÓN CLÍNICA
- SALUD PÚBLICA
- DIETÉTICA
- NUEVOS ALIMENTOS
- ALIMENTOS E INGREDIENTES FUNCIONALES
- PATOLOGÍA NUTRICIONAL
- OBESIDAD
- TRASTORNOS DE LA CONDUCTA ALIMENTARIA
- MALNUTRICIÓN
- EVALUACIÓN DEL ESTADO NUTRICIONAL
- NUTRICIÓN ENTERAL
- NUTRICIÓN PARENTERAL
- SEGURIDAD E HIGIENE ALIMENTARIA
- NUTRIENTES
- NOTICIAS

PERIODICIDAD

4 números al año

TÍTULO ABREVIADO

Nutr Clín Diet Hosp.

INTERNET

Accesible desde URL = <http://www.nutricion.org>
Acceso en línea libre y gratuito



En Madagascar más de la mitad de los menores de 5 años padecen malnutrición crónica, la malnutrición no sólo afecta a nivel físico, también tienen consecuencias en el desarrollo cognitivo de las personas que lo sufren. En Agua de Coco, a través de nuestros proyectos educativos, nutricionales y de conservación del medio ambiente, contribuimos a mejorar la calidad de vida de más de 30.000 personas. ¿Nos apoyas?

CONOCE NUESTROS PROYECTOS EN
WWW.AGUADecOCO.ORG



DONA

ASOCIATE

DIRECCIÓN

Prof. Dr. Jesús Román Martínez Álvarez
Universidad Complutense de Madrid

REDACTOR - JEFE

Prof. Dr. Antonio Villarino Marín

COMITÉ DE REDACCIÓN

Prof. Dr. Andreu Palou Oliver
Catedrático de Bioquímica y Biología Molecular
Universidad de las Islas Baleares

Prof. Dr. Jordi Salas i Salvadó
Catedrático de Bioquímica
Universidad Rovira i Virgili. Reus. España

Prof. Dr. Rafael Moreno Rojas
Catedrático de Nutrición y Bromatología
Universidad de Córdoba

Dra. Marta Hernández Cabria
Área de Nutrición y Salud
Corporación Alimentaria Peñasanta. Oviedo

Dr. Francisco Pérez Jiménez
Profesor de Medicina Interna
Hospital U. Reina Sofía. Córdoba

Prof. Dra. Rosario Martín de Santos
Catedrática de Nutrición y Bromatología
Universidad Complutense de Madrid

Prof. Dra. Rosa Ortega Anta
Catedrática de Nutrición y Bromatología
Universidad Complutense de Madrid

Dra. Victoria Valls Bellés
Facultad de Medicina
Universidad Jaime I. Castellón

SECRETARÍA DE REDACCIÓN

Andrea Calderón García

DIRECTORES HONORÍFICOS

Dr. José María Ordovás Muñoz

Dra. Ana Sastre Gallego

Dra. Pilar Codoñer Franch
Facultad de Medicina
Universidades de Valencia

D^a. M^a Lourdes de Torres Aured
Unidad de Nutrición
Hospital Miguel Servet. Zaragoza

Prof. Dra. Isabel Polanco Allué
Servicio de Gastroenterología y Nutrición
Hospital Universitario Infantil La Paz. Madrid

Dra. Monique Romon
Sociedad Francesa de Nutrición

Dra. Paula Domínguez Salas
University of London. Royal Collegue

Prof. Rosa Elsa Hernández Meza
Universidad de Veracruz. México

D^a Rosa M Uscátegui
Directora de la revista Perspectivas en Nutrición Humana
Universidad de Antioquia. Colombia

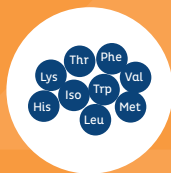
Dra. Mercedes Sotos Prieto
Universidad Autónoma de Madrid
Visiting Scientist, Department of Nutrition and Environmental
Health, Harvard T.H. Chan School of Public Health

Krissia®

Equilibra y completa tu alimentación



APORTE NATURAL
DE PROTEÍNA



GRAN DISPONIBILIDAD
DE AMINOÁCIDOS
ESENCIALES



APORTE NATURAL
DE OMEGA 3



BAJO EN
AZÚCARES



SIN
CONSERVANTES




SIN
GLUTAMATO



SIN
GLUTEN



SIN
LECHE/LACTOSA

 **Angulas
Aguinaga**
Research
Center

¡Forma parte
de nuestra
Plataforma
de Profesionales!



• Suscríbete a nuestra Newsletter científica



• Solicita materiales para tu consulta



• Consúltanos tus dudas



• Visita nuestras instalaciones

 www.krissia.es/profesional-de-la-salud



**CON TU AYUDA LLENAMOS
LOS PLATOS QUE ESTA CRISIS
ESTÁ VACIANDO.**

La COVID-19 está trayendo el hambre a la mesa de miles de familias en España. Gracias a tu colaboración, podremos repartir tarjetas monedero a las familias más afectadas para que puedan comprar bienes de primera necesidad.

Ayúdanos a seguir alimentando.

Colabora en accioncontraelhambre.org o haz tu donación en:

Santander: ES57 0049 0001 5928 1009 0000

Caixabank: ES86 2100 2999 9302 0003 0018

BIZUM: Indicando el código de ONG 11250

Código QR:



SUMARIO

- **Asociación del estado nutricional infantil y la condición nutricia de la madre en una población rural - 2022**
Association between infant nutritional status and the maternal nutritional condition in a rural population - 2022
 Lizet Milagros HUAYLLANI FLORES, Roy Aris CABRERA OSORIO, Diego Christian MATOS KNUTZEN **13**
- **Factores asociados a masa muscular inadecuada evaluada por ecografía en pacientes quirúrgicos de un hospital peruano**
Factors associated with inadequate muscle mass assessed by ultrasound in patients in surgical patients of a Peruvian hospital
 Pedro J. RUÍZ-PÉREZ, Pedro GUERRA-BLASS, Julissa E. VENANCIO-HUERTA, Oscar Gustavo HUAMÁN-GUTIÉRREZ, Carlos J. TORO-HUAMANCHUMO **22**
- **The risk factors of sodium, potassium intake, and physical activity on hypertension in the elderly**
 Annisa YOLANDA, Fivi Melva DIANA, Putri Aulia ARZA **30**
- **A cross-sectional study on the relationship between intuitive eating, hedonic hunger and body mass index in university students**
 Gülin ÖZTÜRK ÖZKAN, Burcu ÇETINER..... **38**
- **Bebida helada de jengibre (*Zingiber officinale*) con miel de abeja**
Iced ginger beverage (*Zingiber officinale*) with bee honey
 Suannie Vanessa MENDOZA LUNA, Luis Humberto VÁSQUEZ CORTEZ, Edgar Rodolfo PINARGOTE MENDOZA, Sanyi Lorena RODRÍGUEZ CEVALLOS **46**
- **Relación entre marcadores inflamatorios y estado nutricional, en pacientes con Enfermedad de Alzheimer de inicio temprano (Antioquia-Colombia)**
Relationship between inflammatory markers and nutritional status in patients with early-onset Alzheimer's disease (Antioquia-Colombia)
 María Fernanda OSPINA CARDONA, Gloria Cecilia DEOSSA RESTREPO, Cristian SANTA, Mateo LONDOÑO PEREIRA, David Fernando AGUILLÓN NIÑO, Francisco LOPERA RESTREPO..... **54**
- **Body dissatisfaction and eating disorders in acrobatic gymnasts as a function of competition level**
 Alicia SALAS-MORILLAS, Águeda GUTIÉRREZ-SÁNCHEZ, Eva M^a PELÁEZ-BARRIOS, Mercedes VERNETTA-SANTANA **65**
- **Relación entre el perfil bioquímico, antropométrico y estilo de vida saludable del personal de una universidad privada: Gestión en la prevención de riesgo ocupacional**
Relationship between the biochemical and anthropometric profile and healthy lifestyle of the staff of a private university: Management of occupational risk prevention
 Ruth Ester MORENO-LEYVA, Roussel Dulio DAVILA-VILLAVICENCIO, Saulo Andrés SALINAS ARIAS, Antonio J. CASTELLANOS-VAZQUEZ, Jhan Arly SANCHEZ TARRILLO, Evaristo MANCHAY SEMBRERA, Nelly Rosario MORENO-LEYVA, Jacksaint SAINTILA **72**
- **Cáncer de cabeza y cuello: revisión del diagnóstico y tratamiento de la sarcopenia**
Review of the diagnosis and treatment of sarcopenia in patients with head and neck cancer
 Jon CACICEDO, Darío SÁNCHEZ CABRERO, Valeria ALCÁNTARA ARAGÓN, Tamara ROZA FERNÁNDEZ, Andrea MARTÍN AGUILAR, Laura CALLES ROMERO **80**
- **Comparación de los hábitos de vida de estudiantes de primer y cuarto curso del grado de enfermería de la Universidad del País Vasco**
Comparison of lifestyle habits among first and fourth year nursing students at the University of the Basque Country
 Jon ELORZA RODRÍGUEZ..... **90**

SUMARIO

- **Contagem total de linfócitos e sua relação com parâmetros clínicos e nutricionais em pacientes candidatos à cirurgias**
Total lymphocyte count and its relationship with clinical and nutritional parameters in patients undergoing surgical procedures
Mariana Gomes de LIMA, Raiza Zacarias COSTA, Julee Stephani Gomes ALVES, Stéfany Crislayne Rocha da SILVA, Janatar Stella Vasconcelos de Melo ME-MPOMO, Poliana Coelho CABRAL, Maria Izabel Siqueira de ANDRADE..... **99**
- **Efecto del consumo de la achira en polvo fortificado con hierro hemínico en el nivel de hemoglobina de niños menores de un año**
Effect of consuming achira powder fortified with heme iron on the hemoglobin level of children under one year of age
Rosseli Maritza CORONEL TEJADA, Xiomara Natalia CORDOVA TOMAYLLA, Luis Pavel PALOMINO QUISPE..... **106**
- **Correlação entre adiponectina e fatores relacionados ao risco de doença cardiovascular em idosos**
Correlation between adiponectin and factors related to the risk of cardiovascular disease in the elderly
Ana Carolina CAVALCANTE VIANA, Macileide da Silva BANDEIRA, Ana Patricia NOGUEIRA AGUIAR, Marcela MATOS MAGALHÃES DE AZEVEDO, Gustavo André BANDEIRA DO RÊGO BARROS, Lília Teixeira EUFRÁSIO LEITE, Anarah Suellen QUEIROZ CONSERVA VITORIANO, Thaise dos Santos ANDRADE, Moema de Souza SANTANA, Synara Cavalcante LOPES BRAGA, Priscila Taumaturgo HOLANDA MELO, Nathália BERNARDO MARINHO, Helen PINHEIRO, Sílvia Maria MEIRA MAGALHÃES, Priscila da Silva MENDONÇA **112**
- **Protein intake recommendation for stunted children: An-update review**
AI MUKHLAS FIKRI, Widya ASTUTI, Vieta Annisa NURHIDAYATI, Fajria Saliha PUSPITA PRAMESWARI, Nazrul HADI ISMAIL..... **117**
- **Effects of a family interdisciplinary intervention on food processing and the stage of eating behavior**
Çhange in overweight or obese adolescents
Ana Paula RIBEIRO GERALDI, Déborah Cristina de Souza MARQUES, Clara Camille SANABRIA MIRANDA, Daniel VICENTINI DE OLIVEIRA, Samuel RODRIGUES LOURENÇO DE MORAIS, Pablo VALDÉS-BADILLA, Isabelle ZANQUETA CARVALHO, Bráulio Henrique MAGNANI BRANCO..... **124**
- **Worldwide research on calorie restriction in aging. A bibliometric study**
Antonio Fernando MURILLO-CANCHO, David LOZANO-PANIAGUA, Francisco MANZANO-AGUGLIARO, Bruno José NIEVAS-SORIANO..... **131**
- **Effect of Nusantara diet feeding with triglyceride glucose index as a measure of insulin resistance in individuals' metabolic syndrome risk**
Rahma WIDIANA, Agussalim BUKHARI, AMINUDDIN, Nurpudji A TASLIM, Haerani RASYID, Yasmin SYAUKI..... **142**
- **Influencia de la dieta vegetariana en el microbioma intestinal humano**
Influence of the vegetarian diet on the human intestinal microbiome
Alejandro BORREGO RUIZ, Juan José BORREGO..... **149**
- **The relationship between water intake and progressivity**
Glomerular filtration rate of chronic kidney disease patients
MUNAQISAH, Haerani A RASYID, AMINUDDIN, Suryani AS'AD, Nurpudji A. TASLIM, Nur ASHARI..... **158**
- **Valoración del estado nutricional y sarcopenia en adultos con artritis reumatoide atendidos en consulta externa, Hospital Hipólito Unanue, Tacna - Perú, 2023**
Assessment of nutritional status and sarcopenia in adults with rheumatoid arthritis treated in outpatient clinic, Hospital Hipólito Unanue, Tacna - Peru, 2023
Cristina CONDORI CASTRO..... **167**
- **Development of an equation to estimate fat-free mass in mountain Guides and Porters**
Jorge TORRES-MEJÍAS, Evangelina RIVAROLA, Erick DIAZ, Gabriela SALAZAR, Daniela TORO, Felipe VILLEGAS, Rossana GÓMEZ, Marcos COSSIO, Miguel ÁNGEL-LÓPEZ, Eugenio MERELLANO-NAVARRO..... **174**

SUMARIO

- **Perfil nutricional e bioquímico de pacientes submetidos ao transplante renal**
Nutritional and biochemical profile of patients undergoing kidney transplant
Ana Carolina CAVALCANTE VIANA, Elissa Maria do Nascimento CARDOZO, Rikeciane BRANDÃO PEREIRA, Macileide da Silva BANDEIRA, Priscila Taumaturgo HOLANDA MELO, Nathália BERNARDO MARINHO, Thaise dos Santos ANDRADE, Helen PINHEIRO, Anarah Suellen Queiroz CONSERVA VITORIANO, Andressa Eslayne CALDAS SALES, Suellyne RODRIGUES DE MORAIS, Lília Teixeira Eufrásio LEITE, Marcela Matos MAGALHÃES DE AZEVEDO, Priscila da Silva MENDONÇA **181**
- **Consumo de calcio y su relación con la densidad mineral ósea en estudiantes que están cursando la carrera de Auxiliar de Enfermería. Loja (Ecuador)**
Calcium intake and its relationship with bone mineral density in students who are studying to become Nursing Assistants. Loja (Ecuador)
Marlene Elizabeth SÁNCHEZ MATA **187**
- **Gender difference in the relationship between metabolic syndrome and vitamin D in Korean adults with obesity**
Hyun HO SUNG, Mi YOUNG GI, Ju AE CHA, So YOUNG PARK, Cho HEE PARK, Sun GYU KIM, Eun SOOK HAN, Hyun YOON..... **194**
- **The relationship of physical activity with nutritional status and body composition in traditional and modern populations in South Sulawesi, Indonesia**
Wanty ARRUAN, Agussalim BUKHARI, Nevi Dwi HANDAYANI, Nurpudji A. TASLIM, Andi FARADILAH, AMINUDDIN..... **204**
- **Relationship between nutritional intake and the duration of mechanical ventilation use in critical patients**
Yunita Lidya ISTIQOMAH, Agussalim BUKHARI, Suryani AS'AD, Nurpudji A. TASLIM, Yasmin SYAUKI, Haerani RASYID, Tien Muliawati ABADI, HUSMIANI, JEFFERY, Desi Vera BUANA **212**
- **Higher mortality rate in postoperative icu patients is associated with combination of early enteral and parenteral nutrition**
Raymond LIEM, Nurpudji A TASLIM, A Yasmin SYAUKI, Yulia WULLUR, Rury L. SAPTARI, Suryani AS'AD, Agussalim BUKHARI, MARDIANA..... **220**
- **Identifying risk factors and recommending interventions to reduce stunting in Sigi Regency**
Nasrul NASRUL, Fahmi HAFID, T. Iskandar FAISAL, Taufiqurrahman TAUFIQURRAHMAN, Kadar RAMADHAN..... **227**
- **Modeling hidden hunger in toddlers to determine the most influential micronutrients in stunting**
Iseu Siti AISYAH, Ali KHOMSAN, Ikeu TANZIHA, Hadi RIYADI **235**
- **Effect of extra virgin olive oil on inflammatory markers and intestinal microbiota in chronic kidney disease patients**
Ruwiyatul ALIYAH, Nurpudji Astuti DAUD, Suryani AS'AD, Mely MARITA, Haerani RASYID, Agussalim BUKHARI, AMINUDDIN..... **244**
- **Neutrophil-Lymphocyte Ratio, prognostic nutritional index and CRP - Albumin Ratio significantly predict mortality in ICU patients with low nutrition risk**
Yulia WULLUR, Nurpudji A TASLIM, A Yasmin SYAUKI, Raymond LIEM, Rury L. SAPTARI, Haerani RASYID, AMINUDDIN, Andi FARADILAH..... **253**
- **The relationship between energy intake and infections in critical patients in intensive care unit (ICU) receiving medical nutrition therapy at Wahidin Sudirohusodo Hospital**
JEFFRY, Suryani AS'AD, Nurpudji A TASLIM, Desi VERA, HUSMIANI, Tien Muliawati ABADI, YUNITA, Agussalim BUKHARI, AMINUDDIN, Haerani RASYID **261**
- **Food security of farmer households in Central Lombok Regency**
Lalu Juntra UTAMA, Lalu Khairul ABDI, Lina YUNITA, Baiq Eka Putri SAUDIA, Kiki KRISTIANDI, Astuti NUR..... **268**

SUMARIO

- **Conocimientos y consumo de alimentos andinos en universitarios del Perú**
Knowledge and consumption of Andean foods in Peruvian university students
Gabriela VIDAL HUAMÁN, María SÁNCHEZ CHARCAPE, Miguel CASTRO MATTOS, Yuliana GOMEZ RUTTI.....**277**
- **Stability of liquid smoked nano-encapsulated on the foodborne pathogens and histamine-forming bacteria's growth in tuna loin sashimi**
Henry Adeleida DIEN, Roike Iwan MONTOLALU, Feny MENTANG, Siegfried BERHIMPON.....**286**
- **Effects of an interdisciplinary program to promote the health of overweight or obese adolescents on the consumption of inflammatory and anti-inflammatory foods**
Isabelle Zanqueta CARVALHO, Isabella Sartori Alvares ACETI, Déborah Cristina de Souza MARQUES, Braulio Henrique Magnani BRANCO, Paulo Leonardo Marotti SICILIANO, Isabela Cabral MARTINS, Ana Carolina Vieira COMAR.....**296**
- **Cambios en el índice de masa corporal según estado de madurez en adolescentes de una región de Chile durante un periodo de 20 años**
Changes in body mass index according to maturity status in adolescents from a region of Chile during a 20-year period
Fernando ALVEAR-VÁSQUEZ, José Francisco GUZMÁN-LUJAN, Ana Belén GUZMÁN, José FUENTES-LÓPEZ, Nicolás VIDAL-FERNÁNDEZ, Rossana GÓMEZ-CAMPOS, Marco COSSIO-BOLAÑOS**304**
- **Physical and chemical properties of instant porridge with added moringa leaf flour**
Zakaria ZAKARIA, Suriani RAUF, Sirajuddin SIRAJUDDIN, Andi SALIM, Bohari BOHARI**311**
- **Green algae *Caulerpa racemosa* inhibit proliferation and promote apoptosis in human HT-29 colon cancer by suppressing PI3K/AKT pathway**
Happy KURNIA PERMATASARI, Nurlinah AMALIA, Hikmawan WAHYU SULISTOMO, Kenty WANTRI ANITA, Husnul KHOTIMAH, Rudy KURNIAWAN, Fahrul NURKOLIS.....**317**
- **Índice de masa corporal y preeclampsia en embarazadas atendidas en un hospital público de Lima**
Body mass index and preeclampsia in pregnant women treated in a public hospital in Lima
Yonathan Josué ORTIZ MONTALVO, Geraldine Brenda GALARZA UBALDO, Melani Rossidel CAMPOS ZEVALLOS, Katherine Jenny ORTIZ ROMANÍ, Nancy Jenny CAMPOMANES CHULLUNCUY.....**325**
- **Estado nutricional materno, lactancia materna y desnutrición crónica en niños peruanos menores de 5 años**
Maternal nutritional status, breastfeeding and chronic malnutrition in peruvian children under 5 years
Yuliana Yessy GOMEZ RUTTI, Marco Alexi TABOADA GARCÍA, Isabel Margot ACEVEDO RIQUE, Janet del Rocio GORDILLO CORTAZA, Eduardo Edison VÉLEZ PILLCO, Yanina Teresa OCHOA MONTOYA, Walter Adalberto GONZÁLEZ GARCÍA**332**
- **Evolução do estado nutricional de pacientes com fibrose cística durante o acompanhamento ambulatorial**
Evolution of the nutritional status of patients with cystic fibrosis during outpatient
Nathalia Maria Cavalcanti DOS SANTOS, Marcela Do Rego Barros Carneiro MONTEIRO, Jaqueline Vasconcelos da Silva GUSMÃO, Derberson José do Nascimento MACÊDO.....**339**
- **Efecto de la capsicina en la conservación y características organolépticas de un embutido de cerdo**
Effect of capsaicin on the preservation and organoleptic characteristics of a pork sausage
Frank Guillermo INTRIAGO FLOR, Luis Humberto VÁSQUEZ CORTEZ, Víctor Javier ZAMBRANO PINARGOTE, Ángel Oliverio FERNÁNDEZ ESCOBAR, Jonathan Estuardo ORTIZ QUIJIJE, Sanyi Lorena RODRÍGUEZ CEVALLOS, Juan Carlos GÓMEZ VILLALVA, Alexander Fernando COBOS MUÑOZ**347**
- **Efecto de la chillangua (*Eryngium foetidum*) y varios niveles de soya (*Glycine max*) en polvo sobre las propiedades sensoriales y bromatológicas de discos de hamburguesas**
Effect of chillangua (*Eryngium foetidum*) and various levels of soy (*Glycine max*) powder on the sensory and bromatological properties of hamburger discs
Gilson ZAMBRANO ZAMBRANO, Vicente ALCÍVAR ZAMBRANO, Patricio MUÑOZ MURILLO**358**
- **Normas de publicación**.....**367**

Asociación del estado nutricional infantil y la condición nutricia de la madre en una población rural - 2022

Association between infant nutritional status and the maternal nutritional condition in a rural population - 2022

Lizet Milagros HUAYLLANI FLORES^{1,2}, Roy Aris CABRERA OSORIO^{1,2}, Diego Christian MATOS KNUTZEN³

1 Universidad Continental.

2 Sociedad Científica Médico Estudiantil Continental - SOCIMEC.

3 Universidad Peruana Los Andes.

Recibido: 30/enero/2024. Aceptado: 8/mayo/2024.

RESUMEN

Introducción: Los problemas nutricionales tienen un impacto significativo en la salud de millones de mujeres y niños, principalmente en comunidades empobrecidas de países en desarrollo. El deterioro del estado nutricional infantil no sólo afecta adversamente al desarrollo económico y social, sino que también contribuye a la perpetuación de la pobreza. El objetivo de este estudio fue determinar la asociación entre el estado nutricional infantil y la condición nutricia de la madre en la población rural de Concepción.

Materiales y métodos: Se realizó un estudio observacional, analítico de corte transversal. La variable "estado nutricional infantil" fue medido con el indicador peso para edad y la variable "Condición Nutricional de la madre" mediante el IMC. La recolección de datos se realizó en la comunidad de Concepción, ubicada en el departamento de Junín, durante el año 2022. En el análisis estadístico para la prueba de hipótesis utilizamos χ^2 y regresión logística como medida de asociación (OR).

Resultados: Se encontró que un 16.67% de los infantes tenían un inadecuado estado nutricional, así como solo el 47.06% de las madres se encontraban con IMC normal. Determinamos una asociación estadísticamente significativa entre el sobrepeso materno y el inadecuado estado nutricional

infantil (OR: 0.77 IC 0.64 – 0.92). Además el ingreso económico bajo tuvo asociación estadísticamente significativa a un mal estado nutricional del infante (OR: 1,17 IC 1,01 – 1,36).

Conclusiones: Las madres con "Sobrepeso" tuvieron una asociación significativa con los infantes que se encontraban en un "inadecuado estado nutricional". Además factores modificables como el nivel de ingresos económicos bajo, la lactancia materna exclusiva, el nivel educativo de la madre y la ocupación fueron también asociados a esta variable.

PALABRAS CLAVE

Crecimiento y desarrollo, lactancia materna, índice de masa corporal, peso para la edad.

ABSTRACT

Introduction: Nutritional problems have a significant impact on the health of millions of women and children, mainly in poor communities in developing countries. The deterioration of children's nutritional status not only adversely affects economic and social development, however this also contributes to the perpetuation of poverty. The objective of this study was to determine the association between infant nutritional status and the maternal nutritional condition in the rural population of Concepción.

Methodology: An observational, analytical cross-sectional study was carried out. The variable "children's nutritional status" was evaluated by weight for age index and the variable "maternal nutritional condition" with BMI. The data collection was carried out in the community of Concepción, located in

Correspondencia:

Lizet Milagros Huayllani Flores
milagros1hf@gmail.com

the department of Junín, during 2022. Statistical analysis we employed the chi-square statistical test logistic regression analysis to calculate association between variables (OR).

Results: 16.67% of the infants had an inadequate nutritional status and only 47.06% of the mother's had a normal BMI. A statistically significant association was found between maternal overweight and inadequate nutritional status (OR: 0.77 CI 0.64 - 0.92). Also poor economic status was associated with inadequate nutritional status (OR: 1,17 IC 1,01 – 1,36).

Conclusions: An association was found between maternal overweight and poor infant nutritional status. Also modifiable factors like a poor economic status, exclusive breast feeding, mother's instruction and mother's occupation were associated with this variable.

KEYWORDS

Growth and development, breast feeding, body mass index, weight for age.

LISTA DE ABREVIATURAS

CRED: Control de Crecimiento y Desarrollo.

PE: Peso para la edad.

IMC: índice de masa corporal.

LME: Lactancia Materna Exclusiva.

INTRODUCCIÓN

Los problemas nutricionales constituyen un desafío significativo para la salud de millones de mujeres y niños, especialmente en comunidades empobrecidas de países en desarrollo¹. Conforme a la información proporcionada por la Organización Mundial de la Salud (OMS), la población más vulnerable a estos desafíos son los niños menores de 5 años, quienes experimentan repercusiones en su desarrollo, con consecuencias notables a nivel económico, social y médico. A nivel global, se estima que 52 millones de niños sufren de emaciación, mientras que 41 millones presentan sobrepeso². El periodo comprendido entre el nacimiento y los primeros años de vida adquiere particular importancia en el contexto del crecimiento y desarrollo físico y mental del infante, así como en el establecimiento de fundamentos sólidos para la consecución de una vida saludable, productiva y útil en la edad adulta³. La presencia de un estado nutricional deficiente durante la infancia incide negativamente, contribuyendo de manera significativa a la perpetuación de la pobreza⁴.

En el año 2020, en el contexto peruano, se identificó una prevalencia del 12.1% de desnutrición crónica en la población infantil menor de cinco años. Dicha problemática manifestó disparidades significativas entre las áreas urbanas y rurales, afectando al 7.2% en el entorno urbano y registrando un 24.7% en las zonas rurales para este grupo etario. Desde una

perspectiva geográfica, los tres primeros departamentos que exhibieron las tasas más elevadas de desnutrición crónica fueron Huancavelica (31.5%), Loreto (25.2%) y Cajamarca (24.4%). Contrariamente, los departamentos con las tasas más reducidas de desnutrición fueron Tacna (1,9%), Moquegua (2,2%) y Lima Metropolitana (4,6%)⁵.

Las causas subyacentes del mal estado nutricional en la población infantil son diversas. En primer lugar, se destaca el consumo inadecuado de alimentos, caracterizado por un exceso de aporte de carbohidratos y una deficiencia de micronutrientes esenciales como hierro, vitamina A, calcio y yodo. En segundo lugar, las enfermedades infecciosas, como las diarreas, parasitosis e infecciones respiratorias agudas, representan una causa significativa que compromete la adecuada nutrición del organismo. Entre otras causas observadas, se identifica la lactancia materna insuficiente durante los primeros seis meses de vida, seguida de una alimentación posterior insuficiente o de baja calidad. Factores ambientales, como el acceso limitado al agua potable y la falta de saneamiento, también se asocian con el mal estado nutricional. Además, se señalan otros elementos contribuyentes, como la estructura familiar, la condición económica, el nivel educativo de los padres y el acceso a servicios de salud, todos los cuales desempeñan un papel crucial en la configuración del estado nutricional infantil^{6,7}.

En el 2017, se realizó un estudio que tuvo como objetivo documentar la prevalencia, coexistencia y correlatos del estado nutricional (retraso del crecimiento, sobrepeso / obesidad y anemia) en niños de 24 a 59 meses en una zona rural, de diseño transversal, donde se evidenció que la prevalencia de retraso de crecimiento moderado o severo fue 20,3%, sobrepeso/obesidad 16,1% y anemia 34,1%. El retraso de crecimiento en niñas fue significativamente menor que en los niños (OR: 0,41; IC 95% 0,21 – 0,79), el sobrepeso/ obesidad se agravia con un nivel socioeconómico familiar más alto y una ingesta menor de azúcar. Finalmente ninguna característica de la madre, niño o del hogar se asocia con más de uno de los resultados del estado nutricional, por lo que vemos que no hay ninguna afección en este grupo de edades⁶.

Otro estudio en Brasil examinó la relación entre el estado nutricional materno, la ingesta de alimentos y el estado nutricional de los niños. Los hallazgos revelan que la desnutrición materna y la ingesta insuficiente de alimentos se vinculan con una mayor prevalencia de retraso en el crecimiento infantil⁸.

Por último, el estudio "Nutritional health status: association of stunted and wasted children and their mothers" examina la relación entre la desnutrición infantil y la nutrición materna en países de bajos ingresos. Los resultados mostraron que existe una asociación significativa entre la desnutrición infantil y la malnutrición materna, lo que sugiere la importancia de abordar la nutrición materna para prevenir la malnutrición infantil⁹.

El objetivo del presente estudio fue determinar la asociación entre el estado nutricional infantil y la condición nutricia de la madre en la población rural de Concepción, Junín, Perú.

Mapear los factores que inciden en el estado nutricional deficiente y como consecuencia las deficiencias en la función cognitiva, problemas en el rendimiento escolar, y el desarrollo incorrecto y crecimiento del niño, resultará en un enfoque integral para abordar estas cuestiones. Este proceso contribuirá significativamente al diseño de intervenciones y la implementación de estrategias dirigidas a mejorar tanto el estado nutricional infantil como la condición nutricional de las madres, con la finalidad de reducir los costos asociados a la atención sanitaria⁴.

METODOLOGÍA

Diseño y población del estudio

Se realizó un estudio observacional, analítico de corte transversal, prospectivo, durante los meses de Agosto a Diciembre del 2022, en el consultorio de Crecimiento y desarrollo (CRED) del Centro de Salud David Guerrero Duarte – Concepción. La población estuvo constituida por lactantes de 0 a 36 meses y sus respectivas madres que acudieron al consultorio mencionado y residían en Concepción, ubicado en el departamento de Junín, Perú. El cálculo muestral se realizó mediante el programa OPENEPI, para estudios transversales, donde se asume un valor Alpha de 95%, con un poder estadístico de 80%, los otros dos valores se obtuvieron del estudio "Associations between maternal BMI, breastfeeding practices and infant anthropometric status in Colombia; secondary analysis of ENSIN 2010" con un porcentaje de No expuestos positivos de 13%, con un OR de 40⁸, donde se calcula un número total de muestra de 84 díadas (madres e hijos).

Instrumentos y Variables

La presente investigación se realizó mediante la evaluación a los pacientes que acudían a sus controles de CRED, a cuyas madres se les realizó una encuesta dirigida por el investigador, el instrumento que se utilizó fue la ficha de recolección de datos que comprendía tres secciones:

La sección 1 estuvo comprendida por los datos sociodemográficos del niño/a, donde se incluyeron las variables edad en meses del infante, sexo, peso al nacer, edad gestacional al nacer, Inmunizaciones completas y lactancia materna exclusiva (LME).

La sección 2 incluyó datos acerca del estado nutricional del infante, donde se midió las variables antropométricas de peso y talla, y se utilizó el indicador de Peso para la edad (PE) obteniendo 2 categorías como resultado; la primera PE normal que se denominó "adecuado estado nutricional" y PE con Desviación Estándar (DS) >2 y <2 el cual se denominó "Inadecuado estado nutricional"¹⁰.

La sección 3 estuvo comprendida con los datos sociodemográficos de la madre, tales como edad, grado de escolaridad, estado civil, ocupación.

La sección 4 evaluó la condición nutricional materna, para lo cual solo se recolectaron peso y talla materna, además se calculó el Índice de masa corporal (IMC) de la madre¹¹ y por último la sección 5 que incluyó datos sobre las características del hogar: Acceso a luz eléctrica, acceso a agua potable, acceso a desagüe y la cantidad de ingresos económicos que fue categorizada en 2 indicadores, la categoría E <1300 soles y categoría Mayor a D > 1300 soles, estratificado según IPSOS¹².

Recolección y ética

Se recolectó los datos en el Centro de Salud David Guerrero Duarte de Concepción, se entrevistó 114 madres con sus respectivos hijos, en el servicio de "Crecimiento y Desarrollo del niño", de los cuales se obtuvieron 12 fichas de recolección incompletas que fueron excluidas, por lo que se trabajó con una muestra total de 102 pacientes madres e hijos.

La participación fue voluntaria y se aplicaron dos consentimientos informados, el primero dirigido a la madre para el permiso de tomar sus datos y el segundo para el apoderado del menor, quien autoriza tomar la información de los datos del infante. Este estudio fue aprobado por el comité de ética de investigación de la Universidad Continental de Perú (Oficio N° 030-2021-VI-UC).

Análisis de datos

Los datos fueron recopilados durante el periodo comprendido entre agosto y diciembre del 2022. Posteriormente, se trasladaron a un documento de Microsoft Excel 2016, donde se llevó a cabo una limpieza exhaustiva de la base de datos, eliminando a aquellos participantes que no cumplían con los criterios de inclusión, así como fichas invalidadas o aquellas que carecían de las variables apropiadas relacionadas con el resultado de interés, es decir, el estado nutricional infantil. La base de datos depurada se exportó luego al software STATA V.15 para llevar a cabo el análisis estadístico correspondiente.

Para el análisis estadístico de las variables numéricas se utilizó la prueba Shapiro Wilk para determinar si las variables eran paramétricas o no, en el caso de las paramétricas se utilizó la media y desviación estándar, mientras que en las no paramétricas la mediana y rango intercuartílico (RI). Para las variables categóricas se utilizó frecuencias y porcentajes.

Para el análisis bivariado se usó Chi cuadrado, dicotomizando todas las variables (tabla N° 3).

La medida de asociación usada fue el *Odds Ratio* (OR), para lo cual se utilizó la regresión logística con las variables estadísticamente significativas ($p < 0,05$)

RESULTADOS

Se analizó una muestra total de 102 díadas madres – infantes con medidas antropométricas completas. Se obtuvo que el 51,96% de los infantes fueron del Sexo femenino, la mediana de la edad materna fue 28 años con un RI de 24 a 34, el estado civil de la madre más frecuente fue el de “con pareja” con un 76,47%, así como el grado de instrucción prevalente en las madres fue el de Secundaria Completa con un 48,04%, el 82,35% de las madres tenían un ingreso menor igual a 1300, lo que clasificaba en la “categoría E”, el 100% de la población tenía acceso a luz eléctrica y solo el 80,39% tenía acceso a desagüe (Tabla N°1).

Tabla N.º 1. Características sociodemográficas y económicas de los infantes (0-36 meses) y sus respectivas madres en el centro de Salud David Guerrero Duarte (n:102)

Variables	Valores
Edad del infante (meses)	11 +- 9,59*
Sexo del infante	
Femenino	53 (51,96%)*
Masculino	49 (48,04%)*
Edad de la madre	28 (24-34)**
Estado Civil materno	
Con Pareja	78(76,47%)*
Sin Pareja	24 (23,53%)*
Grado de Instrucción	
Primaria Completa	3(2,94%)*
Secundaria Completa	49(48,04%)*
Secundaria Incompleta	36(35,29%)*
Educación Superior	14(13,73%)*
Ocupación	
Ama de Casa	84(82,35%)*
Independiente	16(15,69%)*
Dependiente	2(1,96%)*
Ingresos económicos	
Categoría E (<1300)	84 (82,35%)*
Categoría D (>1300)	18 (17,65%)*
Acceso a luz eléctrica	102(100%)*
Acceso a agua potable	95(93,14%)*
Acceso a desagüe	82(80,39%)*

* M+- SD.

** Me (RIC).

*** Frecuencia (Porcentaje).

Acerca de las características propias de las madres y sus respectivos infantes se obtuvo que solo el 5,88% de la población infantil tuvo un bajo peso al nacer (< = 2500 gr), el 3,92% de bebés nació antes de las 37 semanas, el 97,06% tenía las inmunizaciones completas para la edad que les corresponde, el 97,06% de infantes recibió leche materna durante los 6 primeros meses y solo el 19,61% recibió alimentación con Fórmula complementaria. Acerca del estado nutricional de los infantes se obtuvo que 13 de ellos se encontraban en un rango de Desnutrición y 4 de ellos en Sobrepeso. Además en las madres se obtuvo que solo el 47,06% se encontraba en el rango “normal” en el IMC. (Tabla N°2).

Tabla N.º 2. Características maternas e infantiles de niños de (0 a 36 meses) en el centro de Salud David Guerrero Duarte 2022 (N:102)

Variables	Valores
Peso al nacer	
Bajo peso al nacer	6(5,88%)*
Normal	96(94,12%)*
Edad gestacional al nacer	
Pretérmino	4(3,92%)*
A término	98(96,04%)*
Inmunizaciones completas para la edad	99(97,06%)*
Lactancia Materna Exclusiva	99(97,06%)*
Lactancia con Fórmula Complementaria	20(19,61%)*
Talla del infante (m)	68,75 (58,3-78,6)**
Peso del infante (gr)	8383 (6340 – 10360)**
Estado Nutricional según Peso para la edad del infante	
Desnutrición	13 (12,75%)*
Normal	85 (83,33%)*
Sobrepeso	4 (3,92%)*
Talla Materna (m)	1,53 (1,43 – 1,65)**
Peso Materno (kg)	59,57 (45-82)**
IMC Materno	
Normal	48(47,06%)*
Sobrepeso	46(45,10%)*
Obesidad	8(7,84%)*

** Me (RIC).

*** Frecuencia (Porcentaje).

La tabla N°3 presenta un análisis de la variable Estado nutricional, que fue evaluado con el Peso para la edad y su clasificación respectiva en las tablas de valoración nutricional asociado a las características sociodemográficas, infantiles y maternas. Las variables que obtuvieron un valor p estadísticamente signifi-

ficativo fueron: Peso al nacer, edad gestacional, inmunizaciones completas para la edad que corresponde, LME, lactancia con fórmula maternizada complementaria y principalmente se encontró una relación estadísticamente significativa entre el estado nutricional del infante y el IMC de cada madre.

Tabla N.º 3. Estado Nutricional y características sociodemográficas, infantiles y maternas en el Centro de salud David Guerrero Duarte

Parámetros	Desnutrición	Normal	Sobrepeso	Valor p
Género				p=0,048
Femenino	9 (16,98%)	40 (75,47%)	4 (7,55%)	
Masculino	4 (8,16%)	45 (91,84%)	0(0%)	
Peso al nacer				P=0,003
Bajo Peso al Nacer	3 (50%)	2 (33,33%)	1(16,67%)	
Adecuado	10(10,42%)	83 (86,46%)	3(3,92%)	
Edad Gestacional				P=0,004
Pretérmino	2(50%)	1(25%)	1(25%)	
A término	11 (11,22%)	84 (85,71%)	3(3,06%)	
Inmunizaciones completas				P=0,003
NO	0 (0.0%)	3 (100%)	0 (0.0%)	
SI	13 (13,13%)	82 (82,83%)	4 (4,04%)	
Lactancia Materna Exclusiva				P=0,003
NO	0(0.0%)	3 (100%)	0 (0%)	
SI	13 (13,13%)	82 (82,83%)	4 (4,04%)	
Lactancia con Fórmula complementaria				P=0,003
NO	6 (7,32%)	73 (89,02%)	3 (3,66%)	
SI	7 (35%)	12 (60%)	1(5%)	
Índice de masa corporal				P=0,004
Normal	2(8%)	46(40%)		
Sobrepeso	3(1,3%)	5(6,7%)		
Obesidad				
Peso materno				P=0,120
45 – 60 Kg	5(7,81%)	57(89,06%)	2(3,13%)	
>60 Kg	8(21,05%)	28(73,68%)	2(5,26%)	
Talla materna				P=0,836
1.40 – 1.60	12 (12,77%)	78 (82,98%)	4(4,26%)	
1.61 – 1.80	1 (12,5%)	7(87,5%)	0(0%)	

Tabla N.º 3 continuación. Estado Nutricional y características sociodemográficas, infantiles y maternas en el Centro de salud David Guerrero Duarte

Parámetros	Desnutrición	Normal	Sobrepeso	Valor p
Estado Civil Materno				P=0,799
Sin Pareja	4(16,67%)	19(79,17%)	1 (4,17%)	
Con Pareja	9 (11,54%)	66 (84,62%)	3 (3,85%)	
Grado de Instrucción				P=0,977
Primaria Completa	0(0%)	3(100%)	0(0%)	
Secundaria Incompleta	5(13,89%)	41(83,67%)	2(4,08%)	
Secundaria Completa	6(12,24%)	30(83,33%)	1 (2,78%)	
Superior	3(2,3%)	11 (11,7%)	1(7,14%)	
Ocupación de la madre				P=0,134
Ama de casa	9 (10,71%)	73 (86,9%)	2 (2,38%)	
Independiente	4 (25%)	10(62,5%)	2(12,5%)	
Dependiente	0(0%)	2(100%)	0(0%)	
Ingresos Económicas				P=0,356
Categoría E	12(14,29%)	68 (80,95%)	4 (4,76%)	
Categoría D	1(5,56%)	17 (94,44%)	0(0%)	

La tabla N°4 presenta la regresión logística cruda y ajustada con el OR, para lo cual los indicadores de Estado nutricional: Desnutrición y Sobrepeso fueron consideradas como un Mal estado nutricional infantil, por lo que se encontró que en los Infantes de 0 a 36 meses, el ODDS de un Mal estado nutricional en el grupo que tiene las Inmunizaciones completas fue 18% menor con un IC 95% (0,76 – 0,91), además se encontró que las madres con sobrepeso tenían mayor asociación a un Mal estado nutricional (OR 0,77 IC95% 0,64 – 0,92), este resultado fue estadísticamente significativo.

DISCUSIÓN

En el transcurso de la presente investigación, se llevó a cabo un análisis exhaustivo para examinar la asociación entre el estado nutricional de los lactantes y la condición nutricional de sus madres, utilizando como variable principal el IMC materno. Los resultados revelaron una asociación estadísticamente significativa, específicamente en los infantes con un mal estado nutricional que fueron asociados a madres que tenían sobrepeso, este hallazgo coincide con investigaciones previas donde también se observó una asociación significativa entre el mal estado nutricional del infante y las madres con sobrepeso y obesidad^{13,14}. Esta asociación se mantiene signi-

ficativa en el análisis ajustado con las variables sociodemográficas y es debido a que las madres con sobrepeso tienen un efecto muy importante en la salud de los infantes incluso desde el embarazo, siendo el inadecuado estado nutricional un riesgo para la deficiencia de hierro y folato, predice mayor adiposidad y un mayor riesgo de resistencia a la insulina que repercute en la salud del infante desde la gestación¹⁴. Además la mala nutrición materna provoca una inadecuada disponibilidad de alimentos en cada uno de los hogares por lo que influye en la nutrición infantil¹³.

En nuestra muestra, se observa una prevalencia significativa de madres con sobrepeso, alcanzando un marcado 45,10%. Este fenómeno puede ser atribuido al contexto social y económico al que están expuestos tanto las madres como los infantes en nuestro país. Al abordar la evaluación de una población en una comunidad rural, resulta esencial considerar de manera rigurosa los factores determinantes a los que están expuestos, ya que mediante la prevención y el control de estos factores, se puede disminuir esta elevada prevalencia, influyendo en la mejora de la nutrición de nuestros infantes¹⁵.

En el presente estudio, se comparó la talla materna, el peso materno y su relación con el estado nutricional del in-

Tabla N.º 4. ERegresión logística de las variables sociodemográficas al estado nutricional infantil estado Nutricional y características sociodemográficas, infantiles y maternas en el Centro de salud David Guerrero Duarte

Estado nutricional infantil		
Inadecuado estado Nutricional		
Variables	OR crudo	OR ajustado
Peso al nacer		
Bajo Peso al Nacer	Referencia	
Adecuado	2,01 (0,84 – 4,77)	
Edad Gestacional		
Pretérmino	3,42 (0,62 – 18,91)	
A término	Referencia	
Inmunizaciones completas		
NO	Referencia	
SI	0,82 (0,76 – 0,91) *	0,84 (0,66 – 1,07)
Lactancia Materna Exclusiva		
NO	Referencia	
SI	0,82 (0,76 – 0,91) *	0,70 (0,43 - 1,14)
Lactancia con Fórmula complementaria		
NO	Referencia	
SI	0,67 (0,47– 0,97) *	0,68 (0,43 – 1,08)
Índice de masa corporal		
Normal	Referencia	
Sobrepeso	0,77 (0,64 – 0,92) *	0,82 (0,69-0,97) *
Obesidad	0,65 (0,37 – 1,12)	0,80 (0,52 – 1,25)
Edad Materna		
14 - 29	Referencia	
30 - 45	0,96 (0,82 – 1,15)	

Estado nutricional infantil		
Inadecuado estado Nutricional		
Variables	OR crudo	OR ajustado
Peso materno		
45 – 60 Kg	Referencia	
>60 Kg	0,83 (0,67 – 1,02)	
Talla materna		
1.40 – 1.60	Referencia	
1.61 – 1.80	1,05 (0,79 – 1,39)	
Estado Civil Materno		
Sin Pareja	Referencia	
Con Pareja	1,07 (0,85 – 1,34)	
Grado de Instrucción		
Primaria Completa	Referencia	
Secundaria Incompleta	0,83 (0,72 – 0,97) *	0,82 (0,65 – 1,04)
Secundaria Completa	0,84 (0,74 – 0,95) *	0,86 (0,70 – 1,05)
Superior	0,79 (0,59 – 1,03)	0,77 (0,52 – 1,14)
Ocupación de la madre		
Ama de casa	0,87 (0,79 – 0,94) *	0,83 (0,59 – 1,19)
Independiente	0,63 (0,43 – 0,92) *	0,69 (0,44 – 1,11)
Dependiente	Referencia	
Ingresos Económicas		
Categoría E	1,17 (1,01-1,36) *	1,17 (1,01 – 1,36)*
Categoría D	Referencia	

fante. Los resultados arrojaron un OR de 1,05 para la categoría de madres mayores de 60 kg, y un OR de 0,83 para la categoría de altura materna entre 1,61 a 1,80 metros respectivamente. No obstante, es importante señalar que estas asociaciones no alcanzaron significación estadística. Este hallazgo se alinea con los resultados del estudio "Asociaciones entre el IMC materno, las prácticas de lactancia materna y el estado antropométrico infantil en Colombia; análisis secun-

dario de la ENSIN 2010". donde la antropometría materna no predijo el riesgo de retraso de crecimiento en los infantes, sin embargo se conoce que existe una predisposición genética de la altura materna baja hacia el riesgo de retraso de crecimiento, lo cual evidencia significativamente sólo en algunas zonas estudiadas, concluyendo que más allá de la antropometría, el entorno es un factor importante para el riesgo de un déficit nutricional en el infante. Estos resultados respal-

dan la noción de que la relación entre la talla materna, el peso materno y el estado nutricional del infante puede ser compleja y multifacética, requiriendo una evaluación más detallada en futuras investigaciones^{13,16}.

Además, se examinó la variable de inmunizaciones completas según la edad correspondiente de cada infante en relación con un estado nutricional desfavorable, revelando un OR de 0,83, este hallazgo concuerda con estudios realizados con anterioridad donde se explica que las familias que cumplen con el esquema completo de vacunación proponen mejores alternativas de nutrición a los menores¹⁷, además el cumplir con el esquema de vacunación completa promueve el menor desarrollo de enfermedades infecciosas y otras patologías como la anemia que a futuro desarrollan trastornos de nutrición en el infante¹⁸. Por otro lado, se observó que los pacientes que recibieron LME durante los primeros 6 meses de vida mostraron una asociación estadísticamente significativa con el estado nutricional. Estos resultados resaltan los beneficios sustanciales asociados con la LME y su impacto positivo en el estado nutricional infantil¹⁹, sin embargo se debe de considerar que la población rural podría estar propensa a ofrecer respuestas más reservadas y menos sinceras, generando así un sesgo de información. Este fenómeno se alinea con hallazgos de estudios previos realizados en contextos similares, como el estudio llevado a cabo en Ecuador²⁰. Este sesgo potencial podría ser atribuible a diversos factores, incluyendo aspectos culturales, el entorno social y la percepción de la confiabilidad en las comunidades rurales.

Además, se identificó una asociación estadísticamente significativa entre el uso de fórmula maternizada y el inadecuado estado nutricional del infante. Este resultado guarda similitud con el estudio de Hawking²¹, quien sugiere que la LME y el uso de fórmula complementaria después del cuarto mes constituyen un factor protector ante el desarrollo de obesidad en los niños. Sin embargo, contrasta con el estudio de Sandoval et al, que no observó asociación entre ambas variables, una disparidad que podría ser atribuible al tipo de población entrevistada²². Es relevante destacar que, dada la homogeneidad socioeconómica de nuestra población, caracterizada por un nivel medio a bajo, los padres podrían encontrarse limitados en la capacidad de ofrecer alternativas nutricionales más adecuadas durante la lactancia a sus infantes. Esta consideración contextual brinda una perspectiva valiosa para interpretar la asociación encontrada entre el uso de fórmula maternizada y el estado nutricional de los infantes en nuestra población específica.

En relación a la variable de Grado de instrucción, se encontró que haber completado la secundaria tiene un impacto significativo, con un 16% menos de probabilidad de asociarse con un estado nutricional infantil inadecuado. Este resultado es consistente con un estudio previo que identificó una asociación entre la falta de educación formal y un estado nutricional desfavorable (OR: 0,31); sin embargo, en dicho estu-

dio, la asociación no alcanzó significancia estadística²³. Además, se observará que las madres cuya ocupación implica trabajar de manera dependiente están asociadas con un 15% mayor de probabilidad de que el estado nutricional de sus hijos sea inadecuado. Este hallazgo podría explicarse por la menor disponibilidad de tiempo para dedicarse al cuidado y la nutrición de los infantes, en comparación con aquellas madres cuyas ocupaciones les permiten permanecer en casa durante más horas. Este resultado se alinea con un estudio realizado por Bose et al, que indica que las madres con empleos que brindan un mayor salario aumentan las probabilidades de tener un hijo menor de 5 años con bajo peso para la edad²⁴.

En relación a los ingresos económicos, es relevante señalar que en nuestra población ninguna familia tuvo ingresos superiores a 2000 soles. Se observó que las familias con ingresos inferiores a 1300 soles presentaron un incremento del 17% en la probabilidad de desarrollar un estado nutricional inadecuado. Este hallazgo respalda la noción de que mayores ingresos económicos están asociados con mejores opciones alimenticias para los infantes. En la regresión múltiple, esta variable también mantuvo su significancia estadística. Estos resultados concuerdan con la investigación realizada por L. Álvarez et al, donde se indica que la desnutrición infantil está estrechamente vinculada con la pobreza y la falta de recursos económicos. La limitación en el acceso a alimentos nutritivos puede conducir a una nutrición desequilibrada y deficiente en nutrientes esenciales. Este enfoque subraya la importancia de considerar los factores económicos al abordar las causas de los desafíos nutricionales en la población infantil²⁵.

CONCLUSIONES

La importancia de determinar una relación entre el estado nutricional infantil y materno cobra un importante papel en la salud pública. En el presente estudio encontramos que las madres con "Sobrepeso" tuvieron una asociación significativa con los infantes que se encontraban en un "inadecuado estado nutricional". Además otros factores como el nivel de ingresos económicos bajo, la lactancia materna exclusiva, el nivel educativo de la madre y la ocupación fueron asociados al inadecuado estado nutricional de los infantes. Siendo estos factores modificables en la prevención y promoción de la salud, por lo que mediante la presente investigación promovemos la implementación de nuevas políticas de salud para prevenir una mala nutrición en los infantes y madres de nuestro país.

REFERENCIAS BIBLIOGRÁFICAS

- Restrepo Mesa SL, Parra Sossa BE. Implicaciones del estado nutricional materno en el peso al nacer del neonato. *Perspect En Nutr Humana*. diciembre de 2009;11(2):179-86.
- OMS. Malnutrición [Internet]. [citado 9 de mayo de 2023]. Disponible en: <https://www.who.int/es/news-room/fact-sheets/detail/malnutrition>

3. Hernán Daza, M.D. C. Malnutrición de micronutrientes. Estrategias de prevención y control [Internet]. [citado 11 de noviembre de 2022]. Disponible en: <https://colombiamedica.univalle.edu.co/index.php/comedica/article/view/189/192>
4. Calixto RP. Pan American Health Organization / World Health Organization. 2018 [citado 28 de noviembre de 2021]. OPS/OMS Perú - Nutrición | OPS/OMS. Disponible en: https://www3.paho.org/per/index.php?option=com_content&view=article&id=4111:nutricion&Itemid=1062
5. INEI. El 12,1% de la población menor de cinco años de edad del país sufrió desnutrición crónica en el año 2020 [Internet]. 2021 [citado 28 de noviembre de 2021]. Disponible en: <https://www.inei.gob.pe/prensa/noticias/el-12-1-de-la-poblacion-menor-de-cinco-anos-de-edad-del-pais-sufrio-desnutricion-cronica-en-el-ano-2020-12838/>
6. Choy CC, Desai MM, Park JJ, Frame EA, Thompson AA, Naseri T, et al. Child, maternal and household-level correlates of nutritional status: a cross-sectional study among young Samoan children. *Public Health Nutr.* mayo de 2017;20(7):1235-47.
7. Proaño D. Fundación de Waal. 2021 [citado 6 de abril de 2023]. Desnutrición Crónica Infantil. Disponible en: <https://fundacionde-waal.org/index.php/2021/10/07/una-cruzada-por-combatir-la-dci-en-ecuador/>
8. Felisbino-Mendes MS, Villamor E, Velasquez-Melendez G. Association of Maternal and Child Nutritional Status in Brazil: A Population Based Cross-Sectional Study. *PLoS ONE.* 24 de enero de 2014;9(1):e87486.
9. Khadija U, Mahmood S, Ainee A, Quddoos MY, Ahmad H, Khadija A, et al. Nutritional health status: association of stunted and wasted children and their mothers. *BMC Pediatr.* 6 de mayo de 2022;22:255.
10. Ministerio de Salud. Norma técnica de salud para el control de crecimiento y desarrollo de la niña y el niño menor de cinco años. 2011.
11. Ministerio de Salud. Guía técnica para la valoración nutricional antropométrico de la persona adulta. 2012.
12. IPSOS. Características de los niveles socioeconómicos en el Perú [Internet]. [citado 29 de noviembre de 2021]. Disponible en: <https://www.ipsos.com/es-pe/caracteristicas-de-los-niveles-socioeconomicos-en-el-peru>
13. Aldana-Parra F, Vega GO, Fewtrell M. Associations between maternal BMI, breastfeeding practices and infant anthropometric status in Colombia; secondary analysis of ENSIN 2010. *BMC Public Health.* 14 de febrero de 2020;20:232.
14. Bhowmik B, Siddique T, Majumder A, Mdala I, Hossain IA, Hassan Z, et al. Maternal BMI and nutritional status in early pregnancy and its impact on neonatal outcomes at birth in Bangladesh. *BMC Pregnancy Childbirth.* 11 de noviembre de 2019;19:413.
15. Baldarrago E. La educación de la madre como determinante de la salud del niño: evidencia para el Perú en base a la ENDES. CIES [Internet]. 2009 [citado 2 de mayo de 2023]; Disponible en: <https://EconPapers.repec.org/RePEc:bbj:invicie:146>
16. Hernández-Díaz S, Peterson KE, Dixit S, Hernández B, Parra S, Barquera S, et al. Association of maternal short stature with stunting in Mexican children: common genes vs common environment. *Eur J Clin Nutr.* diciembre de 1999;53(12):938-45.
17. Arias M, Tarazona MC, Lamus F, Granados C. Estado nutricional y determinantes sociales asociados en niños Arhuacos menores de 5 años de edad. *Rev Salud Pública.* agosto de 2013;15:613-25.
18. Yepez HC. Asociación entre vacunación completa y anemia en niños menores de 5 años del Perú, en los años 2019 a 2021. *Nutr Clínica Dietética Hosp* [Internet]. 31 de julio de 2023 [citado 18 de diciembre de 2023];43(3). Disponible en: <https://revista.nutricion.org/index.php/ncdh/article/view/393>
19. Flores Ramirez ME, Solano Auccapoma CJ. Guía técnica para la consejería en lactancia materna. 2017.
20. Romero Viamonte K, Salvant Tames A, Almarales Romero MA. Lactancia materna y desnutrición en niños de 0 a 6 meses. *Rev Cuba Med Mil.* diciembre de 2018;47(4):0-0.
21. Hawkins SS, Cole TJ, Law C. An ecological systems approach to examining risk factors for early childhood overweight: findings from the UK Millennium Cohort Study. *J Epidemiol Community Health.* febrero de 2009;63(2):147-55.
22. Jurado LS, Báez MVJ, Juárez SO, Olvera T de la C. Lactancia materna, alimentación complementaria y el riesgo de obesidad infantil. *Aten Primaria.* noviembre de 2016;48(9):572.
23. Appoh LY, Krekling S. Maternal nutritional knowledge and child nutritional status in the Volta Region of Ghana. *Matern Child Nutr.* 17 de marzo de 2005;1(2):100-10.
24. Cunningham K, Ruel M, Ferguson E, Uauy R. Women's empowerment and child nutritional status in South Asia: a synthesis of the literature. *Matern Child Nutr.* 22 de mayo de 2014;11(1):1-19.
25. Ortega LGA. Desnutrición infantil, una mirada desde diversos factores. *Investig Valdizana.* 8 de marzo de 2019;13(1):15-26.

Factores asociados a masa muscular inadecuada evaluada por ecografía en pacientes quirúrgicos de un hospital peruano

Factors associated with inadequate muscle mass assessed by ultrasound in patients in surgical patients of a Peruvian hospital

Pedro J. RUÍZ-PÉREZ^{1,2}, Pedro GUERRA-BLASS², Julissa E. VENANCIO-HUERTA³, Oscar Gustavo HUAMÁN-GUTIÉRREZ¹, Carlos J. TORO-HUAMANCHUMO^{4,5}

1 Facultad de Medicina, Universidad Nacional Mayor de San Marcos, Lima, Perú.

2 Hospital Lima Este Vitarte, Lima, Perú.

3 Facultad de Ciencias e Ingeniería, Universidad Peruana Cayetano Heredia, Lima, Perú.

4 OBEMET Centro de Obesidad y Salud Metabólica, Lima, Perú.

5 Unidad de Investigación para la Generación y Síntesis de Evidencias en Salud, Universidad San Ignacio de Loyola, Lima, Perú.

Recibido: 26/marzo/2024. Aceptado: 27/mayo/2024.

RESUMEN

Introducción: La desnutrición es un problema prevalente en pacientes hospitalizados, afectando hasta el 50% de esta población en Perú, y está vinculada a varios factores, incluyendo alteraciones gastrointestinales, comorbilidades, y estancias hospitalarias prolongadas. La ecografía emerge como una herramienta prometedora para evaluar la masa muscular, superando las limitaciones de métodos convencionales.

Objetivo: Evaluar los factores asociados a la masa muscular inadecuada (MMI), evaluada por ecografía en pacientes adultos atendidos por el Servicio de Cirugía de un hospital peruano.

Métodos: Se realizó un estudio transversal analítico. Se midió por ecografía el grosor del músculo cuádriceps femoral, considerándose MMI a los valores menores a la referencia. Los factores evaluados fueron edad, sexo, estado nutricional, diagnóstico de ingreso, tiempo de enfermedad, comorbilidades, síntomas gastrointestinales, riesgo de desnutrición, anemia y linfopenia. Se calcularon las razones de prevalencia crudas (RP) y ajustadas (RPa), con sus respectivos intervalos de confianza al 95%.

Resultados: De los 126 pacientes, el 55,6% presentó MMI. La edad ≥ 60 años (RPa: 1,44; IC95%: 1,09 – 1,91; $p=0,011$) y un mayor tiempo de enfermedad (RPa: 1,02; IC95%: 1,01 – 1,03; $p=0,034$) se asociaron significativamente con MMI. El sobrepeso y la obesidad mostraron una menor prevalencia de MMI (RPa: 0,62; IC95%: 0,44 – 0,89; $p=0,009$), pero la interacción entre sobrepeso/obesidad y comorbilidad cardiometabólica fue significativa, indicando un riesgo incrementado de MMI en esta población.

Conclusión: La edad avanzada, un prolongado tiempo de enfermedad, y la presencia de comorbilidades cardiometabólicas en pacientes con sobrepeso y obesidad, fueron los principales factores asociados con la MMI.

PALABRAS CLAVE

Grosor muscular; Ecografía; Tejido muscular; Factores de riesgo; músculo cuádriceps (DeCS-Bireme).

ABSTRACT

Introduction: Malnutrition is a prevalent issue in hospitalized patients, affecting up to 50% of this population in Peru, and is linked to various factors, including gastrointestinal alterations, comorbidities, and prolonged hospital stays. Ultrasound has emerged as a promising tool for evaluating muscle mass, overcoming the limitations of conventional methods.

Correspondencia:

Pedro J. Ruíz-Pérez
perumed90@gmail.com

Objective: To assess the factors associated with inadequate muscle mass (IMM), evaluated by ultrasound in adult patients treated by the Surgery Service of a Peruvian hospital.

Methods: A cross-sectional analytical study was conducted. The thickness of the femoral quadriceps muscle was measured by ultrasound, with IMM considered for values below the reference. Evaluated factors included age, sex, nutritional status, admission diagnosis, illness duration, comorbidities, gastrointestinal symptoms, risk of malnutrition, anemia, and lymphopenia. Crude prevalence ratios (cPR) and adjusted prevalence ratios (aPR) were calculated, along with their respective 95% confidence intervals.

Results: Out of 126 patients, 55,6% presented with IMM. Age ≥ 60 years (aPR: 1,44; 95% CI: 1,09 – 1,91; $p=0,011$) and a longer duration of illness (aPR: 1,02; 95% CI: 1,01 – 1,03; $p=0,034$) were significantly associated with IMM. Overweight and obesity showed a lower prevalence of IMM (aPR: 0,62; 95% CI: 0,44 – 0,89; $p=0,009$), but the interaction between overweight/obesity and cardiometabolic comorbidity was significant, indicating an increased risk of IMM in this population.

Conclusion: Advanced age, prolonged illness duration, and the presence of cardiometabolic comorbidities in overweight and obese patients, were the main factors associated with IMM.

KEY WORDS

Muscle Thickness; Ultrasound; Muscles; Risk factors; Muscle quadriceps (DeCS-Bireme).

INTRODUCCIÓN

La desnutrición representa un problema significativo de salud pública, con una prevalencia global igual o superior al 50% en pacientes hospitalizados, tendencia que se replica en las instituciones de salud peruanas lo que sugiere un deterioro del estado nutricional durante la hospitalización¹. Este deterioro está asociado a factores como alteraciones gastrointestinales, comorbilidades, neoplasias, falta de evaluación nutricional, estancias prolongadas e inmovilización, especialmente en pacientes quirúrgicos y críticos^{2,3}. Es importante considerar la sobrecarga de mediadores proinflamatorios en pacientes con enfermedades agudas, los cuales promueven una liberación de glucocorticoides y catecolaminas, desencadenando hipercatabolismo muscular y resistencia anabólica⁴.

En pacientes hospitalizados se ha observado una variabilidad muscular significativa durante los primeros días de hospitalización^{2,4} es fundamental preservar la masa y función muscular para asegurar una respuesta inmune humoral adecuada y prevenir el deterioro de la respuesta local en mucosas y la susceptibilidad a infecciones entéricas y respiratorias, aspecto fundamental en pacientes quirúrgicos⁵.

Dada la inespecificidad y las limitaciones de los métodos convencionales para evaluar la masa muscular⁶, la ecografía ha surgido como una alternativa prometedora. Esta técnica ofrece excelente reproducibilidad y es inocua, ideal para la evaluación, monitorización y seguimiento seriado de la masa y fuerza muscular tanto en distintos pacientes⁷⁻¹⁰. Su correlación con la masa corporal magra ha sido confirmada al evaluar el grosor de varios grupos musculares¹¹⁻¹⁴, y se ha documentado su uso como alternativa a estudios como la resonancia magnética¹⁵ y la tomografía computarizada¹⁶.

Por lo mencionado anteriormente, el presente estudio tuvo como objetivo evaluar los factores asociados a la masa muscular inadecuada evaluada por ecografía en pacientes adultos atendidos por el Servicio de Cirugía de un hospital peruano.

MATERIALES Y MÉTODOS

Diseño de estudio y contexto: Estudio transversal analítico, realizado en pacientes atendidos en el Hospital Lima Este Vitarte. Este hospital, ubicado en el distrito de Ate al este de la ciudad de Lima, Perú, es una institución con atención de emergencia y servicios especializados, categoría II-2 con un total de 156 camas.

Población de estudio: La población estuvo constituida por los pacientes hospitalizados en el Servicio de Cirugía durante el período abril – junio 2022. Criterios de inclusión: pacientes de 18 años o más, de ambos sexos, que hayan firmado el consentimiento informado y que hayan sido admitidos por Emergencia. Criterios de exclusión: pacientes con enfermedades musculares previamente diagnosticadas (parálisis, amputaciones, otros), gestantes o puérperas.

Se consideró un muestreo no probabilístico, de casos consecutivos, con evaluación de pacientes durante el periodo de estudio. El tamaño de muestra alcanzado fue de 126 pacientes.

Variables evaluadas: Se determinó como variable dependiente la masa muscular inadecuada (MMI), definida como los valores de grosor de cuádriceps femoral por debajo de puntos de corte establecidos. Para la evaluación muscular por ecografía, se elaboró un protocolo utilizando las recomendaciones de Carámbula y col.¹¹ y la metodología de Fischer y col.¹² Para considerar una adecuada masa muscular por ecografía se utilizaron los valores mayores o iguales a 4,16cm y 3,64cm, para varones y mujeres respectivamente, según lo descrito por Arts I. et al.¹⁷.

Se determinaron como variables independientes: edad (en años), sexo (masculino/femenino), diagnóstico de ingreso (según CIE10), comorbilidad cardiometabólica (si/no), tiempo de enfermedad (días), trastorno gastrointestinal (si/no), riesgo nutricional medido con el Nutritional Risk Score-2002 (si/no), índice de masa corporal (en kg/m² y categorizado según la Guía técnica para la valoración nutricional antropométrica).

trica de la persona adulta – Perú¹⁸), nivel de hemoglobina (g/dL) y nivel de linfocitos (unidades/uL).

Procedimientos: Para la recolección de información se utilizó una ficha de datos, registrándose los valores correspondientes a las variables. Toda la información se obtuvo del registro físico/digital correspondiente a las primeras 24 horas desde la admisión a la emergencia.

El protocolo de ecografía muscular para músculo cuádriceps femoral consistió en lo siguiente: se marcó el punto medio entre el trocánter mayor y la línea articular de la rodilla, con el miembro extendido y relajado. Posteriormente, se colocó el transductor lineal en sentido transversal y perpendicular a la piel, en la cara anterior a nivel del punto marcado previamente. Se midió el máximo espesor (grosor) entre la interfase grasa-músculo y el fémur (incluidos rectos femorales anterior y vasto intermedio).

Las mediciones se realizaron por un único observador, dentro de las 24 horas desde la admisión a la emergencia. Se utilizó un transductor lineal portátil inalámbrico marca Konted modelo C10T, con una frecuencia de 10MHz, modo B. Para minimizar la variabilidad, se registró la media de las mediciones (en cm) realizadas en los miembros dominantes, con el paciente en posición decúbito supino y con cabecera 30 grados.

Análisis estadístico: Los datos recolectados se digitaron en una hoja de cálculo de Microsoft Excel, siguiendo un sistema de doble digitación independiente, y se realizó un cruce de bases para la detección de valores no plausibles y/o faltantes. Los datos codificados fueron analizados utilizando el paquete estadístico Stata v17.0 (StataCorp, TX, USA).

Para el análisis descriptivo univariado, las variables numéricas se presentaron con las medidas de tendencia central y dispersión más adecuadas de acuerdo con su tipo de distribución; las variables categóricas se presentaron con frecuencias relativas y absolutas. Se realizaron análisis bivariados tanto para el desenlace primario como para cada componente individual. Se usó el test de Chi2 o Fisher cuando el cruce fue con una variable categórica y dependiendo de la cantidad de valores esperados menores o iguales a 5. Cuando el cruce fue con una variable numérica, se usó la T de Student o la U de Mann Whitney, dependiendo de si se cumplía o no el supuesto de normalidad.

Para evaluar los factores asociados con la masa muscular inadecuada (desenlace compuesto), se calcularon las razones de prevalencia crudas (RP) y ajustadas (RPa) a través de modelos lineales generalizados de familia Poisson, función de enlace logarítmico y varianzas robustas. El cumplimiento del supuesto de linealidad se evaluó con los gráficos de los residuales de Anscombe, evidenciando que solo se cumplió para la variable de tiempo de enfermedad. Frente a esto, se decidió categorizar las siguientes variables, siguiendo un criterio clínico y/o epidemiológico: 1) la variable hemoglobina se categorizó como anemia

(sí y no), siguiendo los puntos de corte para cada sexo (<13g/dL en varones/ <12g/dL en mujeres)(19), 2) la variable índice de masa corporal (IMC) se categorizó en "Bajo peso/Normal" y "Sobrepeso/Obesidad". Se decidió colapsar la categoría de bajo peso con normal, debido a que la primera solo tenía un caso; 3) la variable edad se dicotomizó en ≥ 60 años y <60 años, considerando que a partir de esta edad la masa muscular disminuye de manera más significativa^{20,21}; 4) la variable linfocitos se categorizó como linfopenia (sí y no), usando como punto de corte menor a 1500 unidades/uL²². Para construir el modelo ajustado, ingresaron todas las variables que resultaron significativas en el modelo crudo. Se evaluó además la interacción entre las variables comorbilidad cardiometabólica e índice de masa corporal categorizado, resultando estadísticamente significativo. Se calcularon y graficaron los efectos marginales para las categorías de ambas variables, para una mejor interpretación de este resultado.

Se presentaron dos modelos ajustados, uno sin interacción y otro con la interacción. Todos los estimados se presentaron con sus respectivos intervalos de confianza al 95% y los valores $p < 0.05$ se consideraron como significativos.

Aspectos éticos: El presente estudio fue aprobado por el Comité de Investigación del Hospital Emergencia Ate Vitarte y el Comité de Ética de la Clínica Avendaño. Durante su ejecución, se obtuvieron los consentimientos informados de los participantes, respetándose la aceptación o denegación voluntaria del estudio.

RESULTADOS

Características generales de la población de estudio

Se evaluaron 126 pacientes que cumplieron los criterios de selección. La media de edad fue $42,7 \pm 12$ años y el 61,1% fue de sexo femenino. La media de ecografía del cuádriceps femoral fue de $3,9 \pm 0,9$ cm y la prevalencia de masa muscular inadecuada fue de 55,6% (Tabla 1).

Características de la población según masa muscular inadecuada

La media de edad ($p=0,002$), la mediana de estancia hospitalaria ($p=0,009$) y la mediana de tiempo de enfermedad ($p=0,015$) fueron significativamente mayores en las personas con masa muscular inadecuada. Contrariamente, la media de índice de masa corporal fue significativamente menor en las personas con masa muscular inadecuada ($p=0,046$) (Tabla 2).

Factores asociados a masa muscular inadecuada

En el modelo ajustado sin la interacción, se evidencia que el tener ≥ 60 años (RPa: 1,44; IC95%: 1,09 – 1,91; $p=0,011$) y el tiempo de enfermedad se asociaron a una mayor preva-

Tabla 1. Características generales de la población de estudio (n=126)

Características	n (%)
Edad*	42.7 ± 16.0
Sexo	
Masculino	77 (61.1)
Femenino	49 (38.9)
Comorbilidades	
Sí	25 (19.8)
No	101 (80.2)
Estancia hospitalaria (días)**	4 [2 - 6]
Tiempo de enfermedad (días)**	2 [1 - 5]
Trastorno gastrointestinal	
Sí	89 (70.6)
No	37 (29.4)
Riesgo de desnutrición	
Sí	90 (71.4)
No	36 (28.6)
IMC (kg/m ²)*	27.3 ± 4.6
Hemoglobina (g/dL)*	13.2 ± 1.9
Linfocitos*	1372.3 ± 840.8
Ecografía de cuádriceps	3.9 ± 0.9
MMI	
Sí	70 (55.6)
No	56 (44.4)

* Media ± desviación estándar.

** Mediana [p25 - +75].

IMC: índice de masa corporal, MMI: masa muscular inadecuada.

lencia de masa muscular inadecuada (MMI) (RPa: 1,02; IC95%: 1,01 – 1,91; p=0,034). En el modelo con interacción, se mantuvo la asociación para edad (RPa: 1,42; IC95%: 1,07 – 1,87; p=0,014) y el tiempo de enfermedad (RPa: 1,03; IC95%: 1,01 – 1,04; p=0,034). Se evidenció también que el sobrepeso y obesidad se asoció a una menor prevalencia de MMI (RPa: 0,62; IC95%: 0,44 – 0,89; p=0,009) y la interacción resultó significativa (Tabla 3). En el gráfico de efectos marginales (Figura 1), se evidenció que, a medida que la co-

morbilidad cambia de 0 (ausencia) a 1 (presencia), las líneas se cruzan. Esto indica que la relación entre índice de masa corporal y MMI cambia dependiendo de la presencia de comorbilidad. En presencia de comorbilidad, el riesgo de MMI aumenta en el grupo de sobrepeso-obesidad y disminuye en el grupo de bajo peso-normal.

DISCUSIÓN

La prevalencia de masa muscular inadecuada medida por ecografía del grosor del músculo cuádriceps femoral fue superior al 50%, una cifra mayor a la reportada por otros estudios que emplearon métodos distintos de medición²³, los cuáles muchas veces son inaccesibles, costosos o poco fiables. Sin embargo, las cifras de prevalencia fueron similares a las reportadas en pacientes quirúrgicos^{2,4}, en pacientes oncológicos⁸ y adultos^{9,13}, cuando se utilizó ecografía muscular. En contexto, la ecografía surge como una herramienta con buena reproducibilidad interobservador, útil para obtener información sobre la morfología y morfometría muscular^{7,15}.

Edad y masa muscular inadecuada

Encontramos que la edad igual o mayor a 60 años incrementó la probabilidad de masa muscular inadecuada, similar a lo reportado por Huang y col.⁴. Esto se relaciona con la pérdida de masa muscular en pacientes adultos mayores debido a la centralización de la grasa visceral-muscular y un descondicionamiento debido a la infiltración adiposa intramuscular²¹. La evidencia reporta una disminución de hasta 1% por año del área de sección muscular, a partir de los 70 años, y una disminución de la calidad, fuerza y potencia muscular²⁴, relacionados a factores como la disminución de la actividad física e influencia de comorbilidades⁴.

Tiempo de enfermedad y masa muscular inadecuada

Un mayor tiempo de enfermedad se asoció a una mayor prevalencia de masa muscular inadecuada. Esta situación podría ocasionarse por el catabolismo de estrés, la subalimentación y la inactividad física prolongada^{5,21}, lo cual genera una temprana, rápida y transitoria degradación muscular durante los primeros 5 días de enfermedad^{2,4}. La evidencia demostró un mayor desgaste en los músculos de los miembros inferiores, principalmente músculos posturales antigravedad (entre ellos cuádriceps femoral), probablemente debido una menor respuesta a la falta de estímulos de resistencia física y una disminución rápida y progresiva de la síntesis de miofibrillas, debido a su alto contenido en fibras musculares rápidas^{25,26}.

Índice de masa corporal, comorbilidad cardiometabólica y masa muscular inadecuada

Sabemos que el sobrepeso y la obesidad se asocian a trastornos como la hipertensión arterial y problemas cardiorrena-

Tabla 2. Características de la población a la Masa Muscular Inadecuada (MMI) (n = 126)

Características	Masa Muscular Inadecuada (MMI)		p
	Adecuada (n=56)	Inadecuada (n=70)	
Edad*	37.8 ± 13.2	46.7 ± 17.0	0.002†
Sexo			0.935‡
Masculino	34 (44.2)	43 (55.8)	
Femenino	22 (45.0)	27 (55.1)	
Comorbilidades			0.065‡
Sí	7 (28.0)	18 (72.0)	
No	49 (48.5)	52 (51.5)	
Estancia hospitalaria (días)**	3 [2 - 4.5]	4 [2 - 4.5]	0.009††
Tiempo de enfermedad (días)**	2 [1 - 4]	3 [2 - 5]	0.015††
Trastorno gastrointestinal			0.336‡
Si	42 (47.2)	47 (52.8)	
No	14 (37.8)	23 (62.2)	
Riesgo de desnutrición			0.999‡
Si	40 (44.4)	50 (55.6)	
No	16 (44.4)	20 (55.6)	
IMC (kg/m ²)*	28.3 ± 5.1	26.6 ± 4.1	0.046†
Hemoglobina (g/dL)*	13.3 ± 1.9	13.2 ± 2.0	0.732†
Linfocitos*	1397.3 ± 842.3	1352.3 ± 845.1	0.767†

* Media ± desviación estándar. ** Mediana [p25 - +75]. †T de Student. ††U de Mann Whitney. ‡Test de Chi2. IMC: índice de masa corporal, MMI: masa muscular inadecuada.

les y metabólicos²⁷, debido a los cambios fisiopatológicos originados por el efecto inflamatorio sistémico del tejido adiposo acumulado²⁵. Nuestros resultados indicaron una menor prevalencia de masa muscular inadecuada (MMI) en pacientes con sobrepeso y obesidad, esto posiblemente por la acumulación de lípidos que aumenta el volumen del músculo esquelético²⁴, una pseudohipertrofia causada por la acumulación de tejido adiposo intramuscular²¹. Sin embargo, la presencia de comorbilidades cardiometabólicas aumentó el riesgo de MMI en este grupo.

Estos hallazgos podrían explicarse principalmente por la lipotoxicidad local en los miocitos, que conlleva resistencia a la insulina y alteraciones en la síntesis de proteínas²¹. Esta atrofia muscular podría explicarse por la estimulación de la vía ubiquitina-proteosoma dependiente⁷, mayor cantidad de fi-

bras tipo I y reemplazo de células musculares por tejido adiposo²⁵, o la sobreexpresión de KLF15, como se reportó en ratones diabéticos²⁸. Estos mecanismos podrían explicar la asociación entre grasa visceral del área muscular del muslo como indicador potencial e independiente de obesidad sarcopénica en pacientes con síndrome metabólico²¹, y además la pérdida de masa muscular en pacientes con comorbilidades cardiometabólicas^{3,4,21}, situaciones que podrían prevenirse mediante la regulación del índice de masa corporal²⁹ y el aumento de la masa magra, a través de la indicación de ejercicio físico de resistencia³⁰.

RELEVANCIA CLÍNICA

La ecografía muscular es un método que ha evidenciado tener potencial e importante función como método de evalua-

Tabla 3. Factores asociados a la Masa Muscular Inadecuada (MMI) (n = 126)

Variables	Modelo crudo			Modelo ajustado sin interacción			Modelo ajustado con interacción*		
	RPc	IC 95%	p	RPa	IC 95%	p	RPa	IC 95%	p
Edad			<0.001			0.011			0.014
< 60 años	Ref.			Ref.			Ref.		
≥ 60 años	1.70	1.30 - 2.22		1.44	1.09 - 1.91		1.42	1.07 - 1.87	
Sexo			0.935						
Femenino	Ref.								
Masculino	1.01	0.73 - 1.40							
Comorbilidades			0.034			0.117			0.117
No	Ref.			Ref.			Ref.		
Sí	1.40	1.03 - 1.91		1.30	0.94 - 1.80		1.30	0.94 - 1.80	
IMC categorizado			0.043			0.105			0.009
Bajo peso/Normal	Ref.			Ref.			Ref.		
Sobrepeso/Obesidad	0.73	0.54 - 0.99		0.78	0.57 - 1.06		0.62	0.44 - 0.89	
Tiempo de enfermedad (días)	1,03	1.01 - 1.04	<0.001	1.02	1.01 - 1.03	<0.001	1.03	1.01 - 1.04	0.009
Trastorno gastrointestinal			0.318						
No	Ref.								
Sí	0.85	0.62 - 1.17							
Riesgo de desnutrición			0.999						
No	Ref.								
Sí	1.00	0.71 - 1.42							
Anemia			0.351						
No	Ref.								
Sí	1.16	0.85 - 1.60							
Linfopenia			0.358						0.009
No	Ref.						Ref.		
Sí	1.18	0.83 - 1.66					0.62	0.44 - 0.89	

*La interacción fue entre comorbilidad cardiometabólica e índice de masa corporal categorizado (p=0.008).

No se consideró la variable "estancia hospitalaria" por temporalidad.

RP: Razón de prevalencia (c: cruda / a: ajustada), IMC: índice de masa corporal.

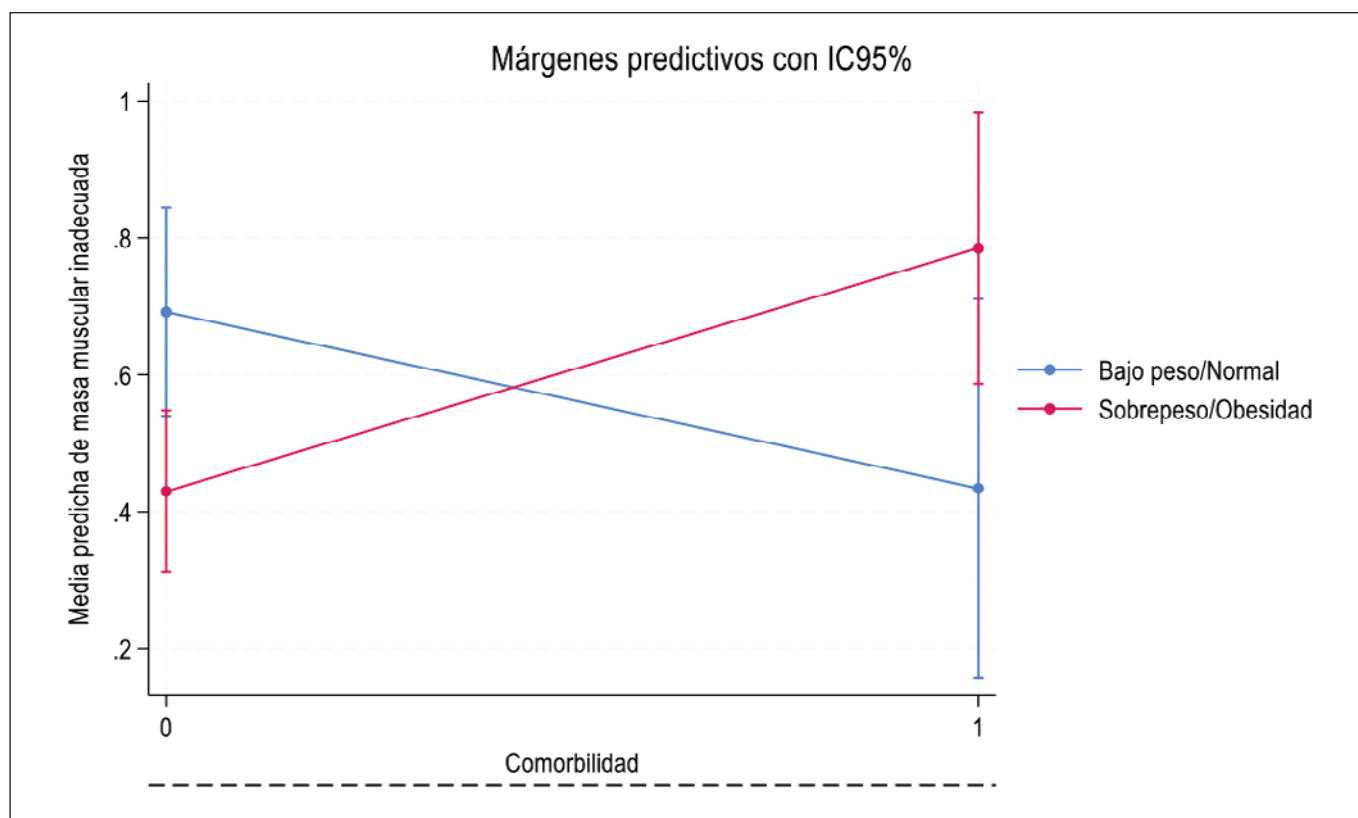


Figura 1. Gráfico de efectos marginales

ción y seguimiento de la masa muscular⁸⁻¹⁰. En esta tendencia, podemos evidenciar que el uso de la ecografía muscular se muestra como un procedimiento de evaluación y monitorización del estado nutricional de pacientes hospitalizados y críticos^{2,7}, a través de mediciones de diversos grupos musculares, correlacionándose con distintas técnicas^{10,15,16} de evaluación muscular.

El entendimiento actual ha supuesto un cambio de actitud sobre la evaluación nutricional *in situ*⁶, protocolizando procesos de evaluación muscular y consolidándose como un método rápido, accesible e inocuo¹⁷, en la evaluación de pacientes con distintas situaciones clínicas.

Limitaciones

El presente estudio no está exento de limitaciones. La principal es la falta de valores de referencia nacionales validados para las mediciones de cuádriceps femoral, lo que implicó el uso de valores reportados en estudios internacionales. Esto podría limitar la aplicabilidad de los resultados debido a diferencias en la composición corporal de la población. Otra limitación es que el estudio se realizó en un único hospital, lo que restringe la generalización de los resultados a otros contextos. Además, la naturaleza transversal del estudio impide inferir causalidad. Por último, se debe considerar el sesgo de información al utilizar datos de historias clínicas como fuente secundaria.

CONCLUSIÓN

En conclusión, los factores asociados con una mayor prevalencia de masa muscular inadecuada (MMI) fueron la edad mayor o igual a 60 años, un mayor tiempo de enfermedad y la presencia de sobrepeso y obesidad en pacientes con comorbilidades cardiometabólicas.

REFERENCIAS BIBLIOGRÁFICAS

- Mariños B, Segovia R, Arévalo E, Castillo P, Arias P, Ponce D, et al. Prevalencia del riesgo de desnutrición y situación de la terapia nutricional en pacientes adultos hospitalizados en Perú. *Revista de Nutrición Clínica y Metabolismo*. 2020;3(2):13–9.
- Hentzen JEKR, Van Wijk L, Buis CI, Viddeleer AR, De Bock GH, Van der Schans CP, et al. Impact and risk factors for clinically relevant surgery-related muscle loss in patients after major abdominal cancer surgery: study protocol for a prospective observational cohort study (MUSCLE POWER). *Int J Clin Trials*. 2019 Jul 24;6(3):138.
- Van Wijk L, Van Duinhoven S, Liem M, Bouman DE, Viddeleer A, Klaase, laase JM. Risk factors for surgery-related muscle quantity and muscle quality loss and their impact on outcome. *Eur J Med Res*. 2021;26(1):1–10.
- Huang DD, Ji Y Bin, Zhou DL, Li B, Wang SL, Chen XL, et al. Effect of surgery-induced acute muscle wasting on postoperative outcomes and quality of life. *Journal of Surgical Research*. 2017 Oct 1;218:58.

5. Narayan S, Gudivada K, Krishna B. Assessment of Nutritional Status in the Critically Ill. *Indian Journal of Critical Care Medicine*. 2020;24(suppl 4).
6. Almeida JMG, García CG, Aguilar IMV, Castañeda VB, Guerrero DB. Morphofunctional assessment of patient's nutritional status: A global approach. *Nutr Hosp*. 2021;38(3):592–600.
7. Puthuchery ZA, Rawal J, McPhail M, Connolly B, Ratnayake G, Chan P, et al. Acute skeletal muscle wasting in critical illness. *JAMA - Journal of the American Medical Association*. 2013;310(15):1591–600.
8. López-Gómez JJ, Plaar KBS, Izaola-Jauregui O, Primo-Martín D, Gómez-Hoyos E, Torres-Torres B, et al. Muscular Ultrasonography in Morphofunctional Assessment of Patients with Oncological Pathology at Risk of Malnutrition. *Nutrients* 2022, Vol 14, Page 1573. 2022 Apr 10;14(8):1573.
9. Minetto MA, Caresio C, Menapace T, Hajdarevic A, Marchini A, Molinari F, et al. Ultrasound-Based Detection of Low Muscle Mass for Diagnosis of Sarcopenia in Older Adults. *PM R*. 2016 May 1;8(5):453–62.
10. Madden KM, Feldman B, Arishenkoff S, Meneilly GS. A rapid point-of-care ultrasound marker for muscle mass and muscle strength in older adults. *Age Ageing*. 2021 Mar 1;50(2):505.
11. Carámbula A, Visca A, D'Amico S, Angulo M. Evaluación muscular respiratoria y periférica en la Unidad de Cuidados Intensivos. *Arch Bronconeumol*. 2019 Feb 1;55(5):258–65.
12. Fischer A, Anwar M, Hertwig A, Hahn R, Pesta M, Timmermann I, et al. Ultrasound method of the USVALID study to measure subcutaneous adipose tissue and muscle thickness on the thigh and upper arm: An illustrated step-by-step guide. *Clin Nutr Exp [Internet]*. 2020;32:38–73. Available from: <https://doi.org/10.1016/j.yclnex.2020.06.003>
13. Annetta MG, Pittiruti M, Silvestri D, Luca Grieco D, Maccaglia A, Fabio M, et al. Ultrasound assessment of rectus femoris and anterior tibialis muscles in young trauma patients. *Ann Intensive Care*. 2017;7(1):104.
14. Amancio N do N, Saldanha CA, Spexoto MCB. Adductor pollicis muscle thickness incorporated to the clinical practice for nutritional diagnosis of cancer patients in clinical treatment. *Nutricion Clinica y Dietetica Hospitalaria*. 2019 Dec 8;39(3):66–74.
15. Hernández A, Gómez M, Soriano R, Hernández M, Gonzales L. Relación entre la medición sonográfica de los músculos recto femoral y vasto intermedio y los parámetros bioquímicos convencionales para valorar el estado nutricional en la unidad de cuidados intensivos. *Med Crit*. 2018;32(6):351–8.
16. Salim SY, Al-Khathiri O, Tandon P, Baracos VE, Churchill TA, Warkentin LM, et al. Thigh Ultrasound Used to Identify Frail Elderly Patients with Sarcopenia Undergoing Surgery: A Pilot Study. *J Surg Res*. 2020 Dec 1;256:422–32.
17. Arts IMP, Pillen S, Schelhaas HJ, Overeem S, Zwarts MJ. Normal values for quantitative muscle ultrasonography in adults. *Muscle Nerve*. 2010;41(1):32–41.
18. Esenarro LA, Contreras M, Juan Del Canto R, Walter Vélchez D, Lima D. GUÍA TÉCNICA PARA LA VALORACIÓN NUTRICIONAL ANTROPOMÉTRICA DE LA PERSONA ADULTA.
19. MINSA. GUÍA TÉCNICA PARA LA VALORACIÓN NUTRICIONAL ANTROPOMÉTRICA DE LA PERSONA ADULTA MAYOR. 2013.
20. Raguso CA, Kyle U, Kossovsky MP, Roynette C, Paoloni-Giacobino A, Hans D, et al. A 3-year longitudinal study on body composition changes in the elderly: Role of physical exercise. *Clinical Nutrition*. 2006 Aug 1;25(4):573–80.
21. Kim TN, Park MS, Ryu JY, Choi HY, Hong HC, Yoo HJ, et al. Impact of Visceral Fat on Skeletal Muscle Mass and Vice Versa in a Prospective Cohort Study: The Korean Sarcopenic Obesity Study (KSOS). *PLoS One*. 2014 Dec 17;9(12):e115407.
22. Alvarez Baca D, Revoredo Rego F, Suarez Lazo M, Acevedo Rique I, Lloclla Kano P. Estado Nutricional y Morbi-Mortalidad en Pacientes con Anastomosis Gastrointestinales en el Hospital Nacional Hipolito Unanue (HNHU). *Rev Gastroenterol Perú*. 2012;32(3):273–80.
23. Abe T, Dankel SJ, Bell ZW, Fujita E, Yaginuma Y, Akamine T, et al. Impact of Fat-Free Adipose Tissue on the Prevalence of Low Muscle Mass Estimated Using Calf Circumference in Middle-Aged and Older Adults. *J Frailty Aging*. 2020;9(2):90–3.
24. Giuliani HK, Shea NW, Gerstner GR, Mota JA, Blackburn JT, Ryan ED. The Influence of Age and Obesity-Altered Muscle Tissue Composition on Muscular Dimensional Changes: Impact on Strength and Function. *The Journals of Gerontology: Series A*. 2020 Nov 13;75(12):2286–94.
25. Belavý DL, Miokovic T, Armbrrecht G, Richardson CA, Rittweger J, Felsenberg D. Differential atrophy of the lower-limb musculature during prolonged bed-rest. *European Journal of Applied Physiology* 2009 107:4. 2009 Aug 13;107(4):489–99.
26. Kilroe SP, Fulford J, Holwerda AM, Jackman SR, Lee BP, Gijsen AP, et al. Short-term muscle disuse induces a rapid and sustained decline in daily myofibrillar protein synthesis rates. *Am J Physiol Endocrinol Metab*. 2020 Feb 1;318(2):E117–30.
27. Hall JE, Do Carmo JM, Da Silva AA, Wang Z, Hall ME. OBESITY-INDUCED HYPERTENSION: INTERACTION OF NEUROHUMORAL AND RENAL MECHANISMS. *Circ Res*. 2015 Mar 3;116(6):991.
28. Hirata Y, Nomura K, Senga Y, Okada Y, Kobayashi K, Okamoto S, et al. Hyperglycemia induces skeletal muscle atrophy via a WWP1/KLF15 axis. *JCI Insight*. 2019 Feb 21;4(4).
29. Cai X, Liu M, Xu X, Zhang S, Huang R, Wang P, et al. Cardiovascular effects of weight loss in old adults with overweight/obesity according to change in skeletal muscle mass. *J Cachexia Sarcopenia Muscle*. 2023 Dec 18;
30. Cheah KJ, Cheah LJ. Benefits and side effects of protein supplementation and exercise in sarcopenic obesity: A scoping review. *Nutr J*. 2023 Dec 1;22(1).

The risk factors of sodium, potassium intake, and physical activity on hypertension in the elderly

Annisa YOLANDA, Fivi Melva DIANA, Putri Aulia ARZA

Department of Nutrition, Faculty of Public Health, Universitas Andalas, Padang, West Sumatra, Indonesia.

Recibido: 13/diciembre/2023. Aceptado: 27/mayo/2024.

ABSTRACT

Introduction: Hypertension is called a *silent killer* because many people with hypertension but do not realize that they have it (no signs or symptoms). This study aimed to determine the characteristics of respondents and the risk factors for sodium intake, potassium, and physical activity on hypertension in the elderly.

Methods: Case-control study design with age and gender matching. *Nonprobability sampling* technique. The number of case group samples (33 people) is the same as the control (33 people). Sodium and potassium intake data using *food recall* form, and physical activity data with GPAQ (*Global Physical Activity Questionnaire*). Data analysis with chi-square test, significant ($p < 0.05$). $OR > 1$ is a risk factor.

Results: The results of this study showed: that the family history of hypertension in the case group was more (54.5%) than the control (18.2%). The highest level of education in the case group was elementary school (33%) compared to the control (24.2%). Most respondents did not work in the case group (48.5%) almost as much as the control (51.5%). Most respondents did not smoke in the case group (84.8%) almost as much as the control (81.8%). Statistical test results showed that respondents with more sodium intake had a 5.46 times risk of developing hypertension compared to respondents with adequate sodium intake ($p=0.003$; $OR = 5.46$), on the other hand, the results of this study showed that potassium intake was not a risk factor for hypertension. Respondents in the low physical activity category had 5.95 times the risk of hypertension compared to respondents in the high physical activity category ($p=0.004$; $OR=5.95$).

Conclusion: Sodium intake and physical activity are risk factors for hypertension. Elderly people are advised to do physical activity for 30 minutes per day to overcome hypertension.

KEYWORDS

Sodium intake, potassium intake, physical activity, hypertension.

INTRODUCTION

Hypertension is often referred to as a *silent killer* because many people with hypertension do not realize that they have it (no signs or symptoms)¹. Hypertension is characterized by systole blood pressure ≥ 140 mmHg and diastole ≥ 90 mmHg².

The P2PM (Disease Prevention and Control) report in 2022 shows that the prevalence of hypertension in Indonesia has increased from 25.8% to 34.1%¹. The West Sumatra Province report from the Basic Health Research (Riskesmas) in 2018 revealed that the prevalence of hypertension based on population aged ≥ 18 years in each District/City in West Sumatra Province was 25.16%. Among them, Sawah Lunto city had the highest prevalence at 33.11%, while the lowest was in Mentawai Islands at 17.18%. Agam district ranked among the top ten districts with the highest prevalence of hypertension in West Sumatra Province, with a prevalence of 27.07%³. Based on the report from the Agam District Central Statistics Agency in 2023, it is shown that the number of blood pressure measurements for population aged 18 years and over and the hypertension condition by gender and Sub-District in Agam District in 2022, in the Ampek Angkek sub-district within the Working Area of Puskesmas Magek, had a higher number of hypertension cases, with 789 cases, compared to Palupuh (329), Baso (641), and Banuh Ampu (261)⁴.

The causes of hypertension are diverse and involve multiple factors such as chronic stress, obesity, environmental fac-

Correspondencia:

Fivi Melva Diana
fividiana0503@ph.unand.ac.id

tors, genetics, excessive sodium intake, potassium and lack of physical activity, low birth weight, and others⁵⁻⁸. The results of research by Wibowo and Wahyono in 2018 stated that the cause of hypertension is sodium intake⁹. In 2019, Fauzan demonstrated a significant relationship between physical activity and hypertension ($p < 0.05$) (OR: 4.00)¹⁰.

Risk factors that cause hypertension are non-modifiable risk factors and modifiable risk factors. Non-modifiable such as age, race, heredity, and gender, while modifiable such as lack of exercise or physical activity, alcoholism, obesity, and smoking¹¹.

Uncontrolled hypertension is at risk of increasing the occurrence of heart disease, stroke, and kidney failure¹. Therefore it is necessary to conduct research with the aim: (1) to determine the characteristics of respondents, (2) the relationship between sodium intake and hypertension, (3) the relationship between potassium intake and hypertension, and (4) the relationship between physical activity and hypertension in the elderly in the working area of the Magek health center, Agam district in 2022.

METHODS

This study was conducted in February 2022-March 2022. The research location is in the working area of the Magek Health Center, Agam Regency. This research design is a *case-control study*, with age and gender *matching*, and the ratio of case and control groups is (1: 1). The number of samples in the case group was 33 people and the control group was 33 people. *Non-probability sampling* technique. The sample formula used is:

$$n = \frac{\{Z_{1-\alpha/2}\sqrt{2P(1-P)} + Z_{1-\beta}\sqrt{P_1(1-P_1) + P_2(1-P_2)}\}^2}{(P_1 - P_2)^2}$$

Description:

n = Sample size

$Z_{1-\alpha/2}$ = Level of significance = 95% = 0.05 = 1.96

$Z_{1-\beta}$ = Power

P_1 = $\frac{OR \times P_2}{(1-P_2) + (OR \times P_2)}$

P_2 = Estimated proportion of exposure in known control group = 0.52

P = $\frac{1}{2} (P_1 + P_2)$

OR = Odds Ratio

This research has obtained informed consent approval from the respondents. The research data consisted of primary and secondary data. Primary data consisted of respondent characteristics, sodium intake, potassium intake, and physical activity. Sodium and potassium intake data were obtained from interviews with 2x 24-hour *food recall forms* and physical activity data were obtained with GPAQ (*Global Physical Activity*

Questionnaire). Secondary data were obtained from Magek Health Center documents. Data analysis used the *Chi-square* test with a significance level of α (0.05) 95% confidence level.

RESULTS

This study comprises age, gender, family history of hypertension, education, occupation, smoking, sodium intake, potassium intake, and physical activity. The results of the data analysis of these variables can be seen in Tables 1, 2, and 3.

Table 1 shows that there were as many respondents in the case group as 11 people (33%) and the control group as 11 people (33%) based on age category. The female gender in the case group was almost the same 17 people (51.5%) with 16 men (48.5%) in the control. Family history of hypertension in the case group was 18 people (54.5%) compared to 6 people (18.2%) in the control group. The highest level of education in the category of elementary school graduates in the case group was 11 people (33%) while the control group amounted to 8 people (24.2%). Most respondents did not work in the case group 16 people (48.5%) almost as much as the control 17 people (51.5%). Most respondents did not smoke in the case group as many as 28 people (84.8%), almost as many as the control group of 27 people (81.8%).

Table 2 shows that the number of respondents with more sodium intake category was 25 people (75.8%) in the case group higher than the control group of 12 people (36.4%). The number of respondents with less potassium intake category in the case group was 26 people (78.8%) higher than the control of 20 people (60.6%), and the physical activity of respondents in the low category in the case group was higher in 28 people (84.8) than the control of 16 people (48.5%).

Table 3 shows that respondents who have sodium intake are more at risk of 5.46 times experiencing hypertension compared to respondents who have adequate sodium intake (OR = 5.46), while potassium intake is not a risk factor for hypertension. Respondents with a low physical activity category had a 5.95 times risk of hypertension compared to respondents with a high physical activity category (OR=5.95).

Table 4 shows that the case group consumed the most sodium-containing foodstuffs from salted fish. Fat consumption was mainly attributed to chicken meat chicken meat, fried instant noodles (indomie), and chicken eggs. Additionally, the highest fiber intake was observed from white bread, fried instant noodles indomie, and mieses toast.

Table 5 illustrates that the case group obtained potassium from various food sources, including rice, potatoes, tilapia, peanuts, corn, bananas, chayote, cucumber, spinach, fried tempeh, and fried bananas. Fat intake in the case group mainly came from peanuts, fried tempeh, and fried bananas. Additionally, fiber was sourced from the consumption of corn, peanuts, and fried bananas in the case group.

Table 1. Frequency distribution of respondent characteristics in the case and control groups

Respondent Characteristics	n	%	n	%
Age				
age (45-59)	11	33.3	11	33.3
Seniors (60-74)	11	33.3	11	33.3
Older Seniors (75-90)	11	33.3	11	33.3
Gender				
Man	16	48.5	16	48.5
Woman	17	51.5	17	51.5
Family History of Hypertension				
There is	18	54.5	6	18.2
There isn't any	15	45.5	27	81.8
Education				
Not completed in primary school	6	18.2	10	30.0
Finished elementary school	11	33.3	8	24.2
Finished high school	4	12.1	4	12.1
Finished high school	11	33.3	8	24.2
Finished PT	1	3.0	3	9.1
Work				
Not working/RT	16	48.5	17	51.5
Farmer	7	21.2	11	33.3
Laborer	2	6.1	0	0.0
Civil servants/private employees	1	3.0	2	6.1
Self-employed	7	21.2	3	9.1
Smoke				
No	28	84.8	27	81.8
Yes	5	15.2	6	18.2
Total	33	100.0	33	100.0

DISCUSSION

Respondent characteristics (age, gender, family history of hypertension, education, occupation, smoking, sodium intake, potassium intake, and physical activity)

Table 1 shows that the number of respondents in the middle age group category (45-59), the elderly (60-74), and the elderly (75-90) is as much as the control. This is in line with Rambing *et al.*, 2021, which shows that there is a significant relationship between age and hypertension ($p=0.01$)¹².

Increasing age is a strong and non-modifiable risk factor for hypertension. As arteries age, their elasticity or flexibility decreases. The heart, blood vessels, and hormones will naturally change with age and will trigger hypertension in the presence of other factors. People who have an age above 40 years have a higher risk of suffering from hypertension than people who have an age below 40 years¹³. A person's blood pressure tends to increase with age, especially systolic blood pressure, systolic blood pressure will continue to increase during a person's life, while diastolic blood pressure will tend to be constant after entering the age of 40 years¹³.

Table 2. Frequency distribution of sodium intake, potassium intake, and physical activity of respondents in the case and control groups

Variable	Case		Control	
	n	%	n	%
Sodium intake				
More (≥ 1500 mg)	25	75.8	12	36.4
Sufficient (< 1500 mg)	8	24.2	21	63.6
Potassium Intake				
Less (< 4700 mg)	26	78.8	20	60.6
Sufficient (≥ 4700 mg)	7	21.1	13	39.4
Physical Activity				
Low (< 3000 MET, not including vigorous activity)	28	84.8	16	48.5
High (≥ 3000 MET, ≥ 7 days/week)	5	15.2	17	51.5

Table 3. Relationship between sodium intake, potassium intake, and physical activity with hypertension

Independent Variable	Hypertension				*p-value	OR
	Case	Control	n	%		
Sodium Intake						
More (≥ 1500 mg)	25	75.8	12	36.4	0.003	5.46(1,883-15,884)
Sufficient (< 1500 mg)	8	24.2	21	63.6		
Potassium Intake						
Less (< 4700 mg)	26	78.8	20	60.6	0.106	2.4(0.813-7.168)
Sufficient (≥ 4700 mg)	7	21.2	13	39.4		
Physical Activity						
Low (< 3000 MET, no including vigorous activity)	28	84.8	16	48.5	0.004	5.95(1,845-19,193)
High (≥ 3000 MET, ≥ 7 days/week)	5	15.2	17	51.5		

*A Chi-square test is significant if $p < 0.05$, where an odds ratio (OR) greater than 1 indicates a risk factor.

This study also shows that the female sex of the case group is almost as much (not too far) as the control sex (male). This is in line with Rahmadani in 2020 showing the number of female respondents as many as 17 people (22.4%) is not too far from men as many as 21 people (27.6%)¹⁴. The majority of respondents were women, but the difference in the number of women and men was not too far (Table 1). The majority of respondents in the age group ≥ 45 years (33.00%) (Table 1). The majority of respondents in this study had a

family history of hypertension (54.5%) in cases while controls (18.2%) (Table 1).

Female or male gender or have an equal chance of developing hypertension during their lifetime. However, men are more at risk of hypertension than women when they are 46 years old. Conversely, when age ≥ 65 years, women are more at risk of hypertension than men. Some hormones influence this condition. Women entering menopause are more at risk of obesity, which will increase the risk of hypertension¹⁵.

Table 4. Food sources containing sodium, fat and fiber consumed by the case group

Food Source	n	%	mg	Energy (Kcal)	Fat (gr)	Fiber (gr)
Fresh bread	5	15.1	573.5	233.8	2	1.9
Mieses toast	4	12.1	933.6	152.6	2.1	1.7
Chicken egg	9	27.2	469	168.9	10.9	0
Salted fish	24	72.7	832.1	104.8	1.9	0
Chicken meat	7	21.2	93.5	321.3	17.7	0
Shrimp crackers	2	6	67.3	94.3	1.4	0
Indomie	3	9	1260	320	12	2
Fried Indomie	2	6	622.5	285	10.9	1.9
Meatball noodles	2	6	570	114	2.3	0.1

Table 5. Food sources containing potassium, fat and fiber consumed by respondents in the case group

Food Source	n	%	mg	Energy (Kcal)	Fat (gr)	Fiber (gr)
Rice	33	100	214.4	931.6	1.5	2.2
Potatoes	6	18.1	277	76.6	0	0.9
Tilapia	9	27.2	190.6	77.6	0.8	0
Groundnut	4	12.1	298.5	56.7	13.7	2.4
Corn	3	9	471	346.9	4.3	8.8
Bananas	13	39.3	902.1	386.6	0.6	7.3
Siamese gourd	4	12.1	126.4	9	0.4	0.4
Cucumbers	5	15.1	151.9	18.2	0.2	1.7
Spinach	14	24.4	278.9	20.3	0.2	0.3
Fried tempeh	2	6	174.2	168.5	11.9	0.7
Fried banana	12	36.3	431.6	221.2	14.9	2.4

Table 1 shows data on other characteristics supporting the results of this study, namely a family history of hypertension in the case group more than the control. The education level of the case group graduated from elementary school and graduated from high school more than the control. Most respondents did not work in the case group almost as much as the control, most respondents did not smoke in the case group almost as much as the control.

A family history of hypertension is an important non-modifiable factor among several risk factors for hypertension¹⁶. A

family history of hypertension has a 3.6 times greater risk of developing hypertension compared to those without a family history of hypertension. In 70-80% of cases of essential hypertension, there is a family history of hypertension. If there is a history of hypertension in both parents, the likelihood of essential hypertension is greater. Hypertension is also commonly found in monozygotic twins (one egg) if one of them has hypertension. Individuals with both hypertensive parents will experience a 50-57% chance of hypertension, while if one has hypertension, the chance of hypertension is 4-20%.

Individuals with genetic traits of primary (essential) hypertension if left naturally without therapeutic intervention, together with the environment will cause hypertension to develop, and within 30-50 years there will be signs and symptoms of hypertension with possible complications^{17,18}.

Relationship between sodium intake and hypertension

Table 2 shows that the number of respondents with more sodium intake category was 25 people (75.8%) in the case group higher than the control group of 12 people (36.4%). The statistical test results showed that respondents who consumed sodium had a risk of 5.46 times suffering from hypertension (OR = 5.46). This is in line with Silaen in 2018 showing that respondents who consume sodium have a risk of 5.598 times suffering from hypertension compared to those who do not consume sodium (OR = 5.598)¹⁹. Gautami & Kumala in 2021 showed that 43 out of 66 elderly individuals experienced hypertension (65.2%). The mean sodium intake was 1942.43 mg, and the majority of 50 (75.8%) subjects were classified as having high sodium intake²⁰.

The relationship between sodium intake and hypertension is well-established in scientific research. High sodium intake is associated with an increased risk of developing hypertension, also known as high blood pressure. Excessive sodium consumption can lead to fluid retention in the body, causing an increase in blood volume and subsequently elevating blood pressure. Excess sodium ingested is rapidly absorbed in the intestines, leading to an increase in plasma osmolality. This stimulates the sensation of thirst and prompts water consumption, increasing in intravascular volume. To counterbalance and control this volume increase, the kidneys respond by eliminating excess sodium and water. To eliminate this excess, blood pressure must be increased to enhance the filtration pressure in the glomeruli, thereby increasing the filtration and urinary sodium excretion burden. Under normal conditions, there is a balance between renal perfusion pressure (approximately 100 mmHg) and urinary sodium elimination (approximately 100–120 mEq). This balance is disrupted by excessive sodium consumption in conjunction with various factors affecting the anatomical and functional integrity of the kidneys, resulting in hypertension²¹.

Relationship between potassium intake and hypertension

Table 3 shows that the number of respondents with insufficient potassium intake category in the case group was 26 people (78.8%) higher than the control category of 20 people (60.6%). Statistical test results showed that there was no relationship between potassium intake and hypertension ($p=0.181$). This is in line with Fitri in 2018 which shows there is no relationship between potassium intake and hypertension ($p>0.05$)²². These results are in line with Putri & Kartini in

2014 which showed that there was no significant relationship between potassium intake and hypertension, ($p>0.05$)²³.

Potassium helps to offset the effects of sodium on blood pressure. Sodium tends to increase blood pressure by causing the body to store water and increase blood volume. On the other hand, potassium helps reduce blood pressure by offsetting the effects of sodium and also by controlling muscle contraction, including muscles in the walls of blood vessels. Increasing potassium intake has a significant antihypertensive effect and reducing sodium consumption can lower blood pressure. So, a balanced ratio of sodium and potassium consumption (1:1), can help maintain an optimal electrolyte balance in the body, which contributes to healthy blood pressure²¹.

Potassium deficiency increases blood pressure. Increasing potassium intake can balance the sodium-potassium ratio in the body, thereby helping to lower blood pressure and reduce the risk of hypertension. Potassium-rich foods include fruits such as bananas, oranges, and avocados, as well as vegetables such as potatoes, spinach, and beans²¹.

Relationship between physical activity and hypertension

Table 3 shows that the low physical activity of respondents in the case group was higher at 28 people (84.8%) than the control group at 16 people (48.5%). Statistical test results showed that respondents with low physical activity had a 5.95 times the risk of developing hypertension compared to those with sufficient physical activity (OR=5.95). The results of this study align with Atun in 2014, less physical activity has a 4.9 times greater risk of suffering from hypertension than sufficient physical activity (OR = 4.9)²⁴.

Physical activity greatly affects blood pressure stability. People who do not do physical activity tend to have a higher heart rate frequency, so the heart muscle works harder with each contraction. The harder the heart muscle tries to pump blood, the more blood pressure is put on the artery walls, causing blood pressure to rise. Physical activity improves blood flow to the heart, arterial flexibility, and arterial function. Physical activity also slows down atherosclerosis and reduces the risk of heart attack and stroke. Various studies have shown that prolonged television viewing (inactivity) is associated with an increased prevalence of obesity which increases the risk of hypertension. Low physical activity (lack of) such as laziness / lazy exercise causes overweight can trigger the risk of hypertension. Moderate to high physical activity will reduce the likelihood of obesity, thereby reducing the risk of hypertension^{25,26}.

LIMITATIONS OF THE STUDY

The sample size used in this research is very small. This research is still on a local scale.

CONCLUSIONS

From the results of this study, it can be concluded that: the number of respondents in the middle age group (45-59), elderly (60-74), and very elderly (75-90) in the case group is the same as the control group. The distribution of females and males in the case group is not significantly different from the control group. The family history of hypertension in the case group is higher than in the control group. The level of education completed at the college level is lower in the case group compared to the control group. The number of respondents who are not employed is higher in the control group than in the case group. The number of non-smoking respondents is higher in the case group compared to the control group. Respondents with higher sodium intake are at a 5.46 times higher risk of experiencing hypertension compared to those with sufficient sodium intake. Potassium intake is not a risk factor for hypertension. Respondents with low physical activity are at a 5.95 times higher risk of experiencing hypertension compared to those with high physical activity. Therefore, it is recommended for the elderly to engage in physical activity for 30 minutes per day to manage hypertension.

ACKNOWLEDGMENTS

Thank you to the Head of Magek Health Center, Agam Regency, who has helped in the implementation of this research. Thank you also to the Department of Nutrition, Faculty of Public Health, Universitas Andalas, which has provided support and assistance for the smooth running of this research, and thanks also to all those who have played a role and facilitated the implementation of this research.

REFERENCES

1. P2PM. (2022). 'Laporan Kinerja Direktorat Jenderal Pencegahan dan Pengendalian Penyakit', Kemkes, pp. 1–114. Available at: <https://e-renggar.kemkes.go.id/file2018/e-performance/1-465827-3tahunan-768.pdf>.
2. Yusuf, S. et al. 2020. 'Modifiable risk factors, cardiovascular disease, and mortality in 155 722 individuals from 21 high-income, middle-income, and low-income countries (PURE): a prospective cohort study', *The Lancet*, 395(10226), pp. 795–808. Available at: [https://doi.org/10.1016/S0140-6736\(19\)32008-2](https://doi.org/10.1016/S0140-6736(19)32008-2).
3. Badan Penelitian dan Pengembangan Kesehatan (2018) Laporan Provinsi Sumatera Barat Risesdas 2018, Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan (LPB). Available at: <https://repository.badankebijakan.kemkes.go.id/id/eprint/3906/>.
4. Badan Pusat Statistik Kabupaten Agam. (2023). 'Kabupaten Agam dalam Angka 2023. Badan Pusat Statistik Kabupaten Agam.
5. Haikerwal A, Doyle LW, Cheung MM, et al. High blood pressure in young adult survivors born extremely preterm or extremely low birthweight in the post surfactant era. *Hypertension* 2020; 75: 211–17.
6. Kanda T, Murai-Takeda A, Kawabe H, Itoh H. Low birth weight trends: possible impacts on the prevalences of hypertension and chronic kidney disease. *Hypertens Res* 2020; 43: 859–68.
7. Münzel T, Sørensen M, Gori T, et al. Environmental stressors and cardio-metabolic disease: part I-epidemiologic evidence supporting a role for noise and air pollution and effects of mitigation strategies. *Eur Heart J* 2017; 38: 550–56.
8. Fuks KB, Weinmayr G, Basagaña X, et al. Long-term exposure to ambient air pollution and traffic noise and incident hypertension in seven cohorts of the European study of cohorts for air pollution effects (ESCAPE). *Eur Heart J* 2017; 38: 983–90
9. Wibowo As, Wahyono W. Pengaruh Pola Makan Terhadap Hipertensi Pada Lansia (Studi Di Posyandu Kutilang 1 Kelurahan Pangkut Kecamatan Arut Utara Kotawaringin Barat Kalimantan Tengah). *Jurnal Borneo Cendekia*. 2018 Mar 8;2(1):129-35.
10. Fauzan A, Qariati Ni. Faktor Risiko Hipertensi Pada Lansia Di Wilayah Kerja Puskesmas Kota Banjarmasin. *Jurnal Kesehatan Indonesia*. 2019 Jan 23;9(1):21-4.
11. Arifin, Mohd, Bin, Hafiz, Muhammad, Weta, I, Wayan, Ratnawati, Ayu, Ketut, N. (2016). Faktor-Faktor yang Berhubungan dengan Kejadian Hipertensi Pada Kelompok Lanjut Usia di Wilayah Kerja UPT Puskesmas Petang I Kabupaten Badung Tahun 2016. *E-Jurnal Medika*, 5(7), 1–23. <https://ojs.unud.ac.id/index.php/eum/article/view/21559>.
12. Ramping DR, Haksama S, Lusno Mf, Wulandari A. 2021. Hubungan Umur Dan Riwayat Pada Keluarga Sebagai Faktor Non-Modifiable Dengan Kejadian Hipertensi. *Media Bina Ilmiah*. 2021 May 2;15(10):5495-504.
13. Tjekyan, S. 2014. Angka Kejadian Dan Faktor Risiko Hipertensi Di Kota Palembang Tahun 2013. *Majalah Kedokteran Sriwijaya*, 46(1), 1–11.
14. Rahmadhani, M. 2021 'Faktor-Faktor Yang Mempengaruhi Terjadinya Hipertensi Pada Masyarakat Di Kampung Bedagai Kota Pinang', *Jurnal Kedokteran STM (Sains dan Teknologi Medik)*, 4(1), pp. 52–62. Available at: <https://doi.org/10.30743/stm.v4i1.132>.
15. Yunita Indah, P 2014. Hipertensi Bukan Untuk Ditakuti Jakarta: Fmedia (Imprint Agro Yogyakarta)
16. Ranasinghe, P., Cooray, D. N., Jayawardena, R., & Katulanda, P. 2015. The influence of family history of Hypertension on disease prevalence and associated metabolic risk factors among Sri Lankan adults Chronic Disease epidemiology. *BMC Public Health*, 15(1), 1–9. <https://doi.org/10.1186/s12889-015- 1927-7>
17. Yoga Prasetya B. Asuhan Keperawatan Hipertensi Pada Pasien Ny. T Dan Ny. S Dengan Masalah Keperawatan Nyeri Akut Di Ruang Melati Rsud Dr. Haryoto Lumajang Tahun 2018.
18. Ramadhan AM, Rijai L, Liu JM. Kajian Penggunaan Obat Hipoglikemik Oral pada Pasien Diabetes Mellitus Tipe 2 di Puskesmas Temindung Samarinda. *J Sains dan Kesehat*. 2015; 1(3):105–10.
19. Silaen Jb. Kejadian Hipertensi Pada Masyarakat Di Wilayah Kerja Puskesmas Harapan Raya Pekanbaru. *Jurnal Ipteks Terapan*. 2018 Mar 31;12(1):64-77.

20. Gautami, G. and Kumala, M. (2021) 'Hubungan rasio asupan natrium berbanding kalium dengan penyakit hipertensi pada lansia', *Tarumanagara Medical Journal*, 3(1), pp. 83–90. Available at: <https://doi.org/10.24912/tmj.v3i2.11747>.
21. Carlos Zehnder, B. (2010) 'Sodium, potassium and hypertension', *Revista Medica Clinica Las Condes*, 21(4), pp. 508–515. Available at: [https://doi.org/10.1016/S0716-8640\(10\)70566-6](https://doi.org/10.1016/S0716-8640(10)70566-6).
22. Fitri Y, Rusmikawati R, Zulfah S, Nurbaiti N. Asupan natrium dan kalium sebagai faktor penyebab hipertensi pada usia lanjut. *AcTion: Aceh Nutrition Journal*. 2018 Nov 30;3(2):158-63.
23. Putri Eh, Kartini A. Hubungan Asupan Kalium, Kalsium Dan Magnesium Dengan Kejadian Hipertensi Pada Wanita Menopause Di Kelurahan Bojongsalaman, Semarang. *Journal Of Nutrition College*. 2014;3(4):580-6
24. Atun L, Siswati T, Kurdanti W. Asupan Sumber Natrium, Rasio Kalium Natrium, Aktivitas Fisik, Dan Tekanan Darah Pasien Hipertensi. *Media Gizi Mikro Indonesia*. 2014;6(1):63-71.
25. Karim NA, Onibala F, Kallo v. 2018 'Hubungan Aktivitas Fisik Dengan Derajat Hipertensi Pada Pasien Rawat Jalan Di Wilayah Kerja Puskesmas Tagulandang Kabupaten Sitaro', *Jurnal Keperawatan*, 6(1), pp. 1–6.
26. Blanco, I., Torres-Castro, R. and Barberà, J.A. 2022 'Exercise tolerance in pulmonary hypertension', *Archivos de Bronconeumologia*, 58(5), pp. 388–389. Available at: <https://doi.org/10.1016/j.arbres.2021.11.012>.

A cross-sectional study on the relationship between intuitive eating, hedonic hunger and body mass index in university students

Gülin ÖZTÜRK ÖZKAN, Burcu ÇETINER

Istanbul Medeniyet University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Turkey.

Recibido: 25/marzo/2024. Aceptado: 27/mayo/2024.

ABSTRACT

Introduction: Unhealthy diet is an important factor in the formation of obesity. In recent years, the relationship between the concepts of intuitive eating and hedonic hunger and obesity has begun to be investigated.

Objectives: The aim of this study is to evaluate the effects of intuitive eating and hedonic hunger on mental health, sleep quality and body mass index.

Methods: In this cross-sectional study, a questionnaire including demographic and general health information, dietary habits, height and body weight measurements was administered to 62 female and 38 male university students aged 18-36 years. The questionnaire also included the Intuitive Eating Scale, the Food Power Scale, the Food Craving Questionnaire, the Pittsburg Sleep Quality Scale, the Warwick-Edinburgh Mental Well-Being Scale, and the Motivation to Eat Deliciously Scale. Number, percentage, mean and standard deviation values were calculated in the evaluation of the data. The relationships between variables were analyzed by independent samples T test, Pearson correlation and regression analyses.

Results: A positive correlation was found between intuitive eating, hedonic hunger ($r=0.332$, $p<0.01$) and mental well-being ($r=0.375$, $p<0.01$). Intuitive eating was found to be negatively correlated with food cravings ($r=-0.413$, $p<0.01$) and body mass index ($r=-0.202$, $p<0.05$). It was found that 28.7% (R^2 adjusted=0.287) of the variance of the intuitive

eating score was explained by hedonic hunger, food craving and body mass index.

Conclusions: Intuitive eating was associated with hedonic hunger, cravings, mental well-being, and body mass index. In addition, poor sleep quality supports hedonic hunger. Clinical trial registration number: NCT05501782

KEYWORDS

Intuitive eating, hedonic feeding, body shape, sleep disorder, mental health.

INTRODUCTION

Obesity caused by positive energy balance is very common all over the world¹. One of the causes of obesity is unhealthy eating habits². The increasing prevalence of obesity indicates that it is difficult to regulate food intake. Regulation of food intake is a complex process influenced by several factors³. Food intake is generally regulated by homeostatic and hedonic pathways⁴. Homeostatic hunger is an increase in the desire to eat to eliminate the negative energy balance after the depletion of energy stores, while hedonic hunger is defined as a tendency to eat only because of the desire for taste and is an important factor in the increase of obesity in the world^{4,5}. There are two important differences between homeostatic and hedonic hunger. The first difference is that in hedonic hunger, the food is preferred because of its taste. The second difference is that hedonic hunger occurs in short-term fasts. Physiological energy deficit in long-term fasting has an effect on food intake⁴.

Sleep is an important factor that can affect eating behavior. Decreased or increased sleep time helps to increase food intake and disrupt homeostatic control⁶. Sleep disturbance att-

Correspondencia:

Gülin Öztürk Özkan
gulin.ozturkozkan@medeniyet.edu.tr

racts attention as a factor that contributes to obesity⁷. Shortening of sleep duration is associated with increased food intake, altered energy expenditure, and changes in the concentration of hormones that affect hunger and satiety^{7,8}. Excessive energy intake following shortening of sleep duration is thought to be under the control of hedonic hunger, not hormonal factors⁸.

People can feel physical and emotional hunger. Physical hunger is a physical sensation accompanied by signals such as low energy, irritability, and stomach rumbling. Emotional hunger can be triggered by loneliness, sadness and stress⁹. In intuitive eating, food intake occurs in response to physiological hunger and satiety cues rather than emotional cues¹⁰. The concept of intuitive eating is based on three basic approaches: allowing to eat unconditionally, eating for physical reasons rather than emotional reasons, and eating based on physical hunger and satiety signals¹¹. Responding to external factors rather than appetite cues is associated with weight gain¹². People who practice this way of eating are not obsessed with overeating, do not ignore hunger cues, and do not follow a set of food rules. They prefer foods that are effective in the functioning of their bodies and that they enjoy consuming. They rely on the feeling of hunger and fullness to guide when and how much food to consume¹³. Intuitive eating is more sustainable than dieting¹⁰. Intuitive eating is linked to lower body mass index (BMI), lower cholesterol and cardiovascular risk^{10,14}. In addition, it is inversely related to disordered feeding behavior and leads to lower weight and maintenance of glucose level^{10,14}.

OBJECTIVE

This study was conducted to evaluate the relationship between intuitive eating, hedonic hunger, sleep quality and body mass index of university students.

MATERIALS AND METHODS

This study was conducted between April-June 2022 with the participation of 62 female and 38 male students aged 18-36 from various universities. Participating students from Istanbul Medeniyet University, Bozok University, Afyon Kocatepe University and Anadolu University were included in the study. An online survey was applied to the participants. The invitation to participate in the study and the link to access the survey were shared with individuals registered in the authors' social media accounts and e-mail accounts. The study invitation was shared on the authors' Facebook, Twitter and Instagram accounts. In addition, an invitation to participate was sent via WhatsApp to the people registered on their phones. The link to access the survey was shared with individuals who accepted the participation invitation. Online consent was obtained from the participants before starting the survey. Arrangements were made for each participant to answer the questions in the survey only once.

The questionnaire included a total of seven sections. In the first section, there were 20 questions about demographic data and general health status of the participants, and 11 questions including dietary habits and anthropometric measurements. Other parts of the questionnaire consist of Intuitive Eating Scale (IES-2), the Power of Food Scale (PFS-Tr), Food Craving Questionnaire (FCQ-T), the Pittsburg Sleep Quality Scale (PSQI), the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) and the Palatable Eating Motive Scale (PEMS). Consent from the participants was also obtained with the questionnaire form.

Intuitive Eating Scale (IES-2)

The intuitive eating scale (IES-2) consists of 23 questions, each of which includes five options ranging from strongly agree to strongly disagree. A 5-point Likert scale was used in the scale. 1,2,3,7,8,9,10. The scoring of the answers given to the questions differs from the other questions. In these questions, I strongly disagree 5, I disagree 4, I am undecided 3, I agree 2 and I strongly agree 1 point. The scoring of the answers to the other questions is in the opposite order (strongly disagree 1, disagree 2, undecided 3, agree 4, and strongly agree 5 points). According to the options chosen by the individuals, the scores they receive per question vary. The scale score was calculated by dividing the total score obtained at the end of the questions by 23. Intuitive eating behavior also increases in parallel with the increase in the scale score. The median values of the Intuitive Eating Scores of the students participating in the study were found. Participants with a scale score below the median value were evaluated as non-intuitive eating behaviors, and participants with a median value and above were evaluated as individuals with intuitive eating behavior¹⁵.

Power of Food Scale (PFS-Tr)

Power of food scale (PIS) is a scale developed to evaluate the effects of palatable foods on the psychological and hedonic states of individuals. A validated version of this scale consisting of 15 items was used. The scale was evaluated using a 5-point Likert scale. Accordingly, I strongly disagree 1 point, I disagree 2 points, I am undecided 3 points, I agree 4 points, and I strongly agree 5 points. The scores obtained from all items were divided into five and the scale score was found. It was concluded that the hedonic hunger levels of individuals with a nutritional power score of 2.5 and above increased. It has been accepted that individuals with a high nutritional power score are sensitive to the food environment and psychologically under the influence of food¹⁶.

Food Craving Questionnaire (FCQ-T)

The Food Craving Questionnaire (FCQ-T) is a scale developed for the assessment of food cravings. The Turkish version

with a reliability study was used in this study. In this scale, evaluation is made with a 6-point Likert scale. It was scored always 6 points, mostly 5 points, often 4 points, occasionally 3 points, rarely 2 points, never 1 point. The high scale scores of the participants indicate an increase in food cravings¹⁷.

Pittsburg Sleep Quality Scale (PSQI)

Pittsburg Sleep Quality Scale (PSQI) is a scale developed to evaluate sleep quality. This scale includes 18 items with 7 components. These components are subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime sleep dysfunction. Each component is scored between 0-3 points and the total score is a maximum of 21. A total score of 5 or more indicates poor sleep quality and an increase in the score indicates a decrease in sleep quality¹⁸.

Warwick-Edinburgh Mental Well-Being Scale (WEMWBS)

In this study, the Warwick-Edinburgh Mental Well-Being Scale (WEMIOS) was used. The scale consists of 14 questions and is evaluated with a 5-point Likert scale. It is scored as 1 point to strongly disagree, 2 points to disagree, 3 points to slightly agree, 4 points to agree and 5 points to completely agree. The total score on the scale is between 14 and 70. The increase in the total score indicates that the mental well-being of the individual increases¹⁹.

Palatable Eating Motive Scale (PEMS)

The Palatable Eating Motivation Scale (PEMS), consisting of 20 items, was used to determine the reasons why the participants consumed delicious foods and beverages. In this scale, evaluation is made with a 5-point Likert scale. The higher the score obtained from the scale, the greater the effect of food on people²⁰.

The compliance of this study with ethical rules was approved by the decision of the the Ministry of Health, Istanbul Medeniyet University Göztepe Training and Research Hospital Clinical Research Ethics Committee, dated 16.03.2022 and numbered 2022/0145. Informed consent was obtained from the participants in this study.

The data obtained at the end of the study were evaluated with the SPSS 22 (IBM, NY) package program²¹. The number and percentage values of the participants in the variable groups and the mean and standard deviation values of the scale scores were calculated. Independent samples T test, Pearson correlation and regression analyzes were performed to evaluate the relationship between intuitive eating scale scores and other scale scores and body mass index. $P < 0.05$ was considered statistically significant.

RESULTS

The mean age of the university students participating in this study was 21.7 ± 2.7 years. 62 of the students are female and 38 are male. It was determined that the average of the students' body mass index (BMI) values was 22.8 ± 4.6 kg/m².

Demographic characteristics of the participants are given in Table 1. 62.0% (n=62) of the participants were female and 38.0% (n=38) were male. It was determined that 68.0% of the participants had irregular sleeping hours. Only 32% of individuals evaluated themselves as happy. The monthly income of 62.0% of the participants is below 357 \$.

Table 1. Demographic characteristics of the participants

Demographic features	N	%
Gender		
Female	62	62.0
Male	38	38.0
Who do you live with?		
With family	47	47.0
Alone	7	7.0
At home with friend	14	14.0
In the dormitory	32	32.0
Smoking		
No	73	73.0
Yes	27	27.0
Alcohol use		
No	71	71.0
Yes	29	29.0
Presence of chronic disease		
No	92	92.0
Yes	8	8.0
Have you ever used antidepressants?		
No	92	92.0
Yes	8	8.0
Are bedtimes regular?		
Yes	32	32.0
No	68	68.0

Table 1 continuation. Demographic characteristics of the participants

Demographic features	N	%
General mood assessment		
Happy	31	32.0
Anxious	21	21.0
Annoyed	21	21.0
Tired	18	18.0
Other	9	9.0
Physical activity		
I never do	36	36.0
2-3 days a week	25	25.0
Mmore than 3 days a week	9	9.0
1 day per week	30	30.0
Income status		
<255 \$	35	35.0
255-357 \$	27	27.0
357-765 \$	31	31.0
>765 \$	7	7.0

Table 2 shows the distribution of the participants according to their meal skipping, consuming delicious food, intuitive eating, hedonic hunger and body mass index classes. It was determined that 90.0% of the individuals had the habit of skipping meals. It was determined that the most common reason for skipping meals was reluctance to eat. 53.0% of the participants stated that they were satisfied with their body weight and 62.0% stated that they had not applied a weight loss diet before. It was determined that 93.0% of the participants had a low tendency to consume palatable food, 44% had hedonic hunger, and 60.0% had a weight within normal limits. It was determined that 53.0% of the participants had intuitive eating.

Table 3 evaluates the relationship between participants' consuming delicious food, intuitive eating, hedonic hunger, excessive food consumption, sleep quality, mental well-being and body mass indexes. PEMS score was positively correlated with hedonic hunger ($r=0.424$, $p<0.01$), FCQ-T score ($r=0.242$, $p<0.05$) and PUKI score ($r=0.237$, $p<0.05$). A positive correlation was found between intuitive eating and hedonic hunger ($r=0.332$, $p<0.01$) and mental well-being ($r=0.375$, $p<0.01$). Intuitive eating was found to be negati-

Table 2. The distribution of the participants according to their meal skipping, consuming delicious food, intuitive eating, hedonic hunger and body mass index classes

	N	%
Meal skipping status		
Yes	40	40.0
No	10	10.0
Sometimes	50	50.0
Reason for skipping meals		
Because I join	17	17.0
Because I don't want	40	40.0
Because I can't find the time	22	22.0
Other	21	21.0
How do you find your weight?		
I am satisfied with my current weight	53	53.0
I wish I was weaker	32	32.0
I wish I was heavier	15	15.0
Weight loss diet application status		
Yes	38	38.0
No	62	62.0
Delicious food consumption scale		
High tendency to consume delicious foods	7	7.0
Low tendency to consume tasty foods	93	93.0
Intuitive Eating		
Intuitive eaters	53	53.0
Non-intuitive eaters	47	47.0
Food power scale		
There is hedonic hunger and influence from food	44	44.0
No hedonic hunger and no influence from food	56	56.0
Body Mass Index		
<18.5 Underweight	13	13.0
18.5-24.9 Normal Weight	60	60.0
25.0-29.9 Lightweight	19	19.0
≥ 30 Obese	8	8.0

Table 3. The correlation between participants' consuming delicious food, intuitive eating, hedonic hunger, excessive food consumption, sleep quality, mental well-being and body mass indexes.

	PEMS	IES-2	PFS-Tr	FCQ-T	PUKI	WEMWBS	BMI
Palatable Eating Motivational Scale score (PEMS)	1						
Intuitive Eating Score (IES-2)	-0.033	1					
Power of Food Scale (PFS-Tr)	0.321	0.332	1				
Food Craving Questionnaire Score (FCQ-T)	0.322	-0.413	-0.054	1			
Pittsburgh Sleep Quality Score (PSQI)	0.198	-0.06	0.11	-0.003	1		
Mental well-being score (WEMWBS)	-0.002	0.375	0.405	-0.528	-0.077	1	
Body Mass Index (BMI)	0.091	-0.202	0.096	0.05	-0.023	0.167	1

† Independent samples T test. p<0.05.

vely correlated with food cravings (r=-0.413, p<0.01) and body mass index (r=-0.202, p<0.05). It was determined that mental well-being was positively correlated with hedonic hunger (r=0.405, p<0.01) and negatively correlated with excessive food cravings (r=-0.528, p<0.01).

In Table 4, hedonic hunger, excessive food cravings, Pittsburgh sleep quality, mental well-being, palatable food consumption motivation scores and body mass indexes of intuitive and non-intuitive eaters were compared. Intuitive eaters have higher food power and mental well-being scale sco-

Table 4. Comparison of power of scale, excessive food cravings, Pittsburgh sleep quality, mental well-being, palatable food consumption motivation scores and body mass indexes of intuitive and non-intuitive eaters

intuitive eating	N	Mean	SD	SE	F	df1	df2	p
Power of Food Scale Score (PFS-Tr)								
Intuitive eaters	53	2.45	0.798	0.1096	7.72	1	92.8	0.007
Non-intuitive eaters	47	1.98	0.897	0.1308				
Food Craving Questionnaire Score (FCQ-T)								
Intuitive eaters	53	103.26	44.09	6,056	14.05	1	86.9	<0.001
Non-intuitive eaters	47	141.49	56.25	8,204				
Pittsburg Sleep Quality Scale Score (PSQI)								
Intuitive eaters	53	6.3	2.83	0.389	1.03	1	97.9	0.313
Non-intuitive eaters	47	6.85	2.58	0.376				
Warwick-Edinburgh Mental well-being Sacle Score (WEMWBS)								
Intuitive eaters	53	51.15	12.79	1,757	11.74	1	82.6	<0.001
Non-intuitive eaters	47	40.43	17.76	2.59				
Body Mass Index (BMI)								
Intuitive eaters	53	21.81	3.62	0.498	5.29	1	80.3	0.024
Non-intuitive eaters	47	23.91	5.26	0.767				
Palatable Eating Motivational Sacle Score (PEMS)								
Intuitive eaters	53	1.53	0.749	0.1029	0.24	1	97.2	0.622
Non-intuitive eaters	47	1.6	0.614	0.0895				

† Independent samples T test. p<0.05.

res; food craving scale scores and body mass index values were found to be lower.

Table 5 presents the results of the multivariate linear regression analysis to evaluate the effects of participants' motivation to consume palatable food, hedonic hunger, cravings for food, sleep quality, mental well-being and body mass indexes on intuitive eating. As a result of the analysis, it was determined that there was a significant regression model, $F(6,93)=7,644$, $p<0,01$). Accordingly, 28.7% of the variance of the intuitive eating score ($R^2_{\text{adjusted}}=0.287$) was found to be explained by hedonic hunger, food cravings and BMI. Hedonic hunger ($\beta=0.296$, $t(93)=2.870$, $p<0.01$, $pr2=0.330$) significantly affects intuitive eating; on the other hand, the desire to food cravings ($\beta=-0.330$, $t(93)=-3.025$, $p<0.01$, $pr2=-0.098$) and body mass index ($\beta=-0.237$, $t(93)=-2.713$, $p<0.01$, $pr2=-0.828$) affects intuitive eating negatively and significantly.

the students felt anxious (Table 1). This study is in agreement with other work. Abdulla et al.²⁴ found in their study that 29.4% of university students did not engage in physical activity. In this study, it was observed that 36% of the students did not engage in physical activity (Table 1). It was observed that university students should be directed to increase physical activity.

It was determined that the majority of university students had the habit of irregular eating and skipping meals²⁵. In this study, the rate of university students who skipped meals was found to be 90.0% (Table 2). Based on this result, it is thought that university students are likely to experience health problems caused by inadequate nutrient intake in the future.

Weight gain and obesity is a health problem that also affects university students²⁶. In this study, it was determined that 32.0% of the students wanted to be thinner. (Table 2).

Table 5. The results of the multivariate linear regression analysis to evaluate the effects of participants' motivation to consume palatable food, hedonic hunger, cravings for food, sleep quality, mental well-being and body mass indexes on intuitive eating

	Unstandardized		Standardized		R ² adjusted	P
	B	Std. error	β	t		
Constant (Intuitive eating score) (IES-2)	89,804	9.81		9,153	0.287	0,000
Palatable Eating Motivational Sacle Score (PEMS)	0.017	0.117	0.015	2.87		0.885
Power of Food Scale Socre (PFS-Tr)	0.330	0.115	0.296	2.87		0.005
Food Craving Questionnaire Score (FCQ-T)	-0.098	0.032	-0.33	-3,025		0.003
Pittsburg Sleep Quality Scale Score (PSQI)	-0.549	0.522	-0.094	-1,051		0.296
Warwick-Edinburgh Mental well-being Sacle Score (WEMWBS)	0.110	0.114	0.112	0.965		0.337
Body Mass Index (BMI)	-0.828	0.305	-0.237	-2,713		0.008

† Linear Regression. $p<0,05$.

DISCUSSION

In this study, the relationship between intuitive eating, hedonic hunger, sleep quality and body mass index of university students was investigated.

Sleep disorders are common among university students²². In this study, it was determined that 68.0% of the students had irregular sleeping hours (Table 1). Sleep disorders can adversely affect the health of university students.

Studies have shown that young adults are vulnerable to mental stress. In addition, various conditions that can disrupt daily and academic life have been associated with the deterioration of students' mental health and increased feelings of unhappiness²³. In this study, it was determined that 21.0% of

Accordingly, a difference was found between the proportions of individuals who want to lose weight and those who need to lose weight. It was observed that some of the participants wanted to lose weight even though they did not need to lose weight. This suggests that some students may be at risk of developing an eating disorder.

Hedonic hunger occurs by suppressing various emotional states or as a reaction to emotional states, and may lead to the behavior of enjoying delicious food and overeating out of necessity. While the hunger that occurs when the need for energy develops causes the tendency to eat in the individuals, the desire to consume the foods that the individual enjoys develops without energy deprivation. Hedonic hunger can activate the desire for intense consumption of foods with

high fat and energy content, which are defined as delicious foods²⁷. In this study, a positive correlation ($r=0.424$, $p<0.01$) was found between these two variables (Table 3). This study supports the previous study.

Poor sleep quality in university students increased the tendency to consume delicious foods. In a study conducted by Açıık et al.⁶, a positive correlation was found between Pittsburgh sleep quality score and palatable food consumption motivation scale score. In a study by Abdulla et al.²⁶ it was concluded that deterioration in sleep quality supports the tendency to consume palatable food. In this study, it was observed that there was a positive relationship between the deterioration in sleep quality and the tendency to consume palatable food (Table 3) ($r=0.237$, $p<0.05$). This study shows parallelism with previous studies.

Karakaş and Saka²⁸ found a negative relationship between intuitive eating and hedonic hunger. In this study, a positive relationship was found between intuitive eating and hedonic hunger (Table 3) ($r=0.332$, $p<0.05$). In this study, it was found that the mean score of the food power scale was higher in individuals with intuitive eating (2.45 ± 0.79) than in individuals without intuitive eating (1.98 ± 0.89) (Table 4) ($p<0.01$). These two studies contradict each other. There are not many studies on the relationship between intuitive eating and hedonic hunger and more comprehensive studies are needed.

In a study conducted by Karakaş and Saka²⁸, it was determined that there is a negative relationship between intuitive eating and excessive food cravings. In this study, a negative relationship was observed between intuitive eating and excessive food cravings (Table 3) ($r=-0.413$, $p<0.05$). In addition, it was also found that individuals with intuitive eating had lower mean scores on the food craving questionnaire score (103.26 ± 44.09) compared to individuals who did not eat intuitively (141.49 ± 56.25) (Table 4) ($p<0.01$). The result found in this study is consistent with the previous study.

It is stated that there is a positive relationship between mental well-being and intuitive eating²⁹. In this study, a positive correlation was found between mental well-being and intuitive eating (Table 3) ($r=0.375$, $p<0.05$). In addition, it was determined that the mental well-being scale mean scores of individuals with intuitive eating (51.15 ± 12.79) were higher than individuals without intuitive eating (40.43 ± 17.76) (Table 4) ($p<0.01$). This study supports the results of previous research.

It has been determined that there is a negative relationship between intuitive eating and BMI³⁰. In this study, an inverse relationship was found between intuitive eating and BMI (Table 3) ($r=-0.202$, $p<0.05$). It was determined that the mean BMI of individuals with intuitive eaters (21.81 ± 3.62) was lower than individuals who did not eat intuitively (23.91 ± 5.26) (Table 4) ($p<0.05$). Intuitive eating behavior has once again been found to support weight control. It is important to encourage intuitive eating to ensure weight control.

In this study, 28.7% ($R^2_{\text{adjusted}}=0.287$) of the variance of intuitive eating was explained by palatable food motivation, hedonic hunger, cravings, sleep quality, mental well-being, and BMI. Here, the most effective variables were determined to be hedonic hunger, excessive food cravings and BMI (Table 5).

CONCLUSION

The aim of this study was to evaluate the relationship between intuitive eating, hedonic hunger states, sleep quality and body mass index of university students. It was observed that obesity is not very common among university students and mean BMI values are within normal limits. It was observed that the majority of the students had a low tendency to consume palatable food, had an intuitive diet and did not have hedonic hunger. This situation also coincides with BMI values. Intuitive eating has a positive aspect with hedonic hunger and mental well-being; It was found that there is a negative correlation with excessive food cravings and BMI. Poor sleep quality supports the motivation for palatable eating. In the light of all these findings, it can be said that mental state, sleep quality and eating behaviors of university students may be related. It is important to improve mental state and sleep quality in order to prevent hedonic hunger and prevent obesity in university students.

STUDY LIMITATIONS

The limitations of this study are that it was conducted online and not many participants could be reached. If the number of samples in the study increased, the relationships between variables could be seen more clearly.

REFERENCES

1. Chmurzynska A, Młodzik-Czyżewska MA, Radziejewska A, Wiebe DJ. Hedonic Hunger Is Associated with Intake of Certain High-Fat Food Types and BMI in 20- To 40-Year-Old Adults. *J Nutr.* 2021; 151(4):820–5.
2. Craven MP, Fekete EM. Weight-related shame and guilt, intuitive eating, and binge eating in female college students. *Eat Behav [Internet].* 2019;33(March):44–8. Available from: <https://doi.org/10.1016/j.eatbeh.2019.03.002>
3. Ruzanska UA, Warschburger P. Intuitive eating mediates the relationship between self-regulation and BMI - Results from a cross-sectional study in a community sample. *Eat Behav [Internet].* 2019;33(May 2018):23–9. Available from: <https://doi.org/10.1016/j.eatbeh.2019.02.004>
4. Şarahman Kahraman C, Akçıl Ok M. Hedonic hunger status and related factors in adults. *Perspect Psychiatr Care [Internet].* 2022 Oct 29;58(4):2099–106. Available from: <https://onlinelibrary.wiley.com/doi/10.1111/ppc.13036>
5. Aliasghari F, Yaghin NL, Mahdavi R. Relationship between hedonic hunger and serum levels of insulin, leptin and BDNF in the Iranian population. *Physiol Behav.* 2019;199(November 2018):84–7.

6. Açık M, Bozdağ ANS, Çakiroğlu FP. The quality and duration of sleep are related to hedonic hunger: a cross-sectional study in university students. *Sleep Biol Rhythms* [Internet]. 2021;19(2):163–72. Available from: <https://doi.org/10.1007/s41105-020-00303-8>
7. Kilkus JM, Booth JN, Bromley LE, Darukhanavala AP, Imperial JG, Penev PD. Sleep and Eating Behavior in Adults at Risk for Type 2 Diabetes. *Obesity* [Internet]. 2012 Jan;20(1):112–7. Available from: <http://doi.wiley.com/10.1038/oby.2011.319>
8. Vidafar P, Cain SW, Shechter A. Relationship between sleep and hedonic appetite in shift workers. *Nutrients*. 2020;12(9):1–9.
9. Ogden J, Pavlova E, Fouracre H, Lammymann F. The impact of intuitive eating v. pinned eating on behavioural markers: A preliminary investigation. *J Nutr Sci*. 2020;9:1–6.
10. Quansah DY, Gross J, Gilbert L, Helbling C, Horsch A, Puder JJ. Intuitive eating is associated with weight and glucose control during pregnancy and in the early postpartum period in women with gestational diabetes mellitus (GDM): A clinical cohort study. *Eat Behav* [Internet]. 2019;34(May):101304. Available from: <https://doi.org/10.1016/j.eatbeh.2019.101304>
11. Özkan N, Bilici S. Yeme Davranışında Yeni Yaklaşımlar: Sezgisel Yeme ve Yeme Farkındalığı. *Gazi Sağlık Bilim Derg* [Internet]. 2018;3(2):16–24. Available from: <https://dergipark.org.tr/tr/pub/gsbdergi/issue/37812/432979>
12. Saunders JF, Nichols-Lopez KA, Frazier LD. Psychometric properties of the intuitive eating scale-2 (IES-2) in a culturally diverse Hispanic American sample. *Eat Behav* [Internet]. 2018; 28(November 2017):1–7. Available from: <https://doi.org/10.1016/j.eatbeh.2017.11.003>
13. Messer M, McClure Z, Lee S, Linardon J. Bidirectional relationships between intuitive eating and shape and weight overvaluation, dissatisfaction, preoccupation, and fear of weight gain: A prospective study. *Body Image* [Internet]. 2021;39:227–31. Available from: <https://doi.org/10.1016/j.bodyim.2021.09.001>
14. Linardon J, Mitchell S. Rigid dietary control, flexible dietary control, and intuitive eating: Evidence for their differential relationship to disordered eating and body image concerns. *Eat Behav* [Internet]. 2017;26:16–22. Available from: <http://dx.doi.org/10.1016/j.eatbeh.2017.01.008>
15. Bas M, Karaca KE, Saglam D, Artıcı G, Cengiz E, Köksal S, et al. Turkish version of the Intuitive Eating Scale-2: Validity and reliability among university students. *Appetite*. 2017;114:391–7.
16. Ulker I, Ayyıldız F, Yıldırım H. Validation of the Turkish version of the power of food scale in adult population. *Eat Weight Disord* [Internet]. 2021;26(4):1179–86. Available from: <https://doi.org/10.1007/s40519-020-01019-x>
17. MÜFTÜOĞLU S, KIZILTAN G, AKÇİL OK M. Adaptation of "Food Craving Questionnaire" for Major Depression Patients into Turkish Culture: A Validity and Reliability Study. *Türkiye Klin J Heal Sci*. 2017;2(1):13–22.
18. Ağgün M, Kara H, Anlar Ö. The Validity and Reliability of the Pittsburgh Sleep Quality Index. *Türk Psikiyatr Derg* [Internet]. 1996;7(2):107–15. Available from: <http://psikiyatridizini.net/viewarticle.aspx?articleid=2668>
19. Keldal G. Turkish version of the Warwick-Edinburgh Mental Well-Being Scale: A validity and reliability study. *J Happiness Well-Being*. 2015;3(1):103–15.
20. Hayzaran M. Determination of the university student's hedonic hunger status with different scales [Internet]. Baskent University; 2018. Available from: <https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=5LFwSnzx2vfHBVOJH3yPmg&no=5LtSpnUKrhzCKCyGJPj97A>
21. SPSS-22. IBM SPSS Statistics Software.
22. Aşıl R, Yıldırım A, Cebi K, Şahin H. Investigation of the Relationship Between Eating Attitudes and Sleep Quality in University Students. *Turkish J Fam Med Prim Care* [Internet]. 2020 Mar 20;14(1):3–14. Available from: <https://dergipark.org.tr/tr/doi/10.21763/tjfmprc.692865>
23. Cao W, Fang Z, Hou G, Han M, Xu X, Dong J, et al. The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res* [Internet]. 2020;287(March):112934. Available from: <https://doi.org/10.1016/j.psychres.2020.112934>
24. Abdulla NK, Obaid RR, Qureshi MN, Asraiti AA, Janahi MA, Abu Qiyas SJ, et al. Relationship between hedonic hunger and subjectively assessed sleep quality and perceived stress among university students: A cross-sectional study. *Heliyon* [Internet]. 2023 Apr;e14987. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2405844023021941>
25. Kabakuş Aykut M, Bilici S. The relationship between the risk of eating disorder and meal patterns in University students. *Eat Weight Disord* [Internet]. 2022;27(2):579–87. Available from: <https://doi.org/10.1007/s40519-021-01179-4>
26. Abdulla NK, Obaid RR, Qureshi MN, Asraiti AA, Janahi MA, Abu Qiyas SJ, et al. Relationship between hedonic hunger and subjectively assessed sleep quality and perceived stress among university students: A cross-sectional study. *Heliyon*. 2023 Apr;e14987.
27. Taş F, Gezer C. The relationship of hedonic hunger with food addiction and obesity in university students. *Eat Weight Disord* [Internet]. 2022;27(7):2835–43. Available from: <https://doi.org/10.1007/s40519-022-01436-0>
28. Karakaş HM, Saka M. BAŞKENT ÜNİVERSİTESİ SAĞLIK BİLİMLERİ FAKÜLTESİ DERGİSİ Obez Olan ve Olmayan Yetişkin Bireylerde Sezgisel Yeme Davranışının Hedonik Açlık ve Aşırı Besin İsteği İle İlişkinin Belirlenmesi Determination of the Relationship Between Intuitive Eating Behavior. *Başkent Üniversitesi Sağlık Bilim Fakültesi Derg*. 2021;6:53–69.
29. Linardon J, Tylka TL, Fuller-Tyszkiewicz M. Intuitive eating and its psychological correlates: A meta-analysis. *Int J Eat Disord*. 2021;54(7):1073–98.
30. Camilleri GM, Méjean C, Bellisle F, Andreeva VA, Kesse-Guyot E, Hercberg S, et al. Intuitive eating is inversely associated with body weight status in the general population-based NutriNet-Santé study. *Obesity*. 2016;24(5):1154–61.

Bebida helada de jengibre (*Zingiber officinale*) con miel de abeja

Iced ginger beverage (*Zingiber officinale*) with bee honey

Suannie Vanessa MENDOZA LUNA¹, Luis Humberto VÁSQUEZ CORTEZ², Edgar Rodolfo PINARGOTE MENDOZA¹, Sanyi Lorena RODRÍGUEZ CEVALLOS¹

1 Facultad de Ciencias de la Industria y Producción, Carrera de Ingeniería en Alimentos, Universidad Técnica Estatal de Quevedo, Los Ríos, Ecuador.

2 Facultad de Ciencias Agropecuarias, Carrera de Ingeniería en Agroindustria, Universidad Técnica de Babahoyo, Los Ríos, Ecuador.

Recibido: 29/abril/2024. Aceptado: 27/mayo/2024.

RESUMEN

Introducción: El consumo frecuente de bebidas azucaradas refleja un estilo de vida caracterizado por la conveniencia y la falta de tiempo, siendo una elección común entre familias y niños. La miel y el jengibre, reconocidos por sus propiedades antioxidantes y antibacterianas, fueron combinados en diferentes proporciones para desarrollar una alternativa más saludable. Este estudio busca analizar las características fisicoquímicas, microbiológicas y organolépticas de estas bebidas, además de determinar su relación beneficio/costo.

Objetivos: Evaluar las características fisicoquímicas, microbiológicas y organolépticas de bebidas elaboradas con miel y jengibre en diferentes proporciones, verificar si cumplen con la normativa del Servicio Ecuatoriano de Normalización (INEN), denominada INEN 2337.

Material y Métodos: Las muestras se analizaron en el laboratorio de Bromatología de la Universidad Técnica Estatal de Quevedo. Se evaluaron variables fisicoquímicas como °Brix y pH, y se realizó un análisis microbiológico para detectar mohos-levaduras y aerobios totales. El perfil organoléptico se evaluó con 80 catadores semientrenados. Se utilizó un diseño completamente al azar con comparación de Tukey ($p > 0.05$) para el análisis estadístico.

Resultados: Los parámetros fisicoquímicos fueron característicos de una bebida inocua, con ausencia de microorga-

nismos. El tratamiento T5 (5% jengibre, 15% miel, 80% agua) fue el más aceptado, presentando color amarillo pálido, aroma y sabor a miel.

Conclusiones: Las bebidas desarrolladas cumplen con los estándares de calidad establecidos, ofreciendo una alternativa saludable a las bebidas azucaradas comerciales. El tratamiento T5 se destacó por su aceptabilidad organoléptica.

PALABRAS CLAVES

Antioxidantes, análisis fisicoquímicos, organolépticos, microbiológicos.

ABSTRACT

Introduction: The frequent consumption of sugary beverages reflects a lifestyle characterized by convenience and lack of time, being a common choice among families and children. Honey and ginger, recognized for their antioxidant and antibacterial properties, were combined in different proportions to develop a healthier alternative. This study aims to analyze the physicochemical, microbiological, and organoleptic characteristics of these beverages, as well as to determine their cost-benefit ratio.

Objectives: To evaluate the physicochemical, microbiological, and organoleptic characteristics of beverages made with honey and ginger in different proportions, verify whether they comply with the regulations of the Servicio Ecuatoriano de Normalización (INEN), known as INEN 2337.

Materials and Methods: Samples were analyzed at the Bromatology laboratory of the Technical State University of Quevedo. Physicochemical variables such as °Brix and pH

Correspondencia:

Luis Humberto Vásquez Cortez
lvazquezc@utb.edu.ec

were evaluated, and a microbiological analysis was conducted to detect molds-yeasts and total aerobes. The organoleptic profile was assessed with 80 semi-trained tasters. A completely randomized design with Tukey comparison ($p > 0.05$) was used for statistical analysis.

Results: The physicochemical parameters were characteristic of a harmless beverage, with absence of microorganisms. Treatment T5 (5% ginger, 15% honey, 80% water) was the most accepted, presenting a pale-yellow color, honey aroma, and flavor.

Conclusions: The developed beverages meet established quality standards, offering a healthier alternative to commercial sugary drinks. Treatment T5 stood out for its organoleptic acceptability.

KEYWORDS

Antioxidants, physicochemical analysis, organoleptic, microbiological.

INTRODUCCIÓN

El rápido aumento de personas afectadas por enfermedades como la obesidad y la desnutrición se debe en gran medida a una dieta deficiente¹. El consumo generalizado de bebidas azucaradas refleja el estilo de vida actual, donde la conveniencia y la falta de tiempo llevan a familias enteras y niños en edad escolar a consumirlas a diario².

El exceso de consumo de bebidas azucaradas y carbonatadas incrementa el riesgo de padecer enfermedades crónicas degenerativas, como el sobrepeso, la obesidad y la malnutrición³. Estas bebidas, ampliamente disponibles en el mercado, reflejan el estilo de vida de las personas. El fácil acceso a productos económicos y la falta de tiempo hacen que estas bebidas sean consumidas a diario por familias enteras y niños en edad escolar⁴.

El consumo de estas bebidas no solo priva al cuerpo de nutrientes esenciales, sino que también aumenta el riesgo de padecer sobrepeso⁵. Esto se debe principalmente a la rápida liberación de insulina que ocurre cuando se ingieren bebidas gaseosas, lo que puede llevar al agotamiento del cuerpo⁶. El exceso de azúcar se convierte en grasa y se acumula en el hígado, ya que el organismo tiene dificultades para eliminarla⁷.

El jengibre, conocido científicamente como *Zingiber officinale*, es una planta medicinal reconocida por sus propiedades antiinflamatorias que pueden ayudar a combatir una variedad de enfermedades, incluyendo problemas respiratorios, artrosis, diabetes y trastornos digestivos. Además, se ha sugerido que el consumo de jengibre puede contribuir al proceso de adelgazamiento. Su distintivo sabor picante y aromático lo hace ideal para ser consumido con moderación y en combinación con otros alimentos.

Este rizoma es rico en aceites esenciales, vitaminas, minerales, antioxidantes y aminoácidos, lo que lo convierte en un verdadero tesoro para la salud humana⁸. Por lo tanto, su consumo va más allá de una simple recomendación, dadas las numerosas ventajas que ofrece para el bienestar general del cuerpo⁹.

La miel es un producto elaborado por las abejas domésticas a partir del néctar de las plantas, que es recolectado, modificado y almacenado en las colmenas¹⁰. Este néctar es recogido por las abejas mientras liban las flores y lo llevan a su saco para miel durante sus excursiones en el campo¹¹. En las colmenas, las abejas depositan este néctar transformado en miel en celdas abiertas con forma hexagonal, que ellas mismas construyen utilizando la cera que segregan a través de glándulas especiales¹². Estas celdas están diseñadas para estar bien ventiladas, lo que promueve la pérdida de agua y la hidrólisis de la sacarosa, proceso conocido como maduración de la miel¹³.

El *Zingiber officinale* Esta raíz es abundante en antioxidantes, algunos de los cuales le otorgan su distintivo aroma, color y sabor picante¹⁴. Además de ser antiinflamatorio y antibacterial, el jengibre ofrece una oportunidad para la creación de una bebida helada combinada con miel de abeja, un endulzante natural que proporciona nutrientes esenciales y energía. Esta bebida sería beneficiosa para la población al ofrecer una alternativa saludable a las bebidas azucaradas, ayudando así a prevenir enfermedades gracias a las propiedades combinadas de ambos ingredientes.

La miel es un alimento multifuncional que desempeña diversas funciones en la naturaleza, como cicatrizar heridas, hidratar la piel, preparar jarabes, regular el funcionamiento intestinal y fortalecer el sistema inmunológico¹⁵. Sin embargo, en el país se aprovecha de manera limitada este producto, ya sea por falta de conocimiento acerca de sus propiedades o por la falta de interés de las industrias en su procesamiento¹⁶.

Entre las materias primas que el gobierno ha buscado impulsar figura el jengibre; sin embargo, su consumo potencial se ha centrado en presentación fresca.

El gobierno se ha comprometido a transformar la matriz productiva, promoviendo la creación de productos con valor agregado que aprovechen las diversas materias primas disponibles en el país. Una de estas materias primas es el jengibre, pero su potencial de consumo radica principalmente en su forma fresca, y a nivel local existe un mayor interés en consumirlo en su estado de raíz.

El propósito es crear un producto accesible y fácil de consumir para la población, centrado en promover la salud y el bienestar al combinar las propiedades medicinales del jengibre con los componentes nutritivos de la miel de abeja.

Además, a través de análisis exhaustivos y una investigación detallada, se busca crear una alternativa de producto que fomente y estimule tanto la producción de jengibre como la de miel de abeja, con el fin de lograr que el producto tenga mayor auge e incluyendo métodos amigables con la salud y el medio ambiente.

El objetivo principal de la investigación es obtener una bebida helada de jengibre (*Zingiber officinale*) con diferentes concentraciones (5%, 7.5%, 10%, 12.5%, 15%) de miel de abeja

MATERIALES Y METODOS

Localización

La investigación se realizó en el Campus Experimental "La María", perteneciente a la Facultad de Ciencias Pecuarias de la Universidad Técnica Estatal de Quevedo, localizada en el Km 7 1/2 de la vía Quevedo – El Empalme, Recinto San Felipe, entrada al Cantón Mocache, Provincia de Los Ríos. Entre las coordenadas geográficas de 01° 06' de latitud sur y 79° 29' de longitud oeste a una altura de 120 msnm (Vásquez et al., 2022).

Diseño de la investigación

El estudio se llevó a cabo utilizando un Diseño Completamente al Azar (DCA), que constaba de 5 tratamientos con 5 repeticiones cada uno. Se empleará la prueba de Tukey ($p \leq 0.05$) para comparar las medias de los diferentes tratamientos, como se muestra en la Tabla 1.

Tabla 1. Esquema de Análisis de Varianza.

Fuente Devariación	Fórmula	Grados Delibertad
Tratamiento	t-1	4
Error experimental	t(r-1)	20
Total	t*(r-1)	24

Tabla 2. Esquema del experimento

Tratamientos	Jengibre/agua/miel de abeja (%)	Repeticiones	Unidad experimental (40 g)	Subtotal (g)
T1	5/90/5	5	1	200
T2	5/87.5/7.5	5	1	200
T3	5/85/10	5	1	200
T4	5/82.5/12.5	5	1	200
T5	5/80/15	5	1	200
	Total			1000

Tratamiento de los datos

Según la tabla 2, se observa el arreglo de los tratamientos de los objetos de estudio y su respectiva descripción.

Proceso de elaboración de la bebida helada

Para la elaboración de la bebida helada de jengibre con miel de abeja, como alimento funcional para el organismo humano se trabajó bajo el diagrama de flujo que se puede observar en la Figura 1.

Se realizó una inspección previa para asegurar que los ingredientes se encontraran en buenas condiciones y en caso del jengibre libres de pudrición, sin apariencia verdosa ya que eso originaría mayor sabor a picante (jengibre 250g).

Se realizó el lavado de la materia prima, retirando todo exceso de tierra, se dio seguimiento con el proceso de troceado, para luego proceder a colocar en una licuadora, por el tiempo de 1 minuto con 30s.

Se procedió a tamizar, con ayuda de un lienzo, extrayendo los residuos de jengibre, del cual existió una pérdida de masa de 75 g y 175 g de extracto.

Se mezcló el agua, el extracto del jengibre y la miel que cumplió con el 15% equivalente a 750 g para obtener una sustancia completamente homogénea. La pasteurización se realizó a alcanzar una temperatura de 100°C, por 1 minuto, para garantizar la conservación en el tiempo del producto. Cantidad obtenida 4735 mL.

Se dejó reposar a temperatura ambiente por 10 minutos y se envasó botellas de vidrio de 500 mL.

Una vez envasada la bebida se colocaron las botellas a baño maría a una temperatura de 55°C por 30 minutos, transcurrido el tiempo se realizó un choque térmico a base de agua helada y hielo. El producto final, ya almacenado en sus respectivos envases (500 mL) se colocó en refrigeración a una temperatura promedio de 4°C.

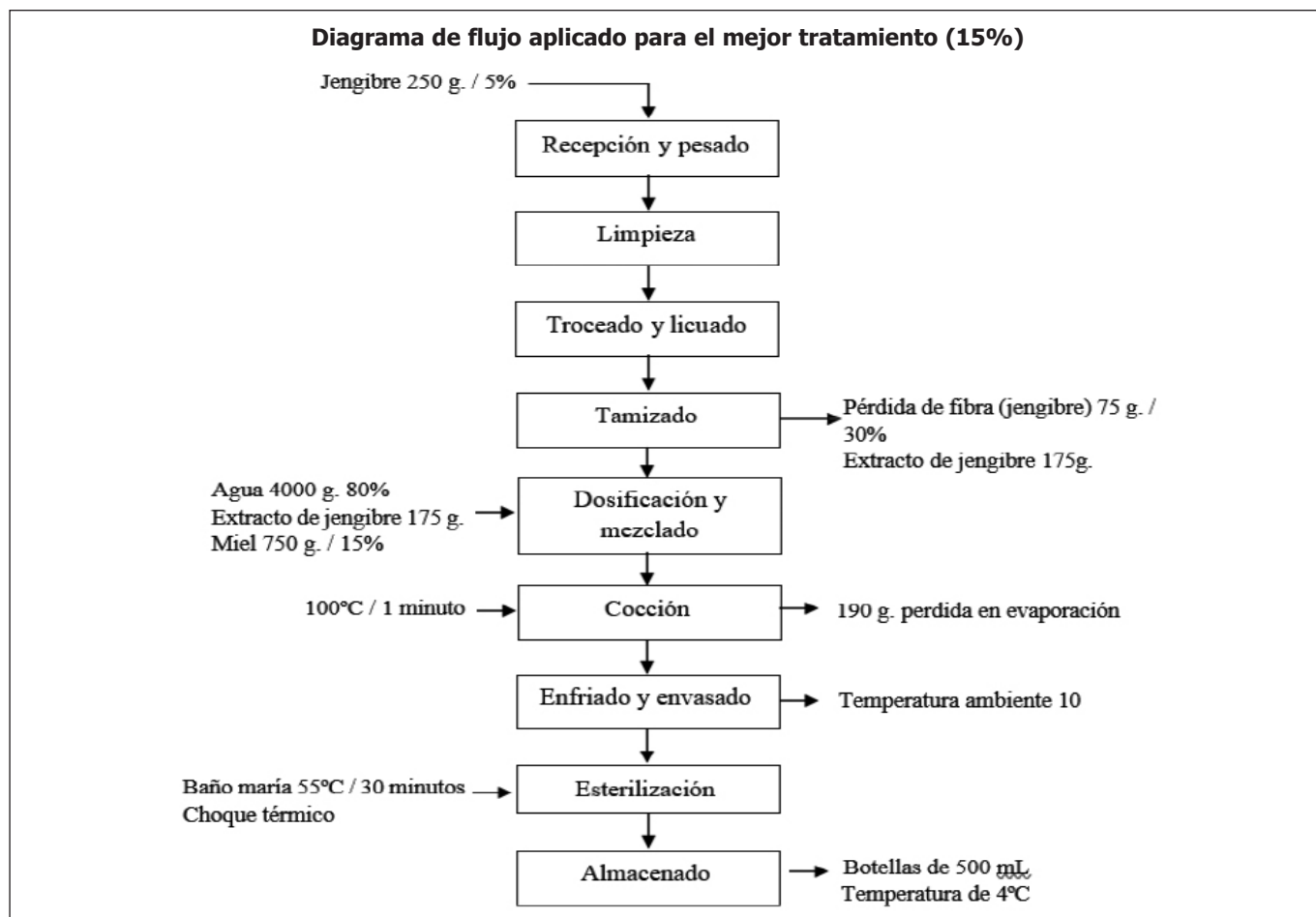


Figura 1. Diagrama de flujo de una bebida de jengibre con miel de abeja

Análisis físicos y químicos

°**Brix**: sistema de medición que sirve para determinar el porcentaje de sólidos solubles en la conservación de alimentos. El análisis se establecerá basado en la norma NTE INEN-ISO 2172, para determinación de sólidos solubles en productos derivados de las frutas por lectura en el refractómetro¹⁸.

Procedimiento

Realizar la limpieza al lente del refractómetro.

Colocar una pequeña muestra en el lente Se procede a tomar lectura.

pH: Es una medida que expresa el grado de acidez o basicidad de una solución que se utiliza principalmente en la elaboración de productos alimenticios como un indicador de las condiciones higiénicas. Se establecerá la norma NTE INEN-ISO 1842 (Vásquez et al., 2023).

Procedimiento

- Pesar la muestra y colocar en vaso de precipitación.
- Tomar 50 ml de agua destilada.

- Limpiar y regular el pH-metro.
- Disolver la muestra en agua destilada.
- Ubicar el electrodo en el vaso y proceder a la lectura.

Análisis sensoriales

Se realizó el análisis sensorial para determinar el mejor tratamiento (aceptabilidad). Evaluándose los parámetros de color, olor, sabor y aceptabilidad; este se obtuvo con la ayuda de 80 panelistas semi entrenados, los que tuvieron la tarea de elegir al mejor tratamiento con base en los siguientes atributos presentados.

Olor

Para analizar este atributo, se entregó a cada panelista las respectivas muestras de la bebida helada de jengibre (*Zingiber officinale*) y niveles de miel de abeja en cada tratamiento, además se facilitó una ficha que contiene todas las indicaciones y parámetros a calificar, aquí los panelistas tuvieron la tarea de respirar profundamente para arrastrar el aroma de acuerdo con los parámetros.

Color

Para establecer el atributo del color, los panelistas deberán que siguieron la guía que tenía toda la información y parámetros a calificar, de acuerdo con sus apreciaciones realizaron sus observaciones, mediante los parámetros de transparente, amarillo pálido, amarillo luminoso dorado, ámbar.

Sabor

Para calificar la variable sabor, los panelistas tuvieron la tarea de elegir cuál de las muestras que se les facilitó durante la evaluación, presenta variabilidad en la intensidad del sabor, de acuerdo con los parámetros.

Análisis microbiológico

Se estableció una normativa que indica los análisis microbiológicos que se realizaron en la bebida, entre los que se evaluaron fueron, mohos – levaduras y aerobios totales (NTE INEN 2337), para la seguridad y garantía del producto.

RESULTADOS

Valoración de los análisis organolépticos

El análisis sensorial permitió determinar por parte de los catadores el sabor, olor, color y aceptabilidad, según los promedios obtenidos de cada característica, se muestra en la Tabla 3. Este análisis fue realizado a 80 panelistas semi entrenados de la carrera de Ingeniería en Alimentos una vez aprobada la unidad de análisis sensorial.

Sabor

De acuerdo con los datos obtenidos, con la prueba de Tukey ($p \leq 0.05$), se observaron diferencias estadísticas significativas, entre el tratamiento T5 y los demás tratamientos; siendo el T3 (3.00) el de menor agrado por su picor, mientras en el T5 (4.09) se muestra agradable a los catadores por su sabor a miel más acentuado.

Color

De los datos obtenidos, con la prueba de Tukey ($p \leq 0.05$), se observa diferencias estadísticas significativas, siendo el tratamiento T5 (2.03) color ámbar el que presentó apariencia no agradable, mientras que el tratamiento T2 (2.81) amarillo pálido indicado como el producto de mejor apariencia por los catadores

Olor

La variable olor de acuerdo con la valoración sensorial y la prueba de Tukey ($p \leq 0.05$), genera diferencias estadísticas significativas entre los tratamientos T2 y T5; siendo el T2 (2.91) el que presenta mayor olor a jengibre y T5 (3.55) en el que se identifica la miel de manera acentuada.

Aceptabilidad

De los datos generados por los catadores y sometidos al análisis estadístico, prueba de Tukey ($p \leq 0.05$), se obtuvo diferencia estadística significativa entre todos los tratamientos, siendo el T2 (2.36) el de menor aceptación y el T5 (4.28) el de mayor aceptabilidad; como se visualiza en la figura 2.

Análisis físico químico

Los análisis físico-químicos fueron realizados en el laboratorio de bromatología de la Facultad de Ciencias de la Industria y Producción de la Universidad Técnica Estatal de Quevedo, y corresponde al tratamiento T5 el que generó mayor aceptabilidad por los catadores.

pH

Según la norma INEN – ISO 1842, señala que el pH de una bebida debe ser inferior a los 4.5 considerándose ácido, a ello encontramos que el tratamiento T5 (4.18).

Brix

El tratamiento con mayor contenido de sólidos solubles representado como °brix es el T5 (12°brix); están en depen-

Tabla 3. Valores de los atributos sensoriales, sabor, olor, color y aceptabilidad registradas en el análisis sensorial en la elaboración de la bebida helada de jengibre con niveles de miel de abeja

Tratamiento	Sabor	Olor	Color
T1 (5% Jengibre, 5% miel, 95% agua)	3.24 a*	3.01 a	2.48 bc
T2 (5% Jengibre, 7.5% miel, 87.5% agua)	3.20 a	2.91 a	2.81 c
T3 (5% Jengibre, 10% miel, 85% agua)	3.00 a	3.03 a	2.63 bc
T4 (5% Jengibre, 12.5% miel, 82.5% agua)	3.05 a	3.08 ab	2.36 b
T5 (5% Jengibre, 15% miel, 80% agua)	4.09 b	3.44 b	203 a

* Medias seguidas con una letra común no son significativamente diferentes, según Tukey ($p \leq 0.05$).

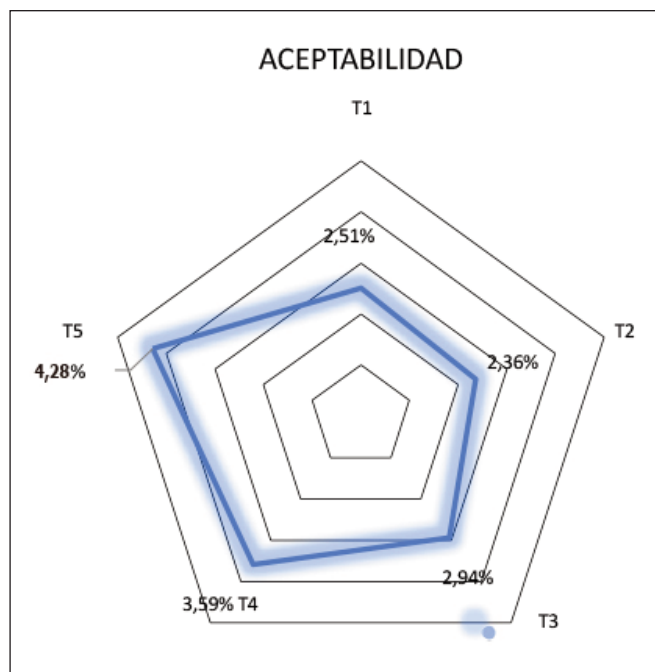


Figura 2. Aceptabilidad de los 5 tratamiento de la "Bebida helada de jengibre (*Zingiber officinale*) con niveles de miel de abeja"

dencia del porcentaje de miel y la dilución realizada, es por eso que estos datos se atribuyen al porcentaje de jengibre añadido, que provoca una disminución de sus características organolépticas al contraste con el porcentaje de miel; de acuerdo a la norma INEN – ISO 2173, donde se expresa que el valor de los °brix serán proporcionales al aporte de la fruta, con la exclusión del azúcar y se aclara que el jengibre no cuenta como una fruta ya que este es un rizoma.

Análisis microbiológicos

De acuerdo con la norma microbiológica que establece criterios de calidad sanitaria para bebidas, néctar, jugos, pulpas, concentrados, bebidas de frutas y vegetales, las pruebas tanto de mohos y levaduras (10^2 ufc) y aerobios totales (10^2 ufc) realizadas al tratamiento con mayor aceptabilidad (T5) presentaron ausencia de contaminación microbiana cumpliendo con la norma establecida, las características organolépticas del producto se conservan iguales al primer día de elaboración después de transcurrido un mes, a lo que se le atribuye que el proceso correcto en el momento de elaboración, lo cual se ve reflejado en la tabla 4.

Tabla 4. Resultados de análisis microbiológicos

Parámetros	Método	Resultado
Mohos y Levaduras	NTE INEN 1529-10	Ausencia
Aerobios Totales	NTE INEN 1529-5	Ausencia

DISCUSIÓN

Valoración de los análisis organolépticos

Según Vera et al., (2023) menciona que el análisis sensorial es fundamental para poder determinar la aceptabilidad y gusto del producto final lo cual ayudara a mejorar próximas investigaciones, corrobora Yépez et al., (2023) que la valoración de los análisis organolépticos es crucial debido a su capacidad para evaluar las características sensoriales de un producto, como su aroma, sabor, textura y apariencia visual.

Por otra parte Zambrano et al., (2023) menciona que estos análisis proporcionan información valiosa sobre la aceptabilidad y calidad del producto final desde la perspectiva del consumidor. Además, los resultados de los análisis organolépticos pueden utilizarse para realizar ajustes en la formulación o procesamiento del producto con el fin de mejorar su aceptación por parte del público objetivo Alvarado et al., (2024).

Intriago et al., (2023) hace referencia en su investigación menciona la conveniencia de emplear un panel semientrenado para evaluar los análisis organolépticos, lo cual resulta fundamental para asegurar la satisfacción del consumidor y la competitividad del producto en el mercado.

Análisis físico químico

Suarez & Pinargote, (2019) indican que sus tratamientos oscilan entre 3.77 y 3.72; lo que señala que ambas investigaciones cumplen con la norma establecida.

Con respecto Cedeño et al., (2018) están entre 3.2 a 4,5 el pH unos de los parámetros a los que se atribuye a la presencia de compuestos específicos que podrían cumplir la función de conservar un alimento y acción antibacteriana²⁷, menciona en su investigación que los parámetros Físico químicos son indispensables para determinar la calidad y la vida útil del producto.

De acuerdo con la norma microbiológica que establece criterios de calidad sanitaria para miel, jaleas y derivados, las pruebas tanto de mohos y levaduras (10^2 ufc), como para coliformes totales (10 ufc) Rm²⁹ realizada a los tratamientos presentaron ausencia de contaminación microbiana, Alvarado et al., (2023), en su estudio menciona que si existe una proceso inocuo y adecuado no existirá algún efecto negativo en el producto final.

CONCLUSIÓN

En cuanto al análisis organoléptico los panelistas manifestaron que el tratamiento de mayor agrado fue el T5 (5% de jengibre, 15% de miel y el 80% de agua) que presentó características como amarillo pálido, olor a miel acentuado, sabor a miel, siendo estas características las que determinaron la aceptación del producto.

Los valores obtenidos para las variables °brix y pH, están dentro de lo establecido por las normas INEN antes citadas, con una diferencia mínima, por ende, estas propiedades ayudaron a la decisión del producto, como un alimento óptimo para el consumo, con diferencia de otras bebidas que se encuentran en el mercado y no ayudan a la nutrición y funcionamiento del organismo humano.

De acuerdo con los resultados obtenidos por el análisis microbiológico se cuenta con la ausencia de mohos y levaduras ya que según la norma INEN 1529-10 expresa que el límite de aceptabilidad tiene un registro de $<1.0 \times 10^2$ de la misma manera para aerobios totales según la norma INEN 2337 con rango de $<1.0 \times 10^2$. Esto demuestra que el producto cuenta con parámetros de calidad, dada la ausencia microbiana en el tratamiento con mayor aceptabilidad.

BIBLIOGRAFÍA

- Vásquez E, Calderón Z, Arias J, Ruvalcaba J, Rivera L, Ramírez E. Sedentarismo, alimentación, obesidad, consumo de alcohol y tabaco como factores de riesgo para el desarrollo de diabetes tipo 2. *J Negat No Posit Results* [Internet]. 2019;4(10):1011–21. Available from: <https://www.redalyc.org/journal/5645/564561530005/html/>
- Ramírez R, Fuentes J, Martínez J, Correa J. Prevalencia y factores asociados al consumo de bebidas azucaradas en escolares de 9 a 17 años de Bogotá, Colombia: Estudio FUPRECOL. *Nutr Hosp* [Internet]. 2019;36(4):422–30. Available from: https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0212-1611201700200422
- Paredes P, Alemán J, Castillo O, Perales A. Consumo De Bebidas Azucaradas Y Su Relación Con Enfermedades Crónicas No Transmisibles En Niños. *Biocencia* [Internet]. 2016;18(1):55–61. Available from: <https://www.redalyc.org/articulo.oa?id=672971114010>
- Gutiérrez C, Vásquez E, Romero E, Troyo R, Cabrera C, Ramírez O. Consumo de refrescos y riesgo de obesidad en adolescentes de Guadalajara, México. *Boletín Médico del Hop Infant México* [Internet]. 2009;6(6):522–8. Available from: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1665-11462009000600006
- Rivera J, Muñoz O, Rossas M, Aguilar C, Popkin B, Willett W. Consumo de bebidas para una vida saludable: Recomendaciones para la población mexicana. *Gac Med Mex* [Internet]. 2008; 50(2):173–95. Available from: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0036-36342008000200011
- Luzarazu I, Cedeño C, Mora K, Vásquez J. Efecto del consumo de bebidas dietéticas sobre los niveles de glucosa e insulina plasmática en jóvenes estudiantes de la Universidad del Norte. *Salud Uninorte* [Internet]. 2016;32(1):25–34. Available from: <https://rcientificas.uninorte.edu.co/index.php/salud/article/view/7656>
- Gugliucci A, Rodríguez R. Fructosa, un factor clave modificable en la patogenia del síndrome metabólico, la esteatosis hepática y la obesidad. *Rev Medica Del Uruguay* [Internet]. 2020;36(4):418–30. Available from: http://www.scielo.edu.uy/scielo.php?script=sci_arttext&pid=S1688-03902020000400204
- Hoang N, Sun J, Nguyen L, Jung M, Young Y, Eun G, et al. Ginger on Human Health: A Comprehensive Systematic Review of 109 Randomized Controlled Trials. *Nutrients* [Internet]. 2020;12(1):1–28. Available from: <https://www.mdpi.com/2072-6643/12/1/157>
- Beñoga P, Arcusa R, Marhuenda J, Yamedjeu K, Zafrilla P. Effect of ginger on inflammatory diseases. *Molecules* [Internet]. 2022; 27(21):1–13. Available from: <https://www.mdpi.com/1420-3049/27/21/7223>
- Vit P. Productos de la colmena recolectados y procesados por las abejas: miel, polen y propóleos. *Rev del Inst Nac Hig Rafael Rangel* [Internet]. 2004;35(2):32–9. Available from: https://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0798-04772004000200006
- Córdova C, Ramírez E, Martínez E, Zaldívar J. Caracterización botánica de miel de abeja (*Apis mellifera* L.) de cuatro regiones del estado de Tabasco, Mexico, mediante técnicas melisopalinológicas. *Univ y Cienc Trópico húmedo* [Internet]. 2013;29(2):163–78. Available from: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0186-29792013000200006
- Gerginova D, Papova M, Chimshirova R, Trhuseva B, Shanahan M, Guzmán M, et al. The chemical composition of scaptotrigona mexicana honey and propolis collected in two locations: similarities and differences. *Foods* [Internet]. 2023;12(17):1–14. Available from: <https://www.mdpi.com/2304-8158/12/17/3317>
- Zapata I, Henao J, Yepes D, Henao D, Giraldo C, Calvo S, et al. Physicochemical Parameters, Antioxidant Capacity, and Antimicrobial Activity of Honeys from Tropical Forests of Colombia: *Apis mellifera* and *Melipona eburnea*. *Foods* [Internet]. 2023;12(5):1–17. Available from: <https://www.mdpi.com/2304-8158/12/5/1001>
- Tarabal C, Cruz A, Prata H, Pereira G, Silva M, Fernandes C, et al. Cuantificación de 6-gingerol, análisis metabólico mediante espectrometría de masas en aerosol de papel y determinación de actividad antioxidante de rizomas de jengibre (*Zingiber officinale*). *Res Soc Dev* [Internet]. 2020;9(8):1–22. Available from: <https://rsdjournal.org/index.php/rsd/article/view/4822>
- García M, Armentero E, Escobar M, García J. Composición química de la miel de abeja y su relación con los beneficios a la salud. *Rev Médica Electrónica* [Internet]. 2022;44(1):155–67. Available from: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1684-18242022000100155
- Velásquez D, Goetschel L. Determinación de la calidad físico-química de la miel de abeja comercializada en Quito y comparación con la miel artificial. *Enfoque* [Internet]. 2019;10(2):52–62. Available from: <https://www.redalyc.org/journal/5722/5722262062005/html/>

17. Vásquez L, Erazo C, Vera J, Intriago F. Induction of rhizobium japonicum in the fermentative mass of two varieties of cacao (*Theobroma Cacao L.*) as a strategy for the decrease of cadmium. *Int J od Heal Sci* [Internet]. 2022;6(3):11354–71. Available from: <https://sciencescholar.us/journal/index.php/ijhs/article/view/8672/5762>
18. Dueñas A, Vargas P, Vera J, Vásquez L, Viteri W, García J, et al. Efecto de la goma del muyuyo (*cordia lutea*) como agente estabilizante en la vida útil del néctar de naranja (*citrus x sinensis*). *Rev Colomb Investig Agroindustriales*. 2022;10(1):41–51.
19. Vásquez L, Vera J, Alvarado K, Ochoa K, Intriago F, Raju M, et al. Calidad sensorial de cuatro cruces experimentales de cacao adicionando pasta de frutas deshidratadas. *Rev Multidisciplinaria Desarro Agropecu Tecnológico, Empres y Humanista* [Internet]. 2023;5(1):1–9. Available from: <https://www.dateh.es/index.php/main/article/view/112>
20. Vera J, Benavides J, Vásquez L, Alvarado K, Reyes J, Intriago F, et al. Effects of two fermentative methods on cacao (*Theobroma cacao L.*) Trinitario, induced with *Rhizobium japonicum* to reduce cadmium. *Rev Colomb Investig Agroindustriales* [Internet]. 2023;10(1):95–106. Available from: <https://revistas.sena.edu.co/index.php/recia/article/view/efectos-de-dos-metodos-fermentativos-en-cacao-theobroma-cacao-l>
21. Yépez P, Vásquez L, Alvarado K, Intriago F, Estrada R, Vera J. Organoleptic characteristics of chicken meat pio pio Campero with balanced diets UTEQ and *saccharomyces cerevisiae*, in the experimental farm "La Maria." *Rev Investig Agroempresariales* [Internet]. 2023;10:9–18. Available from: <https://revistas.sena.edu.co/index.php/riag/article/view/5492>
22. Zambrano S, Suárez G, Vásquez L, Alvarado K, Vera J, Intriago F, et al. Freeding Big- American turkeys with a balanced diet plus turnip (*Brassica rapa L.*). *Rev Vet y Zootec Amaz* [Internet]. 2023;3(2):1–13. Available from: <https://revistas.unsm.edu.pe/index.php/revza/article/view/544>
23. Alvarado K, Rivadeneira C, Intriago F. Utilización de extracto natural del Muicle (*Justicia spicigera*) en la elaboración de chocolate a partir de dos variedades de cacao (*Theobroma bicolor Humb. & Bonpl.* y *Theobroma cacao L.*). *Rev Agrotecnológica Amaz* [Internet]. 2024;4(1):1–19. Available from: <https://revistas.unsm.edu.pe/index.php/raa/article/view/633>
24. Intriago F, Macías M, Napa B, Vásquez L, Alvarado K, Revilla K, et al. Inclusion of cocoa (*Theobroma cacao*) mucilage as a stabilizer in jackfruit (*Artocarpus heterophyllus*) nectar. *Agroindustrial Sci* [Internet]. 2023;13(2):75–81. Available from: <https://revistas.unitru.edu.pe/index.php/agroindscience/article/view/5444>
25. Suarez G, Pinargote E. Adición de niveles de extracto de jengibre (*Zingiber officinale*) en la miel de abeja multiflora (*Apis mellifera scutellata*) Quevedo-Los Ríos [Internet]. Universidad Técnica Estatal de Quevedo; 2019. Available from: <https://repositorio.uteq.edu.ec/items/bba03638-8428-4c9e-86f1-5c1a82fa9c30>
26. Cedeño XA, Neves C, Dueñas A. Evaluación de Propóleo como Conservante Natural en la Leche Chocolateada. *Esc Super Tur e Tecnol do Mar* [Internet]. 2018;1–74. Available from: <https://core.ac.uk/download/pdf/160746358.pdf>
27. Coello E, Vera J, Vásquez L, Alvarado K, Coello E, Rivadeneira C, et al. Characterization of the honey obtained from mucilage of three genetic groups of cocoa (*Theobroma cacao L.*). *Rev Científica Fac Ciencias Básicas* [Internet]. 2023;8(2):17–29. Available from: <https://revistas.utm.edu.ec/index.php/Basedela ciencia/article/view/5728>
28. Alvarado K, Vera J, Vásquez L, Intriago G, Barzola J. Tiempos y temperaturas de torrefacción en almendras de tres variedades de cacao nacional, trinitario, forastero para la obtención de nibs. *Supl CICA Multidiscip* [Internet]. 20AD;7(015):100–135. Available from: <https://uleam.suplementocica.org/index.php/Suplemento CICA/article/view/94>

Relación entre marcadores inflamatorios y estado nutricional, en pacientes con Enfermedad de Alzheimer de inicio temprano (Antioquia-Colombia)

Relationship between inflammatory markers and nutritional status in patients with early-onset Alzheimer's disease (Antioquia-Colombia)

María Fernanda OSPINA CARDONA¹, Gloria Cecilia DEOSSA RESTREPO¹, Cristian SANTA¹, Mateo LONDOÑO PEREIRA², David Fernando AGUILLÓN NIÑO³, Francisco LOPERA RESTREPO³

1 Escuela de Nutrición y Dietética. Universidad de Antioquia.

2 Departamento de Nutrición Clínica. Clínica las Américas, Medellín.

3 Grupo de Neurociencias de Antioquia. Universidad de Antioquia.

Recibido: 11/abril/2024. Aceptado: 27/mayo/2024.

RESUMEN

Antecedentes y objetivos: menos del 1% de los casos de enfermedad de Alzheimer (EA) son causados por mutaciones autosómicas dominantes E280A presenilina 1 (PSEN1) o presenilina 2 (PSEN2), que se relacionan con un inicio temprano y acelerada progresión de los síntomas clínicos. Poco se conoce de la relación entre el estado nutricional y los marcadores inflamatorios en esta población. El objetivo de este estudio fue relacionar los marcadores inflamatorios y el estado nutricional en pacientes con EA de inicio temprano con la mutación E280A-PSEN1.

Material y Métodos: estudio transversal, con muestra de 73 pacientes con variante genética PSEN1 E280A, en seguimiento por el Grupo de Neurociencias de Antioquia (GNA). Se incluyó información socio demográfica, evaluación del estado nutricional por el Mini Nutritional Assessment (MNA), seguridad alimentaria, y medición de citoquinas (IL-6, TNF- α e IFN- γ) por citometría de flujo. Se aplicó estadística descriptiva, análisis de varianza de una sola vía (ANOVA) para establecer la asociación entre los estados de la enfermedad

y el estado nutricional, pruebas post-hoc, pos t-test y Odds Ratio (OR).

Resultados: De los pacientes evaluados 64,86% eran mujeres y un 71,23% tenían edades comprendidas entre 36 y 50 años. Según MNA, el 71,62% se clasificó en riesgo de desnutrición y desnutrición; de estos, 59,46% se encontró en estadios moderado y severo de la enfermedad, reportándose diferencias estadísticas entre el MNA y el deterioro cognitivo. No se encontraron diferencias estadísticas entre marcadores inflamatorios con MNA o estadio de la enfermedad. 68,97% de los pacientes con riesgo de desnutrición tenían inseguridad alimentaria.

Conclusiones: En la medida que progresa la EA de inicio temprano, disminuyen el puntaje del MNA incrementándose la desnutrición. En este estudio no se encontró relación entre los marcadores inflamatorios y el estado nutricional. Es trascendental continuar explorando alternativas que contribuyan al manejo médico y nutricional, ralentizando el progreso de la enfermedad favoreciendo una mejor calidad de vida para los pacientes y sus familias.

PALABRAS CLAVES

Citoquinas, índice de masa corporal, seguridad alimentaria, mini valoración nutricional, Escala Latinoamericana y Caribeña de Seguridad Alimentaria.

Correspondencia:

Gloria Cecilia Deossa Restrepo
gloria.deossa@udea.edu.co

SUMMARY

Background and objectives: Less than 1% of Alzheimer's disease (AD) cases are caused by autosomal dominant E280A presenilin 1 (PSEN1) or presenilin 2 (PSEN2) mutations, which are associated with early onset and accelerated progression of clinical symptoms. Little is known about the relationship between nutritional status and inflammatory markers in this population. The objective of this study was to relate inflammatory markers and nutritional status in patients with early-onset AD with the E280A-PSEN1 mutation.

Material and Methods: cross-sectional study, with a sample of 73 patients with PSEN1 E280A genetic variant, followed by the Antioquia Neuroscience Group (GNA). Sociodemographic information, evaluation of nutritional status by the Mini Nutritional Assessment (MNA), food safety, and measurement of cytokines (IL-6, TNF- α and IFN- γ) by flow cytometry were included. Descriptive statistics, one-way analysis of variance (ANOVA) to establish the association between disease states and nutritional status, post-hoc tests, post t-test and Odds Ratio (OR) were applied.

Results: Of the patients evaluated, 64.86% were women and 71.23% were between 36 and 50 years old. According to MNA, 71.62% were classified as at risk of malnutrition and malnutrition; Of these, 59.46% were found in moderate and severe stages of the disease, reporting statistical differences between MNA and cognitive impairment. No statistical differences were found between inflammatory markers with MNA or disease stage. 68.97% of patients at risk of malnutrition were food insecure.

Conclusions: As early-onset AD progresses, the MNA score decreases, increasing malnutrition. In this study, no relationship was found between inflammatory markers and nutritional status. It is essential to continue exploring alternatives that contribute to medical and nutritional management, slowing the progress of the disease, favoring a better quality of life for patients and their families.

KEY WORDS

Cytokines, body mass index, food safety, mini nutritional assessment, Latin American and Caribbean Food Security Scale.

ABREVIATURAS

EA: Enfermedad Alzheimer.

PSEN1: Presenilina 1.

PSEN2: Presenilina 2.

GNA: Grupo de neurociencias de Antioquia.

MNA: Mini Nutritional Assessment.

IL-6: Interleuquina 6.

TNF- α : Factor de Necrosis Tumoral alfa.

IFN- γ : Interferon gamma.

DCL: Deterioro Cognitivo Leve.

IMC: Índice de masa corporal.

ELCSA: Escala Latinoamericana y Caribeña de Seguridad Alimentaria.

IA: Inseguridad Alimentaria.

EO-ADAD: Enfermedad Alzheimer Autosómica Dominante de Inicio Temprano.

FAST: Escala de Evaluación Funcional.

DEMLE: Demencia Leve.

DEMOMO: Demencia Moderada.

DEMSE: Demencia Severa.

INTRODUCCIÓN

Las enfermedades neurodegenerativas constituyen una amenaza para la salud pública¹. La enfermedad de Alzheimer (EA), demencia más común, afecta alrededor de 47 millones de personas en el mundo². Menos de 1% de pacientes con EA tienen mutaciones en los genes de la proteína precursora de amiloide PSEN1 o PSEN2³. Sin embargo, estas formas de demencia inician tempranamente (antes de 65 años) y suelen ser más agresivas, con progresión acelerada entre los estadios³. En Colombia, el Grupo de Neurociencias de Antioquia (GNA) ha evaluado longitudinalmente cerca de 6000 personas con riesgo de desarrollar EA Autosómica Dominante de Inicio Temprano (EO-ADAD), 20% de quienes son potencialmente portadores de una sola variante genética E280A en el gen PSEN1, responsable de la enfermedad⁴; siendo este grupo poblacional el más grande del mundo con una misma variante causal de esta patología.

En la medida que progresa la EA se ve afectado el estado nutricional; identificándose diferentes factores que influyen en la pérdida gradual de peso, como: neurodegeneración de regiones cerebrales específicas, procesos inflamatorios, disfunción de olfato y gusto, además de síntomas específicos de demencia, como alteraciones de la función ejecutiva y la planificación, amnesia, trastornos conductuales y neuropsiquiátricos, o disfagia⁴⁻⁵; también, se suma la baja calidad de los alimentos a causa de inseguridad alimentaria⁶, entre otros, llevando a una reducción de la ingesta dietética y a la desnutrición⁴. En adultos con demencia, la desnutrición ocasiona disminución de masa muscular, pérdida de autonomía, aumento de caídas, úlceras por decúbito e infecciones sistémicas, con lo que aumenta la morbimortalidad⁷. Aproximadamente 44% de adultos mayores con deterioro cognitivo están en riesgo de desnutrición y 15% la padecen, con variaciones por región de estudio y metodología de diagnóstico⁸.

La sobreexpresión de citoquinas inflamatorias como IL-6, y el TNF- α ⁹, se ha estudiado recientemente como un posible mecanismo de relevancia que repercute en una progresión acelerada de la EA y del deterioro nutricional, considerándose un predictor de morbimortalidad⁹⁻¹⁰. En la EA, la sobreexpresión de citoquinas pro inflamatorias en plasma o líquido cefalorraquídeo se asocia con anorexia y pérdida de peso¹¹, y probablemente con la generación de sarcopenia, alteraciones en la tasa metabólica basal y en las concentraciones de neurotransmisores, aumentando la sensibilidad a la colecistoquinina, con la subsecuente pérdida del apetito¹²; además, la inflamación se caracteriza por aumento del catabolismo proteico y mayor gasto energético, afectando aún más el estado nutricional⁷.

Así, y ante la necesidad de estudios que confirmen los hallazgos y permitan desarrollar alternativas para prevenir y tratar la desnutrición en la EA temprana mediante la modulación de la respuesta inflamatoria, se realizó este estudio, buscando establecer la relación entre marcadores inflamatorios y estado nutricional en pacientes con EA de inicio temprano con la mutación E280A- PSEN1, pertenecientes al GNA.

MATERIALES Y MÉTODOS

Estudio transversal, con muestra por conveniencia de 73 individuos de un total de 102 (tasa de respuesta, 72,54%). La población de estudio consistió en un subgrupo de la cohorte longitudinal de pacientes con una variante genética en PSEN1 (E280A), en seguimiento por el GNA⁴. Los principales criterios de elegibilidad incluyeron: diagnóstico de deterioro cognitivo leve (DCL) y demencia tipo Alzheimer de inicio temprano, portadores de la mutación PSEN1- E280A, demostrado por genotipificación mediante el método molecular PCR-RFLP (*Restriction Fragment Length Polymorphism*), el cual detecta fragmentos de ADN de diferentes longitudes, en estadios de deterioro cognitivo leve, demencia leve, moderada o severa⁴. Los criterios de exclusión fueron: enfermedades autoinmunes como lupus, síndrome de Sjögren, artritis reumatoide, enfermedad de Crohn, colitis ulcerosa, psoriasis. Los datos se recopilaron de 68 pacientes no institucionalizados y 5 pacientes institucionalizados (1 con DCL y 72 con demencia), quienes hacían parte del proyecto "Abordaje Multimodal del Paciente con Alzheimer y otras Demencias (AMPAD)". El estudio fue aprobado por el Comité de Ética del Instituto de Investigaciones Médicas-Facultad de Medicina de la Universidad de Antioquia, acta 025 del 3 de marzo de 2022. Se obtuvo consentimiento informado vía telefónica de pacientes y cuidadores, previa participación en el estudio.

Variables sociodemográficas y clínicas: los datos fueron obtenidos por estudiantes y profesionales de nutrición y dietética de la Universidad de Antioquia, y médicos del GNA capacitados para tal fin. Como fuente primaria, se obtuvo información directamente del cuidador, quien proporcionó datos sociodemográficos (sexo, edad, estrato socioeconómico,

nivel educativo, residencia, institucionalización y edad de postración, según clasificación de la escala FAST, igual o mayor a 13³). Como fuente secundaria, de las historias clínicas se obtuvieron datos relacionados con salud, personales, familiares, diagnóstico médico, estadio de la enfermedad, y antecedentes patológicos, que fueron agrupados según el sistema afectado⁴.

Evaluación nutricional

Datos antropométricos: las circunferencias de brazo, pantorrilla y abdomen se midieron con cinta métrica SECA 101 (sensibilidad 0,1 cm). El perímetro abdominal se midió en el punto medio, entre la última costilla y el borde superior de la cresta ilíaca, y se clasificó como normal o con obesidad abdominal (mujeres ≥ 80 , hombres ≥ 90 cm)¹³; el peso para los pacientes que no se encontraban postrados, se midió en ropa ligera, con precisión de 0,1 kg, usando una balanza electrónica SECA 813 (sensibilidad 0,1 kg); la estatura usando un estadiómetro SECA 206 de montaje en pared, con sensibilidad de 1 cm. En los pacientes postrados, el peso corporal se obtuvo a partir de la ecuación propuesta para estimar el peso de pacientes en cama¹⁴; la altura talón-rodilla se utilizó como alternativa para medir la estatura, mediante la ecuación de Chumlea et al., según sexo y edad¹⁵. Para los pacientes <60 años, se utilizó la clasificación de la Organización Mundial de la Salud para el Índice de Masa Corporal (IMC)¹⁶. Para los pacientes >60 años se utilizó la clasificación sugerida por la Organización Panamericana de la Salud¹⁷. Para los pacientes que padecían edema, se realizó ajuste con respecto al peso seco para calcular el IMC, y en los pacientes con deshidratación, no se realizó ajuste al peso. Personal entrenado estuvo a cargo de la toma de los datos.

Estado nutricional: se aplicó el formulario MNA validado para evaluar el estado nutricional en pacientes con EA hospitalizados, cuidados en casa y ambulatorios⁴. Este instrumento está compuesto por dieciocho ítems, que valoran la condición general (morbilidad, estilos de vida, medicación), antropométrica (peso, estatura, circunferencia de brazo, circunferencia de pantorrilla) y subjetiva (auto percepción de salud y nutrición)¹⁸. El puntaje del MNA permite clasificar al individuo en bien nutrido (24-30), en riesgo de desnutrición (17,0-23,5) o desnutrición (<17)¹⁸. El MNA no permite medir exceso de peso u obesidad¹⁸. Además, se evaluaron signos y síntomas relacionados con el estado nutricional, para detectar indicadores de déficit⁵ y síntomas específicos de demencia⁴.

Seguridad alimentaria: se utilizó la Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA), de aplicación fácil y rápida, que permite medir la inseguridad alimentaria en los hogares¹⁹. Para evaluar la (in)seguridad alimentaria, se usó la clasificación para hogares integrados solamente por personas adultas y hogares integrados por personas adultas y menores de 18 años¹⁹.

Medición de citoquinas

Las muestras de suero de los pacientes fueron facilitadas por el Biobanco del GNA, almacenadas a -80°C . Todas las muestras de sangre tuvieron menos de un año de haberse tomado, en concordancia con las mediciones del MNA y los estadios de la enfermedad²⁰. Se midieron TNF- α , IL-6 e IFN- γ , usando un flexset de BD Biosciences (San Jose, CA), siguiendo las instrucciones del proveedor, mediante el método de laboratorio de citometría de flujo²⁰. Todos los estándares tuvieron como concentración máxima 5000 pg/ml. Las referencias de los kit de medición de las citoquinas fueron: IL -6 (Cat. No. 561521), TNF- α e IFN- γ (Cat. No. 558264)²⁰.

Citoquinas	Mediana fluorescencia	Desviación estándar	Límite de detección
IL-6	4,7	0,4	2,5
TNF- α	3,9	0,3	3,7
IFN- γ	2,1	0,3	7,1

Análisis estadístico

Todos los análisis estadísticos se realizaron con el software R v4.0.5. Para el análisis descriptivo de las variables cualitativas se estimaron proporciones y frecuencias absolutas, y para los datos cuantitativos se utilizaron medias y desviaciones estándar, en caso de cumplir con los criterios de normalidad, verificado con el test de bondad de ajuste Shapiro-Wilk. El comportamiento de la relación entre las citoquinas, los puntajes de MNA e IMC se analizó con gráficos de dispersión y regresión lasso para detectar asociaciones crecientes o decrecientes. La determinación del efecto de los puntajes de MNA y los niveles de citoquinas según los estados de deterioro mental (FAST), se realizó a partir de análisis de varianza de una sola vía (ANOVA) y las pruebas post-hoc por t-test con corrección de los valores-p, por el método de Benjamini-Hockberg. Previamente se verificaron los supuestos de normalidad y homogeneidad de varianzas de los modelos evaluados. Se calcularon los ORP (OR de Prevalencia) con sus respectivos intervalos de confianza, para evaluar la asociación de las variables nutricionales con respecto a la seguridad alimentaria. El nivel de significancia seleccionado para las pruebas fue del 5%.

RESULTADOS

Participaron 73 individuos, en su mayoría mujeres (65,75%), con edades entre 36 y 50 años al momento de diagnóstico de la enfermedad (71,23%); respecto al lugar de residencia, 87,67% vivían en zona urbana, en su mayoría de estrato socioeconómico bajo (1 y 2). Con respecto al nivel educativo, 43,84% tenían entre primaria y secundaria incompleta (5-10 años). Se resalta que 79,45% no se encontraban postrados

al momento de tomar los datos, y solo 6,85% estaban hospitalizados (Tabla 1).

El estado nutricional, como se mencionó, fue determinado mediante MNA, encontrando que 71,62% de los pacientes se clasificaron en riesgo de desnutrición y desnutrición, de los cuales 59,46% se encontraban en estadios de demencia mo-

Tabla 1. Características socio demográficas de los pacientes con EA de Alzheimer de inicio temprano

Variable	N	%
Sexo		
Hombre	25	34,25
Mujer	48	65,75
Edad del diagnóstico de la Enfermedad		
< 35	2	2,74
[36-50]	52	71,23
> 50	19	26,03
Edad de postración		
[36-50]	8	10,96
> 50	7	9,59
No Postrado	58	79,45
Institucionalización del paciente		
Sí	5	6,85
No	68	93,15
Estrato socioeconómico		
Bajo	46	63,01
Medio	27	36,99
Lugar de residencia		
Rural	9	12,33
Urbana	64	87,67
Nivel educativo del paciente		
Menos de Primaria	20	27,40
Primaria y Secundaria	32	43,84
Secundaria y Superior	17	23,29
Más de Superior	4	5,48

derada y severa; además, se hallaron diferencias estadísticas entre el MNA y el deterioro cognitivo (ANOVA $p=0,016$), evidenciándose que aquellos pacientes con demencia leve, presentaron disminución en el puntaje del MNA, al igual que en los pacientes con demencia severa (figura 1). Asimismo, se encontraron relaciones entre el IMC y los estadios de la enfermedad, con una ANOVA significativa $p=0,023$, identificándose que los pacientes en demencia moderada presentaron diferencias estadísticas con respecto al IMC, y también los pacientes que se encontraban en demencia severa $p=0,01$, evidenciándose que, a medida que progresan los estadios de la enfermedad, disminuye el Índice de Masa Corporal (Figura 1).

Al analizar otros diagnósticos clínicos asociados en los pacientes con la EA de inicio temprano, y que además presentaban riesgo de desnutrición y desnutrición según MNA, se halló, en mayor proporción, que 29,72% no tenían diagnóstico asociado, seguido del 27,02% con trastorno de epilepsia y 13,51% con problemas psiquiátricos. Además, con respecto a los signos y síntomas, presentaron con mayor frecuencia: agnosia, 31,08%; alteraciones sensoriales en el gusto, 25,67%; y en olfato y dificultad para masticar, 22,97% (Figura 2). Se destaca, adicionalmente, que 12,1% de los pacientes consumían más de tres medicamentos al día, clasificándose con polifarmacia.

Con respecto al consumo de alimentos, los participantes con riesgo de desnutrición y desnutrición por MNA, en su mayoría (70,96%) solo consumían dos comidas al día, aunque 70,59% consumían (lácteos, huevos-leguminosas y carnes) con una frecuencia diaria y semanal; 71,79% no consumían frutas o verduras y 96,67% tenían un consumo de agua o lí-

quidos inferior a 3 vasos al día (Tabla 2). También se encontró, en quienes se ubicaban en los estadios moderado y severo de la EA, que 79,03% consumían solo 2 comidas al día, 82,05% no consumían frutas o verduras y 93,33% consumían menos de 3 vasos de agua al día (Tabla 2). Al examinar las medidas antropométricas, se encontró que 17,81% de los participantes presentaban un perímetro braquial por debajo del punto de referencia; de igual manera, 24,66% presentaban un perímetro de pantorrilla bajo, lo cual evidencia agotamiento de la masa muscular; es de anotar que en todos los participantes con disminución del perímetro de pantorrilla y brazo, se presentó riesgo de desnutrición o desnutrición por MNA, además de encontrarse en estadios avanzados de la enfermedad: demencia moderada y severa (Tabla 2).

75,0% de los pacientes con estado nutricional en normalidad, se clasificaba en inseguridad alimentaria, al igual que el 68,97% de los pacientes con riesgo de desnutrición, y el 37,50% de los pacientes en desnutrición, no se encontró asociación significativa entre el riesgo de desnutrición y la desnutrición con la inseguridad alimentaria (tabla 3).

Con relación al comportamiento de las citoquinas y el MNA, en la IL-6 no se encontró diferencia estadística ($p=0,531$) por clasificación de riesgo de desnutrición y desnutrición por MNA; 50,71% de los participantes tenían niveles por encima del límite de detección de 2,5 pg/mL²⁰ (figura 3). Respecto al TNF- α , no hubo diferencias estadísticas ($p=0,925$); en los pacientes con riesgo de desnutrición y desnutrición por MNA, 14,86% presentaron valores por encima del límite de detección 3,7pg/mL (figura 3)²⁰. Con respecto a IFN- γ , tampoco se presentaron diferencias según la clasificación del MNA ($p=0,173$)

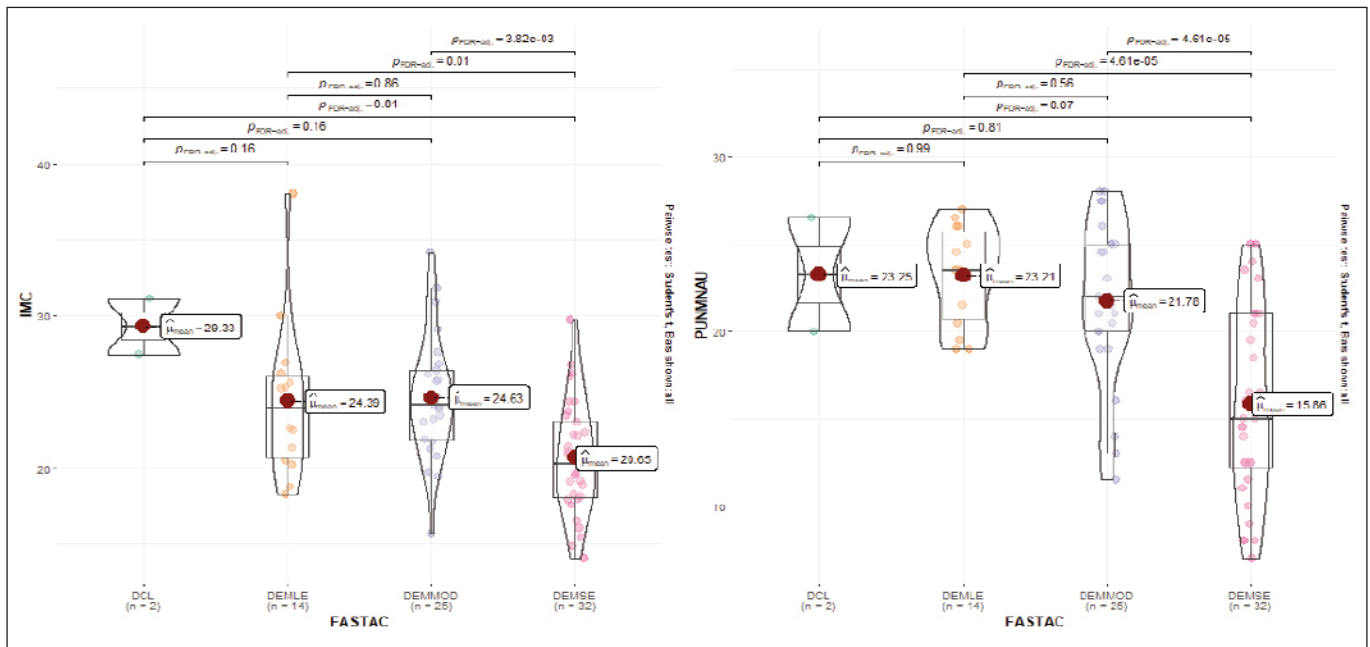


Figura 1. Asociación entre estadios de la enfermedad, IMC y puntaje del MNA

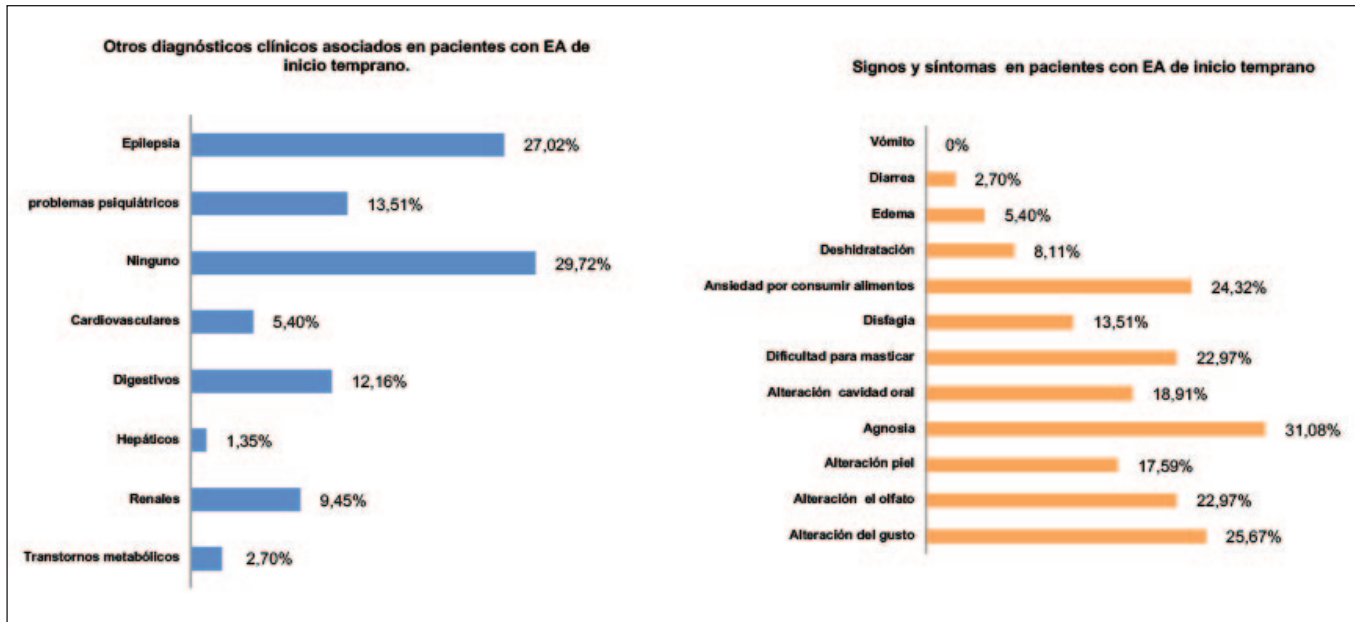


Figura 2. Frecuencia de diagnósticos clínicos, signos y síntomas en pacientes con EA de inicio temprano, clasificados en riesgo de desnutrición y desnutrición por MNA

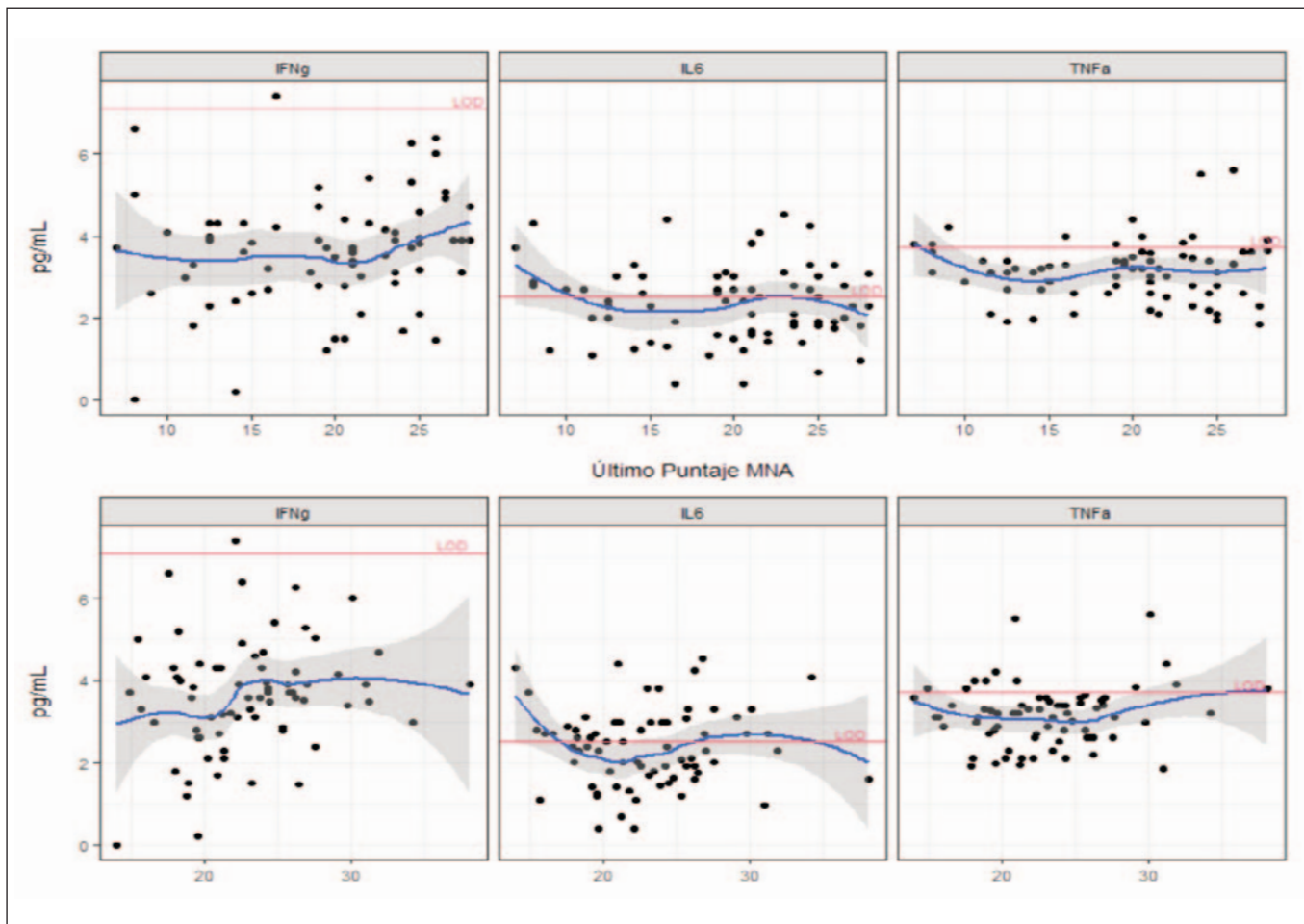


Tabla 2. Clasificación del estado nutricional por MNA vs. consumo de alimentos y medidas antropométricas de los pacientes con EA de inicio temprano

	Normal	Riesgo de Desnutrición - Desnutrición	Total
Comidas diarias (n, %)			
1 Comida	1 (12,50)	7 (87,50)	8 (10,81)
2 Comidas	18 (29,03)	44 (70,96)	63 (85,14)
3 Comidas	1 (33,33)	2 (66,67)	3 (4,05)
Total	20 (27,40)	53 (72,61)	73 (100,00)
Consumo de lácteos, huevos, carnes (n, %)			
0 o 1 [SI]	0 (0)	5 (100,00)	5 (6,85)
2 [SI]	5 (29,41)	12 (70,59)	17 (23,29)
3 [SI]	15 (29,41)	36 (70,59)	51 (69,86)
Total	20 (27,40)	53 (72,61)	73 (100,00)
Consumo frutas o verduras (n, %)			
SI	8 (24,24)	25 (48,48)	33 (45,83)
NO	11 (28,21)	28 (71,79)	39 (54,17)
Total	20 (27,40)	53 (72,61)	73 (100,00)
Consumo de agua u otros líquidos (n, %)			
Menos de 3 vasos	1 (3,33)	29 (96,67)	30 (41,10)
de 3 a 5 vasos	8 (33,33)	16 (66,67)	24 (32,88)
más de 5 vasos	11 (57,89)	8 (42,11)	19 (26,03)
Total	20 (27,40)	53 (72,61)	73 (100,00)
Perímetro braquial (cm)			
CB < 21	0 (0)	10 (100,00)	10 (13,70)
21 ≤ CB ≤ 22	0 (0)	3 (100,00)	3 (4,11)
CB > 22	20 (33,33)	40 (66,66)	60 (82,19)
Total	20 (27,40)	53 (72,61)	73 (100,00)
Perímetro de la pantorrilla (cm)			
CP < 31	0 (0)	18 (100,00)	18 (24,66)
CP ≥ 31	20 (36,36)	35 (63,63)	55 (75,34)
Total	20 (27,40)	53 (72,61)	73 (100,00)

Tabla 3. Asociación de la Seguridad Alimentaria del Hogar y la clasificación del estado nutricional por MNA de los pacientes con EA de inicio temprano

Seguridad alimentaria y estado nutricional (n, %)			
	Seguro	Inseguro	ORP (IC 95%)
Normal	5 (25,00)	15 (75,00)	Referencia
Riesgo de desnutrición	9 (31,03)	20 (68,97)	0,74 (0,19; 2,62)
Desnutrición	15 (62,50)	9 (37,50)	0,20 (0,05; 0,70)

(figura 3); se halló que el 1,36% de los pacientes lo tenían por encima de los límites de detección de 7,1 pg/mL²⁰ (figura 3).

No se encontró relación entre los estadios de la enfermedad y los niveles de IL-6 ($p=0,64$). Se observó en los estadios de Deterioro Cognitivo Leve y demencia, que 50,71% de los pacientes presentaban IL-6 por encima de los límites de detección (figura 4); respecto al TNF- α , no hubo diferencias ($p=0,85$) entre los estadios, y 16,21% de los pacientes en demencia moderada y severa presentaron niveles por encima de los límites de detección (figura 4). Tampoco se encontraron diferencias en los niveles del IFN- γ según estadio de la enfermedad y el 1,36% tenía valores por encima del límite de detección (figura 4).

DISCUSIÓN

Este estudio permitió establecer la relación entre marcadores inflamatorios y estado nutricional, al igual que características sociodemográficas y clínicas en pacientes con EA de inicio temprano, con mutación E280A-PSEN1, pertenecientes al GNA. Al revisar la literatura, no se encontraron artículos que relacionen estados proinflamatorios con estado nutricional por MNA en esta población, por lo que el presente estudio podría ser pionero en explorar esta relación. El estado nutricional puede verse comprometido por cambios en la evolución de la enfermedad, por marcadores pro inflamatorios, y por aquellos inherentes al proceso. El deterioro cognitivo genera alteraciones que afectan directa o indirectamente el estado nutricional⁵, situación analizada en este estudio. Según los datos socio demográficos, la mayoría de participantes fueron mujeres, al momento del diagnóstico con edades entre 36 y 50 años y, en su mayoría de estratos socioeconómicos medio y bajo; datos importantes por las dificultades económicas que afrontan pacientes y sus familias, pues el tratamiento de esta patología demanda cuidados especiales⁵. Estos resultados son similares a lo reportado por Gómez-Vega et al., en pacientes de EA de inicio temprano, donde hallaron que una mayor proporción (54,70%) eran mujeres, y en su mayoría se encontraban en edades entre 38 a 67 años⁴.

Respecto al MNA, en el presente estudio se encontró que el 71,62% de los participantes presentaban riesgo de desnutrición y desnutrición; de igual forma, se halló asociación entre las puntuaciones del MNA y los estadios de deterioro cognitivo; esta proporción es mayor a lo reportado por Vega et al., quienes encontraron 57,30% de pacientes con EA de inicio temprano en desnutrición⁴. En comparación con pacientes con demencia por EA tardía en el estudio DEMDIAG, se encontró que 92% estaba en riesgo de desnutrición y esta condición se asoció con una progresión más acelerada de la enfermedad²¹; además, la investigación NUDAD señala que, en pacientes con EA tardía, un pobre estado nutricional se relacionaba con 31% más riesgo de progresión clínica a dos años²². Con relación a la asociación del IMC y los estadios de la EA, en el presente estudio se hallaron diferencias entre los pacientes con demencia moderada y severa, evidenciándose disminución de la masa corporal en la medida que progresan los estadios de la enfermedad, resultados que coinciden con el estudio de Beerl et al., quienes reportaron que una disminución en el IMC, con el tiempo se asociaba con deterioro cognitivo acelerado²³.

El presente estudio indica que factores como agnosia, alteraciones en el gusto y el olfato, dificultad para masticar y disfagia, podrían incidir en el deterioro del estado nutricional y la progresión de la enfermedad, ya que alteran propiedades sensoriales y la ingesta de los alimentos, afecciones que se ven más comprometidas a medida que evoluciona la enfermedad⁵. Al respecto, Martínez et al. evidenciaron que la EA de inicio temprano tiene un curso potencialmente más agresivo, con mayor probabilidad de presentar lesión cerebral traumática y en el perfil clínico, alteraciones en las funciones ejecutivas, en las praxias ideomotoras y en la función visoespacial, incidiendo en la ingesta de alimentos²⁴. Otro factor que prevalece es la inseguridad alimentaria (IA), donde se observó que, más de la mitad de los pacientes con desnutrición, y gran parte de quienes se clasificaron en riesgo de desnutrición, presentaban esta condición, influyendo posiblemente en que la mayoría de pacientes solo consumieran 2 comidas diarias y presentaran bajo consumo de frutas y verduras, incidiendo en la disminución de la masa muscular, evidenciada en bajo perímetro de pantorrilla, limitación funcional, deterioro cognitivo y dependencia²⁵. Cabe resaltar que se carece de estudios que midan la inseguridad alimentaria en pacientes con EA temprana. No obstante, estos resultados coinciden con estudios descriptivos realizados en adultos que, según Galvan et al., encontraron una correlación negativa entre la IA y el puntaje de MNA, sugiriendo que la IA es un importante factor de riesgo para el deterioro del estado nutricional²⁵.

Respecto a la relación del estado nutricional y los marcadores pro inflamatorios, no se hallaron diferencias estadísticas. Algunas aproximaciones se han realizado en pacientes adultos mayores y con EA de inicio tardío, reportando resultados variables. Mathieux et al., en pacientes con EA probable (n:106), demostraron que los niveles séricos de IL-6 no se correlacionaron con pérdida de peso involuntaria; un indica-

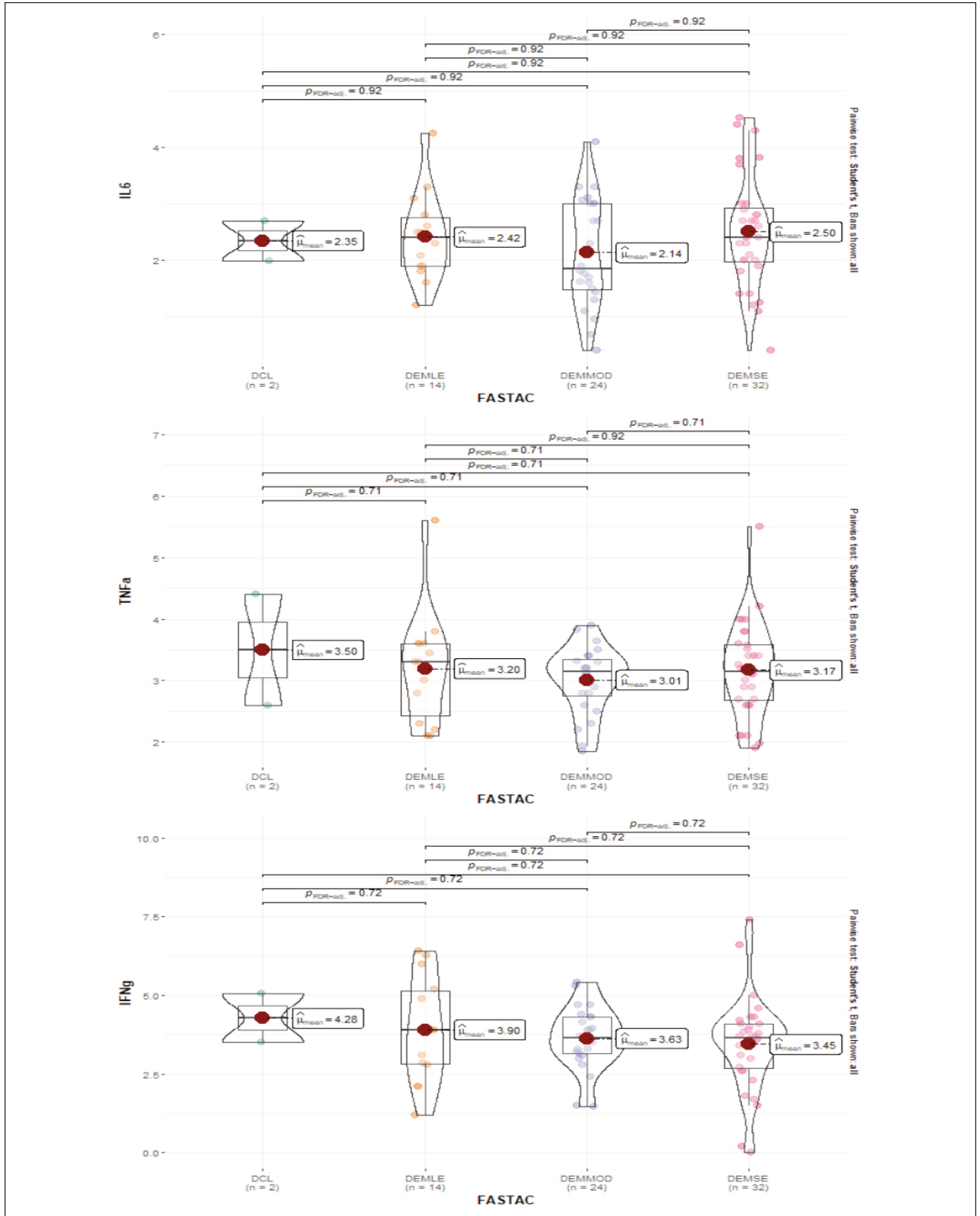


Figura 4. Relación entre citoquinas y estadios de los participantes con EA de inicio temprano

dor pronóstico de desnutrición incorporado en el MNA. Sin embargo, sí encontraron diferencias con los niveles de TNF- α , consolidándose como variable predictora de pérdida de peso en pacientes con EA tardía ($p=0,009$). Se destaca que la media de TNF- α en dicho estudio fue de 18,8 pg/mL, considerablemente superior a la reportada en el presente estudio (3,7 pg/mL) en personas con EA temprana²⁶.

Resultados similares se evidenciaron en el estudio de Fatyga en población geriátrica con enfermedades crónicas (enfermedad pulmonar obstructiva crónica o resistencia a la insulina), en el cual se empleó el MNA como herramienta para el cribado nutricional; en este se evaluaron las concentraciones séricas del receptor soluble tipo II del TNF- α demostrando que valores elevados, predicen de manera independiente el riesgo de malnutrición (OR=3,09 95% CI:1,07-8,96)²⁷, al contrario en el actual estudio la mayor proporción de los pacientes en riesgo de desnutrición no presentaron enfermedades asociadas, por lo cual no hubo diferencias de los niveles TNF- α . Por el contrario, en el estudio de Namioka et al., los pacientes con EA leve-moderada ($n:140$) y con criterios de fragilidad (entre ellos pérdida de peso), presentaron niveles significativamente más altos de IL-6 ($p<0,01$), siendo común en pacientes mayores y en mujeres con comorbilidades; en este estudio no se encontraron diferencias en los valores de TNF- α , en comparación con el grupo sin fragilidad²⁸.

También se ha explorado el comportamiento de las citoquinas en el contexto de otras enfermedades neurológicas, incluyendo el trauma craneoencefálico (TCE), que ocasiona muerte neuronal y alteraciones cognitivas, de manera similar a la EA. En este sentido, Gubari et al examinaron cambios en el estado nutricional de adultos de mediana edad en cuidados intensivos, evidenciando mayor degradación de las proteínas musculares en pacientes con altos niveles séricos de citoquinas, reportando reducción en el índice de masa corporal y en la masa libre de grasa en los pacientes con altos niveles de IL-6 y TNF- α ($p<0,01$)²⁹, tal cual pretendíamos encontrarlo en el presente estudio.

Si bien gran parte de los estudios citados demuestran una relación entre la inflamación y el estado nutricional en pacientes geriátricos y/o con enfermedad neurológica, no se evidenció esta asociación en los pacientes de este estudio; esto puede explicarse porque los valores séricos de citoquinas difieren significativamente en las cohortes estudiadas, siendo más alto en poblaciones clínicas con multimorbilidad asociada³⁰, mientras que, esta es una población modelo de estudio con baja proporción de diagnósticos clínicos asociados, presentando solo comorbilidades como trastorno de epilepsia y problemas psiquiátricos en algunos pacientes; la inflamación se ha consolidado como criterio para diagnosticar la desnutrición asociadas con enfermedades crónicas o agudas, dada su contribución a la aparición de anorexia orgánica, disminución de la ingesta energética desgaste muscular³¹, por lo que se recomiendan estudios en esta dirección para identi-

ficar puntos de corte de valores séricos de marcadores inflamatorios que se relacionen con el estado nutricional en el contexto de diferentes patologías, incluyendo la EA.

CONCLUSIONES

Es necesario estudiar el estado nutricional en pacientes con EA de inicio temprano, debido a que diversos factores pueden influenciar el proceso de desnutrición severa que va afectando a los pacientes, a medida que avanzan en los estadios de la enfermedad. A pesar de que en el presente estudio no se identificaron relaciones con los marcadores inflamatorios, se debe continuar con la búsqueda de factores asociados al deterioro del estado nutricional y la pérdida de peso en características de etapas avanzadas de la enfermedad, con el fin de disminuir el impacto en los pacientes y las complicaciones derivadas de la desnutrición, como son la inmunosupresión, la lenta cicatrización de heridas, pérdida acelerada de independencia, incremento de atrofia muscular, elevación de riesgo de discapacidad, mayor número de ingresos hospitalarios, aumento de costos en salud, incremento de tasas de mortalidad, entre otras. Por ello es importante estudiar aspectos relacionados con la ingesta de alimentos, condiciones socioeconómicas, interacción de medicamentos, reposo en cama, seguridad alimentaria, así como también los conocimientos de los cuidadores en relación con la alimentación saludable, dado que pueden ser determinantes en la evolución del estado nutricional.

AGRADECIMIENTOS

Al Grupo de Neurociencias de Antioquia (GNA), al equipo tutorial y estudiantes de la Escuela de Nutrición y Dietética de la Universidad de Antioquia, al Doctor Mauricio Rojas López por el análisis de las citoquinas, a los pacientes y familiares por su valiosa colaboración en la investigación.

REFERENCIAS

1. Organización Panamericana de la Salud. Trastornos neurológicos: un serio desafío para la salud pública en las Américas y en todo el mundo. 2008. Disponible en: https://www3.paho.org/hq/index.php?option=com_content&view=article&id=240:2008-trastornos-neurologicos-un-serio-desafio-salud-publica-americas-todo-mundo&Itemid=40595&lang=es#:~:text=Los%20trastornos%20neurol%C3%B3gicos%20son%20enfermedades,placa%20neuromuscular%2C%20y%20los%20m%C3%BAsculos
2. Ministerio de Salud. Grupo Gestión Integrada para la Salud Mental. Boletín de salud mental. Demencia. 2017. Disponible en: <https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RID/E/VS/PP/ENT/Boletin-demencia-salud-mental.pdf>
3. Acosta-Baena N, Sepúlveda-Falla D, Lopera-Gómez CM, Jaramillo-Elorza MC, Moreno S, Aguirre-Acevedo DC, et al. Pre-dementia clinical stages in presenilin 1 E280A familial early-onset Alzheimer's disease: a retrospective cohort study. *Lancet Neurol*. 2011; 10(3): 213–20.

4. Gómez VM, García E, Aguillón D, Vélez JE, Jaramillo JE, Vásquez D. Nutritional assessment in patients with early-onset autosomal dominant alzheimer's disease due to PSEN1- E280A genetic variant: a cross-sectional study. *J Aging Res & Lifestyle*. 2021; 10:32-8.
5. Muñoz AM, Agudelo GM, Lopera FJ. Diagnóstico del estado nutricional de los pacientes con demencia tipo Alzheimer registrados en el Grupo de Neurociencias, Medellín, 2004. *Biomédica*. 2006; 26(1):113-25.
6. Rivera JA, Mundo V. Inseguridad alimentaria en el hogar y estado de nutrición en personas adultas mayores de México. *Salud Pública Méx*. 2014; 56(3):71-8.
7. Tamura B, Masaki K, Blanchette P. Weight loss in patients with Alzheimer's disease. *J Nutr Elder*. 2008; 26(3-4):21-38.
8. Vellas B, Lauque S, Gillette-Guyonnet S, Andrieu S, Cortes F, Nourhashemi F et al. Impact of nutritional status on the evolution of Alzheimer's disease and on response to acetylcholinesterase inhibitor treatment. *J Nutr Health Aging*. 2005; 9(2):75-80.
9. Morales I, Farías, G, Maccioni, R. La neuroinflamación como factor detonante del desarrollo de la enfermedad de Alzheimer. *Rev Chil Neuro-Psiquiat*. 2010; 48(1):49-57.
10. Evans DC, Corkins MR, Malone A, Miller S, Mogensen KM, Guenter P, et al. ASPEN Malnutrition Committee. The use of visceral proteins as nutrition markers: an ASPEN position paper. *Nutr Clin Pract*. 2021; 36(1):22-8.
11. Volkert D, Chourdakis M, Faxen-Irving G, Frühwald T, Landi F, Suominen MH, et al. ESPEN guidelines on nutrition in dementia. *Clin Nutr*. 2015; 34(6):1052-73.
12. Pawelec G, Goldeck D, Derhovanessian E. Inflammation, ageing and chronic disease. *Curr Opin Immunol [Internet]*. 2014; 29:23-8. Disponible en: <http://dx.doi.org/10.1016/j.coi.2014.03.007>
13. Terwee CB, Bot SD, De Boer MR, Van der Windt DA, Knol DL, Dekker J, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol*. 2007; 60:34-42.
14. Rabito EI, Vannucchi GB, Suen VMM, Castilho-Neto LL, Marchini JS. Estimate of weight and height of hospitalized patients. *Rev Nutr*. 2006; 19:655-61.
15. Chumlea W C, Guo SS S M. Prediction of stature from knee height for black and white adults and children with application to mobility-impaired or handicapped persons. *J Am Diet Assoc*. 1994; 94:1385-8.
16. World Health Organization. El estado físico: uso e interpretación de la antropometría. OMS Serie de Informes Técnicos. 1993. Disponible en: http://whqlibdoc.who.int/trs/WHO_TRS_854_spa.pdf?ua=1
17. Perú Ministerio de Salud. Guía técnica para la valoración nutricional antropométrica de la persona adulta mayor. 2013. Disponible en: https://bvs.ins.gob.pe/insprint/CENAN/Valoraci%C3%B3n_nutricional_antropom%C3%A9trica_persona_adulta_mayor.pdf
18. Deossa-Restrepo G C, Restrepo-Betancur L F, Velásquez-Vargas J E, Varela Álvarez D. Evaluación nutricional de adultos mayores con el Mini Nutritional Assessment: MNA. *Universidad y Salud*. 2016; 18(3): 494-504.
19. Comité Científico ELCSA. Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA): manual de uso y aplicaciones. 2012. Disponible en: <https://www.fao.org/3/i3065s/i3065s.pdf>
20. Becton, Dickinson and Company. BD Cytometric Bead Array (CBA) Human Soluble Protein Master Buffer Kit. Instruction Manual. 2019. Disponible en: <https://wwwbdbiosciences.com/content/dam/bdb/marketing-documents/Human-Soluble-Protein-Master-Buffer-Kit-User-Manual.pdf>
21. Izquierdo Delgado E, Gutiérrez Ríos R, Andrés Calvo M, Repiso Gento I, Castrillo Sanz A, Rodríguez Herrero R, et al. Nutritional status assessment in Alzheimer disease and its influence on disease progression. *Neurologia (Engl Ed)*. 2020; S0213-4853 (19)30148-3. doi: 10.1016/j.nrl.2019.11.005
22. Doorduyn AS, de van der Schueren MAE, van de Rest O, de Leeuw FA, Hendriksen HMA, Teunissen CE, et al. Nutritional status is associated with clinical progression in Alzheimer's disease: the NUDAD Project. *J Am Med Dir Assoc*. 2023; 24(5):638-644.e1. doi: 10.1016/j.jamda.2020.10.020
23. Beeri MS, Tirosh A, Lin H M, Golan S, Boccarda E, Sano M, et al. Stability in BMI over time is associated with a better cognitive trajectory in older adults. *Alzheimer's & Dementia*. 2022; 18:2131-9.
24. Martínez R, Estrada F, Hernández A, Barajas A, Islas Escoto S, et al. Neuroinflamación: el ying-yang de la neuroinmunología. *Revista Med Inst Mex*. 2018; 61(5), 44-53.
25. Galván M, Rivera A, López G, Hernández J, Gameros Colin M, Morales Sánchez Y, et al. Relationship of food vulnerability with nutritional status and fragility in elderly mexicans. *Nutr Clin Diet Hosp*. 2019; 39(1):32-9.
26. Mahieux F, Couderc R, Fénelon G, Maachi M. Amaigrissement et cytokines circulantes chez des patients souffrant d'une maladie d'Alzheimer. *Psychol Neuropsychiatr Vieil*. 2006; 4(4):281-6.
27. Fatyga P, Pac A, Fedyk-Łukasik M, Grodzicki T, Skalska A. The relationship between malnutrition risk and inflammatory biomarkers in outpatient geriatric population. *Eur Geriatr Med*. 2020; 11(3): 383-91. doi: 10.1007/s41999-020-00303-4
28. Namioka N, Hanyu H, Hirose D, Hatanaka H, Sato T, Shimizu S. Oxidative stress and inflammation are associated with physical frailty in patients with Alzheimer's disease. *Geriatr Gerontol Int*. 2017; 17(6):913-8. doi: 10.1111/ggi.12804
29. Gubari MIM, Norouzy A, Hosseini M, Mohialdeen FA, Hosseinzadeh-Attar MJ. The Relationship between serum concentrations of pro- and anti-inflammatory cytokines and nutritional status in patients with traumatic head injury in the intensive care unit. *Medicina (Kaunas)*. 2019; 55(8):486. doi: 10.3390/medicina55080486
30. Sanders CL, Wengreen HJ, Schwartz S, Behrens SJ, Corcoran C, Lyketsos CG, et al. Nutritional status is associated with severe dementia and mortality: the Cache County Dementia Progression Study. *Alzheimer Dis Assoc*. 2018; 32(4):298-304. doi: 10.1097/WAD.0000000000000274
31. Pourhassan M, Cederholm T, Trampisch U, Volkert D, Wirth R. Inflammation as a diagnostic criterion in the GLIM definition of malnutrition-what CRP-threshold relates to reduced food intake in older patients with acute disease? *Eur J Clin Nutr*. 2022; 76(3):397-400. doi: 10.1038/s41430-021-00977-4

Body dissatisfaction and eating disorders in acrobatic gymnasts as a function of competition level

Alicia SALAS-MORILLAS¹, Águeda GUTIÉRREZ-SÁNCHEZ², Eva M^a PELÁEZ-BARRIOS³, Mercedes VERNETTA-SANTANA⁴

1 Departament of Physical Education, Faculty of Education, Universidad del Atlántico Medio. Departament of Physical Education, Faculty of Education, University International of La Rioja, Spain.

2 Departament of Special Didactics, Faculty of Education and Sport Sciences, Galicia Sur Health Research Institute (IIS), University of Vigo, Spain.

3 Analysis and Evaluation of Physical-Sport Activity. Junta de Andalucía, Spain.

4 Departament of Physical Education and Sport Science, Faculty of Sport Science, University of Granada, Spain.

Recibido: 13/abril/2024. Aceptado: 27/mayo/2024.

ABSTRACT

Introduction: In gymnastics sports, including Acrobatic Gymnastics (AG), there is a prevalence of Eating Disorders (ED). One of its main causes lies in body dissatisfaction. Therefore, the objectives of this study were: a) to know and compare the risk of ED and body dissatisfaction in a group of national level GA athletes at two levels of competition, b) to estimate if there are gymnasts who meet any of the criteria for referral to a health centre.

Methods: A descriptive cross-sectional study was conducted with the participation of 74 national female gymnasts in the Youth and Age Group categories. Height and weight measurements were used to find body mass index (BMI) and bodyfold for % body fat (%BF).

The Eating Disorders Inventory (EDI 3-RF) and the Body Shape Questionnaire (BSQ) were used for the variables Body Dissatisfaction and the EDI 3-RF was also used for the variable EDI 3-RF for the variable ED.

Results: The results showed that there are low percentages of gymnasts at risk of ED, finding body dissatisfaction as a possible antecedent for the presence of these disorders.

Conclusions: The higher category age group gymnasts stand out for a higher risk of developing ED and body dissatisfaction, as they present higher levels of Obsession for thinness, bulimic behaviours and body dissatisfaction, but without

significant differences. Signals a possible onset of risk in higher categories.

KEYWORDS

Gymnastics, Mental Disorders, Body Image, adolescents, Acrobatic gymnastics.

INTRODUCTION

Eating disorders (EDs) are classified as psychological disorders, which are characterised by abnormalities in food intake¹. The most common ED conditions are anorexia nervosa (AN), bulimia nervosa (BN) and eating disorder not otherwise specified (EDNOS) according to the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, Fifth Revision (DSM-5) (APA, 2013). Among the range of possibilities, it seems that body image (BI) and in particular body distortion or dissatisfaction plays an important role in ED².

The BI is the mental and conscious representation that each individual constructs and perceives of his or her body. It is a construct that has different components: the perceptual (perception of the body as a whole or of some of its parts), the cognitive (evaluations regarding the body or a part of it), the affective (feelings or attitudes regarding the body or a part of it and feelings towards the body) and the behavioural (actions or behaviours that occur as a result of the perception³). Dissatisfaction refers to the cognitive-affective component and is the discomfort or dissatisfaction towards our body or some part of it⁴. This dissatisfaction can lead to a disturbance in food intake and undoubtedly has an impact on a causal relationship in ED².

Correspondencia:

Alicia Salas Morillas
aliciasalasmorillas@gmail.com

Generally, these EDs in women carry great weight due to the increasing desire to be thinner, becoming in many cases an obsession with thinness².

In sports or aesthetic physical activities, this concern for BI is often more present due to the artistic requirements that lead athletes to weight concerns because of the social pressures of their sporting environment, leading to greater body dissatisfaction in the first place, which subsequently affects intake restriction or bulimic behaviours^{5,6,7}.

Specifically in gymnastic sports, it is indicated that there is a prevalence of these disorders in the disciplines of rhythmic gymnastics and aerobic gymnastics^{2,8}. The systematic review study by Salas-Morillas et al.⁷ carried out along these lines confirms that gymnasts are at greater risk of suffering from ED, highlighting the appearance in higher categories, with one of the main causes being concern, distortion and dissatisfaction with BI. However, it all depends on the gymnastic discipline, as in a comparative study between rhythmic and acrobatic gymnasts, the latter presented higher body esteem⁹. On the other hand, a study that assessed the CI and nutritional characteristics through the Mediterranean diet in GA athletes from the Autonomous Community of Andalucía (Spain), observed that gymnasts had greater satisfaction than non-gymnasts¹⁰.

With regard to EDs, most studies focus on the sedentary population^{11,12}. It seems appropriate to emphasise the importance of conducting more studies on samples of athletes in order to estimate in depth the degree of impact of EDCs in this population. In addition, athletes aged between 12 and 17 years are the most vulnerable segment of the population, as they not only have to face all that comes with being an adolescent, but also the demands of being a high-level sports practitioner¹³.

On the other hand, we are not aware of scientific studies that quantitatively assess whether acrobatic gymnasts, depending on their competitive category at pre-adolescent and adolescent ages, are at greater or lesser risk of developing Eds.¹⁴ Hence, the aim of this study is precisely a) to know and compare the risk of Eds and body dissatisfaction in a group of national level gymnasts at two levels of competition, b) to estimate whether there are gymnasts who meet any of the referral criteria for referral to a health centre.

METHODS

Participants

The participants were selected through a descriptive cross-sectional study, accessing the collection of information in those groups of gymnasts to which there was easy access and informed consent from the guardians. The final sample consisted of 74 national gymnasts divided into two groups according to competitive category: youths (48.7%) and age

group (51.3%), all of whom were female competitors. The age range was between 8 and 16 years, with a mean age of 12.9 (SD = 1.93), being 12.55 (SD = 1.71) the mean age for the youth gymnasts and 13.2 (SD = 2.08) for the age group gymnasts. The gymnasts had an average of 5 years of practice and trained 12.19 hours on average per week. The study followed the guidelines established by the 2013 Declaration of Helsinki and respected the ethical considerations of the Sport and Exercise Science Research and was approved by the Research Ethics Committee of the University of Granada (reference number: 1484/CEIH/2020).

Variables and instruments

The Body Shape Questionnaire (BSQ) by Cooper et al.¹⁵, adapted by Raich, et al.¹⁶, which measures the cognitive-behavioural component, was used to measure the CI variable. It consists of 34 items, with six response options on a Likert-type scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = very often; and 6 = always). The maximum score to be obtained is 204 points and the minimum 34 points, which are divided into the following cut-off points: a) less than 81, no dissatisfaction with the CI; b) 81-110, mild dissatisfaction; c) 111-140, moderate dissatisfaction; and d) greater than 140, extreme dissatisfaction. It allows obtaining an overall score (sum of the direct scores of the items) and 4 subscales can be derived: body dissatisfaction, fear of gaining weight, low esteem for appearance and desire to lose weight. The Cronbach's alpha internal consistency coefficient in the original version is 0.93 by Cooper et al.¹⁵ to 0.97 by Raich et al.¹⁶, being 0.96 in this study for the whole sample.

The Eating Disorders Inventory (EDI-3-RF), Garner¹⁷, in its Spanish adaptation¹⁸ was used for the EDI variable. It allows a rapid assessment with standardised criteria to rule out or confirm the presence of ED. An individualised score can be obtained for each of the three scales: Obsession with thinness (7 items), bulimic behaviours (8 items) and body dissatisfaction (10 items).

* Drive for Thinness scale (DT) measures a strong drive for getting thinner or a strong fear of fatness, consequently becoming a good predictor of binge eating or ED development. The direct score ranges from 0 to 20, 12 being the critical value.

* Bulimia scale (B) evaluates the tendency towards thoughts related to excessive eating or towards uncontrolled binge eating. The direct score ranges from 0 to 32, the critical value lying between 5 and 8, depending on the gymnast's BMI.

* Body Dissatisfaction scale (BD) assesses the individual's dissatisfaction with their general body shape or those body parts that people with ED are usually most concerned about: belly, hips, thighs, buttocks, etc. The direct score ranges from 0 to 40, divided into three levels depending on the body dissatisfaction intensity: 0-6 low, 7-27 average and 28-40 high.

Lastly, this questionnaire allows for referral to a specialised service, depending on three standard criteria:

- Criterion 1 is exclusively based on the individual's BMI. Depending on sex and age, it is decided whether the body weight is excessively low.

- Criterion 2 relates BMI to the presence of excessive concern about weight or food, or complicated eating patterns (assessed through DT and B scales).

- Criterion 3 focuses on the presence of behavioural symptoms that could suggest an ED (assessed through the B scale of the questionnaire).

Finally, this questionnaire allows the referral of subjects to a specialised care service for a more rigorous study according to three established criteria: criteria 1, based on the subject's BMI; criteria 2 relates BMI to the measures of two scales DT and B; criteria 3 is based on the presence of behavioural symptoms warning of a possible ED (assessed with part B of the questionnaire).

For the anthropometric variables weight and height, the instruments used were: a TEFAL digital scale with a precision of 0.05 kg for weight and a SECA 220 measuring rod with a precision of 1 mm for height. With the weight and height measurements, the BMI was calculated, based on weight (kg) divided by height squared (metres).

Procedure

The most important clubs at national level were visited, requesting permission to access the gymnasts. Prior to the administration of the tests, we explained to them what the study consisted of and informed them of the voluntary, anonymous and confidential nature of the data. Furthermore, as the gym-

nasts were minors, the signed authorization of their parents was requested by means of informed consent. Data collection was carried out in small groups always in the presence of one of the authors, with ISAK level 1 certification. Firstly, a self-registration form was filled in with questions regarding age, years of practice in gymnastics, club, competitive level and weekly training days/hours and then the BSQ and the EDI-3RF. The completion of all the questionnaires took between 15 and 20 minutes. Finally, the anthropometric tests were carried out in accordance with the recommendations and protocol established by the International Society for the Advancement of Kinanthropometry (ISAK)¹⁹. In all measurements the gymnasts were barefoot and in training clothes.

Statistical analysis

For descriptive statistics, means, percentages and standard deviations were calculated. For inferential analysis the normality of the data distributions was tested using the Shapiro-Wilk test for normality. The Mann-Whitney U-test was performed to compare differences by categories in body dissatisfaction and ED due to the non-normal distribution of the data. Correlational analysis between variables was by Spearman correlation coefficients. Statistical significance was set at $p < .05$. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) v. 25.0 software (SPSS Inc., Chicago, IL).

RESULTS

Firstly, table 1 shows the descriptive analysis of the gymnasts' overall mean scores in all the variables analysed, taking into account the different scales of the instruments used.

It can be seen that Youth gymnasts have the highest BMI, with a normal BMI of 19.5. Regarding the body dissatisfaction

Table 1. Descriptions of the different variables according to category

	Youth (n=36)	Age Group (n=38)	Total (n=74)	<i>p</i>
Age	12.55±1.71	13.2±2.08	12.9±1.93	0.000
Wheight (kg)	45.2±10.5	45.9±12.5	45.6±11.5	0.000
Height (m)	1.5±0.11	1.5±0.12	1.5±0.11	0.010
BMI	19.7±2.4	19.3±3.1	19.5±2.8	0.200*
BSQ	69.6±29.5	62.7±36.7	66.1±33.3	0.000
DT	10.3±7.7	10.1±8.4	10.2±8.1	0.000
B	4.7±4.7	6.3±7.7	5.6±6.4	0.000
BD	17.1±4.7	18.1±5.1	17.5±4.9	0.000

BMI= Body Mass Index; BSQ= Body Dissatisfaction by BSQ DT= Thinness Dissatisfaction; B= Bulimia; BD= Body Dissatisfaction by EDI-3RF.

values, the Age Group level gymnasts have the highest values of dissatisfaction. And according to the indexes of Obsession for Thinness, Youth gymnasts have higher values, but the same does not occur with the risk of Bulimia B, as it is the Age Group gymnasts who have higher values.

Tables 2 describe the frequency and percentage of body dissatisfaction levels according to category in the different questionnaires, showing a high percentage of gymnasts in both categories with no dissatisfaction according to the BSQ questionnaire up and none with high levels of dissatisfaction regarding the EDI3 RF questionnaire low.

The majority of gymnasts (79.7%) are in No body dissatisfaction according to the BSQ questionnaire, with Age Group gymnasts having the highest body dissatisfaction scores. 7.9% are at Moderate dissatisfaction and 5.3 at an extreme level.

Regarding the results of the EDI 3RF questionnaire, the majority (36.4%) are at a medium level of body dissatisfaction, with 39.4% of Age Group gymnasts at a medium level, and none of the gymnasts at the High level of the total sample.

Table 3 describes the frequency and percentage of gymnasts who are in the critical value of the different scales Thinness Obsession (DT) and Bulimia (B).

On the other hand, Age Group gymnasts have a higher risk of TD (34.2%) compared to 25% of gymnasts in the Youth category. In the case of the risk of suffering from bulimia, 26.3% of Age Group gymnasts compared to 19.4% of Youth gymnasts. And the Figure 1 describes the differences of the values DT and B according to the categories.

Table 4 describes the frequency and percentage of subject referral to treatment according to the three criteria established by the EDI-3RF. For these percentages, the DT scale related to Obsession with Thinness was considered as an assessment measure to refer gymnasts with a score of 9 or more on this component and 4 for the B scale. Following these criteria, only 1 gymnast, 2.7% of the youths and 3 gymnasts, 7.8% of the age-groups were included in this warning group for risk of ED (criteria 3). In both groups the percentage was similar with no significant differences.

Table 2. Frequency (percentage) of different levels of Body Dissatisfaction (BSQ/EDI 3 RF) according to category

Category	No dissatisfaction	Mild dissatisfaction	Moderate dissatisfaction	Extreme dissatisfaction	p
Youth (n=36) %	29 (80.45)	8 (22.2)	2 (5.6)	1 (2.8)	0.070
AgeGroup (n=38) %	30 (78.9)	3 (7.9)	3 (7.9)	2 (5.3)	0.000
Total (n=74) %	59 (79.7)	11 (14.1)	5 (6.8)	3 (4.1)	0.000

Category	Under	Medium	High	p
Youth (n=36) %	5 (12.8)	12 (33.3)	-	0.096
AgeGroup (n=38) %	4 (10.5)	15 (39.4)	-	0.000
Total (n=74) %	9 (12.8)	27 (36.4)	-	0.000

Table 3. Frequency (percentage) of gymnasts who are in critical values of the variables Thinness Obsession (DT) and Bulimia (B) according to category

Category	DT	B
Youth (n=36) %	9 (25)	7 (19.4)
AgeGroup(n=38) %	13 (34.2)	10 (26.3)
Total (n=74) %	22 (29.7)	17 (22.9)
p	0.000	0.000

Table 4. Frequency (percentage) of gymnasts meeting the referral criteria according to category

Category	Criteria 1	Criteria 2	Criteria 3
Youth (n=36) %	-	10 (27.7)	1 (2.7)
AgeGroup(n=38) %	5 (13.1)	13 (34.2)	3 (7.8)
Total (n=74) %	5 (6.7)	23 (31)	4 (5.4)
p	0.000	0.000	0.000

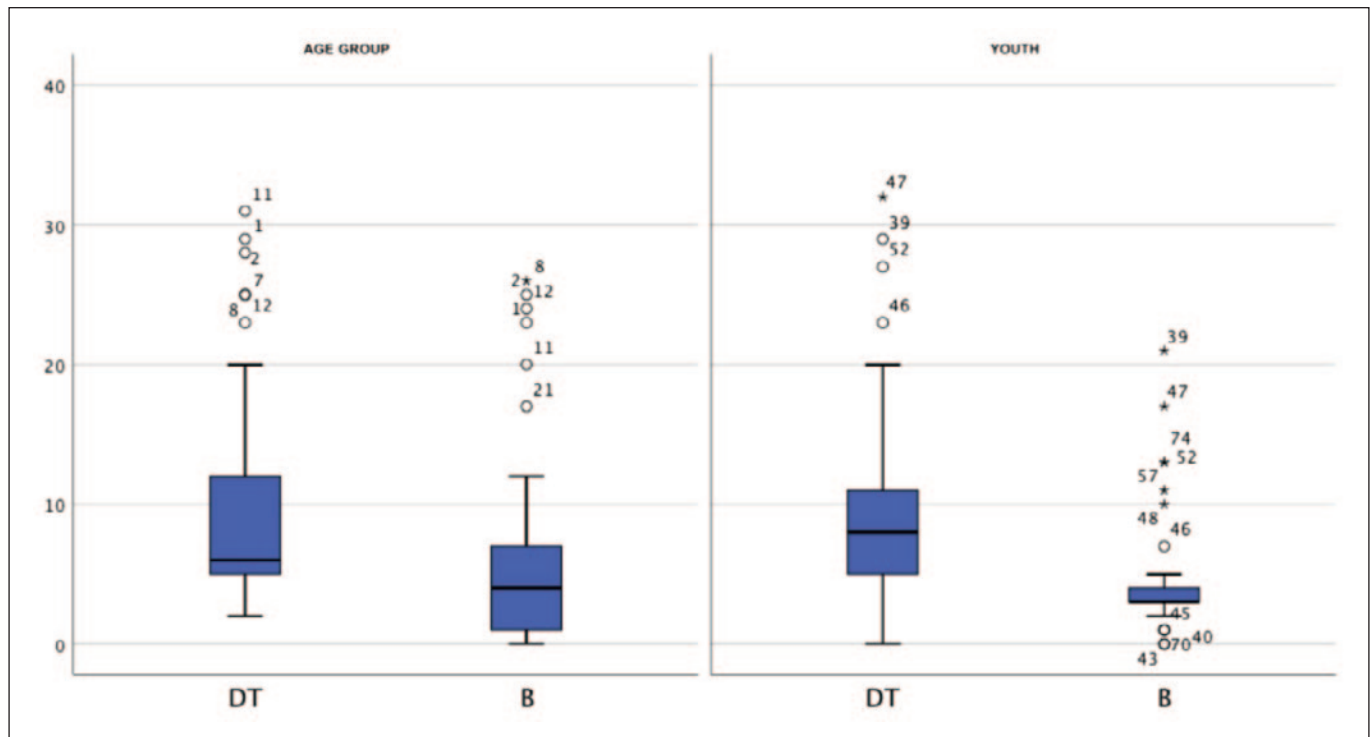


Figure 1. Differences observed between the values of the DT and B subscales according to the category

DISCUSSION

The results of this study indicate that, in relation to body dissatisfaction, there is scientific evidence that found similar responses, where a high percentage of female acrobatic gymnasts (79.7%) were not dissatisfied with their body^{4,9,20}. However, other studies showed that dissatisfaction increases with age in women^{9,14,21} results that do not agree with what was observed in our research where gymnasts of older age and category presented similar results.

With regard to the degree of dissatisfaction in the BSQ, 24.3% of the total sample fell into one of the degrees of dissatisfaction, with the majority being in the mild degree and only 4.1% in the extreme degree. These results coincide with studies where most gymnasts had no dissatisfaction^{4,24}. Furthermore, these results corroborate scientific evidence from studies suggesting that age group gymnasts are less likely to develop CI disturbances^{4,9,20}.

In relation to the results provided by the EDI-3RF questionnaire in the BD scale referring to body dissatisfaction, it should be noted that no gymnast is in high dissatisfaction, with the majority being in moderate dissatisfaction. These percentages of moderate dissatisfaction and, as a consequence, lack of personal satisfaction, is one of the risk factors for ED in competitive gymnasts, together with the rise to high performance at an early age²³. However, it is worth noting the sensitivity of this questionnaire to gymnasts, as it is a ques-

tionnaire prepared for a non-athlete population, so the data should be taken with caution.

In reference to the risk of ED, it is observed that a minimum percentage of gymnasts in this study are vulnerable to developing this type of disorder, an aspect that coincides with previous studies^{22,24}. It should be noted that 73.7% of the gymnasts did not present a risk of developing ED, and several studies confirm these results in lower categories, in our case in national competition categories²⁵.

The risk of suffering from ED, has been reasoned in this work by the main presence of two risk scales: Obsession for thinness^{8,22,24} and bulimic behaviours, higher in both cases in the age group category that are gymnasts who have higher technical requirements; they compete with two exercises in competition, and it is considered a preparatory category for international competition²².

Regarding the referral criteria, the results show that gymnasts belonging to the age group category meet all three referral criteria. A low percentage (5.4%) met criteria 1, which is exclusively related to low BMI, with no youths meeting these criteria. With reference to remission criteria 2, the results are the highest in both categories, being slightly higher in juveniles (39.4% vs. 27.7%), which means that they should be preventively referred to a specialist for the presence of thinness obsession and problematic eating patterns. As for criteria 3, only 1 youth gymnast and 3 age group gymnasts,

5.4% of the gymnasts in the total sample, should be mandatorily referred for extreme weight control behaviour in the last three months (binge eating, vomiting, exercise). These referral rates are lower than the results published in Martínez-Rodríguez et al.²⁴ in rhythmic gymnastics. However, these comparisons must be made with caution, as none of these studies have applied the EDI-3-RF, so the chances of remission have not been analysed. However, it should be noted that our remission results are not at all alarming as wanting to have a slimmer body, lose weight and train longer cannot be taken into account in these performance athletes as symptoms of ED, since the high amount of training hours and the desire for a light, strong and slim aesthetic body to obtain sporting success in the artistic dimension is inherent to high competition in these gymnasts²³.

In general, all the studies analyse the risk of suffering or not from ED, without analysing in detail the symptoms prior to the ED itself. One of the notable variables related to the risk of suffering some type of ED is body dissatisfaction, analysed in our study by two BSQ instruments and one of the EDI 3RF scales. As can be seen, this is a precedent in this case, as associations are observed between the BSQ with the risk scales related to Obsession with thinness and bulimic behaviours measured by the EDI 3RF, as well as with the three referral criteria. This variable is related as a main cause in numerous studies^{2,6,7}.

In relation to BMI, more than half of the gymnasts have a BMI of normal weight or low weight with thinness grade III and II, with only 2.7% being overweight according to the indicators proposed by Cole et al.²⁸, results similar to those obtained in other studies on gymnasts in this speciality^{9,14,27}. There are several authors who claim that these characteristics are due in many cases to a process of "natural selection", since a low weight benefits the practice of these highly technical sports, being a predominant factor in performance²⁸.

The limitations of this study include the low number of existing studies in GA and in other gymnastic disciplines covering athletes of different categories²⁹, as well as the low male participation, which makes it impossible to make a comparison based on gender. Likewise, the use of this instrument, although valid and reliable in the adolescent population, it is important to adapt it to the environment of these gymnasts since daily weight control and specific diets with restriction of certain foods during competitive periods, which in non-athlete patients would be warning signs of ED, are typical in these sports with an aesthetic component.

CONCLUSION

Overall, it can be concluded that gymnasts in both categories show good body satisfaction and low levels of risk of ED. The higher category age group gymnasts stand out for being more vulnerable to suffer from ED, presenting slightly

higher levels of obsession with thinness, bulimic behaviours and body dissatisfaction than the youths, but without significant differences. Likewise, a positive relationship between body dissatisfaction and risk of ED was also found, with no differences between the two groups.

The main contribution of this work is to have studied the preparatory categories to the elite, as it allows us to observe the key point where these disorders begin to be triggered and their main causes. Furthermore, there are practically no studies on this subject carried out in Spain in this discipline, which is why it represents an important complement to knowledge on ED in the field of gymnastics sports. We can observe that in lower categories the level of risk decreases, being rewarding the action that the discipline performs.

With respect to studies already published, it would be interesting to keep the good action of the discipline in higher categories, taking into account the variables that develop it.

REFERENCES

- Villalobos-Hernández, A., Bojórquez-Chapela, I., Hernández-Serrato, M. I., & Unikel-Santoncini, C. *Prevalencia de conductas alimentarias de riesgo en adolescentes mexicanos: Ensanut Continua*. Salud Pública de México. 2022; 65, 1-6. <https://doi.org/10.21149/14800>
- Valles Verdugo, G., Hernández Armas, E., Baños, R., Moncada-Jiménez, J., & Rentería, I. *Distorsión de la imagen corporal y trastornos alimentarios en adolescentes gimnastas respecto a un grupo control de adolescentes no gimnastas con un IMC similar*. Retos. 2020; 37, 297-302. <https://doi.org/10.47197/retos.v37i3.7.67090>
- Thompson, J. K., Burke, N. L., & Krawczyk, R. *Measurement of body image in adolescence and adulthood*. *Encyclopedia of Body Image and Human Appearance*. Elsevier. 2012; pp. 512-520 <https://doi.org/10.1016/B978-0-12-384925-0.00081-X>
- Peláez-Barríos, E. M., & Vernetta, M. *Body Dissatisfaction, Mediterranean Diet Adherence and Anthropometric Data in Female Gymnasts and Adolescents*. Apunts Educación Física y Deportes. 2022a; 149, 12-21. [https://doi.org/10.5672/apunts.2014-0983.es.\(2022/3\).149.02](https://doi.org/10.5672/apunts.2014-0983.es.(2022/3).149.02)
- de Oliveira, G. L., de Oliveira, T. A. P., de Pinho Gongalves, P. S., Silva, J. R. V., Fernandes, P. R., & Filho, J. F. *Body image and eating disorders in female athletes of different sports*. Journal of Exercise Physiology Online. 2017; 20(2), A1+. <https://link.gale.com/apps/doc/A491157362/AONE?u=anon~a5c0c1b9&sid=goo gleScholar&xid=abf98955>
- Mancine, R. P., Gusfa, D. W., Moshrefi, A., & Kennedy, S. F. *Prevalence of disordered eating in athletes categorized by emphasis on leanness and activity type – a systematic review*. Journal of Eating Disorders. 2020; 8(47). <https://doi.org/10.1186/s40337-020-00323-2>
- Salas-Morillas, A., Gutiérrez-Sánchez, A., & Vernetta-Santana, M. *Insatisfacción corporal y trastornos de conducta alimentaria en gimnastas: revisión sistemática*. Retos. 2022; 44, 577-585. <https://doi.org/10.47197/retos.v44i0.91042>

8. Ioannidou, C., & Venetsanou, F. *Social physique anxiety, disturbed eating attitudes and behaviors, and perceived pressure for thin body in competitive Rhythmic and Aerobic Gymnasts*. *Science of Gymnastics Journal*. 2019; 11(3), 331-342. <https://www.fsp.uni-lj.si/mma/-/20191027171537/>
9. Vernetta, M., Montosa, I., & Peláez, E. *Estima corporal en gimnastas adolescentes de dos disciplinas coreográficas: gimnasia rítmica y gimnasia acrobática*. *Psychology, Society, y Education*. 2018; 10(3), 301-314. <https://doi.org/10.25115/psye.v10i3.2216>
10. Peláez-Barrios, E. M., & Vernetta, M. *Insatisfacción corporal en gimnastas españoles de acrobática respecto a un grupo control de no practicantes*. *Cuadernos de Psicología del Deporte*. 2022b; 22(3), 124-139. <https://doi.org/10.6018/cpd.482711>
11. de Aldana, M. S. C., Aguilar, S. S., Paez, A. N., Ortiz, S. P., Torrez Contreras, C. C., & Patiño, L. F. C. *Riesgo de trastornos de conductas alimentarias asociados al estado nutricional de los adolescentes*. *Cultura de los cuidados*. 2023; 27(65), 315-327.
12. Rosero, H. P. P., Bajaña, J. F. M., & Zavala, T. C. Y. *Redes sociales y trastornos de la conducta alimentaria en adolescentes: Social networks and eating disorders in adolescents*. *Maestro y Sociedad*. 2023; 132-139. <https://maestrosociedad.uo.edu.cu/>
13. Pazmiño, J.M. *Trastornos alimenticios de los deportistas: Una revisión sistemática*. *Mentor Revista de Investigación Educativa y Deportiva*. 2022; 1 (1), 7-20. <https://doi.org/10.56200/mried.v1i1.2054>
14. Salas-Morillas, A., Gutiérrez-Sánchez, A., & Vernetta-Santana, M. *Composición corporal y rendimiento deportivo en gimnastas de acrobática*. *International Journal of Morphology*. 2022; 40(1), 220-227. http://www.intjmorphol.com/wp-content/uploads/2022/02/art_32_401.pdf
15. Cooper, P. J.; Taylor, M. J.; Cooper, Z., & Fairburn C. G. *The development and validation of the Body Shape Questionnaire*. *International Journal of Eating Disorders*. 1987; 6, 485-494. [https://doi.org/10.1002/1098-108X\(198707\)6:4<485::AID-EAT2260060405>3.0.CO;2-O](https://doi.org/10.1002/1098-108X(198707)6:4<485::AID-EAT2260060405>3.0.CO;2-O)
16. Raich, R. M., Mora, M., Soler, A., Avila, C., Clos, I., & Zapater L. *Adaptación de un instrumento de evaluación de la insatisfacción corporal*. *Clinica y Salud*. 1996; 7, 51-66.
17. Garner, D. M. *Eating Disorder Inventory-3 Professional manual*. Odessa, FL: Psychological Assessment Resources. 2004.
18. Elosua, P., López-Jáuregui, A., & Sánchez-Sánchez, F. *Adaptación española del Eating Disorder Inventory-3*. Normalización y validación. Madrid: TEA. 2010.
19. Marfell-Jones M., Olds T., Stewart A., & Carter L. *International standards for anthropometric assessment*. ISAK: Potchefstroom, South Africa. 2006.
20. Ariza-Vargas, L., Salas-Morillas, A., López-Bedoya, J., & Vernetta-Santana, M. *Percepción de la imagen corporal en adolescentes practicantes y no practicantes de gimnasia acrobática*. *Retos*. 2021; 39, 71-77. <https://doi.org/10.47197/retos.v0i39.78282>
21. Verand Escudero, D., & Sánchez Díaz, A. *Asociación entre la percepción de la imagen corporal y el riesgo de desarrollar trastornos de la conducta alimentaria en bailarines de ballet, deportistas de nado sincronizado y gimnastas de la selección nacional del Perú*. Universidad Peruana de Ciencias Aplicadas (UPC). 2017. <http://hdl.handle.net/10757/621667>
22. Fortes, L. de S., Neves, C. M., Filgueiras, J. F., Almeida, S. S., & Ferreira, M. E. C. *Body dissatisfaction, psychological commitment to exercise and eating behavior in young athletes from aesthetic sports*. *Revista Brasileira de Cineantropometría y Desempenho Humano*. 2013; 15(6), 695-704. <https://doi.org/10.5007/1980-0037.2013v15n6p695>
23. De Sousa, L., De Sousa, S., & Caputo, M. E. *Psychometric Analysis of Disordered Eating in Sports Scale (DES)*. *Paidéia*. 2016; 26(64), 171-180. <https://doi.org/10.1590/1982-43272664201603>
24. Martínez-Rodríguez, A., Reche-García, C., Martínez Fernández, M. C., & Martínez Sanz, J. M. *Valoración del estado dietético-nutricional, la composición corporal, el comportamiento alimentario y la percepción de la imagen en deportistas de gimnasia rítmica*. *Nutrición Hospitalaria*. 2020; 37(6), 1217-1225. <https://doi.org/10.20960/nh.03141>
25. Kontele, I., Vassilakou, T., & Donti, O. *Weight Pressures and Eating Disorder Symptoms among Adolescent Female Gymnasts of Different Performance Levels in Greece*. *Children*. 2022; 9(2), 254. <https://doi.org/10.3390/children9020254>
26. Cole, T., Flegal, K., Nicholls, D., & Jackson, A. *Body mass index cut off to define thinness in children and adolescents*. *International Survey*. 2007; 335, 194-197. <https://doi.org/10.1136/bmj.39238.399444.55>
27. Taboada-Iglesias, Y., Vernetta-Santana, V., Alonso-Fernández, D., & Gutiérrez-Sánchez, A. *Body composition profiles of female acrobatic gymnasts of difference age categories*. *South African Journal for Research in Sport, Physical Education and Recreation*. 2023; 45(1), 75.91.
28. Kaur, K., & Koley, S. *Anthropometric determinants of competitive performance in gymnastics: a systematic review*. *International Journal Health Science and Research*. 2019; 9(7), 249-256. https://www.ijhsr.org/IJHSR_Vol.9_Issue.7_July2019/38.pdf
29. Salas-Morillas, A., Ariza-Vargas, L., Gutiérrez-Sánchez, Á., & Vernetta-Santana, M. *Eating disorders in spanish acrobatic gymnasts based on sex and competitive level*. *Science of Gymnastics Journal*. 2023; 15, 2, 173-190. <https://doi.org/10.15.2.173-190>

Relación entre el perfil bioquímico, antropométrico y estilo de vida saludable del personal de una universidad privada: Gestión en la prevención de riesgo ocupacional

Relationship between the biochemical and anthropometric profile and healthy lifestyle of the staff of a private university: Management of occupational risk prevention

Ruth Ester MORENO-LEYVA¹, Roussel Dulio DAVILA-VILLAVICENCIO², Saulo Andrés SALINAS ARIAS³, Antonio J. CASTELLANOS-VAZQUEZ⁴, Jhan Arly SANCHEZ TARRILLO⁵, Evaristo MANCHAY SEMBRERA⁶, Nelly Rosario MORENO-LEYVA⁷, Jacksaint SAINTILA⁸

1 Unidad de Posgrado, Universidad Peruana Unión, Lima, Perú.

2 Escuela Profesional de Enfermería, Universidad Peruana Unión, Lima, Perú.

3 Escuela Profesional de Psicología, Universidad Peruana Unión, Tarapoto, Perú.

4 Universidad Peruana Unión, Tarapoto, Perú.

5 Dirección del CRAI, Universidad Peruana Unión, Tarapoto, Perú.

6 Facultad de Teología, Universidad Peruana Unión, Lima, Perú.

7 Escuela Profesional de Contabilidad, Universidad Peruana Unión, Juliaca, Perú.

8 Escuela de Medicina Humana, Universidad Señor de Sipán, Chiclayo, Perú.

Recibido: 13/febrero/2024. Aceptado: 30/mayo/2024.

RESUMEN

Introducción: El entorno laboral, particularmente en las instituciones educativas, puede influir en la salud y el bienestar de los empleados debido a un estilo de vida no saludable.

Objetivo: Determinar la relación entre el perfil bioquímico, antropométrico y el estilo de vida saludable en el personal de una universidad privada.

Método: Se realizó un estudio descriptivo-correlacional en 107 docentes y personal administrativa de una universidad privada de Tarapoto, Perú. Se recolectaron informaciones bioquímicas y antropométricas y se aplicó Escala la de Dieta y Estilo de Vida Saludable (DEVs). Los datos fueron analizados utilizando el lenguaje de programación R version 4.0.2.

Resultados: Las personas casadas reportaron una mejor adherencia al estilo de vida saludable (95.5%, $p = 0.042$). Las

puntuaciones del IMC fueron más altos en aquellos con menor adherencia al estilo de vida saludable (26.8 ± 3.96) respecto a los que informaron mayor adherencia (25.4 ± 3.74), sin embargo, no hubo diferencia significativa. También, presentaron un mayor nivel de hemoglobina (Hb) (13.5 g/dL , $p = 0.045$) y concentraciones de triglicéridos ($112 [99.0-151]$) más altos en comparación a aquellos que no tenían una adherencia saludable.

Conclusiones: Estos hallazgos resaltan la importancia de la planificación de programas de educación nutricional y la prevención de enfermedades no transmisibles el entorno laboral para mejorar la salud y el bienestar de esta población.

PALABRAS CLAVES

Perfil bioquímico, antropometría, estilo de vida saludable, prevención, riesgo ocupacional.

ABSTRACT

Background: The work environment, particularly in educational institutions, can have a significant impact on the health and well-being of employees due to the prevalence of unhealthy lifestyles.

Correspondencia:
Ruth Ester Moreno Leyva
ruthmor@upeu.edu

Objective: To determine the relationship between biochemical, anthropometric profile and healthy lifestyle in the staff of a private university.

Methods: A descriptive-correlational study was conducted in 107 teachers and administrative staff of a private university in Tarapoto, Peru. Biochemical and anthropometric data were collected, and the Diet and Healthy Lifestyle Scale (DEVS) was applied. The data were analyzed using the R programming language version 4.0.2.

Results: Married persons reported better adherence to the healthy lifestyle (95.5%, $p = 0.042$). BMI scores were higher in those with lower adherence to the healthy lifestyle (26.8 ± 3.96) with respect to those who reported higher adherence (25.4 ± 3.74), however, there was no significant difference. Also, they had higher hemoglobin (Hb) (13.5 g/dL , $p = 0.045$) and triglyceride concentrations ($112 [99.0-151]$) compared to those without healthy adherence.

Conclusion: These findings highlight the importance of planning nutrition education and noncommunicable disease prevention programs in the workplace to improve the health and well-being of this population.

KEYWORDS

Biochemical profile, Anthropometry, Healthy lifestyle, Prevention, Occupational risk.

INTRODUCCIÓN

El incremento de enfermedades crónicas no transmisibles (ENT) como la diabetes, la hipertensión y la obesidad, se ha convertido en un problema de salud pública a nivel mundial¹. Estas condiciones no solo impactan la calidad de vida de los individuos, sino que también generan costos significativos para los sistemas de salud y reducen la productividad laboral². Por otro lado, el personal académico y administrativo de las universidades privadas puede estar expuesto a largas horas de trabajo sedentario, lo que aumenta el riesgo de desarrollar enfermedades cardiovasculares y metabólicas³. De hecho, estas enfermedades son responsables de aproximadamente el 71% del total de muertes a nivel mundial¹. Más del 85% de estos casos registrados en países de ingresos bajos y medianos³. En la Región de las Américas, se estima que 2,2 millones de personas fallecen prematuramente por ENT antes de alcanzar los 70 años⁴. En el contexto específico de Perú, las enfermedades cardiovasculares lideran las causas de mortalidad⁵. En el año 2021, el 17.2%, 4.9% y 25.8% de la población peruana mayor de 15 años presenta hipertensión, diabetes tipo 2 y obesidad, respectivamente, evidenciando un incremento de 1.2 puntos porcentuales en obesidad con respecto al año anterior⁵.

Los estilos de vida poco saludables, caracterizados por la inactividad y una dieta rica en sodio, grasas saturadas y azú-

cares, son reconocidos como factores que incrementan el riesgo de ENT⁶. A este panorama se suma la contribución negativa del consumo de alcohol, tabaco y sustancias ilícitas, según evidencian estudios recientes⁷. Una mejor adherencia a un estilo de vida saludable podría tener un impacto significativo, reduciendo en un 80% la incidencia de las ENT⁸.

Estudios anteriores han encontrado que un alto comportamiento sedentario se asoció con niveles elevados de glucosa, mientras que una mayor actividad física se relacionó con niveles más bajos⁹. Estos hallazgos sugieren que reducir el tiempo sedentario y aumentar la actividad física pueden contribuir a mantener niveles óptimos de glucosa en esta población. Del mismo modo, otro estudio encontró que aquellos los estilos de vida saludables, como no fumar, no consumir alcohol, realizar ejercicio regularmente, mantener una dieta saludable y mantener un índice de masa corporal bajo se asocian con perfiles lipídicos más favorables¹⁰. Se destacó la importancia de mantener un estilo de vida saludable para promover perfiles lipídicos óptimos. Adicionalmente, los hallazgos de un análisis transversal reportaron que el 18.5% de los adultos presentaban síndrome metabólico, y factores como el IMC $\geq 25 \text{ kg/m}^2$, el comportamiento sedentario ≥ 8 horas al día, el consumo adecuado de frutas o verduras, la actividad física y el consumo de alcohol estuvieron significativamente asociados con esta condición¹¹.

Si bien se han llevado a cabo diversos estudios en relación con el tema en estudio^{3,9-11}, su abordaje en el contexto peruano es aún limitado. Además, los hallazgos del estudio actual serán fundamentales para llevar a cabo una vigilancia y monitoreo periódico de la salud del personal a través del equipo de gestión del riesgo ocupacional. Del mismo modo, la comprensión detallada del perfil antropométrico, que incluye mediciones como la circunferencia de la cintura (CC) y el índice de masa corporal (IMC), proporciona información crucial sobre el estado cardiovascular, permitiendo prevenir riesgos potenciales. Por lo tanto, el objetivo de este estudio de investigación fue determinar la relación existente entre el perfil bioquímico y antropométrico, junto con el estilo de vida saludable, en el personal universitario de una institución educativa privada.

MATERIALES Y MÉTODOS

Diseño y participantes

Este estudio adopta un enfoque cuantitativo descriptivo-correlacional. La metodología empleada se basa en un diseño no experimental y observacional, con un enfoque transversal para la recolección de datos. La muestra de estudio comprende 107 participantes pertenecientes al ámbito administrativo y docente de una Universidad Privada de Tarapoto, Perú, Región de San Martín. La selección de los participantes se realizó mediante un muestreo no probabilístico por conveniencia, considerado representativo de la totalidad de la población de interés. La muestra se limitó a aquellos individuos

que aceptaron participar y proporcionaron su consentimiento informado, excluyendo a aquellos que no accedieron o presentaban enfermedades no transmisibles. Los datos fueron recolectados entre los meses marzo y abril de 2023.

Aspectos éticos

El proyecto fue evaluado por el Comité de Ética en Investigación de la Universidad Peruana Unión (N° de Referencia: 2023-CEEPG-00064). Todos los participantes dieron su consentimiento informado. Los participantes participaron voluntariamente en el proyecto. Los procedimientos serán realizados de acuerdo las consideraciones éticas descritas en la declaración de Helsinki.

Instrumentos de recolección de datos

Ficha de registro de datos antropométricos y bioquímico. Se recolectaron datos sobre la edad, lugar de procedencia (costa, sierra y selva) y área laboral (facultad de ciencias de la salud, recursos humanos, bienestar universitario, entre otras áreas).

IMC: El peso y la talla de los participantes fueron evaluados con la ayuda de un profesional de enfermería. Posteriormente, se calculó el IMC como peso/altura² (kg/m²). El IMC fue utilizado para evaluar el exceso de peso corporal según los criterios establecidos por el Ministerio de Salud del Perú en la Guía Técnica para la Valoración Nutricional Antropométrica de la persona Adulta¹². Se clasificó el IMC según los parámetros establecidos por la OMS: (a) delgadez, ≤ 18.5 ; (b) normopeso, $\geq 18.5 - \leq 24.9$ kg/m²; (c) sobrepeso, entre 25.0 a 29.9 kg/m²; (d) obesidad ≥ 30 ¹³.

Circunferencia de la Cintura (CC): La CC se determinará a través de una cinta métrica autorretráctil de acero metálica de la marca Cescorf (Cescorf Equipamentos Para Esporte Ltda – Epp, Brasil). Se considerará obesidad abdominal para una CC ≥ 93 cm en hombres y ≥ 79 cm en mujeres adultos peruanos¹².

Perfil lipídico y concentración de glucosa en sangre: La extracción de sangre (5 ml) fue efectuada durante las dos primeras horas de la mañana, después de 12 horas de ayuno de acuerdo con los procedimientos estándar para muestras de sangre. Para determinar el perfil lipídico, se empleó kits comerciales Colestat enzimático AA de Wiener lab, con técnicas estandarizadas basadas en métodos enzimáticos y colorimétricos, por espectrofotometría, según las recomendaciones del fabricante. Además, fueron determinadas mediante el empleo de un analizador bioquímico semiautomático. Posteriormente, se determinó la glucemia utilizando métodos enzimáticos colorimétricos realizados de forma manual. El perfil lipídico de los participantes fue clasificado de la siguiente manera: altos niveles de LDL (LDL ≥ 160 mg/dL), bajos niveles de HDL (HDL-c < 40 mg/dL en varones y < 50 mg/dL en mujeres) e hipertrigliceridemia (TG ≥ 200 mg/dL)¹⁴. Se consideró hiperglucemia una concentración

de glucosa en ayunas ≥ 126 mg/dL¹⁵. La extracción y procesamiento de los sueros se realizaron por un Tecnólogo Médico Certificado y capacitado en el Laboratorio de Microbiología de la Universidad Peruana Unión.

Adherencia al estilo de vida: Las evaluaciones de las informaciones sobre el estilo de vida de los participantes se llevarán a cabo teniendo en cuenta los criterios propuestos por el Índice de Estilo de Vida Vegetariano, elaborado por Le et al.¹⁶, y adaptada y validada en la población peruana por Calizaya-Milla¹⁷, como *Escala de Dieta y Estilo de Vida Saludable (DEVS)* el cual se desarrolló siguiendo las recomendaciones de las guías para dietas y estilos de vida saludables vegetarianos propuestas por el Departamento de Nutrición de la Escuela de Salud Pública, Loma Linda, Universidad¹⁸. El instrumento está compuesto de 14 ítems, de los cuales, 11 están relacionados temas relacionadas a las dietas basadas en plantas, considerando el consumo de alimentos integrales de origen vegetal, como frutas, verduras, legumbres, frutos secos, semillas y cereales integrales. También, alimentos de origen animal como leche y derivados, huevos, fuentes confiables de vitamina B-12, así como dulces. Adicionalmente, los 3 últimos ítems, representan las características de estilo de vida, que incluyen el ejercicio físico regular, ingesta adecuada de agua y exposición moderada a la luz solar. En cada pregunta, las opciones de preguntas se limitaron a 3. Los 14 ítems se suman para obtener una puntuación total que oscila entre 0 a 14 puntos, dividiendo el resultado en 3 categorías: 0, 0.5 o 1 punto. Los participantes obtuvieron una puntuación 1, cuando referirían haber consumido ≥ 6 porciones/día de cereales integrales, ≥ 3 porciones/día de legumbres, ≥ 8 porciones/día de verduras, ≥ 4 porciones/día de frutas, ≥ 1.5 porciones/día de nueces y semillas, ≤ 2 porciones/día de aceites vegetales, 0 porciones/día de productos lácteos y huevos. Las puntuaciones totales más altas indican una mayor adherencia a un hábito de vida saludable.

Análisis de datos

El análisis de datos se realizó a través del lenguaje de programación R version 4.0.2 (R Foundation for Statistical Computing, Austria; <http://www.R-project.org>). Según la naturaleza categórica, numéricas con distribución normal o no normal de las variables se describieron como frecuencias absolutas y relativas (%), media \pm desviación estándar (DE) o mediana y rango intercuartílico (IQR) respectivamente. Para el análisis comparativo se usó la prueba Chi-cuadrado, T de student o U de Mann Whitney dependiendo de la naturaleza de las variables y previo análisis de normalidad a través del test Kolmogorov-Smirnov. Un $p < 0.05$ se consideró como estadísticamente significativo en todos los análisis.

RESULTADOS

La Tabla 1 muestra las características de una población de estudio con una edad promedio de 34 años, donde el 54,2%

Tabla 1. Características generales de la población de estudio

Variables	Total (n=107)	%/±DE/[IQR]
Edad (años)	34	[28.0-42.0]
Sexo (%)		
Mujer	49	45.8%
Hombre	58	54.2%
Estado civil (%)		
Casado	66	61.7%
Soltero	41	38.3%
Grado de instrucción (%)		
Bachiller	51	47.7%
Doctor	3	2.8%
Magister	44	41.1%
Secundaria Completa	7	6.5%
Técnico	2	1.9%
Área de trabajo (%)		
Académico	49	45.8%
Administrativo	58	54.2%
PAS (mmHg)	100	[100-110]
PAD (mmHg)	70	[60.0-70.0]
Peso (kg)	65	[58.0-75.0]
Talla (metros)	1	[1.56-1.67]
IMC (kg/m ²)	25.5	±3.77
Hb (g/dL)	13	[12.5-14.2]
Glucosa (mg/dL)	97	[92.3-103]
Colesterol total (mg/dL)	183	±49.1
Triglicéridos (mg/dL)	99	[59.5-160]
Adherencia estilo de vida (%)		
<p10	10	9.4%
≥p10	97	90.7%

Nota: Variables presentadas como frecuencia absoluta y relativa (%), mediana [IQR] o media ± DE. *p<0.05, **p<0,01 estadísticamente significativo por U de Mann Whitney, T de student o Chi-square.

son hombres y el 61,7% están casados. La mayoría tiene un grado de bachiller (47,7%) y trabaja en el área administrativa. Los valores de presión arterial sistólica y diastólica se encuentran dentro de los rangos normales. El IMC promedio es de 25.5, indicando sobrepeso, pero las variables de Hb, glucosa, colesterol y triglicéridos están en rangos normales. Además, el 90.7% de los participantes reportan adherencia a un estilo de vida saludable.

La Tabla 2 analiza las variables sociodemográficas y su relación con la adherencia al estilo de vida. Los resultados muestran que las personas de mayor edad tienden a tener una mejor adherencia al estilo de vida. Aunque no hay diferencias estadísticamente significativas por sexo, los hombres reportan una mayor adherencia en comparación con las mujeres. Los participantes casados son significativamente más propensos a adherirse adecuadamente que los solteros. No se observan diferencias significativas en la adherencia al estilo de vida entre los trabajadores académicos y administrativos.

La Tabla 3 presenta un análisis de las características antropométricas y bioquímicas en relación con la adherencia al estilo de vida en la población de estudio. Con relación a la presión arterial, no se observan diferencias significativas ni en la presión arterial sistólica (PAS) ni en la diastólica (PAD) entre los grupos (<p10 y ≥p10). De manera similar, en cuanto al peso, talla e Índice de Masa Corporal (IMC), no se detectan diferencias estadísticamente significativas. Sin embargo, algunas variables sugieren posibles asociaciones con la adherencia al estilo de vida. Se destaca que los niveles de hemoglobina (Hb) difieren significativamente entre los grupos (<p10: 11.9 g/dL, ≥p10: 13.5 g/dL) con un valor p de 0.045. Por otro lado, los niveles de glucosa en sangre, colesterol total y triglicéridos no se encontraron diferencias significativas entre los grupos.

DISCUSIÓN

El mantenimiento de un estilo de vida saludable es esencial para mitigar los efectos adversos de los problemas de salud, especialmente para el personal universitario que enfrenta desafíos significativos a nivel mental, físico y psicológico¹⁹. La adopción de prácticas como el consumo adecuado de verduras y frutas, junto con la actividad física, se configura como una estrategia preventiva y de reducción de enfermedades. El objetivo de este estudio fue explorar la relación entre el perfil bioquímico, antropométrico y el estilo de vida saludable en el personal de una universidad privada. Los hallazgos destacados incluyeron: a) se observó una menor adherencia al estilo de vida saludable en aquellos con IMC más alto; b) los hombres tenían una mejor adherencia al estilo de vida saludable que en las mujeres; c) las personas casadas tenían una mejor adherencia al estilo de vida saludable en comparación con solteros; d) se observó una mejor adherencia en aquellos con niveles más altos de hemoglobina; e) también, hubo una mejor adherencia en aquellos con niveles óptimos de coleste-

Tabla 2. Comparación de variables sociodemográficas por adherencia al estilo de vida

Variables	Adherencia al estilo de vida		p-valor
	<p10 (n=10)	≥p10 (n=97)	
Edad (años)	27.0 [26.2-35.0]	34.0 [28.0-42.0]	0.052
Sexo (%)			0.181
Mujer	7 (14.3%)	42 (85.7%)	
Hombre	3 (5.17%)	55 (94.8%)	
Estado civil (%)			0.042*
Casado	3 (4.55%)	63 (95.5%)	
Soltero	7 (17.1%)	34 (82.9%)	
Grado de instrucción (%)			0.496
Bachiller	7 (13.7%)	44 (86.3%)	
Doctor	0 (0.00%)	3 (100%)	
Magister	2 (4.55%)	42 (95.5%)	
Secundaria Completa	1 (14.3%)	6 (85.7%)	
Técnico	0 (0.00%)	2 (100%)	
Área de trabajo (%)			1.000
Académico	5 (10.2%)	44 (89.8%)	
Administrativo	5 (8.62%)	53 (91.4%)	

Nota: Variables presentadas como mediana [rango intercuartílico] o frecuencia absoluta y relativa (%).

*p<0.05, estadísticamente significativo por U de Mann Whitney o Chi-square.

Tabla 3. Comparación de características antropométricas y bioquímicas por adherencia al estilo de vida

Variables	Adherencia al estilo de vida		p-valor
	<p10 (n=10)	≥p10 (n=97)	
PAS (mmHg)	110 [100-110]	100 [100-110]	0.865
PAD (mmHg)	65.5 [60.0-77.5]	70.0 [60.0-70.0]	0.708
Peso (kg)	67.5 [60.8-71.2]	64.0 [58.0-76.0]	0.752
Talla (metros)	1.58 [1.51-1.60]	1.61 [1.56-1.67]	0.112
IMC (kg/m ²)	26.8 ± 3.96	25.4 ± 3.74	0.289
Hb (g/dL)	11.9 [11.6-12.5]	13.5 [12.8-14.3]	0.045*
Glucosa (mg/dL)	97.7 [92.9-101]	97.9 [92.5-103]	0.630
Colesterol total (mg/dL)	172 ± 40.3	184 ± 49.9	0.391
Triglicéridos (mg/dL)	112 [99.0-151]	96.4 [58.8-168]	0.392

Nota: Variables presentadas como mediana [IQR] o media ± DE.

*p<0.05, estadísticamente significativo por U de Mann Whitney o T de student.

rol; y f) menor adherencia en aquellos con mayores niveles de triglicéridos.

Se observó una menor adherencia al estilo de vida saludable en aquellos con IMC más alto, estos hallazgos son similares a lo reportado en estudios previos que también identifican una correlación negativa entre el IMC elevado y la adherencia a estilos de vida saludables¹¹. Esta tendencia puede explicarse por diversos factores conductuales que afectan las decisiones de salud en individuos con sobrepeso u obesidad²⁰. Además, es relevante considerar el contexto específico del personal académico y administrativo de la universidad, quienes podrían enfrentar desafíos únicos relacionados con el ambiente laboral que influyen en su estilo de vida, como horarios extensos de trabajo y estrés laboral, que podrían contribuir a la baja adherencia observada. Estos hallazgos resaltan la importancia de desarrollar estrategias efectivas de promoción de la salud que estén adaptadas a las necesidades específicas de los individuos con un IMC más alto, especialmente en entornos académicos y administrativos, para mejorar la adherencia a estilos de vida saludables y, en última instancia, mejorar su bienestar general.

En nuestro estudio, los hombres reportaron una puntuación de adherencia al estilo de vida saludable significativamente más alta que las mujeres. Este hallazgo es interesante y puede estar influido por varios factores socioculturales y psicológicos que afectan de manera diferente a hombres y mujeres en su capacidad o disposición para adoptar hábitos saludables. Uno de los posibles factores es la diferencia en la percepción del propio estado de salud y la motivación para mejorar o mantener la salud, que tiende a variar entre géneros. Estudios anteriores han sugerido que los hombres, en ciertos contextos, pueden sentir una mayor presión social para mantener una imagen de fortaleza y salud, lo que podría traducirse en una mayor adherencia a actividades físicas y dietas saludables²¹. Sin embargo, también es importante considerar que las mujeres a menudo enfrentan múltiples roles sociales que pueden limitar su tiempo y energía para participar en actividades de autocuidado y ejercicio, lo que podría influir en sus niveles más bajos de adherencia reportados²². Además, las diferencias en la educación sobre salud y el acceso a información relacionada con estilos de vida saludables pueden jugar un rol. En algunos casos, los hombres pueden tener más acceso a espacios y actividades que promueven estilos de vida saludables, como gimnasios y clubes deportivos, debido a normas culturales o restricciones de tiempo menos estrictas comparadas con las mujeres²³. Estos hallazgos resaltan la necesidad de abordar las disparidades de género en la salud con un enfoque que contemple las particularidades socioculturales y los desafíos específicos que enfrentan las mujeres en la adopción y mantenimiento de un estilo de vida saludable.

También, los resultados indican que las personas casadas exhiben una mayor adherencia al estilo de vida saludable.

Este patrón es consistente con investigaciones anteriores que sugieren que el matrimonio puede contribuir a una mejor salud mental y a la adopción de hábitos más saludables, posiblemente debido al apoyo emocional y logístico que ofrece tener una pareja²⁴. Sin embargo, es fundamental considerar las evidencias que apuntan en dirección contraria, donde se argumenta que las responsabilidades y el estrés asociados al matrimonio podrían llevar a un deterioro en la calidad del estilo de vida, al aumentar el cansancio y reducir el tiempo disponible para actividades saludables. Esta dualidad sugiere que la relación entre el estado civil y la salud es compleja y puede estar mediada por varios factores, incluyendo la calidad de la relación conyugal, las redes de apoyo social disponibles y las dinámicas familiares. Así, mientras que el matrimonio puede proporcionar un marco de apoyo que fomente hábitos saludables, también puede imponer presiones que dificulten su mantenimiento²⁵. Futuras investigaciones deberían explorar estas dinámicas con mayor profundidad, considerando variables como la satisfacción marital y el equilibrio entre vida laboral y personal, para entender mejor cómo el estado civil influye en la salud y el bienestar. Además, sería útil desarrollar intervenciones que ayuden a las parejas a manejar el estrés marital y a promover estilos de vida saludables de manera conjunta.

Respecto a los niveles de hemoglobina, los hallazgos indican que los individuos con mejores niveles de hierro tienden a mostrar mayor adherencia a un estilo de vida saludable. Este vínculo podría explicarse por la asociación entre una dieta equilibrada, rica en nutrientes esenciales como el hierro, y la adopción general de hábitos saludables, incluyendo una mayor actividad física y decisiones alimenticias más informadas²⁶. Por lo tanto, abordar tanto la deficiencia de hierro como la promoción de hábitos saludables puede ser una estrategia eficaz para mejorar la salud general y prevenir enfermedades relacionadas con el estilo de vida.

Finalmente, los datos revelan que los individuos con niveles óptimos de colesterol LDL tienen mejor adherencia al estilo de vida saludable. Esta observación puede reflejar la influencia positiva de una dieta equilibrada y la actividad física regular en la regulación del colesterol LDL (lipoproteína de baja densidad), conocido como "colesterol malo"²⁷. Mantener niveles saludables de LDL es importante para prevenir enfermedades cardiovasculares, ya que niveles elevados pueden llevar a la formación de placas en las arterias, incrementando el riesgo de aterosclerosis y complicaciones relacionadas²⁸. La adherencia a un estilo de vida saludable, que incluye una dieta rica en fibra, frutas, verduras, y grasas saludables, junto con la actividad física regular, ha demostrado ser eficaz en la reducción de los niveles de colesterol LDL²⁹. Este estudio subraya la importancia de estrategias de prevención centradas en la modificación del estilo de vida como un método primordial para controlar el colesterol y, por ende, reducir el riesgo de complicaciones cardiovasculares. Asimismo, es importante que las políticas de salud

pública se enfoquen en facilitar el acceso a alimentos saludables y oportunidades para la actividad física, creando entornos que apoyen la adopción y el mantenimiento de hábitos saludables entre la población general.

LIMITACIONES

La interpretación de los resultados de este estudio debe hacerse dentro del contexto de algunas limitaciones. En primer lugar, el tamaño de la muestra podría limitar la representatividad de los resultados, especialmente si la población total es considerablemente más grande y diversa. En segundo lugar, al utilizar muestreo no-probabilístico por conveniencia puede generar sesgos de selección, ya que el personal se eligió por su disponibilidad o accesibilidad en lugar de seguir un proceso aleatorio. Asimismo, en tercer lugar, la Exclusión de individuos con Enfermedades No Transmisibles podría introducir sesgos, porque esta población podría tener características diferentes en términos de salud y estilo de vida en comparación con aquellos sin estas condiciones.

A pesar de estas limitaciones, creemos que nuestra investigación es valiosa, porque los hallazgos podrían servir para realizar gestiones de prevención que beneficiaría el bienestar físico, mental y social del personal. Además, los resultados podrían ser útiles en la implementación de programas integrales de salud y bienestar para detectar enfermedades en etapas tempranas, fomentando un ambiente laboral más saludable y productivo.

CONCLUSIONES

Este estudio ha evidenciado una menor adherencia en individuos con un IMC más alto. Por otro lado, los hombres mostraron una mejor adherencia en comparación con las mujeres. Además, los resultados sugieren que el estado civil influye en la adopción de un estilo de vida saludable, donde las personas casadas exhibieron una mayor adherencia que los solteros. Asimismo, aquellos con niveles más altos de hemoglobina y niveles bajos de colesterol también mostraron una mayor adherencia. Contrariamente, se encontró una menor adherencia en individuos con altos niveles de triglicéridos, lo que subraya la importancia de una dieta adecuada y de la educación nutricional como componentes críticos de los programas de salud.

REFERENCIAS

- Misra A, Khurana L. Obesity-related non-communicable diseases: South Asians vs White Caucasians. *Int J Obes* 2011; 35: 167–187.
- WHO. *Global status report on noncommunicable diseases 2014*. World Health Organisation. Geneva, Switzerland. <https://apps.who.int/iris/bitstream/handle/10665/148114/?sequence=6> (2014, accessed 18 October 2021).
- Zahnd WE, Eberth JM. Lung Cancer Screening Utilization: A Behavioral Risk Factor Surveillance System Analysis. *Am J Prev Med* 2019; 57: 250–255.
- GBD 2017 Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet* 2018; 392: 1736–1788.
- INEI. El 39,9% de peruanos de 15 y más años de edad tiene al menos una comorbilidad, <https://www.inei.gov.pe/prensa/noticias/el-399-de-peruanos-de-15-y-mas-anos-de-edad-tiene-al-menos-una-comorbilidad-12903/> (2020).
- Castillo-fernández D, Brañez-Condorena A, Villacorta-Landeo P, et al. Advances in the investigation of chronic non-communicable diseases in Peru. *Anales de la Facultad de Medicina* 2021; 81: 444–452.
- Ramos-Vera C, Serpa Barrientos A, Calizaya-Milla YE, et al. Consumption of Alcoholic Beverages Associated With Physical Health Status in Adults: Secondary Analysis of the Health Information National Trends Survey Data. *J Prim Care Community Health*; 13. Epub ahead of print 1 January 2022. DOI: 10.1177/21501319211066205.
- Nielsen JB, Leppin A, Gyrd-Hansen D e., et al. Barriers to lifestyle changes for prevention of cardiovascular disease – a survey among 40–60-year old Danes. *BMC Cardiovasc Disord* 2017; 17: 245.
- Gerage AM, Bezerra JB, Tomicki C, et al. High sedentary behavior and low light physical activity are associated with worse glucose rates in cardiometabolic diseases' subjects. *J Bodyw Mov Ther* 2024; 40: 295–299.
- Zhao Y, Liu X, Mao Z, et al. Relationship between multiple healthy lifestyles and serum lipids among adults in rural China: A population-based cross-sectional study. *Prev Med (Baltim)* 2020; 138: 106158.
- Jemal A, Girum T, Kedir S, et al. Metabolic syndrome and its predictors among adults seeking medical care: A trending public health concern. *Clin Nutr ESPEN* 2023; 54: 264–270.
- Ministerio de Salud. Gobierno del Perú. Guía técnica para la valoración nutricional antropométrica de la persona adulta, <https://repositorio.ins.gov.pe/xmlui/handle/INS/225> (2012, accessed 24 June 2020).
- WHO. *Constitution of the World Health Organization, basic documents, Forty-eighth edition*. Geneva, 2014.
- Expert Panel on Detection, Evaluation and T of HBC in A. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA* 2001; 285: 2486–97.
- MINSa. Guía técnica: 'Guía de Práctica Clínica para el diagnóstico, tratamiento y control de la diabetes mellitus tipo 2, en el primer nivel de atención'. Perú: MINSa; 2016.
- Le LT, Sabaté J, Singh PN, et al. The design, development and evaluation of the vegetarian lifestyle index on dietary patterns among vegetarians and non-vegetarians. *Nutrients*; 10. Epub ahead of print 1 May 2018. DOI: 10.3390/nu10050542.

17. Calizaya-Milla YE, Saintila J, Morales-García WC, et al. Evidence of Validity and Factorial Invariance of a Diet and Healthy Lifestyle Scale (DEVS) in University Students. *Sustainability* 2022; 14: 12273.
18. Haddad EH, Sabaté J, Whitten CG. Vegetarian food guide pyramid: A conceptual framework. In: *American Journal of Clinical Nutrition*. American Society for Nutrition, 1999, pp. 615s–619s.
19. Yaguachi RA, Troncoso-Corzo LV, Correa-Asanza K, et al. Estilo de vida, estado nutricional y riesgo cardiovascular en trabajadores de la salud. *Nutr Clín Diet Hosp* 2021; 41: 19–27.
20. Tsuchiya C, Furusawa T, Tagini S, et al. Socioeconomic and Behavioral Factors Associated with Obesity Across Sex and Age in Honiara, Solomon Islands. *Hawaii J Health Soc Welf* 2021; 80: 24–32.
21. McKenzie SK, Collings S, Jenkin G, et al. Masculinity, Social Connectedness, and Mental Health: Men's Diverse Patterns of Practice. *Am J Mens Health* 2018; 12: 1247–1261.
22. Sumra MK, Schillaci MA. Stress and the Multiple-Role Woman: Taking a Closer Look at the "Superwoman". *PLoS One* 2015; 10: e0120952.
23. Wang H, Xu Z, Yang J, et al. Promoting Physical Activity among Working Women: The Influence of Perceived Policy Effectiveness and Health Awareness. *Int J Environ Res Public Health* 2023; 20: 1021.
24. Lin L, Guo H, Duan L, et al. Research on the relationship between marital commitment, sacrifice behavior and marital quality of military couples. *Front Psychol*; 13. Epub ahead of print 4 October 2022. DOI: 10.3389/fpsyg.2022.964167.
25. Graff TC, Birmingham WC, Wadsworth LL, et al. Doing it all: Effects of Family Responsibilities and Marital Relationship Quality on Mothers' Ambulatory Blood Pressure. *Annals of Behavioral Medicine* 2024; 58: 67–78.
26. Cusquisibán-Alcantara Y, Toledo-Garrido C, Calizaya-Milla Y, et al. Impact of a Nutrition Education Intervention on Knowledge, Healthy Eating Index, and Biochemical Profile in a Rural Community in Peru. *J Multidiscip Healthc* 2024; Volume 17: 1111–1125.
27. Gordillo J, Vásquez A, González W, et al. Efecto de dieta con bajo índice glicémico en mujeres obesas con hiperinsulinemia. *Nutrición Clínica Y Dietética Hospitalaria*; 43.
28. Torres L, Canchari A, Lozano L, et al. Hábitos alimentarios, estado nutricional y perfil lipídico en un grupo de pacientes con diabetes tipo 2. *Nutr clín diet hosp* 2020; 40: 135–142.
29. Guasch-Ferré M, Li Y, Bhupathiraju SN, et al. Healthy Lifestyle Score Including Sleep Duration and Cardiovascular Disease Risk. *Am J Prev Med* 2022; 63: 33–42.

Cáncer de cabeza y cuello: revisión del diagnóstico y tratamiento de la sarcopenia

Review of the diagnosis and treatment of sarcopenia in patients with head and neck cancer

Jon CACICEDO¹, Darío SÁNCHEZ CABRERO², Valeria ALCÁNTARA ARAGÓN³, Tamara ROZA FERNÁNDEZ⁴, Andrea MARTÍN AGUILAR⁵, Laura CALLES ROMERO⁶

1 Departamento de Oncología Radiológica, Hospital Universitario Cruces/Universidad del País Vasco (UPV/EHU)/Instituto de Investigación Sanitaria Biobizkaia. Vizcaya, España.

2 Departamento de Oncología Médica. Hospital Universitario La Paz. Madrid, España.

3 Departamento de Endocrinología y Nutrición. Hospital Universitario Marqués de Valdecilla. Santander, España.

4 Scientific Field Trainer. Abbott Laboratories S.A. Madrid, España.

5 Medical Advisor. Abbott Laboratories S.A. Madrid, España.

6 Servicio de Endocrinología y Nutrición. Hospital Universitario de Basurto. Vizcaya, España.

Recibido: 13/marzo/2024. Aceptado: 30/mayo/2024.

RESUMEN

Introducción: Los pacientes con cáncer de cabeza y cuello (CCC) pueden presentar tumores que se originan en la mucosa y/o submucosa que recubre la cavidad oral, faríngea y laríngea, dando lugar a síntomas que impactan habitualmente en la deglución y favorecen los problemas nutricionales de estos pacientes. Hasta un 52% de los enfermos presentan desnutrición al diagnóstico, incrementándose hasta cerca del 90% durante la terapia antineoplásica. Por lo que, son uno de los grupos más vulnerables para desarrollar sarcopenia asociada a la desnutrición y disfagia. El objetivo es revisar el conocimiento actual sobre el estado de la masa muscular, la patogénesis, diagnóstico y tratamiento de la sarcopenia cuando tiene lugar en el cáncer de cabeza y cuello.

Métodos: Búsqueda bibliográfica en bases de datos PubMed, Cochrane Plus y Medline de artículos entre 2015 y 2022 con términos previamente definidos.

Resultados: Los pacientes con cáncer de cabeza y cuello constituyen un grupo heterogéneo en el que la prevalencia de

desnutrición es significativa pero muy variable. Se han desarrollado varios métodos diagnósticos para evaluar la masa muscular en pacientes oncológicos, pero todavía no están estandarizados. Además, no existe una pauta farmacológica concreta para el tratamiento de la sarcopenia o la caquexia a nivel clínico.

Conclusión: La valoración nutricional debe ser una parte fundamental del enfoque inicial del paciente oncológico y posterior seguimiento. El objetivo terapéutico es aumentar el apetito y la ingesta de alimentos, atenuar el estado inflamatorio crónico y mejorar la capacidad y la calidad del ejercicio.

PALABRAS CLAVE

Toxicidad, supervivencia, valoración nutricional, ejercicio físico, sarcopenia.

ABSTRACT

Introduction: Patients with head and neck cancer can present tumors that originate in the mucosa and/or submucosa that lines the oral, pharyngeal and laryngeal cavities, giving rise to symptoms that usually affect swallowing and favor nutritional problems of these patients. Up to 52% of patients present malnutrition at diagnosis, increasing to nearly 90% during antineoplastic therapy. Therefore, they are one of

Correspondencia:

Jon Cacicedo

jon.cacicedofernandezdebadilla@osakidetza.eus

the most vulnerable groups to develop sarcopenia associated with malnutrition and dysphagia. The objective is to review the current knowledge on the state of muscle mass, the pathogenesis, diagnosis and treatment of sarcopenia when it occurs in head and neck cancer.

Methods: bibliographic search in PubMed-Medline databases of articles between 2015 and 2022 with previously defined terms.

Results: Patients with head and neck cancer constitute a heterogeneous group in which the prevalence of malnutrition is significant but highly variable. Several diagnostic methods have been developed to assess muscle mass in cancer patients but they are not yet standardized. In addition, there is no specific pharmacological regimen for the treatment of sarcopenia or cachexia at the clinical level.

Conclusion: Nutritional assessment should be a fundamental part of the initial approach to cancer patients and subsequent follow-up. The therapeutic goal is to increase appetite and food intake, attenuate the chronic inflammatory state, and improve exercise capacity and quality.

KEYWORDS

Toxicity, survival, nutritional assessment, physical exercise, sarcopenia.

ABREVIATURAS

CCC: cáncer de cabeza y cuello.

IMC: Índice de masa corporal.

TC: tomografía computarizada.

RM: resonancia magnética.

CMB: circunferencia muscular del brazo.

CP: circunferencia de la pantorrilla.

VM: velocidad de marcha.

FPP: fuerza de prensión palmar.

BIA: análisis de impedancia bioeléctrica.

AF: ángulo de fase.

DEXA: absorciometría de rayos X de energía dual.

HMB: β -hidroxi- β -metilbutirato.

INTRODUCCIÓN

El cáncer de cabeza y cuello (CCC) se puede considerar un tipo de tumor infrecuente, ya que representa un 5% de todos los tumores. Existen algunas variaciones en cuanto a su frecuencia en distintas áreas geográficas, pero en Europa la localización más frecuente es la laringe, seguido de la orofaringe, la cavidad oral y la nasofaringe¹.

Se puede considerar que este tipo de tumores tienen una etiología fundamentalmente ambiental (externa). Sus principales factores de riesgo se clasifican en dos tipos: factores ambientales (consumo de tabaco y alcohol, malos hábitos dietéticos, mala higiene bucal y roces por prótesis dentales) e infecciones (virus del papiloma humano, virus de Epstein-Barr)¹.

La edad media de aparición de estos tumores está por encima de los cincuenta años, aunque los localizados en nasofaringe y glándulas salivares pueden aparecer a edades más tempranas².

Son tumores que se originan en la mucosa y/o submucosa que recubre la cavidad oral, faríngea y laríngea, cuya sintomatología va a depender de la localización, provocando dolor por infiltración de los tejidos, disfagia, disfonía, disnea, sangrado, parálisis facial, etc.; todos estos síntomas impactan habitualmente en la deglución y favorecen los problemas nutricionales de estos pacientes^{2,3}.

Hasta un 52% de los enfermos presentan desnutrición al diagnóstico, incrementándose hasta cerca del 90% durante la terapia antineoplásica⁴.

La desnutrición en estos pacientes está favorecida por el diagnóstico en estadios avanzados, la sintomatología provocada por el tumor y la toxicidad de los tratamientos que afectan a las funciones fisiológicas esenciales de la alimentación, la fonación y la respiración. Todo ello se asocia con mayor deterioro físico, alteración de la inmunidad, interrupciones del tratamiento y estancias hospitalarias más prolongadas, así como mayor tasa de reingresos hospitalarios, toxicidades tardías más frecuentes y graves derivadas del tratamiento quimiorradioterápico, deterioro de la calidad de vida y aumento de la mortalidad^{5,6}.

Diversos estudios establecen la sarcopenia como factor pronóstico independiente de menor supervivencia y aumento de toxicidades en este tipo de tumores⁷.

La toxicidad resultante de la quimiorradioterapia induce efectos adversos, como la mucositis o la dermatitis rásica, que afectan a la tolerancia al tratamiento con un mayor número de interrupciones en el mismo, comprometiendo de esta manera su eficacia⁸.

Además, los tratamientos comúnmente utilizados para el CCC, a menudo, pueden provocar efectos secundarios adversos que afecten a la salud bucodental, causen trastornos gastrointestinales y alteraciones metabólicas. En consecuencia, la ingesta nutricional puede resultar inadecuada, contribuyendo al desarrollo de la desnutrición^{9,10}.

En el cáncer de cabeza y cuello, al riesgo de desnutrición por la localización anatómica y las consecuencias del tratamiento hay que sumarle el proceso de anorexia-sarcopenia-caquexia provocado por el propio tumor⁵.

La sarcopenia se define por la pérdida de músculo esquelético acompañada de una disminución de la fuerza muscular y del rendimiento físico. Cuando en estos pacientes progresa la desnutrición y la atrofia muscular puede llegar a aparecer la caquexia; situación caracterizada por el agotamiento del tejido sistémico, desnutrición extrema, sarcopenia, fatiga y debilidad, acompañado de una significativa pérdida de peso a expensas de la masa magra¹⁰.

En los pacientes con CCC la situación de sarcopenia se desencadena, por un lado, por la alteración del metabolismo provocado por el crecimiento del propio tumor que consume las reservas energéticas del huésped mediante la liberación de grasas y proteínas almacenadas en el tejido adiposo y muscular mediado por factores lipolíticos y proteolíticos secretados por las células cancerosas¹⁰.

Por otro lado, debido a que el cuerpo requiere cubrir sus propias necesidades energéticas, se produce una liberación de citoquinas proinflamatorias (IL-1, IL-6 y TNF- α) que, a largo plazo, provocan un efecto negativo en el tejido adiposo (favoreciendo la lipólisis y su transformación en tejido graso pardo) y muscular (aumentado el catabolismo y dificultando el anabolismo), así como en las funciones hepática y cerebral¹¹.

El CCC es predominantemente masculino; su distribución por sexos en España es de 10 a 1 para el varón, aunque en los últimos años, debido al aumento del hábito tabáquico en la mujer, este cociente se está modificando. Este dimorfismo sexual se observa también en los estados caquéticos por estos tumores, siendo los varones quienes presentan mayor pérdida de masa magra, de músculo esquelético y de miocardio¹².

La pérdida de peso involuntaria es una condición frecuente de los pacientes con cáncer de cabeza y cuello que aparece tanto previa a los tratamientos como tras su finalización¹³. Se considera que una pérdida del 10% del peso corporal, antes de iniciar tratamientos, es una variable independiente pronóstica de supervivencia, con un efecto que perdura incluso hasta los diez años después del diagnóstico inicial. El peso pretratamiento, que muchas veces no se registra, es un fuerte predictor de mortalidad. Incluso una pérdida moderada, como es del 5 al 10% del peso corporal, se asocia a una disminución de supervivencia a los dos años del diagnóstico¹².

Sin embargo, la desnutrición puede observarse también en pacientes con un índice de masa corporal (IMC) normal o alto, siendo este último caso lo que se conoce como obesidad sarcopénica, definida como la combinación del exceso de tejido adiposo y el desgaste muscular. Esta condición se presenta como otro reto para el diagnóstico de caquexia ya que la obesidad está aumentando su prevalencia. Por lo tanto, valorar el porcentaje de pérdida ponderal involuntaria es fundamental¹².

En pacientes con CCC, la masa muscular baja previa al tratamiento se asocia con mayor toxicidad aguda y tardía, eventos adversos de la radioterapia, complicaciones en la cirugía y disminución de la supervivencia^{13,14}.

El control óptimo de los pacientes con CCC debe basarse tanto en una adecuada intervención nutricional como en el control y manejo de los síntomas de impacto nutricional. Actualmente, se refuerza con dieta y suplementos desde el diagnóstico, pero es fundamental conocer qué pacientes serían candidatos a nutrición enteral precoz desde el inicio del tratamiento oncológico, bien a través de sonda nasogástrica o gastrostomía¹⁵.

El objetivo es revisar el conocimiento actual sobre el estado de la masa muscular, la patogénesis, diagnóstico y tratamiento de la sarcopenia cuando tiene lugar en el cáncer de cabeza y cuello.

METODOLOGÍA

Artículo de revisión narrativa de literatura actualizada sobre el cáncer de cabeza y cuello y sarcopenia.

Se han realizado búsquedas en las bases de datos PubMed, Cochrane Plus y Medline mediante la combinación de descriptores que, en lenguaje controlado tesauro del Medical Subjects Headings (MeSH), se corresponden con cáncer de cabeza y cuello, masa muscular, toxicidad, supervivencia, complicaciones postquirúrgicas, masa muscular (masa magra), intervención nutricional, ejercicio físico, sarcopenia seleccionando preferentemente publicaciones entre los años 2015–2022, en español e inglés.

Se utilizaron los operadores booleanos "AND" y "OR": ((head and neck cancer[Title/Abstract])) AND ((pathophysiology[Title/Abstract]) OR (prevalence[Title/Abstract]) OR (treatment[Title/Abstract]) OR (body mass index[MeSH Terms]) OR (agents, weight loss[MeSH Terms]) OR (muscle strength[MeSH Terms]) OR (atrophic muscular disorder[MeSH Terms]) OR (body weight change[MeSH Terms]) OR (muscle weakness[MeSH Terms]) OR (dietary supplementation[MeSH Terms]) OR (sarcopenia[MeSH Terms]) OR (malnutrition[MeSH Terms]) OR (toxicity[MeSH Terms]) OR (malabsorption[MeSH Terms]) OR (post-surgical complications[MeSH Terms])).

Se aplicaron criterios de selección rigurosos para filtrar los artículos iniciales e identificar los más adecuados para la revisión narrativa. La selección se basó en preguntas clave que abordaban la fisiopatología y prevalencia de la pérdida de masa y función muscular, los tratamientos disponibles y la factibilidad de la medición de masa muscular y función en pacientes con cáncer de cabeza y cuello. A fin de incluir los artículos más relevantes de cara a proporcionar una visión completa y detallada de los temas investigados, los artículos seleccionados pasaron por una evaluación detallada para asegurar que respondieran adecuadamente

a las preguntas de investigación específicas, utilizando la metodología PICO:

1. **P** (Paciente o Problema):
 - Pacientes con cáncer de cabeza y cuello.
 - Problema: Pérdida de masa y función muscular asociada al cáncer de cabeza y cuello.
2. **I** (Intervención):
 - Tratamientos para la pérdida de masa y función muscular.
 - Intervenciones terapéuticas específicas dirigidas a este problema.
3. **C** (Comparación):
 - Dentro de los estudios seleccionados, se han realizado comparaciones entre diferentes tratamientos y enfoques para evaluar su efectividad.
4. **O** (Outcome - Resultados):
 - Fisiopatología y prevalencia de la pérdida de masa y función muscular.
 - Efectividad de los tratamientos en la pérdida de masa y función muscular.
 - Factibilidad de la medición de masa muscular y función en pacientes con cáncer de cabeza y cuello.

RESULTADOS

Se identificaron inicialmente 5.215 artículos que cumplían con los criterios de búsqueda definidos, procediéndose a excluir las referencias que no se ajustaban a los criterios de inclusión, las que habiendo sido seleccionadas por título y abstract se hallaban duplicadas en las distintas bases de datos y las que no reflejaban el texto completo (Fig. 1). La revisión se centró en pacientes con cáncer de cabeza y cuello (P) y buscaba identificar intervenciones efectivas (I) para tratar la pérdida de masa y función muscular asociada a esta enfermedad. No se especificaron comparaciones (C) directas en la selección inicial, pero los estudios probablemente incluyen comparaciones entre diferentes tratamientos. Los resultados esperados (O)

se enfocaron en entender la fisiopatología y prevalencia de esta condición, determinar el mejor tratamiento disponible y evaluar la factibilidad de la medición de masa y función muscular en estos pacientes.

Del total de artículos identificados y tras las exclusiones pertinentes resultado de la revisión del pool de autores, se seleccionaron finalmente un total de 89 artículos que revisaban aspectos clave para la revisión narrativa, tales como el papel de la sarcopenia como factor pronóstico independiente, de menos supervivencia y aumento de toxicidades; la fisiopatología, detección e intervención precoz y postratamiento, la medición de la sarcopenia en este tipo de pacientes y el tratamiento multimodal, y que respondieran preguntas clave:

- ¿Cuál es la fisiopatología y prevalencia de la pérdida de masa y función muscular asociada al cáncer de cabeza y cuello? (P y O)
- ¿Cuál es el mejor tratamiento de la pérdida de masa y función muscular asociado a dicha enfermedad? (I y O)

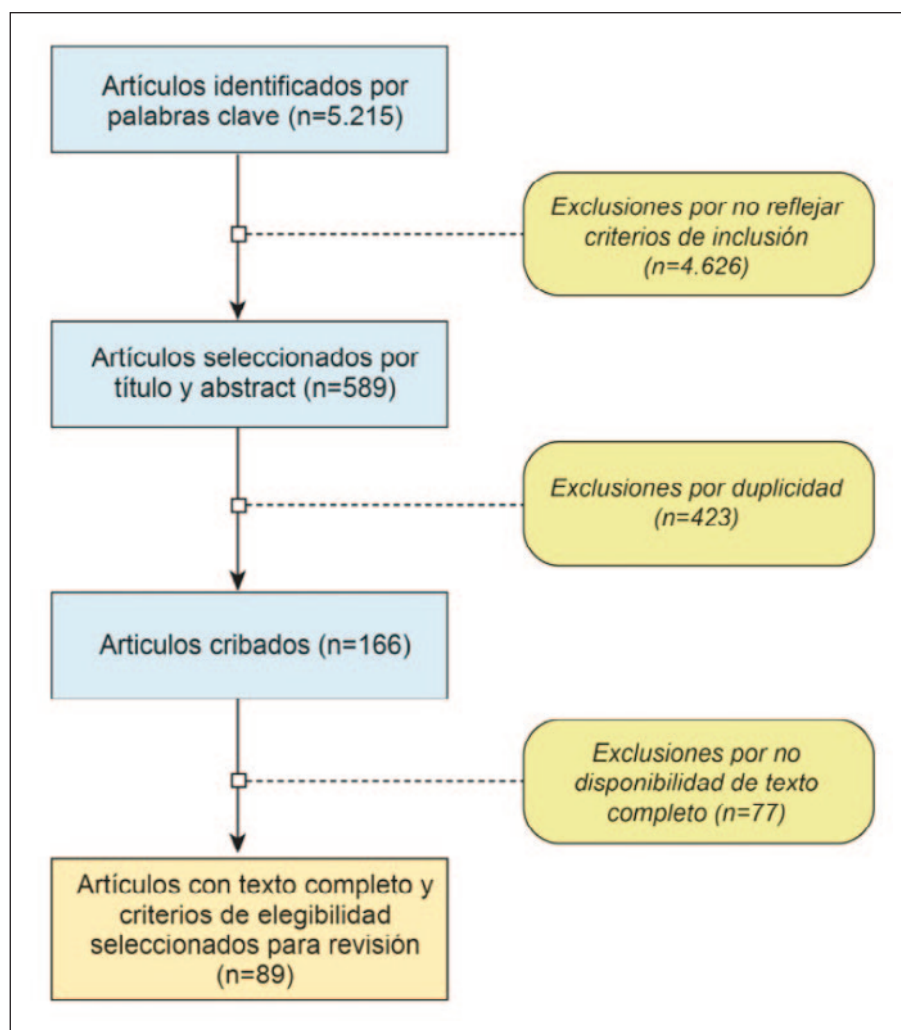


Figura 1. Diagrama de elegibilidad de bibliografía para revisión narrativa.

- ¿Cuán factible es la medición de masa muscular y función en dicha enfermedad? (O).

Los principales resultados se presentan a continuación:

Métodos diagnósticos

Los pacientes con CCC constituyen un grupo heterogéneo en el que la prevalencia de desnutrición es significativa pero muy variable, pudiendo oscilar entre el 20 y el 80%, dependiendo de la localización del tumor, la edad del paciente y el estadio de la enfermedad. A pesar de las recomendaciones de la ESPEN (*European Society for Clinical Nutrition and Metabolism*) y las implicaciones de la desnutrición desde la perspectiva de los resultados oncológicos y la calidad de vida, no es infrecuente la ausencia de una rutina de *screening* de riesgo de malnutrición de estos pacientes en el momento del diagnóstico, antes de iniciar el tratamiento oncológico¹⁶.

Teniendo en cuenta la alta tasa de detección de desnutrición en estadios precoces de la enfermedad, se pone de manifiesto la importancia de la identificación de estos pacientes con el fin de iniciar una estrategia de nutrición rápida que aumente su efectividad¹⁷.

Para el diagnóstico de la desnutrición se han descrito varias escalas de cribado [*Nutritional Risk Screening 2002* (NRS 2002), *Subjective Global Assessment* (SGA), *Mini Nutritional Assessment* (MNA), *Malnutrition Universal Screening Tool* (MUST), *Short Nutritional Assessment Questionnaire* (SNAQ)], teniendo siempre en cuenta el entorno en el que se realizan (hospitalizado, ambulatorio o paciente anciano)¹⁰ (tabla II). El uso de los criterios NRI (*Nutritional Risk Index*), GNRI (*Geriatric Nutritional Risk Index*) y GLIM (*Global Leadership Initiative on Malnutrition*) parecen proporcionar información sobre el pronóstico de la enfermedad. Aquellos pacientes con puntuaciones bajas en estas escalas han demostrado presentar un riesgo de mortalidad aumentado (aunque aún se requieren estudios más amplios para validar estos criterios)^{17,18}. Sin embargo, en muy pocas de ellas (como los criterios GLIM) se incluye la sarcopenia concretamente como parámetro a medir. En los últimos años, aunque se han desarrollado varias pruebas de detección de sarcopenia, faltan estudios que avalen su uso en este subgrupo específico de población oncológica.

Se han desarrollado varios métodos diagnósticos para evaluar la masa muscular en pacientes oncológicos. El actual *gold standard* es la tomografía computarizada (TC) y la resonancia magnética (RM). La masa muscular esquelética se evalúa con mayor frecuencia midiendo el área de la sección transversal del músculo esquelético en TC o RM al nivel de la tercera vértebra lumbar. No obstante, dado que las exploraciones abdominales no siempre están disponibles en los pacientes con CCC, se está estudiando la medición de la masa muscular a nivel de la tercera vértebra cervical como técnica de cribado radiológico en este grupo de pacientes. Sin embargo, el elevado coste que supone la realización de estas

pruebas, el acceso limitado y la exposición a la radiación limitan el uso de esos instrumentos en la práctica clínica^{19,20}. Debido a ello, la ecografía muscular se está estableciendo como una herramienta prometedora y emergente por tratarse de una técnica sencilla, inocua, no invasiva, accesible, portátil y económica^{21,22}.

Las medidas antropométricas también han sido utilizadas como parámetros para medir masa magra de forma práctica y objetiva y traducen buenos resultados, entre ellas la circunferencia muscular del brazo (CMB) y la circunferencia de la pantorrilla (CP)^{23,24}. Una reducción en esas medidas representa un impacto en la alteración de la masa muscular, traduciendo en repercusiones negativas al paciente, así como en un aumento de la incapacidad, fragilidad y mayor riesgo de muerte^{23,24}.

El EWGSOP (*European Working Group on Sarcopenia in Older People*) también desarrolló un algoritmo basado en la medición de la velocidad de marcha (VM) y fuerza de prensión palmar (FPP) como la manera más fácil y fiable para iniciar la detección de sarcopenia en la práctica²⁴.

Por otra parte, el análisis de impedancia bioeléctrica (BIA)²⁵ y el ángulo de fase (AF) se han establecido para el diagnóstico de la desnutrición y el pronóstico clínico, ambos asociados con cambios en la integridad de la membrana celular y las alteraciones en el balance de líquido. El ángulo de fase expresa cambios en la cantidad y la calidad de la masa de los tejidos blandos (es decir, permeabilidad de la membrana celular e hidratación)²⁶. Varios autores^{27,28} sugieren que el AF puede ser una herramienta importante para evaluar el resultado clínico o la progresión de la enfermedad, pudiendo este ser superior a otros indicadores nutricionales, bioquímicos o antropométricos. Sin embargo, la falta de valores de referencia ha limitado su uso.

Las exploraciones de absorciometría de rayos X de energía dual (DEXA) representan métodos objetivos adicionales para definir la composición corporal y el estado nutricional en pacientes con enfermedades crónicas²⁹.

Cabe destacar el cuestionario SARC-F (cuestionario simple para el diagnóstico de Sarcopenia), el cual permite evaluar la fuerza muscular a través de un sistema de evaluación y puntuación en el que los pacientes registran su habilidad en 5 parámetros: fuerza, capacidad para caminar, levantarse de una silla, subir unas escaleras y frecuencia de caídas. Para cada componente, los pacientes son evaluados con 0, 1, o 2 puntos (0 representa ninguna dificultad, 1 supone alguna dificultad y 2 mucha dificultad o incapacidad). La puntuación total va de 0 a 10 y los pacientes que registran 4 puntos o menos padecen sarcopenia³⁰.

Los biomarcadores juegan un papel importante en la detección temprana del agotamiento de los tejidos. La miostatina, el factor de crecimiento transformador beta, la activina

A, así como las citoquinas proinflamatorias, como TNF, IL-1 o IL-6, se están investigando en este escenario. Sin embargo, ninguno de los biomarcadores mencionados anteriormente se ha utilizado específicamente hasta ahora en la práctica clínica¹⁰ (Tabla I).

Dado que estos trastornos debilitantes tienen un alto impacto en el curso clínico y pronóstico de la enfermedad primaria, es importante que se detecten de manera temprana. Por ello, hasta que se desarrolle una herramienta concreta común, es recomendable hacer el diagnóstico con los métodos que se disponga en cada hospital^{19,20}.

Enfoque terapéutico

No existe una pauta farmacológica concreta para el tratamiento de la sarcopenia o la caquexia a nivel clínico. El objetivo terapéutico en estos trastornos es aumentar el apetito y la ingesta de alimentos, atenuar el estado inflamatorio crónico y mejorar la capacidad y la calidad del ejercicio.

En los pacientes con CCC sometidos a cirugía la aplicación del protocolo ERAS (*Enhanced Recovery After Surgery*) que combina estrategias sobre el manejo perioperatorio ha demostrado mejorar la recuperación funcional de los pacientes tras la cirugía, minimizando la respuesta al estrés quirúrgico y reduciendo de manera significativa la duración de la estancia hospitalaria³¹.

• Nutrición

La intervención nutricional precoz es esencial en la evolución de la enfermedad oncológica. Dependiendo de la fase de la enfermedad en la que se encuentre el paciente, la nutrición puede tener un papel preventivo, de mantenimiento o paliativo³².

La ESPEN sugiere que se debería procurar inicialmente unas 25-30 kcal/kg día y 1,2 g de proteínas/kg día, e ir adaptándolo posteriormente a los efectos secundarios que pueden provocar pérdida de peso y de masa muscular³³.

Siempre que sea posible, la vía oral es la vía de elección. Cuando la vía oral no está disponible o es insuficiente se recomienda el uso de nutrición enteral mediante sonda nasogástrica o percutánea. En ciertas situaciones de alto riesgo, como en la disfagia severa, la pérdida de peso de >10% o IMC <18 kg/m², los tumores de hipofaringe que reciben quimio y radioterapia o en estadios T4, algunos autores recomiendan la colocación de sonda profiláctica³⁴.

La NE por sonda debe comenzar dentro de las primeras 24 horas poscirugía en aquellos pacientes en los que la alimentación oral no sea posible³³.

La nutrición parenteral se reserva para aquellos casos en los que la nutrición enteral no es suficiente o factible³³.

Tabla I. Métodos para el diagnóstico del déficit nutricional

Método diagnóstico	Objetivo
Anamnesis ²²	Identificar historia de malabsorción: cirugías gastrointestinales previas, alteraciones del gusto, anorexia, náuseas, vómitos, alteraciones en el ritmo gastrointestinal, disfagia, problemas de salud bucodental, antecedentes de broncoaspiración, gastroparesia diabética, alergias, consumo de tóxicos, suplementos nutricionales, tratamiento habitual...
Exploración física ²²	Identificar la pérdida de grasa y músculo en regiones corporales específicas: a nivel orbitario, temporal, intercostal... Las líneas de Muehrcke en las uñas sugieren hipoalbuminemia, la alopecia se asocia con déficit de proteínas y la descamación del cuero cabelludo con una deficiencia de ácidos grasos esenciales.
Datos antropométricos ^{31,32}	Calcular el IMC y el porcentaje de pérdida de peso inintencionada. Medir la circunferencia muscular del brazo (CMB) y la circunferencia de la pantorrilla (CP).
Métodos bioeléctricos ³⁹	El análisis de impedancia bioeléctrica (AIB) ofrece una descripción detallada de la composición corporal (agua, grasa, minerales, proteínas).
Pruebas de imagen ^{27,29,30}	TC y RM son <i>gold standard</i> , aunque su uso está limitado. La ecografía muscular permite medir la masa muscular de manera sencilla, rápida y barata, aunque es un método que aún no se encuentra validado.
Marcadores analíticos ¹⁴	Varios parámetros bioquímicos (como grelina, leptina, adiponectina, miostatina, CAF, TNF- α , IL-1, IL-6, GH/IGF-1 y testosterona) pueden encontrarse alterados en pacientes con sarcopenia.

Puede considerarse la suplementación cuando el paciente solo sea capaz de cubrir 2/3 de sus requerimientos con la ingesta libre de alimentos³³.

Generalmente se recomiendan suplementos hipercalóricos (1,52 kcal/ml) y, si es necesario, hiperproteicos, ya que parecen mejorar el estado inflamatorio, la calidad de vida y la supervivencia en estos pacientes³³.

La suplementación dietética con aminoácidos, proteínas, vitamina D y ácidos grasos poliinsaturados parece proteger contra la sarcopenia relacionada con la edad, debido a su efecto antiinflamatorio y propiedades antioxidantes (tabla III)¹¹.

Se ha detectado que las necesidades calóricas aumentan tras finalizar la radioterapia, siendo preciso mantener el soporte nutricional durante los seis meses posteriores a la finalización del tratamiento³³.

Diversos estudios demuestran que los aminoácidos de cadena ramificada aumentan la síntesis de proteínas del músculo esquelético, efecto beneficioso para abordar la disminución de la masa muscular relacionada con la edad^{35,36}.

En pacientes con cáncer que pierden peso y que tienen resistencia a la insulina se recomienda aumentar la proporción de energía procedente de las grasas con respecto a los carbohidratos para lograr una mayor densidad energética con menor carga glucémica³⁷.

En pacientes sometidos a resección quirúrgica algunos estudios recomiendan el empleo de inmunonutrición oral o enteral en el perioperatorio (arginina, ácidos grasos omega-3, nucleótidos), pues ha demostrado reducir las complicaciones³⁸.

También hay interés en el β -hidroxi- β -metilbutirato (HMB), un compuesto natural que se produce durante el metabolismo de la leucina (aminoácido de cadena ramificada). El HMB estimula la síntesis de proteínas musculares al activar el sistema de la rapamicina (mTOR) y el eje GH/IGF-1. Además, se asocia con la reducción de la proteólisis muscular y la apoptosis de los mionúcleos, inhibiendo los sistemas ubiquitin-proteasoma y autofagolisosoma³⁹.

Varios estudios han concluido que la suplementación con HMB puede ser útil en la prevención de la atrofia muscular, la

dermatitis rásica y la mucositis inducida por la quimiorradioterapia. No obstante, se necesitan más estudios para determinar estos efectos³⁹ (tabla II).

• Ejercicio físico

La afectación que ocurre a nivel sistémico influye también en el deterioro muscular, causando diversos síntomas que limitan la funcionalidad del paciente en las actividades básicas de la vida diaria. El ejercicio físico es un estímulo necesario para evitar la pérdida de masa muscular, que debe combinarse con un adecuado soporte nutricional con el fin de mitigar los efectos de la desnutrición y sarcopenia subsecuente⁴⁰.

Es importante tomar en cuenta las preferencias individuales y transmitir al paciente la necesidad de colaboración y adherencia al programa⁴¹.

Existen numerosas recomendaciones para la elaboración de los programas de entrenamiento para estos pacientes^{23,42,43}, en los que se suele intentar al menos 90-150 minutos a la semana de ejercicios cardiorrespiratorios (grandes grupos musculares, con moderada intensidad), como caminar, natación, bicicleta, entre otros, junto con al menos dos sesiones semanales de ejercicios adaptados de fuerza muscular, flexibilidad y coordinación (tabla III).

Sin embargo, la prescripción de ejercicio debe ajustarse a cada uno de los pacientes de modo individualizado^{40,42,43}. Desafortunadamente, a pesar de los diferentes estudios publicados se desconoce el programa óptimo de ejercicio físico (intensidad y volumen), para estimular el crecimiento muscular, así como el momento óptimo para iniciar la intervención (pretratamiento, durante el tratamiento oncológico o tras su finalización).

La prioridad fundamental se basa en evitar que el paciente esté inactivo y en que la adherencia sea suficiente como para inducir adaptaciones fisiológicas⁴⁰⁻⁴³. Para conseguir este objetivo, la supervisión técnica tiene un valor fundamental. No obstante, en algunas ocasiones en las que esta no es posible, y cuando la situación clínica no presenta complicaciones, se pueden ofrecer recomendaciones para que el paciente se mantenga lo más activo posible (tabla IV)^{42,43}.

Tabla II. Suplementación con nutrientes específicos

Tipo de nutriente	Beneficio
Proteínas	Potencial de retrasar la pérdida de masa muscular.
β -hidroxi- β -metilbutirato (HMB)	Prevención de la atrofia muscular.
Vitamina D	Papel antiinflamatorio, preservación de la masa muscular.
Vitamina E	Posible mejora de los marcadores de estrés oxidativo.
Ácidos grasos poliinsaturados de cadena larga	Mejora de la fuerza muscular y de la capacidad funcional.

Tabla III. Clasificación cualitativa de actividades físicas

Actividades aeróbicas	• Caminar
	• Nadar
	• Bailar
	• Bicicleta
	• Elíptica
	• Aeróbic de bajo impacto
	• Aquaeróbic
Actividades de fuerza	• Ejercicios con bandas elásticas
	• Autocargas o con carga
	• Subir escaleras
	• Sentarse y levantarse de la silla varias veces
	• Transportar objetos
	• Algunos ejercicios de taichi
	• Yoga
Para trabajar el equilibrio o fitness neuromotor	• Equilibrio
	• Agilidad
	• Coordinación
	• Marcha
	• Entrenamiento propioceptivo
	• Actividades multifacéticas: taichi y yoga
Flexibilidad	• Realizar un bloque de movilidad articular al principio de las sesiones y diferentes bloques de estiramientos en las distintas partes de la sesión

DISCUSIÓN

Una adecuada nutrición durante el tratamiento es fundamental, en especial en los tumores de cabeza y cuello. Es importante ingerir suficientes macro y micronutrientes para prevenir la pérdida de peso y favorecer la cicatrización de las heridas en los pacientes intervenidos³².

Una correcta ingesta puede ser especialmente difícil para los pacientes tratados de con quimio-radioterapia. Son muchos los factores que influyen, como son la xerostomía, disgeusia, la falta de apetito, la mucositis, las náuseas y los vómitos.

En algunos casos, a pesar de que el paciente lo intente, la alimentación puede resultar imposible, necesitando la colocación de un dispositivo que facilite la alimentación: una sonda nasogástrica o una gastrostomía³⁴.

Debido a la falta de métodos diagnósticos del estado nutricional clínicamente aceptados y confiables, y la controversia respecto a las intervenciones nutricionales más efectivas, las recomendaciones en las guías actuales relacionadas con la nutrición resultan insuficientes.

Mientras no se desarrollen intervenciones concretas que involucren a los pacientes con CCC, el cribado muscular y nutricional se debe realizar en todos los pacientes para así poder abordar de manera más efectiva los trastornos nutricionales que afectan a la morbilidad por CCC.

Tabla IV. Modelo general para la prescripción de ejercicio

	Cardiorrespiratorio	Fuerza	Flexibilidad
Frecuencia	3-5 d/s	2-3 d/s	2-3 d/s
Intensidad	Moderada (40-59% VO ₂ R; 64-75% HRmax; PE 12-13) a intensa (60-89% VO ₂ R; 76-95% HRmax; PE 14-17)	Comenzar por debajo del 30% de 1-RM, y progresar lentamente	Movimientos a lo largo de todo el rango articular
Tiempo	150 min/s si moderado 75 min/s si intensa	Al menos 1 serie de 8-12 repeticiones	10-30 s de estiramiento estático
Tipo	Actividades prolongadas y rítmicas (caminar, bicicleta, bailar...)	Pesos libres o máquinas o ejercicios funcionales	Estiramientos de todos los grupos musculares, según limitaciones individuales

1-RM: una repetición máxima. HR max: frecuencia cardiaca máxima. VO₂R: consumo de oxígeno de reserva. Percepción del esfuerzo (PE), en escala de 1 a 18. d/s: días por semana. Min/s: minutos por semana.

CONCLUSIONES

El riesgo nutricional y/o la desnutrición existen en los pacientes con CCC desde antes del diagnóstico y, a corto, medio y largo plazo, tras la finalización del tratamiento oncológico a pesar de que el tratamiento oncológico instaurado (cirugía, quimiorradioterapia) haya sido eficaz y el enfermo esté en remisión completa²⁻⁵.

La valoración nutricional debe ser una parte fundamental del enfoque inicial del paciente oncológico y posterior seguimiento, y debe formar parte del manejo multidisciplinar de los diferentes tumores³². Aunque es una clara recomendación realizada por las distintas sociedades científicas, se ha visto que no forma parte de la rutina inicial en muchos hospitales.

Por tanto, es relevante que se desarrollen investigaciones para permitir una detección precoz de la sarcopenia y preparar intervenciones nutricionales y de aumento de masa muscular que mejoren el impacto negativo que esta puede provocar en el paciente oncológico, con el fin de evitar el deterioro del estado nutricional y la calidad de vida, buscando garantizar un mejor pronóstico para estos pacientes.

BIBLIOGRAFÍA

1. Chow LQM. Head and Neck Cancer. *N Engl J Med*. 2020 Jan 2;382(1):60-72.
2. Bressan V, Stevanin S, Bianchi M, Aleo G, Bagnasco A, Sasso L. The effects of swallowing disorders, dysgeusia, oral mucositis and xerostomia on nutritional status, oral intake and weight loss in head and neck cancer patients: A systematic review. *Cancer Treat Rev*. 2016 Apr;45:105-19.
3. Crowder SL, Douglas KG, Yanina Pepino M, Sarma KP, Arthur AE. Nutrition impact symptoms and associated outcomes in post-chemoradiotherapy head and neck cancer survivors: a systematic review. *J Cancer Surviv*. 2018 Aug;12(4):479-94.
4. Kubrak C, Martin L, Gramlich L, Scrimger R, Jha N, Debenham B et al. Prevalence and prognostic significance of malnutrition in patients with cancers of the head and neck. *Clin Nutr*. 2020 Mar;39(3):901-9.
5. Bossi P, Delrio P, Mascheroni A, Zanetti M. The Spectrum of Malnutrition/Cachexia/Sarcopenia in Oncology According to Different Cancer Types and Settings: A Narrative Review. *Nutrients*. 2021;13(6):1980.
6. Carías Díaz JA, Gonzalez MJ. Tratamiento oncológico y estado nutricional del cáncer de cabeza y cuello. *Nutr Clín Diet Hosp* [Internet]. 11 de junio de 2021 [citado 9 de mayo de 2024];41(2). Disponible en: <https://revista.nutricion.org/index.php/ncdh/articulo/view/138>.
7. Lyra MMF, Meira JEC, Guedes GDS, Bueno NB. Immunonutrition in head and neck cancer: Systematic review and meta-analysis of its clinical and nutritional effects. *Clin Nutr ESPEN*. 2021 Feb;41:30-41.
8. Morse RT, Ganju RG, Gan GN, Cao Y, Neupane P, Kakarala K et al. Sarcopenia and Treatment Toxicity in Older Adults Undergoing Chemoradiation for Head and Neck Cancer: Identifying Factors to Predict Frailty. *Cancers (Basel)*. 2022 Apr 22;14(9):2094.
9. Hunter M, Kellett J, Toohey K, D'Cunha NM, Isbel S, Naumovski N. Toxicities Caused by Head and Neck Cancer Treatments and Their Influence on the Development of Malnutrition: Review of the Literature. *European Journal of Investigation in Health, Psychology and Education*. 2020;10(4):935-49.
10. Lena A, Hadzibegovic S, von Haehling S, Springer J, Coats AJ, Anker MS. Sarcopenia and cachexia in chronic diseases: from mechanisms to treatment. *Pol Arch Intern Med*. 2021 Dec 22;131(12):16135.
11. Mäkitie AA, Alabi RO, Orell H, Youssef O, Almangush A, Homma A, Takes RP, López F, de Bree R, Rodrigo JP, Ferlito A. Managing Cachexia in Head and Neck Cancer: a Systematic Scoping Review. *Adv Ther*. 2022 Apr;39(4):1502-1523.
12. Couch ME, Dittus K, Toth MJ, Willis MS, Guttridge DC, George JR et al. Cancer cachexia update in head and neck cancer: Definitions and diagnostic features. *Head Neck*. 2015 Apr;37(4):594-604.
13. De Bree R, van Beers MA, Schaeffers AWMA. Sarcopenia and its impact in head and neck cancer treatment. *Curr Opin Otolaryngol Head Neck Surg*. 2022 Apr 1;30(2):87-93.
14. Thureau S, Leuret L, Lequesne J, Cabourg M, Dandoy S, Gouley C et al. Prospective Evaluation of Sarcopenia in Head and Neck Cancer Patients Treated with Radiotherapy or Radiochemotherapy. *Cancers (Basel)*. 2021 Feb 11;13(4):753.
15. Gómez-Pérez AM et al. Recomendaciones del grupo GARIN para el manejo nutricional de pacientes con cáncer de cabeza y cuello. *Nutr Clin Med*. 2018;XII(1):1-13.
16. Álvaro Sanz E, Garrido Siles M, Rey Fernández L, Villatoro Roldán R, Rueda Domínguez A, Abilés J. Nutritional risk and malnutrition rates at diagnosis of cancer in patients treated in outpatient settings: Early intervention protocol. *Nutrition*. 2019 Jan;57:148-53.
17. Przekop Z, Milewska M, Szostak-Węgierek D, Panczyk M, Sobocki J. GLIM-Defined Malnutrition in Patients with Head and Neck Cancer during the Qualification Visit for Home Enteral Nutrition. *Nutrients*. 2022 Jan 24;14(3):502.
18. Przekop Z, Szostak-Węgierek D, Milewska M, Panczyk M, Zaczek Z, Sobocki J. Efficacy of the Nutritional Risk Index, Geriatric Nutritional Risk Index, BMI, and GLIM-Defined Malnutrition in Predicting Survival of Patients with Head and Neck Cancer Patients Qualified for Home Enteral Nutrition. *Nutrients*. 2022 Mar 17;14(6):1268.
19. Wong A, Zhu D, Kraus D, Tham T. Radiologically Defined Sarcopenia Affects Survival in Head and Neck Cancer: A Meta-Analysis. *Laryngoscope*. 2021 Feb;131(2):333-41.
20. Vangelov B, Bauer J, Moses D, Smee R. A prediction model for skeletal muscle evaluation and computed tomography-defined sarcopenia diagnosis in a predominantly overweight cohort of patients with head and neck cancer. *Eur Arch Otorhinolaryngol*. 2023 Jan;280(1):321-328.
21. Ticinesi A, Meschi T, Narici MV, Lauretani F, Maggio M. Muscle Ultrasound and Sarcopenia in Older Individuals: A Clinical Perspective. *J Am Med Dir Assoc*. 2017 Apr 1;18(4):290-300.
22. Mirón Mombiola R, Vucetic J, Rossi F, Tagliafico AS. Ultrasound Biomarkers for Sarcopenia: What Can We Tell So Far? *Semin Musculoskelet Radiol*. 2020 Apr;24(2):181-193.

23. Capozzi LC, Boldt KR, Lau H, Shirt L, Bultz B, Culos-Reed SN. A clinic-supported group exercise program for head and neck cancer survivors: managing cancer and treatment side effects to improve quality of life. *Support Care Cancer*. 2015 Apr;23(4):1001-7.
24. Silva PB, Ramos GHA, Petterle RR, Borba VZC. Sarcopenia as an early complication of patients with head and neck cancer with dysphagia. *Eur J Cancer Care (Engl)*. 2021 Jan;30(1):e13343.
25. Pineda Zuloaga MC, González Correa CH, Martínez Durán AG. Puntos de corte para determinar disminución de masa muscular mediante análisis de bioimpedancia eléctrica para el diagnóstico de sarcopenia en adultos mayores: una revisión sistemática. *Nutr Clín Diet Hosp* [Internet]. 2 de octubre de 2023 [citado 20 de mayo de 2024];43(4). Disponible en: <https://revista.nutricion.org/index.php/ncdh/article/view/444>.
26. Di Vincenzo O, Marra M, Di Gregorio A, Pasanisi F, Scalfi L. Bioelectrical impedance analysis (BIA) -derived phase angle in sarcopenia: A systematic review. *Clin Nutr*. 2021 May;40(5):3052-306.
27. Selberg O, Selberg D. Norms and correlates of bioimpedance phase angle in healthy human subjects, hospitalized patients, and patients with liver cirrhosis. *Eur J Appl Physiol* 2002; 86 (6):509-16.
28. Władysiek MS, Mlak R, Morshed K, Surtel W, Brzozowska A, Małecka-Massalska T. Bioelectrical impedance phase angle as a prognostic indicator of survival in head-and-neck cancer. *Curr Oncol*. 2016 Oct;23(5):e481-e487.
29. Grossberg AJ, Rock CD, Edwards J, Mohamed ASR, Ruzensky D, Currie A et al. Bioelectrical impedance analysis as a quantitative measure of sarcopenia in head and neck cancer patients treated with radiotherapy. *Radiother Oncol*. 2021 Jun;159:21-7.
30. Cruz-Jentoft AJ, Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing*. 2019 Jul 1;48(4):601. doi: 10.1093/ageing/afz046. Erratum for: *Age Ageing*. 2019 Jan 1; 48(1):16-31.
31. Bertazzoni G, Testa G, Tomasoni M, Mattavelli D, Del Bon F, Montalto N et al. The Enhanced Recovery After Surgery (ERAS) protocol in head and neck cancer: a matched-pair analysis. *Acta Otorhinolaryngol Ital*. 2022 Aug;42(4):325-33.
32. Arends J, Bachmann P, Baracos V, Barthelemy N, Bertz H, Bozzetti F et al. ESPEN guidelines on nutrition in cancer patients. *Clin Nutr*. 2017 Feb;36(1):11-48.
33. Talwar B, Donnelly R, Skelly R, Donaldson M. Nutritional management in head and neck cancer: United Kingdom National Multidisciplinary Guidelines. *J Laryngol Otol*. 2016;130(S2):S32-S40.
34. Blake CL, Brown TE, Pelecanos A, Moroney LB, Helios J, Hughes BGM, Chua B, Kenny LM. Enteral nutrition support and treatment toxicities in patients with head and neck cancer receiving definitive or adjuvant helical intensity-modulated radiotherapy with concurrent chemotherapy. *Head Neck*. 2023 Feb;45(2):417-430.
35. Weber MG, Dias SS, de Angelis TR, Fernandes EV, Bernardes AG, Milanez VF et al. The use of BCAA to decrease delayed-onset muscle soreness after a single bout of exercise: a systematic review and meta-analysis. *Amino Acids*. 2021 Nov;53(11):1663-1678.
36. Kamei Y, Hatazawa Y, Uchitomi R, Yoshimura R, Miura S. Regulation of Skeletal Muscle Function by Amino Acids. *Nutrients*. 2020 Jan 19;12(1):261.
37. Barazzoni R, Deutz N, Biolo G, Bischoff S, Boire Y, Cederholm T et al. Carbohydrates and insulin resistance in clinical nutrition: recommendations from the ESPEN expert group. *Clin Nutr*. 2017;36(2):355-63.
38. Muscaritoli M, Arends J, Bachmann P, Baracos V, Barthelemy N, Bertz H et al. ESPEN practical guideline: Clinical Nutrition in cancer. *Clin Nutr*. 2021 May;40(5):2898-913.
39. Cornejo-Pareja I, Ramirez M, Camprubi-Robles M, Rueda R, Vegas-Aguilar IM, Garcia-Almeida JM. Effect on an Oral Nutritional Supplement with β -Hydroxy- β -methylbutyrate and Vitamin D on Morphofunctional Aspects, Body Composition, and Phase Angle in Malnourished Patients. *Nutrients*. 2021 Dec 3;13(12):4355.
40. Midgley AW, Lowe D, Levy AR, Mepani V, Rogers SN. Exercise program design considerations for head and neck cancer survivors. *Eur Arch Otorhinolaryngol*. 2018 Jan;275(1):169-79.
41. Crowder SL, Douglas KG, Frugé AD, Carroll WR, Spencer SA, Locher JL et al. Head and neck cancer survivors' preferences for and evaluations of a post-treatment dietary intervention. *Nutr J*. 2019 Sep 10;18(1):57.
42. Aghili M, Farhan F, Rade M. A pilot study of the effects of programmed aerobic exercise on the severity of fatigue in cancer patients during external radiotherapy. *Eur J Oncol Nurs*. 2007 Apr;11(2):179-82.
43. Trommer M, Marnitz S, Skoetz N, Rupp R, Niels T, Morgenthaler J, Theurich S, von Bergwelt-Baildon M, Baues C, Baumann FT. Exercise interventions for adults with cancer receiving radiation therapy alone. *Cochrane Database Syst Rev*. 2023 Mar 13;3(3):CD013448.

Comparación de los hábitos de vida de estudiantes de primer y cuarto curso del grado de enfermería de la Universidad del País Vasco

Comparison of lifestyle habits among first and fourth year nursing students at the University of the Basque Country

Jon ELORZA RODRÍGUEZ

Osakidetza. Servicio Vasco de Salud.

Recibido: 16/abril/2024. Aceptado: 30/mayo/2024.

RESUMEN

Introducción: La profesión de enfermería desempeña una función de suma relevancia en la modificación y promoción de hábitos de vida saludables, así como en la prevención de patologías asociadas a dichos hábitos. No obstante, la literatura científica presenta una escasez de estudios que aborden específicamente el impacto del nivel académico en enfermería sobre los hábitos de vida de los estudiantes.

Objetivos: Determinar el impacto que causa el grado de enfermería en los hábitos de vida de quienes lo estudian.

Metodología: Estudio observacional analítico, estudio de cohortes. Para las variables cuantitativas se repartieron diferentes cuestionarios; los alimentos ingeridos, el tiempo de ejercicio/actividad física realizados, el consumo de alcohol y otras sustancias. Se realizaron la media y a continuación la prueba de T-student, suponiendo previamente que los resultados tenían una distribución simétrica.

Resultados: Se estudió a 90 estudiantes de Enfermería de la UPV, Leioa. El 60% eran del primer curso y el 40% del cuarto. La edad promedio del primer curso fue de 21.7 años y del cuarto fue de 24.5 años. El 83.3% de la muestra era femenina. Se utilizó el cuestionario de la OMS para medir la autoevaluación de salud. El 94.4% del primer curso y el 91.7% del cuarto lo calificaron como 'excelente/muy bueno'. Hubo

diferencias significativas en el consumo de alimentos y sustancias. El ejercicio intenso varió entre el 44.4% y el 36.1% para el primer y cuarto curso.

Discusión: Los hábitos de vida de los estudiantes de enfermería presentan oportunidades de mejora. Se observa un aumento en el consumo de sustancias nocivas entre los estudiantes de cuarto curso. Sin embargo, se aprecia una tendencia positiva hacia la mejora de la calidad de la dieta y la actividad física en el estudiantado. Se sugiere la realización de talleres de mindfulness como una estrategia para reducir el consumo de sustancias nocivas en el futuro.

Conclusiones: La mera participación en el programa de estudios de enfermería conlleva una mejora en los hábitos de vida de los estudiantes. Sin embargo, es importante señalar que dichos hábitos presentan ciertos aspectos no totalmente saludables, evidenciados por un consumo elevado de sustancias como alcohol y tabaco, así como una propensión al sedentarismo.

PALABRAS CLAVE

Healthy Lifestyle [MeSH], Nursing Students [Mesh], Health Promotion[Mesh], Comparative Study[Mesh], Health Behaviour [MeSH], Nursing Education [MeSH].

ABSTRACT

Introduction: The nursing profession fulfills a pivotal role in modifying and advocating for healthy lifestyle habits, while also serving in the prevention of pathologies linked to such habits. Nonetheless, the scientific literature exhibits a paucity

Correspondencia:

Jon Elorza Rodríguez
jonelorza98@gmail.com

of studies directly examining the influence of academic attainment in nursing on students' lifestyle behaviors.

Objective: Ascertain the impact that the nursing degree has on the lifestyle habits of its students.

Methodology: Analytical observational study, cohort study. Various questionnaires were distributed for quantitative variables; these included dietary intake, time spent on exercise/physical activity, alcohol consumption, and other substance use. Means were calculated, followed by the application of the Student's t-test, assuming beforehand that the results had a symmetrical distribution

Results: Ninety Nursing students from UPV, Leioa were studied, with 60% in the first year and 40% in the fourth year. The average age for the first year was 21.7 years, and for the fourth year, it was 24.5 years. 83.3% of the sample were female. The WHO questionnaire was used to measure health self-assessment. 94.4% of the first year and 91.7% of the fourth year rated it as 'excellent/very good'. Significant differences were found in food and substance consumption. Intense exercise varied between 44.4% and 36.1% for the first and fourth years, respectively.

Discussion: Nursing students' lifestyle habits show room for improvement. There is an increase in the consumption of harmful substances among fourth-year students. However, there is a positive trend towards improving diet quality and physical activity among students. Conducting mindfulness workshops is suggested as a strategy to reduce the consumption of harmful substances in the future.

Conclusions: Merely participating in the nursing curriculum leads to an improvement in the students' lifestyle habits. However, it is important to note that these habits exhibit certain aspects that are not entirely healthy, as evidenced by elevated consumption of substances such as alcohol and tobacco, as well as a tendency towards sedentary behavior.

KEYWORDS

Healthy Lifestyle [MeSH], Nursing Students [Mesh], Health Promotion[Mesh], Comparative Study[Mesh], Health Behaviour [MeSH], Nursing Education [MeSH].

INTRODUCCIÓN

En los países con mayor renta per cápita, se ha observado un incremento significativo en la incidencia de enfermedades cardiovasculares, afectando negativamente la calidad de vida de la población. Patologías tales como accidentes cerebrovasculares y enfermedades isquémicas han ganado prominencia, siendo antecedidas por prácticas alimenticias inadecuadas y estilos de vida sedentarios. Entre estos últimos, se destaca la prolongada exposición a dispositivos electrónicos como ordenadores, televisores, tabletas y teléfonos, con un consecuente aumento en las horas de inactividad. A pesar de la evi-

dencia acumulada sobre los beneficios del ejercicio físico, la prevalencia de conductas sedentarias persiste en niveles considerables según distintos estudios¹.

La resolución de esta situación recae no solo en las autoridades competentes, sino también en los profesionales sanitarios. En este contexto, la Educación para la Salud emerge como un elemento esencial, desempeñando un papel fundamental en la promoción de prácticas saludables y la concienciación sobre los riesgos asociados a hábitos de vida perjudiciales². De esta manera, las actividades de promoción de la salud buscan transformar la conducta, el entorno o la predisposición genética en una dirección positiva, asistiendo al individuo en la modificación de su estilo de vida para favorecer un estado óptimo de salud. La promoción de la salud implica facilitar que las personas adquieran conocimientos y asuman la responsabilidad de su propio bienestar³. Mejorar y aumentar los conocimientos sobre hábitos de vida es el primer paso para la optimización del estado general de salud⁴.

La enfermería asume la responsabilidad de fomentar entre la población hábitos de vida saludables, con el objetivo no solo de prolongar la esperanza de vida, sino también de mejorar la calidad de esos años⁵. En este sentido, una formación académica integral que aborde conceptos fundamentales de la promoción de la salud se presenta como un elemento crucial. Por ende, resulta esencial investigar si la realización del grado en enfermería incide en la mejora de los hábitos de vida del estudiantado.

Partiendo de la premisa de que el estudiantado de primero no tiene formación respecto a unos hábitos de vida saludables de calidad el grado de enfermería podría mejorar dichos hábitos de vida, sin necesidad de ninguna otra intervención más allá de la mera adquisición de conocimientos y competencias que se imparten en el grado.

Para responder a las hipótesis planteadas se presenta el siguiente objetivo.

Objetivo general

Determinar el impacto que tienen los estudios de enfermería en los hábitos de vida del estudiantado, tras la adquisición de las competencias propias del grado.

MATERIALY MÉTODOS

Tipo de estudio: Estudio analítico observacional, estudio de cohortes.

Comité de ética: Este estudio obtuvo el visto bueno del comité de ética de la universidad del País Vasco, Nº de expediente TI0311.

La muestra:

La población diana fue el estudiantado de enfermería de la Universidad del País Vasco. Como muestra para el presente estudio se escogió al alumnado de enfermería de 1º y

4º curso. La comparativa de los resultados se realizó entre el estudiantado del primer curso del grado que no había recibido formación en hábitos de vida, y el de último curso, que estaba formado en las competencias que se van adquiriendo a lo largo del grado.

Este estudio analítico observacional de cohortes que obtuvo el visto bueno del comité de ética de la Universidad del País Vasco, Nº de expediente TI0311. La población diana fue el estudiantado de enfermería de la Universidad del País Vasco. Como muestra para el presente estudio se escogió al alumnado de enfermería de 1º y 4º curso. La comparativa de los resultados se realizó entre el estudiantado del primer curso del grado que no había recibido formación en hábitos de vida, y el de último curso, que estaba formado en las competencias que se van adquiriendo a lo largo del grado.

Para determinar el tamaño de la muestra necesaria entre los 160 alumnos de la Universidad del País Vasco, se utilizó la fórmula para estudios comparativos de dos proporciones. Con un nivel de confianza del 95% ($Z=1.96$) y un poder del 80% ($Z=0.84$), y asumiendo proporciones esperadas de 0.30 y 0.50 para los dos grupos, se calculó un tamaño inicial de muestra de 91 personas por grupo.

Se empleó una estrategia de muestreo no aleatorizado, específicamente un muestreo por conveniencia, para seleccionar los participantes del estudio. Se establecieron criterios de inclusión y exclusión para la participación.

Los criterios de inclusión para el estudio consistieron en estar matriculados en el grado en enfermería de la UPV/EHU y tener más de 17 años de edad. Por otro lado, los criterios de exclusión comprendieron estar cursando el cuarto año del grado con asignaturas pendientes de años anteriores, presentar una disfuncionalidad mental, psicológica o visual que afectara la capacidad de comprensión o firma del consentimiento informado, negarse a firmar dicho consentimiento, rechazar la participación después de la explicación del estudio, recibir asesoría nutricional por razones médicas o deportivas, y haber completado estudios superiores relacionados con ejercicio físico o nutrición-dietética antes de iniciar la carrera de enfermería.

Criterios de inclusión

- Estar matriculados en el grado en enfermería de la UPV/EHU
- Ser mayor de 17 años

Criterios de exclusión

- Estar en el cuarto curso del grado, estando a su vez matriculado en asignaturas de años anteriores.
- Tener una disfuncionalidad mental, psicológica o visual debida a la cual no sean capaces de leer, entender y/o firmar el consentimiento informado.

- No querer firmar el consentimiento informado
- Rechazar la participación una vez haya sido explicado el estudio
- Por razones médicas o de rendimiento deportivo estar recibiendo asesoría nutricional
- Previo a haber comenzado los estudios de enfermería, haber realizado/finalizado estudios superiores sobre ejercicio físico y/o nutrición-dietética.

Dentro de la presente investigación se llevaron a estudio diferentes variables: Variables sociodemográficas, de la salud y de hábitos de vida

Dentro del primer grupo de variables se encuentran los datos sociodemográficos de los/las participantes. Estas variables comprenden una variedad de características personales y de contexto, como la edad, el género, el nivel educativo, el lugar de residencia, y el estado socioeconómico. Estos datos proporcionan un panorama completo del perfil de los participantes y permiten identificar posibles factores asociados con los resultados del estudio.

En el segundo grupo, se estudiaron variables de la salud, donde se estudió la autovaloración de la salud. La salud percibida se evaluó mediante la pregunta "¿Cómo diría usted que es su salud?". Estas variables proporcionan información crucial sobre el estado de salud de los sujetos y su relación con otras variables del estudio.

Finalmente, se analizaron las variables relacionadas con los hábitos de vida, que incluyeron la dieta, el consumo de sustancias tóxicas o drogas, y la práctica de ejercicio o actividad física. Estas variables abarcan una amplia gama de comportamientos y prácticas que pueden influir en la salud y el bienestar de los individuos. Incluyen la dieta y el patrón de alimentación (consumo de frutas, verduras, alimentos procesados, etc.), el uso de sustancias como el tabaco, el alcohol y otras drogas, así como la participación en actividades físicas y deportivas. Estos datos son fundamentales para comprender los estilos de vida de los participantes y su impacto en la salud en general.

Las encuestas empleadas en el estudio, eran encuestas validadas. En esta investigación, se emplearon diferentes instrumentos para evaluar distintos aspectos relacionados con la salud y el estilo de vida de los participantes. Para medir la percepción de la salud, se utilizó el Cuestionario de Percepción de Salud de la OMS⁷, reconocido por su exhaustividad en la evaluación del bienestar físico, mental y social. Para analizar los hábitos alimentarios, se aplicó el Cuestionario ENALIA⁸, diseñado específicamente para recopilar información detallada sobre la ingesta de alimentos. En cuanto al consumo de sustancias tóxicas, se utilizó el cuestionario ASSIST V3.0⁹, que proporciona una evaluación exhaustiva del uso de drogas y su impacto en la salud.

Finalmente, para medir el nivel de actividad física, se recurrió al Cuestionario IPAC¹⁰ de la OMS, una herramienta reconocida que permite evaluar de manera precisa el nivel de actividad física y sus efectos en la salud cardiovascular y metabólica de los participantes.

Por último, el modelo de análisis de datos previsto, no es otro que el realizado por el programa SPSS 26.0. En el proyecto se estudiaron variables cuantitativas y cualitativas utilizando el siguiente análisis estadístico. Para las variables cuantitativas se llevó a cabo una verificación exhaustiva de la distribución. Este proceso implicó el análisis detallado de la distribución de los datos mediante métodos estadísticos apropiados, como pruebas de normalidad. Se realizó una media, teniendo en cuenta que los resultados tendrán una distribución simétrica. También se realizó la prueba de T-student para determinar si había una diferencia significativa entre las medias entre dos grupos.

A los resultados obtenidos en el muestrario se les adjudicó un 95% de nivel de confianza, aceptando en consecuencia un 5% de nivel de error.

RESULTADOS

En este estudio participaron un total de 90 estudiantes del Grado en Enfermería de la Universidad del País Vasco (UPV) en la sede de Leioa. La muestra se distribuyó según el curso al que pertenecían durante el año académico 2020-2021. Del total, 54 estudiantes (60%) correspondieron al primer curso, mientras que 36 estudiantes (40%) fueron asignados al cuarto curso. La edad promedio para el primer curso fue de 21,7 años, mientras que para el cuarto curso se elevó a 24,5 años (Tabla 1).

En primer curso, participaron un total de 43 mujeres, siendo en 4º curso un total de 32. El porcentaje de participación femenina se elevó a 83,3% de la muestra.

Para lograr medir el nivel de autosatisfacción de cada participante en lo que respecta a su nivel de salud se utilizó el cuestionario del nivel de salud de la OMS.

51 alumnos de primer curso (94,4%) definieron su nivel de salud como "excelente/muy bueno". 3 alumnos/as definieron su salud como regular. Mientras que en cuarto curso 33 alumnos/as marcaban la casilla de "excelente/muy bueno" (91,7%). 2 alumnos/as marcaron la casilla de "regular" (5,6%). No obstante, sólo un alumno/a de cuarto curso definió su estado de salud como "malo" (2,7%). (Tabla 1).

Los resultados del consumo de alimentos se obtuvieron mediante recuerdo de 24h sobre consumo de alimentos durante 3 días no consecutivos y aplicando un margen de 48h entre los mismos. De este modo, se pudo asegurar que al menos uno de los registros correspondiera al fin de semana, momento en el cual la población aumenta su vida social. Con el propósito de simplificar la categorización de alimentos de forma más amplia en subgrupos, se proporcionó a cada participante una tabla resumida (Tabla 2).

Los alumnos de primer y cuarto curso tenían una frecuencia de consumo de cereales similar. El 79,6% de la muestra de primer curso consumió cereales una o más veces al día, mientras que en cuarto curso, fue del 80,5% (Tabla 3).

El 63,0% del alumnado de primer curso consumió productos tipo snack 2-3 veces por semana, mientras que en cuarto curso fue del 30,5% (Tabla 3).

En primer curso, el consumo diario de pescado fue del 8,9%, mientras que en cuarto curso se elevó al 19,4%. En lo que respecta a las personas que consumen pescado de 2-3 veces por semana, su frecuencia de consumo disminuyó del 73,0% en la muestra de primer curso al 36,6% en cuarto curso. Como resultado, el porcentaje de muestra que no consume pescado "nunca/casi nunca" aumentó del 14,3% en primer curso al 43,3% en cuarto curso. Todos estos resultados fueron estadísticamente significativos ($p < 0,05$) (Tabla 3).

La muestra del primer curso obtuvo un total de 15 participantes, un 27,7% de la muestra, que consumían tabaco. Siendo para cuarto curso un total de 17 participantes, el 47,2% de la muestra.

Tabla 1. Características de la muestra del estudiantado del Grado de Enfermería de la UPV

		1º curso	4º curso	p-valor
SALUD	EXCELENTE/ MUY BUENO <i>n</i> ; % (IC95%)	51,0; 56,7% (45,8-67,1%)	33,0; 36,7% (26,7-46,6)	0,4
	REGULAR <i>n</i> ; % (IC95%)	3,0; 3,3% (0,7-9,4%)	2,0; 2,2% (0,3-7,8%)	
	MALO <i>n</i> ; % (IC95%)	0,0 (0-4%)	1,0; 1,1% (0-6%)	
GÉNERO	MUJER <i>n</i> ; % (IC95%)	43,0; 79,6% (37,1-58,6%)	32,0; 88,8% (25,7-46,3%)	0,2
EDAD	<i>Media (desviación típica)</i>	21,7 (+-8,9)	24,5 (+-2,9)	0,54

IC95%: intervalo de confianza al 95.

Tabla 2. Grupos y subgrupos de alimentos considerados en el Estudio Enalia

Grupo y subgrupo de alimentos	Grupo y subgrupo de alimentos
Cereales Granos y harinas Cereales de desayuno Panes Pastas Galletas	Carnes y derivados Vacuno Cerdo Cordero Aves Vísceras Embutidos Otras carnes
Legumbres Legumbres secas Conservas de legumbres Derivados de legumbres	Pescados y derivados Pescado blanco Pescado azul Conservas de pescado Pescados ahumados Mariscos y derivados Conservas de marisco y derivados Derivados de pescado y otros no clasificables
Snacks Azúcares Chocolates Bollos Pastelería	Pescados y derivados Pescado blanco Pescado azul Conservas de pescado Pescados ahumados Mariscos y derivados Conservas de marisco y derivados Derivados de pescado y otros no clasificables
Frutas Frutas frescas Derivados de frutas Frutas desecadas Frutos secos	Aceites y grasas Aceites Mantequilla/margarina Otras grasas
Lácteos y derivados Leches Yogures y leches fermentadas Quesos Postres/Batidos lácteos	Bebidas con cafeína Cafés/infusiones Zumos comerciales
Varios Productos dietéticos Preparados infantiles	Huevos y derivados
Sal añadida	Platos preparados y precocinados Platos preparados y precocinados

En lo que respecta al alcohol, el porcentaje de muestra también aumentó, siendo del 83,3% en primer curso y del 94% en cuarto curso.

El consumo de cannabis aumentó del 22,2% en primer curso al 41,6%.

El consumo de cocaína disminuyó de una única identificación en primer curso (1,78%) a no obtener ningún registro en cuarto curso.

En lo que respecta a los tranquilizantes, el consumo también aumentó, con un porcentaje de un 14,8% en primer curso que lo consumía hasta el 16,67% de consumidores en cuarto curso (Tabla 4).

Se observaron diferencias en el número de participantes que realizaron ejercicios intensos en tandas de 3-5 días y 6-7 días por semana. En primer curso, el porcentaje de estudiantes que realizó actividad intensa 3-5 días por semana fue del 44,4%, mientras que en cuarto curso fue del 36,1%. En cuanto a este tipo de actividad con una frecuencia de 6-7 días por semana, se observó una variación del 13,8% en cuarto curso en comparación con el 3,7% en primer curso (Tabla 5).

En cuanto a la actividad moderada, esta aumentó en la frecuencia de "3-5 días por semana" de un 33,3% hasta un 50,0% en el último curso. Sin embargo, los porcentajes de resultados por curso académico no contuvieron diferencias estadísticamente apreciables cuando el ejercicio era el de caminar (Tabla 5).

DISCUSIÓN

Los hábitos de vida de los estudiantes de enfermería presentan oportunidades de mejora. En relación con la nutrición, se observa que el alumnado consume alimentos con calidad nutricional, como pescados, carnes, frutas y verduras, entre otros. Sin embargo, se identifica un aumento en el consumo de tabaco, alcohol, cannabis, relajantes y ansiolíticos entre el estudiantado de cuarto curso en comparación con el de primer curso. Además, el estudiantado de cuarto curso dedicaba más tiempo a la práctica de deportes de alta intensidad en comparación con la muestra de primer curso.

Los resultados relativos al consumo de carbohidratos en el primer curso revelan la tendencia ascendente que se observa en la sociedad actual hacia la promoción de dietas cetogénicas, también conocidas como "dietas keto". En el cuarto curso, todos los estudiantes incluían carbohidratos en su dieta. Además, los requerimientos de proteínas y grasas del estudiantado estaban satisfechos mediante el consumo frecuente de carnes, pescados magros y grasos, productos lácteos, entre otros. En comparación con estudios previos realizados en diversas universidades en España, los resultados mostraron una mejora en la densidad nutricional¹¹.

Tabla 3. Frecuencia del consumo de alimentos entre el estudiantado del Grado de Enfermería en la UPV

		>1d	2-3SEM	N/CN	p-valor
CEREALES n; % (IC95%)	1º	43,0; 47,8% (37,1-58,6%)	4,0; 4,4% (1,2-11,0%)	7,0; 7,78% (3,2-15,4%)	0,02
	4º	29,0; 32,02% (22,8-42,9%)	7,0; 7,8% (3,2-15,4%)	0,0; (0,0-4,0%)	
SNACKS n; % (IC95%)	1º	0,0 (0,0-4,0%)	34,0; 37,8% (27,8-48,6%)	20,0; 22,2% (14,1-32,2%)	0,01
	4º	1,0; 1,1% (14,1-32,2%)	11,0; 12,2% (6,3-20,8%)	24,0; 26,7% (17,9-37,0%)	
VERDURAS Y HORTALIZAS n; % (IC95%)	1º	1,0; 1,1% (14,1-32,2%)	53,0; 58,9% (48,0-69,2%)	0,0; (0,0-4,0%)	0,01
	4º	23,0; 25,6% (16,9-35,8%)	13,0; 14,4% (7,9-23,4%)	0,0; (0,0-4,0%)	
CARNES Y DERIVADOS n; % (IC95%)	1º	3,0; 3,3% (0,7-9,4%)	45,0; 50,0% (39,9-60,7%)	6,0; 6,7% (2,5-13,9%)	0,01
	4º	6,0; 6,7% (2,5-13,9%)	14,0; 15,6% (8,8-24,7%)	16,0; 17,8% (10,5-27,3%)	
PESCADOS Y DERIVADOS n; % (IC95%)	1º	5,0; 5,6% (1,8-12,5%)	41,0; 45,6% (35,0-56,4%)	8,0; 8,9% (3,9-16,8%)	0,01
	4º	7,0; 7,8% (3,2-15,4%)	13,0; 14,4% (7,9-23,4%)	16,0; 17,8% (10,5-27,3%)	
LÁCTEOS Y DERIVADOS n; % (IC95%)	1º	26,0; 28,9% (19,8-39,4%)	15,0; 16,7% (9,6-26,0%)	13,0; 14,4% (7,9-23,4%)	0,2
	4º	24,0; 26,7% (17,9-37,0%)	2,0; 2,2% (0,3-7,8%)	10,0; 11,1% (5,5-19,5%)	
BEBIDAS CON CAFEINA n; % (IC95%)	1º	5,0; 5,6% (1,8-12,5%)	13,0; 14,4% (7,9-23,4%)	36,0; 40,0% (29,8-50,9%)	0,1
	4º	1,0; 1,1% (0,0-6,0%)	5,0; 5,6% (1,8-12,5%)	30,0; 33,3% (23,7-44,1%)	
SAL AÑADIDA n; % (IC95%)	1º	6,0; 6,7% (2,5-13,9%)	8,0; 8,9% (3,9-16,8%)	40,0; 44,4% (34,0-55,3%)	0,1
	4º	10,0; 11,1% (5,5-19,5%)	5,0; 5,6% (1,8-12,5%)	21,0; 23,3% (15,1-33,4%)	

>1d: Consumo de más de una vez al día; 2-3SEM: Consumo de 2-3 veces por semana; N-CN: Nunca o casi nunca se consume el producto IC95%: intervalo de confianza al 95%.

Debido a las adversas repercusiones en la salud humana asociadas con productos de snack y bollería, un número considerable de participantes en el cuarto curso optó por eliminarlos de su dieta. Estas consecuencias son minuciosamente abordadas en asignaturas como Enfermería Clínica I y II¹² dentro de sus competencias de aprendizaje. Como resultado del énfasis que se hace a lo largo del programa de enfermería, el estudiantado de cuarto curso incrementó su consumo diario de verduras, legumbres y frutas en comparación con el primer curso. Estos resultados concuerdan con hallazgos similares en estudios previos¹¹.

Los estudiantes de cuarto año mostraron un mayor consumo de azúcar libre en comparación con el grupo de primer año. Esta diferencia podría deberse al hecho de que los estudiantes de cuarto año tenían una edad promedio mayor en comparación con los del primer año. Además, los estudiantes de cuarto año estaban simultáneamente estudiando y trabajando, lo que resultaba en una mayor carga laboral y, como consecuencia, en una mayor fatiga y cansancio. Para combatir estos efectos, es posible que hayan recurrido al consumo

de bebidas con cafeína, como café y coca-cola, las cuales a menudo contienen cantidades adicionales de azúcar.

La afirmación de que el estrés experimentado por individuos en vías de convertirse en profesionales se reduce mediante el consumo de tabaco, alcohol y cannabis sugiere la utilización de estas sustancias como estrategias de afrontamiento. No obstante, es esencial abordar esta perspectiva desde una óptica científica y de salud pública. Aunque algunos individuos puedan recurrir a estas sustancias como medios para aliviar el estrés y facilitar la interacción social, es crucial reconocer que tales prácticas pueden conllevar riesgos significativos para la salud mental y física a largo plazo. Se recomienda explorar enfoques alternativos y más saludables para manejar el estrés, tales como técnicas de gestión del estrés, apoyo social positivo y estrategias de afrontamiento saludables⁵. El 87.7% del conjunto total de la muestra participante reporta el consumo de bebidas alcohólicas, cifra que se asemeja a la prevalencia observada en otros estudiantados de diversas universidades en España, según evidencia documentada¹⁴. Es importante señalar que la condición de ser estu-

Tabla 4. Consumo de sustancias tóxicas entre el estudiantado del Grado de Enfermería de la UPV

	1º	4º	p-valor
TABACO <i>n</i> ; % (IC95%)	15,0; 16,7% (9,6-26,0%)	17,0; 18,9% (11,4-28,5%)	0,06
ALCOHOL <i>n</i> ; % (IC95%)	45;50% (39.3-60.7%)	34,0; 37,8% (27,8-48,6%)	0,1
CANNABIS (SÍ) <i>n</i> ; % (IC95%)	12,0; 13,3% (7,1-22,1%)	15,0; 16,7% (9,6-26,0%)	0,04
COCAINA (SÍ) <i>n</i> ; % (IC95%)	1,0; 1,1% (0,0-6,0%)	0,0 (0,0-4,0%)	0,4
TRANQUILIZANTES(SÍ) <i>n</i> ; % (IC95%)	8,0; 8,9% (3,9-16,8%)	6,0; 6,7% (2,5-13,9%)	0,8
ALUCINÓGENOS (SÍ) <i>n</i> ; % (IC95%)	2,0; 2,2% (0,3-7,8%)	1,0; 1,1% (0,0-6,0%)	0,8
OPIACEOS (SÍ) <i>n</i> ; % (IC95%)	1,0; 1,1% (0,0-6,0%)	0,0	0,4

IC95%: intervalo de confianza al 95%.

Tabla 5. Cuestionario de actividad física realizada entre el estudiantado del Grado de Enfermería de la UPV

		0-2D/SEM	3-5D/SEM	6-7D/SEM	p-valor
A.F. INTENSA <i>n</i> ; % (IC95%)	1º	28,0 31,1% (21,8-41,7%)	24,0 26,7% (17,9-37,0%)	2,0 2,2% (0,3-7,8%)	0,2
	4º	18,0 20% (12,3-29,8%)	13,0 14,4% (7,9-23,4%)	5,0 5,6% (1,8-12,5%)	
A.F. MODERADA <i>n</i> ; % (IC95%)	1º	34,0 37,8% (27,8-48,6%)	18,0 20% (12,3-29,8%)	2,0 2,2% (0,3-7,8%)	0,12
	4º	15,0 16,7% (9,6-26,0%)	18,0 2,0 % (12,3-29,8%)	3,0 3,3% (0,7-9,4%)	
CAMINAR <i>n</i> ; % (IC95%)	1º	2,0 2,2% (0,3-7,8%)	13,0 14,4% (7,9-23,4%)	39,0 43,3% (32,9-54,2%)	0,5
	4º	0,0 (0,0-4,0)	9,0 10% (4,7-18,1%)	27,0 30% (20,8-40,6%)	

A.F. INTENSA: Actividad física intensa; A.F. MODERADA: Actividad física moderada; 0-2D/SEM: Entre 2 o ningún día de actividad por semana; 3-5D/SEM: Entre 3-5 días de actividad por semana; 6-7D/SEM: Entre 6 y 7 días de actividad por semana; Las actividades intensas y/o moderadas se clasifican según el cuestionario internacional para la actividad física IPAQ.

IC95%: intervalo de confianza al 95%.

dante de enfermería o de Ciencias de la Salud no se percibe como un factor protector frente al consumo de tabaco, según consta en estudios previos¹⁴. La notoria frecuencia de consumo en la población adulta joven suscita inquietud, ya que este segmento demográfico se revela como particularmente propenso al mantenimiento y aumento de tales patrones de consumo, generando preocupaciones adicionales en el ámbito de la salud pública¹⁴. Los participantes de cuarto curso exhibieron estrategias mejoradas para mitigar el estrés, evidenciado por una disminución en el consumo de tabaco y alcohol, así como por un aumento en la frecuencia de días en los que se llevaba a cabo ejercicio de alta intensidad. En comparación con investigaciones realizadas en otras universidades de España, el estudiantado universitario del programa de enfermería demostró resultados superiores en términos de actividad física¹⁴. Teniendo en cuenta los resultados de actividad física, y el número de participantes de sexo femenino, los re-

sultados son mejores que en estudios realizados con anterioridad¹¹. Esto puede ser debido a la importancia que está obteniendo la imagen física, musculada y esculpida, en una sociedad con visión masculina y que simplifica la belleza femenina¹⁵. Y es que el estudiantado de enfermería y de esta muestra, se ha caracterizado por ser predominante femenina, así lo ponen de manifiesto no sólo los datos estadísticos sino también las investigaciones realizadas en la rama sanitaria, que evidencian, que la Enfermería tiene una composición mayoritariamente del sexo femenino^{6,16}.

Se observó un aumento en el consumo de fármacos relacionados entre los participantes del cuarto curso. Este fenómeno podría atribuirse al incremento del estrés experimentado por los participantes al acercarse al ámbito laboral de la enfermería ya que no se identificaron otras razones, tales como el ocio, que pudieran explicar este consumo. Sería de interés investigar las motivaciones detrás de este consumo. La imple-

mentación de un taller sobre “mindfulness” o terapia colectiva podría ser una estrategia adecuada para reducir el consumo de sustancias nocivas, especialmente si se comprenden a fondo los motivos que llevan a este grupo a consumirlas.

Para futuras investigaciones, se recomienda llevar a cabo una reunión previa con los participantes del estudio. Esto posibilitaría la elucidación de los procedimientos de tratamiento de datos y aclararía los aspectos relacionados con los cuestionarios. Esta estrategia tiene el potencial de incrementar la tasa de respuesta, ya que brindaría a los participantes una comprensión más nítida y abarcadora de la investigación, lo que a su vez fomentaría una mayor participación y compromiso con el estudio.

LIMITACIONES DE ESTUDIO

Las limitaciones del estudio pueden incluir varios factores que afectaron la realización y los resultados del mismo, dados los desafíos particulares durante la pandemia de COVID-19. La imposibilidad de reunirse en persona con los alumnos para resolver dudas debido a las restricciones de distanciamiento social puede haber afectado la calidad de la interacción y la comprensión del estudio. Además, el estrés y la incertidumbre experimentados por los participantes en relación con la situación académica y la evolución constante de las restricciones sociales y deportivas pueden haber influido en su capacidad para mantener hábitos saludables de alimentación y ejercicio, lo que a su vez podría haber afectado los resultados del estudio. Por último, las dificultades experimentadas por el investigador en términos de retrasos en la comunicación con los estudiantes y la obtención de asesoramiento docente pueden haber obstaculizado la realización efectiva del estudio y la implementación de mejoras necesarias. Estas limitaciones deben tenerse en cuenta al interpretar los resultados y considerar futuras investigaciones en circunstancias similares.

CONCLUSIONES

Tras analizar los resultados obtenidos en el estudio, se pueden extraer varias conclusiones significativas. En primer lugar, a pesar de las limitaciones experimentadas durante la pandemia de COVID-19, se observa un patrón positivo en cuanto a la calidad nutricional de los alimentos consumidos por los estudiantes de enfermería, destacando la inclusión de alimentos saludables como pescados, carnes magras, frutas y verduras en su dieta. Sin embargo, se identifica una preocupante tendencia al aumento en el consumo de sustancias nocivas, como tabaco, alcohol, cannabis, relajantes y ansiolíticos, especialmente entre los estudiantes de cuarto curso. Este hallazgo sugiere la necesidad urgente de implementar estrategias de intervención para abordar estos comportamientos de riesgo y promover hábitos de vida más saludables entre la población estudiantil. Además, se destaca la importancia de brindar herramientas efectivas para gestionar el estrés, dado su impacto significativo en los hábitos de vida y el bienestar general de los estudiantes. En conjunto, estas conclusiones

resaltan la importancia de abordar de manera integral la salud y el bienestar de los estudiantes de enfermería, con el objetivo de promover un estilo de vida saludable y prevenir futuros problemas de salud.

BIBLIOGRAFÍA

1. World health organization.[Internet].Suiza.2018.Vida saludable, bienestar y objetivos de desarrollo sostenible.Boletín de la Organización Mundial de la Salud. <https://www.who.int/bulletin/volumes/96/9/18-222042/es>
2. Organización mundial de la salud. Una conferencia internacional sobre promoción de la salud. [Online]. Available from: <https://www.paho.org/hq/dmdocuments/2013/Carta-de-ottawa-para-la-apromocion-de-la-salud-1986-SP.pdf> [Accessed 10 March 2023]
3. Pender NJ, Murdaugh CL, Parsons MA, editors. Health promotion in nursing practice.[Internet] Pearson Education;Upper Saddle River, Nueva Jersey, United States: 2010. Disponible: <https://www.pearsonhighered.com/assets/preface/0/1/3/4/0134754085.pdf>
4. Cerqueira Sousa I, Fontenelle Catrib AM, Teixeira Medeiros N, Pereira da Silva Godinho CC, Ferreira Carioca AA, Marinho Holanda GP, Nogueira Bezerra I, et al. Health students' knowledge about healthy eating and factors associated with the university environment. *Rev Peru Med Exp Salud Publica.* 2022;39(4):425-33. doi: <https://doi.org/10.17843/rpmesp.2022.394.11349>.
5. Josie evans, M.M. Nurse Education in Practice. Health and health behaviours among a cohort of first year nursing students in Scotland: A self-report survey. *Escocia* 2018;36(): 71- 75.
6. Urbanetto, J.S. et al. Estrés y sobrepeso/obesidad en estudiantes de enfermería. *Revista Latino-Americana Enfermagem.* 2019;
7. World Health Organization. (1998). Development of the World Health Organization WHOQOL-BREF quality of life assessment. *Psychological Medicine,* 28(3), 551-558. doi:10.1017/s0033291798006667
8. Ortega, R. M., Pérez-Rodrigo, C., López-Sobaler, A. M., & Grupo Colaborativo ENALIA. (2013). La revisión del cuestionario de frecuencia de consumo de alimentos en el estudio enalia: 2011. *Nutrición Hospitalaria,* 28(6), 1426-1433. doi:10.3305/nh.2013.28.6.6848
9. World Health Organization. (2010). The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST): development, reliability and feasibility. *Addiction,* 103(6), 1039-1047. doi:10.1111/j.1360-0443.2007.02040.x
10. Armstrong, T., & Bull, F. (2006). Development of the World Health Organization Global Physical Activity Questionnaire (GPAQ). *Journal of Public Health,* 14(2), 66-70. doi:10.1007/s10389-006-0024-x
11. Irazusta, A. et al.: Hábitos de vida de los estudiantes de enfermería. 2005.
12. Universidad país vasco. Universidad País Vasco, Grado enfermería LeioaPlan de estudio. [Online]. Available from: <https://www.ehu.eus/es/web/graduak/grado-enfermeria-bizkaia/creditos-y-asignaturas> [Accessed 19 October 2023].

13. Mahoney CR, Giles GE, Marriott BP, Judelson DA, Glickman EL, Geiselman PJ, Lieberman HR. Intake of caffeine from all sources and reasons for use by college students. *Clin Nutr*. 2019 Apr;38(2):668-675. doi: 10.1016/j.clnu.2018.04.004. Epub 2018 Apr 10. PMID: 29680166.
14. Rodríguez PM et al. Influencia del consumo de tabaco y alcohol, hábitos alimenticios y actividad física en estudiantes de enfermería. *Revista Latino-Americana Enfermagem*. 2020.
15. Molina AJ, Varela V, Fernandez T, Martin V, Ayan C, Cancela JM. Unhealthy habits and practice of physical activity in Spanish college students: the role of gender, academic profile and living situation. *Adicciones*. 2012 [cited Feb 7, 2023]; 24(4):319-27. Disponible: <https://www.redalyc.org/articulo.oa?id=289124639006>
16. INE. Instituto Nacional de Estadística. Enfermeros colegiados por tipo de especialidad, año y sexo. <https://www.ine.es/jaxi/Datos.htm?tpx=49002>

Contagem total de linfócitos e sua relação com parâmetros clínicos e nutricionais em pacientes candidatos à cirurgias

Total lymphocyte count and its relationship with clinical and nutritional parameters in patients undergoing surgical procedures

Mariana Gomes de LIMA¹, Raiza Zacarias COSTA¹, Julee Stephani Gomes ALVES¹, Stéfany Crislayne Rocha da SILVA², Janatar Stella Vasconcelos de Melo ME-MPOMO^{3,4}, Poliana Coelho CABRAL⁴, Maria Izabel Siqueira de ANDRADE¹

1 Faculdade de Nutrição (FANUT), Universidade Federal de Alagoas (UFAL).

2 Residência Multiprofissional em Saúde do Adulto e do Idoso, Hospital Universitário Professor Antunes (HUPAA).

3 Unidade Multiprofissional, Hospital Universitário Professor Antunes (HUPAA).

4 Programa de Pós-graduação em Nutrição, Universidade Federal de Pernambuco (UFPE).

Recibido: 3/mayo/2024. Aceptado: 8/junio/2024.

RESUMO

Objetivo: Avaliar a relação entre a contagem total de linfócitos e variáveis clínicas e nutricionais em pacientes candidatos a cirurgias.

Métodos: Estudo observacional, de caráter transversal, realizado na clínica cirúrgica do Hospital Universitário Professor Alberto Antunes - AL. A contagem total de linfócitos foi obtida a partir de fórmula pré-estabelecida, permitindo a classificação do nível de desnutrição em depleção leve a grave. Foram coletados dados sociodemográficos; clínicos, como tempo de internamento, tipo do procedimento, severidade da cirurgia e desfecho clínico; dados antropométricos, incluindo peso, altura, circunferências e pregas cutâneas; e níveis séricos de albumina, para verificação de possíveis significâncias estatísticas com a contagem total de linfócitos. Foi adotado o valor de 5% para rejeição da hipótese de nulidade.

Resultados: A amostra foi composta por 109 pacientes, sendo 54,1% do sexo feminino, com média de idade de 54,4±14,3 anos. Segundo a contagem total de linfócitos, 47,7% (n=50) dos pacientes apresentaram algum grau de depleção, condição evidenciada principalmente nos indivíduos do sexo masculino (58,3% nos homens *versus* 38,6% nas mu-

lheres; p=0,044). Houve associação do desfecho clínico com a contagem total de linfócitos, onde pacientes desnutridos apresentaram mais alta sem a realização do procedimento cirúrgico (p=0,017). Em análise estratificada pelo nível de depleção da linfocitometria, aqueles classificados nas categorias de moderada a grave apresentaram eutrofia ou desnutrição pelo IMC (p=0,008), desnutrição pela área muscular do braço corrigida (p=0,031) e pela espessura do músculo adutor do polegar dominante (p=0,048). A contagem total de linfócitos se correlacionou diretamente com a albumina (p<0,001).

Conclusão: A contagem total de linfócitos, nas categorias de moderada a grave, apresentou significância com parâmetros antropométricos convencionais e se correlacionou com níveis séricos de albumina nos pacientes cirúrgicos. Ressalta-se que o marcador em questão pode ser obtido a partir de valores do hemograma, exame rotineiramente realizado no pré-operatório.

DESCRITORES

Avaliação Nutricional; Estado nutricional; Desnutrição; Procedimentos Cirúrgicos; Contagem de Linfócitos.

ABSTRACT

Objective: To assess the relationship between total lymphocyte count and clinical and nutritional variables in patients undergoing surgical procedures.

Methods: Cross-sectional study, carried out in the surgical clinic of the Hospital Universitário Professor Alberto

Correspondencia:
Maria Izabel Siqueira de Andrade
maria.andrade@fanut.ufal.br

Antunes - AL. The total lymphocyte count was obtained from a pre-established formula, allowing the classification of the level of malnutrition as mild to severe depletion. Sociodemographic, clinical and anthropometric data were obtained to check possible statistical significance with the total lymphocyte count. The value of 5% was adopted to reject the null hypothesis ($p < 0.05$).

Results: The sample comprised 109 patients, 54.1% female, with a mean age of 54.4 ± 14.3 years. According to the total lymphocyte count, 47.7% ($n=50$) of patients presented some degree of depletion, a condition evident mainly in males (58.3% in men versus 38.6% in women; $p=0.044$). There was an association between the clinical outcome and the total lymphocyte count, where malnourished patients presented higher frequency of hospital discharge without undergoing the surgical procedure ($p=0.017$). In an analysis stratified by the level of lymphocytometry depletion, those classified in the moderate to severe categories presented eutrophy or malnutrition according to BMI ($p=0.008$), malnutrition according to the corrected arm muscle area ($p=0.031$) and by the thickness of the dominant adductor pollicis muscle ($p=0.048$). The total lymphocyte count correlated with albumin ($p < 0.001$).

Conclusions: Total lymphocyte count, in the moderate to severe categories, was significant with conventional anthropometric parameters and correlated with serum albumin levels in surgical patients. It is noteworthy that the studied marker can be easily obtained from blood count values, an exam routinely performed preoperatively.

KEYWORDS

Nutritional Assessment; Nutritional Status; Malnutrition; Surgical Procedures; Lymphocyte count.

ABREVIACIONES

AMBc: Área Muscular do Braço Corrigida.

CB: Circunferência do Braço.

CMB: Circunferência Muscular do Braço.

CTL: Contagem Total de Linfócitos.

DM: Diabetes Mellitus.

EMAP: Espessura do Músculo Adutor do Polegar.

HAS: Hipertensão Arterial Sistêmica.

IBGE: Instituto Brasileiro de Geografia e Estatística.

IMC: Índice de Massa Corpórea.

PCT: Prega Cutânea Tricipital.

INTRODUÇÃO

A desnutrição hospitalar é um problema de saúde pública de magnitude mundial. Na América Latina, foi encontrada

uma prevalência entre 40 e 60% de desnutrição hospitalar ainda na admissão, sendo associada ao aumento no tempo de internamento e o pior prognóstico clínico¹.

No ambiente hospitalar, verificar o risco nutricional é etapa primordial no rastreio da desnutrição^{2,3}. Nos pacientes identificados com risco, procede-se com a avaliação nutricional, a qual é composta por métodos objetivos (antropometria, composição corporal, dados bioquímicos) e subjetivos (exame físico e consumo alimentar)⁴. Conhecer o estado nutricional dos pacientes no ambiente hospitalar é de extrema importância em virtude das evidências de que a desnutrição pode predispor ao maior risco de infecção, complicações metabólicas, internações prolongadas, aumento da morbimortalidade, além de alto custo hospitalar⁵⁻⁸.

Parâmetros como a contagem total de linfócitos (CTL) têm sido relacionados com o estado nutricional e a gravidade da doença, pois além de medirem as reservas imunológicas momentâneas, indicando as condições do mecanismo de defesa celular do organismo, também é um bom preditor da desnutrição⁹. A utilização da CTL na prática clínica hospitalar possui a vantagem de ser um método simples, de fácil avaliação e baixo custo, visto que os dados utilizados para o cálculo do parâmetro já fazem parte do exame básico realizado na rotina pré cirúrgica¹⁰⁻¹².

Os valores referentes à linfocitometria podem fornecer informações sobre a competência imunológica do indivíduo e, conseqüentemente, do seu estado nutricional¹³⁻¹⁵. A CTL sofre interferência dos sinais de inflamação, apresentando limitações em casos de infecção, doenças agudas, uso de alguns medicamentos, entre outros^{13,16}. Apesar disso, tal parâmetro pode estar relacionado com aumento da morbimortalidade em pacientes hospitalizados por apresentarem comprometimento imunológico, sugerindo que a CTL seja utilizada por demonstrar associação com a piora do estado clínico, além de ser realizada de forma rápida e se adequar a todos os grupos etários^{16,17}.

A literatura encontra-se escassa no que diz respeito à verificação da CTL e seu emprego na avaliação nutricional. Com base no exposto, o presente estudo teve como objetivo associar a contagem total de linfócitos com variáveis clínicas e do estado nutricional em pacientes candidatos a cirurgias em um hospital universitário público no nordeste brasileiro.

MÉTODOS

Trata-se de um estudo transversal, realizado com pacientes admitidos na clínica cirúrgica do Hospital Universitário Professor Alberto Antunes da Universidade Federal de Alagoas (HUPAA/UFAL), localizado em Maceió, Alagoas, Brasil, no período entre agosto de 2021 e outubro de 2022. A pesquisa foi previamente aprovada pelo comitê de ética em pesquisa da Universidade Federal de Alagoas, sob parecer n. 5.324.656 e CAAE 47896321.9.0000.5013.

A amostra foi do tipo não probabilística, de acordo com os indivíduos que se enquadraram nos critérios de elegibilidade e que aceitaram participar do estudo espontaneamente, através da assinatura do Termo de Consentimento Livre e Esclarecido (TCLE). Foram incluídos indivíduos adultos e idosos, de ambos os sexos, com idade igual ou superior a 20 anos, em período pré-operatório. Gestantes, lactantes, pacientes com dificuldade de locomoção, com doença em fase terminal, em pré e pós-operatório de cirurgia bariátrica, reinternações por complicações pós-operatórias, internações para procedimentos diagnósticos e os que se recusaram a participar da pesquisa foram devidamente excluídos.

Dados demográficos (sexo e idade) foram obtidos para caracterização dos participantes. Para a avaliação do *status* socioeconômico foram utilizados os Critérios de Classificação Econômica Brasil 2021 (CCEB), indicados pela Associação Brasileira de Empresas de Pesquisa – Abep [abep.org/critério-brasil] o qual divide as classes nas categorias: alta (subcategorias A1 e A2), média (subcategorias B1, B2 e C1) e baixa (subcategorias C2, D e E). Os indivíduos foram questionados quanto ao grau de escolaridade, e foram classificados em: >8 anos de estudo e ≤8 anos de estudo.

A avaliação clínica contou com dados referentes à presença de comorbidades, classificação do tipo de cirurgia (categorizada em eletiva, urgência e urgência eletiva conforme nota técnica de 2021 da Agência Nacional de Vigilância Sanitária [gov.br/anvisa]), severidade do procedimento cirúrgico realizado¹⁸, complicações¹⁹, tempo de internamento e desfecho clínico (alta com cirurgia, alta sem cirurgia, transferência ou óbito).

Na ocasião da antropometria foram obtidas medidas como o peso e a altura, para realização do Índice de Massa Corporal (IMC), e parâmetros de circunferências corporais (Circunferência do Braço - CB), dobras cutâneas (Prega Cutânea Tricipital - PCT) e Espessura do Músculo Adutor do Polegar (EMAP).

O peso e a altura foram aferidos de acordo com a técnica proposta por Lohman et al.²⁰. O diagnóstico do estado nutricional, segundo o IMC, foi realizado de acordo com os valores indicados pela World Health Organization²¹, para adultos, e segundo a classificação de Lipschitz²² para idosos.

A CB foi realizada com a utilização de uma fita métrica inelástica, no braço não dominante, com o paciente em posição ereta, com o braço flexionado, para localização do ponto médio através do ponto mais distal do acrômio e a parte mais distal do olécrano. A medida da CB foi adquirida com o braço do indivíduo relaxado em direção ao tórax²⁰.

A PCT foi obtida com uso de adipômetro científico da marca CESCORF® e realizada no braço não dominante seguindo a técnica de Lohman et al.²⁰.

A partir da CB e da PCT foram calculadas a circunferência muscular do braço (CMB) e a área muscular do braço corrigida (AMBc), segundo Blackburn²³ e Heymsfield²⁴, respectivamente.

Os valores obtidos de CB, CMB e AMBc foram comparados aos padrões de referência recomendados por Frisncho²⁵.

A EMAP foi realizada com o indivíduo sentado, mão repousando sobre o joelho homolateral, cotovelo em ângulo de aproximadamente 90° sobre o membro inferior, com o adipômetro da marca CESCORF® exercendo uma pressão contínua de 10g/mm² para pinçar o músculo adutor no vértice de um ângulo imaginário formado pela extensão do polegar e o dedo²⁶. Os pontos de corte utilizados para diagnóstico de desnutrição, foram aqueles definidos por Bragagnolo et al.²⁷. O procedimento foi feito em duplicata na mão dominante e não dominante sendo empregada a média como medida da EMAP.

Com relação aos dados bioquímicos, foram registrados valores de albumina e do leucograma, os quais foram coletados diretamente dos prontuários dos pacientes. A linfocitometria foi calculada a partir do percentual de linfócitos e valor dos leucócitos (mL), utilizando-se a seguinte equação: CTL = % linfócitos x leucócitos/100. Os pontos de corte utilizados para a classificação do nível de desnutrição segundo a CTL foram: >2000 células/m³ (eutrófico), 1.200 a 2.000 células/m³ (depleção leve), 800 a 1.199 células/m³ (depleção moderada) e <800 células/m³ (depleção grave)²³.

A construção do banco de dados foi realizada no Excel® e todas as análises foram efetuadas com uso do *software* SPSS versão 13.0 para Windows (SPSS Inc., Chicago, IL, USA). As variáveis contínuas foram testadas quanto à normalidade da distribuição pelo teste Kolmogorov Smirnov. Os dados das variáveis de distribuição normal foram expressos na forma de média e desvio padrão (DP), e aqueles com distribuição não gaussiana foram apresentados como medianas acompanhadas de seus respectivos intervalos interquartílicos (IQ). Para a verificação de possíveis associações entre as variáveis categóricas, foi empregado o teste de qui-quadrado de Pearson, sendo também utilizada a correlação de Pearson, para as relações entre dados contínuos. Adotou-se o $p < 0,05$ para constatação de significância estatística.

RESULTADOS

A amostra foi composta por 109 pacientes, sendo 54,1% (n=59) do sexo feminino, com média de idade de 54,4±14,3 anos. A maioria era do grupo etário adulto (66,3%; n=72), incluído no *status* socioeconômico baixo (68,8%; n=75) e com escolaridade ≤8 anos de estudo (56%; n=61). Os dados que caracterizam a amostra estão descritos na tabela 1.

Com relação aos dados clínicos (Tabela 2), destaca-se que 77,8% (n=70) realizaram cirurgias eletivas. As cirurgias de menor e médio porte somaram 72,6% (n=58) dos procedimentos realizados e a maioria dos pacientes não apresentou complicações perioperatórias (98%; n=101).

Não houve diferença entre os percentuais de indivíduos com e sem comorbidades, onde 52,8% (n=56) apresentaram

Tabela 1. Caracterização da amostra de pacientes candidatos à cirurgia em um hospital universitário no Nordeste Brasileiro. Maceió-AL, 2021-2022.

Variável	N=109	%
Sexo		
Masculino	50	45,9
Feminino	59	54,1
Grupo etário		
Adulto	72	66,1
Idoso	37	33,9
Escolaridade		
≤ 8 anos	61	56,0
> 8 anos	48	44,0
Status socioeconômico		
Alta / Média	34	31,2
Baixa	75	68,8

Grupo etário=Adulto <60 anos; Idoso ≥60 anos.

Status socioeconômico segundo os critérios de Classificação Econômica Brasil categorizada em alta/média (A1, A2, B1, B2, C1) e baixa (C2, D e E).

algum tipo de doença associada, sendo hipertensão (58,9%) a mais frequente.

A mediana do tempo de internamento geral foi de 3,5 dias (intervalo interquartil (IQ): 2-9 dias) e o principal desfecho evidenciado foi alta com realização da cirurgia (74,7%; n=74).

As principais variáveis antropométricas analisadas estão expostas na tabela 3. De acordo com o IMC, 7,5% (n=8) dos indivíduos apresentaram diagnóstico de desnutrição ou baixo peso.

Analisando as reservas musculares pela CB, CMB, AMBc e adiposa pela PCT, observou-se a presença de desnutrição em taxas que variaram de 30,6 a 37,7% da amostra. Aproximadamente 50% dos indivíduos foram classificados com desnutrição através da aferição da EMAP dominante e não dominante (Tabela 3).

Segundo a CTL, 47,7% apresentaram algum nível de desnutrição, especialmente a depleção leve (30,5%; n=32), seguida de depleção moderada a grave (8,6%; n=9 para ambas as classificações) (dados não apresentados em tabela).

Houve associação estatisticamente significativa entre o sexo e a CTL, onde indivíduos do sexo masculino apresentaram maiores taxas de desnutrição, quando comparados ao sexo

Tabela 2. Dados clínicos de pacientes candidatos à cirurgia internados em um Hospital Universitário no Nordeste Brasileiro. Maceió-AL, 2021-2022.

Variável	N	%
Severidade da cirurgia (n=80)		
Menor porte	27	33,8
Médio porte	31	38,8
Maior porte	22	27,5
Classificação do tipo de cirurgia (n=90)		
Eletiva	70	77,8
Urgência	18	20,0
Urgência eletiva	2	2,2
Complicações (n=103)		
Sem complicações	101	98,0
Infecciosa	1	1,0
Gastrointestinal	1	1,0
Tipo de comorbidade (n=56)		
HAS	33	58,9
DM	6	10,7
HAS + DM	17	30,4
Desfecho clínico (n=99)		
Alta com cirurgia	74	74,7
Alta sem cirurgia	25	25,3

HAS: hipertensão arterial sistêmica; **DM:** diabetes mellitus.

Severidade da Cirurgia: Maior porte (grande probabilidade de perda de fluido e sangue); Médio porte (média probabilidade de perda de fluido e sangue); Menor porte (pequena probabilidade de perda de fluido e sangue).

Classificação Temporal da Cirurgia: Eletiva (com data facultada pelo paciente ou cirurgião); Urgência (realizada em até 24h após admissão); Urgência eletiva (realizada dentro de 2 semanas).

feminino (58,3% versus 38,6%) (p=0,044). Pacientes classificados com desnutrição ainda tiveram um número maior de alta sem cirurgia (68,0%; n=17) (p=0,017) (Tabela 4).

Em análise estratificada dos parâmetros antropométricos pelo nível de depleção da CTL, aqueles classificados nas categorias de moderada a grave do parâmetro bioquímico apresentaram eutrofia ou desnutrição pelo IMC (p=0,008), desnutrição pela AMBc (p=0,031) e pela EMAP dominante (p=0,048) (dados não apresentados em tabela).

Tabela 3. Dados antropométricos de pacientes candidatos à cirurgia em um hospital universitário no Nordeste Brasileiro. Maceió-AL, 2021-2022.

Variável	N	%
Classificação IMC (n=106)		
Desnutrição / Baixo peso	8	7,5
Eutrofia	34	32,1
Excesso de peso	64	60,4
Classificação CB (n=107)		
Desnutrição	38	35,9
Eutrofia	47	43,9
Excesso de peso	22	20,6
Classificação CMB (n=107)		
Desnutrição	40	37,4
Eutrofia	67	62,6
Classificação AMBc (n=106)		
Desnutrição	40	37,7
Eutrofia	66	62,3
Classificação de PCT (n=108)		
Desnutrição	33	30,6
Eutrofia	18	16,7
Excesso de peso	57	52,8
Classificação EMAP D (n=105)		
Desnutrição	57	54,3
Eutrofia	48	45,7
Classificação EMAP ND (n=104)		
Desnutrição	56	53,8
Eutrofia	48	46,2

IMC: Índice de Massa Corporal; **CB:** Circunferência braquial; **CMB:** Circunferência Muscular do Braço; **AMBc:** Área Muscular do Braço Corrigida; **PCT:** Prega Cutânea Tricipital; **CP:** Circunferência do Braço; **EMAP D:** Espessura do Músculo Adutor do Polegar Dominante. **EMAP ND:** Espessura do Músculo Adutor do Polegar Não Dominante.

Adicionalmente, houve correlação direta da CTL com os valores de albumina sérica ($r=0,467$; $p<0,001$).

DISCUSSÃO

O presente estudo, realizado com amostra de pacientes hospitalizados em clínica cirúrgica de uma instituição pública, reflete a possibilidade da inclusão da CTL como um método simples, rápido e de baixo custo para a verificação de níveis de desnutrição no pré-operatório. O parâmetro bioquímico baseado na linfocitometria se associou de maneira significativa com variáveis antropométricas (IMC, AMBc e EMAP dominante), com o sexo masculino e o desfecho clínico, se correlacionando ainda positivamente com níveis séricos de albumina.

Apesar do valor obtido pelo cálculo da CTL representar a medição da competência imunológica, situações como desnutrição podem levar ao comprometimento da produção das células de defesa¹⁶, o que justifica seu emprego na avaliação nutricional em âmbito hospitalar. De acordo com revisão crítica realizada por Rocha e Fortes em 2013¹⁶, a utilização da CTL, principalmente quando aplicada em conjunto com outras ferramentas objetivas e subjetivas, pode ser preditora de risco nutricional em pacientes cirúrgicos.

Nesta pesquisa, foram identificados aproximadamente 50% de indivíduos com desnutrição pela CTL, independente do grau. Outros trabalhos que fizeram uso da mesma medida encontraram diferentes resultados possivelmente em virtude da heterogeneidade da amostra e da ausência de pontos de corte padronizados.

Kristian et al.²⁸, em estudo conduzido com 85 pacientes diagnosticados com câncer de cabeça e pescoço verificaram 18,6% de indivíduos com valores reduzidos da CTL ($<1,0 \times 10^3/\mu\text{L}$). Já Aghdaii et al.²⁹, em amostra com 1171 candidatos a cirurgias cardíacas, observaram CTL >1500 células/ μL em 65,3% dos participantes, entre 1500-1001 células/ μL em 32,5% e 2,2% com valores ≤ 1000 células/ μL . Fazendo uso do mesmo ponto de corte empregado na presente casuística, Leandro-Mehri et al.³⁰ e Rocha e Fortes⁹, evidenciaram níveis de desnutrição em 36% de idosos e 73,9% de pacientes cirúrgicos, respectivamente.

No que diz respeito às associações encontradas, vale destacar a significância da CTL com parâmetros antropométricos convencionais que são realizados como rotina na prática clínica, incluindo o IMC e medidas do compartimento proteico como a AMBc e a EMAP dominante.

Paralelamente, estudo transversal³⁰ conduzido com 131 idosos admitidos em clínica cirúrgica de um hospital universitário na cidade de Campinas-SP, a CTL se correlacionou fracamente com a CB ($\rho=0,20507$; $p=0,018$) e a PCT ($\rho=0,29036$; $p<0,001$). Os autores concluíram que, em função dos diferentes indicadores utilizados para o estabelecimento do diagnós-

Tabela 4. Associação da contagem total de linfócitos com variáveis demográficas e clínicas de pacientes candidatos à cirurgia em um Hospital Universitário no Nordeste Brasileiro. Maceió-AL, 2023.

Variáveis	Contagem Total de Linfócitos		Valor de <i>p</i> *
	Eutrofia	Depleção	
Sexo			
Masculino	20 (41,7%)	28 (58,3%)	0,044*
Feminino	35 (61,4%)	22 (38,6%)	
Faixa Etária			
Adulto	33 (51,6%)	31 (48,4%)	0,834
Idoso	22 (53,7%)	19 (43,3%)	
Comorbidades			
HAS/DM	25 (46,3%)	29 (53,7%)	0,225
Sem comorbidades	28 (58,3%)	20(41,7%)	
Desfecho clínico			
Alta com cirurgia	44 (59,5%)	30 (40,5%)	0,017*
Alta sem cirurgia	8 (32,0%)	17 (68,0%)	

Teste Qui-quadrado de Pearson. * $p < 0,05$.

tico nutricional e as peculiaridades dos pacientes avaliados, outros estudos são necessários para definição de novas modalidades diagnósticas e monitoramento hospitalar do estado nutricional.

Associação com o IMC também foi relatada em uma pesquisa retrospectiva²⁹, onde indivíduos com menores valores de CTL também apresentaram menores médias de IMC ($22.54 \pm 2.25\text{kg/m}^2$ para CTL ≤ 1000 Vs. $\leq 24.89 \pm 2.37\text{kg/m}^2$ para CTL > 1000 ; $p < 0,001$). Vale salientar a limitação do IMC como método com baixa sensibilidade para verificação da composição corporal⁹.

A correlação da albumina com a CTL é alvo de análise em estudos previamente publicados^{9,16}. Entretanto, evidências que tratam da comparação conjunta entre estas duas variáveis são escassas na literatura¹⁶. Pesquisa que avaliou a influência dos valores de CTL e albumina no risco de complicações pós-operatórias, verificou que, após análise de regressão logística univariada, houve associação entre a albumina ($p=0,01$) e CTL ($p=0,02$)⁹.

Nas análises de associação, os homens apresentaram maior frequência de desnutrição segundo a CTL, podendo-se inferir que a maior taxa deste desfecho, deva-se à procura mais tardia aos serviços de saúde, o que aumenta as chances deste grupo específico se apresentarem desnutridos no momento

da internação. Em contrapartida, Kristian et al.²⁸, relataram maiores valores de CTL em indivíduos do sexo masculino.

Alguns dados devem ser considerados para a interpretação dos resultados aqui apresentados, como o delineamento transversal que impossibilita relações de causalidade, a falta de padronização de pontos de corte para a CTL, o tamanho amostral e o número limitado de pesquisas disponíveis com o público em questão.

Ressalta-se que o presente estudo foi importante para a reflexão da aplicação da CTL na rotina hospitalar, visto que a sua obtenção advém de informações usuais da avaliação bioquímica pré-operatória, podendo ser considerado como mais um método para acompanhamento do estado nutricional e imunológico.

CONCLUSÕES

A CTL se associou com dados antropométricos e clínicos na amostra de pacientes cirúrgicos. A frequência de desnutrição, segundo o método empregado, foi expressiva, variando em níveis de depleção leve a grave. Recomenda-se a condução de novos estudos, com amostras maiores e representativas e diferentes públicos, visando a implementação deste parâmetro como forma de avaliação rápida e objetiva de possíveis desvios nutricionais em indivíduos hospitalizados.

REFERÊNCIAS

1. Correia M, Perman MI, Waitzberg DL. Hospital malnutrition in Latin America: A systematic review. *Clin Nutr.* 2017;36(4):958-967.
2. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr.* 2003;22(3):321-336.
3. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. *Clin Nutr.* 2003;22(4):415-421.
4. Cederholm T, Barazzoni R, Austin P, Ballmer P, Biolo G, Bischoff SC, et al. ESPEN guidelines on definitions and terminology of clinical nutrition. *Clin Nutr.* 2017;36(1):49-64.
5. Stratton RJ, Hackston A, Longmore D, Dixon R, Price S, Stroud M, et al. Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the 'malnutrition universal screening tool' ('MUST') for adults. *Br J Nutr.* 2004;92(5):799-808.
6. Sungurtekin H, Sungurtekin U, Hanci V, Erdem E. Comparison of two nutrition assessment techniques in hospitalized patients. *Nutrition.* 2004;20(5):428-432.
7. Barbosa-Silva MCG, Barros AJDD. Avaliação nutricional subjetiva: Parte 2 - Revisão de suas adaptações e utilizações nas diversas especialidades clínicas. *Arquivos de Gastroenterologia.* 2002;39(4):248-252.
8. Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. *Clin Nutr.* 2003;22(3):235-239.
9. Rocha NP, Fortes RC. Total lymphocyte count and serum albumin as predictors of nutritional risk in surgical patients. *ABCD Arquivos Brasileiros de Cirurgia Digestiva (São Paulo).* 2015;28(3):193-196.
10. Soares DDS, Brandão RRM, Mourão MRN, Azevedo VLFD, Figueiredo AV, Trindade ES. Relevância de exames de rotina em pacientes de baixo risco submetidos a cirurgias de pequeno e médio porte. *Revista Brasileira de Anestesiologia.* 2013;63(2):197-201.
11. González Madroño A, Mancha A, Rodríguez FJ, de Ulibarri JI, Culebras J. The use of biochemical and immunological parameters in nutritional screening and assessment. *Nutr Hosp.* 2011;26(3):594-601.
12. Mueller C, Compher C, Ellen DM. A.S.P.E.N. clinical guidelines: Nutrition screening, assessment, and intervention in adults. *JPEN J Parenter Enteral Nutr.* 2011;35(1):16-24.
13. Oliveira LMLD, Rocha APC, Silva JMAD. Avaliação nutricional em pacientes hospitalizados. *Saber Científico (1982-792X).* 2021;1(1):240-252.
14. Jardim MDN, Costa HMD, Kopel L, Lage SG. Avaliação nutricional do cardiopata crítico em terapia de substituição renal: dificuldade diagnóstica. *Revista Brasileira de Terapia Intensiva.* 2009;21(2):124-128.
15. Arruda CVd, Pinho CPS, Santos ACOd. Repercussões nutricionais em pacientes portadores de insuficiência cardíaca associada à miocardiopatia no Nordeste Brasileiro. *Nutr clín diet hosp.* 2014:37-47.
16. Rocha NP, Fortes RC. Utilização da contagem total de linfócitos e albumina sérica como preditores do risco nutricional em pacientes cirúrgicos. *Com Ciênc Saúde.* 2013;24(1):51-64.
17. Sodré MTM, Benseñor IJM, Lotufo PA, Gomes RLE, Kalil J, Raslan S, et al. Avaliação nutricional de pacientes com carcinoma espinocelular de cabeça e pescoço. *Rev bras cir cabeça pescoço.* 2009:88-92.
18. Stefani LC, Gutierrez CDS, Castro SMDJ, Zimmer RL, Diehl FP, Meyer LE, Caumo W. Derivation and validation of a preoperative risk model for postoperative mortality (SAMPE model): an approach to care stratification. *PLoS One.* 2017;12(10):e0187122.
19. Grocott MP, Browne J, Van der Meulen J, Matejowsky C, Mutch M, Hamilton M, et al. The Postoperative Morbidity Survey was validated and used to describe morbidity after major surgery. *Journal of clinical epidemiology.* 2007;60(9):919-928.
20. Lohman TG, Roche AF, Martorell R. *Anthropometric standardization reference manual* 1988.
21. Organization WH. *Physical status: The use of and interpretation of anthropometry, Report of a WHO Expert Committee: World Health Organization;* 1995.
22. Lipschitz DA. Screening for nutritional status in the elderly. *Primary Care: Clinics in Office Practice.* 1994;21(1):55-67.
23. Blackburn G, Bistrian B, Maini B, Schlamm H, Smith M. Nutritional and metabolic assessment of the hospitalized patient. 1977.
24. Heymsfield S, McManus C, Smith J, Stevens V, Nixon DW. Anthropometric measurement of muscle mass: revised equations for calculating bone-free arm muscle area. *The American journal of clinical nutrition.* 1982;36(4):680-690.
25. Frisancho AR. New standards of weight and body composition by frame size and height for assessment of nutritional status of adults and the elderly. *The American journal of clinical nutrition.* 1984;40(4):808-819.
26. Lameu EB, Gerude MF, Campos AC, Luiz RR. The thickness of the adductor pollicis muscle reflects the muscle compartment and may be used as a new anthropometric parameter for nutritional assessment. *Current Opinion in Clinical Nutrition & Metabolic Care.* 2004;7(3):293-301.
27. Bragagnolo R, Caporossi FS, Dock-Nascimento DB, Aguilar-Nascimento JED. Espessura do músculo adutor do polegar: um método rápido e confiável na avaliação nutricional de pacientes cirúrgicos. *Revista do Colégio Brasileiro de Cirurgiões.* 2009;36(5):371-376.
28. Kristian YY, Cahyanur R, Wulandari Y, Sinaga W, Lukito W, Prasetyawaty F, Lestari W. Correlation between branched-chain amino acids intake and total lymphocyte count in head and neck cancer patients: a cross-sectional study. *BMC Nutr.* 2023;9(1):86.
29. Aghdaii N, Ferasatkish R, Mohammadzadeh Jouryabi A, Hamidi SH. Significance of preoperative total lymphocyte count as a prognostic criterion in adult cardiac surgery. *Anesth Pain Med.* 2014;4(3):e20331.
30. Leandro-Merhi VA, Bráz VN, Aquino JLBd. Is total lymphocyte count related to nutritional markers in hospitalized older adults? *Arquivos de Gastroenterologia.* 2017;54.

Efecto del consumo de la achira en polvo fortificado con hierro hemínico en el nivel de hemoglobina de niños menores de un año

Effect of consuming achira powder fortified with heme iron on the hemoglobin level of children under one year of age

Rosseli Maritza CORONEL TEJADA¹, Xiomara Natalia CORDOVA TOMAYLLA¹, Luis Pavel PALOMINO QUISPE²

1 Universidad Privada César Vallejo.

2 Universidad Privada del Norte.

Recibido: 21/marzo/2024. Aceptado: 9/junio/2024.

RESUMEN

Introducción: La anemia es una enfermedad caracterizada por la disminución de la concentración del nivel de hemoglobina en sangre. La mayor prevalencia en Perú, se presenta en niños de 6 a 11 meses de edad.

Objetivo: Evaluar el efecto del consumo de la papilla de achira fortificada con hierro hemínico en el valor de hemoglobina de niños de 6 a 11 meses, durante seis semanas de intervención.

Material y métodos: Investigación de enfoque cuantitativo, diseño experimental, de tipo cuasiexperimental. La muestra estuvo conformada por 50 niños con edades de 6 a 11 meses, quienes recibieron atención en el Centro de Salud de Magdalena del Mar; durante el periodo septiembre a noviembre del 2023. La medición del nivel de hemoglobina, se realizó en el laboratorio del centro de salud, antes y después de la intervención. Los niños intervenidos consumieron en forma diaria 10 gramos de achira pulverizada mezclada con hierro hemínico obtenido de la sangre bovina atomizada, con un aporte de hierro 11,2 mg/día, durante seis semanas de intervención. Los valores de nivel hemoglobina antes y después fueron trasladados a una ficha de recolección de datos. Para comparar, se utilizó la prueba no paramétrica de Wilcoxon.

Resultados: Antes de la intervención, el 58% presentó anemia leve y el 42% diagnóstico normal. El promedio del valor de hemoglobina fue 11,38 + 0,93 g/dL. Al término de la intervención el 8% presentó anemia leve y el 92% normal. Asimismo, el promedio del valor de hemoglobina fue 11,79 + 0,7 g/dL. Al comparar el valor de hemoglobina antes y después, se obtuvo un valor $p < 0,05$.

Conclusión: Los resultados indican que el consumo de papilla de Achira con hierro hemínico tiene efecto en el aumento del nivel de hemoglobina en niños de 6 a 11 meses, durante seis semanas de intervención.

PALABRAS CLAVES

Sangre bovina, atomización, anemia ferropénica, complemento alimentario.

LISTA DE ABREVIATURAS

DS: Desviación estándar.

DC: Desnutrición crónica.

DCI: Desnutrición crónica infantil.

SPSS: Paquete Estadístico para las Ciencias Sociales.

ABSTRACT

Introduction: Anemia is a disease characterized by a decrease in the concentration of hemoglobin in the blood. The highest prevalence in Peru occurs in children from 6 to 11 months of age.

Correspondencia:

Rosseli Maritza Coronel Tejada
coroneltejadamari@gmail.com

Objective: To evaluate the effect of consuming achira porridge fortified with heme iron on the hemoglobin value of children aged 6 to 11 months, during six weeks of intervention.

Material and methods: Research with a quantitative approach, experimental design, quasi-experimental type. The sample was made up of 50 children aged 6 to 11 months, who received care at the Magdalena del Mar Health Center; during the period September to November 2023. The measurement of the hemoglobin level was carried out in the health center laboratory, before and after the intervention. The intervened children consumed 10 grams of powdered achira mixed with heme iron obtained from atomized bovine blood daily, with an iron intake of 11.2 mg/day, for six weeks of intervention. The hemoglobin level values before and after were transferred to a data collection form. For comparison, the non-parametric Wilcoxon test was used.

Results: Before the intervention, 58% had mild anemia and 42% had a normal diagnosis. The average hemoglobin value was 11.38 ± 0.93 g/dL. At the end of the intervention, 8% presented mild anemia and 92% normal. Likewise, the average hemoglobin value was 11.79 ± 0.7 g/dL. When comparing the hemoglobin value before and after, a p value < 0.05 was obtained.

Conclusion: The results indicate that the consumption of Achira porridge with heme iron has an effect on increasing the hemoglobin level in children from 6 to 11 months, during six weeks of intervention.

KEYWORDS

Bovine blood, atomization, iron deficiency anemia, food supplement.

INTRODUCCIÓN

La anemia representa un desafío significativo para la sociedad, el grupo etario con mayor riesgo y prevalencia de anemia, son los niños menores de un año¹. Siendo su causa principal la deficiencia de hierro en la dieta². A nivel mundial, alrededor de 269 millones de niños, cuyas edades oscilan entre los 6 y 59 meses, sufren de anemia^{1,3}. Este problema no solo afecta la salud física, sino que también se ha observado que 2 de cada 5 niños experimentan un retraso en su desarrollo cognitivo y psicomotor^{4,5}.

En Latinoamérica, aproximadamente 22,5 millones de niños sufren de anemia por deficiencia de hierro². En el Perú, la anemia ha sido una condición recurrente en los niños a lo largo del tiempo, y en la actualidad, con un porcentaje alarmante del 42,4% de niños de 6 a 35 meses⁴. El gobierno peruano busca reducir esta prevalencia al 19%, consignado en el Plan Nacional de Reducción de la Anemia, reconociendo el impacto negativo de la deficiencia de hemoglobina en niños menores de 36 meses⁵. En el distrito de Magdalena del Mar el 66,6% de niños de entre 6 y 11 meses tienen anemia⁶.

A pesar de los esfuerzos por implementar programas de asistencia alimentaria que proporcionan suplementos nutricionales y se realizó fortificación casera con micronutrientes (Sprinkles), el comportamiento epidemiológico de la anemia, ha experimentado impactos adversos⁷⁻⁹. Por tal motivo se requieren estrategias innovadoras, efectivas y sostenibles; nosotros proponemos la fortificación de alimentos con hierro hemínico, hemos seleccionado una papilla de achira (planta milenaria) que fue consumida por Caral, la civilización más antigua de América, el cual fue fortificado con hierro hemínico.

La investigación tiene como objetivo evaluar el efecto del consumo de la papilla de achira fortificada con hierro hemínico en el valor de hemoglobina en niños de 6 a 11 meses, durante 6 semanas de consumo.

MATERIAL Y MÉTODOS

Investigación de enfoque cuantitativo, diseño experimental, de nivel cuasi-experimental. La muestra estuvo conformada por 50 niños de 6 a 11 meses de edad atendidos en el Centro de Salud Materno Infantil Magdalena del Mar ubicado en Lima Metropolitana en Perú. La intervención se realizó durante el periodo agosto-setiembre del 2023. El grupo experimental estuvo conformado por 21 niños con diagnóstico de anemia leve o moderada y el grupo control conformado por 29 niños quienes presentaban un nivel de hemoglobina normal para su edad. Los criterios de inclusión fueron, niños de 6 a 11 meses, atendidos en el Centro de Salud de Magdalena del Mar, cuyos padres hayan firmado el consentimiento informado y que contaron con la autorización y registro de valor de hemoglobina en la historia clínica. Se excluyó a niños que fueron diagnosticados con anemia severa, con patologías y/o alergias alimentarias o cuyos padres decidieron no cumplir con el esquema de suplementación propuesto por el Ministerio de Salud del Perú.

El diagnóstico de anemia se realizó siguiendo los criterios establecidos en la Guía que establece los límites de hemoglobina para definir la anemia en individuos y poblaciones, publicado por la OMS el 2024; donde se establece los valores de corte de dicha concentración para definir la anemia y su gravedad a escala poblacional, así como, la cronología de dichos valores. En niños con rango de edad de 6 a 12 meses, se consideró como normal un valor de hemoglobina mayor a 10,5 g/dL; anemia leve (9,5 – 10,49 g/dL); anemia moderada (7,0 – 9,49 g/dL)¹³. Para evaluar el nivel de hemoglobina, se solicitó un análisis a través del servicio de nutrición al Centro de Salud Materno Infantil Magdalena. Posteriormente, se coordinó la toma de muestras con el laboratorio y se analizaron para determinar los niveles de hemoglobina, antes y después de la intervención. Los resultados se adjuntaron a las historias clínicas de los niños del centro de salud para su revisión y seguimiento.

El estudio antropométrico se realizó siguiendo los protocolos estandarizados por el Ministerio de Salud del Perú y para el cálculo de los puntajes Z y curvas de crecimientos a nivel global y por sexo, se utilizó el WHO Anthro V 3.2.2 para los estándares de la OMS (2006)¹⁴. El peso corporal (kg) se midió con una balanza digital de la marca (Soehnle), con una precisión de 100 gramos. La longitud de los niños se midió en centímetros (cm), utilizando un infantómetro de madera con una precisión de 1 milímetro. El estado nutricional de los niños se evaluó a través de los índices antropométricos de P/E, T/E, P/T e IMC, utilizando los estándares de la OMS (2006)¹⁵. Los índices antropométricos se transformaron a puntajes Z. Se clasificó con bajo peso, baja talla y emaciación (peso bajo para la talla) a los niños cuyo puntaje Z fue menor a -2 DE, longitud o talla para edad y peso para longitud o talla, respectivamente. Con el índice P/T $>+2DE$ se consideró como sobrepeso y $>+3DE$ como obesidad; asimismo los valores entre 2DE a -2DE se consideró con diagnóstico nutricional normal.

Para recopilar los datos sobre el consumo de la papilla, se utilizó una ficha específica que permitía registrar el seguimiento de consumo, a través de las visitas domiciliarias, llamadas telefónicas y fotografías a través de Whatssap, a fin de verificar el consumo diario. Este proceso de verificación se extendió a lo largo de seis semanas. Todos estos registros se consolidaron en una base de datos en Excel. Se realizó la entrega de frascos junto con una cucharita medidora de 5 gramos que contenía el complemento alimentario de papilla de achira fortificado con hierro hemínico. La dosificación de la papilla se realizó administrando una cucharadita de 5 gramos en el desayuno y otra en el almuerzo. El proceso de preparación incluyó la adición de una o más frutas disponibles y preferidas, seguido de su pelado, desinfección mediante breve cocción, y al hervir, se agregaba la dosis de la papilla en polvo antes de apagar el fuego. Posteriormente, se servía y enfriaba a temperatura tibia, proporcionando la cantidad adecuada al niño o niña.

Se realizó el análisis del valor nutricional del complemento alimentario de papilla de Achira fortificada con hierro hemínico, se enviaron muestras al laboratorio certificado y acreditado de la Universidad Nacional Agraria de la Molina de Perú. El cual reportó los siguientes resultados expresados en 100 gramos de producto: Energía: 349 kcal. Proteína: 63,4 g. Carbohidratos: 23,4 g. Grasa: 0,2 g. y Hierro: 111,6 mg. En una porción de 5 gramos de consumo diario el aporte nutricional fue de: 17,5 kcal; 3,17 g de proteína; 1,2 g de carbohidratos y 5,58 mg de Hierro. Cumpliendo los requisitos de un complemento alimentario nutricional, al ser una fuente concentrada mineral (hierro) otros macronutrientes que se añaden o suma en la alimentación ingerida para completar requerimientos de la población priorizada o vulnerable y conseguir un efecto nutricional o fisiológico deseado, que es normalizar el nivel de hemoglobina en los niños¹⁶.

La investigación fue aprobada por el comité de ética de la Facultad de Ciencias de la Salud de la Universidad César Vallejo bajo el código de estudio PI-CEI-NUT-EST.2023-010, asimismo con la aprobación del Centro Materno Infantil Magdalena del Mar, se respetó los principios éticos y las directrices establecidas por instituciones internacionales pertinentes en el ámbito de la investigación, se consiguió la aprobación informada de los participantes que formaron parte de esta investigación, quienes participaron de manera voluntaria. Además, se garantizó el resguardo de la confidencialidad de los datos al mantener el anonimato mediante la asignación de códigos.

Análisis estadístico

Toda la información recopilada fue almacenada en una base de datos y fueron registrados en una hoja de cálculo utilizando la herramienta de Excel. Posteriormente, se trasladó al programa estadístico SPSS versión 26.0, donde se realizó un análisis estadístico descriptivo, en las variables cualitativas se utilizó frecuencia absoluta y relativa; en las variables cuantitativas se utilizó la media y desviación estándar. Para realizar la contrastación de hipótesis, se utilizó la prueba estadística inferencial no paramétrica, prueba de Wilcoxon a fin de comparar el nivel de hemoglobina antes y después de la intervención. Asimismo, para comparar la variación del nivel de hemoglobina entre el grupo experimental y el grupo control se utilizó el estadístico de prueba no paramétrico U de Mann-Whitney. Los datos presentaron una distribución asimétrica.

RESULTADOS

En la investigación participaron 50 niños de 6 a 11 meses, el 56% del género masculino y el 44% femenino. Asimismo, el mayor número de participantes se presentó en el grupo etario de 6 a 8 meses de edad, que representó el 76% (tabla 1).

Al realizar un análisis de las características antropométricas y realizar el diagnóstico nutricional según el indicador peso/talla, se determinó que el 80% presentó un diagnóstico

Tabla 1. Características descriptivas de la muestra en niños de 6 a 11 meses (n=50)

	Frecuencia	Porcentaje (%)
Sexo		
Masculino	28	56
Femenino	22	44
Grupo edad		
6 – 8 meses	38	76
9 – 11 meses	12	24

normal, el 12% presentó sobrepeso y el 8% obesidad. Al analizar el indicador talla/edad el 10% presentó desnutrición crónica infantil (DCI) y el 4% presentó riesgo de DCI. Asimismo, no se encontró diferencias significativas al comparar los indicadores antropométricos entre el grupo control y el grupo experimental (tabla 2).

Tabla 2. Características antropométricas de la muestra en niños de 6 a 11 meses antes de la intervención nutricional entre el grupo experimental y control

Indicador	Frecuencia	Porcentaje (%)	Valor P (*)
Peso / Edad			
Desnutrición	1	2	>0,05
Normal	43	86	
Sobrepeso	6	12	
Talla / Edad			
Alta	5	10	>0,05
riesgo	2	4	
DCI	5	10	
Normal	38	76	
Peso / Talla			
Normal	40	80	>0,05
Obesidad	4	8	
Sobrepeso	6	12	

(*) Estadístico de prueba de Wilcoxon.

Antes de la intervención el promedio del valor de hemoglobina fue de 11,38 g/dL, después de la intervención el promedio fue de 11,79 g/dL. Asimismo, la variación del valor de hemoglobina fue de 0,94 g/dL. Al comparar a través de la prueba no paramétrica, estadístico de Wilcoxon, se obtuvo un $p=0,001$ ($p<0,05$), encontrándose diferencias significativas (tabla 3).

Tabla 3. Promedio del nivel de Hemoglobina antes y después de la intervención en el grupo experimental

Nivel de Hemoglobina	Media	DS	Min	Max	p
Antes de la Intervención	10,49	,26	10,1	10,49	0,001 (*)
Después de la Intervención	11,43	,55	10,45	13,1	
Variación del nivel de Hemoglobina	0,94	0,43	0,10	2,5	

(*) Estadístico de prueba de Wilcoxon.

Al término de la intervención, el grupo experimental aumento el valor de hemoglobina en 0,94 g/dL y en el grupo control fue de 0,06 g/dL. Los datos presentaron una distribución asimétrica, para comparar, se utilizó la prueba estadística no paramétrica U de Mann-Whitney, se obtuvo un valor $p=0,0001$ ($p<0,05$); encontrándose diferencias significativas (figura 1).

DISCUSIÓN

El estudio realizado tuvo como propósito evaluar el efecto del consumo de la papilla de Achira fortificada con hierro hemínico en niños de 6 a 11 meses, durante 6 semanas de intervención el cual mostró un aumento significativo en el nivel de hemoglobina de 0,42 g/dL al final del periodo de intervención. Estos resultados coinciden con investigaciones previas, como la realizada por Palomino L, quien sugiere la eficacia de suplementos como Nutrihem en el tratamiento de la anemia, demostrando un aumento de 1,52 g/dL en hemoglobina en niños peruanos⁵. Además, otro estudio llevado a cabo por Arcaya M, utilizando galletas fortificadas con sangre bovina, el cual reportó un incremento significativo en los niveles de hemoglobina en niños anémicos, con un aumento de 0,8 g/dL en el grupo que consumió estas galletas, en comparación con un incremento de 0,4 g/dL en el grupo control¹¹. Estos hallazgos respaldan la noción de que la fortificación de alimentos con hierro hemínico de la sangre de bovina puede representar una estrategia efectiva para reducir la prevalencia de la anemia en niños en Perú.

El estudio de Puranitee y colaboradores identificó que, de 145 bebés de 9 meses, 99 presentaban anemia (68.3%) debido a una ingesta insuficiente de hierro, lo que condujo a problemas de salud como anemia y desnutrición infantil. Estos problemas estuvieron vinculados con bajo peso para la edad, baja estatura y afectaciones en el crecimiento y desarrollo físico más lento². Una muestra experimental de 50 niños y niñas mostró parámetros antropométricos similares antes de la intervención. Sin embargo, el consumo de papilla fortificada con hierro hemínico mostró una distribución más favorable de los valores de hemoglobina en el grupo de niños evaluados entre 6 y 11 meses, lo que sugiere una respuesta positiva a esta intervención en la mejora de la salud de los niños en esa franja de edad¹².

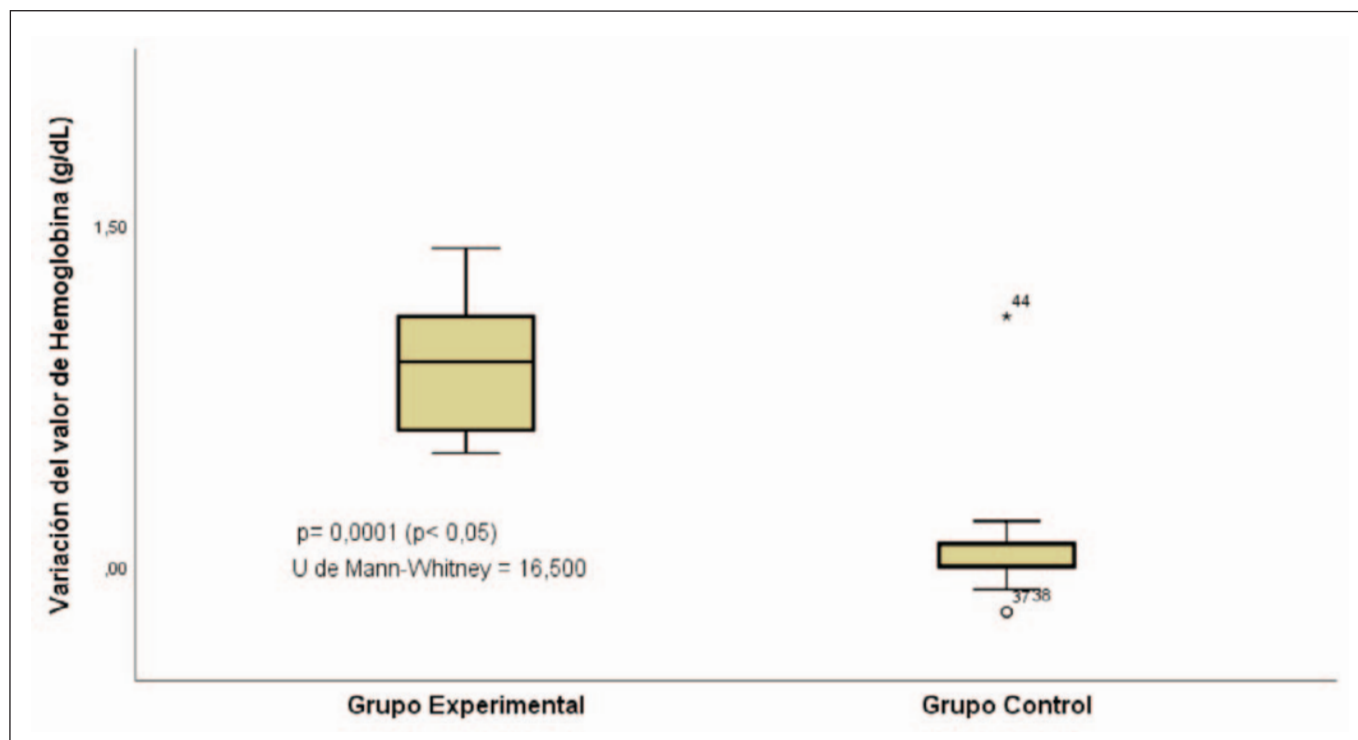


Figura 1. Variación del valor de hemoglobina en el grupo experimental y grupo control

Los resultados de la intervención demuestran que antes de la intervención el 58% de niños de 6 a 11 meses presentó anemia leve y el 42% diagnóstico normal. El promedio del valor de hemoglobina fue $11,38 \pm 0,93$ g/dL. Al término de la intervención el 8% presentó anemia leve y el 92% con diagnóstico normal, asimismo, el promedio del valor de hemoglobina fue $11,79 \pm 0,7$ g/dL. Estos resultados indican una notable mejora en la prevalencia de anemia y un aumento en el promedio de hemoglobina después de la intervención.

La investigación identificó limitaciones como el periodo corto de intervención que impidió un análisis exhaustivo del impacto a largo plazo de la intervención. La falta de estudios previos sobre la achira, un producto nutricional poco conocido en el país y con disponibilidad estacional limitada en Perú, representó un desafío adicional. No se logró evaluar la reserva de hierro a través del valor de ferritina, por el alto costo de la prueba.

CONCLUSIÓN

Los resultados indican que el consumo de papilla de achira fortificado con hierro hemínico tiene efecto en el aumento del nivel de hemoglobina en niños de 6 a 11 meses, durante seis semanas de intervención.

AGRADECIMIENTOS

Agradecemos a la Universidad César Vallejo y al Centro de Salud Materno Infantil de Magdalena del Mar en Lima - Perú.

REFERENCIAS BIBLIOGRAFICAS

1. Equipo Técnico de la World Health Organization (WHO). Las nuevas orientaciones de la OMS ayudan a detectar la carencia de hierro y a proteger el desarrollo cerebral. World Health Organization; 20 de abril 2020. Disponible en: <https://www.who.int/es/news/item/20-04-2020-who-guidance-helps-detect-iron-deficiency-and-protect-brain-development>
2. Puranitee P, Fuangfu S, Dumrongwongsiri O. Determination of Hemoglobin Level Among 9-Month-Old Infants Visiting Well Child Clinic. *Glob Pediatr Health*. 2021; 8(1). doi: <https://doi.org/10.1177/2333794X211036629>
3. Li H, Xiao J, *et al*. Anemia prevalence, severity and associated factors among children aged 6–71 months in rural. *BMC Public Health*. 2020;20(1): 989-1002. doi: <https://doi.org/10.1186/s12889-020-09129-y>
4. Moyano E, Méndez C, Robles P. Factores sociodemográficos y nutricionales asociados a anemia en niños de 1 a 5 años en Perú. 2023; 47(6), 925-932. doi: <https://doi.org/10.4067/s0717-7518202000600925>.
5. Palomino L, Palomino F. Eficacia comparada de suplemento y complemento alimentario en el tratamiento de la anemia ferropénica en niños peruanos. *Nutr Clín Diet Hosp*. 2024; 44(1):55-65. doi: <https://doi.org/10.12873/441palomino>
6. Balazar J, Fernández A, *et al*. Análisis De Situación De Salud Del Distrito De Magdalena Del Mar; noviembre 2019. Disponible en: https://www.dge.gob.pe/portal/docs/asis-lima-2019/CD_MINSA/DOCUMENTOS_ASIS/ASIS_DISTRITO%20MAGDALENA%202019.pdf

7. Mamani R, Gonzales C, *et al.* Factors associated with hemoglobin levels in children under 6 months of age hospitalized in a pediatric center in Peru. *Rev Fac Medicina Humana.* 2023; 23(1), 33-43. doi: <https://doi.org/10.25176/rfmh.v23i1.5059>
8. Céspedes A. Factores asociados a la anemia infantil. Caso: Ex Micro Red de Salud San Bartolo. *Rev. Arbitr. Interdiscip. Cienc. Salud.* 2022; 6 (11): 12-20. doi: <https://doi.org/10.35381/s.v.v6i11.1583>
9. López E, Atamari N, *et al.* Prácticas de alimentación complementaria, características sociodemográficas y su asociación con anemia en niños peruanos de 6 - 12 meses. *Rev. Habanera de Cienc. Med.* 2019; 5 (18): 1-16. Disponible en: <https://revhabanera.sld.cu/index.php/rhab/article/view/2602>
10. Lizarraga A. Efecto de una barra nutricional enriquecida con hierro hemínico en niveles de hemoglobina en niños de 4–10 años. *Rev Innovación Transf. Product.* 2022; 2(2): 1-16. doi: <https://doi.org/10.54353/ritp.v2i2.e001>.
11. Arcaya M, García F, *et al.* Efecto de la ingesta de galletas fortificadas con sangre bovina en hemoglobina de niños anémicos. *Rev. Cub. Enfermería.* 2020;36(3):1-11. doi:<http://orcid.org/0000-0003-0961-1193>
12. Puma L, Palomino L, Gomez Y. Tiempo de inicio de la alimentación complementaria y nivel de hemoglobina en niños menores de siete meses. *Nutr Clín Diet Hosp.* 2023;43(1):121-126. doi: <https://doi.org/10.12873/431puma>
13. Organización Mundial de la Salud. Directrices sobre los límites de hemoglobina para definir la anemia en individuos y poblaciones. Ginebra, 2024.
14. MINSA. Guía Técnica para la Valoración Nutricional Antropométrica de la Niña y el Niño de 0 a 11 Años aprobado por Resolución Ministerial N.º 034-2024-MINSA, 2024. Disponible en: <https://www.gob.pe/institucion/minsa/normas-legales/5059776-034-2024-minsa>
15. World Health Organization. Multicentre Growth Reference Study Group. WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva: World Health Organization. 2006, pag. 312.
16. MINSA. Plan multisectorial para la prevención y reducción de la anemia materno infantil en el Perú, periodo 2024-2030. Disponible en: <https://www.gob.pe/institucion/minsa/normas-legales/5093832-002-2024-sa>.

Correlação entre adiponectina e fatores relacionados ao risco de doença cardiovascular em idosos

Correlation between adiponectin and factors related to the risk of cardiovascular disease in the elderly

Ana Carolina CAVALCANTE VIANA¹, Macileide da Silva BANDEIRA¹, Ana Patricia NOGUEIRA AGUIAR², Marcela MATOS MAGALHÃES DE AZEVEDO¹, Gustavo André BANDEIRA DO RÉGO BARROS¹, Lília Teixeira EUFRÁSIO LEITE¹, Anarah Suellen QUEIROZ CONSERVA VITORIANO¹, Thaise dos Santos ANDRADE¹, Moema de Souza SANTANA¹, Synara Cavalcante LOPES BRAGA¹, Priscila Taumaturgo HOLANDA MELO¹, Nathália BERNARDO MARINHO¹, Helen PINHEIRO¹, Sílvia Maria MEIRA MAGALHÃES³, Priscila da Silva MENDONÇA⁴

¹ Empresa Brasileira de Serviços Hospitalares (EBSERH) - Hospital Universitário Walter Cantídio (HUWC/UFC/EBSERH).

² Programa de pós graduação em Ciências Médicas/ UFC.

³ Programa de pós graduação em Ciências Médicas/ UFC Departamento de Medicina Clínica/ UFC.

⁴ Programa de pós graduação em Ciências Médicas/ UFC, Hospital Walter Cantídio/UFC/EBSERH Empresa Brasileira de Serviços Hospitalares, Instituto Doutor José Frota.

Recibido: 9/mayo/2024. Aceptado: 11/junio/2024.

RESUMO

Introdução: O tecido adiposo produz inúmeras substâncias endócrinas que atuam na regulação de funções fisiológicas diversas. Dentre essas substâncias, destaca-se a adiponectina, que entre outras funções, pode conferir proteção contra Doenças Cardiovasculares, através dos seus efeitos anti-aterosclerótico e anti-hipertensivo.

Objetivo: avaliar o perfil de ADPN em idosos e sua correlação com fatores relacionados ao risco de DCV em idosos.

Método: Estudo transversal, observacional, quantitativo, realizado em um hospital universitário localizado no nordeste brasileiro. A amostra foi composta por 76 pacientes idosos, com idade igual ou superior a 60 anos, de ambos os sexos. Foram coletados dados demográficos (sexo, idade), estilo de vida (atividade física, tabagismo), variáveis antropométricas (peso, altura), circunferências (cintura, quadril, pescoço); de avaliação laboratorial (hemograma, níveis séricos de triacilgli-

cerol, de HDL-colesterol, de LDL-colesterol, colesterol total, PCR, glicemia, adiponectina).

Resultados: Dos 76 pacientes avaliados, 31,58% eram do sexo masculino, com média de idade de 71,21 anos. Da população estudada, 36 idosos coletaram a amostra de adiponectina sérica. Os pacientes que apresentaram índice de adiposidade elevado apresentaram média de adiponectina de 7,56 mcg/dl ($p=0,041$), os que receberam diagnóstico nutricional de excesso de peso obtiveram média de adiponectina de 6,80mcg/dl ($p=0,001$). Aqueles que apresentaram circunferência da cintura elevado apresentaram média de adiponectina de 8,05 mcg/dl ($p=0,01$) e os que obtiveram a medida da circunferência do pescoço elevada apresentaram média de adiponectina de 7,69 mcg/dl ($p= 0,038$).

Discussão: Observou-se que houve prevalência de excesso de peso na população estudada (56,58%) e correlação negativa com o nível de adiponectina ($r= -0,595$ $p < 0,001$). Também foi evidenciado correlação significativamente negativa entre o percentual de gordura corporal ($p = 0,004$) e adiponectina.

Conclusão: A adiponectina apresentou correlação significativa com parâmetros antropométricos relacionados à doença cardiovascular e composição corporal.

Correspondencia:

Ana Carolina Cavalcante Viana
ana.cavalcante@ebserh.gov.br

PALAVRAS-CHAVE

Adiponectina; Doenças Cardiovasculares; Tecido Adiposo.

ABSTRACT

Introduction: Adipose tissue produces numerous endocrine substances that regulate various physiological functions. Among these substances, adiponectin stands out, which, among other functions, can provide protection against Cardiovascular Diseases, through its antiatherosclerotic and antihypertensive effects.

Objective: to evaluate the ADPN profile in the elderly and its correlation with factors related to the risk of CVD in the elderly.

Method: Cross-sectional, observational, quantitative study, carried out in a university hospital located in northeastern Brazil. The sample consisted of 76 elderly people, aged 60 years or over, of both sexes. Demographic data (sex, age), lifestyle (physical activity, smoking), anthropometric variables (weight, height), circumferences (waist, hips, neck) were collected; laboratory evaluation (blood count, serum levels of triacylglycerol, HDL-cholesterol, LDL-cholesterol, total cholesterol, CRP, blood glucose, adiponectin).

Results: Of the 76 patients evaluated, 31.58% were male, with a mean age of 71.21 years. Of the studied population, 36 elderly people collected a serum adiponectin sample. Patients who had a high adiposity index had an average adiponectin of 7.56 mcg/dl ($p=0.041$), those who received a nutritional diagnosis of being overweight had an average adiponectin of 6.80 mcg/dl ($p=0.001$). Those who had a high waist circumference had an average adiponectin of 8.05 mcg/dl ($p=0.01$) and those who had a high neck circumference had an average adiponectin of 7.69 mcg/dl ($p=0.038$).

Discussion: It was observed that there was a prevalence of excess weight in the studied population (56.58%) and a negative correlation with the level of adiponectin ($r = -0.595$, $p < 0.001$). A significantly negative correlation was also evidenced between the percentage of body fat ($p = 0.004$) and adiponectin.

Conclusion: Adiponectin showed a significant correlation with anthropometric parameters related to cardiovascular diseases and body composition.

KEYWORDS

Adiponectin; Cardiovascular diseases; Adipose Tissue.

INTRODUÇÃO

O tecido adiposo, classificado como órgão endócrino recentemente, secreta inúmeras substâncias endócrinas que atuam na regulação de funções fisiológicas diversas. Dentre essas substâncias, destaca-se a adiponectina (ADPN), citocina se-

cretada em maior quantidade no plasma, principalmente pelo tecido adiposo branco¹.

A ADPN exerce inúmeros efeitos no organismo: possui efeito protetor sobre neurônios e células-tronco neurais², é anti-inflamatório, antidiabético, antiapoptótico e antiaterogênico³.

A ADPN pode conferir proteção contra DCV, através da participação na regulação do metabolismo lipídico e glicídico, promovendo efeito protetor as células endoteliais vasculares, impedindo a formação de células espumosas e a proliferação de células musculares lisas vasculares⁴, reduz o estresse oxidativo e da inflamação. Essas ações demonstram o seu efeito antiaterosclerótico e anti-hipertensivo⁵.

Muitos estudos têm destacado a potencial utilização da ADPN como biomarcador para o diagnóstico e tratamento de DCV⁶. Existem outros que, inclusive, sugerem a utilização para prever insuficiência cardíaca⁵.

Diante das funções e evidências quanto a ADPN e sua associação a DCV, foi proposto estudo para avaliar o perfil de ADPN em idosos e sua correlação com fatores relacionados ao risco de DCV em idosos.

METODOLOGIA

Estudo transversal, observacional, quantitativo, realizado no ambulatório de geriatria de um hospital universitário localizado no nordeste brasileiro. O período da pesquisa ocorreu no ano de 2019 e 2020. O projeto foi aprovado pelo Comitê de Ética em Pesquisa do Hospital Universitário Walter Cantídio (HUWC), sob número de parecer 3.428.312.

A amostra foi composta por 76 pacientes idosos, acompanhados pelo ambulatório, com idade igual ou superior a 60 anos, de ambos os sexos, após consentimento e assinatura de TCLE (Termo de Consentimento Livre e Esclarecido).

Foram coletados dados demográficos (sexo, idade), estilo de vida (atividade física, tabagismo), variáveis antropométricas (peso, altura), circunferências (cintura, quadril, pescoço); de avaliação laboratorial (hemograma, níveis séricos de triacilglicerol, de HDL-colesterol, de LDL-colesterol, colesterol total, PCR, glicemia, adiponectina). Realizados por análise de prontuários, exames laboratoriais, entrevistas e aferições por equipe bem treinada.

Os dados de peso (kg) e altura (m), foram utilizados para cálculo do Índice de Massa Corporal (IMC), a classificação foi feita de acordo com Lipschitz (1994)⁷, referência utilizada pelo Ministério da Saúde. A circunferência da cintura (CC) e quadril foram utilizados para calcular o indicador relação cintura/quadril (RCQ), o qual está relacionado a riscos de doenças cardiovasculares (DCV), com ponto de corte 0,85m para mulheres e 1,0 m para homens, de acordo com a classificação World Health Organization⁸. A circunferência do pescoço (CP) correlacionada a riscos de DCV⁹, parâmetro de adiposi-

dade¹⁰ e síndrome metabólica¹¹, foi utilizado o ponto de corte de 34 cm para mulheres e 36cm para homens. Os parâmetros para avaliação de triacilglicerol, HDL-colesterol, LDL-colesterol, colesterol total, PCR, glicemia foram da diretriz brasileira de dislipidemias e prevenção da aterosclerose¹².

Para mensuração sérica da adiponectina total, utilizou-se o kit comercial imunoenzimático ELISA de captura, da marca Invitrogen®, conforme protocolo do fabricante.

As análises estatísticas foram realizadas utilizando o software Statistical Product and Service Solutions - SPSS® (versão 20.0). As variáveis contínuas foram testadas quanto à distribuição de normalidade, usando o teste de Kolmogorov-Smirnov. A comparação das médias ocorreu através dos testes t de Student ou ANOVA. Os valores observados para as variáveis contínuas foram submetidos à análise de correlação, sendo os resultados expressos como o coeficiente de correlação de Pearson (r) e o nível de significância foi fixado em $p < 0,05$.

RESULTADOS

Participaram do estudo 76 idosos, nos quais 31,58% eram do sexo masculino, com média de idade de 71,21 anos ($\pm 7,64$ anos).

Conforme o diagnóstico nutricional de acordo com IMC, cuja a média foi de 27,80 kg/m² ($\pm 4,48$ Kg/m²), 56,6% apresentaram-se com excesso de peso e 38,16% obteve diagnóstico nutricional de eutrofia. Outro parâmetro estudado foi a circunferência da cintura, no qual 85,53% exibiram risco elevado para DCV.

Dos participantes, 36 idosos coletaram a amostra de adiponectina sérica. A média de adiponectina foi de 8,94 mcg/dL ($\pm 5,09$), para o sexo masculino e 8,88 ($\pm 3,73$) para o sexo feminino (tabela 1).

Conforme a tabela 1, os pacientes que apresentaram índice de adiposidade elevado apresentaram média de adiponectina de 7,56 mcg/dl ($\pm 3,88$, $p=0,041$), os que receberam diagnóstico nutricional de excesso de peso obtiveram média de adiponectina de 6,80mcg/dl ($\pm 3,75$, $p=0,001$). Aqueles que apresentaram circunferência da cintura elevado apresentaram média de adiponectina de 8,05 mcg/dl ($\pm 3,63$, $p=0,01$) e os que obtiveram a medida da circunferência do pescoço elevada apresentaram média de adiponectina de 7,69 mcg/dl ($\pm 4,02$, $p= 0,038$).

Houve correlação significativamente negativa entre os níveis séricos de adiponectina dos idosos e os valores de IMC ($r= -0,595$, $p < 0,001$), de circunferência da cintura ($r= -0,552$, $p < 0,001$) e percentual de gordura corporal ($r= -0,516$, $p = 0,004$).

Não foi observado correlação significante entre os níveis de adiponectina e as variáveis idade, índice de adiposidade visceral ($r = 0,040$, $p = 0,874$), Relação cintura quadril ($r= -0,255$, $p= 0,134$), circunferência do pescoço($r = -0,125$, $p = 0,469$),

colesterol total ($r= -0,039$, $p= 0,877$), LDL colesterol ($r= -0,039$, $p= 0,877$), HDL ($r= -0,133$, $p= 0,599$), triglicérides ($r= -0,92$, $p= 0,455$) e glicemia ($r= -0,350$, $p= 0,150$) ($p > 0,05$) (tabela 2).

DISCUSSÃO

No presente estudo observou-se que houve prevalência de excesso de peso na população estudada (56,58%) e correlação negativa com o nível de adiponectina ($r= -0,595$, $p < 0,001$). Em outro estudo, níveis mais baixos de adiponectina foi encontrado em idosos com diagnóstico de Síndrome Metabólica e nos subgrupos com doença vascular, aterosclerose e diabetes mellitus tipo 2 em comparação com pacientes sem essa síndrome¹³.

A presença simultânea de níveis elevados de leptina e baixos níveis de adiponectina parece ter um efeito sinérgico no desenvolvimento de danos vasculares subclínicos, aumentando o risco em 36 vezes¹⁴.

Os benefícios do nível sérico adequado de adiponectina está no efeito protetor nas células β , na redução das citocinas inflamatórias e estresse oxidativo, favorecendo à melhora da resistência à insulina. Além disso, relaciona-se à redução da gliconeogênese e da glicogenólise hepática e aumentam a utilização de glicose e ácidos graxos pelos músculos esqueléticos, resultando em níveis mais baixos de glicose¹⁵.

Esse estudo apresentou correlação negativa entre adiponectina e circunferência da cintura ($r= -0,552$, $p < 0,001$), havendo prevalência de risco aumentado para DCV conforme esse parâmetro (85,53%). Assim como o percentual de gordura corporal também apresentou correlação negativa nesse público ($r= -0,516$, $p = 0,004$).

A literatura afirma que a circunferência da cintura pode ser usada como fator para risco cardiovascular, além de possuir a vantagem de ser uma aferição de baixo custo, não invasiva e de fácil aplicação na prática clínica¹⁶. Além disso, o infarto do miocárdio apresenta relação positiva com a CC, sugerindo que essa circunferência é um indicador antropométrico mais apropriado para prever o risco dessa doença na população idosa⁵.

Em um estudo coreano, no qual avaliou a adiponectina, circunferência da cintura e IMC de 125 indivíduos, mostrou que o aumento da gordura visceral em pessoas com sobrepeso e obesidade está associado à diminuição dos níveis totais de adiponectina sérica⁶. Corroborando com o presente estudo, no qual foi visto correlação significativamente negativa entre o percentual de gordura corporal ($r= -0,516$, $p = 0,004$) e adiponectina.

Constatou-se nesse estudo que os níveis de adiponectina não apresentaram correlação significante com a glicemia. Entretanto, um estudo transversal com 5.673 indivíduos idosos indicou que níveis elevados de adiponectina e resistência à insulina podem estar associados ao envelhecimento ou ao baixo estado nutricional (MURATSU et al, 2021).

Tabela 1. Comparação dos valores de adiponectina, de acordo com variáveis clínicas, antropométricas e bioquímicas dos idosos, Fortaleza, Ceará, Brasil

Características		Adiponectina (mcg/dL)		p valor	Post-test
		Média	DP(±)		
Sexo	Masculino	8,94	5,09	0,969	
	Feminino	8,88	3,73		
Índice de adiposidade visceral	Elevado	7,56	3,88	0,041	
	Adequado	12,81	2,55		
Índice de massa corporal	Excesso peso	6,80	3,75	0,001	Eutrofia x Excesso de peso (p= 0,002) Eutrofia x Baixo peso (p= 0,005)
	Peso adequadoBaixo peso	11,683,53	3,632,53		
Circunferência da Cintura	Adequado	14,19	3,92	0,01	
	Elevado	8,05	3,63		
Relação Cintura Quadril	Adequado	10,11	5,6	0,291	
	Alto risco	8,44	3,5		
Circunferência do Pescoço	Adequado	10,61	3,96	0,038	
	Elevado	7,69	4,02		
Percentual Gordura Corporal	Adequado	11,82	5,48	0,290	
	Elevado	8,57	4,05		
Colesterol total	Adequado	8,36	4,30	0,950	
	Elevado	8,49	4,26		
LDL colesterol	Adequado	7,61	3,92	0,310	
	Elevado	9,71	4,48		
HDL	Adequado	7,10	4,05	0,087	
	Inadequado	10,53	3,62		
Triglicerídeos	Adequado	8,55	4,88	0,883	
	Inadequado	8,24	3,00		
Glicemia	Adequado	9,52	4,22	0,168	
	Inadequado	6,72	3,68		

Fonte: dados da pesquisa (2020).

Tabela 2. Correlação Adiponectina e variáveis clínicas e nutricionais dos pacientes idosos

Variáveis	Adiponectina (µg/ml)	
	(r)	p valor
Idade	0,292	0,084
Índice de adiposidade visceral	0,040	0,874
Índice de massa corporal:	-0,595	<000
Circunferência da Cintura:	-0,552	<000
Relação Cintura Quadril	-0,255	0,134
Circunferência do Pescoço	-0,125	0,469
Percentual Gordura Corporal	-0,516	0,004
Colesterol total	-0,91	0,720
LDL colesterol	-0,39	0,877
HDL	0,133	0,599
Triglicerídeos	-0,092	0,716
Glicemia	-0,350	0,150

Fonte: dados da pesquisa (2020).

No envelhecimento a resistência à insulina é induzida por magreza ou perda muscular, estes fatores podem resultar em níveis elevados de adiponectina e resistência à insulina em idosos (MURATSU et al, 2021).

CONCLUSÃO

A adiponectina apresentou correlação significativa com parâmetros antropométricos relacionados à doença cardiovascular e composição corporal. Entretanto, são necessários mais estudos a fim de usá-la como marcador para DCV em idosos.

REFERÊNCIAS

- Fang H, & Judd RL. Adiponectin regulation and function. *Comprehensive Physiology*. 2011; 8(3): 1031-1063.
- Khoramipour K, Chamari K, Hekmatikar AA, Ziyaiyan A, Taherkhani S, Elguindy NM, & Bragazzi NL. Adiponectin: Structure, physiological functions, role in diseases, and effects of nutrition. *Nutrients*. 2021; 13(4): 1180.
- Choi HM, Doss HM, & Kim KS. Multifaceted physiological roles of adiponectin in inflammation and diseases. *International journal of molecular sciences*. 2020; 21(4):1219.
- Peng J, Chen Q, & Wu C. The role of adiponectin in cardiovascular disease. *Cardiovascular Pathology*. 2023; 64: 107514.
- Han SY, Kim NH, Kim DH, Kim YH, Park YK, & Kim SM. Associations between body mass index, waist circumference, and myocardial infarction in older adults aged over 75 years: a population-based cohort study. *Medicina*. 2022; 58(12): 1768.
- Aljafary MA, & Al-Suhaimi EA. Adiponectin system (rescue hormone): the missing link between metabolic and cardiovascular diseases. *Pharmaceutics*. 2022; 14(7):1430.
- Lipschitz DA. Screening for nutritional status in the elderly. *Primary Care Clinics in Office Practice*. 1994; 21(1): 55-67.
- World health organization (WHO). Physical status: the use and interpretation of anthropometry. Genebra, World Health Organization. 1995.
- Dos Santos NC, & Fulan G. Correlação da circunferência do pescoço com fatores de risco cardiovascular. *Revista Baiana de Enfermagem*35; 2021.
- Barbosa PS, dos Santos RP, Mendonça JLS, & de Sousa Rocha V. Circunferência do pescoço e sua associação com parâmetros antropométricos de adiposidade corporal em adultos. *Braspen Journal*. 2023; 32(4): 315-320.
- Ramírez-López LX, Aguilera AM, Rubio CM, & Aguilar-Mateus ÁM. Síndrome metabólico: una revisión de criterios internacionales. *Revista colombiana de cardiología*. 2021; 28 (1): 60-66.
- Faludi AA, Izar MCD, Saraiva JFK, Chacra APM, Bianco HT, Afiune A, & Salgado W. (2017). Atualização da diretriz brasileira de dislipidemias e prevenção da aterosclerose–2017. *Arquivos brasileiros de cardiologia*. 2017; 109: 1-76.
- Ma L, Xu Y, Zhang Y, Ji T, & Li Y. Lower levels of circulating adiponectin in elderly patients with metabolic inflammatory syndrome: a cross-sectional study. *Diabetes, Metabolic Syndrome and Obesity*. 2020; 591-596.
- Fantin F, Disegna E, Manzato G, Comellato G, Zoico E, Rossi AP, & Zamboni M. Adipokines and arterial stiffness in the elderly. *Vascular Health and Risk Management*. 2020; 535-543.
- Yanai H, & Yoshida H. Beneficial effects of adiponectin on glucose and lipid metabolism and atherosclerotic progression: mechanisms and perspectives. *International journal of molecular sciences*. 2019; 20(5): 1190.
- Souza A M, Pereira MHQ, Teles BKA, de Souza AL, dos Santos Pereira D, & Pereira MLAS. Marcadores de risco cardiovascular em idosos da Estratégia de Saúde da Família. *Brazilian Journal of Development*. 2020; 6(6): 36094-36109.
- Gariballa S, Alkaabi J, Yasin J, & Al Essa A. Total adiponectin in overweight and obese subjects and its response to visceral fat loss. *BMC endocrine disorders*. 2019; 19: 1-6.
- Muratsu J, Kamide K, Fujimoto T, Takeya Y, Sugimoto K, Taniyama Y, & Rakugi H. The combination of high levels of adiponectin and insulin resistance are affected by aging in non-obese old peoples. *Frontiers in Endocrinology*. 2022; 12: 1-10.

Protein intake recommendation for stunted children: An-update review

Al MUKHLAS FIKRI¹, Widya ASTUTI², Vieta Annisa NURHIDAYATI³, Fajria Saliha PUSPITA PRAMESWARI², Nazrul HADI ISMAIL⁴

1 Department of Nutrition, Faculty of Health Sciences, Universitas Singaperbangsa Karawang, Indonesia.

2 Nutrition Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Bandung, Indonesia.

3 Management of Food Service and Nutrition Study Program, College of Vocational Studies, IPB University, Bogor, Indonesia.

4 Centre for Dietetics Studies, Faculty of Health Sciences, Universiti Teknologi MARA, Malaysia.

Recibido: 14/marzo/2024. Aceptado: 11/junio/2024.

ABSTRACT

Introduction: Childhood stunting remains a pervasive global health issue affecting millions of children, with significant repercussions on their physical and cognitive development.

Objective: This study aimed to collect information on dietary guidelines and protein recommendation specifically designed for stunted children.

Methods: A systematic review was performed using several databases, including Pubmed, Scopus, and Google Scholar. A literature search was conducted to collect studies on dietary guidelines (keywords: Dietary recommendation OR Dietary Guidelines AND Stunting OR Stunted OR Retarded Growth) and protein recommendation (keywords: protein AND catch-up growth AND stunting AND children OR infant) for stunted children. This review also included a narrative review for additional information.

Results: A total of 12 and 9 related articles were included in this systematic review on dietary guidelines and protein intake, respectively. This systematic review shows that protein intake stands out as a critical determinant in stunting, with low intake associated with growth faltering. However, guidelines specifically tailored to manage stunting remain scarce. Current evidence suggests protein's beneficial role in sup-

porting linear growth, but excessive intake may contribute to obesity risk, highlighting the need for balanced recommendations.

Conclusion: This review synthesizes existing knowledge on protein's role in stunting management, emphasizing the importance of appropriate protein intake in promoting optimal growth while mitigating associated risks.

Keywords: dietary guidelines, protein requirements, retarded growth, systematic review, under-five children

INTRODUCTION

Childhood stunting remains a critical global health concern, posing significant challenges to the physical and cognitive development of millions of children worldwide. The World Health Organization (WHO) reported that 22.3% of all under-five children worldwide were stunted in 2022¹. Stunting can be characterized by impaired linear growth and height-for-age deficits, reflecting chronic malnutrition during the early years of life. As the manifestation of childhood malnutrition, stunting can have profound and lasting consequences that extend beyond physical stature, including delayed cognitive development, reduced immune function, and increased risk of chronic diseases².

Stunting is caused by multifactor, but poor nutritional intake and frequent infection are the two crucial determinants^{2,3}. Specifically, protein, as a fundamental macronutrient, plays a pivotal role in supporting various physiological processes crucial for growth and development. A study in Malawi showed a significant association between low animal protein intake and decreased height-for-age z-score in under five children⁴. A randomized controlled trial (RCT) comparing high and low

Correspondencia:

Al Mukhlas Fikri
mukhlas.fikri@fikes.unsika.ac.id

protein intake from complementary feeding revealed that length-for-age z-score increased significantly in high protein complementary feeding⁵.

Despite current evidence showing the beneficial effect of protein on improving the linear growth of stunted children, information regarding protein intake guidelines for managing stunting is still limited. To the best of our knowledge, there are currently no specific guidelines on nutrition management for stunted children. The guidelines are mostly found for growth catch-up considering the rate of weight gain. WHO recommends a protein intake of 2.82 g/kg/day for optimal catch-up⁶. Moreover, the other recommendation demonstrates that the intake can reach 5.4 g/kg/day for supporting catch-up growth⁷.

Considering relatively unclear recommendations for stunted children, some studies showed a risk of obesity after administering stunted or malnourished children with a high protein diet. A systematic review showed that high protein content in infant formula may increase the risk of obesity in later life⁸. A European Union CHOP study found that children's body mass index (BMI) and obesity risk were reduced (2.43 lower) by lower protein content in infant formula⁹. Due to the high velocity of growth after high-protein intervention, this may lead to increased IGF-1, lower β -oxidation, and excessive adipogenesis. Therefore, the objective of this study was to present current evidences assessing the role of protein in stunting management.

METHODS

A systematic review was performed to collect the present evidences on dietary guidelines and protein intake recommendation for stunted children. A literature search was performed across databases, including Pubmed, Scopus, and Google Scholar from February to May 2024, with no restrictions on publication dates. Keywords used to collect studies on current dietary guidelines for stunting were "Dietary recommendation" OR "Dietary Guidelines" AND "Stunting" OR "Stunted" OR "Retarded Growth". Moreover, keywords for studies on protein recommendation were "Protein" AND "Catch-Up Growth" AND "Stunting" AND "Children" OR "Infant". The inclusion criteria in the dietary guidelines or protein intake recommendation literature search were to evaluate or suggest dietary guidelines or protein intake specifically for under-five stunting recovery with no comorbidities. Any supplement was not considered to be included. All related studies were included with no restriction on the design of study. All literature searches were conducted with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. A manual literature search was also performed to ensure that the retrieved studies were complete.

RESULTS AND DISCUSSION

Protein Intake and Its Association with Stunting

Adequate protein intake is needed by all humans across their lifespans to ensure optimal growth and development. Protein can stimulate the release of the hormone which is responsible for cell proliferation and differentiation. Insulin-like Growth Factor-1 (IGF-1), also known as somatomedin, is one important hormone that is closely related to protein intake. IGF-1 consists of 70 amino acids with a molecular weight of 7,649 Daltons. IGF-1 is a hormone produced in the liver and regulated by the secretion of growth hormone (GH) from the anterior pituitary gland. In general, IGF-1 plays a role in stimulating cell growth, protein anabolism, and inhibiting apoptosis. Almost all cells in the human body are influenced by the actions of IGF-1, especially in muscles, cartilage, bones, liver, kidneys, nerves, skin, and lungs¹⁰.

IGF-1 can promote bone growth and calcium absorption in the body. The study revealed that low IGF-1 levels in the body can increase the risk of bone fractures. Another study by Tang⁵ stated that IGF-1 is a major supporting factor for bone growth, significantly influencing a person's linear growth. During the active growth period in children and adolescents, IGF-1 plays a role in the process of longitudinal bone growth. IGF-1 stimulates the epiphysis, which is the end of the long bone, to continue producing new bone cells, resulting in an increase in bone length. Therefore, children with low IGF levels are at a greater risk of experiencing stunting¹¹.

Lower protein intake has been identified as a significant contributor to delayed linear growth in children, exposing them to a higher risk of stunting than those with sufficient protein intake. This correlation is further emphasized by the finding that the average protein intake of stunted children is 13 grams lower compared to their normal-height counterparts¹². Inadequate intake of essential amino acids limits the utilization of protein to support overall growth, especially linear growth. A study conducted in Malang, Indonesia, revealed that stunted children exhibited significantly lower intake of essential amino acids, such as histidine, isoleucine, and methionine, even when their overall protein intake was categorized as normal¹³.

Current Dietary Guidelines for Stunted children

A total of 1065 articles were initially collected from the databases, while 108 articles were removed due to duplication. After reviewing title and abstract, 96 articles were included for further review. Among these, only 12 articles were included in this study. The rest were excluded for various reasons, including not discussing stunting recovery (63 articles), non-dietary recommendations (17 articles), including subjects over 5 years (3 articles), and being set in an emergency context (1 article) (Fig 1).

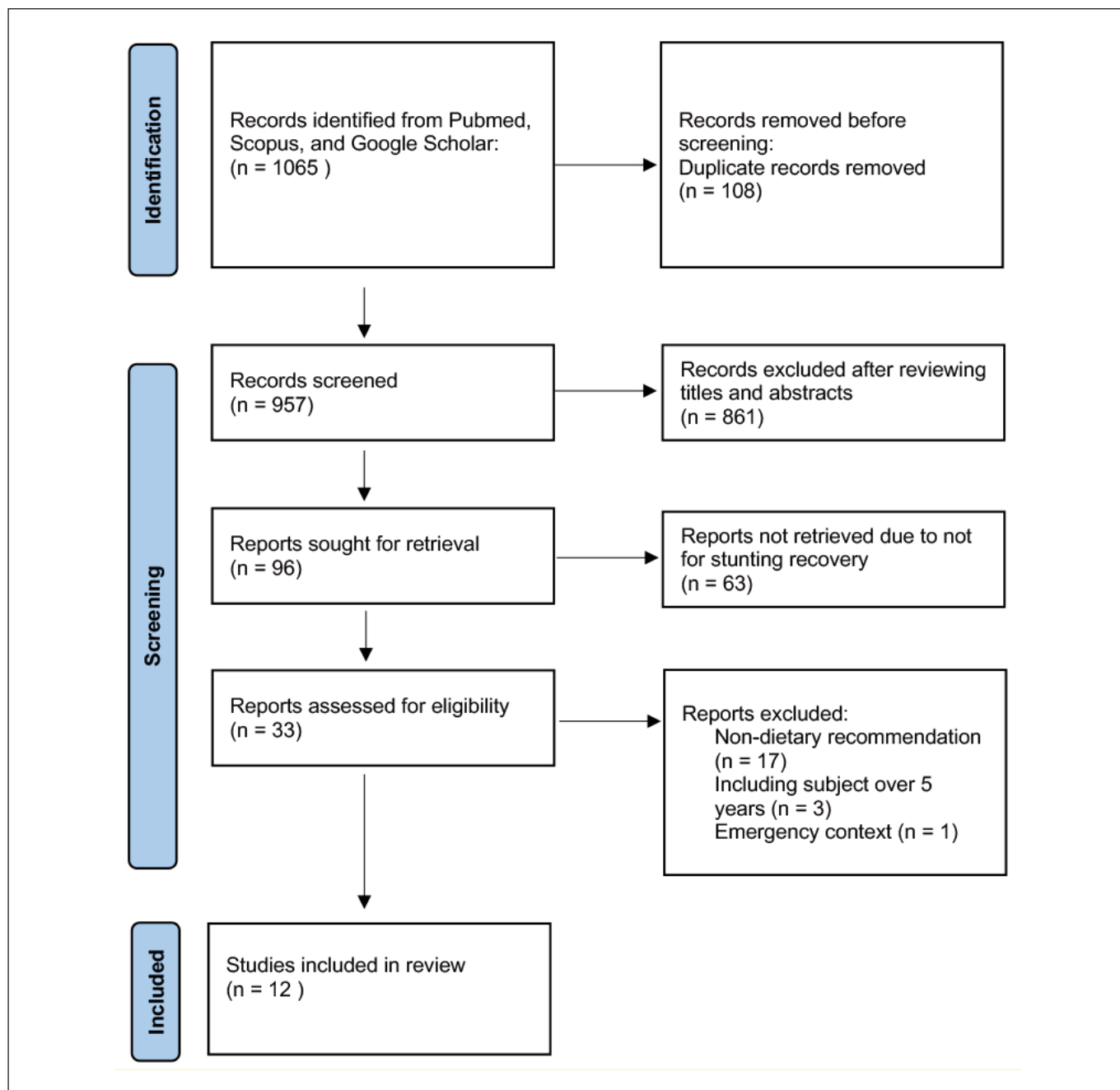


Figure 1. Prisma flow diagram for identifying study on dietary guidelines for stunted children

With the purpose of collecting data on the current dietary guidelines for stunted children, this study obtained 4 randomized controlled trials (RCTs), 3 systematic reviews with or without meta-analysis, 2 cross-sectional studies, and the rest were policy brief, guidelines document, and narrative review. The studies were originated from several countries, including Cambodia, Indonesia, Ecuador, Malawi, United States, and Chad. However, the included study did not discuss specifically dietary guidelines for stunted children. They partially suggested several points for dietary guidelines, including exclusive breast-

feeding^{14,15}, consuming nutrient-rich and diverse diet^{14,16}, providing complementary food supplements¹⁷, promoting the daily consumption of animal food sources¹⁸, such as fish¹⁹, egg²⁰, meat⁵, and milks^{21,22}. However, the other studies recommend to perform further study on fish¹⁹, egg^{23,24}, and milk²⁵ due to lack of evidence. Moreover, one study showed that ready-to-use supplementary food (RUSF) for 4 months may be used to recover the height of stunted children²⁶ (Table 1).

In children with stunting, the determination of their nutrient requirements is adjusted with their height age rather than

Table 1. Characteristics of included studies on dietary guidelines for stunted children

No	Author	Country	Type of article	Results/ Dietary Recommendation
1	Tang et al. ⁵	US	RCT of meat and dairy base complementary feeding for 7 months toward children aged 5 months	A complementary diet based on meat and dairy provides differing results in infant length. Meat has been showed to increase length-for-age Z-score, whereas dairy does not.
2	Arthur et al. ¹⁵	-	Systematic review	Breastfeeding is important to help recover malnourished children
3	Penny ¹⁷	-	Narrative review	Complementary food supplements may be used to catch-up growth. However, studies have demonstrated that complementary food supplements (peanut butter or beans with or without milk) showed beneficial effect in term of weight gain but not linear growth.
4	Asare et al. ¹⁸	-	Systematic review and Meta-analysis	Animal-source foods are considered as a suitable supplementary food for improving the growth of 6 to 24 month children
4	Byrd et al. ¹⁹	-	Systematic review	Promoting the consumption of fish could catch-up the growth, but more evidence is needed
6	Iannotti et al. ²⁰	Ecuador	Randomized controlled trial (RCT) of consuming 1 egg per day for 6 months toward 6-9 months children	Egg could be introduced early to children for stunting reduction
7	Fikawati et al. ²¹	Indonesia	A cross-sectional study involving 113 toddlers aged 3 years	Milk consumption could be considered as an important strategy to reduce stunting
8	Sjarif et al. ²²	Indonesia	A cross-sectional study with a total of 41 stunted (height-for-age z-score less than -2) and 131 normal under-five children	Growing up milk can be considered as part of a daily diet to protect children from stunting. However, several meat products, including sausage, nugget, and meatball, could not be considered as animal protein sources due to wide variations of nutrient content.
9	WHO ²³	-	Guidelines Document	Egg had no effect on overall linear growth
10	Stewart et al. ²⁴	Malawi	RCT of consuming 1 egg per day for 6 months toward 6-9 months children	Egg had no effect on overall linear growth
11	Huybregts et al. ²⁶	Chad	A Cluster RCT with intervention of 46 g of RUSF for 4 months on children aged 6-36 months.	Children with daily consumption of RUSF gained higher in height-for-age Z-score.
12	WHO ²⁸	-	Policy brief	Exclusive breastfeeding during the first 6 months, along with healthy and diverse complementary feeding

their chronological age to obtain more realistic results. Meeting the nutritional needs of stunted children aims for catch-up growth so that the child's height can reach their chronological age. However, current management for nutrition guidelines are heavily influenced by the severity and causes of malnutrition itself. For catch-up growth in infants, it is recommended to provide formula with an optimal protein-energy ratio of no more than 15% ²⁷, while this percentage is still under-discussion. The recommended fat intake is 40% of

energy needs, with an emphasis on high-quality fats. Fat provided should contain 15% of energy from monounsaturated fatty acids (MUFA), with oleic acid as the main source, saturated fatty acids (SFA) <10% of energy needs, Omega 6 Polyunsaturated Fatty Acid (PUFA) ranging from 4-8% with linoleic acid as the main source, and Omega 3 PUFA ranging from 0.5-2% of energy with alpha-linolenic acid as the main source. The lower limit of carbohydrate intake is 45% with an upper limit of 60% of total energy.

Protein Recommendation for Stunted children

The initial search obtained a total of 629 articles, where 35 articles were removed due to duplication. After reviewing the titles and abstracts, 585 articles were excluded due to irrelevant discussions. A total of 23 articles were reviewed in depth, where 12 articles did not report specific amount of protein recommendation, 1 article was a research protocol, and the rest focused on children with kidney disease. Therefore, 9 articles were included in this study (Fig. 2), consisting 2 RCTs, 1 non-RCT, 2 systematic reviews, 3 narrative

reviews, and 1 recommendation document. The experimental studies were originated from Bangladesh, UK, and Jamaica.

Generally, the protein intake for stunted children to support catch-up growth is still inconclusive. Current guidelines, which may be used, refer to FAO⁶ which states that the protein intake of children (1-2 years) for catch-up growth is 2.82 g/kg/day. However, this recommendation is based on limited data that represents human models using true ileal digestibility. Moreover, Pencharz²⁹ suggests a higher recommendation of protein intake for lean body mass repletion (1 g new lean tissue/day), amount-

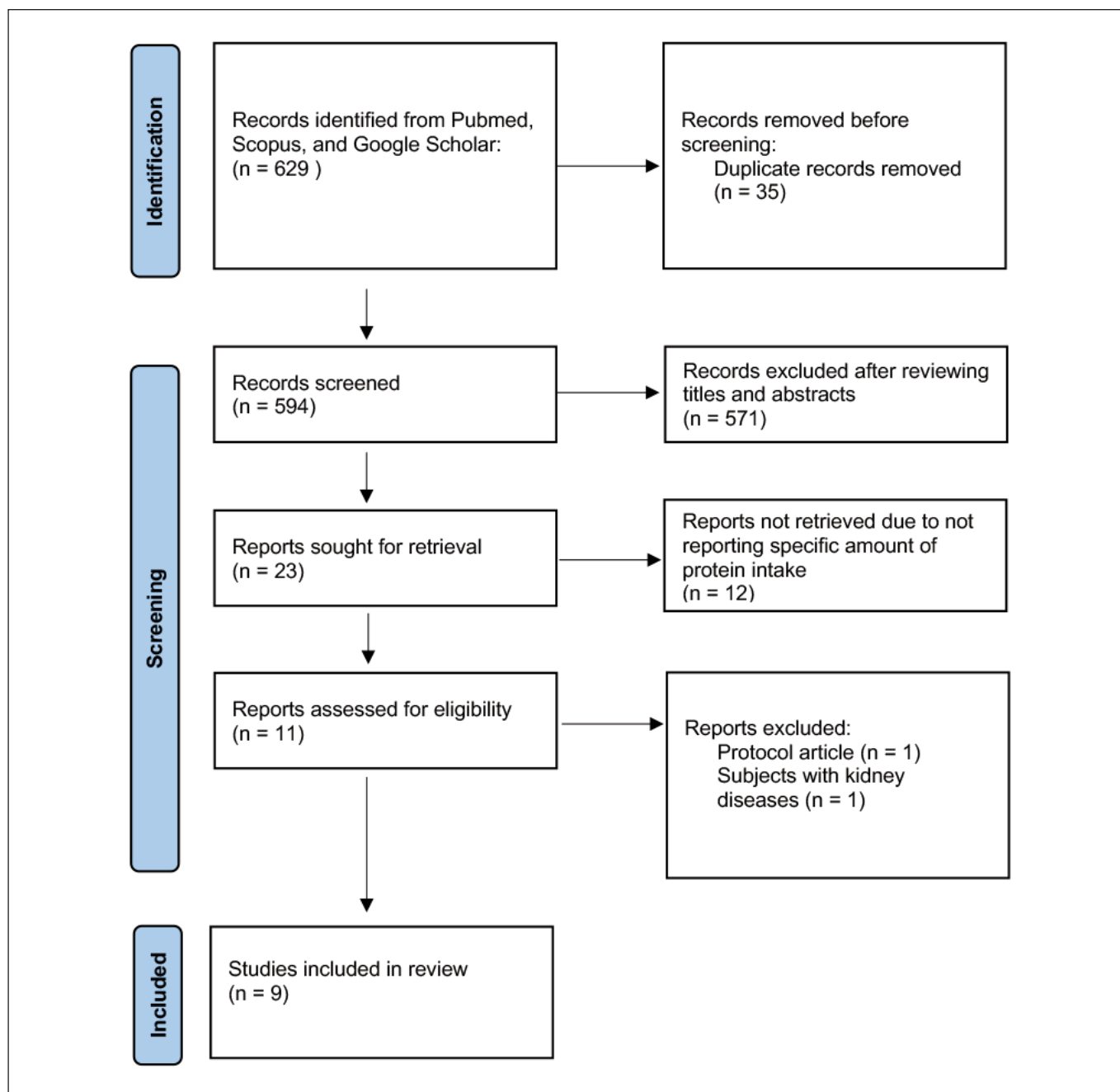


Figure 2. Prisma flow diagram for identifying study on protein intake for stunted children

ing to 3.7 g/kg/day. Higher protein recommendation is also found from the study by Doherty et al.³⁰ demonstrated that malnourished children might have effective catch-up growth by receiving 4.4 g protein/kg/day, considering higher weight gain and greater N balance. Another recommendation proposes that protein intake per day may reach 5.4 g/kg/day, depending on the composition of weight gain³¹. However, there is a possibility of having excess weight gain after high-protein diet intervention in stunted children. Providing more than 15% protein of total energy has been reported to increase the risk of obesity²⁷. Meanwhile, administering standard protein intake (8-15% of energy or 1-1,1 g/kg BW) has been showed to support normal growth in stunted children³²⁻³⁴. Moreover, Golden³⁵ has proposed the specific amount of protein intake in moderate acute malnutrition: 24 g/1000 kcal.

Increased risk of obesity due to higher intake of protein in children has been reported by several previous studies. The most contributing study suggesting that a higher protein intake increases the risk of obesity is a CHOP study employing a randomized controlled trial (RCT) with 1138 children. The study found that mean weight, BMI, and z-score were higher in high-protein formula groups, respectively³⁶. Moreover, follow-up of the CHOP study demonstrated that a high protein group had a higher risk of becoming obese (OR = 2.43; 95% CI: 1.12, 5.27)⁹. Moreover, a study in Indonesia showed an increase in energy intake and body weight after providing high protein snack to under-five children for 30 days³⁷.

As there is no robust data evaluating protein intake recommendations for stunted children, a theory hypothesis the emergence of obesity as an adverse effect of higher protein intake in growth catch-up. Increased protein intake may elevate the concentrations of amino acids, particularly branched-chain amino acids (BCAA), subsequently enhancing insulin and IGF levels through the rapamycin pathway in children³⁸. This may increase the risk of adipogenesis, which then causes obesity. Another mechanism may involve methionine intake. Methionine participates in DNA methylation, which contributes to developmental programming. A prospective cohort study found that there was a significant association between higher intake of methionine and higher BMI among children aged 1 year³⁹. Methionine participates in epigenetics through DNA methylation. Previous study showed methionine restriction produced a leaner phenotype in rats through increasing oxidation of lipids⁴⁰.

CONCLUSION

Protein plays a crucial role in children growth. Low protein intake has been linked to growth retardation and stunting. Present dietary guidelines is still partially providing recommendation for stunting children. Moreover, specific protein intake recommendations have not been firmly established. Nevertheless, several studies have suggested protein intake ranging from 2.8 to 5.4 g/kg/day for accelerating catch-up

growth, considering factors such as age and body composition. However, a recent study have even indicated a risk of obesity associated with higher protein intake recommendations. Therefore, there is a strong need for more specific guidelines regarding dietary guidelines and protein intake recommendation in stunted children.

REFERENCE

1. WHO. <https://www.who.int/data/gho/data/themes/topics/joint-child-malnutrition-estimates-unicef-who-wb>. 2022. Joint Child Malnutrition Estimate.
2. TABOADA GARCÍA MA, ROMÁN LÓPEZ IR, del Rocío GORDILLO CORTAZA J, GONZÁLEZ GARCÍA WA, ESTRADA RODRÍGUEZ DR, BURGOS GARCÍA EG, et al. Factores asociados al retardo de crecimiento en niños menores de 5 años con cardiopatías congénitas. *Revista Nutrición Clínica y Dietética Hospitalaria*. 2023;43(4).
3. Rosidi A, Margawati A. The potency of socio-economic family and cultural factor in affecting stunting of Muna ethnic in Batalaiworu, Southeast Sulawesi. In: IOP Conference Series: Earth and Environmental Science. IOP Publishing; 2019. p. 012015.
4. Kaimila Y, Divala O, Agapova SE, Stephenson KB, Thakwalakwa C, Trehan I, et al. Consumption of animal-source protein is associated with improved height-for-age z scores in rural Malawian children aged 12–36 months. *Nutrients*. 2019;11(2):480.
5. Tang M, Krebs NF. High protein intake from meat as complementary food increases growth but not adiposity in breastfed infants: a randomized trial. *Am J Clin Nutr*. 2014;100(5):1322–8.
6. Shivakumar N, Jackson AA, Courtney-Martin G, Elango R, Ghosh S, Hodgkinson S, et al. Protein quality assessment of follow-up formula for young children and ready-to-use therapeutic foods: recommendations by the FAO Expert Working Group in 2017. *J Nutr*. 2020;150(2):195–201.
7. Scrimshaw NS, Waterlow JC, Schurch B. Energy and protein requirements: proceedings of an IDECG workshop. *Eur J Clin Nutr*. 1996;50.
8. Abrams SA, Hawthorne KM, Pammi M. A systematic review of controlled trials of lower-protein or energy-containing infant formulas for use by healthy full-term infants. *Advances in Nutrition*. 2015;6(2):178–88.
9. Weber M, Grote V, Closa-Monasterolo R, Escribano J, Langhendries JP, Dain E, et al. Lower protein content in infant formula reduces BMI and obesity risk at school age: follow-up of a randomized trial. *Am J Clin Nutr*. 2014;99(5):1041–51.
10. Cohen P. Overview of the IGF-I system. *Horm Res Paediatr*. 2006;65(Suppl. 1):3–8.
11. Widayati SA, Suhartono S, Mexitalia M, Soejoenoes A. The relationship between pesticide exposure and umbilical serum igf-1 levels and low-birth weight: A case-control study in brebes, indonesia. *Int J Occup Environ Med*. 2020;11(1):15.
12. Fikawati S, Syafiq A, Ririyanti RK, Gemily SC. Energy and protein intakes are associated with stunting among preschool children in Central Jakarta, Indonesia: a case-control study. *Malays J Nutr*. 2021;27(1).

13. Rizky Maulidiana A, Sutjiati E. Low intake of essential amino acids and other risk factors of stunting among under-five children in Malang City, East Java, Indonesia. *J Public Health Res.* 2021; 10(2):jphr-2021.
14. Organization WH. Global nutrition targets 2025: Stunting policy brief. World Health Organization; 2014.
15. Arthur SS, Nyide B, Soua AB, Kahn K, Weston M, Sankoh O. Tackling malnutrition: a systematic review of 15-year research evidence from INDEPTH health and demographic surveillance systems. *Glob Health Action.* 2015;8(1):28298.
16. Darapheak C, Takano T, Kizuki M, Nakamura K, Seino K. Consumption of animal source foods and dietary diversity reduce stunting in children in Cambodia. *Int Arch Med.* 2013;6(1):1–11.
17. Penny ME. Micronutrients in the treatment of stunting and moderate malnutrition. In: Meeting micronutrient requirements for health and development. Karger Publishers; 2012. p. 11–21.
18. Asare H, Rosi A, Faber M, Smuts CM, Ricci C. Animal-source foods as a suitable complementary food for improved physical growth in 6 to 24-month-old children in low-and middle-income countries: A systematic review and meta-analysis of randomised controlled trials. *British Journal of Nutrition.* 2022;128(12):2453–63.
19. Byrd KA, Shieh J, Mork S, Pincus L, O'Meara L, Atkins M, et al. Fish and fish-based products for nutrition and health in the first 1000 days: a systematic review of the evidence from low and middle-income countries. *Advances in Nutrition.* 2022;13(6): 2458–87.
20. Iannotti LL, Lutter CK, Stewart CP, Gallegos Riofrío CA, Malo C, Reinhart G, et al. Eggs in early complementary feeding and child growth: a randomized controlled trial. *Pediatrics.* 2017;140(1).
21. Fikawati S, Adhi EK, Syafiq A, Bakara SM. Age of Milk Introduction is a Dominant Factor of Stunting Among Toddlers Aged 24 Months in Bogor District: A Cross-Sectional Study. *Pakistan Journal of Nutrition.* 2019 Sep 15;18(10):969–76.
22. Sjarif DR, Yuliarti K, Iskandar WJ. Daily consumption of growing-up milk is associated with less stunting among Indonesian toddlers. *Medical Journal of Indonesia.* 2019;28(1):70–6.
23. Organization WH. Guideline: assessing and managing children at primary health-care facilities to prevent overweight and obesity in the context of the double burden of malnutrition. 2017;
24. Stewart CP, Caswell B, Iannotti L, Lutter C, Arnold CD, Chipatala R, et al. The effect of eggs on early child growth in rural Malawi: the Mazira Project randomized controlled trial. *Am J Clin Nutr.* 2019;110(4):1026–33.
25. Tang M, Hendricks AE, Krebs NF. A meat-or dairy-based complementary diet leads to distinct growth patterns in formula-fed infants: a randomized controlled trial. *Am J Clin Nutr.* 2018;107(5): 734–42.
26. Huybregts L, Houngré F, Salpéteur C, Brown R, Roberfroid D, Ait-Aissa M, et al. The effect of adding ready-to-use supplementary food to a general food distribution on child nutritional status and morbidity: a cluster-randomized controlled trial. 2012;
27. Hörnell A, Lagström H, Lande B, Thorsdottir I. Protein intake from 0 to 18 years of age and its relation to health: a systematic literature review for the 5th Nordic Nutrition Recommendations. *Food Nutr Res.* 2013;57(1):21083.
28. WHO U. Global nutrition targets 2025: breastfeeding policy brief (WHO/NMH/NHD14. 7). Geneva: World Health Organization. 2014;
29. Pencharz PB. Protein and energy requirements for 'optimal' catch-up growth. Vol. 64, *European Journal of Clinical Nutrition.* 2010. p. S5–7.
30. Doherty T, deBenoist MH, Hibbert J, Persaud C, Jackson AA. The effect of the level of dietary protein and the quality of dietary energy on urea kinetics in young children recovering from severe malnutrition. *Proceedings of the Nutrition Society.* 1989;48:55.
31. Joosten K, Meyer R. Nutritional screening and guidelines for managing the child with faltering growth. *Eur J Clin Nutr.* 2010;64(1): S22–4.
32. Arsenault JE, Brown KH. Effects of protein or amino-acid supplementation on the physical growth of young children in low-income countries. *Nutr Rev.* 2017;75(9):699–717.
33. Kabir I, Rahman MM, Haider R, Mazumder RN, Khaled MA, Mahalanabis D. Increased height gain of children fed a high-protein diet during convalescence from shigellosis: a six-month follow-up study. *J Nutr.* 1998;128(10):1688–91.
34. Clarke SE, Evans S, MacDonald A, Davies P, Booth IW. Randomized comparison of a nutrient-dense formula with an energy-supplemented formula for infants with faltering growth. *Journal of human nutrition and dietetics.* 2007;20(4):329–39.
35. Golden MH. Proposed recommended nutrient densities for moderately malnourished children. *Food Nutr Bull.* 2009;30 (3_suppl3):S267–342.
36. Koletzko B, Von Kries R, Closa R, Escribano J, Scaglioni S, Giovannini M, et al. Lower protein in infant formula is associated with lower weight up to age 2 y: A randomized clinical trial. *American Journal of Clinical Nutrition.* 2009 Jan 6;89(6):1836–45.
37. Permatasari O, Murwani R, Rahfiludin MZ. Tempe nuggets provision improves energy adequacy and protein intake in underweight underfive children. *Current Research in Nutrition and Food Science Journal.* 2018;6(1):89–96.
38. Luque V, Closa-Monasterolo R, Escribano J, Ferré N. Early programming by protein intake: the effect of protein on adiposity development and the growth and functionality of vital organs. *Nutr Metab Insights.* 2015;8:NMI-S29525.
39. Braun KVE, Voortman T, Kiefte-de Jong JC, Jaddoe VW V, Hofman A, Franco OH, et al. Dietary intakes of folic acid and methionine in early childhood are associated with body composition at school age. *J Nutr.* 2015;145(9):2123–9.
40. Orgeron ML, Stone KP, Wanders D, Cortez CC, Gettys TW. The impact of dietary methionine restriction on biomarkers of metabolic health. *Prog Mol Biol Transl Sci.* 2014;121:351–76.

Effects of a family interdisciplinary intervention on food processing and the stage of eating behavior change in overweight or obese adolescents

Ana Paula RIBEIRO GERALDI^{1,2}, Déborah Cristina de Souza MARQUES^{1,2}, Clara Camille SANABRIA MIRANDA², Daniel VICENTINI DE OLIVEIRA^{1,2}, Samuel RODRIGUES LOURENÇO DE MORAIS², Pablo VALDÉS-BADILLA^{3,4}, Isabelle ZANQUETA CARVALHO^{1,2}, Bráulio Henrique MAGNANI BRANCO^{1,2}

1 *Interdisciplinary Laboratory of Intervention in Health Promotion, Cesumar Institute of Science, Technology and Innovation, Maringá, PR, Brazil.*

2 *Graduate Program in Health Promotion, Cesumar University, Maringá, PR, Brazil; Universidade Cesumar (UNICESUMAR), Maringá, PR, Brazil.*

3 *Department of Physical Activity Sciences, Faculty of Educational Sciences, Universidad Católica del Maule, Talca, Chile.*

4 *Sports Coaching Career, School of Education, Universidad Viña del Mar, Viña del Mar, Chile.*

Recibido: 9/mayo/2024. Aceptado: 11/junio/2024.

ABSTRACT

Introduction: Due to the increasing prevalence of obesity in recent years, the treatment of excess weight has become necessary and a global public health problem, especially in childhood and adolescence.

Objective: The present study aimed to analyze the effects of an interdisciplinary intervention on the processing and food consumption behavior of overweight and obese adolescents.

Methods: This is a pre-experimental, analytical, and interventional study. Sixty-four adolescents (65% females and 35% males), with a mean age of 13.72 ± 2.46 years, who were overweight or obese, were included in the study. The interdisciplinary interventions took place over 12 weeks, three times a week, with the participation of an interdisciplinary team composed of physical education professionals (three times a week), nutritionists (twice a week), and psychologists (twice a week). To analyze the level of food processing, a 3-day food record was applied before and after the 12 weeks of intervention. Foods were calculated in grams, calories, and % of total energy value (TEI). Data were expressed as mean and standard deviation. Subsequently, the normality of the data was tested using the Kolmogorov-Smirnov test. After this

confirmation, a paired t-test was performed to compare the pre- and post-intervention moments.

Results: significant reduction in processed and ultra-processed foods and increased consumption of fresh foods in grams and calories ($p < 0.05$). However, no significant differences were observed for consuming minimally processed foods ($p > 0.05$). In addition, there were significant results in the domain portion size and quantity ($p < 0.01$) and consumption of fruits and vegetables ($p < 0.05$).

Conclusion: 12 weeks of interdisciplinary interventions provided positive impacts on the level of food processing and consumption behavior of overweight and obese adolescents, contributing to the fight against obesity in adolescence.

KEYWORDS

Lifestyle modifications; Obesity in Adolescence; Adolescent Health; Interdisciplinarity.

INTRODUCTION

Obesity is a multifactorial disease resulting from the interaction between environmental and genetic aspects¹. Environments that provide ample supply and encouragement of sugary, fatty, and sodium-rich foods tend to promote unhealthy eating habits, resulting in negative individual food preferences and, consequently, in the prevalence of diseases associated with poor food quality, such as chronic non-communicable diseases (NCDs)².

Correspondencia:
Bráulio Henrique Magnani Branco
brauliohmagnani@gmail.com

The scenario increased the prevalence of overweight and decreased malnutrition in children and adolescents, which is why obesity is considered a global public health problem³. It is a chronic non-communicable disease (NCD) detected by excess weight or body fat. In 2020, according to data from the National Health Survey conducted with adolescents, 31.8% were overweight, and 11.9% were obese³.

Therefore, to prevent it, it is necessary to identify the causes and contexts related to weight gain and the development of diseases⁴. The condition encompasses multiple factors, and it is necessary to highlight excessive food consumption, sedentary lifestyle, and, in short, intra-family relationships⁵. Eating habits can be influenced by psychological, family, cultural, environmental, and social factors and are directly related to food choices, which can impair health in adulthood⁵.

However, to implement the intervention, assessing the stages of behavior change readiness (CHR)⁶ is necessary. It is important to emphasize that identification through the CRIC, also known as the transtheoretical model, is essential for the choice of intervention methods and the implementation of effective strategies according to the motivation and responsibility of adolescents. Thus, the determination of stages is essential for the adoption of effective strategies and behavior change⁷.

Therefore, including guardians can contribute to behavior change and help adolescents adopt healthy habits (through access to fruits and vegetables), promoting a non-obesogenic environment⁸. Family meals teach children about behaviors, habits, and food choices⁹. However, due to overwork and daily stress, caregivers give their children a different view, such as easy access to ready-to-eat and fast food, negatively influencing the food choices and lifestyle of adolescents⁹. The literature shows that interdisciplinary interventions are the most effective for treating obesity¹⁰.

It is critical to highlight the importance of addressing the growing problem of overweight and obesity among adolescents. This condition has been associated with many adverse health consequences, including chronic diseases such as type 2 diabetes and cardiovascular disease³. Understanding and intervening in food processing and consumption behaviors can effectively prevent and control overweight and obesity in this population. In addition, an interdisciplinary approach can be more comprehensive and practical by considering different aspects of adolescents' lifestyles, such as diet, physical activity, mental health, and socioeconomic factors¹¹.

In addition, it is believed that the family could also participate in the fight against obesity, with the adolescent intending to improve their health status and aspects of nutritional education¹². Therefore, this study aimed to analyze the effects of an interdisciplinary family intervention on the level of food processing and consumption behavior of overweight adolescents.

METHODS

Experimental Design: This is a pre-experimental, analytical, and interventional study¹³. Data were collected at the University, on the premises of the Interdisciplinary Laboratory of Intervention in Health Promotion, over 12 weeks of interdisciplinary interventions. The Research Ethics Committee of the site approved the study through opinion No. 4,913,453/2021. The procedures followed the standards required in Resolution 466/2012 of the National Health Council on research involving human beings.

Participants: Sixty-two adolescents (65% female and 35% male) aged 13.8 ± 2.4 years agreed to participate in the study. The inclusion criteria were: (i) age between 11 and 19 years; (ii) overweight or obese; (iii) who completed the requested questionnaires and the ICF and FA; (iv) who were available to participate in interdisciplinary interventions twice a week in the evening (6:15 p.m. or 7:15 p.m.) throughout the 12 weeks, and (v) adolescents who attended all baseline intervention assessments. Regarding the exclusion criteria, the following were considered: (i) participating in sports activities outside the intervention; (ii) not reaching 75% of attendance in the interventions offered; (iii) missing the intervention more than twice in a row; (iv) did not complete any of the requested questionnaires; (v) followed a restrictive diet (low carb, low fat or hypocaloric) during the development of the intervention; and (vi) used psychotropic or appetite regulating medications.

Assessment of food intake: Food intake was measured in all adolescents at the beginning and end of the interventions using the food record. Participants were instructed to write down all their meals for three non-consecutive days: two days during the week and one day on the weekend¹⁴. They were instructed to fill in all food items and the appropriate quantities in detail (employing household measurements), using measuring utensils, or to provide the best estimate of portion size if they were away from home. In addition, all participants were instructed to detail each food item, such as brand or restaurant names and labeling of specific items (e.g., low-fat, 1% milk). To this end, support material was provided for information on household measurements and the correct completion of the questionnaire. In addition, to assist, at the beginning of the intervention, in the middle, and the final fulfillment, theoretical classes were held on how to fill in the material and what the home measurements are.

The food records collected were calculated using the Avanutri software (2004® version, Avanutri Equipamentos de Análise Ltda, Três Rios, Rio de Janeiro, Brazil). After tabulation in the software, it was possible to analyze the amount, in grams and kilocalories, of the level of food processing: fresh (in natura), minimally processed, processed, or ultra-processed¹⁵. The results found from the record were tabulated in Excel (version 2013, Microsoft, United States of America).

Stage of Eating Behavior Change: The Stage of Change questionnaire was translated into the Brazilian context by Cattai, Hintze, and Nardo Junior to assess the stages of readiness for eating behavior change¹⁶. This questionnaire was applied to adolescents before and after 12 weeks of intervention, which consisted of 38 statements distributed in four domains: size and number of portions (9 statements); amount of fat in the diet (11 statements); fruit and vegetable consumption (9 statements) and physical activity (9 statements). The answers to each statement ranged on a Likert scale from 1 to 5, with 1 pre-contemplation, 2 contemplation, 3 preparation, 4 action and 5 maintenance. The mean score for the three domains was calculated to obtain the steps related to each. The following classifications have been used: 1 to 1.4 – pre-contemplation; 1.5 to 2.4 – contemplation; 2.5 to 3.4 – preparation; 3.5 to 4.4 – action; 4.5 to 5.0 – maintenance^{17,18}.

Anthropometry: Height was measured using a stadiometer attached to a scale with 0.1 division, and body weight was also calculated on a digital scale with a precision of 0.1 kg (Welmy R-110, Santa Bárbara D'Oeste, São Paulo). All participants were previously instructed on the recommendations. Body mass index (BMI) was calculated for all participants (kg/m^2), and BMI-for-age z-score (BMI/A) was also calculated¹⁹.

Interdisciplinary interventions: The family interdisciplinary interventions followed the methodology previously published by Marques et al.¹². The legal guardians participated in all activities, i.e., physical exercises, dietary re-education, and psychological interventions, including theoretical or practical activities. All activities began with theoretical classes: dietary re-education or psychological interventions (lasting around 30 minutes – twice a week) and practical activities with physical exercises – three times a week. Dietary re-education was theoretically based on the Food Guide for the Brazilian Population¹⁵. Psychological intervention was carried out through theoretical and practical activities, carefully elaborated based on the National Health Promotion Policy (PNPS)²⁰. The physical exercises were performed in a circuit model. Thus, the functional training sessions were developed based on locomotor ability, stabilization, and manipulation skills and performed with em-

phasis on localized muscle groups, muscle strength and endurance work, flexibility, and cardiorespiratory endurance sectioned into 10 minutes of walking, in addition to 45 minutes of functional exercises and 5 minutes of stretching/resting.

Statistical analysis: The data are presented as mean \pm standard deviation (SD). First, normality data was tested using the asymmetry-kurtosis test, and values from 2 to -2 were given to indicate an accurate statistical parametric analysis. The comparison between pre- and post-intervention was performed through paired t-tests. It was accepted at $p < 0.05$ for all analyses. In addition, the effect size using Cohen's d was calculated and classified as < 0.20 – *small*, $> 0.20 < 0.80$ – *medium*, and > 0.80 – *large*. Statistical analyses were performed using SPSS 24 software (IBM, USA).

RESULTS

The final sample consisted of 64 adolescents, one of whom showed a significant increase in height during the intervention period (12 weeks). There were no significant changes in body weight, BMI, height, and BMI Z-score ($p > 0.05$). Table 1 shows the general characteristics of the sample.

When comparing each level of processing described in Table 2, it is noted that there was a change in the dietary pattern with an increase in the consumption of fresh foods, both in grams and kcal and no significant change was observed in the consumption of minimally processed foods. However, concerning processed foods, there was a reduction in kcal intake but no significant difference in grams. On the other hand, the reduction in their consumption is evident in grams and kcals ($p < 0.05$).

Significant changes were found in the size and quantity of portions consumed by the adolescents, as well as greater adherence to the consumption of fruits and vegetables. Therefore, it is a positive aspect since these are variables related to consumption and food choices. However, no significant differences were observed in the amount of fat in the diet and physical activity between the pre- and post-intervention moments. The results aim to contribute to the gaps in the

Table 1. General Characteristics of the Participants in the pre and post-intervention moments

General Characteristics	Pre-intervention	Post-intervention	p-value	Effect size
Age (years)	13.72 \pm 2,46	13.98 \pm 2,53	$p > 0.05$	0.10 - <i>small</i>
Body Weight (Kg)	1.63 \pm 0,12	1.64 \pm 0,11	$p > 0.05$	0.08 - <i>small</i>
Height (m)	1.55 \pm 0,06	1.56 \pm 0,05	$p > 0.05$	0.16 - <i>small</i>
IMC (kg/m^2)	29.85 \pm 7,97	29.66 \pm 7,46	$p > 0.05$	-0.02 - <i>small</i>
BMI/A Z-score	1.60 \pm 1,11	1.54 \pm 1,03	$p > 0.05$	-0.05 - <i>small</i>

Note: Data are expressed as mean and standard deviation (\pm); BMI = Body Mass Index (kg/m^2); BMI/A = Body Mass Index (kg/m^2) by age.

Table 2. Comparison of food processing levels previous and post-interventions

Food Processing Level	Pre-intervention	Post-intervention	p-value	Effect size
Food Processing Level	118.2 ± 128.1	213.9 ± 192.2	$p < 0.05$	0.74 - <i>medium</i>
Natural food (g)	49.1 ± 60.9	93.0 ± 90.3	$p < 0.05$	0.72 - <i>medium</i>
Natural food (kcal)	680.9 ± 408.7	726.0 ± 451.9	$p > 0.05$	0.11 - <i>small</i>
Minimally processed (g)	860.8 ± 494.2	828.0 ± 434.4	$p > 0.05$	-0.06 - <i>small</i>
Minimally processed (kcal)	315.5 ± 401.7	180.7 ± 218.4	$p > 0.05$	-0.33 - <i>medium</i>
Processed (g)	405.7 ± 406.3	259.5 ± 237.5	$p < 0.05$	-0.35 - <i>medium</i>
Processed (kcal)	327.6 ± 355.6	178.9 ± 204.7	$p < 0.05$	-0.41 - <i>medium</i>
Ultra-processed (g)	661.6 ± 660.1	349.9 ± 388.8	$p < 0.05$	-0.47 - <i>medium</i>

Note: Data are expressed as mean and (±) standard deviation.

Table 3. Comparison of pre and post-intervention using the Stage of Change questionnaire

Domain	Pre-intervention	Post-intervention	p-value	Effect size
Portion Control	2.0 ± 0.9	3.0 ± 0.8*	$p < 0.001$	1.11 - <i>large</i>
Consumption of fruits and vegetables	2.0 ± 1.0	3.0 ± 1.0*	$p < 0.05$	1.00 - <i>large</i>
Control of fat consumption	1.2 ± 4.7	1.8 ± 4.2	$p > 0.05$	0.12 - <i>small</i>
Physical activity	1.0 ± 4.0	1.2 ± 4.0	$p > 0.05$	-0.05 - <i>small</i>

Note: Data are expressed as mean and (±) standard deviation.

literature regarding the best intervention method for changing eating behavior in adolescents and their guardians.

The identification of assertive interventions corroborates health promotion, body weight reduction (although in our study, no significant difference was observed for this variable), and, consequently, diseases related to excess weight. The results found that the study participants were willing to participate in the proposed interventions, especially when involved in nutritional issues, such as portion size, quantity, and consumption of fruits and vegetables. Table 2 shows the comparison of food processing levels in previous and post-interventions.

DISCUSSION

The present study aimed to analyze the effects of an interdisciplinary intervention on the level of food processing and eating behavior of overweight and obese adolescents. The main results showed significant changes in the improvement of fresh food consumption, reduced processed and ultra-processed foods, improved fruit and vegetable consumption, and portion control. However, no significant differences were

observed between the consumption of minimally processed foods, the amount of fat, and physical activity in the diet and post-intervention periods. Due to the progressive gain of autonomy during adolescence, individuals are susceptible to making food choices of good or poor nutritional quality²¹, which is reflected in the nutritional status of these adolescents, which ends up causing weight gain in this age group. The results showed that the participants were willing to participate in the proposed interventions, especially when involved in nutritional issues such as portion size, quantity, and consumption of fruits and vegetables.

This finding makes it clear that family support can be complex, so that support implies encouragement to participate in activities together and changes in the family's habits at home²². Therefore, the family should be an example in changing eating habits and healthy lifestyles, encouraging physical activity, and monitoring it so that the child feels safe, motivated, and welcomed by his or her family²³. Thus, these changes made throughout the intervention were beneficial for health status and lifestyle, both in adolescence and adulthood, in which the better quality of food choices contributes

to the reduction of energy density, weight loss, and reduces the risk of developing chronic NCDs in the short and long term¹². It is known that food choices are not only determined by the physiological needs of the adolescent, but accessibility, coexistence, environmental factors, media advertising, and the price of food also influence them. In this context, substituting natural and minimally processed foods for processed and ultra-processed foods has become extremely important²⁴.

Several studies state that interdisciplinary interventions can improve the components of body composition, but few use the Likert rating of the stage of readiness for behavior change, so promoting this change is essential^{17,24,25}. Based on the above, with the evaluation of the stage of readiness for behavior change, it becomes possible to identify the level of commitment to change the individuals are at, and thus, professionals can develop more effective strategies based on the level of motivation. Therefore, encouraging interdisciplinary actions and recovering health conditions will help prevent complications associated with excess weight²⁶. In the study, after 12 weeks of intervention, it was possible to verify an improvement in the dietary profile of overweight and obese adolescents. Therefore, modifying the lifestyle in this age group is essential to prevent diseases in adulthood^{17,25}. Some studies have shown that improving dietary patterns and levels of physical activity through fresh foods, such as fruits and vegetables, and practicing physical exercises is associated with better lipid profile values and health status^{26,27}.

The improvement identified after the proposed interventions, through a significant increase in the consumption of fruits and vegetables, corroborates the results found in the literature, confirming that our study was able to give adolescents autonomy in food decisions. Therefore, encouraging adolescents and guardians to make better food choices is essential, especially in the environment in which they live¹⁴. Family members are essential, as food choices are inspired by caregivers and provide availability and accessibility to nutritious food⁸. Therefore, the diet quality can be influenced by the family's diet²⁸. Changes in adolescents' daily living activities concerning their eating habits and physical activity, together with nutrition and psychology education professionals, directly influence their health status and lifestyle.

Consequently, the strength of this study is that it is a framework that can be easily applied elsewhere. The program sought to encourage adolescents and parents to change their sedentary behavior to a healthy lifestyle through an interdisciplinary approach. Therefore, it is considered that the interdisciplinary program can positively influence both groups and modify behaviors by adopting healthy daily habits despite the family's participation in activities. Change is one of the main factors for the success of the treatment, and one of the most considerable difficulties encountered in the process is that these habits are often already ingrained in the family, and changing them requires a joint effort, a point that parents

have a lot of difficulty^{7,28,29}. Families that show greater acceptance and willingness to change their eating habits have greater adherence to treatment³⁰. Thus, multidisciplinary family interventions can contribute to strategies based on family incentives, support for the practice of physical activity, and health education¹⁴.

For a complete understanding of the results of this study, it is essential to consider the following limitations: The study did not assess the impact of family involvement, and this variable may play a significant role in adolescents' eating behavior and lifestyle habits, influencing the study's results. It is also important to emphasize that the effects of interventions may manifest differently over time, and the absence of long-term follow-up assessments may limit some findings. We can gain a fuller and more accurate understanding of future possibilities from these limitations. Future studies may consider the impact of family involvement and the relationship between adolescents and their guardians, which can help in the complete and accurate understanding of the factors that directly influence the most effective actions to control excess weight. By evaluating in the long term, it would be possible to verify the durability of the effects of the interventions.

CONCLUSION

Based on the results obtained, the 12 weeks of multidisciplinary family interventions (theoretical-practical) could positively impact the dietary profile and the level of food processing in overweight and obese adolescents. These results highlight the importance of multidisciplinary approaches in the treatment of overweight adolescents, in addition to the inclusion of the family in the approaches, in order to improve not only lifestyle habits in adolescence but also to improve the family scenario about healthy eating, ensuring health for all in adult life.

REFERENCES

1. Cardel MI, Jastreboff AM, Kelly AS. Treatment of Adolescent Obesity in 2020. *JAMA* [Internet]. 2019 Nov 5 [cited 2024 Apr 25]; 322(17):1707–8. Available at: <https://pubmed.ncbi.nlm.nih.gov/31566652/>
2. Swinburn BA, Kraak VI, Allender S, Atkins VJ, Baker PI, Bogard JR, et al. The Global Syndemic of Obesity, Malnutrition and Climate Change: Report of the Lancet Commission. *Lancet* (London, England) [Internet]. 2019 Feb 23 [cited 2024 Apr 25]; 393(10173):791–846. Availability date: <https://pubmed.ncbi.nlm.nih.gov/30700377/>
3. Vardell E. Global Health Observatory Data Repository. *Med ref serv q* [internet]. 2020 Jan 2 [cited 2024 Apr 25]; 39(1):67–74. Available at: https://www.researchgate.net/publication/339341479_Global_Health_Observatory_Data_Repository
4. Wehrauch-Blüher S, Kromeyer-Hauschild K, Graf C, Widhalm K, Korsten-Reck U, Jödicke B, et al. Current Guidelines for Obesity Prevention in Childhood and Adolescence. *Obes Fatos* [Internet].

- 2018 Jul 1 [cited 2024 Apr 25]; 11(3):263–76. Available at: <https://pubmed.ncbi.nlm.nih.gov/29969778/>
5. Pereira TDS, Pereira RC, De Angelis-Pereira MC. Cien Saúde Colet [Internet]. 2017 [cited 2024 Apr 25]; 22(2):427–35. Available at: <https://www.scielo.br/jj/csc/a/rK7CxmYPBp9KyYNWRsmGKwt/abstract/?lang=pt>
 6. Nakabayashi J, Melo GR isa, Toral N. Nutritional interventions based on transtheoretical models in adolescents: a systematic review. BMC Public Health [Internet]. 2020 Dec 1 [cited 2024 Apr 25]; 20(1). Available at: <https://pubmed.ncbi.nlm.nih.gov/33054748/>
 7. Salahshoornezhad S, Sohrabi Z, Mani A, Abdelbasset WK, Mehrabi M, Zare M, et al. Effect of a multidisciplinary program on anthropometric and biochemical parameters in obese and overweight elementary school girls: a randomized clinical trial. Nutr Metab Cardiovasc Dis [Internet]. 2022 Aug 1 [cited 2024 Apr 25]; 32(8):1982–9. Available at: <https://pubmed.ncbi.nlm.nih.gov/35610083/>
 8. Scaglioni S, De Cosmi V, Ciappolino V, Parazzini F, Brambilla P, Agostoni C. Factors influencing children’s eating behaviors. Nutrients [Internet]. 2018 Jun 1 [cited 2024 Apr 25]; 10(6). Available at: <https://pubmed.ncbi.nlm.nih.gov/29857549/>
 9. Da Silva JI, De Souza Andrade AC, Bloch KV, Brunken GS. Association between sharing meals with parents or guardians and obesity in Brazilian adolescents. Cad Public Health. 2020; 36(8).
 10. de Oliveira FM, De Souza Marques DC, Coelho AA, Marques MGDS, Araújo CGA, Branco BHM. Effects of a multidisciplinary approach on anthropometric and dietary profile variables of overweight or obese adolescents. J Hum Growth Dev [Internet]. 2021 [cited 2024 Apr 25]; 31(2):257–66. Availability date: http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S0104-12822021000200009&lng=pt&nrm=iso&lng=en
 11. Faight EL, Gleddie D, Storey KE, Davison CM, Veugelers PJ. Healthy Lifestyle Behaviors Are Positively and Independently Associated with Academic Achievement: An Analysis of Self-Reported Data from a Nationally Representative Sample of Canadian Early Teens. PLoS One [Internet]. 2017 Jul 1 [cited 2024 Apr 25]; 12(7). Available at: <https://pubmed.ncbi.nlm.nih.gov/28753617/>
 12. Marques DCS, Ferreira WC, Santos IC, Ryal JJ, Marques MGS, Oliveira FM, et al. Impacts of a multiprofessional versus isolated family intervention on food processing in overweight adolescents: a randomized trial. Nutrients [Internet]. 2023 Feb 1 [cited 2024 Apr 25]; 15(4). Availability date: <https://pubmed.ncbi.nlm.nih.gov/36839292/>
 13. Jerry R. Thomas, Jack K. Nelson. Research Methods in Physical Activity. 6th ed. São Paulo: Artmed; 2012.
 14. Magnani Branco BH, Carvalho IZ, Garcia De Oliveira H, Fanhani AP, Machado Dos Santos MC, Pestillo De Oliveira L, et al. Effects of 2 types of resistance training models on body composition, cardiometabolic risk, and physical fitness of obese adolescents. J Force Cond Res [Internet]. 2020 Sep 1 [cited 2024 Apr 25]; 34(9):2672–82. Available at: <https://pubmed.ncbi.nlm.nih.gov/30557175/>
 15. Moura NC de, Paiva NMN de, Costa J da S, Pereira MR, Carvalho É, Brazil, et al. Virtual Health Library of the Ministry of Health. Food Guide for the Brazilian Population [Internet]. 2015 [cited 2024 Apr 25]; 33(4):1–11. Available at: www.saude.gov.br/bvs
 16. Cattai GBP, Hintze LJ, Nardo N. Internal validation of the readiness stage questionnaire for change of eating and physical activity behavior. Rev Paulo Pediatr [Internet]. 2010 [cited 2024 Apr 25]; 28(2):194–9. Availability date: <https://www.scielo.br/jj/rpp/a/CJBxHm5c7pFd7YRd4Sfmpms/abstract/?lang=pt>
 17. da Silva DF, Bianchini JAA, Lopera CA, Capelato DA, Hintze LJ, Nardo CCS, et al. Impact of behavior change readiness on the effects of a multidisciplinary intervention in obese Brazilian children and adolescents. Appetite [Internet]. 2015 Apr 1 [cited 2024 Apr 25]; 87:229–35. Available at: <https://pubmed.ncbi.nlm.nih.gov/25558026/>
 18. Marcus B.H., Simkin L.R. The transtheoretical model: applications to exercise behavior. Med Sci Sports Exerc [Internet]. 1994 [cited 2024 Apr 25]; 26(11):1400–4. Availability date: <https://psycnet.apa.org/record/1994-98849-004>
 19. by Onis M. World Health Organization Growth Patterns. Acta Paediatr [Internet]. 2006 [cited 2024 Apr 25]; 5–6. Available at: http://www.who.int/childgrowth/standards/Technical_report.pdf?ua=1
 20. Brazil. Ministry of Health. Department of Health Surveillance. National Health Promotion Policy Revision of Ordinance MS/GM No. 687, of March 30, 2006 [Internet]. 2014. Available at: <http://editora.saude.gov.br>
 21. Carbert NS, Brussoni M, Geller J, Mâsse LC. Family environment and physical activity of overweight/obese adolescents. Int J Environ Res Public Heal 2019, Vol 16, Page 2558 [Internet]. 2019 Jul 17 [cited 2024 Apr 25]; 16(14):2558. Available at: <https://www.mdpi.com/1660-4601/16/14/2558/htm>
 22. Victorino SVZ, Soares LG, Marcon SS, Higarashi IH. Living with childhood obesity: the experience of children enrolled in a multidisciplinary follow-up program. Rev René [Internet]. 2014 Dec 21 [cited 2024 Apr 25]; 15(6). Available at: <http://periodicos.ufc.br/rene/article/view/3295>
 23. Enes CC, de Camargo CM, Justino MIC. Consumption of ultra-processed foods and obesity in adolescents. Rev Nutr. 2019;32.
 24. Cardel MI, Atkinson MA, Taveras EM, Holm JC, Kelly AS. Treatment of obesity among adolescents: a review of current evidence and future directions. JAMA Pediatr [Internet]. 2020 Jun 1 [cited 2024 Apr 25]; 174(6):609–17. Availability date: <https://pubmed.ncbi.nlm.nih.gov/32202626/>
 25. Branco BHM, Valladares D, de Oliveira FM, Carvalho IZ, Marques DC, Coelho AA, et al. Effects of Physical Exercise Order on Body Composition, Physical Fitness and Cardiometabolic Risk in Adolescents Participating in an Interdisciplinary Program Focused on the Treatment of Obesity. Fisiol Frontal [Internet]. 2019 [cited 2024 Apr 25]; 10 (AUG). Available at: <https://pubmed.ncbi.nlm.nih.gov/31447700/>
 26. Tiainen AM, Männistö S, Blomstedt PA, Moltchanova E, Perälä MM, Kaartinen NE, et al. Length of leukocyte telomeres and their relationship to food and nutrient intake in an elderly population. Eur J Clin Nutr [Internet]. 2012 Dec [cited 2024 Apr 25]; 66(12):1290–4. Available at: <https://pubmed.ncbi.nlm.nih.gov/23073262/>

27. Beserra JB, Soares NI da S, Marreiros CS, de Carvalho CMRG, E Martins M do C de C, Freitas B de J e. S de A, et al. Do children and adolescents who consume ultra-processed foods have a worse lipid profile? A systematic review. *Science and Public Health*. 2020; 25(12):4979–89.
28. Jaworowska A, Blackham T, Davies IG, Stevenson L. Nutritional challenges and health implications of takeaway and fast food. *Nutr Rev* [Internet]. 2013 May [cited 2024 Apr 25]; 71(5):310–8. Availability date: https://www.researchgate.net/publication/236205248_Nutritional_challenges_and_health_implications_of_takeaway_and_fast_food
29. Zolotarjova J, ten Velde G, Vreugdenhil ACE. Effects of multidisciplinary interventions on weight loss and health outcomes in morbidly obese children and adolescents [Internet]. 19, *Obesity Reviews*. Rev. Obes; 2018 [cited 2024 Apr 25]. p. 931-46. Available at: <https://pubmed.ncbi.nlm.nih.gov/29701298/>
30. Dornelles AD, Anton MC, Pizzinato A. The role of society and the family in care for childhood overweight and obesity: perception of health workers at different levels of care. *Health and Soc* [Internet]. 2014 [cited 2024 Apr 25]; 23(4):1275–87. Availability date: <https://www.scielo.br/j/sausoc/a/H9xy43YnMHLZnFxPjVysvvp/abstract/?lang=pt>

Worldwide research on calorie restriction in aging. A bibliometric study

Antonio Fernando MURILLO-CANCHO¹, David LOZANO-PANIAGUA¹, Francisco MANZANO-AGUGLIARO²,
Bruno José NIEVAS-SORIANO¹

1 Department of Nursing, Physiotherapy, and Medicine, University of Almeria.

2 Department of Engineering, University of Almeria.

Recibido: 31/mayo/2024. Aceptado: 17/junio/2024.

ABSTRACT

Background: Human aging is often associated with diseases that limit quality of life. Therapeutic anti-aging interventions, such as calorie restriction, can slow its progression. Analyzing the main areas of interest in the scientific literature allows us to understand the trends in research on calorie restriction in aging. This research aimed to conduct a comprehensive bibliometric analysis to determine the approaches and areas of research activity related to studying calorie restriction in aging and its use as a therapeutic intervention to slow its development.

Methods: A bibliometric analysis was conducted based on publications deposited in Scopus using its API and VOSViewer.

Results: A total of 5565 published documents were reviewed. The main keywords were analyzed and grouped into five study groups: risk factors and pathological consequences, biochemical mechanisms linked to caloric restriction and aging, experimental issues and clinical studies, functional aspects of the cell and caloric restriction, and his experimental study. The study shows the trend of increasing publications. Most of these articles are written in English and published in the United States.

Conclusions: Calorie restriction in aging is a topic of interest to researchers, and more research is needed to improve its understanding and therapeutic application.

KEYWORDS

Calorie restriction; aging; bibliometric, medicine antiaging, worldwide research.

INTRODUCTION

Human longevity is increasing globally, particularly in more developed countries. It is essential to ensure that people live longer and enjoy a high quality of life. The "anti-aging medicine" field aims to implement various studies to develop effective strategies for clinically slowing or limiting the aging process¹.

One of the most effective therapeutic interventions for delaying aging is dietary-metabolic modulation. This method generally involves restricting energy or nutrient intake while ensuring the individual does not experience malnutrition. This aspect is a priority, as it could negatively affect the individual's health².

The support for these strategies is based on their impact on various metabolic pathways studied to promote longevity in experimental models³. These pathways are responsible for the different physiological adaptations related to improvements in health.

Calorie restriction, a dietary intervention that involves reducing energy intake without causing malnutrition, holds immense potential. It is a well-researched non-genetic, non-pharmacological approach that has been shown to extend lifespan and promote health in experimental animals, sparking curiosity about its potential in humans.

Implementing energy restriction offers a ray of hope to individuals, providing enhanced protection against pathophysiological changes⁴ to aging. This includes heart and metabolic health, neurodegeneration, obesity, and cancer, instilling opti-

Correspondencia:
Antonio Fernando Murillo Cancho
afmurillo@ual.es

mism about the potential of calorie restriction as a therapeutic intervention.

The aging process affects the long human lifespan, various lifestyle habits, and non-physiological factors such as customs, culture, and socioeconomic conditions. However, it is challenging to assess the effectiveness of calorie restriction as a therapeutic tool for extending life. However, it is possible to improve overall health by following a diet with moderate energy restriction and balanced nutrients.

While there is limited and recent clinical research on controlled calorie restriction in humans, it is crucial to emphasize the need for more comprehensive and long-term studies. This urgency is underscored by the fact that certain important epidemiological aspects, such as mortality and longevity, have not been clearly defined yet.

Several clinical trials are being developed to evaluate various aspects of energy re-striction and its benefits in slowing the progression of age-related pathologies. Other factors related to good health have also been confirmed, including improved sleep quality, better mood, and increased sexual appetite. However, a lower mineral density in the bones was observed^{5,6}.

Caloric restriction and other dietary modifications have gained popularity for their potential health benefits. To date, no bibliometric analysis has examined the patterns of scientific literature in this area, which could help guide the development of future research. Bibliometric analysis is a valuable tool for quantitatively evaluating and interpreting literary production across various fields of study. This study method uses statistical techniques to analyze multiple publications, extracting useful information about patterns and trends in scientific research. Using bibliometric analysis makes it possible to obtain quality information on relevant publications, the direction of re-search trends in that field, and even the discovery of gaps or potholes in the development of research that are not detectable in any other way.

This research aimed to conduct a comprehensive bibliometric analysis to determine the approaches and areas of research activity related to studying calorie restriction in aging and its use as a therapeutic intervention to slow its development.

MATERIALS AND METHODS

To conduct this study, we searched the Scopus database and used its API to locate the articles published up to March 2024. Our research strategy was ((TITLE-ABS-KEY ("caloric restriction") AND TITLE-ABS- KEY (aging))). The data was recovered in April 2024.

The scientific clusters were analyzed based on keywords and the connections between countries or authors using the VOSViewer software version 1.6.20, which allows the construction of graphic representations of the relative distribution of bibliometric elements.

The software allows the analysis of the coexistence of keywords by graphically representing the relationships between keywords in a set of data or texts of the same type, such as selected scientific articles.

The processing of the information carried out makes it possible to identify different re-search groups and point out elements of high research productivity that make it possible to mark trends in research and its direction, providing interesting information.

The possibility of having a representation between keywords facilitates the identification and analysis of the most important themes of a set of texts, which, among other things, can serve to focus new research.

RESULTS

The search retrieved 5565 publications, which were analyzed in various aspects: research trends, distribution by countries and institutions, types of documents and languages, thematic category, sources and authors, country collaboration network, and keywords.

Research trends

The search for documents initially had a limited amount of time on production (Figure 1a). Research results on the subject were published regularly from 1998 onwards.

There has been a clear publishing trend since 2000, with the highest number of publications reached in 2013: 285. This trend has been consistent, with more than 200 literary contributions produced each year from 2006 to 2023, indicating that this is an emerging area of research.

The slight decrease in the years 2022 and 2023 is not very significant. This is especially true when considering that 86 articles were published in the first quarter of 2024 alone. This suggests that there may have been an extensive literary contribution throughout this year, confirming the positive trend in research interest in this subject.

3.2. Distribution by countries and institutions

The data we extracted indicates that at least 73 countries and 160 institutions have participated in contributing literature on the topic of study. Figure 1b shows the 15 nations that have published the most articles.

Seven countries published over 250 articles: the United States, Italy, and the United Kingdom were the most productive, contributing 2,925, 420, and 398, respectively. They comprise 52.6%, 7.54%, and 7.15%, over half of all global publications.

The most surprising thing about these results is China's remarkable capacity for literary production, which, in the first four months of 2024, has published practically half of the articles it produced throughout 2023.

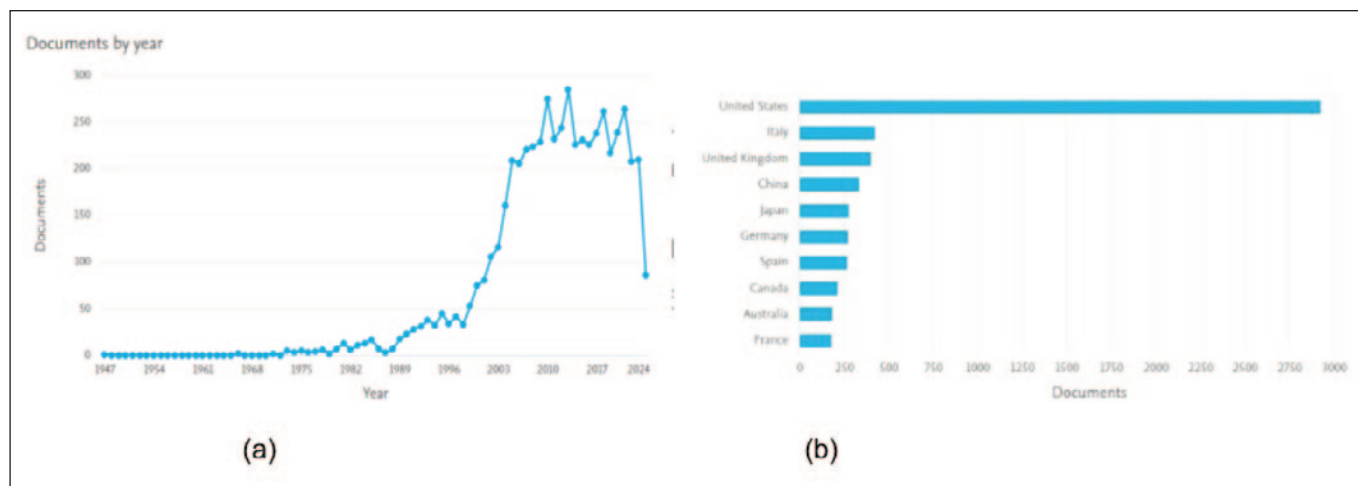


Figure 1. a) The trend over time in publications on calorie restriction in aging
 b) Publications by country (15 most productive countries)

The top 15 institutions that have published the most on this subject are in North America. Specifically, the institution with the highest affiliation contributing to the literature is the National Institute on Aging (NIA) (4%), followed by the University of Texas Health Sciences Center at San Antonio (3.45%) and the National Institutes of Health (NIH) (3.36%).

The first non-American institution that appears in the ranking of the most literary productive on the subject in ques-

tion is The University of Sydney, which is in 21st place in the ranking above.

Regarding citations, it's important to note that a group of authors from various European institutions has the most significant citations, totaling 10,875.

Table 2 displays the top ten most cited documents analyzing calorie restriction. Interestingly, none of them belong to the institutions with the most publications on the subject.

Table 1. Publications made by the institutions

Affiliation	Documents
National Institute on Aging (NIA)	224
University of Texas Health Science Center at San Antonio	192
National Institutes of Health (NIH)	187
Joe R. & Teresa Lozano Long School of Medicine	164
University of Wisconsin-Madison	161
University of Wisconsin School of Medicine and Public Health	139
Harvard Medical School	129
Pennington Biomedical Research Center	120
William S. Middleton Memorial Veterans Hospital	102
Washington University School of Medicine in St. Louis	94
Others	4.053

Types of documents and languages

The analysis of the published documents (Table 4) reveals that articles (55.5%) are the most frequently occurring document type, followed by reviews (29.8%). Conference papers (3.6%), book chapters (3.0%), editorials (2.7%), short surveys, (2.5%), notes (2.2%) and other document types collectively represent less than 0.7% of the analyzed records, indicating their lower frequency.

The analyzed documents have been written in 19 different languages. English is the most frequent language (97.2%). However, many publications appear in other languages, mainly French, Japanese, German, Chinese, and Spanish (1.9%). The remaining languages (<1%) include Russian, Italian, Ukrainian, Czech, Hungarian, Portuguese, Polish, Korean, Swedish, Persian, Malay, Greek, and Croatian. This diversity is not an issue for indexing in Scopus since it only requires that the title, abstract, and keywords be published in English, which is necessary for locating the publications.

Thematic category

The analysis considered various thematic areas within literary production on the subject. Most publications were in the field of biochemistry (40.0%), followed by medicine (28.6%). Other thematic areas such as were also represented although

Table 2. Most cited documents that analyze calorie restriction

Title	Authors	Year	Citations	Country
Free radicals and antioxidants in normal physiological functions and human disease	Valko, N. et al.	2.007	10,875	EUR
Oxidants, antioxidants, and the degenerative diseases of aging	Ames, B.N. et al.	1.993	5.573	USA
Resveratrol improves health and survival of mice on a high-calorie diet	Baur, J.A. et al.	2.006	3,802	USA
Mitochondria, oxidants, and aging	Balaban, R.S. et al.	2.005	3.576	USA
Small molecule activators of sirtuins extend <i>Saccharomyces cerevisiae</i> lifespan	Howitz, K.T. et al.	2.003	3.301	USA
Nutrient control of glucose homeostasis through a complex of PGC-1 α and SIRT1	Rodgers, J.T et al.	2.005	2.715	USA
Oxidative stress, caloric restriction, and aging	Sohal, R.S., Weindruch, R.	1.996	2.694	USA
Extending healthy life span from yeast to humans	Fontana, L. et al.	2.010	2.287	USA
The human intestinal microbiome in health and disease	Lynch, S.V., Pedersen, O.	2.016	2.185	USA
Oxidative damage and mitochondrial decay in aging	Shigenaga, M.K., Hagen, T.M., Ames, B.N.	1.994	1.875	USA

to a lesser extent, neuroscience (6.8%), nursing (5.4%), and pharmacology (3.5%). Mathematics and engineering had the lowest participation.

Sources and authors

During the period under review, we analyzed various journals that have published articles on calorie restriction and aging to assess research trends. This analysis allowed us to obtain valuable information on the results approach, quality, and visibility. In total, 159 journals have published articles on this topic. Table 3a lists the top ten journals where scientific collaborations have been published.

The scientific journals included in this analysis have each published more than 70 articles on the topic being studied. The provided table displays the ranking of these journals based on the total number of publications and the citations received for their contributions. The table also presents the leading bibliometric indicators for the top ten journals under review. It is worth noting that 4 of the top 10 WoS-JCR journals in this field are in the first quartile, while another four are in the second quartile, underscoring the significance of the researched topic. Regarding the number of publications, *Experimental Gerontology* leads the way, with 25% more publications than the next journal in the ranking, *Mechanisms Of Aging And Development*.

The author who contributed the most published documents (as shown in Table 3b) was D.K. Ingram from the Pennington Biomedical Research Center in Baton Rouge, United States,

followed by R. Weindruch from the University of Wisconsin School of Medicine and Public Health in Madison, United States. The author with the highest h-index (104) is Rafael De Cabo, who ranked sixth on the list of authors with the most published documents.

The analysis of the collaboration network among authors who have contributed more than 20 documents to the scientific literature is shown in Figure 4. The figure illustrates nine clusters, with the largest being red, including eleven authors, with Rafael De Cabo as a central member. The second most significant group is green, with five authors, followed by blue, yellow, and purple, each composed of four authors. Lastly, there are four groups - brown, cyan, orange, and light blue - each of 2 authors. Figure 2 displays the collaboration networks among authors with more than 20 documents on this topic.

Country Collaboration Network

A collaboration network has been established to show the countries of origin of the institutions responsible for the different research. Figure 3 displays the countries for each group and the leading country for each study.

The key countries in this collaboration network are the United States, United Kingdom, China, Spain, Italy, Germany, and South Korea. The largest group is led by the United Kingdom, which maintains strong connections with other Central European countries while being linked to other nations, particularly the United States.

Table 3a. Top ten journals where scientific collaborations have been published

Source Title	N	ISSN	SJR	SNIP	CS	JCR	IF
Experimental Gerontology	274	0531-5565	0.937	1.017	6.7	Q ₂	3.9
Mechanisms of Ageing and Development	203	0047-6374	1.380	1.124	9.9	Q ₂	5.3
Journals of Gerontology Series A Biological Sciences and Medical Sciences	194	1079-5006	1.703	1.522	9.9	Q ₂	5.1
Aging Cell	182	1474-9718	2.738	1.580	15.0	Q ₁	7.8
Ageing Research Reviews	109	1568-1637	3.007	2.673	17.5	Q ₁	31.1
Biogerontology	104	1389-5729	0.907	0.969	8.3	Q ₂	4.5
Age*	95	0161-9152			6.5	Q ₁ (2018)	
Aging**	90	0394-9532					
Annals of The New York Academy of Sciences	73	0077-8923	1.626	1.878	11.0	Q ₁	4.0
Rejuvenation Research	71	1549-1684	0.522	0.724	5.4	Q ₃	2.6

* Since 2017, known as GeroScience ISSN: 2509-2715 CS 9.6 SJR 1,570 SNIP 1,199 Q2 1.26 IF.

** Since 1989 known as Aging clinical and experimental research ISSN:1594-0667 CS 7.3 SJR 0.982 SNIP 1.306 Q2 0.83 IF.

Table 3b. Top 10 authors on caloric restriction in aging research

Rank	Author	N	h-index	Affiliation, Country	Most contributed topics [2018-2022]
1	Ingram, D.K	99	83	Pennington Biomedical Research Center, Baton Rouge, United States	Caloric Restriction; Animals; Fasting
2	Weindruch, R.	97	78	University of Wisconsin School of Medicine and Public Health, Madison, United States	Caloric Restriction; Animals; Fasting
3	Bartke, A.	75	86	SIU School of Medicine, Springfield, United States	Somatotropin Receptors; Animals; Laron Syndrome
4	Roth, G.S.	69	64	Prolongevity Technologies LLC, Pylesville, United States	Caloric Restriction; Animals; Fasting
5	Leeuwenburgh, C.	62	89	University of Florida College of Medicine, Gainesville, United States	Intermittent Claudication; Ankle Brachial Index; Peripheral Arterial Disease
6	De Cabo, R.	59	104	National Institute on Aging [NIA] Bethesda, United States	Caloric Restriction; Animals; Fasting
7	Lane, M.A.	57	47	National Institute on Aging [NIA], Bethesda, United States	
8	Fontana, L.	52	70	Faculty of Medicine and Health, Sydney, Australia	Caloric Restriction; Animals; Fasting
9	Chung, H.Y.	51	79	Pusan National University, Busan, South Korea	Melanogenesis; Monophenol Monooxygenase; Extract
10	Yu, B.P.	49	60	University of Texas Health Science Center at San Antonio, United States	Signal Transduction; Group III Histone Deacetylase; Srt1720

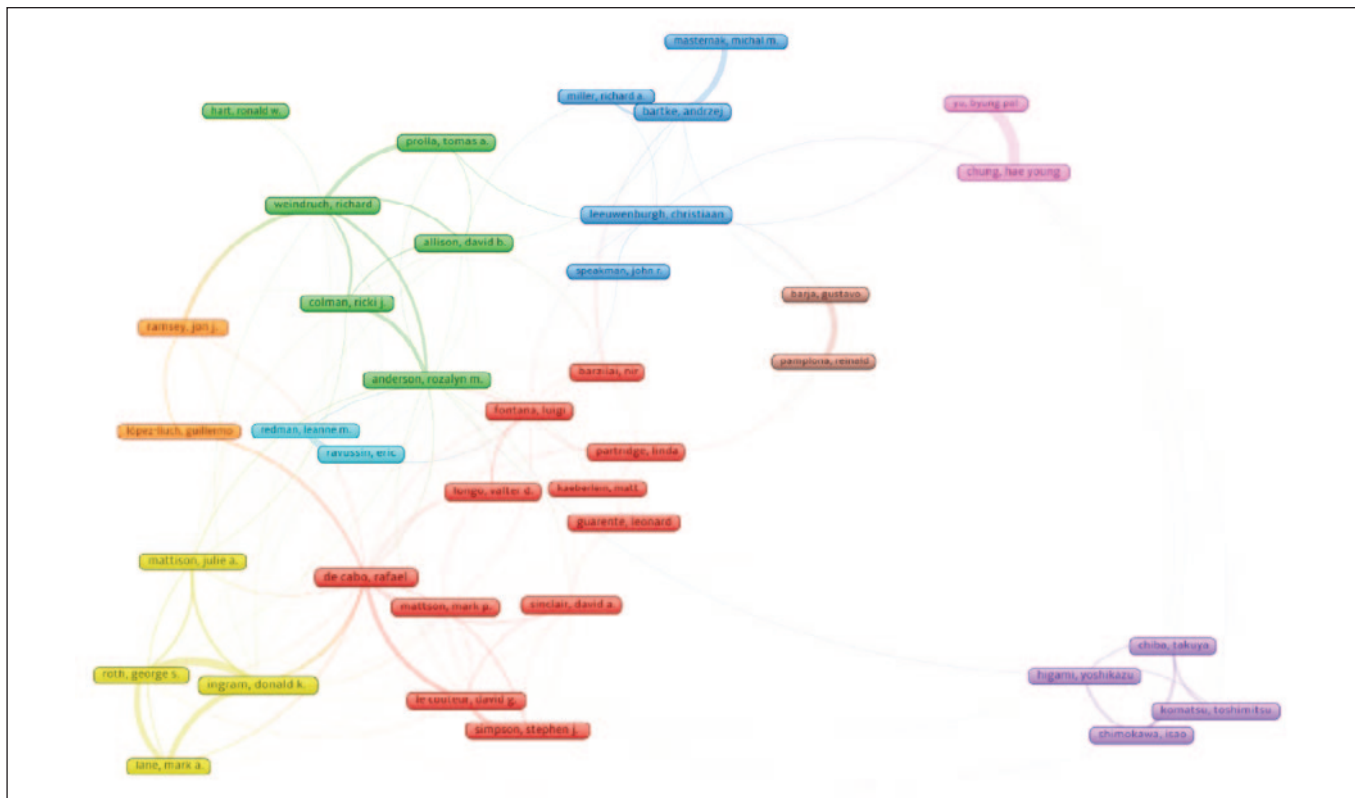


Figure 2. A network of authors who have published more than 20 articles on calorie restriction and aging

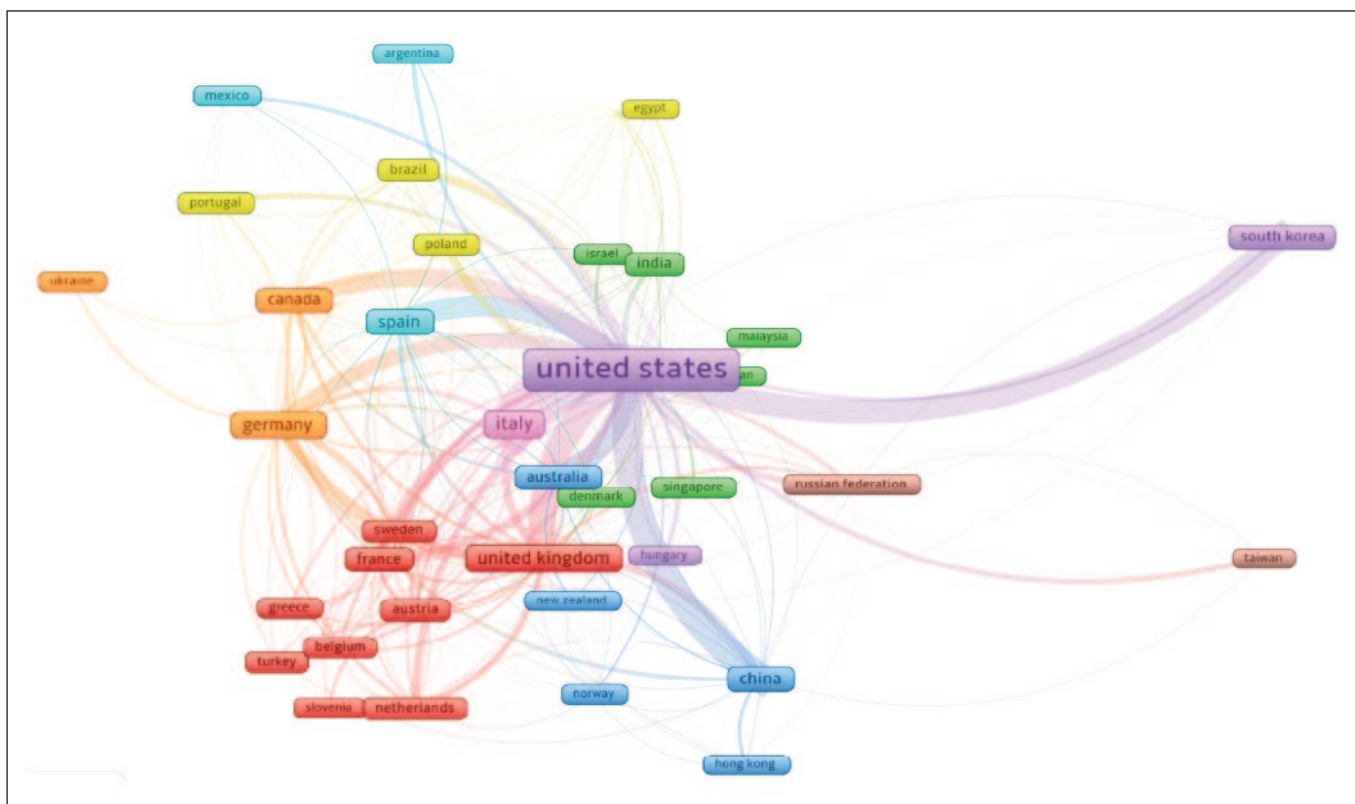


Figure 3. Countries network collaboration

The first group, led by China, cooperates with nearby countries such as Australia, New Zealand, and the United States. The second group, led by India, includes Israel, Malaysia, and Denmark. The third group, led by Germany, collaborates with Canada, the United States, and the United Kingdom. The fourth group, led by Spain, has connections with practically all the participating nations in this research.

However, the United States is the clear leader in directly connecting with the world's leading research nations. Also, to a lesser extent, there are small groups led by Russia and Italy.

Keywords

The primary keywords in the documents have been analyzed, including protein, aging, cell, calorie restriction, metabolism, longevity, priority, transcription, human, animal, and gene. A word cloud has been created to identify the most frequently used keywords in each topic efficiently. This approach has the potential to uncover areas within the field of research that need further attention and highlight those that are heavily researched from a bibliometric standpoint.

The keywords related to the research analyzed here have evolved, as shown in Figure 4a. The graph uses the size of the term to indicate its occurrence in a certain period and the color it has. More guides about the occurrence were provided during the period studied.

Our research found that older documents often contain keywords like body weight, animal experiment, body fat, and diet reduction. In contrast, recent publications feature sirtuin,

metformin, frailty, epigenesis, genetics, life extension, and intermittent fasting.

A network has been created with the main keywords used by the different research communities on the topic under study (Figure 4 b). In the graphic representation, the keywords are grouped into clusters of various colours depending on their defining keywords the green cluster groups terms related to the biochemical mechanisms linked to caloric restriction and aging. The blue cluster refers to words that point to aspects associated with experimental issues and clinical studies.

The red cluster is connected to topics related to risk factors and pathological consequences. The yellow cluster is associated with the functional aspects of the cell. Finally, the purple cluster encompasses words directly linked to calorie restriction and its study in experimental animals. A detailed description of the clusters with their keywords is shown in Table 4.

DISCUSSION

The main aim of this study was to analyze the scientific advances related to calorie restriction and aging. The bibliometric analysis includes all scientific and literary production to provide information on research trends, institutions, and countries. A total of 5565 publications, including 3089 articles and 1658 reviews, were included in this study. Publications in this field showed an increasing trend starting in 1999, reaching peak production in 2013. As far as we know, this is the first bibliometric analysis study specifically focused on caloric (energy) restriction and its relationship with the biological aging process.

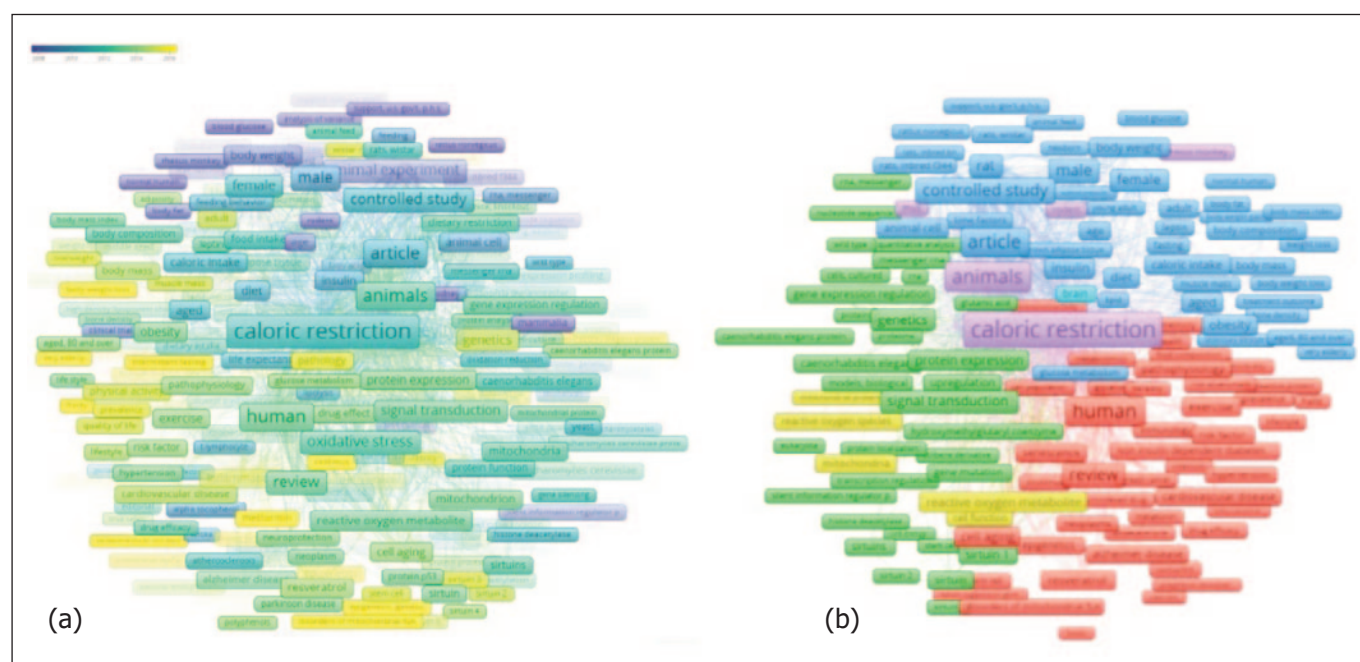


Figure 4. a) Evolution trend of keywords on calorie restriction in aging publications
b) Network of keywords on calorie restriction in aging publications

Table 4. The main keywords used by the communities detected the topic of calorie re-striction in aging

Colour Cluster	Keywords by cluster	Main Keywords	Topic
Red	382	Human/humans, review, inflammation, pathophysiology, senescence, degenerative disease	Risk factors and pathological consequences
Green	248	Signal transduction, protein expression, enzyme activity, gene expression, genetics	Biochemical mechanisms linked to calorie restriction and aging
Blue	216	Controlled study, male, female, article, animal cell, caloric intake, insulin, aged, animal experiment	Experimental issues and clinical studies
Yellow	82	Oxidative stress, reactive oxygen metabolite, mitochondria, reactive oxygen species	Functional aspects of the cell
Purple	67	Caloric restriction, priority journal, animals, nonhuman, longevity, life span, mouse	Calorie restriction and its experimental study

Most of the contributions consist of original articles in biochemistry and medicine written in English. The authors come from 160 different research centers in over 70 countries. The leading institutions in terms of literary production on this subject are the National Institute on Aging (NIA), the University of Texas Health Science Center at San Antonio, the National Institutes of Health (NIH), Joe R. & Teresa Lozano Long School of Medicine, University of Wisconsin-Madison, University of Wisconsin School of Medicine and Public Health, and Harvard Medical School. The most significant scientific production in this field comes from research centers in universities and medical schools, primarily in the United States. The United States publishes the most publications by a wide margin, leading to most institutions and citations related to this subject being from the United States.

A total of 159 authors contributed to this field. The most productive were Ingram, K., Weindruch, R., Bartke, A. Roth, G.S., Leeuwenburgh, C., and De Cabo, R., All with affiliations to American research centers.

When studying the effects of calorie restriction on aging, it's interesting to observe how the keywords associated with this topic have evolved. The earlier studies focused on experimental methods and included terms like age, animal experiment, mammalian, rodent, and body weight. However, in more recent research, there is a shift towards using terms such as sirtuins, epigenesis, genetic intermittent fasting, and disorders of mitochondrial function. The recent publications show a significant change in focus. They are now more interested in the mechanisms of action of calorie restriction and its potential benefits in aging, such as the role of sirtuins⁷. Likewise, the documents focus on studying physiological factors related to cells, such as mitochondrial dysfunction in aging⁸ or epigenetic effects⁹.

One objective of a bibliometric study is to analyze the keywords used by researchers in published documents and iden-

tify any connections between them. This aspect helps determine the scientific groups into which the different subjects of a study can be categorized^{10,11}.

The study of calorie restriction in aging often involves research on experimental animals such as nonhumans, mice, *Drosophila*, or *C. elegans*. This finding can be explained because testing dietary interventions focused on aging in humans is complex due to the long duration of human life and other factors that can influence aging independently of diet. Therefore, conducting numerous tests on experimental animals is necessary for this research¹².

When studying the keywords associated with the leading countries that have made significant contributions to scientific literature in this field, it is evident that the most prevalent ones are Caloric Restriction, Aging, Nonhuman, Animals, and Human.

The analysis of keyword clusters enables their classification into distinct groups based on research trends¹³. The subjects are grouped into five categories in our study. The most important one is "red," linked to risk factors and pathological consequences in aging. The keywords used guide toward the indicated topic and include terms such as human/humans, review, inflammation, pathophysiology, senescence, and degenerative disease. Aging is a degenerative physiological process that originates from various biological factors¹⁴ that imply the appearance of associated pathological problems due to different impairments in molecular and cellular functions^{15,16} that represent a deterioration in the quality of life of individuals. In the literature produced by this group, we also observe the presence of keywords related to oncological processes and degenerative diseases^{17,18}, as these pathological events share some biological mechanisms^{19,20}.

The cluster highlighted in green is the second most important based on the number of publications contributed. These documents study the biochemical mechanisms related to

calorie restriction and aging. Within this cluster, keywords such as sirtuin, signal transduction, protein expression, and longevity are prevalent. Calorie restriction is an intervention that can modulate metabolic processes associated with aging, with sirtuins playing a prominent role, for example^{21,22}. Understanding the mechanisms involved in the aging process and its associated diseases is essential for designing interventions to limit it, such as calorie restriction^{23,24}. Metabolic signaling pathways^{25,26} are a primary focus in understanding how to reduce the impact of aging on individuals.

The next most important group is the blue one related to experimental issues and clinical studies. The main terms that appear as keywords are controlled study, male, female, article, animal cell, caloric intake, insulin, aged, and animal experiment. The effects of potential interventions to limit the effects of aging, such as calorie restriction, can be measured and analyzed^{27,28}. This group includes certain words, such as insulin, which are closely linked to the metabolic changes resulting from calorie re-striction²⁹, and caloric intake, which refers to the energy amount ingested through the diet^{30,31,32}. We can expect new research on this topic in the coming years, as one of the most significant interests is to demonstrate the effectiveness of these dietary proposals in limiting the adverse effects of aging.

The fourth most important group, concerning the presence of keywords, has a much lower number than the previous ones. This group focuses on studying the functional aspects of the cell, including topics such as oxidative stress, reactive oxygen metabolite, mitochondria, and reactive oxygen species. Although this topic is related to the mechanisms of aging, which are primarily studied in another cluster, this group re-searches specific aspects of abnormal cellular functioning energy generation and the damage that can affect cells³³. They also discuss the investigation of oxidative processes^{26,34} as limiting factors in mitochondrial functionality that cause an abnormal metabolic response. Naturally, words related to antioxidant activity, such as manganese superoxide dismutase, are mentioned, as this action protects cells from damage caused by oxidizing agents that disturb mitochondrial functionality^{35,36}.

The purple group primarily researches caloric restriction and its impact on longevity, particularly in experimental animal models. The main keywords used in their research include caloric restriction, priority journal, animals, nonhuman, longevity, life span, and mouse. Since human life spans are too long to accurately measure the effects of different interventions on longevity and life expectancy, keywords such as mouse, animal, or nonhuman are used, as studies are conducted on much shorter-lived experimental animals, allowing for better evaluation of the interventions^{37,38}. Relating caloric restriction to lifespan or longevity is another area of interest for this re-search group, as it seeks to assess the effectiveness of various dietary strategies in aging^{39,40}. We understand

that extensive knowledge will soon be generated in this regard due to the conclusion of clinical trials showing their results in this field for the blue group.

Limitations and strengths

This research has some limitations. Despite being methodologically precise, it is impossible to guarantee that all documents have been extracted for production. The key-words used have attempted to cover most of the literature, although we understand that it is only sometimes possible when it comes to a topic as specific as the one that is the object of the study. This search could have been expanded by modifying the equation for this purpose and introducing other terms such as treatment or anti-aging effect. Still, we have considered the formula valid because it better adapts to the true meaning of the intended bibliometric evaluation. Furthermore, it can sufficiently define the search, as other bibliometric studies have similarly proposed, providing appropriate information to establish research trends in the chosen area. The quality of the documents analyzed was not a primary focus as they were not the main subject of the study. However, we acknowledge that the database from which the publications were retrieved ensures their quality. The scientific impact of the obtained documents should have been explicitly considered. Still, efforts were made to demonstrate the significance of the leading publishing journals we collaborated with, as they are ranked in the first two quartiles (9 out of 10) in terms of impact.

This study also has some strengths. The methodology used is not only rigorous but also systematic, a standard approach employed in many other areas of knowledge and published after review by prestigious publishers. This systematic and rigorous approach, combined with the use of Scopus as a database for document extraction, ensures the quality and credibility of the results obtained. Therefore, we believe that this study could serve as a solid foundation for future analyses to observe the progress of research trends in the chosen subject.

CONCLUSIONS

Although scientific literary production has decreased slightly in the last two years, there has been exciting progression during the first quarter of this year, and this trend is expected to continue. Additionally, different studies and clinical trials in humans regarding the analyzed topic are being concluded, and the publication of their results is likely to lead to an increase in published documents in the coming months.

The bibliometric analysis of caloric restriction in aging identified several research groups with different approaches within the literature. The study of risk factors and pathological consequences, biochemical mechanisms linked to caloric restriction, functional aspects of the cell, and the study of experimental calorie restriction are the most prominent.

New approaches will likely appear in the investigation of calorie restriction in aging, providing new dietary formulas, supported or not, in the presence of nutraceutical supplements that facilitate the completion and development of this as an effective therapeutic intervention capable of limiting the incidence of pathological events typical of advanced age. This is relevant to reduce the morbidity and mortality that aging produces. This research aims to minimize the frailty of older adults, improve their quality of life, and reduce the economic and social costs associated with aging and the dependency that it causes in older people.

Direct research toward assessing the economic and social cost of interventions focused on reducing the effects of aging to understand their potential impact on society. More studies are needed to address specific gaps in our knowledge, such as applying optimal dietary-nutritional interventions about caloric restriction and assessing their long-term results in the human race.

These findings are essential for understanding the research on calorie restriction in aging and determining future study trends.

REFERENCES

- Ok, S.-C. Insights into the Anti-Aging Prevention and Diagnostic Medicine and Healthcare. *Diagnostics (Basel)* 2022, 12, doi:10.3390/diagnostics12040819.
- Ros, M.; Carrascosa, J.M. Current Nutritional and Pharmacological Anti-Aging Interventions. *Biochim Biophys Acta Mol Basis Dis* 2020, 1866, 165612, doi:10.1016/j.bbadis.2019.165612.
- Green, C.L.; Lamming, D.W.; Fontana, L. Molecular Mechanisms of Dietary Restriction Promoting Health and Longevity. *Nat Rev Mol Cell Biol* 2022, 23, 56–73, doi:10.1038/s41580-021-00411-4.
- Fukuoh, T.; Nozaki, Y.; Mizunoe, Y.; Higami, Y. [Regulation of Aging and Lifespan by White Adipose Tissue]. *Yakugaku Zasshi* 2024, 144, 411–417, doi:10.1248/yakushi.23-00165-4.
- Most, J.; Gilmore, L.A.; Smith, S.R.; Han, H.; Ravussin, E.; Redman, L.M. Significant Improvement in Cardiometabolic Health in Healthy Nonobese Individuals during Caloric Restriction-Induced Weight Loss and Weight Loss Maintenance. *American Journal of Physiology-Endocrinology and Metabolism* 2018, 314, E396–E405, doi:10.1152/ajpendo.00261.2017.
- Martin, C.K.; Bhapkar, M.; Pittas, A.G.; Pieper, C.F.; Das, S.K.; Williamson, D.A.; Scott, T.; Redman, L.M.; Stein, R.; Gilhooly, C.H.; et al. Effect of Calorie Restriction on Mood, Quality of Life, Sleep, and Sexual Function in Healthy Nonobese Adults. *JAMA Intern Med* 2016, 176, 743, doi:10.1001/jamainternmed.2016.1189.
- Hall, J.A.; Dominy, J.E.; Lee, Y.; Puigserver, P. The Sirtuin Family's Role in Aging and Age-Associated Pathologies. *Journal of Clinical Investigation* 2013, 123, 973–979, doi:10.1172/JCI64094.
- Madreiter-Sokolowski, C.; Sokolowski, A.; Waldeck-Weiermair, M.; Malli, R.; Graier, W. Targeting Mitochondria to Counteract Age-Related Cellular Dysfunction. *Genes (Basel)* 2018, 9, 165, doi:10.3390/genes9030165.
- Hwangbo, D.-S.; Lee, H.-Y.; Abozaid, L.S.; Min, K.-J. Mechanisms of Lifespan Regulation by Calorie Restriction and Intermittent Fasting in Model Organisms. *Nutrients* 2020, 12, 1194, doi:10.3390/nu12041194.
- Salmerón-Manzano, E.; Garrido-Cardenas, J.A.; Manzano-Agugliaro, F. Worldwide Research Trends on Medicinal Plants. *Int J Environ Res Public Health* 2020, 17, doi:10.3390/ijerph17103376.
- Zupic, I.; Čater, T. Bibliometric Methods in Management and Organization. *Organ Res Methods* 2015, 18, 429–472, doi:10.1177/1094428114562629.
- Ros, M.; Carrascosa, J.M. Current Nutritional and Pharmacological Anti-Aging Interventions. *Biochim Biophys Acta Mol Basis Dis* 2020, 1866, 165612, doi:10.1016/j.bbadis.2019.165612.
- Niknejad, N.; Ismail, W.; Bahari, M.; Hendradi, R.; Salleh, A.Z. Mapping the Research Trends on Blockchain Technology in Food and Agriculture Industry: A Bibliometric Analysis. *Environ Technol Innov* 2021, 21, 101272, doi:10.1016/j.eti.2020.101272.
- López-Otín, C.; Blasco, M.A.; Partridge, L.; Serrano, M.; Kroemer, G. Hallmarks of Aging: An Expanding Universe. *Cell* 2023, 186, 243–278, doi:10.1016/j.cell.2022.11.001.
- Baechle, J.J.; Chen, N.; Makhijani, P.; Winer, S.; Furman, D.; Winer, D.A. Chronic Inflammation and the Hallmarks of Aging. *Mol Metab* 2023, 74, 101755, doi:10.1016/j.molmet.2023.101755.
- Moskalev, A.A.; Shaposhnikov, M. V.; Plyusnina, E.N.; Zhavoronkov, A.; Budovsky, A.; Yanai, H.; Fraifeld, V.E. The Role of DNA Damage and Repair in Aging through the Prism of Koch-like Criteria. *Ageing Res Rev* 2013, 12, 661–684, doi:10.1016/j.arr.2012.02.001.
- Barzilai, N.; Ferrucci, L. Insulin Resistance and Aging: A Cause or a Protective Response? *J Gerontol A Biol Sci Med Sci* 2012, 67, 1329–1331, doi:10.1093/gerona/gls145.
- Giunta, S. Exploring the Complex Relations between Inflammation and Aging (Inflamm-Aging): AntiInflammAging Remodelling of InflammAging, from Robustness to Frailty. *Inflamm Res* 2008, 57, 558–563, doi:10.1007/s00011-008-7243-2.
- Hall, J.A.; Dominy, J.E.; Lee, Y.; Puigserver, P. The Sirtuin Family's Role in Aging and Age-Associated Pathologies. *J Clin Invest* 2013, 123, 973–979, doi:10.1172/JCI64094.
- Szarc vel Szic, K.; Declerck, K.; Vidaković, M.; Vanden Berghe, W. From Inflammaging to Healthy Aging by Dietary Lifestyle Choices: Is Epigenetics the Key to Personalized Nutrition? *Clin Epigenetics* 2015, 7, 33, doi:10.1186/s13148-015-0068-2.
- Wątroba, M.; Szukiewicz, D. The Role of Sirtuins in Aging and Age-Related Diseases. *Adv Med Sci* 2016, 61, 52–62, doi:10.1016/j.advms.2015.09.003.
- Wątroba, M.; Dudek, I.; Skoda, M.; Stangret, A.; Rzdokiewicz, P.; Szukiewicz, D. Sirtuins, Epigenetics and Longevity. *Ageing Res Rev* 2017, 40, 11–19, doi:10.1016/j.arr.2017.08.001.
- Lee, M.B.; Hill, C.M.; Bitto, A.; Kaeberlein, M. Antiaging Diets: Separating Fact from Fiction. *Science* 2021, 374, eabe7365, doi:10.1126/science.abe7365.

24. Green, C.L.; Lamming, D.W.; Fontana, L. Molecular Mechanisms of Dietary Restriction Promoting Health and Longevity. *Nat Rev Mol Cell Biol* 2022, 23, 56–73, doi:10.1038/s41580-021-00411-4.
25. Madeo, F.; Carmona-Gutierrez, D.; Hofer, S.J.; Kroemer, G. Caloric Restriction Mimetics against Age-Associated Disease: Targets, Mechanisms, and Therapeutic Potential. *Cell Metab* 2019, 29, 592–610, doi:10.1016/j.cmet.2019.01.018.
26. Bárcena, C.; Mayoral, P.; Quirós, P.M. Mitohormesis, an Antiaging Paradigm. In: 2018; pp. 35–77.
27. Martin, C.K.; Bhapkar, M.; Pittas, A.G.; Pieper, C.F.; Das, S.K.; Williamson, D.A.; Scott, T.; Redman, L.M.; Stein, R.; Gilhooly, C.H.; et al. Effect of Calorie Restriction on Mood, Quality of Life, Sleep, and Sexual Function in Healthy Nonobese Adults: The CALERIE 2 Randomized Clinical Trial. *JAMA Intern Med* 2016, 176, 743–752, doi:10.1001/jamainternmed.2016.1189.
28. Velingkaar, N.; Mezhnina, V.; Poe, A.; Makwana, K.; Tulsian, R.; Kondratov, R. V. Reduced Caloric Intake and Periodic Fasting Independently Contribute to Metabolic Effects of Caloric Restriction. *Aging Cell* 2020, 19, doi:10.1111/ace1.13138.
29. Cypser, J.R.; Kitzenberg, D.; Park, S.-K. Dietary Restriction in *C. Elegans*: Recent Advances. *Exp Gerontol* 2013, 48, 1014–1017, doi:10.1016/j.exger.2013.02.018.
30. Green, C.L.; Lamming, D.W.; Fontana, L. Molecular Mechanisms of Dietary Restriction Promoting Health and Longevity. *Nat Rev Mol Cell Biol* 2022, 23, 56–73, doi:10.1038/s41580-021-00411-4.
31. Martucci, M.; Ostan, R.; Biondi, F.; Bellavista, E.; Fabbri, C.; Bertarelli, C.; Salvioli, S.; Capri, M.; Franceschi, C.; Santoro, A. Mediterranean Diet and Inflammaging within the Hormesis Paradigm. *Nutr Rev* 2017, 75, 442–455, doi:10.1093/nutrit/nux013.
32. Weiss, E.P.; Racette, S.B.; Villareal, D.T.; Fontana, L.; Steger-May, K.; Schechtman, K.B.; Klein, S.; Holloszy, J.O.; Washington University School of Medicine CALERIE Group Improvements in Glucose Tolerance and Insulin Action Induced by Increasing Energy Expenditure or Decreasing Energy Intake: A Randomized Controlled Trial. *Am J Clin Nutr* 2006, 84, 1033–1042, doi:10.1093/ajcn/84.5.1033.
33. Harman, D. Origin and Evolution of the Free Radical Theory of Aging: A Brief Personal History, 1954–2009. *Biogerontology* 2009, 10, 773–781, doi:10.1007/s10522-009-9234-2.
34. Yee, C.; Yang, W.; Hekimi, S. The Intrinsic Apoptosis Pathway Mediates the Pro-Longevity Response to Mitochondrial ROS in *C. Elegans*. *Cell* 2014, 157, 897–909, doi:10.1016/j.cell.2014.02.055.
35. Tavalalaie, M.; Voshtani, R.; Deng, X.; Qiao, Y.; Jiang, F.; Collman, J.P.; Fu, L. Moderation of Mitochondrial Respiration Mitigates Metabolic Syndrome of Aging. *Proceedings of the National Academy of Sciences* 2020, 117, 9840–9850, doi:10.1073/pnas.1917948117.
36. Chen, G.; Kroemer, G.; Kepp, O. Mitophagy: An Emerging Role in Aging and Age-Associated Diseases. *Front Cell Dev Biol* 2020, 8, doi:10.3389/fcell.2020.00200.
37. Hodge, B.A.; Meyerhof, G.T.; Katewa, S.D.; Lian, T.; Lau, C.; Bar, S.; Leung, N.Y.; Li, M.; Li-Kroeger, D.; Melov, S.; et al. Dietary Restriction and the Transcription Factor Clock Delay Eye Aging to Extend Lifespan in *Drosophila Melanogaster*. *Nat Commun* 2022, 13, 3156, doi:10.1038/s41467-022-30975-4.
38. Rana, A.; Oliveira, M.P.; Khamoui, A. V.; Aparicio, R.; Rera, M.; Rossiter, H.B.; Walker, D.W. Promoting Drp1-Mediated Mitochondrial Fission in Midlife Prolongs Healthy Lifespan of *Drosophila Melanogaster*. *Nat Commun* 2017, 8, 448, doi:10.1038/s41467-017-00525-4.
39. Speakman, J.R.; Mitchell, S.E.; Mazidi, M. Calories or Protein? The Effect of Dietary Restriction on Lifespan in Rodents Is Explained by Calories Alone. *Exp Gerontol* 2016, 86, 28–38, doi:10.1016/j.exger.2016.03.011.
40. Campanella, A.; Misciagna, G.; Mirizzi, A.; Caruso, M.G.; Bonfiglio, C.; Aballay, L.R.; Vas de Arruda Silveira, L.; Bianco, A.; Franco, I.; Sorino, P.; et al. The Effect of the Mediterranean Diet on Lifespan: A Treatment-Effect Survival Analysis of a Population-Based Prospective Cohort Study in Southern Italy. *Int J Epidemiol* 2021, 50, 245–255, doi:10.1093/ije/dyaa222.

Effect of Nusantara diet feeding with triglyceride glucose index as a measure of insulin resistance in individuals' metabolic syndrome risk

Rahma WIDIANA¹, Agussalim BUKHARI¹, AMINUDDIN¹, Nurpudji A TASLIM¹, Haerani RASYID², Yasmin SYAUKI¹

¹ Department of Clinical Nutrition, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia.

² Department of Internal Medicine, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia.

Recibido: 24/abril/2024. Aceptado: 20/junio/2024.

ABSTRACT

Background: Both young individuals and the elderly are affected by the increased prevalence of metabolic syndrome. The main component of this illness, insulin resistance, can be made worse by Indonesian diets heavy in fat. On the other hand, virgin coconut oil, an essential component of the traditional Nusantara diet, may help control metabolic syndrome and increase insulin sensitivity.

Objective: Assess the effect of the Archipelago Diet on insulin resistance in individuals at risk of metabolic syndrome as measured by the TyG Index assessment.

Methods: The study used a parallel clinical trial with a pre-posttest randomized design to compare insulin resistance between groups using HOMA-IR values. Fifty subjects were divided into intervention and control groups. Conducted at the Department of Nutritional Sciences, Faculty of Medicine, Hasanuddin University, Makassar, data collection took place from September to December 2022, followed by data processing and analysis in January 2023.

Results: The results showed that after 2 months of the Nusantara diet, there was a decrease in body weight, body mass index (BMI), and abdominal circumference in the intervention group compared to the control group. Specifically, the intervention group experienced a 3.2% decrease in body weight ($p = 0.587$), a 3.1% decrease in BMI ($p = 0.603$), and a 4.2% decrease in abdominal circumference ($p = 0.100$). The control group experienced a 1.1% decrease in body

weight ($p = 0.587$), a 0.7% decrease in BMI ($p = 0.603$), and a 1.1% decrease in abdominal circumference ($p = 0.100$).

Conclusion: The Nusantara diet for 2 months showed no significant effect on the TyG Index of individuals at risk of metabolic syndrome.

KEYWORDS

Metabolic Health, Nutritional Therapy, Archipelago, Insulin Sensitivity.

INTRODUCTION

Metabolic syndrome is a global public health problem associated with an increased risk of cardiovascular disease, diabetes mellitus, and stroke^{1,2}. Based on Global Burden of Disease (GBD) data from 1990 to 2010, the prevalence of metabolic syndrome in the world is 82%, with 11.9% to 31.1% occurring in Asia Pacific. Basic Health Research (Riskesmas) in 2018 showed an increase in the prevalence of non-communicable diseases compared to Riskesdas 2013, where at the age of over 15 years the prevalence of central obesity reached 31.0%³. In addition, based on Riskesdas 2018, 19 provinces have a high prevalence of central obesity, one of which is the South Sulawesi Province at 32%⁴.

Metabolic syndrome is associated with an increased risk of cardiovascular disease, type-2 diabetes, and stroke. Metabolic syndrome is more prevalent in men than women, but in recent years, the prevalence has increased in younger women⁵. Genetic factors, physical activity, and diet or type of diet influence the occurrence of insulin resistance^{6,7}. Insulin resistance can be assessed using the homeostatic model assessment-insulin resistance (HOMA-IR) or quantitative insulin sensitivity check index (QUICKI) and the Triglyceride Glucose

Correspondencia:

rahmawidiana2@gmail.com

agussalim.bukhari@med.unhas.ac.id

Index (TyG Index)⁸. TyG index is a formula derived from the product of fasting triglyceride and glucose levels that is more effective in assessing insulin resistance in healthy adults⁹.

Indonesian food is characterized by being fatty and coconut milk-based, so it is considered an unhealthy food because it contains a lot of coconut milk¹⁰. Coconut milk is a white-colored vegetable juice derived from grated coconut fruit that is squeezed and filtered, where the coconut fruit is squeezed and filtered¹¹. Indonesia as one of the countries in Southeast Asia, has a diet or diet with a tendency to compose a fairly high amount of fat, which is 25-30% of total calories, where the fat that characterizes Indonesian cuisine is saturated fat¹². In Alatawi and Alshubaily's research in 2021, on experimental animals (Wistar rats) injected with streptozotocin (STZ), there were significant improvements in blood sugar levels, HbA1c, triglycerides, total cholesterol, LDL, creatinine, total protein, albumin after receiving coconut product intervention¹³.

Coconuts are native to the coasts of the Indian Ocean, including Indonesia¹⁴. One of the regional foods in Indonesia with a mixture of coconut milk or processed coconut it is a food originating from Minangkabau Padang City, West Sumatra Province¹⁵. In addition to coconut milk, the use of vegetables along with spices such as turmeric, nutmeg, onions, pepper, and so on are also used in these food preparations¹⁶. In addition to West Sumatra, coconut milk and coconut products are also used in various regions in Indonesia such as Java¹⁷. In the 2004 Lipoeto NI study of a population with a high risk of chronic heart disease in West Sumatra, a diet with the name Nusantara diet was developed where Nusantara is a word used by Indonesians to describe the islands from Sabang to Merauke, where the Nusantara diet developed in West Sumatra is a diet with the characteristic of using coconut milk and processed coconut as an ingredient in the diet menu, which consists of 23-27% fat, 53-58% carbohydrates, and at least 50 grams of protein. In addition, the Archipelago Diet has also been developed in several regions in Indonesia such as Medan¹⁸.

The Nusantara Diet study on Body Composition, Insulin Resistance, and Lipid Profile in Patients with Metabolic Syndrome Risk, where this study was conducted to assess changes in the TyG Index as a marker of insulin resistance in individuals at risk of metabolic syndrome who were given the Nusantara Diet for 2 months compared to the control group. The Nusantara Diet is a balanced menu dietary guide made from local Makassar city food, made from fish, accompanied by vegetables, spices, and coconut or its processed products.

METHODOLOGY

This study is experimental research, with a parallel clinical trial, with pre-posttest randomized design and open trial study to compare insulin resistance from HOMA-IR value between the Nusantara diet group (DN group) and control group (K group). The research site was at the Department of Nutritional

Sciences, Faculty of Medicine, Hasanuddin University, Makassar. Data collection was planned from September to December 2022, and then data processing and analysis continued in January 2023. The study population was all participants who worked as paramedics and residents at Wahidin Sudirohusodo Hospital from September to December 2022. The number of research samples was determined by consecutive sampling method. The sample size for each group was calculated based on the 2002 Madiyono formula. The number of samples required was 48 research subjects but rounded up to 50 research subjects, which were divided into two groups, namely the intervention group and the control group with each group consisting of 25 research subjects.

Research Subject Criteria is participants eligible for inclusion in the study were male or female, aged between 18 and 60 years old, with an abdominal circumference greater than 90 cm for men and greater than 80 cm for women, and a body mass index (BMI) of ≥ 25 kg/m² at the initial assessment. They had to provide written consent to participate in the study by signing the consent form. Individuals excluded from the study were those who were pregnant or breastfeeding and those with allergies to coconut-based or processed foods. Participants were considered to have dropped out of the study if they refused to adhere to the research guidelines, declined to continue participating, or became seriously ill or deceased during the study period.

The confidentiality of the research data was guaranteed and the research procedures and protocols were approved by the Health Research Ethics Commission of the Faculty of Medicine, Hasanuddin University, Makassar, with Number: 510/UN4.6.4.5.31/PP36/2022.

The Archipelago Diet is a healthy eating guide that uses traditional Indonesian foods to reduce the risk of metabolic syndrome. In this study, it uses typical Makassar foods, such as fish, vegetables, coconut, and spices. The Nusantara Diet has a breakfast, snack, and dinner menu with a choice of total calories per day. The control group did not receive the Nusantara Diet but received counseling on healthy eating. Metabolic syndrome risks include obesity, high blood sugar, high blood pressure, and high triglycerides. Insulin resistance is the body's inability to respond effectively to insulin and was measured by the TyG Index. Physical activity was assessed using the IPAQ scale. The International Physical Activity Questionnaire (IPAQ) is an assessment tool used globally to measure a person's level of physical activity. The IPAQ collects information about the frequency, duration, and intensity of the physical activity performed by individuals during certain periods, such as walking, moderate activity, and high-intensity activity. The tool is designed to provide a comprehensive overview of a person's physical activity patterns in daily life, and can be used in public health research, epidemiological research, as well as in clinical practice to evaluate the risk of lifestyle-related diseases and monitor the effectiveness of physical interventions¹⁹.

Study subjects were recruited through flyers on WhatsApp after approval from the Ethics Committee. Demographic, dietary intake, and physical activity data were collected. Anthropometric and blood pressure measurements were taken. Subjects were divided into two groups: Diet Nusantara (DN) and control (K). DN received box lunches for 8 weeks with Diet Nusantara guidelines, while K only counseling. Blood was checked before and after the study after an 8-hour fast. Data were presented in tabular form and statistically analyzed.

The collected data were grouped by type for statistical analysis. Normality tests were performed using the Mann-Whitney Test, Wilcoxon test, and independent t-test using SPSS software version 26. Analysis was performed to compare the values of abdominal circumference, fasting blood sugar, triglycerides, and TyG Index at the beginning of the

study (day 0) and the end of the study (day 56). The results were used to test the hypotheses, where results were considered statistically significant if the p-value was ≤ 0.05 , insignificant if the p-value was > 0.05 , and highly significant if the p-value was ≤ 0.05 .

RESULTS AND DISCUSSION

Results

This study showed that the study was dominated by women, where the number of women was 34 people consisting of 18 people in the intervention group and 16 people in the control group. The gender characteristics of respondents in this study were equal ($p = 0.762$). The characteristics of the research subjects are described in Table 1 which shows there is no statistically significant difference in the charac-

Table 1. Characteristics of the research subjects between the DN group and the Control group

Subject Characteristics	Group DN		Control Group		p-value		
	n	%	n	%			
Gender					0.762		
Male	7	28.00	9	36.00			
Women	18	72.00	16	64.00			
	Group DN			Control Group			
	Mean	SD	Median	Mean	SD	Median	
Age	34.32	5.50	35.00	35.84	8.19	35.00	0.741 ^a
TB (cm)	158.50	6.85	157.00	159.84	7.18	158.00	0.613 ^a
BW (kg)	76.80	14.35	72.50	76.45	8.78	77.30	0.587 ^a
BMI (kg/m ²)	30.37	3.72	30.93	29.90	2.61	29.63	0.603 ^b
LP (cm)	100.18	8.77	100.00	96.56	6.28	96.50	0.100 ^b
GDP	91.88	9.88	88.00	86.60	11.88	87.00	0.094 ^b
24 Hour Recall:							
Energy (kcal)	1931.15	165.09	1880.0	1980.9	173.54	1952.5	0.284 ^b
Protein (gr)	87.83	6.82	87.40	88.24	13.40	88.80	0.894 ^b
Carbohydrate (gr)	296.07	28.28	288.00	307.63	21.74	309.00	0.119 ^b
Fat (gr)	51.70	10.73	55.80	51.70	9.12	51.02	0.997 ^b
IPAQ Score							
High Activity	312.00	513.81	0.00	348.80	746.06	0.00	0.92 ^a
Medium Activity	529.60	759.28	300.00	620.00	1362.30	80.00	0.35 ^a
Light Activity	1540.40	1888.30	594.00	2028.00	2643.80	990.00	0.62 ^a
Total	2382.00	2416.50	1470.00	2996.80	3504.90	1710	0.60 ^a

^a Mann-Whitney test; ^b independent t-test; BW: Weight; TB: Height; BMI: Body Mass Index; LP; Abdominal Circumference.

teristics of the research subjects between the DN group and the control group assessed in terms of age ($p = 0.741$), BMI ($p = 0.603$), abdominal circumference, ($p = 0.100$), GDP ($p = 0.094$) and LP. In addition, the initial data of food recall in 24 hours in both groups were also not statistically significant consisting of energy ($p = 0.284$), protein ($p = 0.894$) and fat ($p = 0.997$). The body weight, BMI, and abdominal circumference of the intervention group after treatment were lower than those of the control group, although the differences were not significant based on statistical tests. Then each research subject in both groups was asked to complete an IPAQ form to assess the level of activity performed. During the study, both groups were asked not to increase or decrease activities that could cause changes in activity levels and changes in IPAQ scoring. There was no significant difference between the two groups in activity levels based on IPAQ scores, namely high activity ($p = 0.929$), moderate activity ($p = 0.353$), and light activity ($p = 0.267$).

Differences between Triglyceride, GDP, and TyG Index levels between DN and control groups

Table 2 shows that both groups experienced insulin resistance as indicated by the TyG Index results although the difference between Triglyceride levels, and TyG Index between the DN group and the control group before and after the intervention

was not statistically significant. Where in the DN group showed Δ TG -6.88 ($p = 0.989$), Δ GDP -5.08 ($p = 0.012$), and Δ TyG Index -0.07 ($p = 0.459$), although only Δ GDP was statistically significant. While in the control group, there was an increase in TG levels, and TyG Index where Δ TG 15.48 ($p = 0.898$), and Δ TyG Index 0.02 ($p = 0.424$), although there was a decrease in GDP where Δ GDP -1.24 ($p = 0.112$).

Food recall data in the intervention group with the control group during the study are described in the table in the appendix. The results showed a statistically significant difference in energy, protein, carbohydrate, and fat recall between the DN intervention group and the control group ($p < 0.001$). Overall, the results showed that the GDP value in the intervention group decreased compared to the pre-intervention GDP value although it was not statistically significant. In addition, TyG index and GDP values in the intervention group decreased but there was no statistically significant difference compared to the control group.

DISCUSSION

The results of this study showed that the Archipelago Diet with caloric restriction caused a decrease in BW accompanied by a decrease in LP that occurred in the DN intervention group compared to the control group. This is supported by the recall results in Table 2 which show a lower recall of en-

Table 2. Differences between Triglyceride, GDP, and TyG Index levels between DN and control groups

Group	Group DN			Control group			p-value
	Mean	SD	Median	Mean	SD	Median	
TG Pre	126.84	56.47	108.00	134.28	42.19	131.00	0.600 ^b
TG Post	119.96	36.54	109.00	149.76	61.20	133.00	0.093 ^a
Δ TG	-6.88	47.88	0.00	15.48	58.02	-2.00	0.600 ^a
p-value		0.989^{c*}			0.898^{c*}		
GDP Pre	91.88	9.88	88.00	86.6	11.88	87.00	0.094 ^b
GDP Post	86.80	10.72	85.00	85.36	24.65	83.00	0.207 ^a
Δ GDP	-5.08	9.49	-3.00	-1.24	23.28	-2.00	0.620 ^a
p-value		0.012^{c*}			0.112^{c*}		
TyG Index Pre	4.67	0.22	4.60	4.66	0.17	4.61	0.828 ^b
TyG Index Post	4.60	0.15	4.57	4.68	0.20	4.63	0.123 ^a
Δ TyG Index	-0.06	2.48	-0.40	0.03	0.03	0.02	0.211 ^b
p-value		0.459^{c*}			0.424^{c*}		

^a Mann-Whitney test; ^b independent t-test; ^c Wilcoxon test; TG: Tryglicerides; GDP: Fasting Blood Glucose; TyG Index for Insulin Resistance; Δ Difference between post and pre results; $p < 0.05$ was considered significant.

ergy, protein, carbohydrates, and fat in the DN intervention group compared to the statistically significant control group ($p < 0.001$). Where LP more than 80 cm in women and more than 90 cm in men is a risk of metabolic syndrome. The relationship between LP reduction and the risk of metabolic syndrome is quite significant, whereas Normadin's research (2017) shows that calorie restriction accompanied by resistant exercise can significantly reduce LP in metabolic syndrome groups with central obesity, and hypertension. In addition, LP can serve as a practical screening method to detect the presence of metabolic risk in individuals with excessive body weight or obesity. In addition, a decrease in LP illustrates a decrease in BW where a 1 cm decrease in LP is equivalent to a 0.6 kg decrease in BW²⁰.

This is in line with the research of Julia et al. (2020) and Montefusco (2021) which shows that calorie restriction can cause a decrease in body weight in obese individuals, where a decrease in body weight will reduce BMI, LP, GDP, and HOMA IR as a marker of insulin resistance as in Montefusco's research (2021) on eighteen men with metabolic syndrome who experienced calorie restriction and experienced a 5% decrease in body weight²¹. This is related to improvements in lipid profiles and levels of pro-inflammatory cytokines in the periphery which play a role in the mechanism of insulin resistance which increases the risk of cardiometabolic diseases such as coronary heart disease, and Type 2 Diabetes Mellitus²². The high intake of fiber in the Nusantara Diet meal plan is also one of the factors that play a role in weight loss, this is in line with Tremblay's research (2020) which states that fiber intake is an important variable that plays a role in diet programs for weight loss²³.

This study also showed that there was a decrease in TG levels even though it was not statistically significant in the Nusantara Diet intervention group which received calorie restriction accompanied by a meal plan and lunch with a total of 1700 kcal, 1500 kcal, and 1300 kcal calories served with a balanced menu consisting of 23-27% fat, 53-58% carbohydrates, and a minimum of 50 grams of protein, as well as containing a minimum of 20 grams of fiber/day and containing enough micronutrients. This is in line with research conducted by Sun (2023) on 72 research subjects who underwent calorie restrictions accompanied by carbohydrate restrictions for up to 12 days. which shows that calorie restrictions without carbohydrate restrictions do not reduce triglyceride levels, while calorie restrictions accompanied by carbohydrate restrictions can reduce triglyceride levels, due to the mechanism of gluconeogenesis where triglycerides are converted into glucose to produce energy or ATP so that with carbohydrate restrictions accompanied by calorie restriction can reduce triglycerid levels in the body²⁴.

The presence of fiber in the Archipelago Diet also leads to improvements in the gut microbiota that play a role in mechanisms such as increased SCFA production, and modulation

of genes related to lipid metabolism²⁵. In addition, fiber has a bulking effect that causes an increase in satiety, and suppression of glucose absorption, adequate amounts of fiber in the Nusantara Diet also play a role in reducing body weight and glucose levels even though it is not statistically significant²⁶. This is also because fiber causes a rapid satiety mechanism, due to an increase in food transit time in the intestine, thereby reducing excess food consumption, and also reduces glucose absorption in the intestine due to increased intraluminal viscosity and increased macronutrient absorption time accompanied by increased release of Ghrelin and peptide YY²⁷.

The results of this study showed a decrease in the TyG Index in the Nusantara Diet group even though it was not statistically significant. Where this study showed fiber intake in the intervention group with the Nusantara diet did not reach 20 gr/day, presumably due to complaints or lack of compliance of the research subjects with the meal plan that had been given, so that the TyG index decreased but was not statistically significant. It is known that high fiber intake, which is degraded by the gut microbiota into short-chain fatty acids (SCFA), can improve insulin sensitivity or insulin resistance. Although the decrease in the TyG index was not statistically significant, the decrease in the TyG index only occurred in the Nusantara Diet group and did not occur in the control group. This could be due to the protein content, especially processed fish containing Omega 3 in the Nusantara Diet menu which plays a role in improving insulin resistance²⁸.

Research by Marta Chacińska et al (2019), using Wistar rats divided into three groups: standard-control diet (SD), high-fat diet (HFD), and high-fat diet + fish oil (HFD+FO) where the high-fat diet + fish oil (HFD+FO) significantly decreased plasma insulin concentrations and the Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) index²⁹. In addition, OMEGA-3 fatty acid supplementation improves insulin sensitivity and prevents insulin resistance. This is in line with research showing that consumption of 2 g omega-3 daily for 3 months in T2DM patients with NAFLD significantly improved β -cell function and IL-6³⁰. Nazarii Kobylak's research (2020) also showed improvements in triglyceride levels in the group that received fish oil intervention as well as glucose and C-peptide³¹.

In the results of this study, there was a decrease in GDP levels in the Nusantara Diet intervention group even though it was not statistically significant. This is because the meal plan given did not include the number of spices used in the meal plan so there was no uniform effect in reducing GDP or TyG index. It is known that spices that are rich in polyphenols such as garlic, shallots, ginger, turmeric, and chili, which are isoflavonoids contained in these spices are antioxidants that play a role in improving blood sugar regulation. Where the gingerol content contained in ginger can inhibit α -glucosidase and α -amylase, and increase glucose uptake in skeletal mus-

cle cells, which occurs through translocation of the GLUT4 glucose transporter to the surface of the muscle cell plasma membrane to insert GLUT4 into muscle cell plasma and increase insulin receptor GLUT protein and improve pancreatic cell function and also inhibit the liver "glucose 6-phosphatase" enzyme, which converts glucose 6-phosphate into glucose. This causes ginger phenolic compounds (gingerol and shogaol) to play a role in increasing insulin secretion and cell sensitivity and reducing the amount of reactive oxygen species in pancreatic beta cells³².

ADVANTAGES OF RESEARCH

The strength of this study is that it is a branch of the Nusantara Diet research tree with the development of the Nusantara Diet based on local Indonesian food, so that in terms of the taste of dietary dishes according to people's tastes and used as a healthy dietary pattern in helping to improve the risk of metabolic syndrome carried out by examining the TyG index as a marker for examining the presence of insulin resistance that is applicable, effective and affordable for use in daily practice. The weaknesses in the results of this study indicate that the provision of the Nusantara Diet in the Nusantara Diet intervention group reduces the levels of TG, GDP, and TyG Index although not statistically significant due to the compliance and level of compliance of participants with the meal plan provided, as well as the absence of the number of spices in the meal plan so that the effect of polyphenols and isoflavone derived from these spices is not optimal in improving insulin resistance.

ACKNOWLEDGMENT

This study is part of the Collaborative Research Programme Indonesia by Indra et al with the branch of the Nusantara Diet Study on Body Composition, Insulin Resistance, and Lipid Profile in Patients with Metabolic Syndrome Risk.

REFERENCES

1. Alshammary AF, Alharbi KK, Alshehri NJ, Vennu V, Khan IA. Metabolic syndrome and coronary artery disease risk: A meta-analysis of observational studies. *Int J Environ Res Public Health*. 2021;18(4):1-17.
2. Gonzalez-Chávez A, Chávez-Fernández JA, Elizondo-Argueta S, González-Tapia A, León-Pedroza JI, Ochoa C. Metabolic Syndrome and Cardiovascular Disease: A Health Challenge. *Arch Med Res*. 2018;49(8):516-21.
3. Indonesian Ministry of Health. Basic Health Research Results 2013. *Science (80-)*. 2013;127(3309):1275-9.
4. Indonesian Ministry of Health. Basic Health Research Results 2018. Ministry of Health. 2018;53(9):1689-99.
5. Korrapati D, Jeyakumar SM, Putcha UK, Mendu VR, Ponday LR, Acharya V, et al. Coconut oil consumption improves fat-free mass, plasma HDL-cholesterol, and insulin sensitivity in healthy men with normal BMI compared to peanut oil. *Clin Nutr [Internet]*. 2019;38(6):2889-99. Available from: <https://doi.org/10.1016/j.clnu.2018.12.026>
6. Ramos-Lopez O, Milagro FI, Riezu-Boj JI, Martinez JA. Epigenetic signatures underlying inflammation: an interplay of nutrition, physical activity, metabolic diseases, and environmental factors for personalized nutrition. *Inflamm Res [Internet]*. 2021;70(1):29-49. Available from: <https://doi.org/10.1007/s00011-020-01425-y>
7. Jurkovičová J, Hirošová K, Vondrová D, Samohýl M, Štefániková Z, Filová A, et al. The prevalence of insulin resistance and the associated risk factors in a sample of 14-18-year-old Slovak adolescents. *Int J Environ Res Public Health*. 2021;18(3):1-19.
8. Rani V, Yadav UCS. Functional food and human health. *Funct Food Hum Heal*. 2018;(January):1-694.
9. Lichtenstein AH, Appel LJ, Vadiveloo M, Hu FB, Kris-Etherton PM, Rebholz CM, et al. 2021 Dietary Guidance to Improve Cardiovascular Health: A Scientific Statement from the American Heart Association. *Circulation*. 2021;144(23):E472-87.
10. Wong HK, Choo QC, Chew CH. Coconut milk gavage enhanced fecal bile excretion by modulating hepatic Fxr expression but failed to improve fasting serum cholesterol profile in C57BL/6 mice. *OCL - Oilseeds fats, Crop Lipids*. 2020;27.
11. Martadajaja IGMID. Goat Curry uses Fibercreme as a substitute for coconut milk. *J Gastron Indones*. 2022;10(2):68-77.
12. Imelda SI. Factors affecting the occurrence of diabetes mellitus at Harapan Raya Health Centre in 2018. *Sci J*. 2019;8(1):28-39.
13. Alatawi KA, Alshubaily FA. Coconut products alleviate hyperglycaemic, hyperlipidemic, and nephropathy indices in streptozotocin-induced diabetic Wistar rats. *Saudi J Biol Sci [Internet]*. 2021;28(8):4224-31. Available from: <https://doi.org/10.1016/j.sjbs.2021.06.060>
14. Descals A, Wich S, Szantoi Z, Struebig MJ, Dennis R, Hatton Z, et al. High-resolution global map of the closed-canopy coconut palm. *Earth Syst Sci Data*. 2023;15(9):3991-4010.
15. Mardatillah A. The enterprise culture heritage of Minangkabau cuisine, West Sumatra of Indonesia is a source of sustainable competitive advantage. *J Ethn Foods*. 2020;7(1).
16. NURSHILLAH C, ANGGOROWATI D, PUTRI ER, BALGIS M, NURWULANDARI M, MURTININGSIH M, et al. Diversity of edible plants traded in Legi Traditional Market, Surakarta, Indonesia. *Asian J Ethnobiol*. 2022;5(1):52-61.
17. Prastowo I, Nurusman AA, Moro HKEP, Rizkianti, Dewi C. Diversity of Indonesian offal-based dishes. *J Ethn Foods [Internet]*. 2023;10(1). Available from: <https://doi.org/10.1186/s42779-023-00181-8>
18. Lipoeto NI, Agus Z, Oenzil F, Wahlqvist ML, Wattanapenpaiboon N. Dietary intake and the risk of coronary heart disease among the coconut-consuming Minangkabau in West Sumatra, Indonesia. *Asia Pac J Clin Nutr*. 2004;13(4):377-84.
19. Sember V, Meh K, Sorić M, Starc G, Rocha P, Jurak G. Validity and reliability of international physical activity questionnaires for

- adults across EU countries: systematic review and meta-analysis. *International journal of environmental research and public health*. 2020 Oct;17(19):7161.
20. Eve Normandin, Elizabeth Chmelo, Mary F. Lyles, Anthony P. Marsh, and BJN. Effect of Resistance Training and Caloric Restriction on the Metabolic Syndrome. *Med Sci Sport Exerc*. 2017;176(3):139-48.
 21. Montefusco L, D'Addio F, Loretelli C, Ben Nasr M, Garziano M, Rossi A, et al. Anti-inflammatory effects of diet and caloric restriction in metabolic syndrome. *J Endocrinol Invest [Internet]*. 2021;44(11):2407-15. Available from: <https://doi.org/10.1007/s40618-021-01547-y>
 22. Sbierski-Kind J, Mai K, Kath J, Jurisch A, Streitz M, Kuchenbecker L, et al. Association between Subcutaneous Adipose Tissue Inflammation, Insulin Resistance, and Calorie Restriction in Obese Females. *J Immunol*. 2020;205(1):45-55.
 23. Tremblay A, Clinchamps M, Pereira B, Courteix D, Lesourd B, Chapier R, et al. Dietary fibers and the management of obesity and metabolic syndrome: The resolve study. *Nutrients*. 2020; 12(10):1-20.
 24. Sun J, Ruan Y, Xu N, Wu P, Lin N, Yuan K, et al. The effect of dietary carbohydrate and calorie restriction on weight and metabolic health in overweight/obese individuals: a multi-center randomized controlled trial. *BMC Med [Internet]*. 2023;21(1):1-12. Available from: <https://doi.org/10.1186/s12916-023-02869-9>
 25. Kamil RZ, Murdiati A, Juffrie M, Nakayama J, Rahayu ES. Gut microbiota and short-chain fatty acid profile between normal and moderate malnourished children in Yogyakarta, Indonesia. *Microorganisms*. 2021;9(1):1-15.
 26. Chibuzo Carole Nweze, Eneh Williams Nebechukwu, Muhammad Yusuf Bawa. Dietary fiber and risk of coronary heart diseases. *GSC Adv Res Rev*. 2021;9(3):001-9.
 27. Abutair AS, Naser IA, Hamed AT. The Effect of Soluble Fibre Supplementation on Metabolic Syndrome Profile among Newly Diagnosed Type 2 Diabetes Patients. *Clin Nutr Res*. 2018;7(1):31.
 28. Portincasa P, Bonfrate L, Vacca M, De Angelis M, Farella I, Lanza E, et al. Gut Microbiota and Short Chain Fatty Acids: Implications in Glucose Homeostasis. *Int J Mol Sci*. 2022;23(3).
 29. Chacińska M, Zabielski P, Książek M, Szałaj P, Jarząbek K, Kojta I, et al. The impact of omega-3 fatty acids supplementation on insulin resistance and content of adipocytokines and biologically active lipids in adipose tissue of high-fat diet-fed rats. *Nutrients*. 2019;11(4).
 30. Sinha S, Haque M, Lugova H, Kumar S. The Effect of Omega-3 Fatty Acids on Insulin Resistance. *Life*. 2023;13(6):1-17.
 31. Kobyliak N, Falalyeyeva T, Mykhalchyshyn G, Molochek N, Savchuk O, Kyriienko D, et al. Probiotic and omega-3 polyunsaturated fatty acids supplementation reduces insulin resistance, improves glycemia and obesity parameters in individuals with type 2 diabetes: A randomized controlled trial. *Obes Med [Internet]*. 2020;19(April):100248. Available from: <https://doi.org/10.1016/j.obmed.2020.100248>
 32. Memarzia A, Khazdair MR, Behrouz S, Gholamnezhad Z, Jafarnejhad M, Saadat S, et al. Experimental and clinical reports on anti-inflammatory, antioxidant, and immunomodulatory effects of *Curcuma longa* and curcumin, an updated and comprehensive review. Vol. 47, *BioFactors*. 2021. 311-350 p.

Influencia de la dieta vegetariana en el microbioma intestinal humano

Influence of the vegetarian diet on the human intestinal microbiome

Alejandro BORREGO RUIZ¹, Juan José BORREGO²

1 Departamento de Psicología Social y de las Organizaciones. Universidad Nacional de Educación a Distancia (UNED), Madrid, España.

2 Departamento de Microbiología. Universidad de Málaga, Málaga, España. Instituto de Investigación Biomédica de Málaga y Plataforma en Nanomedicina-IBIMA. Plataforma BIONAND, Málaga, España.

Recibido: 29/mayo/2024. Aceptado: 20/junio/2024.

RESUMEN

Introducción: Las dietas vegetarianas son cada vez más populares en todo el mundo, sobre todo por sus beneficios para la salud, por su sostenibilidad medioambiental, y por su contribución al bienestar animal. Varios estudios han identificado una asociación entre el vegetarianismo y distintos indicadores de salud, por medio de una modulación de la diversidad y de la estabilidad del microbioma intestinal humano.

Metodología: Desde una perspectiva holística, se revisan los efectos de las dietas vegetarianas en la composición de la microbiota intestinal y en la producción de metabolitos microbianos que pueden afectar a la salud física y mental humana.

Resultados: La adopción de una dieta vegetariana, rica en fibras no digeribles, reduce la diversidad microbiana β del microbioma intestinal humano, conduciendo a un aumento en la abundancia de los géneros *Prevotella*, *Clostridium* y *Faecalibacterium*, y a una disminución de los géneros *Bacteroides* y *Bifidobacterium*.

Conclusiones: La fermentación de las fibras y el cambio del ecosistema microbiano intestinal se traduce en la producción de metabolitos, como los ácidos grasos de cadena corta (AGCC) y otros posbióticos, que ejercen efectos muy beneficiosos en el sistema inmune intestinal, en la integridad de la

barrera hematoencefálica, en el suministro de sustratos energéticos, y en las defensas contra patógenos microbianos.

PALABRAS CLAVE

Microbioma intestinal, Dieta vegetariana, Metabolitos microbianos, Posbióticos.

ABSTRACT

Introduction: Vegetarian diets are increasingly popular around the world, especially for their health benefits, their environmental sustainability, and their contribution to animal welfare. Several studies have identified an association between vegetarianism and different health indicators, through modulation of the diversity and stability of the human gut microbiome.

Methods: From a holistic perspective, the effects of vegetarian diets on the composition of the intestinal microbiota and on the production of microbial metabolites that can affect human physical and mental health are reviewed.

Results: The adoption of a vegetarian diet, rich in indigestible fibers, reduces the β microbial diversity of the human intestinal microbiome, leading to an increase in the abundance of the genera *Prevotella*, *Clostridium* and *Faecalibacterium*, and to a decrease in the genera *Bacteroides* and *Bifidobacterium*.

Conclusions: The fermentation of fibers and the change of the intestinal microbial ecosystem result in the production of metabolites, such as short chain fatty acids (SCFAs) and other postbiotics, which exert beneficial effects on the intes-

Correspondencia:
Alejandro Borrego Ruiz
a.borrego@psi.uned.es

tinal immune system, on the integrity of the blood-brain barrier, on the supply of energy substrates, and on defenses against microbial pathogens.

KEYWORDS

Gut microbiome, Vegetarian diet, Microbial metabolites, Postbiotics.

INTRODUCCIÓN

El vegetarianismo es un patrón dietético, exento de cualquier tipo de carne, que puede subdividirse en distintas categorías de dietas, como el lacto-ovo-vegetarianismo, que incluye el consumo de lácteos y huevos, o el veganismo, que se restringe a una nutrición totalmente basada en productos vegetales¹. En la sociedad occidental, el interés hacia las dietas vegetarianas se ha visto incrementado en los últimos años², debido a cuestiones animalistas, éticas, religiosas, económicas, de salud, y/o medioambientales¹⁻³. Diversos estudios epidemiológicos han establecido los beneficios de las dietas vegetarianas en la salud humana, debido a su alto contenido en macro- y micronutrientes, tales como: fibras vegetales, ácido fólico (vitamina B₉), vitaminas C y E, potasio, magnesio, fitoquímicos, ácidos grasos insaturados, y sustancias antioxidantes⁴. Sin embargo, las dietas vegetarianas presentan bajas concentraciones de ciertos nutrientes esenciales, como las proteínas, el hierro, o la vitamina B₁₂⁵.

En comparación con las personas omnívoras, las vegetarianas presentan un menor riesgo de desarrollar diabetes tipo 2, cardiopatía isquémica, ciertos tipos de cáncer, y obesidad^{1,6}. El vegetarianismo también se ha asociado con una mayor longevidad⁷, y con el bienestar psicológico⁸. Asimismo, el tipo de alimentación es un factor que ejerce un rol crucial en la composición y en la función del microbioma intestinal, y las personas vegetarianas poseen una microbiota estrictamente diferenciada de la de individuos que siguen otros patrones dietéticos⁹.

Aunque los términos «microbioma» y «microbiota» con frecuencia se utilizan de manera indistinta, existen algunas diferencias conceptuales entre ambos. El microbioma engloba a todos los microorganismos, incluidos los Dominios Bacteria, Archaea, Eukarya (hongos y protozoos), los virus, la colección de genomas de los microorganismos mencionados, así como otros elementos estructurales microbianos, los metabolitos, y las condiciones ambientales. Por otra parte, la microbiota describe de manera más restringida al grupo de microorganismos comensales, simbióticos y patógenos que se encuentran en un ecosistema determinado¹⁰. El dominio Bacteria es, tanto cuantitativa como funcionalmente, el más importante del microbioma intestinal humano sano, y este bacterioma consta de 12 filos bacterianos (de los cuales, más del 93% está constituido por Actinomycetota, Bacillota, Bacteroidota y Pseudomonadota); 18 familias, siendo las más prevalentes *Bacteroi-*

daceae (65,6%), *Lachnospiraceae* (11,5%) y *Ruminococcaceae* (8,4%); y 59 géneros, siendo *Bacteroides* el más abundante (más del 65%)⁹.

El objetivo principal del presente trabajo es investigar la influencia de la dieta vegetariana en el microbioma intestinal humano a través de una revisión de estudios recientes. Como objetivo secundario, se analizan los efectos que ejercen los componentes de la dieta vegetariana en los metabolitos microbianos y en los neurotransmisores, destacando su impacto sobre la salud fisiológica y psicológica de las personas.

MÉTODO

Revisión sistemática dirigida a responder al objetivo de la investigación, que es determinar el efecto de la dieta vegetariana en la composición del microbioma intestinal humano, complementando las evidencias recabadas con un análisis en torno a los efectos ejercidos por los posbióticos microbianos. La metodología se basó en las pautas establecidas en la guía PRISMA¹¹. Pese a la naturaleza sistemática del proceso relativo a la búsqueda y selección de artículos, los resultados del presente estudio se exponen de acuerdo a una revisión narrativa. Esta decisión se tomó considerando la gran heterogeneidad de los estudios seleccionados, que presentan variaciones significativas en términos de método y de intervenciones implementadas. De esta manera, el enfoque narrativo facilita la comprensión del fenómeno investigado.

Se consultaron las bases de datos PubMed y Scopus durante el mes de abril de 2024. Para la búsqueda se emplearon las siguientes palabras clave y operadores booleanos: (vegetarian diet OR vegan diet) AND (human gut microbiota OR gut microbiome). Se aplicaron filtros para restringir los resultados de búsqueda a artículos publicados a partir del año 2012. En PubMed también se aplicaron los filtros «full text» y «clinical trials».

Los criterios de exclusión establecidos fueron: [1] artículos no originales; [2] artículos sobre patologías fisiológicas, endocrinas, infecciosas, genéticas o mentales. Los criterios de inclusión establecidos fueron: [1] estudios experimentales y cuasi-experimentales; [2] estudios con participantes humanos; [3] estudios que realicen una intervención clínica en la que se analizan los efectos de la dieta vegetariana en la microbiota intestinal. El primer autor realizó la búsqueda de artículos en las bases de datos, y ambos autores cribaron cada estudio recuperado de manera independiente.

Los siguientes parámetros fueron extraídos de la selección de artículos para su posterior análisis: tamaño de muestra, distribución por género, edad media, contexto geográfico, tipo de dieta vegetariana, diseño del estudio, género/especie bacteriana, abundancia microbiana (incremento/descenso), método de secuenciación empleado, referencia del artículo. No se utilizaron herramientas automatizadas en el proceso.

RESULTADOS

De la primera identificación de artículos (PubMed: N = 1805; Scopus: N = 187) se excluyeron los duplicados (N = 170) y de los restantes se excluyeron 1791 artículos en función de la lectura de su título y de su resumen. Los artículos restantes

(N = 31) se examinaron mediante la lectura íntegra de su contenido, y se descartaron aquellos que no satisfacían las pautas de elegibilidad. Finalmente, 14 artículos (dentro del periodo temporal 2012-2024) fueron incluidos en la presente revisión. En la Figura 1 se muestra una síntesis del proceso de búsqueda y selección de artículos.

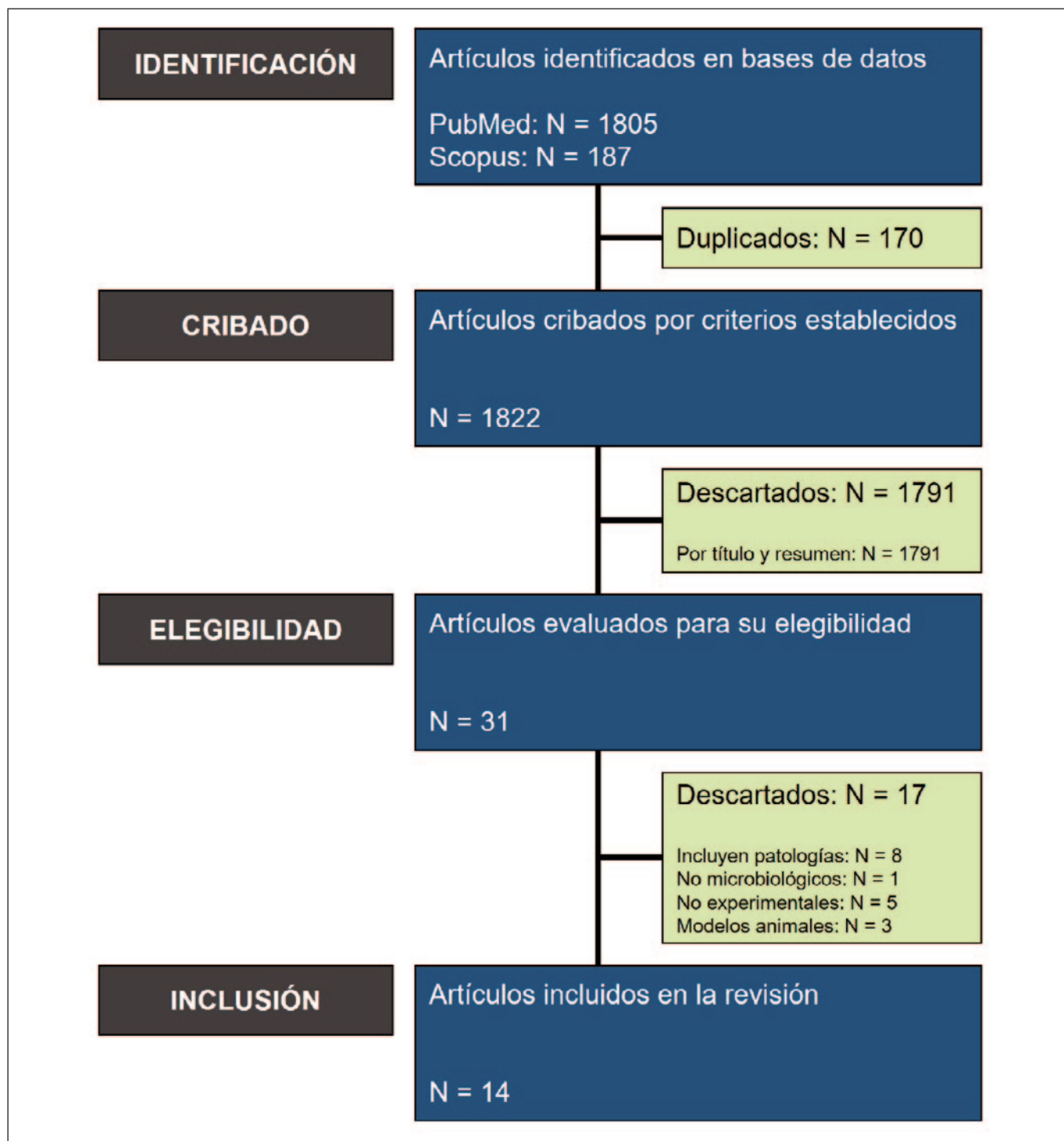


Figura 1. Diagrama de flujo sobre la búsqueda y selección de artículos

Influencia de la dieta vegetariana en la composición del microbioma intestinal

En base a los resultados obtenidos, es posible afirmar que la diferencia en la composición del microbioma intestinal entre personas vegetarianas y omnívoras está bien documentada. Los cambios en la composición de este microbioma podrían deberse a las diferencias en las bacterias suministradas directamente a través de los alimentos, a las diferencias en los sustratos consumidos, a las variaciones temporales en el tránsito a través del sistema gastrointestinal, al pH y a las secreciones gastrointestinales del hospedador influenciadas por los patrones dietéticos, o a la regulación de la expresión genética del hospedador y/o de su microbiota¹². Las dietas vegetarianas aportan ciertos nutrientes implicados en la cinética del crecimiento de las bacterias intestinales, como los glicanos (inulina, lignina, pectina, celulosa y fructooligosacáridos), que son carbohidratos no digeribles por el ser humano¹³. Sin embargo, ciertas bacterias intestinales, denominadas degradadoras primarias y que incluyen miembros de los géneros *Bacteroides*, *Bifidobacterium* y *Ruminococcus*, pueden descomponer los glicanos¹⁴. Además, las dietas pueden influir en el metabolismo y en el sistema inmunológico del hospedador y, por tanto, pueden modular la configuración del microbioma a través de diversas sustancias, como compuestos derivados del indol, vitaminas A y D, y ácidos grasos poliinsaturados¹⁵. La adopción de estas dietas reduce la diversidad microbiana β (la magnitud de cambio en la composición de las comuni-

dades microbianas, o el grado de diferenciación entre las comunidades microbianas) del microbioma intestinal, pero no la diversidad individual a nivel local (diversidad microbiana α)¹⁶.

Los principales enterotipos bacterianos del microbioma intestinal humano están conformados por los géneros *Bacteroides*, *Prevotella*, y *Ruminococcus*¹⁷. La abundancia de *Bacteroides* (filo Bacteroidota) se ha correlacionado positivamente con hábitos dietéticos de larga duración ricos en proteína animal y ácidos grasos saturados¹⁸, y la prevalencia de este enterotipo desciende con las dietas vegetarianas¹⁹. *Prevotella* es un género del filo Bacteroidota, cuya abundancia aumenta como respuesta a una dieta vegetariana²⁰. El género *Ruminococcus* (filo Bacillota) está asociado con el consumo cotidiano de frutas y vegetales; las especies de este género son capaces de degradar carbohidratos complejos, como la celulosa o el almidón resistente, presentes frecuentemente en las dietas vegetarianas²¹. Sin embargo, *Ruminococcus* también se ha relacionado con dietas omnívoras que son pobres en fibras vegetales²¹. Respecto a otros microorganismos, las dietas vegetarianas inducen un cambio en la distribución de los mismos, conllevando un aumento de la abundancia de los géneros *Roseburia*, *Haemophilus*, *Neisseria*, *Aggregatibacter*, *Clostridium*, *Lactobacillus*, *Eubacterium*, *Faecalibacterium*, y *Veillonella*; y un descenso de la abundancia de *Bifidobacterium*^{21,22}. La Tabla 1 muestra los diferentes estudios seleccionados sobre la influencia de la dieta vegetariana en la composición del microbioma intestinal humano.

Tabla 1. Influencia de la dieta vegetariana en la composición del microbioma intestinal humano

Género/Especie bacteriana	Alteración	Método	Datos descriptivos	Referencia
<i>Bacteroides</i> <i>Escherichia coli</i> <i>Bifidobacterium</i>	D D D	Cultivo	Alemania. Transversal. GI: (V: n=46 [H/M:60,8/39,1%] EM:47,8) (Vg: n=46 [H/M:60,8/39,1%] EM:46,5) GC: (n=46 [H/M:60,8/39,1%] EM:46,2)	Zimmer et al. ²³
<i>Bacteroides thetaiotaomicron</i> <i>Bacteroides/Prevotella</i> <i>Clostridium clostridioforme</i> <i>Faecalibacterium prausnitzii</i>	I I I I	DGGE	Eslovenia. Transversal. GI: (V: n=11 [H/M:58,3/41,7%] EM:34) (Vg: n=20 [H/M:60/40%] EM:35) GC: (n=29 [H/M:43,3/56,7%] EM:30)	Matijašič et al. ²⁴
<i>Alistipes</i> <i>Bilophila</i> <i>Bacteroides</i> <i>Roseburia</i> <i>Eubacterium</i> <i>Ruminococcus</i>	D D D I I I	Secuenciación gen ARNr 16S	Estados Unidos. Transversal. GI: (V: n=11 [H/M:54,5/45,5%] EM:28,1) GC: NE	David et al. ²⁵
<i>Bacteroides fragilis</i> <i>Bifidobacterium</i> <i>Prevotella</i>	D D I	Cultivo y DGGE	Italia. Transversal. GI: (V: n=51) (Vg: n=51) GC: (n=51) 3 grupos: ([H/M:50/50%] EM:38)	Ferrocino et al. ²⁶
<i>Bilophila wadsworthia</i> <i>Escherichia hermannii</i> <i>Klebsiella pneumoniae</i>	D D I	Pirosecuenciación	Tailandia. Transversal. GI: (V: n=36 [H/M:NE] EM:50,9) GC: (n=36 [H/M:NE] EM:51,8)	Ruengsomwong et al. ²⁷

D: Descenso. I: Incremento. DGGE: Electroforesis en gel con gradiente de desnaturalización del ARNr. GI: Grupo intervención. GC: Grupo control. V: Vegetarianos/as. Vg: Veganos/as. H: Hombres. M: Mujeres. EM: Edad media. NE: No especificado.

Tabla 1 continuación. Influencia de la dieta vegetariana en la composición del microbioma intestinal humano

Género/Especie bacteriana	Alteración	Método	Datos descriptivos	Referencia
<i>Prevotella</i> <i>Bacteroides</i> <i>Bifidobacterium</i>	I D D	Cultivo	Italia. Transversal. GI: (V: n=12 [H/M:25/75%] EM:39) (Vg: n=10 [H/M:70/30%] EM:33) GC: (n=7 [H/M:57,1/42,9%] EM:41)	Federici et al. ²⁸
<i>Haemophilus</i> <i>Neisseria</i> <i>Aggregatibacter</i> <i>Veillonella</i> <i>Roseburia</i> <i>Ruminococcus</i> <i>Streptococcus</i> <i>Lactobacillus</i> <i>Alistipes</i> <i>Proteus</i>	I I I I I I I I D D	Secuenciación metagenómica «shotgun»	China. Longitudinal (3 meses). GI: (V: n=15 [H/M:46,7/53,3%] EM:35,4) GC: (n=14 [H/M:50/50%] EM:37,9)	Zhang et al. ²⁹
<i>Lachnospira</i> <i>Ruminococcus</i>	I D	Secuenciación metagenómica «shotgun»	Italia. Transversal. GI: (V: n=10 [H/M:40/60%]) (Vg: n=10 [H/M:50/50%]) GC: (n=10 [H/M:50/50%]) 3 grupos: EM:36	De Angelis et al. ³⁰
<i>Faecalibacterium prausnitzii</i> <i>Bacteroides fragilis</i>	I D	Secuenciación gen ARNr 16S (uBiome)	Estados Unidos. Longitudinal (16 semanas). GI: (V: n=84 [H/M:17,9/82,1%] EM:52,9) GC: (n=84 [H/M:11,9/88,1%] EM:57,5)	Kahleova et al. ³¹
<i>Anaerostipes</i> <i>Streptococcus</i> <i>Clostridium</i> <i>Odoribacter</i>	I I I I	Secuenciación gen ARNr 16S (NGS)	Italia. Longitudinal (3 meses). GI: (V: n=12 EM:55,2) GC: (n=11 EM:62,4) 2 grupos: [H/M:69,6/30,4%]	Pagliai et al. ³²
<i>Lachnoclostridium</i> <i>Dialister</i> <i>Prevotella</i> <i>Faecalibacterium</i>	D D I I	Secuenciación gen ARNr 16S	Alemania. Transversal. GI: (V: n=36 [H/M:50/50%] EM:37,5) GC: (n=36 [H/M:50/50%] EM:38,5)	Trefflich et al. ³³
<i>Coprococcus</i> <i>Faecalibacterium</i> <i>Roseburia</i>	I I D	Secuenciación gen ARNr 16S	Alemania. Longitudinal (4 semanas). GI: (V: n=26 [H/M:30,8/69,2%] EM:33,2) GC: (n=27 [H/M:44,4/55,6%] EM:29,9)	Kohnert et al. ³⁴
<i>Lachnospira</i> <i>Ruminiclostridium</i> <i>Alistipes</i> <i>Bifidobacterium</i> <i>Blautia</i> <i>Fusicatenibacter</i> <i>Dorea</i> <i>Anaerostipes</i>	I I D D D D D D	Secuenciación gen ARNr 16S	República Checa. Transversal. GI: (V: n=62 [H/M:40,3/59,7%] EM:30,9) GC: (n=33 [H/M:51,5/48,5%] EM:31,3)	Prochazkova et al. ³⁵
<i>Faecalibacterium</i> <i>Eubacterium</i> <i>Bacteroides</i> <i>Blautia</i> <i>Dorea</i> <i>Alistipes</i> <i>Eisenbergiella</i> <i>Sellimonas</i>	I I I D D D D D	Secuenciación metagenómica «shotgun»	Estados Unidos. Longitudinal (3 meses). GI: (V: n=705 [H/M:32,5/67,5%] EM:71) GC: NE	Shen et al. ³⁶

D: Descenso. I: Incremento. DGGE: Electroforesis en gel con gradiente de desnaturización del ARNr. GI: Grupo intervención. GC: Grupo control. V: Vegetarianos/as. Vg: Veganos/as. H: Hombres. M: Mujeres. EM: Edad media. NE: No especificado.

Influencia de los posbióticos microbianos en la salud humana

Dependiendo del tipo bacteriano de la microbiota intestinal, los nutrientes presentes en la dieta vegetariana son transformados en diferentes moléculas bioactivas, como los posbióticos y/o ácidos grasos de cadena corta (AGCC), que poseen efectos beneficiosos para la salud humana, incluyendo efectos antiinflamatorios, inmunomoduladores, antioxidantes, antiproliferativos, y antihipertensivos³⁷. Además, se ha demostrado que estos metabolitos microbianos poseen un papel esencial en la función del eje microbiota-intestino-cerebro, al actuar sobre funciones cerebrales, y al estar implicados en determinados trastornos psicológicos y neuropsiquiátricos^{38,39}.

Los AGCC son metabolitos microbianos que se producen como resultado de la fermentación de la fibra vegetal y otros carbohidratos, siendo los más importantes el acetato, el propionato, y el butirato. La concentración de estas sustancias aumenta con el consumo de frutas, vegetales y legumbres, componentes propios de las dietas vegetarianas⁴⁰. Los principales microorganismos sintetizadores de AGCC son: *Akkermansia muciniphila*, *Bifidobacterium* spp., *Prevotella* spp. y *Bacteroides* spp. para el acetato; *Bacteroides* spp. para el propionato; y *Coprococcus* spp. y *Clostridium* spp. para el butirato^{21,40}. Los AGCC presentan un papel protector en diferentes tipos de enfermedades, como las del sistema inmune, la diabetes tipo 2 y la enfermedad intestinal inflamatoria, y también aportan protección contra las infecciones microbianas²¹. Además, hay evidencias que sugieren que los AGCC están asociados con aspectos psicobiológicos a través de vías endocrinas, neuronales e inmunes; de esta manera, podrían regular los síntomas y las respuestas relacionadas con el estrés, con los trastornos del comportamiento alimentario, o con los brotes esquizofrénicos^{41,42}.

Los fitoestrógenos son polifenoles de origen vegetal que interactúan con los receptores de estrógenos mediante acciones agonistas o antagonistas. Estos polifenoles poseen propiedades anticancerígenas, antiinflamatorias y antioxidantes, y se ha descrito su asociación con una disminución en el riesgo de padecer enfermedades cardiovasculares, obesidad, diabetes y osteoporosis, y también en la formación de fibras amiloides, característica de las enfermedades de Parkinson y de Alzheimer⁴³. Estos efectos beneficiosos se obtienen cuando los polifenoles vegetales son bioactivados por la microbiota intestinal humana, que los convierte en equol, urolitina y enterolignanos, principalmente por los géneros *Bifidobacterium*, *Lactobacillus*, *Clostridium*, *Eubacterium*, *Bacteroides*, *Saccharomyces*, y miembros de la familia *Coriobacteriaceae*^{44,45}. La interacción entre los polifenoles y la microbiota intestinal es bidireccional; las bacterias intestinales sintetizan metabolitos a partir de los polifenoles, que a su vez actúan como prebióticos para el crecimiento microbiano, principalmente de los géneros *Lactobacillus* y *Bifidobacterium*⁴⁵.

El papel de la microbiota intestinal también es crucial para mantener los niveles adecuados de vitaminas en el organismo humano, fundamentalmente la menaquinona (vitamina K₂), el folato (vitamina B₉), la cobalamina (vitamina B₁₂) y la riboflavina (vitamina B₂). El género *Bifidobacterium* sintetiza vitaminas K₂, B₉, B₇ (biotina) y B₁ (tiamina), mientras que otros microorganismos sintetizadores son *Bacillus* y *Escherichia* (vitamina B₂), y *Lactobacillus* (vitamina B₁₂)⁴⁶. Se ha reportado que las deficiencias de las vitaminas B₉, B₁₂, B₁, B₆ y E causan disfunciones mentales y trastornos neurológicos, como ataques epilépticos, depresión, síntomas de confusión y desorientación, encefalopatía de Wernicke, psicosis de Korsakoff⁴⁷, así como una reducción en la síntesis de diversos neurotransmisores (dopamina, noradrenalina, adrenalina, serotonina, histamina, GABA) que también están asociados con diferentes trastornos mentales^{38,47} (Tabla 2).

Los isotiocianatos son compuestos de glucosinolatos que se encuentran en elevada cantidad en las plantas. Estos glucosi-

Tabla 2. Relación entre los microorganismos productores de neurotransmisores y los trastornos psicológicos y neuropsiquiátricos (modificado de Borrego-Ruiz & Borrego³⁸)

Neurotransmisor	Género microbiano productor	Trastornos mentales implicados
Ácido γ-aminobutírico (GABA)	<i>Lactobacillus</i> <i>Bifidobacterium</i> <i>Escherichia</i> <i>Pseudomonas</i> <i>Bacteroides</i> <i>Parabacteroides</i> <i>Eubacterium</i>	Ansiedad
L-Glutamina	<i>Lactobacillus</i> <i>Bacteroides</i> <i>Corynebacterium</i> <i>Brevibacterium</i> <i>Campylobacter</i>	Ansiedad Depresión Trastorno bipolar Esquizofrenia Enfermedad de Alzheimer
Dopamina	<i>Bacillus</i> <i>Escherichia</i> <i>Staphylococcus</i> <i>Serratia</i>	Depresión Ansiedad Esquizofrenia Enfermedad de Parkinson
Serotonina	<i>Escherichia</i> <i>Streptococcus</i> <i>Staphylococcus</i> <i>Clostridium</i> <i>Lactobacillus</i> <i>Enterococcus</i> <i>Candida</i>	Depresión Estrés Trastornos emocionales Trastornos del espectro autista
Norepinefrina	<i>Bacillus</i> <i>Escherichia</i> <i>Saccharomyces</i>	Depresión Esquizofrenia

nolatos son metabolizados a isotiocianatos por diferentes microorganismos intestinales, como *Escherichia coli*, *Bacteroides* spp., *Enterococcus* spp., *Ligilactobacillus agilis*, *Peptostreptococcus* spp. y *Bifidobacterium* spp. Estos metabolitos tienen propiedades citoprotectoras y efectos antioxidantes a través de la regulación de la expresión genética de procesos neoplásicos, de aterosclerosis, y neurodegenerativos⁴⁸.

Un grupo diferente de posbióticos son los metabolitos derivados del colesterol. Determinadas cepas bacterianas intestinales pueden convertir el colesterol dietético o el sintetizado *de novo* en coprostanol, que es escasamente absorbido por el intestino humano, lo que reduce su concentración sérica y disminuye el riesgo de enfermedades cardiovasculares⁴⁹. Por otro lado, los ácidos biliares sintetizados a partir del colesterol se convierten por la microbiota en ácidos biliares secundarios, que están involucrados en diversas enfermedades, como la inflamatoria intestinal, la hepática o el cáncer de colon, además de en el desarrollo de varios trastornos psicológicos, como la ansiedad y la depresión⁵⁰⁻⁵².

El N-óxido de trimetilamina (TMAO) es un metabolito microbiano que se asocia con trastornos cardiovasculares y neurológicos⁵³. Los precursores del TMAO son la carnitina y la colina, que se encuentran principalmente en alimentos de origen animal, e inducen el crecimiento de diferentes géneros de la microbiota intestinal, como *Bacteroides*, *Alistipes*, *Ruminococcus*, *Clostridium* y *Bilophila*, y la estarvación de *Bifidobacterium*. Los vegetarianos, por su particular composición de la microbiota, poseen una reducida capacidad de síntesis de trimetilamina, que es la molécula precursora del TMAO⁵⁴.

DISCUSIÓN

Como cualquier otro trabajo de revisión, el presente también es susceptible de haber podido incurrir en sesgos durante el proceso de búsqueda y selección de artículos. En este sentido, se han consultado solo dos bases de datos, por lo que podrían no haberse considerado estudios elegibles dentro del periodo establecido (2012-2024). Entre las limitaciones de la presente revisión también se encuentra un posible sesgo relativo a las características diferenciales de los distintos estudios seleccionados, como la heterogeneidad en los tamaños poblaciones, el tipo de intervención realizada, la edad de los grupos intervenidos, y la diversidad de métodos utilizados para la secuenciación de las muestras. Por otro lado, un factor de confusión implícito en casi todos los estudios que analizan las dietas vegetarianas es, precisamente, dicho término, ya que incluye variantes alimentarias que pueden afectar al proceso de homeostasis microbiana intestinal de distintas formas. De igual modo, es importante señalar un aspecto negativo de los estudios incluidos en la revisión: la mayoría son intervenciones transversales y no longitudinales. Además, la adherencia a las dietas vegetarianas se ha evaluado mediante autoinformes, no especificándose el tiempo durante el que los participantes han mante-

nido dicha adherencia dietética. Asimismo, los tratamientos antibióticos previos a la intervención se han considerado en pocos estudios, así como otros parámetros clínicos vinculados a los participantes. A pesar de lo expuesto, una clara fortaleza de la revisión se refleja en la homogeneidad y coherencia de los resultados obtenidos en cuanto a «disbiosis» bacterianas resultantes del consumo de una dieta vegetariana, incluso a través de la utilización de diferentes métodos de secuenciación genética de las muestras.

Aunque diversos estudios han establecido que las dietas vegetarianas son pobres en macro- y micronutrientes esenciales para el ser humano, como proteínas, hierro y vitamina B₁₂, otros estudios establecen importantes beneficios para la salud, debido a su capacidad antioxidante, antiinflamatoria, inmunomoduladora, antiproliferativa y antihipertensiva. Además, los componentes de estas dietas inducen la síntesis microbiana de AGCC y posbióticos, como equol, urolitina, enterolignanos, vitaminas (K₂, B₁, B₂, B₇, B₉, y B₁₂), isotiocianatos, coprostanol y ácidos biliares secundarios, que presentan diversas funciones beneficiosas sobre distintos procesos fisiológicos e inmunológicos.

CONCLUSIONES

Se ha demostrado que las dietas vegetarianas influyen significativamente en la composición y en la función del microbioma intestinal humano. Asimismo, estas dietas podrían desempeñar un papel clave en relación al tratamiento de diversos trastornos fisiológicos, psicológicos y neuropsiquiátricos. Cabe resaltar que, más allá de los potenciales efectos beneficiosos para la salud humana, las dietas vegetarianas destacan por su sostenibilidad medioambiental, pues generan una cantidad considerablemente menor de gases de efecto invernadero, y de otros contaminantes, en comparación con otras dietas, además de requerir un menor uso de recursos terrestres y acuícolas. Por último, es de rigor considerar que las dietas vegetarianas poseen importantes implicaciones éticas, especialmente en relación con el bienestar de los animales, ya que suponen una menor explotación y un menor sufrimiento para ellos.

REFERENCIAS

1. Craig WJ, Mangels AR, Fresán U, Marsh K, Miles FL, Saunders AV, et al. The safe and effective use of plant-based diets with Guidelines for Health Professionals. *Nutrients*. 2021; 13(11):4144. doi: 10.3390/nu13114144
2. Ruby MB. Vegetarianism. A blossoming field of study. *Appetite*. 2012; 58(1):141-50. doi: 10.1016/j.appet.2011.09.019
3. Fox N, Ward K. Health, ethics and environment: A qualitative study of vegetarian motivations. *Appetite*. 2008; 50(2-3):422-9. doi: 10.1016/j.appet.2007.09.007
4. Neufingerl N, Eilander A. Nutrient intake and status in adults consuming plant-based diets compared to meat-eaters: A systematic review. *Nutrients*. 2021; 14(1):29. doi: 10.3390/nu14010029

5. Gilsing AM, Crowe FL, Lloyd-Wright Z, Sanders TA, Appleby PN, Allen NE, et al. Serum concentrations of vitamin B12 and folate in British male omnivores, vegetarians and vegans: Results from a cross-sectional analysis of the EPIC-Oxford cohort study. *Eur J Clin Nutr.* 2010; 64: 933-9. doi: 10.1038/ejcn.2010.142
6. Melina, V., Craig, W., & Levin, S. Position of the Academy of Nutrition and Dietetics: Vegetarian diets. *J Acad Nutr Diet.* 2016; 116(12):1970-80. doi: 10.1016/j.jand.2016.09.025
7. Norman K, Klaus S. Veganism, aging and longevity: New insight into old concepts. *Curr Opin Clin Nutr Metab Care.* 2020; 23(2): 145-50. doi: 10.1097/MCO.0000000000000625
8. Jin Y, Kandula NR, Kanaya AM, Talegawkar SA. Vegetarian diet is inversely associated with prevalence of depression in middle-older aged South Asians in the United States. *Ethn Health.* 2021; 26:504-11. doi: 10.1080/13557858.2019.1606166
9. Borrego-Ruiz A, Borrego JJ. Human gut microbiome, diet, and mental disorders. *Int Microbiol.* 2024a; 27(3). doi: 10.1007/s10123-024-00518-6
10. Berg G, Rybakova D, Fischer D, Cernava T, Vergès MC, Charles T, et al. Microbiome definition re-visited: Old concepts and new challenges. *Microbiome.* 2020; 8:103. doi: 10.1186/s40168-020-00875-0
11. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ.* 2021; 372:n71. doi: 10.1136/bmj.n71
12. Salonen A, de Vos WM. Impact of diet on human intestinal microbiota and health. *Annu Rev Food Sci Technol.* 2014; 5:239-62. doi: 10.1146/annurev-food-030212-182554
13. Cantarel BL, Lombard V, Henrissat B. Complex carbohydrate utilization by the healthy human microbiome. *PLoS One.* 2012; 7:e28742. doi: 10.1371/journal.pone.0028742
14. Eilam O, Zarecki R, Oberhardt M, Ursell LK, Kupiec M, Knight R, et al. Glycan degradation (GlyDeR) analysis predicts mammalian gut microbiota abundance and host diet-specific adaptations. *mBio.* 2014; 5:e01526-14. doi: 10.1128/mBio.01526-14
15. Hibberd MC, Wu M, Rodionov DA, Li X, Cheng J, Griffin NW, et al. The effects of micronutrient deficiencies on bacterial species from the human gut microbiota. *Sci Transl Med.* 2017; 9:eaal4069. doi: 10.1126/scitranslmed.aal4069
16. Sidhu SRK, Kok CW, Kunasegaran T, Ramadas A. Effect of plant-based diets on gut microbiota: A systematic review of interventional studies. *Nutrients.* 2023; 15(6):1510. doi: 10.3390/nu15061510
17. Arumugam M, Raes J, Pelletier E, Le Paslier D, Yamada T, Mende DR, et al. Enterotypes of the human gut microbiome. *Nature.* 2011; 473(7346):174-80. doi: 10.1038/nature09944
18. Wu GD, Chen J, Hoffmann C, Bittinger K, Chen YY, Keilbaugh SA, et al. Linking long-term dietary patterns with gut microbial enterotypes. *Science.* 2011; 334:105-18. doi: 10.1126/science.1208344
19. Jain A, Li XH, Chen WN. Similarities and differences in gut microbiome composition correlate with dietary patterns of Indian and Chinese adults. *AMB Express.* 2018; 8:104. doi: 10.1186/s13568-018-0632-1
20. De Filippo C, Cavalieri D, Di Paola M, Ramazzotti M, Poullet JB, Massart S, et al. Impact of diet in shaping gut microbiota revealed by a comparative study in children from Europe and rural Africa. *Proc Natl Acad Sci USA.* 2010; 107:14691-6. doi: 10.1073/pnas.1005963107
21. Tomova A, Bukovsky I, Rembert E, Yonas W, Alwarith J, Barnard ND, et al. The effects of vegetarian and vegan diets on gut microbiota. *Front Nutr.* 2019; 6:47. doi: 10.3389/fnut.2019.00047
22. Xiao W, Zhang Q, Yu L, Tian F, Chen W, Zhai Q. Effects of vegetarian diet-associated nutrients on gut microbiota and intestinal physiology. *Food Sci Hum Wellness.* 2022; 11(2):208-17. doi: 10.1016/j.fshw.2021.11.002
23. Zimmer J, Lange B, Frick JS, Sauer H, Zimmermann K, Schwiertz A, et al. A vegan or vegetarian diet substantially alters the human colonic faecal microbiota. *Eur J Clin Nutr.* 2012; 66(1):53-60. doi: 10.1038/ejcn.2011.141
24. Matijašič BB, Obermajer T, Lipoglavšek L, Grabnar I, Avguštin G, Rogelj I. Association of dietary type with fecal microbiota in vegetarians and omnivores in Slovenia. *Eur J Nutr.* 2014; 53:1051-64. doi: 10.1007/s00394-013-0607-6
25. David LA, Maurice CF, Carmody RN, Gootenberg DB, Button JE, Wolfe BE, et al. Diet rapidly and reproducibly alters the human gut microbiome. *Nature.* 2014; 505:559-63. doi: 10.1038/nature12820
26. Ferrocino I, Di Cagno R, De Angelis M, Turrone S, Vannini L, Bancalari E, et al. Fecal microbiota in healthy subjects following omnivore, vegetarian and vegan diets: Culturable populations and rRNA DGGE profiling. *PLoS One.* 2015; 10(6):e0128669. doi: 10.1371/journal.pone.0128669
27. Ruengsomwong S, La-Ongkham O, Jiang J, Wannissorn B, Nakayama J, Nitisinprasert S. Microbial community of healthy Thai vegetarians and non-vegetarians, their core gut microbiota, and pathogen risk. *J Microbiol Biotechnol.* 2016; 26:1723-35. doi: 10.4014/jmb.1603.03057
28. Federici E, Prete R, Lazzi C, Pellegrini N, Moretti M, Corsetti A, et al. Bacterial composition, genotoxicity, and cytotoxicity of fecal samples from individuals consuming omnivorous or vegetarian diets. *Front Microbiol.* 2017; 8:300. doi: 10.3389/fmicb.2017.00300
29. Zhang C, Björkman A, Cai K, Liu G, Wang C, Li Y, et al. Impact of a 3-months vegetarian diet on the gut microbiota and immune repertoire. *Front Immunol.* 2018; 9:908. doi: 10.3389/fimmu.2018.00908
30. De Angelis M, Ferrocino I, Calabrese FM, De Filippis F, Cavallo N, Siragusa S, et al. Diet influences the functions of the human intestinal microbiome. *Sci Rep.* 2020; 10(1):4247. doi: 10.1038/s41598-020-61192-y
31. Kahleova H, Rembert E, Alwarith J, Yonas WN, Tura A, Holubkov R, et al. Effects of a low-fat vegan diet on gut microbiota in overweight individuals and relationships with body weight, body composition, and insulin sensitivity. A randomized clinical trial. *Nutrients.* 2020; 12(10):2917. doi: 10.3390/nu12102917

32. Pagliai G, Russo E, Niccolai E, Dinu M, Di Pilato V, Magrini A, et al. Influence of a 3-month low-calorie Mediterranean diet compared to the vegetarian diet on human gut microbiota and SCFA: the CAR-DIVEG study. *Eur J Nutr.* 2020; 59(5):2011-24. doi: 10.1007/s00394-019-02050-0
33. Trefflich I, Jabakhanji A, Menzel J, Blaut M, Michalsen A, Lampen A, et al. Is a vegan or a vegetarian diet associated with the microbiota composition in the gut? Results of a new cross-sectional study and systematic review. *Crit Rev Food Sci Nutr.* 2020; 60(17):2990-3004. doi: 10.1080/10408398.2019.1676697
34. Kohnert E, Kreutz C, Binder N, Hannibal L, Gorkiewicz G, Müller A, et al. Changes in gut microbiota after a four-week intervention with vegan vs. meat-rich diets in healthy participants: A randomized controlled trial. *Microorganisms.* 2021; 9(4):727. doi: 10.3390/microorganisms9040727
35. Prochazkova M, Budinska E, Kuzma M, Pelantova H, Hradecky J, Heczkova M, et al. Vegan diet is associated with favorable effects on the metabolic performance of intestinal microbiota: A cross-sectional multi-omics study. *Front Nutr.* 2022; 8:783302. doi: 10.3389/fnut.2021.783302
36. Shen X, Tilves C, Kim H, Tanaka T, Spira AP, Chia CW, et al. Plant-based diets and the gut microbiome: Findings from the Baltimore Longitudinal Study of aging. *Am. J. Clin. Nutr.* 2024; 119:628-38. doi: 10.1016/j.ajcnut.2024.01.006
37. Aguilar-Toalá JE, Garcia-Varela R, Garcia HS, Mata-Haro V, Gonzalez-Cordova AF, Vallejo-Cordoba B, et al. Postbiotics: An evolving term within the functional foods field. *Trends Food Sci Technol.* 2018; 75:105-14. doi: 10.1016/j.tifs.2018.03.009
38. Borrego-Ruiz A, Borrego JJ. An updated overview on the relationship between human gut microbiome dysbiosis and psychiatric and psychological disorders. *Prog Neuropsychopharmacol Biol Psychiatry.* 2024b; 128:118061. doi: 10.1016/j.pnpbp.2023.110861
39. Cryan JF, O'Riordan KJ, Sandhu K, Peterson V, Dinan TG. The gut microbiome in neurological disorders. *Lancet Neurol.* 2020; 19:179-94. doi: 10.1016/S1474-4422(19)30356-4
40. Koh A, De Vadder F, Kovatcheva-Datchary P, Bäckhed F. From dietary fiber to host physiology: Short-chain fatty acids as key bacterial metabolites. *Cell.* 2016; 165:1332-45. doi: 10.1016/j.cell.2016.05.041
41. Quagebeur R, Dalile B, Rae, J, Van Oudenhove L, Verbeke K, Vriese E. The role of short-chain fatty acids (SCFAs) in regulating stress responses, eating behavior, and nutritional state in anorexia nervosa: Protocol for a randomized controlled trial. *J Eat Disord.* 2023; 11(1):191. doi: 10.1186/s40337-023-00917-6
42. Peng H, Ouyang L, Li D, Li Z, Yuan L, Fan L, et al. Short-chain fatty acids in patients with schizophrenia and ultra-high risk population. *Front Psychiatry.* 2022; 13:977538. doi: 10.3389/fpsy.2022.977538
43. Hossen MS, Ali MY, Jahurul MHA, Abdel-Daim MM, Gan SH, Khalil MI. Beneficial roles of honey polyphenols against some human degenerative diseases: A review. *Pharmacol Rep.* 2017; 69:1194-1205. doi: 10.3389/fpsy.2022.977538
44. Landete JM, Arqués J, Medina M, Gaya P, de Las Rivas B, Muñoz R. Bioactivation of phytoestrogens: Intestinal bacteria and health. *Crit Rev Food Sci Nutr.* 2016; 56:1826-43. doi: 10.1080/10408398.2013.789823
45. Tomás-Barberán FA, González-Sarrías A, García-Villalba R, Núñez-Sánchez MA, Selma MV, García-Conesa MT, et al. Urolithins, the rescue of "old" metabolites to understand a "new" concept: Metabotypes as a nexus among phenolic metabolism, microbiota dysbiosis, and host health status. *Mol Nutr Food Res.* 2017; 61:1. doi: 10.1002/mnfr.201500901
46. LeBlanc JG, Milani C, de Giori GS, Sesma F, van Sinderen D, Ventura M. Bacteria as vitamin suppliers to their host: A gut microbiota perspective. *Curr Opin Biotechnol.* 2013; 24:160-8. doi: 10.1016/j.copbio.2012.08.005
47. Cornish S, Mehl-Madrona L. The role of vitamins and minerals in psychiatry. *Integr Med Insights.* 2008; 3:33-42.
48. Giacoppo S, Galuppo M, Montaut S, Iori R, Rollin P, Bramanti P, et al. An overview on neuroprotective effects of isothiocyanates for the treatment of neurodegenerative diseases. *Fitoterapia.* 2015; 106:12-21. doi: 10.1016/j.fitote.2015.08.001
49. Horácková Š, Plocková M, Demnerová K. Importance of microbial defence systems to bile salts and mechanisms of serum cholesterol reduction. *Biotechnol Adv.* 2018; 36:682-690. doi: 10.1016/j.biotechadv.2017.12.005
50. Chen S, Shao Q, Chen J, Lv X, Ji J, Liu Y, et al. Bile acid signalling and its role in anxiety disorders. *Front Endocrinol.* 2023; 14:1268865. doi: 10.3389/fendo.2023.1268865
51. Hashimoto K. Gut-microbiota-brain axis by bile acids in depression. *Psychiat Clin Neurosci.* 2022; 76(7):281. doi: 10.1111/pcn.13370
52. Li S, Hua D, Wang Q, Yang L, Wang X, Luo A, et al. The role of bacteria and its derived metabolites in chronic pain and depression: Recent findings and research progress. *Int J Neuropsychopharmacol.* 2020; 23(1):26-41. doi: 10.1093/ijnp/pty061
53. Praveenraj SS, Sonali S, Anand N, Tousif HA, Vichitra C, Kalyan M, et al. The role of a gut microbial-derived metabolite, trimethylamine N-oxide (TMAO), in neurological disorders. *Mol Neurobiol.* 2022; 59(11):6684-700. doi: 10.1007/s12035-022-02990-5
54. Obeid R, Awwad HM, Keller M, Geisel J. Trimethylamine-N-oxide and its biological variations in vegetarians. *Eur J Nutr.* 2017; 56:2599-609. doi: 10.1007/s00394-016-1295-9

The relationship between water intake and progressivity Glomerular filtration rate of chronic kidney disease patients

MUNAQISAH¹, Haerani A RASYID², AMINUDDIN², Suryani AS'AD², Nurpudji A. TASLIM², Nur ASHARI²

1 Department of Nutrition, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

2 Clinical Nutrition Specialist Program, Department of Nutrition, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

Recibido: 25/abril/2024. Aceptado: 21/junio/2024.

ABSTRACT

Introduction and objectives: The increasing incidence of chronic kidney disease in Indonesia and several previous studies assessing the relationship of water intake by evaluating all inputs including total daily water intake as well as output (urine volume) found that there is a role of fluid input on the progressivity of CKD which shows that patients who drink too much or little water tend to progress the failure of kidney function faster so we raised this study to determine and important implications for education of CKD patients regarding water intake.

Methods: This prospective observational study entails the enrollment of CKD stage 3a, 3b and 4 outpatients from Hypertension Kidney Poluclinic at Dr. Wahidin Sudirohusodo Hospital and Makassar Satellite Hospital, The search for research subjects from October to December 2023 (11 subjects), followed by observation and data collection lasted for a duration of 3 months (10 subjects) and was analyzed from March to April 2024. The daily average water intake was measured using a 2-liter tumbler and 24-hour urine volume was measured using a chamber pot and the results were recorded in a food diary. Creatinine levels (LFG) were collected from red blood cells and urine osmolarity from 24-hour urine.

Results: The correlation between average daily water intake and delta creatinine was $r = 0.151$ ($p = 0.677$), average daily water intake and delta eLFG was $r = -0.196$ ($p = 0.588$),

average daily water intake and 24-hour total urine volume was $r = 0.625$ ($p = 0.053$), average daily water intake and delta urine osmolarity was $r = 0.608$ ($p = 0.062$). A p-value exceeding 0.05 indicates an insignificant correlation.

Conclusions: The physiological function of the kidneys can still function properly as evidenced by the amount of water given where the more the amount of water drunk, the more the amount of urine and urine osmolarity decreases. This study has not been able to prove the research hypothesis with research limitations.

KEYWORDS

Hydration, Renal Function, Fluid Consumption, Kidney Health, Renal Insufficiency.

INTRODUCTION

Chronic kidney disease (CKD) represents a gradual deterioration in kidney function spanning months or years. According to the Kidney Disease Improving Global Outcomes (KDIGO) 2012 guidelines, CKD is characterized by an abnormality in kidney function or structure persisting for over three months, with consequential health implications, manifested through the presence of one or more signs of kidney damage or the kidney's impaired ability to carry out its functions¹⁻⁴.

CKD commonly coexists with hypertension and diabetes, necessitating patients to adhere to a regimen involving multiple medications, dietary restrictions, and fluid control. Adherence to dietary and fluid limitations is pivotal for CKD patients, with dietary adjustments playing a crucial role in preserving kidney function^{4,5}. Dietary modifications encompassing alterations in energy, macronutrient intake, minerals, and fluids have been

Correspondencia:
munamizwar@gmail.com
haeraniabdurasid@yahoo.com

shown to significantly mitigate the heightened risks of mortality and morbidity associated with CKD⁵.

The hydration aspect of nutrition warrants particular attention. Despite various guidelines recommending different daily water intakes, the evidence supporting these recommendations is relatively weak. Nevertheless, research has elucidated a correlation between water intake and kidney function, with adequate hydration potentially offering protection against kidney disease. Studies indicate that increased water intake is linked to a decreased risk of kidney disease, while consumption of sugary drinks may elevate the risk. Furthermore, higher water intake is associated with a reduced risk of kidney stone recurrence, whereas sugary drink consumption may heighten the recurrence risk⁶⁻⁸.

Research conducted by Wagner et al. and several prior studies has highlighted the complex relationship between water intake and CKD progression, influenced by factors such as urine osmolarity and volume. While adequate water intake generally correlates with a lower CKD prevalence in the general population, findings in CKD patients may vary. Some studies suggest that elevated urine osmolarity, possibly due to insufficient fluid intake, could exacerbate kidney function decline, whereas others propose that reduced urine osmolarity, potentially resulting from increased fluid intake, might also accelerate CKD progression^{6,9}.

Classification of CKD is predicated on etiology, glomerular filtration rate (GFR) category, and albuminuria category. Determination of CKD etiology hinges on the presence or absence of systemic disease and the observation of kidney disorder localization or anatomical pathology findings^{6,10-13}.

LITERATURE REVIEW

Chronic Kidney Disease

Chronic kidney disease denotes a gradual deterioration in kidney function occurring over months or even years. According to the 2012 Kidney Disease Improving Global Outcomes (KDIGO) guidelines, CKD is delineated as an anomaly in kidney function or structure persisting for more than three months, with health implications marked by the presence of one or more indicators of kidney damage, or whether such damage exists, and the kidneys' capacity to perform their functions¹¹⁻¹³.

The classification of CKD hinges on factors such as its underlying cause, the glomerular filtration rate (GFR) category, and the albuminuria category. The etiology of CKD is ascertained by assessing the presence or absence of systemic diseases and scrutinizing the location of kidney pathology or anatomical finding^{10,14}.

Stage 1 CKD: In this early stage, kidney function is mildly impaired. The estimated glomerular filtration rate (eGFR) is greater than or equal to 90 mL/min/1.73m². Stage 2 CKD: Kidney function is still relatively preserved, but eGFR ranges from 60 to 89 mL/min/1.73m². Stage 3a CKD: eGFR falls between 45 and 59 mL/min/1.73m². At this point, symptoms may become more noticeable, and patients are at moderate risk for progression. Stage 3b CKD: eGFR is between 30 and 44 mL/min/1.73m². This stage represents moderate to severe kidney function loss. Patients are at high risk for CKD progression and heart disease. Stage 4 CKD: eGFR ranges from 15 to 29 mL/min/1.73m². Stage 5

Table 1. Degree of CKD and Risk of Progression

Prognosis of CKD by GFR and albuminuria categories: KDIGO 2012				Persistent albuminuria categories, description and range		
				A1	A2	A3
				Normal to mildly increased	Moderately increased	Severely increased
				<30 mg/g <3 mg/mmol	30-300 mg/g 3-30 mg/mmol	>300 mg/g >30 mg/mmol
GFR Categories (ml/min/1,73 m ²) Description and range	G1	Normal or high	≥90			
	G2	Mildly decreased	60-89			
	G3a	Mildly to moderately decreased	45-59			
	G3b	Moderately to severely decreased	30-44			
	G4	Severely decreased	15-29			
	G5	Kidney failure	<15			

Green, low risk (if no other markers of kidney disease, no CKD); yellow, moderately increased risk; orange, high risk; red, very high risk.

CKD: Also known as end-stage renal disease (ESRD), eGFR is less than 15 mL/min/1.73m² 9,11,15.

Water Needs in PGK

In human studies, several observational investigations have highlighted a positive correlation between increased water intake and enhanced kidney function. For instance, in a prospective cohort study involving 2000 Canadian adults without renal ailments, heightened urine volume at baseline corresponded with a decelerated renal decline during subsequent monitoring. Likewise, in two cross-sectional analyses of Australian and American cohorts, greater self-reported water consumption correlated with improved kidney function. Recently, researchers pinpointed chronic dehydration, stemming from hot climates, as a primary contributor to the chronic kidney disease (CKD) surge in Central America, thereby reinforcing the notion of the protective impact of increased water intake on kidney health. Nevertheless, conclusive evidence from rigorously designed and large-scale randomized controlled trials is warranted to ascertain whether elevated water intake can effectively mitigate the pace of kidney function decline^{2,7,16}.

Kidney function naturally diminishes with age, as the kidneys lose their capacity to concentrate urine, thereby indicating an augmented necessity for adequate water intake to uphold optimal kidney function (IOM, 2005; EFSA, 2010). Benelam & Wyness (2010) have documented numerous health advantages associated with sufficient water consumption among older adults, encompassing a reduction in falls and constipation. Furthermore, a review by Armstrong (2012) revealed hydration to be linked with diminished risks of chronic kidney disease, fatal coronary heart disease, hypertension, venous thromboembolism, cerebral infarction, and dental ailments, albeit the evidence remains somewhat tenuous and relies on limited studies. A particular cross-sectional study conducted in Australia highlighted a significantly reduced risk of chronic kidney disease among participants in the highest quintile of fluid intake (3.3 L/day) compared to those in the lowest quintile (1.7 L/day).^(3,6,17)

Relationship Between Water Intake and GFR

Fluid consumption is beneficial for kidney function. Choi et al found an inverse linear relationship between fluid intake and CKD prevalence. The higher the fluid intake the lower the risk, with an intake of 3.3 L/day associated with a 30–50% reduction compared with an intake of 1.7 L/day. Several observational studies examined the role of water intake in the development of CKD. Two large studies report that higher fluid intake and urine volume can preserve kidney function. Clark et al in a prospective Canadian cohort of 2,148 participants followed up for 6 years showed that the estimated rate of decline in glomerular filtration rate (GFR) was inversely related to the increase in 24-hour urine volume. For each litre of increase in 24-hour urine volume from <1 L to >3 L (stratified

by quartiles), the annual percentage decrease in GFR decreased by 1.3, 1.0, 0.8, and 0.5%, respectively¹⁸⁻²¹.

In another study, Strippoli et al. in 2011 conducted two cross-sectional Australian population-based studies. The proportion of participants who completed a food frequency questionnaire (FFQ) and had a GFR measurement was 2,744/3,654 (75.0%) for the first survey and 2,476/3,508 (70.6%) for the second survey. CKD occurs in 12.4-23.5% of men and 14.9-28.7% of women (mean age 66.4-65.4 years). Participants in the highest quintile of fluid intake (3.2 L/day) had a significantly lower risk of CKD (odds ratio 0.5; 95% CI 0.32 to 0.77, p for trend=0.003). There was a significant inverse linear relationship between self-reported daily fluid intake volume and CKD prevalence. They concluded that higher fluid intake appeared to protect against CKD²².

The relationship between water intake and estimated glomerular filtration rate (GFR) has been investigated in several observational studies and results have been mixed. In a retrospective analysis of adult patients with CKD in the Modification of Diet in Renal Disease study, higher urine volumes were associated with greater reductions in GFR, however, this association was not significant after controlling for the use of diuretics and antihypertensive medications. In contrast, in a prospective cohort study of adults free of CKD at study entry, higher urine volumes at baseline were associated with a slower decline in GFR over 7 years and those with the largest urine volumes (>3L/day) did not show a rapid decline in GFR (defined as a decline≥5%/year)²³⁻²⁷.

METHODS

Research design

This research is a prospective observational study of CKD stage 3a, stage 3b and stage 4 outpatients at the Hypertension Kidney Polyclinic at Dr Wahidin Sudirohusodo Hospital Makassar and Makassar Satellite Hospital

Place and time

This study was conducted at Dr. Wahidin Sudirohusodo Hospital Makassar and Makassar Satellite Hospital, where the search for research subjects from October to December 2023, followed by observation and data collection lasted for 3 months and data were analyzed from March to April 2024.

Research Sample

The research sample was the total sampling of CKD patients who met the inclusion criteria and were accessible to researchers during the research period

Inclusion Criteria

CKD stage 3a, 3b and 4 patients who seek treatment at the RSWS Polyclinic or Makassar Satellite Hospital. Age >18 years.

The estimated glomerular filtration rate (GFR) is between 15-60 mL/minute/1.73 m² at Prodia Makassar Laboratory. No hemodialysis and no history of previous kidney transplantation. Patients can communicate well, understand and provide written consent to participate in this research

Exclusion Criteria

There has been education by doctors to limit the volume of water intake. Symptoms of oliguria in the last 1 week. Currently taking antidiuretics. Gastrointestinal diseases or disorders (diarrhea, vomiting, inflammatory bowel disease and gastrointestinal bleeding) and respiratory diseases. Pregnant or breastfeeding. The subject has clinical symptoms of oedema or ascites. Subject died.

Research Procedures

The sample consisted of 10 participants. Data collection was carried out in 2 stages. First, screening is carried out to find samples, then samples are determined that meet the inclusion and exclusion criteria,

Second, collecting data from all variables to be studied, where water intake data uses a 2 liter tumbler to measure daily water intake by filling the 2 liter tumbler completely with water every day when the subject wakes up in the morning (for example at 5 am) then water intake, including when the subject wants to make juice/tea/coffee, is taken from the tumbler and the rest is recorded (at 5 am the next day) in the food diary, then every 1 working day and 1 weekend every week for 3 months (24 recording times). Data on 24-hour urine volume using a urine bedpan by discarding the first urine, then the next urine until the first urine the next day is collected using a urine bedpan and recording the 24-hour urine volume in litres in the *food diary* (for example: 1/9/2023 at 7 am urine is collected until 2/9/2023 at 7 am), then every 1 weekday and 1 weekend every week for 3 months (24 recordings).

Measurement of urea/creatinine (GFR) levels was carried out at the beginning and end of the study by taking blood samples at the Prodia Makassar Laboratory where before inserting the syringe, the blood collection location was cleaned with an alcohol swab and then left to dry. Ensure that the stabbing site is free from wounds and scars. The blood taken is venous blood through the median cubital vein or through a double lumen catheter. 5 ml of blood was taken and stored in a sample tube without EDTA. Urine osmolarity measurements were carried out at the beginning and end of the study where 24 hour urine samples were collected and collected by discarding the first urine, then the next urine until the first urine the next day was collected using bagged urine which had been provided by the Prodia Makassar laboratory (for example: 1/9 /2023 at 8 am urine is collected until 2/9/2023 at 8 am) and the 24 hour urine volume is recorded in liters, then

the pot containing the urine is taken to the Makassar Prodia laboratory which will then be sent to the Harapan Kita Heart Hospital laboratory, Jakarta for analyzed.

Research Subject Consent

This research has received approval from the Health Research Ethics Commission (KEPK) of the Faculty of Medicine, Hasanuddin University with Number: 824/UN4.6.4.5.31/PP36/2023 and a research license from Human Resources, Education and Research of RSUP. Wahidin Sudirohusodo with Number: DP.04.03/D.XIX.2/22321/2023 and a research license from the manager of education and research at UNHAS Hospital with Number: 13669/UN4.24.1.1/PT.01.04/2023.

Data analysis

The data obtained is collected based on the type of data and then the appropriate statistical method is selected. Correlation test with Pearson if the data is normally distributed or Spearman correlation if the data is not normally distributed. The data normality test uses Shapiro Wilk because the sample is < 50.

RESULTS

The research findings are presented in Table 2, which outlines the characteristics of the sample under observation, including the number of individuals (n) and the percentage (%) for each variable category. The mean age of the participants was 52.70 years, with a standard deviation of 10.26 years, indicating the spread of data from the mean. The median age, representing the middle value in the data set, was 54 years. The age distribution ranged from 40 to 67 years, with most participants falling within a similar age range.

The average Body Mass Index (BMI) was 23.60, with a standard deviation of approximately 3.77. The median BMI was 23.80, with values ranging from 17.20 to 30.30. Regarding gender (JK), out of the total 10 individuals, 7 (70%) were men and 3 (30%) were women. In terms of employment status, 7 (70%) were employed, while 3 (30%) were not.

Regarding health habits, 5 individuals (50%) were smokers, and an equal number were non-smokers. Only 2 individuals (20%) reported alcohol consumption, while the remaining 8 (80%) did not. Hypertension (HT) was prevalent among 9 individuals (90%), while 1 (10%) did not have hypertension. Diabetes Mellitus (DM) affected 3 individuals (30%), while 7 (70%) did not have it. Similarly, only 1 individual (10%) experienced nasopharyngeal carcinoma (NPC), hyperuricemia, and dyslipidemia, respectively, while the majority did not have these conditions.

Figure 1 depicts the correlation between average daily water intake and delta creatinine, indicating a weak positive correlation (0.151) with a p-value of 0.677. Figure 2 illustrates

Table 2. Characteristics of research subjects

Characteristics		n (%)
Age		52.70 [10.26]
BMI		23.60 [3.77]
Gender	Man	7 (70.0)
	Woman	3 (30.0)
Work	Work	7 (70.0)
	Doesn't work	3 (30.0)
Smoke	Yes	5 (50.0)
	No	5 (50.0)
Alcohol	Yes	2 (20.0)
	No	8 (80.0)
Hypertension	Yes	9 (90.0)
	No	1 (10.0)
Diabetes	Yes	3 (30.0)
	No	7 (70.0)
Nasopharyngeal carcinoma	Yes	1 (10.0)
	No	9 (90.0)
Hyperuricemia	Yes	1 (10.0)
	No	9 (90.0)
Dyslipidemia	Yes	1 (10.0)
	No	9 (90.0)
Total		10 (10.0)

Data are presented as n (%) or mean [SD].

the correlation between water intake and glomerular filtration rate delta, showing a weak negative correlation (-0.196) with a p-value of 0.588. Figure 3 displays a relatively strong positive correlation (0.625) between water intake and 24-hour urine output, with a p-value of 0.053. Figure 4 demonstrates a strong negative correlation (0.608) between water intake and urine osmolality delta, although the p-value (0.062) is slightly above 0.05, suggesting insignificance

DISCUSSION

Based on the analysis of Figure 1, it is evident that there is no significant correlation between average daily water intake

and creatinine levels ($r = 0.151$, $p = 0.677$). Despite the lack of statistical significance, there appears to be a weak positive correlation between water intake and creatinine levels, suggesting that higher water consumption is associated with a slight decrease in creatinine values. However, it's important to note that water intake does not directly impact changes in creatinine levels. Creatinine is a byproduct of muscle metabolism excreted by the kidneys, commonly used as an indicator of kidney function. The findings indicate that other factors such as physical activity, diet, or underlying health conditions may play a more significant role in determining creatinine levels^{15,28-31}.

Moving on to Figure 2, the correlation analysis between average daily water intake and glomerular filtration rate (GFR) indicates a weak negative correlation ($r = -0.196$, $p = 0.588$). Although the correlation is not statistically significant, there appears to be a trend towards a weak negative relationship between water intake and changes in GFR values. However, this suggests that there is minimal correlation between total water intake and changes in GFR, which is an important parameter in assessing kidney function^{9,15}.

Regarding Figure 3, the research findings demonstrate that higher water intake correlates with increased urine production. Clinically, this suggests that individuals with higher water intake tend to excrete more urine, indicating healthy kidney function. However, in patients with kidney failure, decreased urine production may result from increased water intake, leading to fluid retention. Changes in body fluid requirements, such as physical activity or environmental conditions, can also influence the relationship between water intake and urine production^{2,9,15}.

Moving to Figure 4, a strong negative correlation is observed between average daily water intake and urine osmolality ($r = -0.608$, $p = 0.062$). This indicates that higher water intake leads to lower urine osmolality, suggesting dilution of urine. However, despite the numerical strength of the correlation, the p-value suggests that this relationship does not reach statistical significance. Hence, while there is a trend towards a relationship between water intake and changes in urine osmolality, further statistical evidence is required to validate this conclusion^{9,27}.

In conclusion, while there are trends suggesting associations between water intake and various kidney function parameters, additional research with larger sample sizes and controlled factors is needed to establish conclusive evidence. Notably, Hebert et al.'s study underscores the importance of fluid intake in kidney disease progression, emphasizing the role of urine osmolality and volume in delaying kidney disease progression, even in patients without polycystic kidney disease (PKD)⁸.

LIMITATIONS

The sample taken was a sample of new patients diagnosed with stage 3a, 3b and 4 CKD so the number of subjects successfully recruited was small.

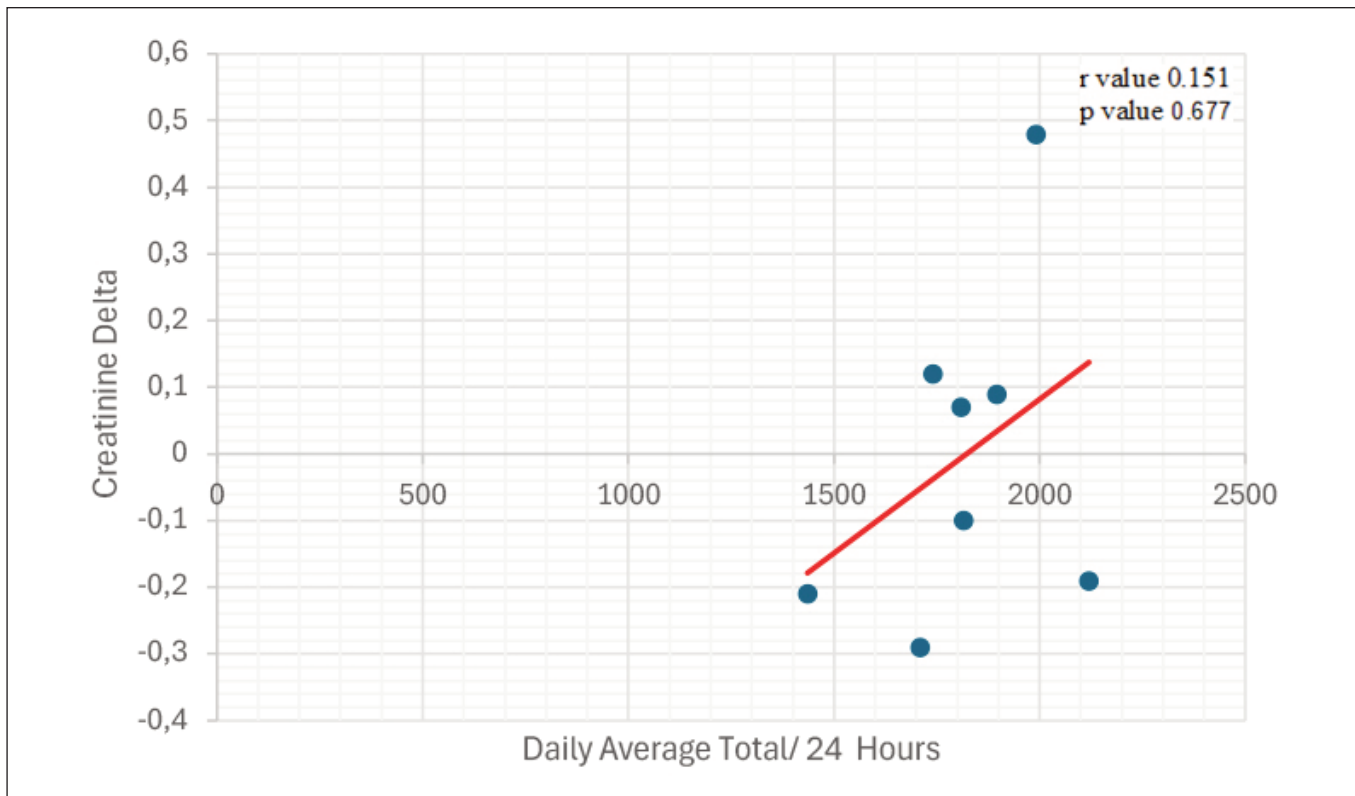


Figure 1. Correlation between average daily water intake and delta creatinine

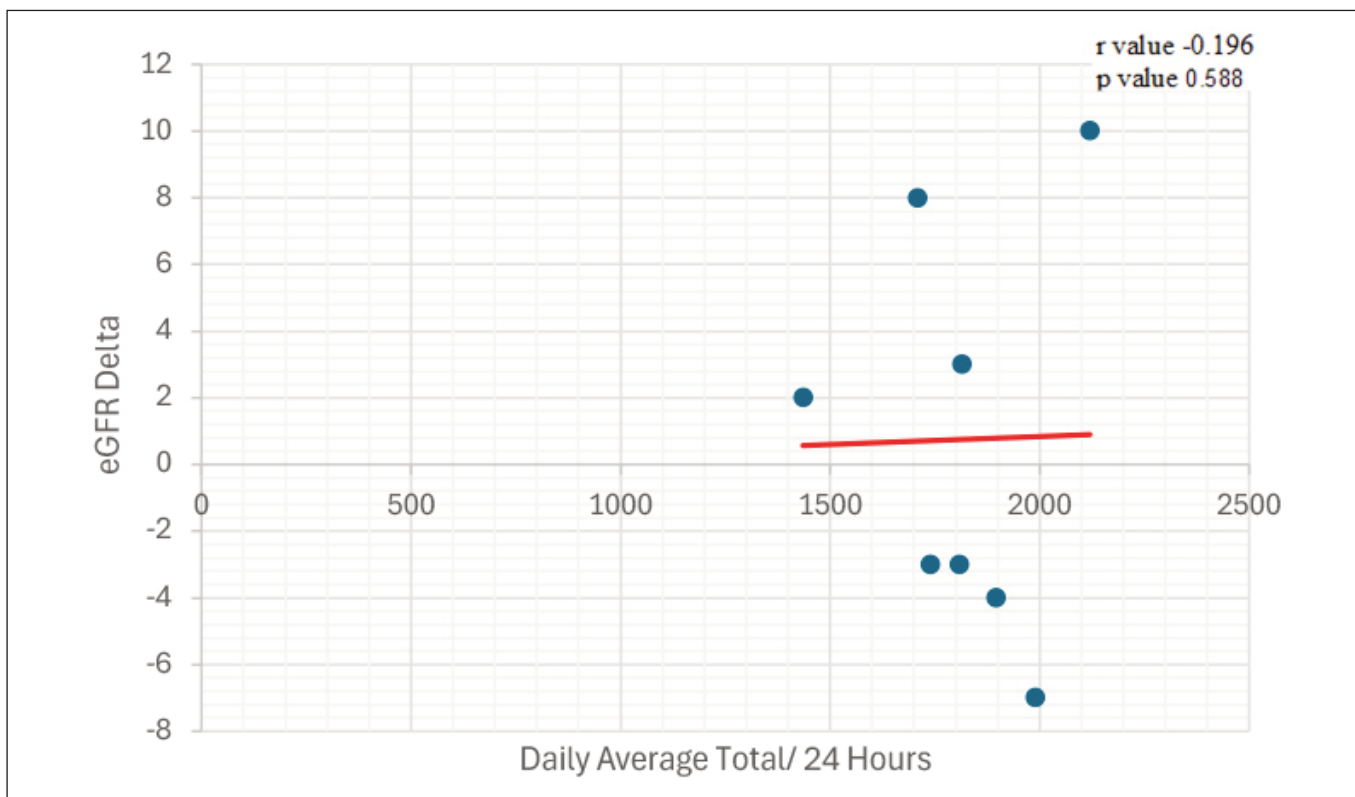


Figure 2. Correlation between average daily water intake and glomerular filtration rate delta

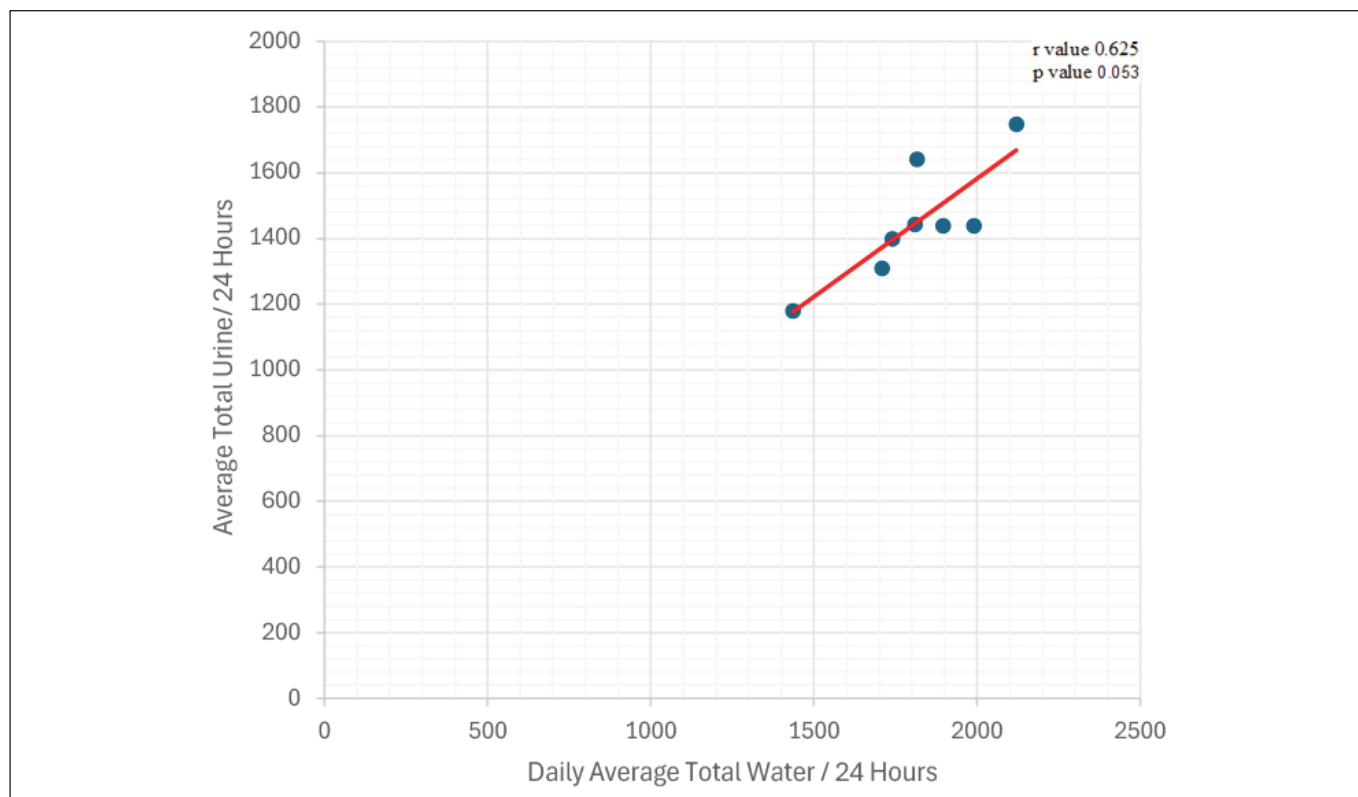


Figure 3. Correlation between average daily water intake and average 24 hour total urine

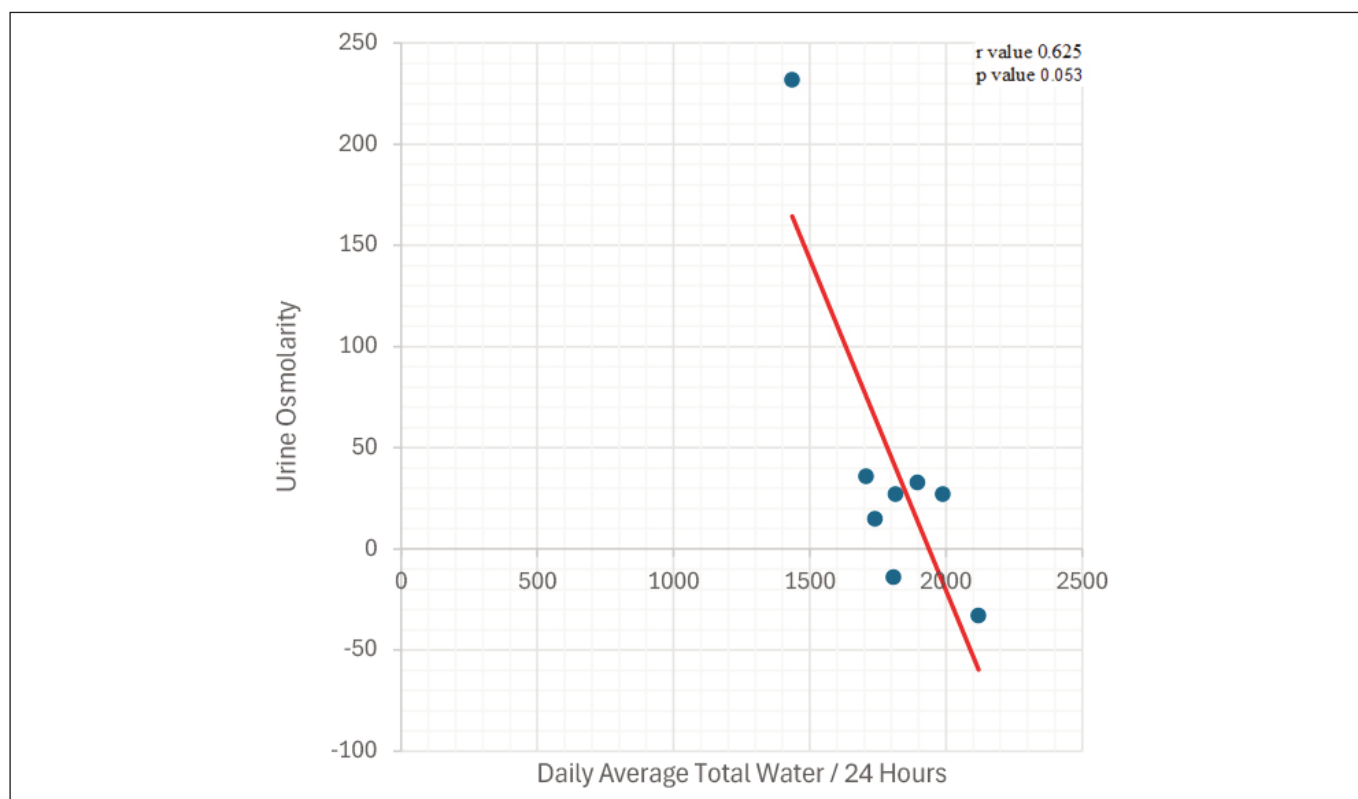


Figure 4. Correlation between average daily water intake and urine osmolarity delta

The study time was short so the number of patients could not meet the criteria 3.

CONCLUSION

The physiologically, kidneys can still function properly as evidenced by the amount of water given where the more the amount of water drunk, the amount of urine and urine osmolality decreases^{9,15}.

This study has not been able to prove the research hypothesis about the relationship between water intake with 24-hour urine volume, urine osmolality and LFG progressivity of stage 3a, 3b and 4 CKD patients with research limitations.

RECOMMENDATION

Based on the results of this research, it can be recommended that further research needs to be carried out with more subjects and a longer time to assess water intake on the progressivity of LFG of CKD patients stages 3a, 3b and 4 so that it can provide more generalizable and accurate results.

ACKNOWLEDGEMENT

Thank you to Hasanuddin University for helping facilitate this research

REFERENCES

- Beerendrakumar N, Ramamoorthy L, Haridasan S. Dietary and Fluid Regime Adherence in Chronic Kidney Disease Patients. *J Caring Sci* [Internet]. 2018;7(1):17–20. Available from: <http://dx.doi.org/10.15171/jcs.2018.003>
- Choi HY, Park HC, Ha SK. High water intake and progression of chronic kidney diseases. *Electrolyte and Blood Pressure*. 2015; 13(2):46–51.
- Clark WF, Sontrop JM, Huang SH, Gallo K, Moist L, House AA, et al. The chronic kidney disease Water Intake Trial (WIT): Results from the pilot randomised controlled trial. *BMJ Open*. 2013; 3(12):1–8.
- Clark WF, Sontrop JM, Huang SH, Gallo K, Moist L, House AA, et al. Effect of coaching to increase water intake on kidney function decline in adults with chronic kidney disease the CKD WIT randomized clinical trial. *JAMA - Journal of the American Medical Association*. 2018;319(18):1870–9.
- Clark WF, Huang SH, Garg AX, Gallo K, House AA, Moist L, et al. The chronic kidney disease water intake trial: Protocol of a randomized controlled trial. *Can J Kidney Health Dis*. 2017;4.
- Ekingen T, Sob C, Hartmann C, Rühli FJ, Matthes KL, Staub K, et al. Associations between hydration status, body composition, sociodemographic and lifestyle factors in the general population: a cross-sectional study. *BMC Public Health* [Internet]. 2022;22(1):1–12. Available from: <https://doi.org/10.1186/s12889-022-13280-z>
- Kovesdy CP. Epidemiology of chronic kidney disease: an update 2022. *Kidney Int Suppl* (2011) [Internet]. 2022;12(1):7–11. Available from: <https://doi.org/10.1016/j.kisu.2021.11.003>
- Travers S, Prot-Bertoye C, Daudon M, Courbebaisse M, Baron S. How to Monitor Hydration Status and Urine Dilution in Patients with Nephrolithiasis. *Nutrients*. 2023;15(7).
- Wagner S, Merklung T, Metzger M, Bankir L, Laville M, Frimat L, et al. Water intake and progression of chronic kidney disease: The CKD-REIN cohort study. *Nephrology Dialysis Transplantation*. 2022;37(4):730–9.
- Idrus A. Ilmu Penyakit Dalam. Ilmu Penyakit Dalam. 2014. p. 26.
- Draft PR. KDIGO 2023 CLINICAL PRACTICE GUIDELINE FOR THE MANAGEMENT OF LUPUS NEPHRITIS CONFIDENTIAL: DO NOT DISTRIBUTE PUBLIC REVIEW DRAFT. 2023;(March).
- Kemenkes. PNPk malnutrisi 2017. pnpk. 2019;6(1):5–10.
- Ikizler TA, Burrowes JD, Byham-gray LD, Campbell KL, Carrero J, Jesus, Chan W, et al. KDOQI CLINICAL PRACTICE GUIDELINE FOR NUTRITION IN CKD: 2020 UPDATE. *American Journal of Kidney Diseases* [Internet]. 2020;76(3):S1–107. Available from: <https://doi.org/10.1053/j.ajkd.2020.05.006>
- Kasper D, Hauser S, Jameson JL, Fauci A, Hauser S, Longo D, et al. *Harrison's Principles of Internal Medicine*. 2022;
- Wang HW, Jiang MY, Li J. Higher volume of water intake is associated with lower risk of albuminuria and chronic kidney disease. *Medicine (United States)*. 2021;100(20):E26009.
- Romagnani P, Remuzzi G, Glassock R, Levin A, Jager KJ, Tonelli M, et al. Chronic kidney disease. *Nat Rev Dis Primers*. 2017;3.
- Scientific Opinion on Dietary Reference Values for water. *EFSA Journal*. 2016;8(3):1–48.
- Of Veterans Affairs D, of Defense D, Lewin Group T. VA/DoD CLINICAL PRACTICE GUIDELINE FOR THE MANAGEMENT OF CHRONIC KIDNEY DISEASE The Management of Chronic Kidney Disease Work Group With support from. Available from: www.tricare.mil
- López-Novoa JM, Martínez-Salgado C, Rodríguez-Peña AB, Hernández FJL. Common pathophysiological mechanisms of chronic kidney disease: Therapeutic perspectives. *Pharmacol Ther* [Internet]. 2010;128(1):61–81. Available from: <http://dx.doi.org/10.1016/j.pharmthera.2010.05.006>
- Guy Howard, Jamie Bartram, Ashley Williams, Alycia Overbo, David Fuente JAG. *Domestic Water Quantity, Service Level and Health*, second edition [Internet]. World Health Organization. 2020. 76 p. Available from: http://www.who.int/water_sanitation_health/diseases/wsh0302/en/
- Johnson RJ, García-Arroyo FE, Gonzaga-Sánchez G, Vélez-Orozco KA, Álvarez-álvarez YQ, Aparicio-Trejo OE, et al. Current Hydration Habits: The Disregarded Factor for the Development of Renal and Cardiometabolic Diseases. *Nutrients*. 2022;14(10):1–14.
- Choi HY, Park HC, Ha SK. High water intake and progression of chronic kidney diseases. *Electrolyte and Blood Pressure*. 2015; 13(2):46–51.
- Sontrop JM, Dixon SN, Garg AX, Buendia-Jimenez I, Dohein O, Huang SHS, et al. Association between water intake, chronic kidney disease, and cardiovascular disease: A cross-sectional analysis of NHANES data. *Am J Nephrol*. 2013;37(5):434–42.

24. Wales NS, Bhsc LL. Evidence based practice guidelines for the nutritional management of chronic kidney disease. *Nutrition and Dietetics*. 2006;63(SUPPL. 2):S33–45.
25. Moonen HPFX, Van Zanten ARH. Bioelectric impedance analysis for body composition measurement and other potential clinical applications in critical illness. *Curr Opin Crit Care*. 2021;27(4):344–53.
26. Zsom L, Zsom M, Salim SA, Fülöp T. Estimated Glomerular Filtration Rate in Chronic Kidney Disease: A Critical Review of Estimate-Based Predictions of Individual Outcomes in Kidney Disease. *Toxins (Basel)*. 2022;14(2).
27. Lee MJ, Chang TI, Lee J, Kim YH, Oh KH, Lee SW, et al. Urine Osmolality and Renal Outcome in Patients with Chronic Kidney Disease: Results from the KNOW-CKD. *Kidney Blood Press Res*. 2019;44(5):1089–100.
28. Magaña A, García A, Mundo V, Amado Q, Carlos G, Mejía F, et al. Nutrición Hospitalaria Trabajo Original. *Nutr Hosp [Internet]*. 2022;39(3):537–46. Available from: <https://scielo.isciii.es/pdf/nh/v39n3/0212-1611-nh-39-3-537.pdf>
29. Iorember FM. Malnutrition in chronic kidney disease. *Front Pediatr*. 2018;6(June).
30. Luo Y, Huang H, Wang Q, Lin W, Duan S, Zhou J, et al. An Exploratory Study on a New Method for Nutritional Status Assessment in Patients with Chronic Kidney Disease. *Nutrients*. 2023;15(11):1–14.
31. Kim SM, Jung JY. Nutritional management in patients with chronic kidney disease. *Korean Journal of Internal Medicine*. 2020;35(6): 1279–90.

Valoración del estado nutricional y sarcopenia en adultos con artritis reumatoide atendidos en consulta externa, Hospital Hipólito Unanue, Tacna - Perú, 2023

Assessment of nutritional status and sarcopenia in adults with rheumatoid arthritis treated in outpatient clinic, Hospital Hipólito Unanue, Tacna - Peru, 2023

Cristina CONDORI CASTRO

Maestría en Nutrición Clínica. Facultad de Medicina. Universidad Nacional Mayor de San Marcos. Lima, Perú. Licenciada en Nutrición Humana.

Recibido: 25/diciembre/2023. Aceptado: 26/junio/2024.

RESUMEN

Introducción: La prevalencia de sarcopenia en la población adulta aumenta con la edad, lo que puede agravar otras condiciones como el sobrepeso, la obesidad y enfermedades como la artritis reumatoide, afectando significativamente la calidad de vida de las personas.

Objetivo: Determinar la asociación entre el nivel de actividad de la artritis reumatoide y sarcopenia en pacientes atendidos en consulta externa del hospital Hipólito Unanue, Tacna 2023.

Materiales y Métodos: Estudio observacional-transversal. La población estuvo compuesta por pacientes con edades comprendidas entre 25 a 60 años (n=75). Las variables estudiadas fueron: artritis reumatoide, sarcopenia, edad, sexo, peso, talla, IMC, masa grasa corporal, fuerza muscular, hábitos alimentarios y de actividad física. La composición corporal se midió a partir de antropometría. El rendimiento físico se determinó con el test de "Short Physical Performance Battery" (SPPB). Con el objetivo de dilucidar la posible relación entre las variables estado nutricional y sarcopenia se utilizó la prueba de normalidad de Kolmogorov-Smirnov, ya que la muestra era mayor a 50, un nivel de significancia de 0.05, y la prueba estadística de Chi Cuadrado para determinar la relación entre las variables con un p-valor $0,00 < 0,05$.

Resultados: Los pacientes evaluados presentan un 41.3% de sobrepeso, el 33.3% tiene un estado nutricional normal y un 25,3% presenta obesidad. En cuanto a la actividad de artritis reumatoide el 65,3% tiene nivel de actividad moderada, el 24% leve y el 4% severa, a su vez de los evaluados según los criterios de EGWSOP2 el 60% tiene sarcopenia grave y el 20% de sarcopenia confirmada. Los pacientes con exceso de peso según IMC no necesariamente tienen mayor grado de sarcopenia. Se determinó que el valor de $p = 0,176$ $p \geq 0,05$, por lo tanto, no existe relación significativa entre el estado nutricional y el nivel de sarcopenia de los pacientes con enfermedad reumatoidea, no existiendo asociación directa entre las variables.

Conclusión: La valoración nutricional de la actividad de la artritis reumatoide tiene un efecto considerable en los resultados clínicos de los indicadores de la sarcopenia. Se encontró que siete de cada diez personas adultas evaluadas tienen sarcopenia grave. Por lo tanto, se sugiere la implementación de pruebas de tamizajes que puedan ser de ayuda para la detección de personas con riesgo de sarcopenia en el primer nivel de atención

PALABRAS CLAVE

Dinapenia; artrosis; estado nutricional.

ABSTRACT

Introduction: The prevalence of sarcopenia in the adult population increases with age, which can aggravate other conditions such as overweight, obesity and diseases such as rheumatoid arthritis (RA), significantly affecting people's quality of life.

Correspondencia:
Cristina Condori Castro
cristinacondori28@gmail.com

Objective: Determine the association between the level of activity of rheumatoid arthritis and sarcopenia in patients treated in the outpatient clinic of the Hipólito Unanue hospital, Tacna 2023.

Materials and Methods: Observational-cross-sectional study. The population was made up of patients with a diagnosis of rheumatoid arthritis aged between 25 and 60 years (n=75). The variables studied were: rheumatoid arthritis, sarcopenia, age, sex, weight, height, BMI, body fat mass, muscle strength, eating habits and physical activity. Body composition was measured using anthropometry. Physical performance was determined with the "Short Physical Performance Battery" (SPPB) test. The Kolmogorov-Smirnov normality test was used, since the sample was greater than 50, a significance level of 0.05, and the Chi Square statistical test was used to determine the relationship between the variables with a p-value $0.00 < 0.05$.

Results: The patients evaluated are 41.3% overweight, 33.3% have a normal nutritional status and 25.3% are obese. Regarding the activity of rheumatoid arthritis, 65.3% have a moderate activity level, 24% mild and 4% severe. In turn, of those evaluated according to the EGWSOP2 criteria, 60% have severe sarcopenia and 20% have severe sarcopenia. of confirmed sarcopenia. Patients with excess weight according to BMI do not necessarily have a higher degree of sarcopenia. A significant association was found with $p < 0.00 < 0.05$, whereby the level of rheumatoid arthritis activity is associated with the severity of sarcopenia.

Conclusion: The nutritional assessment of rheumatoid arthritis activity has a considerable effect on the clinical results of sarcopenia indicators; it was found that seven out of ten adults evaluated have severe sarcopenia. Therefore, the implementation of screening tests that can be helpful in detecting people at risk of sarcopenia at the first level of care is suggested.

KEYWORDS

Dynapenia; osteoarthritis; nutritional condition.

INTRODUCCIÓN

La artritis reumatoide es una enfermedad sistémica crónica inflamatoria de origen desconocido que representa una elevada mortalidad a largo plazo, afecta por lo general al 14% de la población mayor de 65 años, pero menor de 70 años, llegando al 53% en adultos mayores de 80 años^{1,2}. Según la Organización Mundial de la Salud (OMS), esta enfermedad es un problema de salud pública pues representa un riesgo mayor en las personas adultas, padeciéndola 1 de cada 10 personas^{2,3}.

Con respecto al estado nutricional del individuo se verá comprometido puesto que la pérdida de masa muscular

juega un rol importante en su etiología y desarrollo en los adultos^{4,5}. Como consecuencia la composición corporal en pacientes con AR señala que la masa grasa y masa magra tienen efectos de valor sobre el estado de salud generando complicaciones futuras^{6,7}.

En un estudio realizado por Karahan y colaboradores, determinaron la frecuencia de sarcopenia y factores asociados en personas mayores con artritis reumatoide, sus resultados mostraron que del total de evaluados el grupo sarcopénico fue mayor a comparación del no sarcopénico y además que la tasa de desnutrición, fragilidad, niveles de PCR (Proteína C Reactiva) y dependencia en las actividades de vida fueron mayor en el grupo sarcopénico^{8,9}. En otra investigación realizada por Mochizuki y colaboradores, a 240 pacientes con artritis reumatoide mayores de 65 años, se evidenció una prevalencia del 29,6% de sarcopenia, estimándose que existe factores asociados a su afección como: la edad, el IMC, la proteína c reactiva y la densidad mineral ósea de la cadera en pacientes diagnosticados con la enfermedad¹⁰. Según un estudio realizado en Brasil en pacientes con lupus eritematoso sistémico y artritis reumatoide que fueron atendidos en un centro de referencia, un estado de malnutrición por exceso predispone en estas patologías conllevar a un grado severo de sarcopenia¹¹.

La sarcopenia en la población adulta con enfermedad de artritis reumatoidea tiene gran impacto¹², teniendo eventualidad en edades comprendidas entre 25 - 55 años¹³, las consecuencias tienden a comprometer la calidad de vida, el sistema inmunológico y la productividad en el desarrollo personal¹⁴. Es de importancia conocer el estado nutricional de esta población con presencia de sarcopenia agravada que podría afectar la salud y conllevar a malnutrición como sobrepeso y obesidad: o daños a causa de la fragilidad^{15,16}. La práctica de hábitos saludables se ha considerado un factor esencial para la prevención de la enfermedad y mejora de la calidad de vida de la población, siendo de importancia promoverlos desde edades tempranas^{17,18}.

En este contexto, el objetivo de esta investigación fue determinar la asociación entre estado nutricional y la sarcopenia en pacientes adultos con artritis reumatoide que son atendidos en consulta externa del Hospital Hipólito Unanue del departamento de Tacna (Perú en el 2023).

MÉTODOS

Diseño del estudio

Estudio cuantitativo, observacional analítico, prospectivo. La muestra fue de 75 adultos atendidos en consulta. La población fue seleccionada por muestreo no probabilístico y compuesta por pacientes de 29 a 60 años de edad que se encontraban neurológicamente y físicamente estables atendidos en consulta externa de la especialidad de reumatología en el Hospital Hipólito Unanue de Tacna. El mismo que se realizó

conforme a los principios indicados en la declaración de Helsinki, también firmaron una carta de consentimiento informado. Los datos se tomaron en el periodo de un año, 2023. La recopilación de información fue realizada por estudiantes de la Maestría en Nutrición, quienes fueron capacitados y estandarizados en el uso de métodos y técnicas de recolección de información. Con el objetivo de dilucidar la posible asociación entre las variables estado nutricional y sarcopenia se empleó la prueba estadística chi cuadrado.

Variables de estudio

Estado Nutricional

Se evaluó el estado nutricional mediante la valoración antropométrica del índice de masa corporal (IMC), calculado como el peso del individuo en kilogramos (kg) dividido por la altura en metros al cuadrado, clasificándolo en normal (18,5-24,99), sobrepeso ($\geq 25,00 \leq 29,99$) y obesidad ($\geq 30,00$). Para ello se utilizó una báscula de pie para obtener el peso y un tallímetro de madera con 3 cuerpos con una altura de 1.92 metros, portátil y validado por el Centro Nacional de Alimentación y Nutrición (CENAN)^{19,20}.

Sarcopenia

Para el diagnóstico de sarcopenia se tomó cuenta los 3 criterios propuestos por el Consenso Europeo sobre Sarcopenia en Adultos (EWGSOP2), el cual describe como sarcopenia la presencia baja de función muscular; ya sea fuerza o rendimiento físico y baja masa muscular^{20,21}. La fuerza de agarre se evaluó con la mano más predominante del paciente y se empleó para ello un dinamómetro hidráulico de mano, de la marca Jamar®, el cual cuenta con registro de fuerza de unidad de masa con capacidad máxima de 90 kg²¹. Para el criterio de masa muscular se determinó mediante bioimpedancia, con un bioimpedanciometro de marca Tanita bc-602 la cual tiene límite de peso 150 kg, corriente de medición de 50 kilo Hertz y cuenta con 6 electrodos presentes a nivel de manos y pies, aplicándose la fórmula del IMMEA^{21,22}. El rendimiento físico se obtuvo con el test de "Short Physical Performance Battery" (SPPB), el cual cuenta con la ejecución de 3 pruebas físicas de las cuales: la primera hace referencia a la prueba de equilibrio que consiste en evaluar tres posiciones del sujeto, pies juntos, semitándem y tándem; a continuación, la segunda prueba que es la velocidad de marcha de 4 metros y la última prueba es la de sentarse y levantarse de una silla, con cinco repeticiones en el tiempo mínimo de ser posible^{21,22}.

Análisis estadístico

Para la estadística descriptiva se usó medidas de frecuencia (número y porcentaje), se aplicó la prueba de normalidad según Shapiro Wilk con un p valor < 0.05 . Como estadística inferencial se optó por la prueba de chi cuadrado. Todos los da-

tos se procesaron en el programa Microsoft Office Excel 2016 y posterior a ello se evaluó en el programa SPSS versión 22.0.

Aspectos éticos

El estudio fue aprobado por el comité de ética del Hospital Hipólito Unanue de Tacna. Toda la información recolectada fue confidencial y no representó ningún riesgo; los evaluados firmaron el consentimiento informado voluntariamente.

RESULTADOS

Se estudiaron 75 pacientes (06 varones y 69 mujeres) con una edad media de 29-59 años. La mayor parte de los evaluados tienen ocupación ama de casa (59%), La media del IMC fue 27,13 kg/m² (DE =4,3 kg/m²), para mujeres fue de 27,26 kg/m² (DE=4,4 kg/m²) y para hombres 25,45 kg/m² (DE=4,1 kg/m²), el peso medio (64,6kg) (DE=10,81kg), estatura media 1,54 m (DE=,058) (**tabla 1**).

Se evaluó el estado nutricional según el IMC se observó que el 66,67%(04) de los hombres tienen un IMC normal, el 43,48%³⁰ de las mujeres tienen un IMC con sobrepeso y el 26,09%¹⁸ tienen obesidad (**tabla 1**).

Se evaluaron tres indicadores de la Sarcopenia: Fuerza muscular, Índice de masa muscular esquelética apendicular (IMMEA) y el rendimiento físico, donde la media de la masa muscular en mujeres es de 4,41 Kg/m² (D.E 1,32 kg/m²) y la de los hombres es de 6,22 Kg/m² (D.E 1,86 kg/m²) y la mínima de la masa muscular 2,70 kg/m² para las mujeres y el 10,00 kg/m² correspondiente a los hombres. Fuerza muscular (Kg.) en hombres es de 13,45 (D.E 11,73 Kg.), y la mínima fuerza muscular en mujeres es de 3,3 kg. y en hombres la máxima de 33,3 kg. El rendimiento físico en mujeres es de 7,54 (D.E 2,26) y el mínimo en mujeres es cero, mientras que en hombres el máximo es 8. También se presenta resultados de la sarcopenia, siendo que el 50% de los hombres no tiene sarcopenia y el 33,33% tiene sarcopenia grave, mientras que las mujeres el 62,32% tiene sarcopenia grave y solo el 2,90% no tiene sarcopenia.

La sarcopenia grave encontrada fue mayor de la mitad del total de evaluados, según los criterios de EGWSOP2. Además, se encontró que existe un porcentaje considerable de evaluados con diagnóstico de sarcopenia confirmada. Asimismo, se pudo observar que un grupo pequeño se encontraban estables, dentro de los criterios normales según las pruebas realizadas (**Tabla 2**).

Se muestra que pacientes con IMC normal el 3% no presenta sarcopenia, mientras que el 25% presenta sarcopenia grave, pacientes con diagnóstico de IMC con sobrepeso el 2% no presenta sarcopenia y el 24% presenta sarcopenia grave y pacientes con IMC con obesidad el 1% no presenta sarcopenia, y el 11% sarcopenia grave, se determinó que el valor de es de 0,176 p ≥ 0.05 , por lo tanto, no existe relación sig-

Tabla 1. Características antropométricas de los pacientes atendidos en consulta externa del Hospital Hipólito Unanue de Tacna, 2023

	Media	D.E	Mín.	Máx.		
Estatura (m)	1,54	,058	1,43	1,70		
Mujer	1,52	,056	1,43	1,62		
Hombre	1,64	,083	1,54	1,70		
Peso (kg)	64,60	10,81	41,90	90,60		
Mujer	64,30	10,36	41,90	87,00		
Hombre	68,76	14,38	55,00	90,60		
IMC (kg/m²)	27,13	4,30	20,20	37,40		
Mujer	27,26	4,40	20,02	37,40		
Hombre	25,45	4,10	21,09	31,30		
IMC (kg/m²)	Hombre	%	Mujer	%	Total	%
Normal	4	66,67	21	30,43	25	33,33%
Sobrepeso	1	16,67	30	43,48	31	41,33%
Obesidad	1	16,67	18	26,09	19	25,33%
Total	6	100,00	69	100,00	75	100,00%

Tabla 2. Indicadores de la sarcopenia en pacientes atendidos en consulta externa del Hospital Hipólito Unanue de Tacna, 2023

	Media	D.E	Mín.	Máx.		
Masa Muscular (kg/m²)	4,70	1,43	2,70	10,0		
Mujer	4,41	1,32	2,70	9,3		
Hombre	6,22	1,86	6,2	10,0		
Fuerza Muscular (kg)	11,1	6,2	3,3	33,3		
Mujer	10,64	5,50	3,3	8,9		
Hombre	13,45	11,73	6,0	33,3		
Rendimiento Físico	7	2,2	0	12		
Mujer	7,54	2,26	0	12		
Hombre	7,0	2,10	6	8		
Sarcopenia	Hombre	%	Mujer	%	Total	%
No sarcopenia	3	50,00%	2	2,90%	5	6,67%
Presarcopenia	1	16,67%	9	13,04%	10	13,33%
Sarcopenia Confirmada	0	0,00%	15	21,74%	15	20,00%
Sarcopenia Grave	2	33,33%	43	62,32%	45	60,00%
Total	6	100,00	69	100,00	75	100,00%

nificativa entre el estado nutricional y el nivel de sarcopenia de los pacientes con enfermedad reumatoidea, no existiendo asociación directa entre las variables.

con un adecuado IMC y sarcopenia no comprobada²⁶. La revisión que realizó Hurtado y colaboradores muestra significancia en cuanto a las alteraciones nutricionales, en el pa-

Tabla 3. Prueba Chi cuadrado del estado nutricional y nivel de sarcopenia de pacientes con artritis reumatoide del Hospital Hipólito Unanue de Tacna (n=75)

VARIABLES		NIVEL DE SARCOPIENIA										PRUEBA DE CHI-CUADRADO
		No Sarcopenia		Presarcopenia		Sarcopenia Confirmada		Sarcopenia Grave		Total		
		N	%	N	%	N	%	N	%	N	%	
Dx. ESTADO NUTRICIONAL	Normal	2	3%	0	0%	4	9%	19	25%	25	33%	$\chi^2 = 8,956$; GL = 1 P valor = 0,176 > 0,05 Existe relación estadísticamente significativa
	Sobrepeso	2	3%	6	8%	5	11%	18	24%	31	41%	
	Obesidad	1	1%	4	5%	6	13%	8	11%	19	25%	
	Total	5	7%	10	13%	15	33%	45	60%	75	100%	

DISCUSIÓN

El nivel de sarcopenia en la muestra del presente estudio, evidenció que poco más de la cuarta parte presentó sarcopenia grave, y en un mínimo resultado de pacientes fueron diagnosticados como no sarcopénicos, en similitud al estudio realizado por Ramírez y colaboradores donde describen que la sarcopenia puede estar presente en un 13 a 43% en diferentes poblaciones, sobretodo en la edad adulta con la patología de artritis reumatoidea¹⁵; también en la investigación de Karahán y colaboradores se encontraron una prevalencia del 37.1% de sarcopenia en personas adultas⁸, mientras que en otro estudio realizado en Brasil se encontró una prevalencia del 46.1% de sarcopenia probable y 15.8 % de sarcopenia confirmada en el adulto mayor de 60 años²⁴. Por otra parte, en una investigación llevada a cabo en el Japón, obtuvieron que la tasa de prevalencia de sarcopenia fue del 29,6% en una muestra de 240 pacientes adultos con enfermedad de artritis reumatoide⁹. Por otro lado, en países como Chile, la prevalencia de sarcopenia en edades adultas es similar a la del presente estudio, según Robles y colaboradores alcanzó el 23,8 %²⁵; sin embargo, se apreció diferencia entre el grupo de muestra ya que mayormente estuvo compuesta por mujeres (62,5 %), a comparación de nuestro estudio que fue de un 93.3%.

En relación con el estado nutricional y sarcopenia, en el trabajo de Cano y colaboradores se menciona que del total de su muestra el 1.3% se encontraba en delgadez, 18.4% en estado nutricional adecuado, 40.8% con sobrepeso, mientras que, en obesidad se encontraba un 39.5%, este último valor se asemeja a lo obtenido en la presente investigación²⁴. La asociación que existe entre la malnutrición y la afección de sarcopenia según indica Radić, es positiva ya que solo el 26.2% de participantes estaban sobrellevando la enfermedad

cientemente oscila desde un 4% hasta valores del 26 al 52%, particularmente en poblaciones con artritis reumatoide²⁷.

Los resultados de la presente investigación son similares a los estudios anteriormente descritos, sin embargo, no presencia de asociación entre sus variables; expresando que una malnutrición por exceso no necesariamente podría presentar también sarcopenia en la enfermedad de artritis reumatoidea, no habiendo relación con un incremento de masa grasa en contraste con la masa magra corporal, pudiendo ser otra la causa, como las prácticas de malos hábitos alimentarios, inactividad física y la propia enfermedad, afectando la calidad de vida del individuo^{7,10}.

Con estos hallazgos se podría tener implicaciones importantes en la contribución al tratamiento y atención de los pacientes con artritis reumatoidea, aunque se sugiere más investigaciones que permitan confirmar y ampliar esta información.

CONCLUSIÓN

Los resultados de la investigación planteada muestran que las personas adultas que padecen de artritis reumatoide tienen mayor riesgo de sarcopenia, pero no se asocia a una malnutrición, especialmente en el caso de las mujeres que son quienes padecen en su mayoría de esta patología y presentan a menudo un estado nutricional alterado.

REFERENCIAS BIBLIOGRÁFICAS

1. Camacho Castillo KP, Del Pilar Martínez Verdezoto T, Ortiz Granja LB, Urbina Aucancela KD. Artritis reumatoide en el adulto mayor. Rev Cuba Reumatol [Internet]. 2019 [citado el 02 de julio de 2022];21(3). Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1817-59962019000300007

2. Bellorin A-V, Zamara Ramírez P, Junior I, Niño B, Isabel E, Abreu V, et al. Calidad de vida en pacientes con artritis reumatoide [Internet]. [citado el 12 de julio de 2022]. Disponible en: <http://bdigital2.ula.ve:8080/xmlui/654321/3379>
3. Carmona L. Epidemiología de la artritis reumatoide. *Rev Esp Reumatol*. 1 de marzo de 2002 [citado el 13 de julio de 2022];29(3):86-90. Disponible en: https://www.researchgate.net/publication/288233316_Epidemiologia_de_la_artritis_reumatoide
4. Santilli V, Bernetti A, Mangone M, Paoloni M. Clinical definition of sarcopenia. *Clin Cases Miner Bone Metab Off J Ital Soc Osteoporos Miner Metab Skelet Dis*. septiembre de 2014;11(3): 177-80.
5. Kim D, Lee YJ, Song ES, Kim A, Bang CH, Jung JH. The high prevalence of sarcopenia in rheumatoid arthritis in the Korean population: A nationwide cross-sectional study. *Healthcare (Basel)* [Internet]. 2023 [citado el 13 de julio de 2022];11(10):1401. Disponible en: <https://pubmed.ncbi.nlm.nih.gov/37239687/>
6. Tekgoz E, Colak S, Ozalp Ates FS, Sonaeren I, Yilmaz S, Cinar M. Sarcopenia in rheumatoid arthritis: Is it a common manifestation? *Int J Rheum Dis* [Internet]. 2020 [citado el 13 de julio de 2022]; 23(12):1685–91. Disponible en: <https://pubmed.ncbi.nlm.nih.gov/32979041/>
7. Malafarina V, Uriz-Otano F, Gil-Guerrero L. Valoración y tratamiento nutricional de la sarcopenia. *Rev Esp Geriatr Gerontol* [Internet]. 2013 [citado el 13 de julio de 2022];48(4):153–4. Disponible en: <https://www.sciencedirect.com/science/article/pii/S0211139X13000590>
8. Karahan İ, Aras S, Varlı M, Çınar E, Karaarslan Cengiz Ö, Atlı T. The Frequency of Sarcopenia and Associated Factors in Older Patients with Rheumatoid Arthritis. *Eur J Geriatr Gerontol*. 29 de julio de 2020;2(2):41-5.
9. Li T-H, Chang Y-S, Liu C-W, Su C-F, Tsai H-C, Tsao Y-P, et al. The prevalence and risk factors of sarcopenia in rheumatoid arthritis patients: A systematic review and meta-regression analysis. *Semin Arthritis Rheum* [Internet]. 2021 [citado el 13 de julio de 2022]; 51(1):236–45. Disponible en: <https://pubmed.ncbi.nlm.nih.gov/33385864/>
10. Mochizuki T, Yano K, Ikari K, Okazaki K. Sarcopenia-associated factors in Japanese patients with rheumatoid arthritis: A cross-sectional study. *Geriatr Gerontol Int*. septiembre de 2019;19(9): 907-12.
11. Vasconcelos M, de Seabra Trevisan F, Silva Augusto de Andrade E, Ferreira da Rocha Junior L, de Oliveira Borba MJ. Correlação da composição corporal e prevalência de sarcopenia em pacientes portadores de lúpus eritematoso sistêmico e artrite reumatoide assistidos em centro de referência em pernambuco, brasil. *Nutr Clínica Dietética Hosp* [Internet]. 19 de septiembre de 2021 [citado el 13 de julio de 2022]; 41(3). Disponible en: <https://doi.org/10.12873/413siqueira>
12. Torii M, Hashimoto M, Hanai A, Fujii T, Furu M, Ito H, et al. Prevalence and factors associated with sarcopenia in patients with rheumatoid arthritis. *Mod Rheumatol*. julio de 2019;29(4): 589-95.
13. Sarcopenia in elderly men and women: the Rancho Bernardo study. [Internet]. *Epistemonikos*. [citado 9 de agosto de 2022]. Disponible en: <https://www.epistemonikos.org/en/documents/e247abd0d9072a618e19e11b5a1deae385390b62>
14. Fernando Á, Caballero C, José M, Planells F, Vela Jarquín E, Gómez Martín D. Estrategias terapéuticas para la artritis reumatoide: hacia las terapias biotecnológicas Therapeutic strategies for rheumatoid arthritis: towards biotechnological therapies [Internet]. *Medigraphic.com*. [citado el 25 de diciembre de 2023]. Disponible en: <https://www.medigraphic.com/pdfs/invidis/ir-2017/ir172d.pdf>
15. Jácome MSR, Villacís MVG. Importancia nutricional en el manejo de sarcopenia en adultos mayores. *Revista de Investigación en Salud VIVE* [Internet]. 2023 [citado el 09 de agosto de 2023];6(16):337–53. Disponible en: <http://portal.amelica.org/ameli/journal/541/5414343029/html/>
16. Ramírez-Villafaña M, Aceves-Aceves JA, Delgado-Nuño JE, Gabriela Vizcaíno-Cortés Z, Efraín Gómez-Ramírez E, Castro-Jiménez A, et al. Sarcopenia en artritis reumatoide [Internet]. *Medigraphic.com*. [citado el 09 de agosto de 2023]. Disponible en: <https://www.medigraphic.com/pdfs/residente/rr-2018/rr181e.pdf>
17. Hernández Batista S de la C, Villafuerte Morales JE, Chimbolema Mullo SO, Pilamunga Lema CL, Hernández Batista S de la C, Villafuerte Morales JE, et al. Relación entre el estado nutricional y la actividad clínica en pacientes con artritis reumatoide. *Rev Cuba Reumatol* [Internet]. agosto de 2020 [citado 9 de marzo de 2023];22(2). Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S1817-59962020000200007&lng=es&nrm=iso&tng=es
18. Alvarez-Nemegyei J, Pacheco-Pantoja E, González-Salazar M, López-Villanueva RF, May-Kim S, Martínez-Vargas L, et al. Asociación entre sobrepeso/obesidad y estado clínico en artritis reumatoide. *Reumatol Clínica*. Noviembre de 2020 [citado 9 de marzo de 2023];16(6):462-7.
19. Hernández Batista S, Morales JEV, Mullo SOC, Lema CLP. Relación entre el estado nutricional y la actividad clínica en pacientes con artritis reumatoide. *Rev Cuba Reumatol* [Internet]. 2020 [citado el 22 de mayo de 2023];22(2):140. Disponible en: <https://revreumatologia.sld.cu/index.php/reumatologia/article/view/781/1479#:~:text=Conclusiones%3A,coeficiente%20de%20correlaci%C3%B3n%20de%20Pearson>.
20. Oliveira Neta RS de, Souza IF da S, Câmara SMA da, Souza MC de. Sarcopenia, estado nutricional y funcionalidad en mujeres adultas mayores residentes en la comunidad. *Rev Bras Geriatr Gerontol* [Internet]. 2018 [citado el 22 de mayo de 2023];21(3):342–51. Disponible en: scielo.br/j/rbgb/a/McJGnscsbbC6R4HKrq6YWyG/?lang=pt
21. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing* [Internet]. 2019 [citado el 10 de agosto de 2023];48(1):16–31. Disponible en: <https://academic.oup.com/ageing/article/48/1/16/5126243>
22. Ruiz-López MD, Rodríguez-Rejón AI, Artacho Martín-Iagos R. Diagnóstico y prevalencia de sarcopenia en residencias de ancianos: EWGSOP2 versus EWGSOP1. *Hospital Nutr* [Internet]. 2019

- [citado el 22 de agosto de 2023];36(5):1074–80. Disponible en: https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0212-16112019000500012
23. Santos KT de O, Gomes FMA, Silva SME da, Silva ARA da, Pinho CPS, Santos KT de O, et al. Sarcopenia en pacientes oncológicos en tratamiento Quimioterápico. *Rev Chil Nutr.* agosto de 2019 [citado 9 de noviembre de 2023];46(4):375-83.
24. Cano-García L, Manrique-Arija S, Domínguez-Quesada C, Vacas-Pérez JC, Armenteros-Ortiz PJ, Ruiz-Vilchez D, et al. Sarcopenia and nutrition in elderly rheumatoid arthritis patients: A cross-sectional study to determine prevalence and risk factors. *Nutrients* [Internet]. 2023 [citado el 09 de noviembre de 2023];15(11):2440. Disponible en: <https://www.mdpi.com/2072-6643/15/11/2440>
25. Robles-Robles M, Yáñez-Yáñez R, Cigarroa I. Relación entre sarcopenia y calidad de vida en personas mayores chilenas autovalentes y dependientes leves de dos ciudades del sur de Chile. *Salud UNINORTE* [Internet]. 2021 [citado el 11 de noviembre de 2023];422–41. Disponible en: <https://pesquisa.bvsalud.org/portal/resource/pt/biblio-1377259?src=similardocs>
26. Radić M, Vlák I, Vučković M, Radić J, Bešić E, Vlák T. Association between nutritional status, lifestyle habits, and disease activity in Dalmatian patients with rheumatoid arthritis. *Nutrients* [Internet]. 2023 [citado el 11 de noviembre de 2023];15(7):1738. Disponible en: <https://pubmed.ncbi.nlm.nih.gov/37049577/>
27. Hurtado-Torres GF, González-Baranda LL, Abud-Mendoza C. Caquexia reumatológica y otras alteraciones nutricionales en las enfermedades reumatológicas. *Reumatol Clin* [Internet]. 2015 [citado el 11 de noviembre de 2023];11(5):316–21. Disponible en: <https://www.reumatologiaclinica.org/es-caquexia-reumatologica-otras-alteraciones-nutricionales-articulo-S1699258X15000522>

Development of an equation to estimate fat-free mass in mountain Guides and Porters

Jorge TORRES-MEJÍAS¹, Evangelina RIVAROLA², Erick DIAZ³, Gabriela SALAZAR³, Daniela TORO⁴, Felipe VILLEGAS⁴, Rossana GÓMEZ⁵, Marcos COSSIO⁵, Miguel ÁNGEL-LÓPEZ⁶, Eugenio MERELLANO-NAVARRO^{1,5}

¹ Doctoral Program in Physical Activity Sciences, Faculty of Education Sciences, Universidad Católica del Maule, Talca, Chile.

² Escuela de Nutrición. Facultad de Ciencias Médicas. Universidad Nacional de Córdoba. Argentina.

³ Laboratory of Energy Metabolism and Stable Isotopes, INTA, U. of Chile.

⁴ Andesgear, Chile.

⁵ Department of Physical Activity Sciences, Faculty of Education Sciences, Universidad Católica del Maule, Talca, Chile.

⁶ Nutrición y Dietética. Facultad de Ciencias de la Salud, Universidad Adventista de Chile, Chillán, Chile.

Recibido: 7/mayo/2024. Aceptado: 26/junio/2024.

ABSTRACT

Body composition (BC) is a crucial component in the monitoring of athletes, not only as a variable related to physical performance, but also as a follow-up of dietary intervention and training.

Objective: To propose regression equations from body surface area (BSA) to estimate fat-free mass (FFM) of mountain guides and porters using deuterium oxide dilution (MDD) as a criterion method.

Methods: Cross-sectional study in 23 young and adult men working as mountain guides and porters on Aconcagua (Argentina). The volunteers ranged in age from 20 to 50 years. Weight, height, body mass index (BMI) and BSA were assessed by eight regression equations.

Results: Three linear regression equations were generated considering chronological age and ASC as predictors: Model 1 ($FFM = -25.287 - (0.260 * age) + (49.014 * ASC1)$, $R^2 = 63.0\%$), model 2 ($FFM = -20.736 - (0.191 * age) + (45.523 * ASC2)$, $R^2 = 62.0\%$) and model 3 ($FFM = -28.592 - (0.244 * age) + (52.499 * ASC3)$, $R^2 = 63.0$). The three equations presented tolerance indices (T) and variance inflation values (VIF) within limits; more evidence of absence of autocorrelation.

Correspondencia:

Marco Cossio; Eugenio Merellano-Navarro
mcossio@ucm.cl emerellano@ucm.cl

Conclusion: Three predictive models based on age and BSA were generated that allow estimating the FFM in a valid and reliable way. The results suggest their use and application for monitoring before, during and after expeditions.

KEYWORD

Body Composition; equation development; Body Surface Area; Hipobaric Hipoxia; High Altitude workers.

INTRODUCTION

Mountaineering is the sport of mountain climbing and often incorporates the skills of alpine rock and ice climbing¹, and is characterized by hiking, trekking and high mountain climbing activities². Its objective is to ascend the mountain as a whole rather than individual rock formations or rock walls. To do this, it is necessary to organize a detailed planned expedition that involves organizing the ascent and descent of the summit at regular and efficient intervals³. This involves activities such as camping, facing geographical difficulties (crevasses, avalanches, rock falls and ice, among others), oxygen depletion due to altitude, low temperatures and extreme weather conditions⁴.

In general, this sport is characterized as high risk and is associated with deaths, frequent physical injuries, often severe⁵. Despite this, in recent years the practice of mountaineering¹ has grown rapidly and there has even been an increased interest in research in this area⁶.

In this context, body composition (BC) assessment is a crucial component in the follow-up of athletes, not only as a vari-

able related to physical performance, but also as a follow-up of dietary and training intervention^{7,8}.

In fact, it is widely known that ostensible changes in BC and body weight occur during high mountain expeditions⁸⁻¹⁰. So, the possible mechanisms responsible could have to do with increased energy expenditure because of increased basal metabolic rate and/or high levels of physical activity, inadequate energy intake, fluid loss and gastrointestinal malabsorption¹¹⁻¹³.

From this perspective, taking into account the environment in which mountaineering takes place, the length of stay and the physical demands at high altitude, health professionals are obliged to constantly monitor the BC¹⁴, especially the fat-free mass (FFM), since this compartment is an important component in the regulation of energy metabolism as a reservoir of glucogenic amino acids and nitrogen^{15,16}. Indeed, the gradual loss of FFM in altitude conditions compromises physical performance and musculoskeletal adaptations¹⁷.

Therefore, the assessment, monitoring and control of FFM in mountain guides and porters is extremely important, as maintaining adequate levels of FFM can improve physical performance (such as strength and endurance) for carrying heavy equipment, overcoming rough and steep terrain in hypoxic conditions¹⁴. Under this context, different equations have been validated in young and adult population, one of the oldest and most used being that of Du Bois and Du Bois¹⁸ and more currently the equation of Kuehnappel et al. (2017)¹⁹; however, to our knowledge, there are no studies on equations that predict GLM from anthropometric indicators in young and adult mountaineers, so in recent years several studies have suggested that body surface area (BSA) could be an appropriate indicator to estimate FFM in young and adults^{16,20}.

In general, the use and application of the BSA could be useful for predicting the FFM of mountain guides and porters; moreover, it is expected to serve as an easy-to-use tool during expeditions²¹, as often most of the tools normally used to assess BC require a laboratory and/or field environment, where specific protocols, equipment and resources are needed, making their use difficult and limiting their use during expeditions²².

Therefore, this study aims to propose regression equations based on the BSA to estimate the FFM of mountain guides and porters. For this purpose, we used nine equations that estimate the BSA as possible predictors of the FFM.

MATERIALS AND METHODS

A cross-sectional descriptive study was carried out on 23 young and adult men who work as mountain guides and porters during the 2017 season on Mount Aconcagua.

The sample selection was non-probabilistic (accidental). The volunteers ranged in age from 20 to 50 years. All partic-

ipants worked on the traditional ascent route called Plaza de Mulas (Mount Aconcagua, Argentina) and had an average of 3.2 ± 1.5 years of experience in mountain ascents.

All guides and porters of Argentinean nationality and with at least three years of experience in ascents of Mount Aconcagua were included in the study. Participants of other nationalities were excluded (there were two mountaineers), those over 50 years of age and those who ingested acetazolamide or another diuretic at least four days prior to sample collection for the deuterium dilution method (MDD).

The study was conducted in accordance with the Declaration of Helsinki for human subjects²³ and in compliance with the ethical Committee of the Institute of Nutrition and Foods Technology approved this study, for the use of isotopic dilution.

TECHNIQUES AND PROCEDURES

The anthropometric evaluations and use of the deuterium oxide dilution method (MDD) were carried out at the "Plaza de Mulas" base camp, located at 4,300 meters above sea level (masl), with an average barometric pressure of 444 millimeters of mercury (mmHg). Field work included an anthropometric assessment, followed by MDD sampling. Both assessments were performed early in the morning, between 7:00 and 8:00 hr, during the mountaineers' rest day.

Weight and height were evaluated with the least amount of clothing possible (barefoot and light clothing), according to the suggestions described by Ross, Marffel-Jones²⁴. For weight, a brand name electronic scale (Tanita, United Kingdom) with a scale of 0 to 150 kg and an accuracy of 100 g was used. Height was measured using a Seca portable stadiometer (Seca GmbH & Co. KG, Hamburg, Germany) with an accuracy of 0.1 mm.

Body mass index (BMI) was calculated using the formula: $BMI = \text{weight (kg)}/\text{height}^2 \text{ (m)}$. Body surface area (BSA) was calculated using nine equations (proposed for adult men), these being the most used today for determining BSA.

The equations are shown in Table 1.

The MDD measurement was performed following the recommendations of the International Atomic Energy Agency (IAEA)²⁵. Volunteers were instructed to empty their bladder. Then saliva sample was collected on cotton placed under the tongue. The saliva sample was used to determine the natural deuterium abundance of each participant. The wet cotton ball was transferred from the mouth into a 20 ml syringe and the saliva was squeezed into a 2 ml vial. Subsequently, 3.5 g of 99% deuterium was given to each person to ingest. Once the deuterium was administered, the participants lay down again in their respective sleeping bags for a period of 3.5 hr, so that the ingested deuterium could equilibrate with the rest of the body water. Once the equilibration time had elapsed, the first step for saliva col-

Table 1. BSA equations for young and adult males

Authors	Equations BSA
Du Bois and Du Bois ¹⁸	$0.007184 \cdot \text{Hei}^{0.725} \cdot \text{Wei}^{0.425}$
Boyd ²⁶	$0.0003207 \cdot \text{Hei}^{0.3} \cdot (1000 \cdot \text{Wei})^{0.7285 - 0.0188 \cdot \log_{10}(1000 \cdot \text{Peso})}$
Fujimoto et al. ²⁷	$0.008883 \cdot \text{Hei}^{0.663} \cdot \text{Wei}^{0.444}$
Haycock et al. ²⁹	$0.024265 \cdot \text{Hei}^{0.3964} \cdot \text{Wei}^{0.5378}$
Livingston and Lee ³⁰	$0.1173 \cdot \text{Wei}^{0.6466}$
Mattar ³¹	$(\text{Hei} + \text{Wei} - 60) / 100$
Meeh ³⁵	$0.1053 \cdot \text{Wei}^{2/3}$
Mosteller ²⁸	$\sqrt{\text{Hei} \cdot \text{Wei} / 3600}$
Kuehnappel et al. ¹⁹	$0.0051 \cdot \text{Hei}^{0.8516} \cdot \text{Wei}^{0.3262} \cdot e^{0.0036 \cdot \text{BMI}} \cdot e^{-0.0120}$

Legend: BSA: body surface area, Hei: Height. Wei: Weight.

lection was repeated again, determining a second saliva or contrast collection. All samples were collected in sterilized polypropylene tubes, sealed and stored in a safety transport case for subsequent laboratory analysis, where they were stored at -20 degrees Celsius and subsequently analyzed using an Esiorbitrap and Maldi-tof mass spectrometer, according to IAEA protocol²⁵.

Before analysis, saliva samples were thawed at room temperature and centrifuged to remove solid particles. Each participant's sample was analyzed twice. Finally, body compartments were calculated: % fat, fat mass FM (kg), fat-free mass FFM (kg) and total body water (TBW) (%) (IAEA 2010)²⁵.

Statistics

The Shapiro-Wilk test was used to contrast the normality of the study data. Descriptive analysis of arithmetic mean, standard deviation, confidence interval (CI) was performed. One-way Anova and Tukey's test of specificity were used to determine the differences between BSA equations. Pearson's correlation was used to relate the variables.

Three simple and multiple stepwise regression models were developed. The criteria used for the models generated were: explanatory power (R^2), standard error of estimation (SEE), Durbin-Watson contrast test, Tolerance and variance inflation factor (VIF). In all cases, $p < 0.05$ was considered significant. Calculations were performed in SPSS 26.0 and MedCalc 11.1.0.

RESULTS

The descriptive values of the anthropometric indicators, body composition and the BSA of the young and adult mountaineers (guides and porters) are shown in Table 2. In the BSA there were no significant differences between the nine equations proposed for adult men ($p > 0.05$).

The relationships between age and BSA values with FFM (criterion MDD) are shown in Table 3. The relationships between FFM (MDD criterion) with BSA values (nine methods), ranged from ($r = 0.72$ to 0.76), meanwhile, with age with FFM, the relationship was positive and low ($r = 0.29$, $p = 1.82$).

Table 2. Anthropometric and body composition indicators of the sample studied

Variables	Mean	SD	CI	
			Lower limit	Upper limit
Age (years)	30.35	6.60	27.5	33.2
Weight (kg)	70.25	6.86	67.3	73.2
Hieght (cm)	175.17	6.31	172.4	177.9
BMI (kg/m ²)	22.89	1.93	22.1	23.7
Body Composition (MDD)				
MDD Fat Mass (%)	17.9	5.6	15.4	20.3
MDD FM (kg)	12.7	4.8	10.6	14.8
MDD FFM (kg)	57.6	5.7	55.1	60.0
MDD TBW (%)	60.1	4.1	58.3	61.9
BSA (equations)				
Du Bois and Du Bois ¹⁸	1.85	0.11	1.8	1.9
Boyd ²⁶	1.85	0.11	1.8	1.9
Fujimoto et al. ²⁷	1.80	0.11	1.8	1.8
Haycock et al. ²⁹	1.85	0.11	1.8	1.9
Livingston and Lee ³⁰	1.83	0.12	1.8	1.9
Mattar ³¹	1.86	0.11	1.8	1.9
Meeh ³⁵	1.79	0.12	1.7	1.8
Mosteller ²⁸	1.85	0.11	1.8	1.9
Kuehnappel et al. ¹⁹	1.78	0.10	1.7	1.8

Legend: SD: standard deviation. CI: confidence interval, L: limit, MDD: deuterium oxide dilution method: %: percentage, FM: fat mass, FFM: fat-free mass, TBW: total body water, BSA: body surface area.

Table 3. Relationship between age and ASC equations with MDD

Equations BSA	r	p
Age (years)	0.29	0,182
Du Bois y Du Bois ¹⁸	0.76	<0.001
Boyd ²⁶	0.75	<0.001
Fujimoto et al. ²⁷	0.75	<0.001
Haycock et al. ²⁹	0.75	<0.001
Livingston and Lee ³⁰	0.72	<0.001
Mattar ³¹	0.75	<0.001
Meeh ³⁵	0.72	<0.001
Mosteller ²⁸	0.76	<0.001
Kuehnappel et al. ¹⁹	0.76	<0.001

Legend: BSA: body surface area, MDD: deuterium dilution method.

In general, the BSA equations proposed by Du Bois and Du Bois¹⁸, Boyd²⁶, Fujimoto et al.²⁷, Mosteller²⁸ and Kuehnappel et al.¹⁹ showed the strongest correlations with the MDD.

Table 4 shows the models generated to propose the equations that predict the FFM. These models use age and BSA. In general, we identified three predictive models: model 1 uses the BSA calculated by Du Bois and Du Bois, model 2 the BSA calculated by Mosteller and model 3 uses the BSA calculated by Kuehnappel. The best models were models 1 and 3, whose percentage of explanation was 63% and model 2 62%. In the three models the SES ranged from 1.98 to 2.12, the tolerance was from 0.61 to 0.67 and the IFV from 1.49 to 1.64.

The FFM comparisons between the criterion method (MDD) with the three predictive models based on age and BSA are

shown in Figure 1. There was no difference between the three models vs. the criterion ($p > 0.05$). The FFM values by criterion MDD was 57.57 ± 5.7 kg, model 1 (Dubois) 57.56 ± 4.9 kg, model 2 (Mosteller) 57.57 ± 4.4 kg and model 3 (Kuehnappel) 57.57 ± 4.5 kg.

DISCUSSION

The aim of the study was to propose regression equations to estimate the FFM of mountain guides and porters from the BSA. For this purpose, we used as a contrast criterion method, Deuterium Oxide dilution (MDD), a technique recognized as the gold standard for determining total body water²⁵.

These results indicate that of the nine BSA equations used as predictors of the FFM, three equations^{18,19,27} and chronological age are the ones that reflected a higher percentage of explanation ($R^2 = 62$ to 63%) compared to the rest of the BSA equations, with SES lower than 4% in the three models. Both tolerance and IFV in the three models evidenced values within the limits established by the literature²⁹; evidencing a controlled multicollinearity of age and BSA, thus demonstrating the relevance of these two variables in the models constructed; with absence of autocorrelation (independence of the residuals measured with Durbin-Watson ~ 2 test). Furthermore, there were no significant differences between the averages and \pm DE of the MDD with the three predictive models.

These findings indicate that these new, easily applied, low-cost equations that integrated age and BSA play a relevant role in determining the FFM of young and adult mountain porters, where weight loss and changes in BC often occur frequently during high-altitude mountaineering expeditions³⁰.

In fact, it has been evidenced that BSA represents human dimensionality and predicts metabolic activity in clinical applications and metabolic heat production in physiology³¹. Even

Table 4. Equations predicting Free Fat Mass for young and adult mountain guides and porters

Model	Equations	R ²	SEE	Durbin-Watson	Predictor	T	IFV
1	FFM = -25.287-(0.260*age)+(49.014*BSA1)	0.632	3.60	2.02	Age	0.61	1.64
					Du Bois	0.61	1.64
2	FFM = -20.736-(0.191*age)+(45.523*BSA2)	0.623	3.64	2.12	Age	0.67	1.49
					Mosteller	0.67	1.49
3	FFM = -28.592-(0.244*age)+(52.499*BSA3)	0.630	3.60	1.98	Age	0.63	1.60
					Kuehnappel	0.63	1.60

Legend: FFM: fat-free mass, SEE: standard error of estimation, T: Tolerance, IFV: inflation values, BSA1: Du Bois and Du Bois, BSA2: Mosteller, BSA3: Kuehnappel.

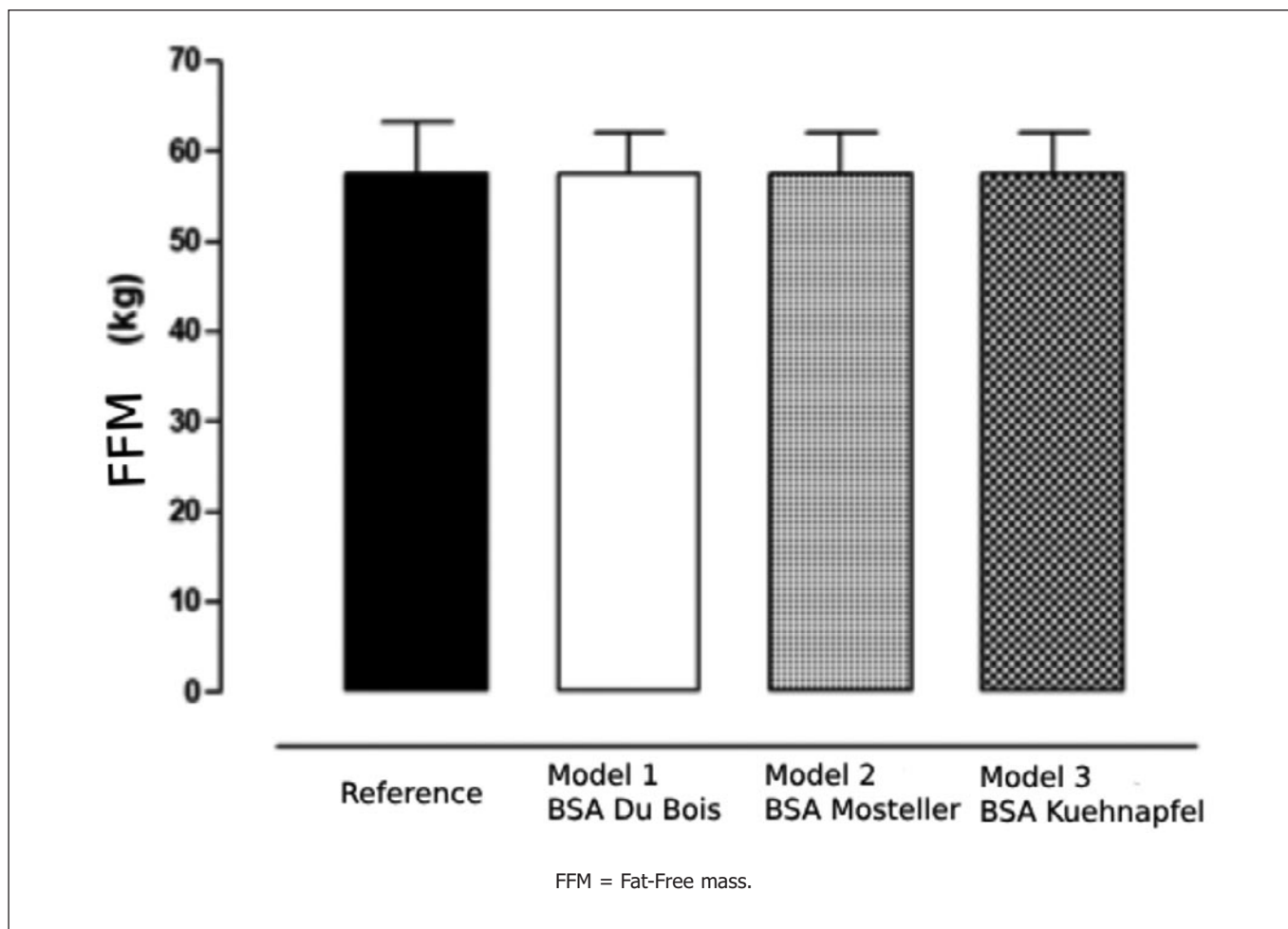


Figure 1. Comparison of the equations predicting free fat mass, with the three anthropometric prediction models

its use and application could contribute to identify the limits of performance due to strenuous physical work, especially in extreme temperatures, where climatic and ecological sources produce considerable biological variations³², especially in regions of high altitudes.

Thus, the main reason for this relationship is that BSA provides a better representation of FFM in mountain guides and porters, as this component in adult men is represented by 80% of total body weight that includes bone, muscle, extracellular water, nerve tissue, and non-fat cells³²; This can serve as a non-invasive tool for monitoring health status and disease in diverse populations, especially in those who often experience physiological mechanisms associated with acute and chronic adaptation to nutrition and physical exercise^{33,34}, as is the case of mountain guides and porters.

The equations proposed here allow estimation of the FFM, which information is useful for mountaineers, scientists and multidisciplinary teams planning high-altitude expeditions. Therefore, it is necessary to present adequate FFM levels, as

this has an important impact on the performance and adaptation of the body to a challenging environment³⁰.

In sum, this study presents some strengths that we highlight below. It is one of the first studies carried out on Aconcagua Mountain in Argentina in young and adult mountaineers, and we used a standard method, recognized as the gold standard for the determination of body composition, for the validation of the equations that estimate the FFM. We also highlight some limitations, since it was not possible to measure other anthropometric variables (circumferences and bone diameters) or physical variables (such as muscle strength), which could have contributed to generate other models and analyze which one best models FFM. Future studies should control for these variables and expand the sample size used.

CONCLUSIONS

This we verified that the body surface area is a predictor of the fat-free mass of mountain guides and porters.

Three predictive models based on age and body surface area were generated that allow us to estimate fat-free mass in a valid and reliable way. The results suggest their use and application for monitoring before, during and after high-altitude mountain expeditions.

FUNDING

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of the Institute of Nutrition and Food Technology, INTA U. de Chile for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Acknowledgments: We thank all those people who helped in carrying out this research, especially the guides and porters of Mount Aconcagua who always open the doors of their tents and their work life to us.

Conflicts of Interest: The authors declare that they have no conflicts of interest. "The funders had no role in the design of the study; in the collection, analysis or interpretation of data; in writing the manuscript; or in the decision to publish the results."

REFERENCES

- Monasterio E, Alamri YA, Mei-Dan O. Personality characteristics in a population of mountain climbers. *Wilderness. Wilderness Environ Med.* 2014;25 (02):214–9.
- Apollo M. The true accessibility of mountaineering: the case of the High Himalaya. *Journal of Outdoor Recreation and Tourism.* 2017;17:29–43.
- Crust L. Personality and mountaineering: A critical review and directions for future research. *Personality and Individual Differences.* 2020;163(110073).
- Jackman PC, Hawkins RM, Burke SM, Swann C, Crust L. The psychology of mountaineering: a systematic review. *Int Rev Sport Exerc Psychol.* 2023 31;16(1):27–65.
- Monasterio ME. Accident and fatality characteristics in a population of mountain climbers in New Zealand. *N Z Med J.* 2005; 118(1208):U1249.
- Crust L, Swann C, Allen-Collinson J. Crust, L, Swann, C & Allen-Collinson, J (2018) Mentally tough behaviour in extreme environments: perceptions of elite high-altitude mountaineers, *Qualitative Research in Sport, Exercise & Health.* *Qual Res Sport Exerc.* 2018;1–14.
- Arias MJ, Carrasco F, España V, Inostroza J, Bustamante A, Solar I. A comparison of body composition assessment methods in climbers: Which is better? *PLoS One.* 2019;14(11):e0224291.
- Zamboni M, Armellini F, Turcato E, Robbi R, Micciolo R, Todesco T, et al. Effect of Altitude on Body Composition during Mountaineering Expeditions: Interrelationships with Changes in Dietary Habits. *Ann Nutr Metab.* 1996;40(6):315–24.
- Boyer SJ, Blume FD. Weight loss and changes in body composition at high altitude. *J Appl Physiol.* 1984 Nov 1;57(5):1580–5.
- Sitko S, Cirer-Sastre R, López Laval I. Effects of high altitude mountaineering on body composition: a systematic review. *Nutr Hosp.* 2019; 36(5): 1189-95
- Westerterp KR, Meijer EP, Rubbens M, Robach P, Richalet JP. Operation Everest III: energy and water balance. *Pflugers Arch.* 2000;439(4):483–8.
- Dünnwald T, Gatterer H, Faulhaber M, Arvandi M, Schobersberger W. Body Composition and Body Weight Changes at Different Altitude Levels: A Systematic Review and Meta-Analysis. *Front Physiol.* 2019;10:430.
- Fuentes-López J, Callata-Gallegos Z, Mamani-Luque O, Ibáñez-Quispe V, Canqui-Flores B, Mendoza-Mollocondo C, et al. Aplicabilidad de la superficie corporal e índices antropométricos para valorar el tamaño corporal en adolescentes que viven a gran altitud. *Nutr Clín Diet Hosp.* 2022;42(2):117-22.
- Torres-Mejías J, Rivarola E, López-Espinoza MA, Loyola J, Vargas R, Luna R, et al. Somatotipo y composición corporal de porteadores y guías del monte Aconcagua, Argentina. *Rev Fac Cien Med Univ Nac Córdoba.* 2018;29–30.
- Wing-Gaia S. Nutritional Strategies for the Preservation of Fat Free Mass at High Altitude. *Nutrients.* 2014;6(2):665–81.
- Fulco CS, Rock PB, Cymerman A. Maximal and submaximal exercise performance at altitude. *Aviat Space Environ Med.* 1998; 69(8):793–801.
- Sergi G, Imoscopi A, Sarti S, Perissinotto E, Coin A, Inelmen EM, et al. Changes in total body and limb composition and muscle strength after a 6-8 weeks sojourn at extreme altitude (5000-8000 m). *J Sports Med Phys Fitness.* 2010;50(4):450–5.
- Du Bois D, Du Bois EF. A formula to estimate the approximate surface area if height and weight be known. 1916. *Nutrition.* 1989;5(5):303–11; discussion 312-3.
- Kuehnappel A, Ahnert P, Loeffler M, Scholz M. Body surface assessment with 3D laser-based anthropometry: reliability, validation, and improvement of empirical surface formulae. *Eur J Appl Physiol.* 2017;117(2):371–80.
- Wells JCK. Measuring body composition. *Arch Dis Child.* 2005 Jun 14;91(7):612–7.
- Burmeister W. Human body composition as related to surface area. *Eur J Pediatr.* 1980;135(2):147–51.
- Duren DL, Sherwood RJ, Czerwinski SA, Lee M, Choh AC, Siervogel RM, et al. Body Composition Methods: Comparisons and Interpretation. *J Diabetes Sci Technol.* 2008;2(6):1139–46.
- Czarkowski M. Kolejna nowelizacja Deklaracji Helsińskiej [Helsinki Declaration—next version]. *Pol Merkur Lekarski.* 2014;36 (215): 298–301.

24. Ross WD., Marfell-Jones MJ. Physiological testing of elite athlete. 2nd ed. MacDougall JD. - Wenger HA. - Geeny HJ., editor. Vol. 14. London; 1991. 223–308 p.
25. International Atomic Energy Agency. Introduction to Body Composition Assessment Using the Deuterium Dilution Technique with Analysis of Saliva Samples by Fourier Transform Infrared Spectrometry. IAEA Human Health Series. 2011;12.
26. Edith Boyd. The Growth of the Surface Area of the Human Body. University of Minnesota Press 1935, editor. Michigan; 1935.
27. Fujimoto S, Watanabe T, Sakamoto A, Yukawa K, Morimoto K. Studies on the Physical Surface Area of Japanese. Nippon Eiseigaku Zasshi (Japanese Journal of Hygiene). 1968;23(5):443–50.
28. Mosteller RD. Simplified Calculation of Body-Surface Area. New England Journal of Medicine. 1987;317(17):1098–1098.
29. Haycock GB, Schwartz GJ, Wisotsky DH. Geometric method for measuring body surface area: A height-weight formula validated in infants, children, and adults. J Pediatr. 1978;93(1):62–6.
30. Livingston EH, Lee S. Body surface area prediction in normal-weight and obese patients. American Journal of Physiology-Endocrinology and Metabolism. 2001;281(3): E586–91.
31. Mattar JA. A Simple Calculation to Estimate Body Surface Area in Adults and Its Correlation with the Du Bois Formula. Crit Care Med. 1989;17(8):846.
32. Tanner DA, Stager JM. Partitioned weight loss and body composition changes during a mountaineering expedition: a field study. Wilderness Environ Med. 1998;9(3):143–52.
33. Looney DP, Potter AW, Arcidiacono DM, Santee WR, Friedl KE. Body surface area equations for physically active men and women. American Journal of Human Biology. 2023;35(2).
34. Pietrobelli A, Heymsfield S, Wang Z, Gallagher D. Multi-component body composition models: recent advances and future directions. Eur J Clin Nutr. 2001;55(2):69–75.
35. Meeh K. Oberflächenmessungen des menschlichen Körpers. Z Biol. 1879;15:425–85.

Perfil nutricional e bioquímico de pacientes submetidos ao transplante renal

Nutritional and biochemical profile of patients undergoing kidney transplant

Ana Carolina CAVALCANTE VIANA¹, Elissa Maria do Nascimento CARDOZO², Rikeciane BRANDÃO PEREIRA³, Macileide da Silva BANDEIRA¹, Priscila Taumaturgo HOLANDA MELO¹, Nathália BERNARDO MARINHO¹, Thaise dos Santos ANDRADE¹, Helen PINHEIRO¹, Anarah Suellen Queiroz CONSERVA VITORIANO¹, Andressa Eslayne CALDAS SALES¹, Suelyne RODRIGUES DE MORAIS¹, Lília Teixeira Eufrásio LEITE¹, Marcela Matos MAGALHÃES DE AZEVEDO¹, Priscila da Silva MENDONÇA⁴

1 Empresa Brasileira de Serviços Hospitalares (EBSERH) - Hospital Universitário Walter Cantídio (HUWC/UFC/EBSERH).

2 Programa de residência, Universidade Federal do Ceará.

3 Curso de Nutrição, Universidade de Fortaleza.

4 Programa de pós-graduação em Ciências Médicas/ UFC, Hospital Walter Cantídio/UFC/EBSERH Empresa Brasileira de Serviços Hospitalares, Instituto Doutor José Frota.

Recibido: 10/mayo/2024. Aceptado: 26/junio/2024.

RESUMO

Introdução: No transplante renal, um rim saudável de um doador vivo ou falecido é implantado através de cirurgia a fim de desempenhar funções de filtração e eliminação.

Objetivo: Avaliar o estado nutricional e as alterações bioquímicas em pacientes transplantados renais no 1º e 6º meses pós-transplante.

Metodologia: Trata-se de um estudo transversal, comparativo e descritivo com 93 pacientes submetidos a transplante renal. Foram coletados dados demográficos, clínicos, bioquímicos e parâmetros antropométricos. O estado nutricional foi avaliado pela classificação do índice de massa corporal.

Resultados: A média de idade foi de 43,74±9,96 anos. A doença de base diagnosticada com maior prevalência foi a hipertensão arterial sistêmica (21,50%). No primeiro mês, 48,38% da população estudou com peso normal e esse percentual aumentou 4,3% em relação ao sexto mês. Todas as variáveis analisadas pelos exames bioquímicos apresentaram evolução significativa tendo como referência $p < 0,05$.

Correspondencia:

Ana Carolina Cavalcante Viana
ana.cavalcante@ebserh.gov.br

Discussão: Todos os exames bioquímicos analisados apresentaram redução significativa ($p < 0,05$) pós-transplante. Houve também redução no número de pacientes classificados como desnutridos, com sobrepeso e obesidade, com aumento no número de pacientes eutróficos.

Conclusão: Concluiu-se que houve melhora estatisticamente significativa nos valores de colesterol, triglicerídeos e glicemia de jejum em pacientes após 6 meses de transplante renal.

PALAVRAS-CHAVE

Avaliação nutricional; Transplante de rim; Transtornos do Metabolismo dos Lipídeos.

ABSTRACT

Introduction: In kidney transplantation, a healthy kidney from a living or deceased donor is implanted through surgery in order to perform filtration and elimination functions.

Objective: To evaluate the nutritional status and biochemical changes in kidney transplant patients in the 1st and 6th months post-transplant.

Methodology: This is a cross-sectional, comparative and descriptive study with 93 patients undergoing kidney transplantation. Demographic, clinical, biochemical data and anth-

ropometric parameters were collected. Nutritional status was assessed using the body mass index classification.

Results: The average age was 43.74±9.96 years. The most prevalent underlying disease diagnosed was systemic arterial hypertension (21.50%). In the first month, 48.38% of the population studied with normal weight and this percentage increased by 4.3% in relation to the sixth month. All variables analyzed by biochemical tests showed significant evolution with $p < 0.05$ as a reference.

Discussion: All biochemical tests analyzed showed a significant reduction ($p < 0.05$) post-transplant. There was also a reduction in the number of patients classified as malnourished, overweight and obese, with an increase in the number of eutrophic patients.

Conclusion: It was concluded that there was a statistically significant improvement in the values of cholesterol, triglycerides and fasting blood glucose in patients after 6 months of kidney transplantation.

KEYWORDS

Nutrition Assessment; Kidney Transplantation; Lipid Metabolism Disorders.

INTRODUÇÃO

A doença renal crônica (DRC) pode ser definida como uma lesão e perda progressiva e irreversível da função dos rins que se prolonga em um período maior que 3 meses. A etiologia é multifatorial e o estágio da doença deve ser determinado com base na causa, taxa de filtração glomerular (TFG) e excreção de albumina na urina¹.

Atualmente, o transplante renal e a diálise são consideradas terapias renais substitutivas (TRS) para pacientes com DRC em estágio terminal. A diálise é uma terapia empregada para remover os solutos urêmicos acumulados e o excesso de água. O transplante renal pode ser considerado quando a TFG é inferior à 15mL/min/1,73m² após ou antes do começo da diálise, esse último é chamado de transplante renal preemptivo².

No transplante renal (TXR), um rim saudável de um doador vivo (DV) ou falecido (DF) é implantado e através de uma cirurgia, para exercer as funções de filtração e eliminação³.

O último Censo Brasileiro de diálise mostrou que o número estimado de pacientes em diálise na lista de espera para transplante renal em 2020 foi de 23%⁴. Em janeiro a junho de 2020 foram realizados 2409 transplantes de rim no Brasil, desses, a maioria (35,37%) foram realizados no estado de São Paulo⁵. As principais doenças de base que acarretam no TXR são doenças por causa indefinida, insuficiência renal crônica, doença arterial hipertensiva, diabetes e glomerulonefrites⁶.

Após o transplante (TX), os indivíduos transplantados necessitam da utilização de imunossuppressores, pois o sistema imu-

nológico reconhece, defende e protege o nosso organismo contra corpos estranhos e infecções. O uso desses medicamentos se faz importante para que não haja rejeição do órgão⁷.

As principais classes de imunossuppressores utilizados pós-transplante são: glicocorticoides, inibidores da calcineurina, inibidores da mTOR, inibidores da síntese de purinas e pirimidinas, anticorpos policlonais e anticorpos monoclonais. Como efeitos colaterais da utilização desses medicamentos, pode surgir intolerância à glicose, sintomas gastrointestinais, hipercalemia, dislipidemias e outros efeitos que geralmente são dose dependente e diminuem com o a redução da dosagem que ocorre gradativamente até o limiar estabelecido pela equipe médica⁷.

O ganho de peso pós-transplante renal tem se mostrado comum tanto em pacientes obesos como em não obesos. Estes efeitos podem causar hiperlipidemia, alterações no metabolismo da glicose e aumento da pressão arterial; atenuando o desenvolvimento do processo aterosclerótico⁸.

Diante destes fatos, torna-se necessário avaliar o impacto do uso dos imunossuppressores associando ao perfil nutricional, lipídico e glicídico dos pacientes submetidos ao transplante renal. Esses fatores contribuem para o sucesso do tratamento tardio e para a melhor sobrevida desses pacientes.

O objetivo desse estudo foi avaliar o perfil nutricional e bioquímico de pacientes submetidos ao transplante renal.

METODOLOGIA

Trata-se de um estudo transversal, comparativo e descritivo, com pacientes submetidos ao transplante de rim de doador falecido no período de Janeiro de 2018 à Janeiro de 2020. O local de coleta foi o Ambulatório de Nutrição do Centro de Transplante de Rim do Ceará do Hospital Universitário Walter Cantídio (HUWC) da Universidade Federal do Ceará (UFC). O estudo foi aprovado pelo Comitê de Ética e Pesquisa, sob o parecer 2.804766.

A amostra foi constituída por conveniência por 93 pacientes pós-transplante renal em atendimento no período de estudo no referido ambulatório. Incluíram-se na pesquisa pacientes com idade entre 18 e 59 anos. Foram excluídos aqueles com diagnóstico prévio de diabetes mellitus. Tais pacientes, depois de receber alta hospitalar com orientações sobre alimentação saudável, faziam seguimento terapêutico no ambulatório especializado.

Os dados coletados dos prontuários foram: informações sociodemográficas (sexo, idade e escolaridade), clínicas (doença de base, presença de diabetes mellitus – DM e esquema de imunossupressão utilizado) e laboratoriais no primeiro mês pós-transplante e após seis meses do procedimento cirúrgico (glicemia em jejum, triglicerídeos (TG), *low density lipoprotein* (LDL), colesterol total (CT) e *high density lipoprotein* (HDL).

Em seguida, realizou-se avaliação antropométrica diretamente com cada paciente em dois momentos distintos: 1 mês após o transplante e 6 meses após o transplante. A avaliação foi composta pelas aferições de peso atual e altura. Para aferição do peso e da altura, utilizou-se balança com estadiômetro (Filizola®, Brasil).

Para classificação do índice de massa corpórea (IMC) foi utilizada a classificação da Organização Mundial de Saúde (OMS). Utilizou-se os seguintes valores de referências: IMC abaixo de 18,5kg/m² classificou paciente como desnutrido; acima de 18,5kg/m² até 24,9kg classificou o paciente como eutrófico, acima de 25kg/m² até 29,9kg/m² classificou como sobrepeso e acima de 30kg/m² como obesidade⁹.

As análises bioquímicas foram realizadas por meio da coleta de sangue por punção venosa periférica, de todos os sujeitos participantes nos dois períodos de coleta. O triglicérideo, colesterol e glicemia em jejum foram analisados por meio de testes enzimáticos. O HDL foi determinado utilizando métodos colorimétricos. O LDL foi estimado através da fórmula de Friedewald ([LDL] = [CT- HDL]= [TG/5]).

Para avaliação dos valores de triglicédeos foram utilizado os critérios de classificação da National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATP III)¹⁰. Os valores referenciais de LDL, Colesterol e HDL seguem os critérios da Sociedade Brasileira de Cardiologia (SBC)¹¹. A classificação da glicemia em jejum levou em consideração a Sociedade Brasileira de Diabetes (SBD)¹².

Após a coleta de dados, as variáveis do estudo foram expressas em média, desvio-padrão, mediana, e prevalência. Na análise das características dos participantes no baseline e 6 meses foi utilizado o teste t de *Student* pareado e *Wilcoxon*, verificada a não aderência dos dados à distribuição gaussiana. O valor de p<0,05 foi definido como estatisticamente significativo. As análises estatísticas foram realizadas utilizando o programa estatístico JAMOV.

RESULTADOS

A amostra foi composta por 93 indivíduos que realizaram transplante de rim por doador falecido, entre os anos de 2018 a 2020, com idade média de 43,74±9,96 anos. Desses 62,0% eram do sexo masculino.

O diagnóstico de doença de base mais encontrado na população desta pesquisa foi por causa indeterminada, seguido de hipertensão arterial sistêmica (HAS), conforme tabela 1.

As doenças já instaladas previamente ao transplante estão listadas na tabela 2. Onde se observa que 73,11% dos pacientes submetidos ao transplante de rim apresentavam diagnóstico prévio de HAS.

A mudança do perfil nutricional, conforme tabela 3, foi verificada através do IMC-OMS. Os dados foram classificados

Tabela 1. Doença de base dos pacientes transplantados

Diagnóstico	Indivíduos com respectivo diagnóstico
Doença de base indeterminada	33 (35,48)
Hipertensão arterial sistêmica (HAS)	20 (21,50)
Glomerulonefrite	15 (16,12)
Doença renal policística	10 (10,75)
Lúpus eritematoso sistêmico	5 (5,37)
Nefrolitíase	2 (2,15)
Glomerulosclerose segmentar focal	2 (2,15)
Uropatia obstrutiva congênita	1 (1,07)
Síndrome pulmão-rim	1 (1,07)
Síndrome nefrótica	1 (1,07)
Infecção Urinária de Repetição	1 (1,07)
Tubulopatia renal	1 (1,07)

Fonte: elaborada pelo autor.

Legenda: resultado expresso por n(%).

Tabela 2. Doenças prévias ao transplante renal

Diagnóstico	Indivíduos com respectivo diagnóstico
Hipertensão arterial sistêmica	68 (73,11)
Doenças cardiovasculares	9 (9,67)
Dislipidemia	3 (3,22)
Lúpus eritematoso sistêmico	5 (5,37)
Hipotireoidismo	2 (2,15)

Fonte: elaborada pelo autor.

Legenda: resultado expresso por n(%).

em desnutrição, eutrofia, sobrepeso e obesidade. Destaca-se que 48,38% da população no primeiro mês cursavam com eutrofia e esse percentual teve um aumento de 4,3% comparado ao sexto mês pós-transplante.

A média dos valores de glicemia em jejum mostrou-se acima do normal segundo os critérios da Sociedade Brasileira de Diabetes (SBD), outros parâmetros como triglicédeos, *low density lipoprotein*, colesterol total e *high density lipoprotein* estão demonstrados na tabela 4.

Tabela 3. Mudança no perfil nutricional conforme a classificação do IMC em percentual

IMC	Classificação	Indivíduos no 1º mês de transplante com a respectiva classificação	Indivíduos no 6º mês de transplante com a respectiva classificação
<18kg/m ²	Magreza	5 (5,37)	4 (4,30)
18,5 – 24,9kg/m ²	Eutrofia	45 (48,38)	49 (52,68)
25-29,9kg/m ²	Sobrepeso	33 (35,48)	31 (33,33)
>30kg/m ²	Obesidade	10 (10,75)	9 (9,67)

Fonte: elaborada pelo autor.

Legenda: resultado expresso por n(%).

Tabela 4. Média dos valores de glicemia, triglicerídeos, LDL, colesterol e HDL no 1º e 6º mês pós-transplante renal

Exames bioquímicos	Média 1º mês	Média 6º mês	p*
Glic jejum	107.13	99.53	<.001
TG	200.65	156.00	<.001
LDL	117.56	105.67	0.008
CT	194.55	178.45	0.002
HDL	37.52	44.22	<.001

Fonte: elaborada pelo autor.

Legenda: Glic jejum (glicemia em jejum); TAG (triglicerídeos); LDL (*low density lipoprotein*); CT (colesterol), HDL (*high density lipoprotein*); *t de Student.

Todas as variáveis analisadas através de exames bioquímicos tiveram redução significativa tendo como referência $p < 0,05$, como exposto na tabela 4.

DISCUSSÃO

A população estudada apresentou maior prevalência do gênero masculino (N=58, 62%) corroborando com os achados de artigos de variadas modalidades de transplantes que encontraram indivíduos homens acima de 60%, concordando com Ribeiro (2018)¹³. A média de idade dos pacientes submetidos ao transplante renal foi de 43 anos, assemelhando-se ao encontrado na análise de Colombo (2022)¹⁴.

Nesse estudo, observou como diagnóstico de maior dominância a doença de base não diagnosticada (35,48%), seguido por hipertensão arterial sistêmica (21,50%), reforçando os dados apresentados pelo Governo do Estado do Ceará no período de 2019 e com o Senso de diálise de 2020⁶.

Mesmo nos pacientes sem etiologia associada à HAS, houve predomínio dessa doença durante o curso da doença, confirmando o que foi constatado no estudo de Ferreira (2021)¹⁵.

O uso do IMC como indicador é provável que seja um dos principais motivos para achados controversos, pois além de

não discriminar a gordura da massa magra, o IMC não identifica o acúmulo de gordura visceral associada a complicações cardiovasculares em pacientes com DRC¹⁶.

O maior limitador do transplante é a rejeição, a qual pode ser controlada pelo uso de drogas imunossupressoras. A escolha do protocolo é definida pela equipe médica baseada nas características da combinação doador-receptor¹⁷.

No primeiro mês de transplante, 40 pacientes (43,01%) estavam em uso do esquema triplo com micofenolato, prednisona e tacrolimo. No 6º mês pós-transplante o esquema duplo com micofenolato e tacrolimo tornou-se o mais usado por 27,95% dos pacientes. Essa mudança no protocolo de imunossupressão não é comum, mas pode ser feita quando for motivada por eventos adversos relacionados à falência de eficácia ou de segurança que já foi demonstrada por Opelz (2008)¹⁸.

A média e mediana da glicemia em jejum apresentaram redução quando comparadas as primeiras quatro semanas e o 6º mês pós-operatório. Esse padrão é esperado e explicado por múltiplos fatores, como a resistência a insulina que se estabelece durante a cirurgia e pode durar até três semanas após a realização do Tx (MARCARINI, 2017)¹⁹.

O uso dos corticosteroides utilizado por 43,01% dos pacientes no 1º mês têm efeito diabetogênico direto, piorando a resistência insulínica, assim como indireto, aumentando o peso e diminuindo a massa muscular. O tacrolimo foi utilizado por 78,72% dos pacientes nos primeiros 30 dias, esse exerce seu efeito diabetogênico por provável efeito inibitório direto sobre a secreção proteica da célula beta²⁰.

O aumento dos lípidos pós TXR pode ser explicado pela diminuição na remoção periféricas das lipoproteínas secundária a hiperinsulinemia, pois as enzimas responsáveis pela remoção periféricas dos lipídeos tendem a estar com a sua atividade ou síntese reduzida em pacientes transplantados, devido a resistência à insulina, uso de β bloqueadores e pela presença de insuficiência renal²¹.

O tacrolimo foi o medicamento utilizado em todos os esquemas de imunossupressão desse estudo. Garcia (2004)²² aponta que em relação à hiperlipidemia, o tacrolimo não possui efeito expansionista, contrapondo o que foi observado por Riella (2012)²³ que relatou a incidência de novos casos de dislipidemia apenas em menor quantidade comparado a outros inibidores de calcineurina.

Todos os exames bioquímicos analisados apresentaram redução significativa ($p < 0,05$), e quando analisado o IMC houve diminuição do número de pacientes classificados como desnutridos, sobrepeso e obesos, com aumento do número de pacientes eutróficos. A melhora do perfil clínico desses pacientes pode ser relacionada a múltiplos fatores como diminuição nas doses dos imunossupressores que geram menos efeitos colaterais, melhora da qualidade de vida após o período de hospitalização, retorno as atividades físicas e redução do estresse pós-cirúrgico²⁴.

Este estudo teve número consideravelmente elevado de pacientes em comparação a quantidade de pacientes transplantados renais por ano no Ceará o que fornece maior credibilidade aos dados apontados nessa pesquisa. Dessa forma, os resultados aqui apontados contribuem para o conhecimento do perfil metabólico e nutricional de pacientes pós transplante renal.

Algumas limitações podem ser apontadas, como o fato de o estudo ter sido transversal e não ter sido possível acompanhar o paciente antes da doença e em um tempo de evolução pós transplante renal, assim como seus hábitos alimentares e interferência de outras drogas.

O presente estudo avaliou o estado nutricional através do IMC, cujo método não faz divisão dos compartimentos corporais, fato que pode acarretar a limitações no diagnóstico nutricional. Para se obterem dados mais plausíveis do estado nutricional e alterações metabólicas, sugerem-se estudos longitudinais e com mais métodos de avaliação.

CONCLUSÃO

Esse estudo mostrou alterações bioquímicas significativas analisando os valores de triglicérides, glicemia em jejum, co-

lesterol total, *low density lipoprotein*, *high density lipoprotein* e estado nutricional por meio do índice de massa corporal para paciente pós transplante renal em dois momentos distintos.

A análise desses parâmetros se faz importante para o acompanhamento da saúde dos indivíduos, progressão e aparecimento de doenças que podem levar a perda tardia do enxerto.

REFERÊNCIAS

1. Rovin BH, Adler SG, Barratt J, Bridoux F, Burdige KA, Chan TM, & Floege J. KDIGO 2021 clinical practice guideline for the management of glomerular diseases. *Kidney international*. 2021; 100 (4): 1-276.
2. Brasil. Ministério da Saúde. Portaria nº2600/2009. Aprova o Regulamento Técnico do Sistema Nacional de Transplantes. *Diário Oficial da União*; Brasília; 21 out 2019. Cap VI, Seção 1, art 51 [citado em 2022 jul 12]. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/gm/2009/prt2600_21_10_2009.html.
3. Wolfe RA, Ashby VB, Milford EL, Ojo AO, Ettenger RE, Agodoa LY, & Port FK. Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. *The New England journal of medicine*. 1999; 341(23): 1725-1730.
4. Nerbass FB, Lima HDN, Thomé FS, Vieira NOM, Lugon JR, & Sesso R. Brazilian dialysis survey 2020. *Brazilian Journal of Nephrology*. 2022; 44: 349-357.
5. ASSOCIAÇÃO BRASILEIRA DE TRANSPLANTE DE ÓRGÃOS et al. Dados numéricos da doação de órgãos e transplantes realizados por estado e instituição no período: Janeiro/Junho-RBT [https://site.abto.org.br/wp-content/uploads/2020/08/rbt-1sem-final-leitura.pdf]. 2015; 2 (2): 1-21.[citado 2015 ago 22].
6. Integra SUS - Indicadores. Disponível em: <<https://integrassus.saude.ce.gov.br>>. Acesso em: 6 dez. 2022.
7. GOLAN DE. *Principios de farmacologia: Bases fisiopatológicas del tratamiento farmacológico*. 4. ed. Madrid, Spain: Ovid Technologies, 2017.
8. Kasiske BL, Snyder JJ, Gilbertson D, & Matas AJ. Diabetes mellitus after kidney transplantation in the United States. *American Journal of Transplantation*. 2003; 3 (2): 178-185.
9. World Health Organization (WHO). Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. Geneva: WHO; 1998. [WHO Technical Report Series 894].
10. Lipy RJ. The National Cholesterol Education Program Adult Treatment Panel III guidelines. *Journal of managed care pharmacy*. 2003; 9 (1): 2-5.
11. Prêcoma D B, Oliveira G M M D, Simão A F, Dutra O P, Coelho O R, Izar M C D O, Mourilhe Rocha R. Atualização da diretriz de prevenção cardiovascular da Sociedade Brasileira de Cardiologia-2019. *Arquivos Brasileiros de Cardiologia*; 2019; 113: 787-891.
12. SOCIEDADE BRASILEIRA DE DIABETES (SBD). *Diretrizes da Sociedade Brasileira de Diabetes: 2019-2020*. São Paulo: Editora Clannad; 2020.

13. RIBEIRO, M. et al. Perfil e desfecho clínico de pacientes transplantados renais em um serviço especializado: desfechos de um projeto de extensão. *Cidadania Ação*. 2018; 2(2):19–30.
14. Quevedo CDM, de Almeida SLC, da Silva ACP, & Pereira VA. Perfil de Pacientes Transplantados Renais Associado com Situação Previdenciária ou BPC e Trabalhista. *Brazilian Journal of Transplantation*. 2022; 25(2).
15. Ferreira BE, Batista LCB, da Silva DAV, & Ramalho ADCA. Comorbidades Associadas À Doença Renal Crônica Em Adultos Submetidos A Hemodiálise. *Gep News*. 2021; 5(1): 135-138.
16. CUPPARI L, KAMIMUR MA. Avaliação nutricional na doença renal crônica: desafios na prática clínica. *Jornal brasileiro de nefrologia*. 2009; 31(1): 28–35.
17. Lim MA, Kohli J, & Bloom RD. Immunosuppression for kidney transplantation: Where are we now and where are we going? *Transplantation Reviews*. 2017; 31(1): 10-17.
18. Opelz G, & Döhler B. Effect on kidney graft survival of reducing or discontinuing maintenance immunosuppression after the first year posttransplant. *Transplantation*. 2008; 86(3): 371-376.
19. Marcarini M, da Rosa SC, Wieck FP, & Betti AH. Abrevação do jejum: aspectos clínicos perioperatórios de pacientes submetidos à cirurgia cardíaca. *Braspen Journal*. 2023; 32(4): 375-379.
20. Nam JH, Mun JI, Kim SI, Kang SW, Choi KH, Park K, Huh KB. β -Cell dysfunction rather than insulin resistance is the main contributing factor for the development of postrenal transplantation diabetes mellitus. *Transplantation*. 2001; 71(10): 1417-1423.
21. Cattran DC, Steiner G, Wilson DR, & Fenton SSA. Hyperlipidemia after renal transplantation: natural history and pathophysiology. *Annals of Internal Medicine*. 1979; 91(4): 554-559.
22. Garcia SC, Lopes LDS, Schott KL, Beck ST, & Pomblum VJ. Ciclosporina A e tacrolimus: uma revisão. *Jornal Brasileiro de Patologia e Medicina Laboratorial*. 2004; 40: 393-401.
23. Riella LV, Gabardi S, & Chandraker A. Dyslipidemia and its therapeutic challenges in renal transplantation. *American Journal of Transplantation*. 2012; 12(8): 1975-1982.
24. Mendonça AEOD, Torres GDV, Salvetti MDG, Alchieri JC, & Costa IKF. Mudanças na qualidade de vida após transplante renal e fatores relacionados. *Acta Paulista de enfermagem*. 2014; 27: 287-292.

Consumo de calcio y su relación con la densidad mineral ósea en estudiantes que están cursando la carrera de Auxiliar de Enfermería. Loja (Ecuador)

Calcium intake and its relationship with bone mineral density in students who are studying to become Nursing Assistants. Loja (Ecuador)

Marlene Elizabeth Sánchez Mata

Médico General, Docente de la Universidad Estatal de Milagro, Guayaquil, Ecuador.

Recibido: 20/mayo/2024. Aceptado: 26/junio/2024.

RESUMEN

Introducción: En Ecuador, el 94% de las personas no sigue las pautas recomendadas para ingerir alimentos que contienen calcio, el cual está vinculado con la salud de los huesos y se relaciona de manera opuesta con el índice de masa corporal, contribuyendo al riesgo de sobrepeso y obesidad. La cantidad diaria recomendada (RDA) de calcio para adolescentes se establece en 1.300 miligramos por día.

Objetivo: Describir cómo la ingesta de calcio y el estado nutricional influyen en la densidad mineral ósea (DMO) de los estudiantes que están cursando la formación de auxiliar de enfermería.

Métodos: Un estudio transversal, retrospectivo con 49 estudiantes de 19 a 21 años, aparentemente sanos. La dieta se recogió mediante encuestas de recuento de 24 horas que consistió en que los participantes recordaran y detallaran todo lo que habían comido durante ese periodo de tiempo.

Resultados: En la muestra de individuos examinados, donde más de la mitad eran mujeres (51%), se descubrió que un porcentaje del 18% tenía obesidad y un 25% mostraba sobrepeso. El 68% de los jóvenes consumió una cantidad menor al 50% de la cantidad de calcio recomendada para la ingesta. En hombres, el consumo medio de calcio se

situó en 658 miligramos por día con una desviación estándar de 328 miligramos, mientras que en mujeres fue de 568 miligramos por día con una desviación estándar de 299 miligramos. El puntaje Z estandarizado de la DMO fue dentro del rango considerado normal para hombres y mujeres, con una desviación estándar mayor de -1.

Conclusión: No se encontró ninguna correlación entre la cantidad de calcio consumida por los estudiantes y la densidad ósea de sus huesos. Se encontró una asociación entre la mineralización ósea y el estado nutricional, observándose que la densidad mineral ósea era más alta en las personas con obesidad.

PALABRAS CLAVE

Hábitos alimenticios, Bienestar óseo, Salud esquelética, Evaluación nutricional, Minerales esenciales.

ABSTRACT

Introduction: In Ecuador, 94% of people do not follow the recommended guidelines for ingesting foods containing calcium, which is linked to bone health and is oppositely related to body mass index, contributing to the risk of overweight and obesity. The recommended daily allowance (RDA) of calcium for adolescents is set at 1,300 milligrams per day.

Objective: To describe how calcium intake and nutritional status influence bone mineral density (BMD) in students undergoing nursing assistant training.

Methods: A cross-sectional, retrospective study of 49 apparently healthy students aged 19-21 years. Diet was collected us-

Correspondencia:
Marlene Elizabeth Sánchez Mata
msanchezm8@unemi.edu.ec

ing 24-hour tally surveys that consisted of participants recalling and detailing everything they had eaten during that time period.

Results: In the sample of individuals examined, where more than half were female (51%), a percentage of 18% were found to be obese and 25% were found to be overweight. Sixty-eight percent of the young people consumed less than 50% of the recommended amount of calcium intake. In males, the mean calcium intake stood at 658 milligrams per day with a standard deviation of 328 milligrams, while in females it was 568 milligrams per day with a standard deviation of 299 milligrams. The standardized BMD Z-score was within the range considered normal for both men and women, with a standard deviation greater than -1.

Conclusion: No correlation was found between the amount of calcium consumed by the students and their bone density. An association was found between bone mineralization and nutritional status, observing that bone mineral density was higher in people with obesity.

KEYWORDS

Eating habits, Bone health, Skeletal health, Nutritional assessment, Essential minerals, Bone wellness.

INTRODUCCIÓN

El calcio presente en la alimentación cotidiana aporta numerosos beneficios para mantener una buena salud. Consumir la cantidad apropiada de nutrientes desde una edad temprana hasta la vejez resulta en alcanzar un nivel máximo de densidad ósea ideal. Durante todas las etapas de la vida, se requiere una cantidad elevada de este mineral a diario, y esto depende de la cantidad exacta necesaria para mantener el equilibrio de este en el organismo^{1,2}. En lo que respecta a los alimentos que son ricos en calcio, se destacan principalmente los productos lácteos, tales como la leche, el queso y el yogur. Asimismo, el calcio también puede encontrarse en alimentos de origen vegetal que brindan valiosas contribuciones, como los frutos secos, las verduras de hojas verdes, diversas hortalizas, los cereales, las legumbres y los alimentos fortificados, los cuales son consideradas como significativas fuentes de calcio. Estos alimentos pueden influir en la cantidad total de calcio que se consume y esto varía según cómo cada población elige qué alimentos consumir³.

El calcio es un micronutriente esencial que se encuentra en abundancia en el cuerpo humano, desempeñando un papel crucial principalmente en la fortaleza de los huesos y dientes⁴. Este mineral constituye alrededor del 2% del peso corporal, siendo el 99% distribuido en el sistema esquelético y dental, y el restante 1% presente en el plasma sanguíneo, líquido intersticial, cefalorraquídeo y diversas células del organismo. Lleva a cabo diversas funciones que afectan tanto al esqueleto como a la regulación del cuerpo, siendo el proceso principal el de mineralización ósea⁵.

En varios países, la principal fuente de ingesta de calcio en la dieta es la leche y sus derivados, aunque también hay otros alimentos que no son lácteos y que contienen cantidades significativas de este mineral. Para que un alimento pueda ser considerado como una fuente suficiente de calcio, es importante no solo que contenga las cantidades adecuadas de este mineral, sino también que exhiba una alta biodisponibilidad para que el cuerpo pueda absorberlo de manera efectiva⁶. Algunos quesos tienen niveles de calcio superiores a 1 gramo por cada 100 gramos de alimento, destacando la mantequilla por tener el menor contenido con tan solo 15 miligramos por cada 100 gramos. La cantidad promedio de 124 mg por cada 100 gramos de leche líquida. En la leche, aproximadamente dos tercios del calcio se hallan enlazados a la cadena, mientras que el tercio restante se encuentra de forma independiente^{7,8}.

Consumir la cantidad diaria recomendada de 1.000 mg de calcio entre las edades de 19 y 50 años puede ser complicado sin incluir adecuadamente en la dieta suficiente cantidad de productos lácteos como la leche y sus derivados. Varias encuestas que analizan los patrones de consumo individual han demostrado que el nivel de consumo de ciertos productos alcanza su punto más alto durante la infancia, reduciéndose gradualmente a medida que se llega a la adolescencia⁹.

La alimentación de los estudiantes universitarios presenta un desafío significativo, dado que podría implicar ajustes relevantes en sus rutinas diarias, teniendo la posibilidad de influir en su bienestar a largo plazo.

OBJETIVO

El propósito de esta investigación es analizar cómo la ingesta de calcio y el estado nutricional influyen en la densidad mineral ósea de los estudiantes que se están formando como auxiliares de enfermería.

MÉTODOS Y MATERIALES

En la presente investigación se llevó a cabo la entrevista en el año 2022 a un total de 49 jóvenes sanos entre ellos 49% varones y 51% mujeres, cuyas edades oscilaban entre los 19 y los 21 años, con un índice de masa corporal (IMC) inferior a 35 kg/m² y sin historial de enfermedades genéticas, crónicas o autoinmunes. Fueron seleccionados al azar de entre dos cursos específicos, sin ningún criterio preestablecido. Cuando un estudiante decidió no participar en la actividad, se buscó a otro estudiante que tuviera características similares para ocupar su lugar y así lograr completar el grupo necesario. Antes de comenzar con la investigación, cada estudiante firmó su consentimiento informado.

Un solo nutricionista capacitado administró una encuesta de recordatorio de alimentos durante tres días no seguidos, incluyendo dos días laborales y uno de fin de semana, con un intervalo de 24 horas entre cada sesión de encuesta. Durante

cada entrevista, se anotaron meticulosamente todos los alimentos que las personas recordaban haber consumido en el día anterior. Las respuestas de las encuestas fueron introducidas manualmente en una hoja de cálculo de Excel, y luego se procedió a realizar los cálculos de la ingesta de nutrientes utilizando la Tabla de Composición Química de los Alimentos de Ecuador. Se determinó la cantidad de nutrientes consumidos promediando la información recopilada en tres encuestas de recordatorio alimenticio de 24 horas, y luego se procedió a analizar los datos utilizando el software estadístico SPSS Statistics.

Se utilizó una balanza electrónica extremadamente precisa para llevar a cabo la medición del peso. La medida de altura fue tomada con los participantes de pie y con la posición de Frankfurt, en la que estaban en ropa interior y camiseta, sin usar zapatos, empleando un instrumento llamado tallímetro de pared. Se utilizó una cinta flexible que no tenía elasticidad para tomar la medida de la circunferencia de la cintura. Se obtuvo las medidas antropométricas de cada participante como es su talla y su peso. Luego de eso, se procedió a calcular el Índice de Masa Corporal (IMC), que se obtiene dividiendo el peso entre la talla al cuadrado, para el IMC considerando el sexo y la edad, y se llevó a cabo la evaluación del estado nutricional de acuerdo con las pautas de la Organización Mundial de la Salud. El método utilizado para identificar la obesidad abdominal se basó en el estándar establecido por la Federación Internacional de Diabetes (IDF), que implica la medición de la circunferencia de la cintura, requerida para ser de 90 cm en hombres y 80 cm en mujeres, según las pautas definidas por la organización internacional. Las mediciones fueron todas realizadas por el mismo equipo de trabajo, y además se encargaron de calibrar los instrumentos de medición de manera diaria¹⁰.

Se realizó la medición de la densidad mineral ósea utilizando la técnica de absorciometría de rayos X de doble energía. Fue llevada a cabo la evaluación de la densidad mineral ósea total en todas las áreas del cuerpo humano, la cual se presentó en forma de medidas de masa ósea total por centímetro cuadrado y también en términos de puntajes Z con el propósito de normalizar y facilitar la comparación de este valor.

Se midió el nivel de calcio en el suero de una muestra de sangre que fue tomada después de un período de ayuno de 8 horas.

La información fue introducida en un formato digital y luego verificada para precisión en una hoja de cálculo de Microsoft Excel.

Las variables numéricas fueron proporcionadas en formato de promedio junto con su respectiva desviación estándar, la cual se calculó como la suma de la media y la resta de la desviación estándar¹¹. Las discrepancias en promedios fueron analizadas mediante la prueba de t de Student de dos colas para conjuntos de datos que no están relacionados entre

sí. Se utilizó la prueba de Chi² de Pearson para analizar y comparar posibles disparidades entre las variables categóricas en el estudio. Se realizó un experimento que consistió en llevar a cabo un análisis de varianza (ANOVA) con el propósito de examinar si existe una conexión entre el estado de alimentación y la densidad mineral ósea (DMO), además de evaluar la relación entre la cantidad de nutrientes consumidos y los indicadores metabólicos.

RESULTADOS

Se llevó a cabo un análisis en un grupo de 49 estudiantes, en el cual se determinó que el 51% eran mujeres. Los valores medios más menos la desviación estándar de los parámetros antropométricos, junto con la observancia de la ingesta de calcio recomendada por los estudiantes, están representados en la Tabla 1. El porcentaje de personas con sobrepeso se situó en un 25%, mientras que la tasa de obesidad alcanzó el 21% en esta población en particular. En el grupo de hombres, se observaron valores estadísticamente más altos en cuanto a la edad, peso, estatura y medida de la circunferencia de la cintura en comparación con otras variables medidas. Solo un pequeño porcentaje, específicamente el 5%, de los estudiantes logró satisfacer la cantidad de calcio recomendada en su dieta, y no se encontraron disparidades en función del género. La cantidad total de masa ósea fue considerablemente más alta en los adolescentes del sexo masculino en comparación con otros grupos. Debido a que los participantes eran personas sanas, tanto los hombres como las mujeres mostraron niveles promedio de calcio en la sangre dentro de los límites normales establecidos, que van desde 8,8 a 10,3 miligramos por decilitro.

Los niveles de calcio en la sangre y la cantidad total de masa fueron notablemente superiores en los hombres que formaron parte del estudio. En promedio, el resultado de la medida de desviación estándar fue dentro de los límites normales para ambos grupos, con un valor superior a un desvío estándar por debajo de la media. No se encontraron disparidades significativas entre los grupos según género. Según la información presentada en la tabla 2, se observa que, dentro de la muestra analizada, los hombres tuvieron un consumo considerablemente superior en términos de calorías, proteínas y carbohidratos en comparación con las mujeres. Después de tomar en cuenta el factor del género, no se observó una variación notable en la cantidad de calcio consumida. Los datos mostraban que la cantidad de calcio ingerida por los hombres al día se situaba en un promedio de 659 mg, en contraste con las mujeres cuyo consumo diario se promediaba en 569 mg de este mineral. Los productos lácteos aportaron en promedio 330 mg de calcio a la dieta de los hombres, mientras que las mujeres consumieron en promedio 270 mg de calcio proveniente de estos alimentos. No se encontró una diferencia estadísticamente significativa en términos de la cantidad de calcio proveniente de

Tabla 1. Se analizó las medidas antropométricas y la densidad de minerales en los huesos de los adolescentes que formaron parte de la muestra. Los valores expuestos significan las medias y desviaciones del estudio

	Hombres (n= 19)	Mujeres (n= 20)	P valor*	Total
Edad cronológica (años)	17,3 ± 0,89	16,6 ± 0,61	<0,051	17,1 ± 0,85
Peso (kg)	69,5 ± 12,3	60,5 ± 11,5	<0,012	65,6 ± 12,8
Talla (cm)	170,1 ± 6,0	158 ± 5	<0,001	164,5 ± 8,0
Circunferencia de cintura (cm)	81,6 ± 10,1	74,3 ± 8,8	<0,001	77,9 ± 10,1
IMC (kg/m ²)	24,3 ± 3,9	24,2 ± 4,2	NS	24,3 ± 4,0
Peso bajo	2,7%	0,0%	NS [†]	1,4%
Peso normal	51,4%	60,2%	NS [†]	55,8%
Sobrepeso	25,6%	25,1%	NS [†]	25,3%
Obesidad	27,9%	15,5%	NS [†]	21,7%
Obesidad abdominal	30,9%	22,6%	NS [†]	26,7%
Calcio sérico (mg/dl)	9,2 ± 0,8	8,8 ± 0,8	<0,050	9,0 ± 0,8
Densidad mineral ósea (g/cm ²)	1,21 ± 0,11	1,11 ± 0,08	<0,001	1,16 ± 0,10
Densidad mineral ósea (puntaje z)	0,64 ± 0,92	0,44 ± 0,82	NS [†]	0,54 ± 0,87

Tabla 2. Consumo de energía y sustancias nutritivas en los jóvenes que participaron en el estudio

	Hombres (n=19)	Mujeres (n=20)	P valor	Total (n=49)
Energía (Kcal)	2274 ± 612	1998 ± 586	<0,05	2134 ± 611
Proteínas (g)	73,2 ± 22,1	62,5 ± 19,6	<0,05	67,8 ± 21,4
Lípidos (g)	75,4 ± 24,7	74,1 ± 29,3	NS	74,8 ± 27,0
Carbohidratos (g)	329 ± 97	274 ± 86	<0,01	301 ± 95
Calcio (mg)	659 ± 328	569 ± 299	NS	613 ± 315
Zinc (mg)	9,0 ± 3,7	7,8 ± 4,0	NS	8,4 ± 3,9

alimentos lácteos en comparación con alimentos no lácteos, aunque esta información no ha sido presentada en detalle. No se encontraron variaciones significativas en la ingesta de frutas y verduras en función del género.

De acuerdo con el estado de nutrición, no se encontraron diferencias estadísticamente significativas en cuanto a la cantidad de nutrientes consumidos en general y especialmente en cuanto al calcio, como se puede observar en la Figura 1. Diversas variaciones en la densidad mineral ósea estandarizada fueron identificadas, las cuales se encuentran detalladas

en la Tabla 3. Después de realizar un análisis adicional y aplicar una corrección de Bonferroni, se observó que el índice de masa ósea densitométrica estandarizado era significativamente mayor en los jóvenes con obesidad en comparación con aquellos jóvenes que tenían un peso dentro de los parámetros normales. Este hallazgo mostró una diferencia estadísticamente significativa, con un valor de P inferior a 0.05. No se encontró ninguna relación significativa entre la cantidad de calcio consumida y la densidad mineral ósea ($r= 0,16$) ni con la densidad mineral ósea estandarizada ($r= 0,05$).

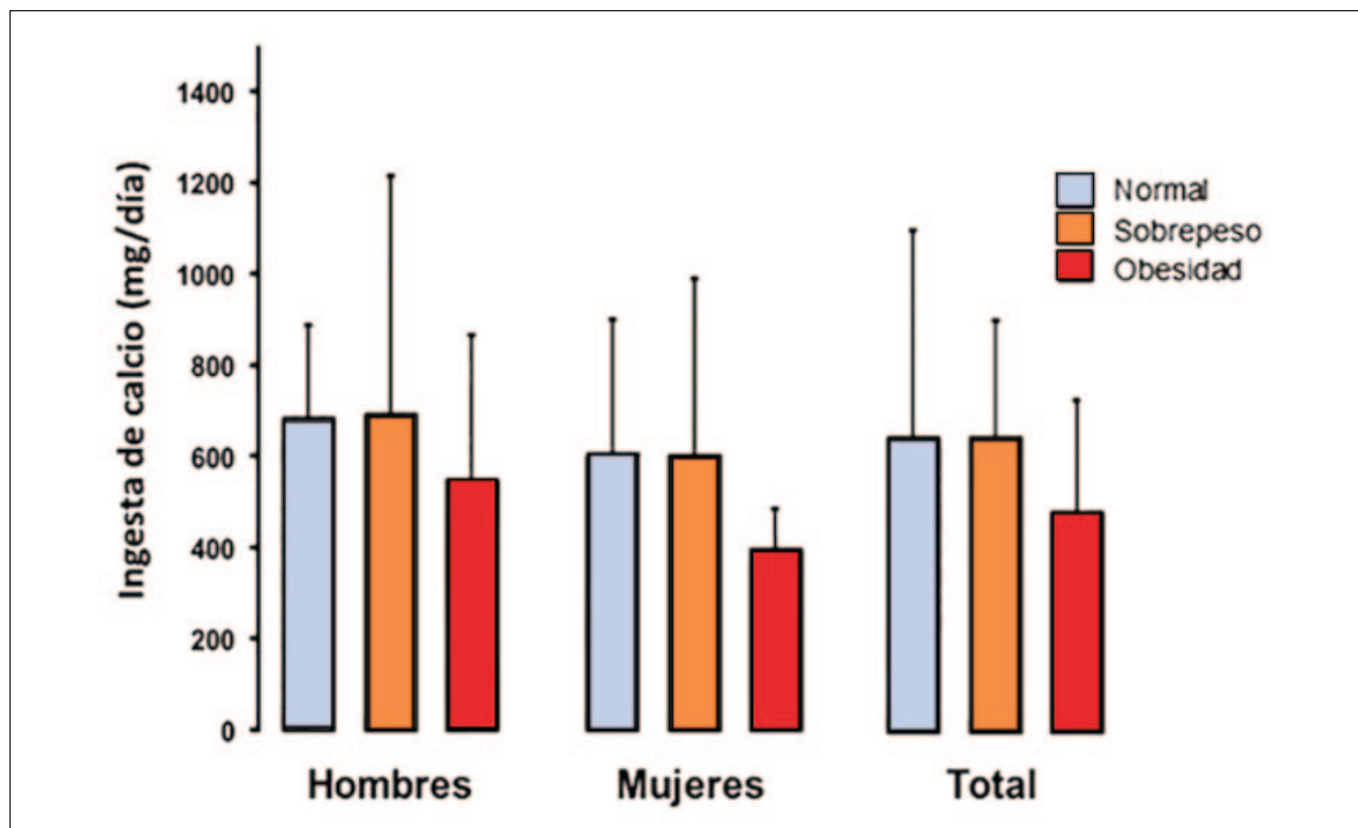


Figura 1. Muestra el promedio diario de consumo de calcio entre los estudiantes, se evidencia que no se encontraron diferencias estadísticamente significativas de acuerdo con el estado nutricional

Tabla 3. Mineralización ósea e ingesta de nutrientes relacionados con la salud ósea, según estado nutricional de los adolescentes

	Normopeso	Sobrepeso	Obesidad	P valor*
N (%)	35	10	4	
Calcio (mg)	641 ± 258	637 ± 443	484 ± 253	NS
Proteína (g)	68,3 ± 18	65,4 ± 27,4	66,5 ± 20	NS
DMO (g/cm ²)	1,14 ± 0,10	1,18 ± 0,11	1,22 ± 0,74	NS
DMO (z)	0,33 ± 0,86	0,87 ± 0,71	1,05 ± 0,85	< 0,010
Circunferencia cintura (cm)	72,2 ± 5,3	80 ± 3,2b	93 ± 8,5c	< 0,050

DISCUSIÓN

El propósito primordial de esta investigación era identificar y analizar de qué manera la cantidad de calcio consumida a través de la alimentación afecta a los alumnos que estudian para ser auxiliares de enfermería, así como examinar de manera más detallada cómo dicha ingesta se relaciona con la densidad mineral ósea. La falta de consumo de calcio en cantidades suficientes es un fenómeno frecuente que se observa

en todas las etapas de la vida y se manifiesta con mayor frecuencia en naciones en vías de desarrollo.

En el estudio que realizamos, solamente el 6 por ciento de los individuos observados cumplieron con la sugerencia diaria de ingesta de calcio, que es de 1.300 miligramos por día. Se ha observado que este descubrimiento está conectado con la reducción en la ingesta de leche y productos lácteos. La evidencia científica es contundente al señalar que se observa un

aumento significativo en la densidad mineral ósea en individuos con obesidad, gracias a la influencia positiva de la presión mecánica generada por el peso corporal¹². Existe la creencia de que los osteocitos situados en el hueso cortical tienen la capacidad de percibir alteraciones en las fuerzas gravitacionales y, como respuesta, generan factores de crecimiento que estimulan el proceso de osteogénesis, favoreciendo así la formación de tejido óseo¹³.

A pesar de que la dieta carecía de suficiente calcio, el nivel medio de este mineral en la sangre se mantuvo dentro de los parámetros normales. Esta situación es comparable al hecho de que los estudiantes chino-americanos tenían un nivel de calcio en la sangre de 9,6 mg/dl, a pesar de que su ingesta de calcio era baja, similar a la estimada en nuestro grupo de personas. El calcio es esencial para mantener la salud ósea y del resto del cuerpo, por lo que cuando hay escasez, el organismo activa mecanismos de control para aumentar la absorción de calcio en el intestino y su retención en los riñones.

En el análisis estratificado por estado nutricional en nuestro estudio, descubrimos que los diferentes factores dietéticos que influyen en el metabolismo óseo no mostraron diferencias. Al interpretar los resultados de este estudio, hay que recordar que existen limitaciones que deben tenerse en cuenta. Los resultados que obtuvimos no son representativos de todos los estudiantes que cursan el programa de tecnología de auxiliar de enfermería, ya que la muestra se limitó únicamente a los estudiantes del cantón Loja. No obstante, debido a que la elección de los participantes en ese grupo específico se realizó de manera aleatoria, este proceso en cierta medida contribuye a disminuir posibles distorsiones^{14,15}. En segundo lugar, debido a la falta de un monitoreo de los individuos que tomaron parte en el estudio, no contamos con la capacidad de analizar cómo el estado nutricional influyó en el incremento de la densidad mineral ósea, lo cual sería de gran ayuda para mejorar nuestra comprensión de la contradicción existente entre la obesidad y la salud ósea. Además, debido a la naturaleza transversal del estudio, no es posible prever cómo la disminución en el consumo de productos lácteos afectará la calidad de la densidad mineral ósea (DMO). Otra restricción a tener en cuenta es que el tamaño de la muestra es pequeño, lo que posiblemente explique la ausencia de relaciones estadísticamente significativas entre las variables que normalmente se consideran como interconectadas en la literatura científica. Además, es importante destacar que en el proceso de evaluación no se consideran los posibles efectos adicionales que podrían influir en la densidad mineral ósea, tales como la cantidad de Vitamina D que se consume, la frecuencia con la que se lleva a cabo actividad física, el hábito de consumir sustancias adictivas como tabaco, alcohol u otras drogas, la posible ingesta excesiva de café y bebidas carbonatadas, la presencia de trastornos alimenticios o la adopción de determinados estilos de alimentación como el vegetarianismo o el veganismo^{16,17}. Por último, es impor-

tante destacar que solo la medición del nivel de calcio en la sangre por sí sola no proporciona una evaluación completa de la salud ósea, como ocurrió en nuestra situación específica; por lo tanto, habría sido recomendable realizar también pruebas adicionales como la medición de los niveles de fosfatasa alcalina y/o la hormona paratiroidea para obtener información más detallada y precisa.

Entre las cosas buenas de este estudio, es relevante destacar que la medición de la masa ósea total fue realizada con el instrumento de referencia establecido, y la valoración de la alimentación fue llevada a cabo a través de la utilización de tres cuestionarios de recordatorio alimentario. Además, queremos resaltar que la investigación se ha centrado en un grupo específico de estudiantes cuyas elecciones alimenticias, incluyendo el consumo de lácteos, muestran signos de deterioro.

CONCLUSION

La única conclusión obtenida es negativa: NO se puede correlacionar la ingesta de calcio calculada mediante recuerdos de 24 horas con la DMO. Debido a que los estudios de densidad ósea reflejan la ingesta promedio de calcio a lo largo del tiempo, no es posible establecer una correlación con la ingesta actual de calcio.

LIMITACIONES DEL ESTUDIO

Muestra poblacional reducida.

Problemas con las muestras de investigación y la selección.

REFERENCIAS BIBLIOGRÁFICAS

1. Antonio L, Lapa JH, Mayuri S, Pajuelo LT, Yessy Y, Rutti G, et al. Artículo Original Frecuencia de consumo de productos lácteos y derivados e indicadores antropométricos en adultos de Lima-Perú Frequency of consumption of dairy products and derivatives and anthropometric indicators in adults from Lima-Peru. *Nutrición Clínica y Dietética Hospitalaria*. 2024;44(2):239-47.
2. Du C, Hsiao PY, Ludy MJ, Tucker RM. Relationships between Dairy and Calcium Intake and Mental Health Measures of Higher Education Students in the United States: Outcomes from Moderation Analyses. *Nutrients*. 2022 Feb 1;14(4).
3. González Ibáñez L, Solorio Sánchez J, González Bonilla A, Martínez Carrera D, Macías López A, Torre Villalvazo I, et al. Evaluation of nutritional status and diet quality in two rural communities, Puebla, Mexico. *Nutrición Clínica y Dietética Hospitalaria*. 2021;41(4):30-8.
4. Ersoy B, Kizilay DÖ, Yilmaz SK, Taneli F, Gümüşer G. Bone mineral density, vitamin D status, and calcium intake in healthy female university students from different socioeconomic groups in Turkey. *Arch Osteoporos*. 2018 Dec 1;13(1):135.
5. Negro E, Hochstrasser A, Joubert MV, Williner MR. Calcium intake in young students of Nutrition. Santa Fe (Argentina). *Nutrición Clínica y Dietética Hospitalaria*. 2020 Oct 10;40(3):185-90.

6. Tao X, Shao Y, Xu D, Huang Y, Yu X, Zhong T, et al. Dietary Patterns and Nutrient Intake in University Students of Macao: A Cross-Sectional Study. *Nutrients*. 2022 Sep 1;14(17).
7. Salamoun MM, Kizirian AS, Tannous RI, Nabulsi MM, Choucair MK, Deeb ME, et al. Low calcium and vitamin D intake in healthy children and adolescents and their correlates. *Eur J Clin Nutr*. 2005 Feb;59(2):177–84.
8. Breitling LP. Calcium intake and bone mineral density as an example of non-linearity and threshold analysis. *Osteoporosis International*. 2015 Apr 1;26(4):1271–81.
9. Morgan SL. Nutrition and bone: It is more than calcium and vitamin D. *Women's Health*. 2009;5(6):727–37.
10. Nyisztor J, Carías D, Velazco Y. CONSUMO DE CALCIO Y DENSIDAD MINERAL ÓSEA EN HOMBRES JÓVENES CON DIFERENTES NIVELES DE ACTIVIDAD FÍSICA. *Rev Venez Endocrinol Metab*. 2014;12(1):12–24.
11. Reid IR, Bristow SM, Bolland MJ. Calcium supplements: Benefits and risks. Vol. 278, *Journal of Internal Medicine*. Blackwell Publishing Ltd; 2015. p. 354–68.
12. Kim MJ, Kim KW. Nutrition knowledge, outcome expectations, self-efficacy, and eating behaviors by calcium intake level in Korean female college students. *Nutr Res Pract*. 2015 Oct 1;9(5):530–8.
13. Surez Cortina L, Moreno Villares JM, Martnez Surez V, Aranceta Bartrina J, Dalmau Serra J, Gil Hernández A, et al. Ingesta de calcio y densidad mineral sea en una poblacin de escolares espaoles (estudio CADO). *An Pediatr (Engl Ed)*. 2011 Jan;74(1):3–9.
14. Bravo P, Carías D, Velazco Y, Acosta E. Consumo de calcio y otros predictores de la densidad mineral ósea en adolescentes venezolanos. *Revista de la Sociedad Latinoamericana de Nutrición*. 2019;69(3).
15. Jaisaard R, Kanjanarach T, Chanaboon S, Ban B. Consumption of calcium and knowledge about calcium sources and nutrition labels among lower secondary school students in Thailand. *Risk Manag Healthc Policy*. 2021;14:3829–40.
16. Tangestani H, Ghaseminasab Parizi M, Mazloomi SM, Shams M, Ahmadi A, Fararouei M. The relationship between dietary intakes assessed by duplicate portion sampling method and bone health in female students: a cross-sectional study. *Nutr Food Sci*. 2023 Feb 28;53(3):618–29.
17. Barahona Meneses A del R, Castillo Andrade RE, Espín Capelo M, Folleco Guerrero JC, Criollo Ibujes J, Hidrobo Guzman JF. Calcium intake and relationship to overweight and obesity in adolescent females, Ecuador. *Revista Espanola de Nutricion Humana y Dietetica*. 2018;22(1):31–41.

Gender difference in the relationship between metabolic syndrome and vitamin D in Korean adults with obesity

Hyun HO SUNG¹, Mi YOUNG GI², Ju AE CHA³, So YOUNG PARK⁴, Cho HEE PARK⁵, Sun GYU KIM¹, Eun SOOK HAN⁶, Hyun YOON⁷

1 Department of Clinical Laboratory Science, Dongnam Health University, Cheoncheon-ro 74beon-gil, Jangan-gu, Suwon-si, Gyeonggi-do, South Korea.

2 Department of Nursing, Christian College of Nursing, Gwangju, South Korea.

3 Department of Nursing, Chunnam Technouniversity, Gokseong-gun, Jeollanam-do, South Korea.

4 Department of Dental Hygiene, Wonkwang Health Science University, Iksan-si, Jeollabuk-do, South Korea.

5 Department of Global Medical Beauty, Konyang University, Daehak-ro, Nonsan-si, Chungcheongnam-do, South Korea.

6 Department of Public Relations, Seoul National University Bundang Hospital, Gumi-ro 173beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea.

7 Department of Clinical Laboratory Science, Wonkwang Health Science University, Iksan-daero, Iksan-si, Jeollabuk-do, 54538, South Korea.

Recibido: 19/mayo/2024. Aceptado: 27/junio/2024.

ABSTRACT

Background: The present study was conducted to assess the relationship between metabolic syndrome (MetS) and serum 25-hydroxyvitamin D [25(OH)D] in Korean adults with or without obesity.

Materials and Methods: The study was performed using data from the sixth Korean National Health and Nutrition Examination Survey (KNHANES VI, 2013-2014) and included Korean adults (n = 1,140) with or without obesity (n = 2,359) aged 20 years or older (n = 3,499).

Results: The key results of this study were as follows: first, adjusting related variables in logistic regression analysis, the relationship between MetS and the odds ratio (OR) of vitamin D deficiency [25(OH)D < 10 ng/mL] was not significant in men, premenopausal women, and postmenopausal women without obesity. Second, in a logistic regression analysis of premenopausal women with obesity, the relationship between MetS and vitamin D deficiency was not significant (OR, 1.241; 95% CI, 0.551–2.797; p = 0.603). However, MetS was positively associated with vitamin D deficiency in men (OR, 1.839; 95% CI, 1.038–3.258; p = 0.037) and postmenopausal women (OR, 3.136; 95% CI, 1.316–7.470; p = 0.010) with obesity.

Conclusions: MetS was not associated with vitamin D deficiency in Korean men, and postmenopausal women without

obesity. MetS was positively associated with vitamin D deficiency in Korean men and postmenopausal women with obesity but not in premenopausal women with obesity.

KEYWORDS

Vitamin D; metabolic health; insulin resistance; cardiovascular risk; chronic diseases.

INTRODUCTION

The World Health Organization (WHO) estimated that in 2016, over 650 million people worldwide were obese¹. The prevalence of obesity in Korea showed a steady increase from 35.1% in 2011 to 37.8% in 2013 and 42.3% in 2016². Obesity is a major cause of morbidity and mortality from noncommunicable diseases and their complications, including type 2 diabetes mellitus (T2DM), cardiovascular disease (CVD), and cancer^{3,4}. Metabolic syndrome (MetS) is defined as a disease in which at least three of the five coronary risk factors, including elevated blood pressure (BP), elevated fasting blood glucose (FBG), elevated triglycerides (TGs), reduced high-density lipoprotein cholesterol (HDL-C), and abdominal obesity, occur simultaneously⁵. MetS is a strong risk factor for developing CVD, chronic kidney disease (CKD), and T2DM⁶. In the United States, 44% of those aged 50 or older, and approximately 23.7% of adults aged 20 or older, have MetS, and a leading cause of MetS has been found to be obesity due to lack of external activities and exercise⁷. In the Republic of Korea, the prevalence of MetS showed a steady increase from 22.9% in 2008 to 25.1% in 2013 and 30.3% in 2016⁸.

Correspondencia:
Hyun Yoon
yh9074@yahoo.co.kr

Vitamin D, which is a fat-soluble secosteroid, can mostly be synthesized in the body following exposure to UV light or consumption of foods rich in vitamin D, such as milk, eggs, and fatty fish^{9,10}. In humans, the most important forms of vitamin D are vitamin D₃, which is synthesized from 7-dehydrocholesterol in the skin by UV light, and vitamin D₂, which is present in plants, such as mushrooms, and in fatty fish, such as mackerel^{10,11}. Vitamin D is transported to the liver, where it is metabolized to 25-hydroxyvitamin D [25(OH)D] (hereafter referred to as 25(OH)D), the major circulating form of vitamin D, which is then metabolized principally to 1,25-dihydroxyvitamin D [1,25(OH)₂D], the biologically active form of vitamin D, in the kidneys¹². Vitamin D status in the human body is generally estimated by measurements of serum 25(OH)D because of its relatively long half-life of 2–3 weeks¹³. In the past, studies of vitamin D have focused on its role in calcium absorption and bone metabolism (e.g., calcium homeostasis maintenance, skeletal growth and maintenance, osteoporosis prevention and treatment)¹⁴. Currently, many researchers are paying attention to another function of vitamin D: its role in the prevention of chronic diseases such as cancer, CVD, and CKD, and insulin resistance diseases, such as T2DM and MetS^{15,16}.

There is still much controversy regarding the association between MetS and vitamin D because the findings vary across countries and races and with the health status of the subjects. That is, some studies report that MetS is associated with vitamin D^{17,18}, but some studies report that MetS is not associated with vitamin D^{19,20}. These relationships may vary by gender due to sex hormones, lifestyle, and dietary habits. To the best of our knowledge, there is still no research on the gender-specific association of MetS and vitamin D in populations with obesity. The Republic of Korea is one of the countries with very severe vitamin D deficiency²¹, and the prevalence of chronic diseases, such as obesity, MetS, and CVD, is increasing due to the westernization of diet. Therefore, the present study aimed to investigate the association between MetS and vitamin D by gender in adults aged 20 or older using the sixth Korean National Health and Nutrition Examination Survey (KNHANES VI) data.

METHODS

Study Subjects

This study was based on data from the KNHANES VI. The KNHANES is a cross-sectional survey conducted nationwide by the Division of Korean National Health and Welfare. The KNHANES VI (2013–2014) was performed from January 2013 to December 2014. In the KNHANES VI (2013–2014), 11,925 subjects who participated in the KNHANES VI, we limited the analyses to adults aged ≥ 20 years. We excluded participants 2,516 subjects whose data were missing for important analytic variables, such as blood pressure, body mass index (BMI), waist circumference (WC), various blood chemistry tests, and information about lifestyle. Among them, of the 9,409 subjects who participated in the KNHANES VI, We excluded 5,910 subjects whose

data were missing for serum 25(OH)D levels. Finally, 3,499 subjects were included in the statistical analysis. This study has been conducted according the principles expressed in the Declaration of Helsinki (Institutional Review Board No, 2013-07 CON-034C; 2013-12 EXP-03-5C). All participants in the survey signed an informed written consent form. All participants in the survey signed an informed written consent form. Further information can be found in "The KNHANES VI Sample", which is available on the KNHANES website. The data from KNHANES is available on request by email if the applicant logs onto the "Korea National Health and Nutrition Examination Survey" website.

General Characteristics and Blood Chemistry

Research subjects were classified by sex (men, and premenopausal women, and postmenopausal women), alcohol drinking (yes or no), and regular exercise (yes or no). Alcohol drinking was indicated as "yes" for participants who had consumed at least one glass of alcohol every month over the last year. Regular exercise was indicated as "yes" for participants who had exercised on a regular basis regardless of indoor or outdoor exercise. Regular exercise was defined as 30 min at a time and 5 times/wk in the case of moderate exercise, such as swimming slowly, doubles tennis, volleyball, badminton, table tennis, and carrying light objects; and for 20 min at a time and 3 times/wk in the case of vigorous exercise, such as running, climbing, cycling fast, swimming fast, football, basketball, jump rope, squash, singles tennis, and carrying heavy objects. Research subjects were classified by men and women. Anthropometric measurements included measurement of height, weight, BMI, WC, systolic blood pressure (SBP), and diastolic blood pressure (DBP). Blood chemistry included measurement of estimated glomerular filtration rate (eGFR), total cholesterol (TC), HDL-C, TGs, white blood cell (WBC), FBG, and 25(OH)D. Obesity was classified as BMI ≥ 25.0 kg/m²²². Hypertension was classified as SBP ≥ 140 mmHg or DBP ≥ 90 mmHg or current use of antihypertensive medication²². T2DM was classified as FBG ≥ 126 mg/dL or current use of glucose lowering medication²². CKD was classified as eGFR < 60 ml/min/1.73 m² or CKD medication²².

Serum 25(OH)D and Metabolic Syndrome

Serum 25(OH)D were measured with a radioimmunoassay (25-hydroxy-vitamin D ¹²⁵I RIA Kit; DiaSorin, Stillwater, MN, USA) using a 1470 Wizard Gamma Counter (PerkinElmer, Turku, Finland). Serum 25(OH)D was classified as vitamin D deficiency [25(OH)D < 10 ng/mL] or vitamin D normal [25(OH)D ≥ 10 ng/mL]²³. MetS was defined using the diagnostic criteria of the Revised National Cholesterol Education Program Adult Treatment panel III (Revised NCEP-ATP III) based on common clinical measures, including WC, BP, TGs, HDL-C, and FBG. The criteria for abdominal obesity were WC of over 90 cm and 80 cm for men and women, respectively, according to the Asia-Pacific criteria²⁴. SBP over 130 mmHg or DBP over 85 mmHg were set as the criteria for elevated BP. TGs over 150 mg/dL

was set as the criteria for elevated TGs. The criteria for reduced HDL-C were HDL-C of less than 40 mg/dL and 50 mg/dL for men and women, respectively. FBG over 100 mg/dL was set as the criteria for elevated FBG. The presence of defined abnormalities in any three of these five measures constitutes a diagnosis of MetS. The MetS score indicates the presence of abdominal obesity, elevated BP, elevated TGs, reduced HDL-C, and elevated FBG.

Data Analysis

The collected data was statistically analyzed using SPSS WIN version 18.0 (SPSS Inc., Chicago, IL, USA). The distributions of the participant characteristics were converted into percentages, and the resultant data was presented as a series of averages with standard deviations. The distribution and average difference in clinical characteristics according to non-obesity and obesity (Table 1) were calculated using chi-squared

Table 1. Clinical characteristics of research subjects

n (%), M ± SD					
Variables	Category	Overall (n = 3,499)	Non-obesity (n = 2,359)	Obesity (n = 1,140)	p-value
Age (years)		45.52 ± 14.49	44.80 ± 14.83	47.03 ± 14.09	< 0.001
Gender	Men	1,755 (50.2)	1,068 (45.3)	687 (60.3)	< 0.001
	Premenopausal women	1,000 (28.5)	795 (33.7)	205 (18.0)	
	Postmenopausal women	744 (21.3)	496 (33.7)	248 (21.8)	
Alcohol drinking	Current drinker	2,052 (58.6)	1,396 (58.0)	683 (59.9)	0.305
Smoking	Current smoker	841 (24.0)	520 (22.1)	321 (28.2)	< 0.001
Regular exercising	Yes	1,013 (29.0)	688 (29.2)	325 (28.5)	0.720
BMI (kg/m ²)		22.79 ± 3.43	21.93 ± 1.97	27.64 ± 2.44	< 0.001
WC (cm)		80.74 ± 9.86	76.20 ± 7.39	90.14 ± 7.37	< 0.001
SBP (mmHg)		116.48 ± 15.85	113.78 ± 15.40	122.13 ± 15.27	< 0.001
DBP (mmHg)		75.49 ± 10.18	73.62 ± 9.56	79.38 ± 10.33	< 0.001
TC (mg/dL)		188.01 ± 35.16	185.03 ± 33.71	194.18 ± 37.24	< 0.001
TGs (mg/dL)		138.88 ± 115.90	120.10 ± 97.85	177.75 ± 138.52	< 0.001
HDL-C (mg/dL)		52.43 ± 12.10	54.51 ± 12.05	48.14 ± 11.03	< 0.001
WBC (10 ³ /μL)		6.27 ± 1.71	6.06 ± 1.66	6.70 ± 1.73	< 0.001
FBG (mg/dL)		98.07 ± 19.77	95.07 ± 16.25	104.28 ± 24.42	< 0.001
eGFR (mL/min/1.73 m ²)		95.91 ± 17.66	97.12 ± 17.30	93.40 ± 18.14	< 0.001
25(OH)D (ng/dL)		16.95 ± 6.64	16.97 ± 6.79	16.95 ± 6.31	0.949
	25(OH)D ≥ 10	3,082 (88.1)	2,074 (87.9)	1,008 (88.4)	0.697
	25(OH)D < 10	417 (11.9)	285 (12.1)	132 (11.6)	
Hypertension		803 (22.9)	384 (16.3)	419 (36.8)	< 0.001
T2DM		210 (6.0)	86 (3.6)	124 (10.9)	< 0.001
CKD		51 (1.5)	26 (1.1)	25 (2.2)	0.015
MetS	MSS < 3	2,718 (77.7)	2,078 (88.1)	640 (56.1)	< 0.001
	MSS ≥ 3	781 (22.3)	281 (11.9)	500 (43.9)	

BMI, body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TGs, triglycerides; HDL-C, high density lipoprotein cholesterol; WBC, white blood cell; FBG, fasting blood glucose; eGFR: estimated glomerular filtration rate; 25(OH)D, 25-hydroxyvitamin D; T2DM; type 2 diabetes mellitus; CKD, chronic kidney disease; metabolic syndrome.

and an independent t test. Mets components of subjects according to vitamin D deficiency without obesity (Table 2) and with obesity (Table 3). In the case of the logistic regression for the incidence odds ratio (OR) for vitamin D deficiency according to MetS in men, premenopausal women, and postmenopausal women without obesity (Table 4), adjusted for age, smoking, drinking, regular exercising, hypertension, CKD, T2DM, and WBC or menstruation (only premenopausal women). The significance level for all statistical data sets was set as $p < 0.05$.

RESULTS

Clinical characteristics according to the non-obesity and obesity groups

Clinical characteristics according to the non-obesity and obesity groups are shown in Table 1. The mean age of the non-obesity and obesity groups were 44.80 ± 14.83 and 47.03 ± 14.09 years. The prevalence rate of MetS and vitamin D deficiency in the non-obesity group were 281 (11.9%) and 285 (12.1%), respectively. The prevalence rate of MetS and vitamin D deficiency in the obesity group were 500 (43.9%) and 132 (11.6%), respectively. The prevalence rate of MetS in the obesity group was higher ($p < 0.001$) than in the non-obesity

group. The prevalence rate of vitamin D deficiency in the non-obesity and obesity groups was not significant ($p = 0.697$).

MetS components of subjects according to vitamin D deficiency in subjects without obesity

Clinical characteristics according to vitamin D deficiency in men, premenopausal women, and postmenopausal women without obesity are shown in Table 2. In men, the elevated BP ($p = 0.030$) in the vitamin D deficiency group were higher than those in the vitamin D normal group but other MetS components (the elevated TGs, reduced HDL-C, elevated FBG, and abdominal obesity) and MetS were not significantly associated with vitamin D deficiency. In premenopausal and postmenopausal women, all MetS components and MetS were not significantly associated with vitamin D deficiency.

MetS components of subjects according to vitamin D deficiency in subjects with obesity

Clinical characteristics according to vitamin D deficiency in men, premenopausal women, and postmenopausal women with obesity are shown in Table 3. In men, the elevated TGs ($p = 0.047$), reduced HDL-C ($p = 0.004$), and abdominal obesity ($p = 0.041$) in the vitamin D deficiency group were higher

Table 2. Mets components of subjects according to vitamin D deficiency in subjects without obesity

(n = 2,359)									
Variables	Men (n = 1,068)			Premenopausal women (n = 795)			Postmenopausal women (n = 496)		
	Vitamin D normal (n = 965)	Vitamin D deficiency (n = 103)	p-value	Vitamin D normal (n = 662)	Vitamin D deficiency (n = 133)	p-value	Vitamin D normal (n = 447)	Vitamin D deficiency (n = 49)	p-value
25(OH)D (ng/dL)	18.93 ± 6.46	8.32 ± 1.33	< 0.001	16.24 ± 4.89	8.13 ± 1.44	< 0.001	19.38 ± 7.28	8.32 ± 1.24	< 0.001
Age (years)	45.69 ± 14.83	42.98 ± 15.83	0.083	35.13 ± 8.93	34.15 ± 9.49	0.255	59.34 ± 6.58	57.88 ± 6.84	0.142
BMI (kg/m ²)	22.28 ± 1.84	22.14 ± 2.09	0.467	21.18 ± 2.04	21.13 ± 2.13	0.255	22.42 ± 1.73	22.33 ± 1.77	0.746
Menstruation	–			21 (3.2)	2 (1.5)	0.402	–		
Elevated BP	229 (23.7)	35 (34.0)	0.030	38 (5.7)	13 (9.9)	0.118	144 (32.2)	22 (44.9)	0.081
Abdominal obesity	44 (4.6)	7 (6.8)	0.328	79 (11.9)	10 (7.5)	0.174	152 (34.0)	12 (24.5)	0.203
Elevated TGs	277 (28.7)	32 (31.1)	0.648	71 (10.7)	16 (12.0)	0.649	119 (26.6)	11 (22.4)	0.610
Reduced HDL-C	134 (13.9)	20 (19.4)	0.140	156 (23.6)	32 (24.1)	0.911	167 (37.4)	23 (46.9)	0.216
Elevated FBG	265 (27.5)	25 (24.3)	0.580	90 (13.6)	11 (8.3)	0.116	136 (30.4)	20 (10.8)	0.146
MetS	102 (10.6)	14 (13.8)	0.322	31 (4.7)	7 (5.3)	0.823	111 (24.8)	16 (32.7)	0.232

Vitamin D normal, 25(OH)D ≥ 10 ng/dL; Vitamin deficiency, 25(OH)D < 10 ng/dL.

Elevated BP is defined as SBP ≥ 130 mmHg or DBP ≥ 85 mmHg; Abdominal obesity is defined as WC ≥ 90 cm in men or WC ≥ 80 cm in women; Elevated TGs is defined as TGs ≥ 150 mg/dL; Reduced HDL-C is defined as HDL-C < 40 mg/dL in men or HDL-C < 50 mg/dL in women; Elevated FBG is defined as FBG ≥ 100 mg/dL.

Table 3. Mets components of subjects according to vitamin D deficiency in subjects with obesity

(n = 1,140)									
Variables	Men (n = 687)			Premenopausal women (n = 205)			Postmenopausal women (n = 248)		
	Vitamin D normal (n = 627)	Vitamin D deficiency (n = 60)	p-value	Vitamin D normal (n = 168)	Vitamin D deficiency (n = 37)	p-value	Vitamin D normal (n = 213)	Vitamin D deficiency (n = 35)	p-value
25(OH)D (ng/dL)	18.25 ± 5.67	8.13 ± 1.59	< 0.001	16.37 ± 4.59	8.61 ± 1.14	< 0.001	18.98 ± 6.73	8.15 ± 1.14	< 0.001
Age (years)	45.52 ± 13.74	39.13 ± 15.04	0.001	37.76 ± 9.22	36.62 ± 9.01	0.495	60.37 ± 5.89	61.51 ± 6.20	0.290
BMI (kg/m ²)	27.47 ± 2.21	28.14 ± 2.35	0.027	27.96 ± 3.13	27.94 ± 2.50	0.970	27.72 ± 2.51	27.37 ± 1.94	0.442
Menstruation	–			7 (4.2)	0 (0.0)	0.355	–		
Elevated BP	281 (44.8)	22 (36.7)	0.276	40 (23.8)	7 (18.9)	0.522	93 (43.7)	16 (45.7)	0.821
Abdominal obesity	352 (56.1)	42 (70.0)	0.041	136 (81.0)	29 (78.4)	0.721	192 (90.1)	30 (85.7)	0.428
Elevated TGs	334 (53.3)	40 (66.7)	0.047	43 (25.6)	12 (32.4)	0.395	79 (37.1)	18 (51.4)	0.107
Reduced HDL-C	171 (27.3)	27 (45.0)	0.004	68 (40.5)	15 (40.5)	1.000	89 (41.8)	20 (57.1)	0.090
Elevated FBG	304 (48.5)	19 (31.7)	0.013	58 (34.5)	8 (21.6)	0.128	104 (48.8)	19 (54.3)	0.549
MetS	271 (43.2)	30 (50.0)	0.342	55 (32.7)	12 (32.4)	0.971	106 (49.8)	26 (74.3)	0.007

Vitamin D normal, 25(OH)D ≥ 10 ng/dL; Vitamin deficiency, 25(OH)D < 10 ng/dL.

Elevated BP is defined as SBP ≥ 130 mmHg or DBP ≥ 85 mmHg; Abdominal obesity is defined as WC ≥ 90 cm in men or WC ≥ 80 cm in women; Elevated TGs is defined as TGs ≥ 150 mg/dL; Reduced HDL-C is defined as HDL-C < 40 mg/dL in men or HDL-C < 50 mg/dL in women; Elevated FBG is defined as FBG ≥ 100 mg/dL.

than those in the vitamin D normal group but the elevated FBG ($p = 0.013$) was lower. The elevated BP ($p = 0.276$) and MetS ($p = 0.342$) were not significantly associated with vitamin D deficiency. In premenopausal women, all MetS components and MetS were not significantly associated with vitamin D deficiency. In postmenopausal women, MetS ($p = 0.007$) in the vitamin D deficiency group was higher than those in the vitamin D normal group but all MetS components were not significantly associated with vitamin D deficiency.

Comparisons of MetS and vitamin D deficiency in subjects with and without obesity

Comparisons of MetS and vitamin D deficiency in men, premenopausal women, and postmenopausal women with and without obesity are shown in Table 4. In subjects without obesity, after adjusting for the related variables, MetS was not associated with vitamin D deficiency in men (odds ratio [OR], 1.307; 95% confidence interval [CI], 0.664–2.575; $p = 0.439$), premenopausal women (OR, 1.166; 95% CI, 0.467–2.907; $p = 0.742$), and postmenopausal women (OR, 1.596; 95% CI, 0.798–3.191; $p = 0.186$). In subjects with obesity, MetS was positively associated with vitamin D deficiency in men (OR, 1.839; 95% CI, 1.038–3.258; $p = 0.037$) and postmenopausal

women (OR, 3.136; 95% CI, 1.316–7.470; $p = 0.010$) but not in premenopausal women (OR, 1.241; 95% CI, 0.551–2.797; $p = 0.603$).

DISCUSSION

The present study investigated the association between MetS and vitamin D in Korean adults with obesity using data from the sixth KNHANES conducted in 2013–2014. MetS was positively associated with vitamin D deficiency in men and postmenopausal women with obesity but not in premenopausal women with obesity.

The prevalence of MetS in our participants with obesity (43.9%) was higher than in Spanish (13.2%)¹⁸ and New Zealanders (22.4%)²⁵ but was lower than in Norwegian (68%)²⁰ and Indian (57.6%)²⁶. Obesity has been strongly linked to chronic diseases, such as renal failure, heart failure, hypertension, atherosclerosis, and MetS in humans²⁷. The high prevalence of vitamin D deficiency in subjects with obesity is a well-documented finding. Whether vitamin D deficiency is the result or cause of obesity is still unclear. It must also be acknowledged that there could be a mutual causality between vitamin D deficiency and obesity because the greater volumes of

Table 4. Comparisons of vitamin D deficiency according to MetS in subjects with or without obesity

	Gender	Variables	Vitamin D deficiency
Non-obesity (n = 2,359)	Men (n = 1,068)	Non-MetS	1
		MetS	1.307 (0.664–2.575)
		p-value	0.439
	Premenopausal women (n = 795)	Non-MetS	1
		MetS	1.166 (0.467–2.907)
		p-value	0.742
	Postmenopausal women (n = 496)	Non-MetS	1
		MetS	1.596 (0.798–3.191)
		p-value	0.186
Obesity (n = 1,140)	Men (n = 687)	Non-MetS	1
		MetS	1.839 (1.038–3.258)
		p-value	0.037
	Premenopausal women (n = 205)	Non-MetS	1
		MetS	1.241 (0.551–2.797)
		p-value	0.603
	Postmenopausal women (n = 248)	Non-MetS	1
		MetS	3.136 (1.316–7.470)
		p-value	0.010

Vitamin D deficiency, 25(OH)D < 10 ng/dL; MetS, metabolic syndrome. Adjusted for age, alcohol drinking, smoking, and regular exercising or menstruation (only premenopausal women), hypertension, CKD, T2DM, and WBC.

serum, fat, muscle, and liver allow for greater dilution of 25(OH)D in people with obesity compared to those without obesity^{28,29}.

The previous studies on the relationship between vitamin D and MetS have yielded varied results by country, ethnicity, and health status. Among previous studies on vitamin D and MetS in populations with obesity, Miñambres et al. reported that the OR for vitamin D deficiency (25(OH)D < 50 nmol/L) was 2.710 (95% CI, 1.147–6.401) for the MetS group versus non-MetS group in Caucasians with overweight or obesity¹⁸. Mirhoseini et al. revealed that vitamin D levels in the MetS group (18.88 ± 1.24 ng/mL) were lower (p < 0.001) than in the non-MetS group (40.38 ± 2.15 ng/mL) in Iranians with obesity³⁰. Some studies have shown that vitamin D and MetS are not related. In a study of Caucasians with obesity, Hjelmessaeth et al. suggested that 25(OH)D level was not a significant independent variable for the prevalence of MetS (OR, 1.06; 95% CI, 0.69–1.63)²⁰. Rueda et al. revealed that 25(OH)D levels (men, p_{trend} = 0.1; women, p_{trend} = 0.9) were not independently associated with the pathogenesis of the MetS in Spanish adults with severe obesity³¹. In the presented study, MetS was positively associated with vitamin D deficiency in subjects with obesity (OR, 1.830; 95% CI, 1.230–2.722; P = 0.003) but not in subjects without obesity (OR, 1.321; 95% CI, 0.870–2.006; p = 0.192) (Supplementary table 1).

Research on the gender specific association of MetS and vitamin D is rare, and the results have varied according to the study. Ghadieh et al. reported that MetS was positively associated with vitamin D deficiency in

Supplementary table 1. Comparisons of vitamin D deficiency and MetS in overall population with and without obesity

		(n = 3,499)			
Gender	Variables	Vitamin D deficiency			
		Model 1	Model 2	Model 3	Model 4
Non-obesity (n = 2,359)	Non-MetS	1	1	1	1
	MetS	1.123 (0.775–1.626)	1.045 (0.717–1.524)	1.142 (0.761–1.712)	1.321 (0.870–2.006)
	p-value	0.540	0.818	0.522	0.192
Obesity (n = 1,140)	Non-MetS	1	1	1	1
	MetS	1.417 (0.985–2.38)	1.379 (0.955–1.990)	1.685 (1.142–2.488)	1.830 (1.230–2.722)
	p-value	0.060	0.086	0.009	0.003

Vitamin D deficiency, 25(OH)D < 10 ng/dL; MetS, metabolic syndrome. Model 1 (OR, 95% CI), Non-adjusted; Model 2 (OR, 95% CI), adjusted for gender, alcohol drinking, smoking, and regular exercising; Model 3 (OR, 95% CI), Model 2 further adjusted for hypertension, CKD, T2DM, and WBC; Model 4 (OR, 95% CI), Model 3 further adjusted for age.

Lebanese women ($p = 0.021$) but not in Lebanese men ($p = 0.174$)³². In contrast, Kim et al. reported that the OR of MetS for vitamin D sufficiency was lower than that for vitamin D deficiency in Korean men (OR, 0.824; 95% CI, 0.688–0.988) but was not significant in Korean women (OR, 0.978; 95% CI, 0.823–1.163)³³. In our results, the outcomes in subjects with obesity differed by gender. In men (OR, 1.839; 95% CI, 1.038–

3.258) and postmenopausal women (OR, 3.136; 95% CI, 1.316–7.470), MetS was positively associated with vitamin D deficiency. However, the association between MetS and vitamin D deficiency in premenopausal women was not significant (OR, 1.241; 95% CI, 0.551–2.797) was not significant (Table 4). The mechanism for the gender difference in the association between vitamin D and MetS is not clear. We consider that it may be due

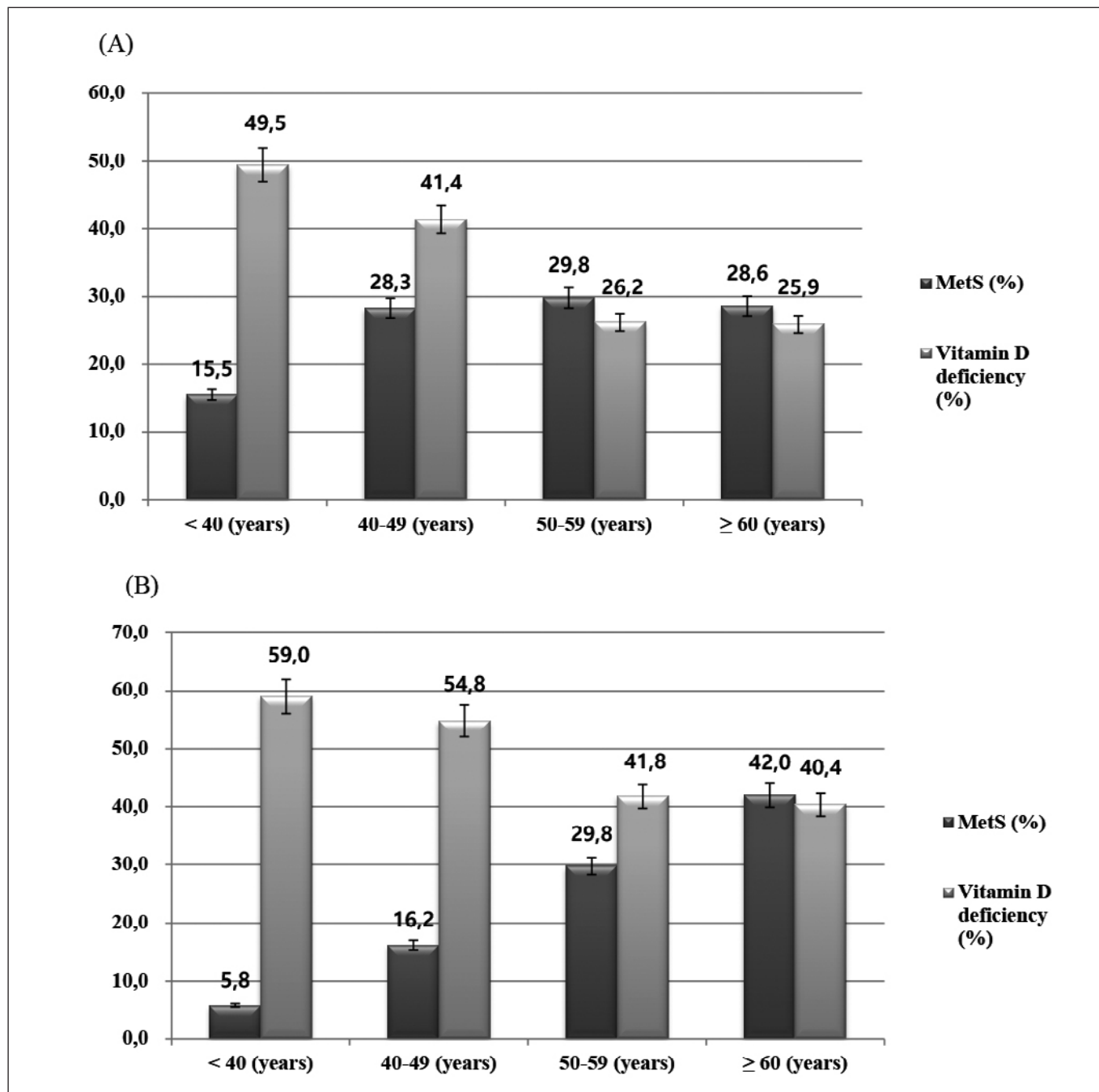


Figure 1. Comparisons of vitamin D deficiency and MetS for age groups in men (A) and women (B). The prevalence of vitamin D deficiency decreased with increasing age in men and women. The prevalence of MetS was continuously increased after 40s age group in women but was not significant after 40s age group in men.

to the physical and body fat composition changes according to an increase in age³⁴. In our results, the prevalence of MetS was not significant in the over-40s age group in men but continuously increased in the over-40s age group in women (Figure 1).

We believe that differences in female hormones are the cause of the different results in the relationship between vitamin D deficiency and MetS in premenopausal and postmenopausal women. Women experience a rapid decrease in estrogen levels due to menopause. Hormonal changes that start at the menopausal transition and abrupt cessation of hormone production can cause chronic diseases, such as hypertension, T2DM, and MetS³⁵. Huang et al, argued that low estradiol increased MetS risk with Vitamin D deficiency in Chinese women (OR, 3.49; 95% CI, 1.45–8.05 for the lowest vs the highest tertile)³⁶. There are gender differences in lifestyle (drinking, smoking, and physical activity) as well as physical changes according to age. Compared to their counterparts without obesity, vitamin D intake has been reported as being lower in men with obesity but not in women with obesity^{37,38}. Men with morbid obesity had a significantly higher prevalence of vitamin D deficiency than women³⁹. Therefore, some researchers argued that researchers should consider analyzing men and women separately when constructing research hypotheses in medical studies^{40,41}.

The present study has a few limitations. First, parathyroid hormone (PTH) and calcium play an important role in the metabolism of vitamin D. However, KNHANES VI (2013–2014) does not measure the PTH and calcium of these participants. Second, KNHANES VI (2013–2014) does not record the intake of vitamin D and calcium supplements. Third, serum 25(OH)D levels vary across seasons, but KNHANES VI (2013–2014) does not specify the serum 25(OH)D levels for each season. Therefore, we were unable to include these variables as adjustment variables for vitamin D levels. The serum levels for PTH and calcium, seasonal measurements of serum 25(OH)D, and information on vitamin D and calcium supplements should be included as variables of vitamin D status in future studies. Fourth, the two-year continuous data from KNHANES on vitamin D are the most recent data from 2013–2014, but these are old in terms of time point. Therefore, future studies should be utilized the most recent data on vitamin D. Despite these limitations in the present study, it is the first reported study to determine the gender-specific association of MetS and vitamin D in Korean adults with or without obesity. Therefore, more accurate results might be obtained by performing a cohort study that includes these variables.

CONCLUSIONS

The present study investigated the sex-specific association of MetS and serum vitamin D in Korean adults aged 20

and older with or without obesity, using the KNHANES VI (2013–2014) data. In non-obesity group, MetS was not associated with vitamin D deficiency in men, premenopausal women, and postmenopausal women. In obesity group, MetS was positively associated with vitamin D deficiency in men and postmenopausal women but not in premenopausal women.

FUNDING RESOURCES

This paper was financially supported by Dongnam Health University

REFERENCES

1. Obesity and overweight factsheets. World Health Organization. Available from: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>. Published 2021.
2. Ministry of Health Welfare and Family Affairs & Korea Center for Disease Control and Prevention. Korea National Health and Nutrition Examination Survey. 2013.
3. Lin X, Li H. Obesity: Epidemiology, Pathophysiology, and Therapeutics. *Front Endocrinol (Lausanne)*. 2021;12:706978. doi:10.3389/fendo.2021.706978.
4. Yang YS, Han BD, Han K, et al. Obesity Fact Sheet in Korea, 2021: Trends in Obesity Prevalence and Obesity-Related Comorbidity Incidence Stratified by Age from 2009 to 2019. *J Obes Metab Syndr*. 2022;31:169–177. doi:10.7570/jomes22024.
5. Reaven GM. Role of insulin resistance in human disease (syndrome X): an expanded definition. *Annu Rev Med*. 1993;44:121–131. doi:10.1146/annurev.me.44.020193.001005.
6. Moukayed M, Grant WB. Linking the metabolic syndrome and obesity with vitamin D status: risks and opportunities for improving cardiometabolic health and well-being. *Diabetes Metab Syndr Obes*. 2019;12:1437–1447. doi:10.2147/DMSO.S176933.
7. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. *JAMA*. 2002;287:356–359. doi:10.1001/jama.287.3.356.
8. Kim MH, Lee SH, Son DY, Kim SH, Joe H, Yoo BW, Cho CY, Shin HS, Cho YJ, Oh JE. The Change of Metabolic Syndrome Prevalence and Its Risk Factors in Korean Adults for Decade: Korea National Health and Nutrition Examination Survey for 2008–2017. *Korean J Fam Pract*. 2020;10:44–52. doi:10.21215/kjfp.2020.10.1.44.
9. Dominguez LJ, Farruggia M, Veronese N, Barbagallo M. Vitamin D Sources, Metabolism, and Deficiency: Available Compounds and Guidelines for Its Treatment. *Metabolites*. 2021;11:255. doi:10.3390/metabo11040255.
10. Meza-Meza MR, Ruiz-Ballesteros AI, de la Cruz-Mosso U. Functional effects of vitamin D: From nutrient to immunomodulator. *Crit Rev Food Sci Nutr*. 2022;62:3042–3062. doi:10.1080/10408398.2020.1862753.

11. Janoušek J, Pilařová V, Macáková K, Nomura A, Veiga-Matos J, Silva DDD, Remião F, Saso L, Malá-Ládová K, Malý J, Nováková L, Mladěnka P. Vitamin D: sources, physiological role, biokinetics, deficiency, therapeutic use, toxicity, and overview of analytical methods for detection of vitamin D and its metabolites. *Crit Rev Clin Lab Sci*. 2022;59:517–554. doi:10.1080/10408363.2022.2070595.
12. Chen C, White DL, Marshall B, Kim WK. Role of 25-Hydroxyvitamin D3 and 1,25-Dihydroxyvitamin D3 in Chicken Embryo Osteogenesis, Adipogenesis, Myogenesis, and Vitamin D3 Metabolism. *Front Physiol*. 2021;12:637629. doi:10.3389/fphys.2021.637629.
13. Hollis BW. Assessment of vitamin D nutritional and hormonal status: what to measure and how to do it. *Calcif Tissue Int*. 1996;58:4–5. doi:10.1007/BF02509538.
14. Fleet JC. Vitamin D-Mediated Regulation of Intestinal Calcium Absorption. *Nutrients*. 2022;14:3351. doi:10.3390/nu14163351.
15. Wang H, Chen W, Li D, Yin X, Zhang X, Olsen N, Zheng SG. Vitamin D and Chronic Diseases. *Aging Dis*. 2017;8:346–353. doi:10.14336/AD.2016.1021.
16. Muscogiuri G. Vitamin D: past, present and future perspectives in the prevention of chronic diseases. *Eur J Clin Nutr*. 2018;72:1221–1225. doi:10.1038/s41430-018-0261-4.
17. Liu L, Cao Z, Lu F, et al. Vitamin D deficiency and metabolic syndrome in elderly Chinese individuals: evidence from CLHLS. *Nutr Metab (Lond)*. 2020;17:58. doi: 10.1186/s12986-020-00479-3.
18. Miñambres I, Sánchez-Hernández J, Sánchez-Quesada JL, Rodríguez J, de Leiva A, Pérez A. The association of hypovitaminosis d with the metabolic syndrome is independent of the degree of obesity. *ISRN Endocrinol*. 2012;2012:691803. doi:10.5402/2012/691803.
19. Abboud M, Rizk R, Haidar S, Mahboub N, Papandreou D. Association between Serum Vitamin D and Metabolic Syndrome in a Sample of Adults in Lebanon. *Nutrients*. 2023;15:1129. doi:10.3390/nu15051129.
20. Hjelmestaeth J, Hofsø D, Aasheim ET, Jenssen T, Moan J, Hager H, Røislien J, Bollerslev J. Parathyroid hormone, but not vitamin D, is associated with the metabolic syndrome in morbidly obese women and men: a cross-sectional study. *Cardiovasc Diabetol*. 2009;8:7. doi:10.1186/1475-2840-8-7.
21. Palacios C, Gonzalez L. Is vitamin D deficiency a major global public health problem? *J Steroid Biochem Mol Biol*. 2014;144:138–145. doi:10.1016/j.jsbmb.2013.11.003.
22. Kim SG, Kim GS, Lee JH, Moon AE, Yoon H. The relationship between vitamin D and estimated glomerular filtration rate and urine microalbumin/creatinine ratio in Korean adults. *J Clin Biochem Nutr*. 2018;62:94–99. doi:10.3164/jcbs.17-69.
23. Cheng Q, Du Y, Hong W, et al. Factors associated to serum 25-hydroxyvitamin D levels among older adult populations in urban and suburban communities in Shanghai, China. *BMC Geriatr*. 2017;17:246. doi:10.1186/s12877-017-0632-z.
24. Yoon H. Relationship between metabolic syndrome and metabolic syndrome score and insulin resistance and beta cell function in Korean adults with obesity. *Korean J Clin Lab Sci*. 2020;52:327–334. doi:10.15324/KJCLS.2020.52.4.327.
25. McGill AT, Stewart JM, Lithander FE, Strik CM, Poppitt SD. Relationships of low serum vitamin D3 with anthropometry and markers of the metabolic syndrome and diabetes in overweight and obesity. *Nutr J*. 2008;7:4. doi:10.1186/1475-2891-7-4.
26. Negi PC, Sondhi S, Merwaha R, Asotra S. Prevalence and risk determinants of metabolic syndrome in obese worksite workers in hill city of Himachal Pradesh, India. *Indian Heart J*. 2019;71:45–51. doi:10.1016/j.ihj.2019.01.001.
27. Canale MP, Manca di Villahermosa S, Martino G, Rovella V, Noce A, De Lorenzo A, Di Daniele N. Obesity-related metabolic syndrome: mechanisms of sympathetic overactivity. *Int J Endocrinol*. 2013;2013:865965. doi:10.1155/2013/865965.
28. Vranić L, Mikolašević I, Milić S. Vitamin D Deficiency: Consequence or Cause of Obesity? *Medicina (Kaunas)*. 2019;55:541. doi:10.3390/medicina55090541.
29. Walsh JS, Bowles S, Evans AL. Vitamin D in obesity. *Curr Opin Endocrinol Diabetes Obes*. 2017;24:389–394. doi:10.1097/MED.0000000000000371.
30. Mirhoseini M, Daemi H, Babaie MM, Asadi-Samani M, Mirhoseini L, Sedehi M. The relationship between vitamin D deficiency and metabolic syndrome in obese individuals. *J Renal Inj Prev*. 2018;7: 275–279. doi:10.15171/jrip.2018.61.
31. Rueda S, Fernández-Fernández C, Romero F, Martínez de Osaba J, Vidal J. Vitamin D, PTH, and the metabolic syndrome in severely obese subjects. *Obes Surg*. 2008;18:151–154. doi:10.1007/s11695-007-9352-3.
32. Ghadieh R, Mattar Bou Mosleh J, Al Hayek S, Merhi S, El Hayek Fares J. The relationship between hypovitaminosis D and metabolic syndrome: a cross sectional study among employees of a private university in Lebanon. *BMC Nutr*. 2018;4:36. doi:10.1186/s40795-018-0243-x.
33. Kim MH, Lee J, Ha J, et al. Gender specific association of parathyroid hormone and vitamin D with metabolic syndrome in population with preserved renal function. *Sci Rep*. 2018;8:1149. doi:10.1038/s41598-017-17397-9.
34. Ponti F, Santoro A, Mercatelli D, et al. Aging and Imaging Assessment of Body Composition: From Fat to Facts. *Front Endocrinol (Lausanne)*. 2020;10:861. doi:10.3389/fendo.2019.00861.
35. Jeong HG, Park H. Metabolic Disorders in Menopause. *Metabolites*. 2022;12:954. doi: 10.3390/metabo12100954.
36. Huang H, Guo J, Chen Q, Chen X, Yang Y, Zhang W, et al. The synergistic effects of vitamin D and estradiol deficiency on metabolic syndrome in Chinese postmenopausal women. *Menopause*. 2019;26:1171–1177. doi:10.1097/GME.0000000000001370.

37. Taslim NA, Bukhari A, As'ad S, et al. The Effects of 10,000 IU Vitamin D Supplementation on Improvement of Clinical Outcomes, Inflammatory and Coagulation Markers in Moderate COVID-19 Patients: A Randomized-Controlled Trial. *Nutr Clín Diet Hosp*. 2023;43:21–33. doi:10.12873/432taslim.
38. Orces C. The Association between Body Mass Index and Vitamin D Supplement Use among Adults in the United States. *Cureus*. 2019;11:e5721. doi:10.7759/cureus.5721.
39. Almesri N, Das NS, Ali ME, Gumaa K, Giha HA. Gender-Dependent Association of Vitamin D Deficiency with Obesity and Hypercholesterolemia (LDLC) in Adults. *Endocr Metab Immune Disord Drug Targets*. 2020;20:425–436. doi:10.2174/1871530319666191009154528.
40. Kanter R, Caballero B. Global gender disparities in obesity: a review. *Adv Nutr*. 2012;3:491–498. doi:10.3945/an.112.002063.
41. Rich-Edwards JW, Kaiser UB, Chen GL, Manson JE, Goldstein JM. Sex and Gender Differences Research Design for Basic, Clinical, and Population Studies: Essentials for Investigators. *Endocr Rev*. 2018;39:424–439. doi:10.1210/er.2017-00246.

The relationship of physical activity with nutritional status and body composition in traditional and modern populations in South Sulawesi, Indonesia

Wanty ARRUAN¹, Agussalim BUKHARI², Nevi Dwi HANDAYANI¹, Nurpudji A. TASLIM², Andi FARADILAH², AMINUDDIN²

1 Clinical Nutrition Medical Speciality Education Program, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

2 Department of Nutrition, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

Recibido: 7/mayo/2024. Aceptado: 27/junio/2024.

ABSTRACT

Background: Decreased physical activity in modern society, influenced by lifestyle and technology, leads to energy imbalances that impact nutrition, obesity, and body composition issues, which increase the risk of metabolic diseases, such as hypertension, type 2 diabetes, cardiovascular disease, and dyslipidaemia.

Objective: This study aimed to determine the relationship of physical activity to nutritional status and body composition in traditional and modern populations in South Sulawesi.

Methods: This study was an observational study with a cross-sectional approach, which examined the relationship between variables in modern and traditional groups. The study was conducted in Tana Toa village and Makassar city from February to November 2022. Each group consisted of 50 adults who met the criteria. Data were collected through IPAQ questionnaire and direct measurement for anthropometric data and body composition. Data were analysed using SPSS version 26.

Results: The results showed that the traditional group performed moderate physical activity (56%), while the modern group performed light physical activity (58%) with $p < 0.001$. BMI, waist circumference, fat mass and visceral fat had a negative correlation with physical activity, where subjects with overweight-obese BMI tended to be less active ($r = -0.298$, $p = 0.003$), subjects with central obesity, high fat

mass and high visceral fat performed more low activities: ($r = -0.403$, $p < 0.001$) ($r = -0.425$, $p < 0.001$), ($r = -0.335$, $p = 0.001$). Muscle mass had a positive correlation with physical activity where subjects with normal muscle mass were more active ($r = 0.356$, $p < 0.001$). However, the relationship between physical activity and bone mass was not significant ($p = 0.111$).

Conclusion: Light physical activity found in the modern population compared to traditional population affects nutritional status and body composition which increase body mass index, waist circumference, fat mass and visceral fat.

KEYWORDS

Body mass index, Health behavior, Cultural differences, Lifestyle factors, Metabolic health.

INTRODUCTION

Changes in lifestyle caused by technological development and modernisation have resulted in a significant decrease in people's physical activity levels¹. As a result, there has been an increase in the number of cases of obesity and other health problems related to sedentary lifestyles²⁻⁴. Physical activity has a very important role in maintaining energy balance and regulating body composition^{5,6}. Energy imbalance, where calorie intake exceeds energy expended through physical activity, is a major trigger of obesity and a range of associated health conditions, including hypertension, type 2 diabetes, and cardiovascular disease⁷.

The problem of obesity has become a global concern, and Indonesia is no exception. According to data from the Ministry of Health, the prevalence of obesity in Indonesia increased

Correspondencia:

Wanty Arruan
arruanwanty@gmail.com

from 19.7% in 2013 and 21.8% in 2018. This condition is more prominent in South Sulawesi, with the adult obesity rate reaching 25.4%. This increase has a serious impact on public health, as obesity is closely linked to various metabolic diseases that have the potential to reduce quality of life and increase the economic burden on the healthcare system^{8,9}.

Physical activity, in addition to its role in maintaining a healthy body composition, also contributes to energy balance. When physical activity decreases, the risk of energy imbalance increases, leading to excessive fat accumulation and triggering obesity¹⁰. This results in various health complications and can have a negative impact on the social and economic aspects of society¹¹. Therefore, efforts to encourage increased physical activity are of paramount importance in preventing obesity and improving quality of life^{12,13}.

Various measures have been taken to address this issue, such as awareness campaigns on the importance of physical activity, promotion of healthy diets, and government programmes that support active lifestyles¹⁴. However, challenges remain, especially in modern environments that tend to promote convenience and reduce the need to move¹⁵. Therefore, in-depth research is needed to understand the relationship between physical activity and nutritional status and body composition, especially among traditional and modern populations in South Sulawesi.

This study will explore the relationship of physical activity to nutritional status and body composition by comparing a traditional population with a modern population. By studying these two groups, the research can provide better insight into the factors that drive obesity and offer effective solutions. The results of this study are expected to make a significant contribution to the development of public health programmes and support efforts to tackle obesity and nutrition problems. This research can also serve as a basis for more targeted policy interventions to increase physical activity and encourage healthy lifestyles in the community.

METHODS

This study used an observational analytic research design with a cross-sectional approach. Observational analytic research design, namely by making direct observations on the object under study and looking for relationships between variables with a cross-sectional approach, namely each subject is observed once, and variable measurements are made during the examination.

Place and Time of Research: This study was conducted in Tana Toa village and Makassar city from February to November 2022.

Research Subjects: The population of this study were male and female adults from Tana Toa village and Makassar city. Then for research subjects, namely 50 people/ groups,

namely modern and traditional groups. The inclusion criteria were age above 50 years old. Exclusion criteria were 1) having chronic gastrointestinal disease or chronic inflammation 2) having Diabetes Mellitus 3) having history of antibiotic consumption in the last 3 months 4) having history of prebiotic/probiotic consumption 5) having income < Rp. 3,400,000 6) rarely (<1x/week) consumes UPF (ultra process food).

Data collection: The traditional group are people whose daily lives are still influenced by customs which are still not influenced by modern lifestyles (Tana Toa village). Modern group are people whose daily lives have been influenced by modern lifestyles where their lives are influenced and depend on technological (Makassar city). Each subject participating in the study recorded personal information such as name, age, gender, address, phone number, number of family members, occupation, monthly income, and consent to participate in the study. Nutritional status is measured through weight and height to calculate the Body Mass Index (BMI) and through waist circumference. Body weight was measured with a TANITA BC 730 on a flat surface, recorded to the nearest 0.01 kg, and averaged over two measurements. Height was measured with a SECA device with an accuracy of 0.1 cm without shoes and headwear. Abdominal circumference was measured midway between the lower border of the ribs and the crista iliaca with a tape measure attached to the skin at the end of expiration. Body composition measurements include muscle mass, fat mass, bone mass, and visceral fat were taken using the BIA (Bioelectrical Impedance Analysis) tool. Physical activity was measured using the IPAQ questionnaire, which measures adult physical activity in the past 7 days, including walking, moderate, and vigorous activity¹⁶.

Research Permission and Ethical Clearance: This study was conducted after reviewing and obtaining approval from the Health Research Ethics Committee of the Faculty of Medicine, Hasanuddin University with ethical number No.688/UN4.6.4.5.31/PP36/2021. While medical action was carried out by first briefly explaining the background, objectives, and benefits of the study to the subject. The subject then signed the informed consent form that had been provided.

Data processing and analysis: The collected data were organized by purpose and type, and then analyzed using appropriate statistical methods with the help of SPSS software version 26 (IBM Corp., 2019). Univariate analyses were used to describe basic data characteristics through frequency distributions presented in tables and graphs. Bivariate analyses were conducted using various approaches. The T-Test was used for normally distributed data, while Mann-Whitney test was chosen if the data were not normally distributed. To compare two or more groups on classified data, Chi-square test was used. The relationship between dependent and independent variables was analyzed by Spearman Test. Hypothesis test-

ing decisions were made based on p values: results were not significant if p-value >0.05, significant if p-value ≤0.05, and highly significant if p-value <0.001.

RESULTS

This study evaluated the effect of physical activity on nutritional status and body composition in traditional and modern populations in South Sulawesi. Of 80 traditional group in Tana Toa village, 54 met the inclusion criteria, and 50 were tested with the anthropometric measurement, BIA examination and physical activity measurement (IPAQ). In the mod-

ern group in Makassar city, out of 445 people, 310 met the inclusion criteria, and 50 people continuing with anthropometric measurement, BIA examination and physical activity measurement (IPAQ) after exclusion due to factors such as antibiotic use, DM disease, or refusal to be involved in the study (Figure 1).

Characteristics of Research Subjects

The study consisted of 100 men and women, aged over 50 years, divided into 50 people of Tana Toa village who belong to the traditional group and 50 people of Makassar city

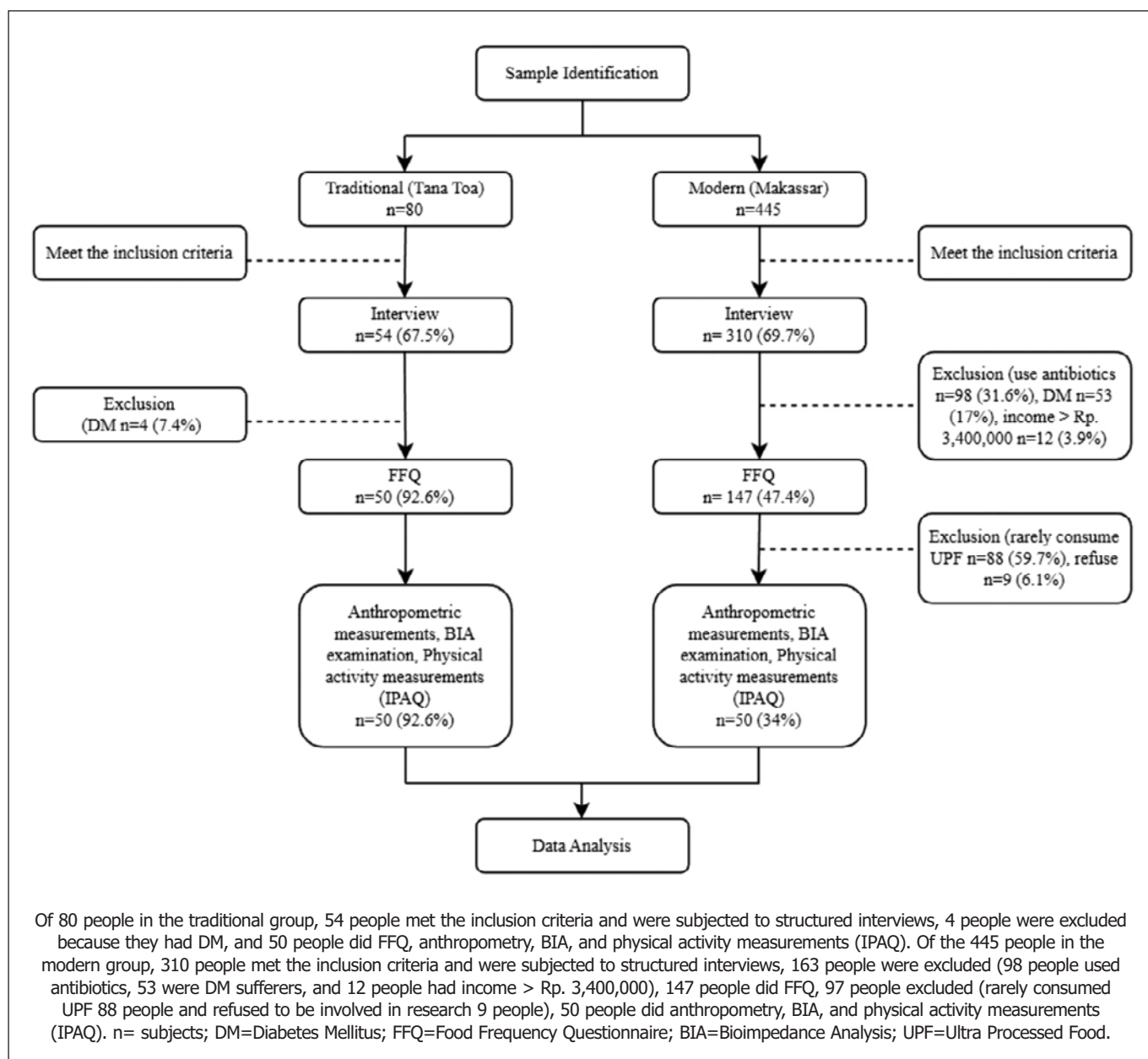


Figure 1. Flow chart of the study

who belong to the modern group. The general characteristics of the subjects in both groups are shown in Table 1.

There was no significant difference in age and gender between the traditional and modern groups. In the traditional group, the median age was 59.5 years and in the modern group, the median age was 56.5 years. The gender in both groups was mostly female.

Table 1 shows that the traditional group in this study are the Kajang who do not use electronics or modern transport. The modern group, consisting of 12% Bugis and 88% Makassar, has adopted an urban lifestyle. All members of the traditional group do not attend school, while the modern group has a variety of education. The income of the traditional group is below Rp. 2,500,000, while 82% of the modern group is also in this range. Most members of both groups are housewives or unemployed. The traditional group had 16% farmers, while the modern group had 12% traders and 14% workers in other sectors. The prevalence of hypertension was higher in the modern group (36%) compared to the traditional group (16%).

Differences in Physical Activity between Traditional and Modern Populations

Differences in physical activity in traditional and modern communities using the IPAQ questionnaire are shown in Table 2. Based on statistical analysis in the table above, the average type of physical activity in the traditional group is moderate activity, namely 56%, while in the modern group is light activity, namely 58%. The difference in physical activity between traditional and modern groups is significantly different based on Chi square test (p-value <0.001). This shows that physical activity in the modern group is lighter than the traditional group.

Table 2. Differences in Physical Activity in Traditional and Modern Groups

Group	Physical Activity			p-value
	Light	Medium	Weight	
Traditional	10	28	12	<0.001**
(n=50)	20%	56%	24%	
Modern	29	19	2	
(n = 50)	58%	38%	4%	

n = number of subjects, Chi-square test; * p ≤ 0.05; ** p < 0.001.

Differences in Nutritional Status and Body Composition between Traditional and Modern Populations

The differences in nutritional status and body composition between the traditional and modern groups are shown in Table 3.

Table 1. Characteristics of Research Subjects

Characteristics	Traditional	Modern	p-value
	(n = 50)	(n = 50)	
Age	59.5 (50, 90)	56.5 (50,68)	0.261 ^a
Gender			0.263 ^b
Male	10 (20%)	5 (10%)	
Women	40	45 (90%)	
Ethnic			< 0.001 ^b
Kajang	50 (100%)	0	
Bugis	0	6 (12%)	
Makassar	0	44 (88%)	
Education			< 0.001 ^b
No	50 (100%)	3 (6%)	
Elementary /Junior High School	0	31 (62%)	
High School	0	12 (24%)	
Bachelor	0	4 (8%)	
Income			0.003 ^b
IDR 2,500,000, - up to	0 0%	9 (18%)	
IDR 3,400,000, -			
< Rp.2,500,000	50 (100%)	41 (82%)	
Employment			< 0.001 ^b
Farmers	8 (16%)	0	
Traders	1 (2%)	6 (12%)	
Others	0	7 (14%)	
Not employment / housewife	41 (82%)	37 (74%)	
Disease History			0.040 ^b
None	42 (84%)	32 (64%)	
Hypertension	8 (16%)	18 (36%)	

n = number of subjects; Median (minimum, maximum); ^a Mann-Whitney test; ^b Chi-square test.

Table 3. Differences in Nutritional Status and Body Composition in Traditional and Modern Population

	Traditional	Modern	p-value
	(n=50)	(n=50)	
Height (cm)	149.48 ± 7.33	151.84 ± 5.73	0.076 ^a
Weight (kg)	49.6 ± 12.08	59.97 ± 10.19	<0.001 ^{a**}
Body Mass Index (kg/m) ²	22.22 ± 5.12	26.02 ± 4.3	<0.001 ^{a**}
Abdominal Circumference (cm)	76 (61, 106)	98.5 (70, 112.5)	<0.001 ^{b**}
Muscle Mass (%)	67.25 (33.3, 89.8)	58.9 (48.6, 89.2)	<0.001 ^{b**}
Bone Mass (kg)	1.9 (0.9, 2.9)	2.2 (1.2, 2.7)	<0.001 ^{b**}
Fat Mass (%)	29.4 (5, 48.3)	37.8 (5.9, 48.3)	<0.001 ^{b**}
Visceral Fat	6.45 ± 3.5	8.16 ± 2.81	0.008 ^{a*}

n = number of subjects; Mean ± SD; median (minimum, maximum);
^a Independent t test; ^b Mann-Whitney test;
 * p ≤ 0.05; ** p < 0.001.

Based on table 3, it is known that there are significant differences between the traditional and modern groups in all variables except height, based on independent t tests found no significant difference with p-value >0.05. The modern group had higher weight, body mass index (BMI), waist circumference, bone mass, fat mass, and visceral fat than the traditional group, but lower percentage of muscle mass.

Relationship between Physical Activity and Nutritional Status with Body Composition of Traditional and Modern Populations

Based on Chi Square test in Table 4 found that BMI has a significant relationship with physical activity. Of the 44 subjects with under-normal, 52.3% had moderate physical activity, while of the 56 subjects with overweight-obese, 55.4% had light physical activity (p-value <0.001). In terms of waist circumference, 53.7% of the 41 subjects with normal size had moderate physical activity, while 54.2% of the 59 subjects with central obesity had light physical activity (p-value <0.001). In terms of muscle mass, 61.2% of 49 subjects with low muscle mass performed light physical activity, while 56.9% of 51 subjects with normal muscle mass performed moderate physical activity (p-value <0.001). However, the relationship between physical activity and bone mass was not significant. Of the 88 subjects with low bone mass, 50% performed moderate physical activity, while 66.7% of the 12 sub-

Table 4. Relationship between Physical Activity and Body Composition in Traditional and Modern Populations

Physical Activity	Body Mass Index		p-value	Waist Circumference		p-value	Muscle Mass		p-value	Bone Mass		p-value	Fat Mass		p-value	Visceral Fat		p-value
	Underweigh Normal	Overweight Obese		Normal	Central Obesity		Low	Normal		Low	Normal		Normal	High		Normal	High	
	(n=44)	(n=56)		(n=41)	(n=59)		(n=49)	(n=51)		(n=88)	(n=12)		(n=48)	(n=52)		(n=71)	(n=29)	
Low	8	31	<0.001**	7	32	<0.001**	30	9	<0.001**	31	8	0.111	6	33	<0.001**	21	18	0.006*
	18,2%	55,4%		17.1%	54.2%		61.2%	17.6%		35.2%	66.7%		12.5%	63.5%		29.6%	62.1%	
Moderate	23	24		22	25		18	29		44	3		29	18		37	10	
	52,3%	42,9%		53.7%	42.4%		36.7%	56.9%		50.0%	25.0%		60.4%	34.6%		52.1%	34.5%	
High	13	1		12	2		1	13		13	1		13	1		13	1	
	29,5%	1,8%		29.3%	3.4%		2.0%	25.5%		14.8%	8.3%		27.1%	1.9%		18.3%	3.4%	

n = number of subjects, Chi-square test; * p ≤ 0.05; ** p < 0.001.

Physical Activity	Body Mass Index		Waist Circumference		Muscle Mass		Fat Mass		Bone Mass		Visceral Fat	
	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value
	-0.298	0.003*	-0.403	<0.001**	0,356	<0.001**	-0.425	<0.001**	-0.074	0.464	-0.335	0.001*

Spearman test; * p ≤ 0.05; ** p < 0.001.

jects with normal bone mass performed light physical activity (p-value 0.111).

Based on Spearman test in Table 4 found that BMI, waist circumference, fat mass and visceral fat had a negative correlation with physical activity. Subjects with overweight-obese BMI tended to be less active ($r = -0.298$, $p = 0.003$), subjects with central obesity, high fat mass and high visceral fat performed more low activities: ($r = -0.403$, $p < 0.001$) ($r = -0.425$, $p < 0.001$), ($r = -0.335$, $p = 0.001$). Muscle mass had a positive correlation with physical activity where subjects with normal muscle mass were more active ($r = 0.356$, $p < 0.001$). However, the relationship between physical activity and bone mass was not significant ($p = 0.111$).

DISCUSSION

Differences in Physical Activity between Traditional and Modern Populations

This study found differences in physical activity between traditional and modern populations based on IPAQ. The traditional group on average had moderate activity compared to the modern group who on average had light physical activity with chi-square test and p-value < 0.001 . Some subjects in the traditional group have farmer/gardener jobs as one of their main livelihoods in Tana Toa village and on average have gardens around their homes so that those who do not have jobs or housewives also do daily gardening activities, where farming and gardening is one of the moderate activities with workloads such as hoeing, carrying or transporting crops or garden products, irrigating fields and cutting trees or plants. Meanwhile, the modern group on average has light activities due to changes in lifestyle or lifestyle with the development of technology (use of gadgets and watching television) and electronic goods (washing machines and electric stoves) as well as ease of transportation such as cars and motorbikes in supporting work and daily activities which causes them to tend to be lazy to do physical activity.

The lifestyle of the people of Makassar city is increasingly developing following the changing times that refer to modernisation has brought negative consequences that cause changes in lifestyle. These lifestyle changes are accelerated by the strong flow of foreign culture (westernization) due to advances in information technology and economic globalisation. Sedentary lifestyles and the development of technology and electronics are the cause of reduced physical activity resulting in a decrease in energy output resulting in changes in body composition¹⁷.

Prior to the 1970s, the Kajang indigenous community had not been exposed to formal education or schooling. The choice was more emphasized on the assumption that: formal education was not necessary, because the land owned by the community was still relatively large and the laborers were still few. Therefore, their daily needs can still be met, and nature

still provides for the community's daily needs. Economic factors are a very important factor in physical activity, where an increase in income increases the ability of the community to buy electronic goods to support the ease and efficiency of time in carrying out daily activities¹⁸.

The modern group suffered more obesity than the traditional group. A person with obesity tends to have a higher risk of developing hypertension. Physical activity performed by the traditional group and the modern group is related to the type of work they do every day. In the traditional group, about 16% have farming jobs and almost all the residents have gardens around their homes, so that even though they do not have jobs, they do garden activities where farmers and gardening based on the type of physical activity are moderate to heavy physical activities. In addition, household physical activities carried out by traditional groups such as sweeping, washing, cooking, and mopping are included in moderate activities. In contrast to modern groups where the household physical activities they do are assisted by electronic goods¹⁹.

This study found significant differences in nutritional status and body composition between the traditional and modern groups. The modern group had higher body weight, body mass index, waist circumference, muscle mass, fat mass and visceral fat compared to the traditional group, while the percentage of bone mass was lower than the traditional group. This is related to the living environment, primary economic sector and local facilities and technology²⁰. In daily life, modern and traditional groups have different activities in work, transport, and leisure activities. The differences in each person's activities involve differences in the type and intensity of physical activity¹⁷.

The Relationship of Physical Activity with Nutritional Status and Body Composition

In this study, it was found that there was a significant relationship between physical activity and BMI and the negative correlation value showed that the higher a person's physical activity, the better their nutritional status, where nutritional status is determined by BMI. These results are in line with the results of a recent study by *Kusumaningati, (2023)* which showed a significant relationship between physical activity and nutritional status in education administration employees at UPN "Veteran" Jakarta²¹. In addition, *Tesfaye et al (2020)* concluded that there is an association between low physical activity and central obesity. Adults who are physically inactive are more likely to be centrally obese than those who are physically active²². Physical activity can burn more calories and increase the body's metabolism. Conversely, low activity will cause the body's metabolism to decrease which can result in the risk of obesity. However, this contradicts research conducted by *Kostecka et al (2021)* who found that higher levels of physical activity did not always correlate with lower BMI scores²³.

In this study, it was found that there was a very significant relationship between physical activity and waist circumference and the negative correlation value showed that the lower a person's physical activity, the smaller the waist circumference so that the risk of obesity. This is in line with research which states that there is a significant relationship between physical activity level and waist circumference, where subjects with waist circumference >80cm in women and >90cm in men, are at greater risk of being at a low activity level. It was also mentioned that moderate and high activity levels have the potential to reduce cardiovascular risk based on waist circumference, but not low physical activity level

Physical activity can reduce waist circumference because it is closely related to a decrease in body fat percentage, especially visceral fat. In addition to playing a role in energy balance, physical activity can also reduce total cholesterol and triglyceride levels in the blood²⁴. Likewise, research conducted by *Kuriyan et al (2012)* found that excessive and high-calorie food intake, as well as decreased activity increased waist circumference²⁵. This is related to the living environment, primary economic sector and local facilities and technology²⁰. In daily life, modern and traditional groups have different activities in work, transport, and leisure activities. The differences in each person's activities involve differences in the type and intensity of physical activity¹⁷.

In this study, it was found that there was a significant relationship between physical activity and muscle mass and a positive correlation value indicating that the lower a person's physical activity, the lower his muscle mass. This is in line with research conducted by *Nishiguchi et al (2014)* which found that physical activity has a decreasing effect on muscle mass²⁶.

In this study, it was found that there was a significant relationship between physical activity and fat mass and the negative correlation value showed that the higher a person's physical activity, the lower of fat mass. This is in line with research that says light physical activity will facilitate the accumulation of body fat. The process of fat accumulation around the body is slow, long and often unconscious. People with obesity show less activity due to greater body weight, where they do more light activities²⁷.

In this study, it was found that there was no significant relationship between physical activity and bone mass. This is in line with research conducted by *Hermastuti, et al (2012)* which found that physical activity did not show a meaningful relationship with bone density²⁸. However, this is not in line with research conducted by *Hasanudin (2018)* which found that there is a relationship between physical activity and bone density in forming bone mass where physical activities such as walking and riding a bicycle have the effect of protecting bones and reducing bone demineralisation due to age²⁹.

In this study, it was found that there was a significant relationship between physical activity and visceral fat and the

negative correlation value showed that the lower a person's physical activity, the higher of visceral fat. Physical activity is any body movement that requires energy that varies according to the level of intensity and duration of physical activity. Strenuous physical activity will directly use energy derived from body fat reserves that were previously converted into energy. This will reduce fat stores in the subcutaneous and other fatty tissues³⁰.

CONCLUSION

Traditional and modern groups have different levels of physical activity. Physical activity is related to nutritional status and body composition. The modern group had light physical activity with a higher body mass index, waist circumference, fat mass and visceral fat as well as lower muscle mass, compared to the traditional group that had moderate physical activity with higher muscle mass.

RESEARCH LIMITATIONS

This study has several limitations, namely the use of a questionnaire that requires physical activity data 1 (one) week earlier, so there is a possibility of bias in remembering physical activity with its intensity, besides that subjects only often remember what activities are most often done but do not remember other activities that expend energy before.

REFERENCES

1. Sharif S, Sharif H, Rehman J, Fatima Z. Is a sedentary lifestyle a leading causal factor of obesity and distress in type 2 diabetes? A cross-sectional study in low-socioeconomic areas of Karachi, Pakistan. *BMJ Public Heal.* 2023;1(1):e000149.
2. Lavie CJ, Ozemek C, Carbone S, Katzmarzyk PT, Blair SN. Sedentary Behavior, Exercise, and Cardiovascular Health. *Circ Res.* 2019;124(5):799–815.
3. Popkin BM, Ng SW. The nutrition transition to a stage of high obesity and noncommunicable disease prevalence dominated by ultra-processed foods is not inevitable. *Obes Rev.* 2022;23(1):1–18.
4. Dai J, Menhas R. Sustainable development goals, sports and physical activity: The localization of health-related sustainable development goals through sports in China: A narrative review. *Risk Manag Healthc Policy.* 2020;13:1419–30.
5. Pinckard K, Baskin KK, Stanford KI. Effects of Exercise to Improve Cardiovascular Health. *Front Cardiovasc Med.* 2019;6(June):1–12.
6. Ekkekakis P, Vazou S, Bixby WR, Georgiadis E. The mysterious case of the public health guideline that is (almost) entirely ignored: Call for a research agenda on the causes of the extreme avoidance of physical activity in obesity. *Obes Rev.* 2016;17(4):313–29.
7. Elagizi A. A Review of Obesity, Physical Activity, and Cardiovascular Disease American College of Cardiology. *Curr Obes Rep.* 2020;9(4):571–81.

8. Ministry of Health Republic Indonesia. Indonesia Basic health research (Riskesmas) 2013 [Internet]. 2013. 1 p. Available from: http://www.dof.gov.my/en/c/document_library/get_file?uuid=e25cce1e-4767-4acd-afdf-67cb926cf3c5&groupId=558715
9. Ministry of Health Republic Indonesia. Indonesia Basic health research (Riskesmas) 2018 [Internet]. Agency of Health Research and Development (Indonesia). 2018. 198 p. Available from: http://labdata.litbang.kemkes.go.id/images/download/laporan/RKD/2018/Laporan_Nasional_RKD2018_FINAL.pdf
10. Fox A, Feng W, Asal V. What is driving global obesity trends? Globalization or "modernization"? *Global Health*. 2019;15(1):1–16.
11. Gaetano A. Relationship between physical inactivity and effects on individual health status. *J Phys Educ Sport*. 2016;16(2):1069–74.
12. Wu XY, Zhuang LH, Li W, Guo HW, Zhang JH, Zhao YK, et al. The influence of diet quality and dietary behavior on health-related quality of life in the general population of children and adolescents: a systematic review and meta-analysis. *Qual Life Res*. 2019;28(8):1989–2015.
13. Marquez DX, Aguinãga S, Vásquez PM, Conroy DE, Erickson KI, Hillman C, et al. A systematic review of physical activity and quality of life and well-being. *Transl Behav Med*. 2020;10(5):1098–109.
14. Fletcher GF, Landolfo C, Niebauer J, Ozemek C, Arena R, Lavie CJ. Promoting Physical Activity and Exercise: JACC Health Promotion Series. *J Am Coll Cardiol*. 2018;72(14):1622–39.
15. Breda J, Jakovljevic J, Rathmes G, Mendes R, Fontaine O, Hollmann S, et al. Promoting health-enhancing physical activity in Europe: Current state of surveillance, policy development and implementation. *Health Policy (New York)*. 2018;122(5):519–27.
16. International Physical Activity Questionnaire. LONG LAST 7 DAYS SELF-c. 2002;71(October). Available from: www.ipaq.ki.se
17. Sudikno, Syarief H, Meti Dwiriani C, Riyadi H. Risk Factors of Overweight and Obese in Indonesian Adults (Analysis Data of Basic Health Research 2013). *Gizi Indones* [Internet]. 2015;38(2):91–104. Available from: <http://ejournal.persagi.org/go/>
18. Alamsyah Agit, Hasmawati, Sahurri, Sari Yunus, Fitriyani Syukri. Peran Dan Kontribusi Teknologi Dalam Menunjang Potensi Ekonomi Masyarakat Di Wilayah Pedesaan. *Semin Nas Pariwisata dan Kewirausahaan*. 2023;2:263–71.
19. Oktovin O, Unja EE, Chrisnawati C. Implementation of Community Service Program "Control Obesity, Optimize Physical Activity" for People with Hypertension in South Kalimantan. *J Pengabd Masy Indones*. 2024;4(1):149–57.
20. Onge JM, Krueger PM. Education and Racial-Ethnic Differences in Types of Exercise in the United States. *J Health Soc Behav*. 2011;52(2):197–211.
21. Kusumaningati W, Indraaryani SA I, Yunieswati W. Aktivitas Fisik dan Status Gizi pada Tenaga Kependidikan Fakultas Kedokteran dan Kesehatan Universitas Muhammadiyah Jakarta. *J Gizi Kerja dan Produkt*. 2023;4(1):1.
22. Tesfaye TS, Zeleke TM, Alemu W, Argaw D, Bedane TK. Dietary diversity and physical activity as risk factors of abdominal obesity among adults in Dilla town, Ethiopia. *PLoS One* [Internet]. 2020;15(7 July):1–11. Available from: <http://dx.doi.org/10.1371/journal.pone.0236671>
23. Kostecka M, Bojanowska M, Kostecka J, Ciołek A. Analysis of Dietary Patterns and Body Composition Parameters in the Polish Population. *Rocz Panstw Zakl Hig / Ann Natl Inst Hyg*. 2021;72(1):55–66.
24. Sulistyorini L. *Jurnal Keperawatan Soedirman (The Soedirman Journal of Nursing)*, Volume 9, No.1. Perbedaan Prestasi Belajar Anak Obesitas Dan Tidak Obesitas Di Sekol Dasar Kabupaten Jember. 2014;9(1):38–44.
25. Kuriyan R, Thomas T, Sumithra S, Lokesh DP, Sheth NR, Joy R, et al. Potential factors related to waist circumference in urban south Indian children. *Indian Pediatr*. 2012;49(2):124–8.
26. Nishiguchi S, Yamada M, Kajiwara Y, Sonoda T, Yoshimura K, Kayama H, et al. Effect of physical activity at midlife on skeletal muscle mass in old age in community-dwelling older women: A cross-sectional study. *J Clin Gerontol Geriatr* [Internet]. 2014;5(1):18–22. Available from: <http://dx.doi.org/10.1016/j.jcgg.2013.09.002>
27. Suryana S, Fitri Y. Hubungan Aktivitas Fisik dengan IMT dan Komposisi Lemak Tubuh. *AcTion Aceh Nutr J*. 2017;2(2):114.
28. Hermastuti A, Isnawati M. Hubungan Indeks Massa Tubuh, Massa Lemak Tubuh, Asupan Kalsium, Aktivitas Fisik Dan Kepadatan Tulang Pada Wanita Dewasa Muda. *J Nutr Coll*. 2012;1(1):63–71.
29. Hasanudin, Adriyani VM, Perwiraningtyas P. Hubungan Aktivitas Fisik Dengan Tekanan Darah Pada Masyarakat Penderita Hipertensi Di Wilayah Tlogosuryo Kelurahan Tlogomas Kecamatan Lowokwaru Kota Malang. *J Nurs News*. 2018;3(1):787–99.
30. Kurniasanti P. Hubungan Asupan Energi, Lemak, Serat, dan Aktivitas Fisik dengan Visceral Fat Pada Pegawai Uin Walisongo Semarang. *Nutr J Gizi, Pangan dan Apl*. 2020;4(2):139–52.

Relationship between nutritional intake and the duration of mechanical ventilation use in critical patients

Yunita Lidya ISTIQOMAH¹, Agussalim BUKHARI², Suryani AS'AD^{2,3}, Nurpudji A. TASLIM², Yasmin SYAUKI², Haerani RASYID², Tien Muliawati ABADI¹, HUSMIANI¹, JEFFERY¹, Desi Vera BUANA¹

1 Department of Nutrition, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

2 Clinical Nutrition Specialist Program, Department of Nutrition, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

3 Faculty of Medicine, Muhammadiyah University, Makassar, South Sulawesi, Indonesia.

Recibido: 8/mayo/2024. Aceptado: 27/junio/2024.

ABSTRACT

Introduction: The incidence of malnutrition among critically ill patients undergoing treatment in intensive care unit (ICU) ranges from 30-50%. This malnutrition is primarily attributed to hypercatabolism and hypermetabolism, leading to significant reductions in energy and protein levels. Muscle atrophy, particularly in the diaphragm, exacerbates respiratory muscle fatigue, making breathing difficult and necessitating prolonged mechanical ventilation. This prolonged ventilation often leads to complications such as infections, delayed recovery, and extended hospital stays.

Objectives: This study aims to examine the relationship between energy, protein, carbohydrate, and fat intake and the duration of mechanical ventilation in patients receiving collaborative clinical nutrition (first group) versus non-collaborative clinical nutrition (second group) at the Wahidin Sudirohusodo Hospital from 2020 to 2022.

Methods: This retrospective cohort study employed an analytical observational approach and was conducted at the Medical Records section of Wahidin Sudirohusodo Hospital in Makassar. The study included 37 patients who had been on mechanical ventilation for ≥ 8 days and received enteral and parenteral nutrition. The patients were divided into two groups: one receiving collaborative clinical nutrition and the other receiving only enteral nutrition. Data collection involved 24-hour food recall recording, blood tests for routine

parameters, and assessment of the duration of mechanical ventilation.

Results: The study found significant differences in nutritional intake between the collaborative clinical nutrition (first group) and the non-collaborative clinical nutrition (second group). The collaborative group had higher mean energy (first group 1199.70 vs. second group 848.73), protein (first group 22.38 vs. second group 17.29), and fat (first group 22.62 vs. second group 15.31) intake, while carbohydrate intake was lower in the first group (55.30 vs. second group 63.86). These differences were statistically significant with a p-value < 0.05 . This study also found a correlation between nutritional intake and duration of mechanical ventilation use. There was a negative correlation between energy, protein and fat intake while carbohydrate intake had a positive correlation.

Conclusions: The study concludes that the collaborative clinical nutrition (first group) had higher nutritional intake compared to the non-collaborative (second group). The First group exhibited higher energy, protein, and fat intake. Nutritional intake also had a significant influence on mechanical ventilation (per day). The lower the energy, protein, and fat intake, while the carbohydrate intake increased, the longer the use of mechanical ventilation.

KEYWORDS

Long-term ventilation, enteral nutrition, parenteral nutrition.

INTRODUCTION

Patients who are critically ill suffer from severe illnesses that cause dysfunction of vital organs and pose an imminent risk of death in the absence of immediate intervention. However, such conditions may be potentially reversible. Critical illness often in-

Correspondencia:

Yunita Lidya Istiqomah
yunitalidya26istiqomah@gmail.com

volves hypercatabolism induced by stress hormones and inflammatory cytokines, with hormones such as glucagon, cortisol, and catecholamines rapidly breaking down macronutrients to meet elevated energy demands. This process is further compounded by a number of factors, including prolonged immobilization, nosocomial infections, sedation, and the use of muscle relaxants, which collectively increase protein catabolism. Consequently, inadequate nutritional intake combined with heightened metabolic demands can result in malnutrition in these patients^{1,2}.

The incidence of malnutrition among critical patients undergoing treatment in intensive care unit (ICU) ranges from 30-50%³. These patients often experience respiratory failure or circulatory dysfunction, triggering hypermetabolic and hypercatabolic responses and exacerbating malnutrition. Hypercatabolism and hypermetabolism significantly reduce energy and protein levels, particularly in muscle tissues such as the diaphragm, leading to muscle atrophy and respiratory muscle fatigue, thereby complicating breathing and necessitating prolonged mechanical ventilation. Continuously, this can lead to complications such as infections, delayed recovery, and extended hospitalization.

Research by Koontalay (2021) demonstrated that nutritional status, timing of initial enteral administration, and target calorie requirements were statistically associated with the duration of mechanical ventilation. This highlights the importance of assessing nutritional status in critical patients. Regular monitoring of daily target calorie requirements for patients receiving enteral nutrition (EN) every 7 days can facilitate the implementation of appropriate nutritional strategies to reduce mechanical ventilation duration in the ICU. Nutritional support based on guidelines can effectively shorten mechanical ventilation duration by providing tailored nutritional care, assessing nutritional status, and optimizing enteral nutrition promptly after hemodynamic stabilization or as soon as possible⁴.

A study by Sutrisnawati (2021) using a cross-sectional approach found that Nutric score correlated with the duration of mechanical ventilation in the ICU. Adequate energy and protein intake were significantly negatively correlated with mechanical ventilation duration. Prolonged mechanical ventilation serves as an outcome measure for evaluating ICU care quality. Malnutrition among ICU patients increases morbidity, mortality, costs, and mechanical ventilation duration⁵.

Factors contributing to prolonged mechanical ventilation include underlying diseases, poor nutritional status, electrolyte imbalances such as hypokalemia, hypomagnesemia, and hypophosphatemia, age-related factors, drug side effects, and ICU-acquired weakness⁶.

This research contributes to the understanding of the relationship between energy intake and mechanical ventilation duration in intensive care settings. Providing appropriate energy support to critical patients can help prevent catabolic states, promote gluconeogenesis, facilitate glycemic control, and enhance successful weaning from mechanical ventilation.

LITERATURE REVIEW

Metabolic Response of Critical Patients

The metabolic response to stress in critically ill patients represents an essential adaptive mechanism for survival. This response encompasses various mechanisms that have persisted throughout evolution. These include the stimulation of sympathetic nerves, secretion of pituitary hormones, peripheral resistance to stress, and modulation of metabolic factors to enhance the availability of energy substrates to vital tissues. Consequently, there are alterations in energy production pathways and utilization of alternative substrates due to a loss of control over energy substrate utilization. Clinical manifestations of the metabolic stress response include changes in energy delivery, stress-induced hyperglycemia, alterations in body composition, and psychological and behavioral disturbances. Notably, the loss of muscle protein and its functionality is a significant consequence of metabolic stress.

Specific therapeutic interventions, such as hormone supplementation, increased protein intake, and early mobilization, are currently under investigation for their efficacy in mitigating the adverse effects of metabolic stress³.

The metabolic response to stress involves both neuroendocrine and inflammatory/immune components. Additionally, hormones released from adipose tissue and the digestive tract play pivotal roles in mediating metabolic responses. The neuroendocrine component of the response initiates stimulation in areas proximal to the hypothalamus, including the paraventricular nucleus and locus coeruleus. Upon detection of stress signals and transmission to the central nervous system, a prototypical response ensues, leading to activation of the sympathetic nervous system, the hypothalamic-pituitary axis, and subsequent alterations in inflammatory, immune, and behavioral responses

Factors Influencing the Use of Mechanical Ventilation

In the ICU, mechanical ventilation serves as a lifesaving breathing aid. The weaning process refers to the transition from full ventilation to successful extubation following the first spontaneous breathing trial (SBT). Typically, most ventilation management (VM) deployments conclude within a week. Successful weaning hinges upon the strength of respiratory muscles and respiratory drive⁷. Failure to wean indicates respiratory failure stemming from various contributing factors. Patients requiring mechanical ventilation for over two weeks face a 30% in-hospital mortality rate and a 60% mortality rate within one year⁷.

Prolonged mechanical ventilation in critically ill patients can lead to complications such as leg muscle atrophy, diminished functional capacity, and diaphragm dysfunction. Reduced basal pulmonary respiratory pressure levels contribute to respiratory failure. Brainstem lesions may disrupt both upper and

lower respiratory functions, leading to abnormal breathing patterns, hypoventilation, respiratory acidosis, and consequently, prolonged mechanical ventilation⁸.

Complications of Mechanical Ventilation

Ventilation using high tidal volumes can elevate vascular filtration pressure, leading to damage to endothelial capillaries, epithelium, and basement membrane, ultimately resulting in lung rupture. Mechanical trauma induces leakage of fluid, protein, and blood into tissue and air spaces, or in some cases, air leakage into tissue spaces. These pathological events trigger an inflammatory response, potentially compromising the body's defense against infection. Elevated peak inspiratory volume and pressure, along with high mean airway pressure, serve as predisposing factors for lung injury⁹.

In patients with Acute Respiratory Distress Syndrome (ARDS) of severe degree (P/F ratio ≤ 200 mmHg), Fan et al. recommend treatment in a prone position for a minimum of 12 hours daily. The prone position is believed to enhance ventilation by increasing lung perfusion, expanding end-expiratory lung volume, and promoting more uniform distribution of tidal volume throughout the lung. However, it is important to note that the prone position may also elevate the risk of endotracheal tube displacement¹⁰.

Mechanical ventilation weaning involves gradually reducing the level of mechanical ventilation support, allowing the patient to assume a greater proportion of their ventilation. This can be achieved through attempts at spontaneous breathing or a gradual reduction in mechanical ventilation support¹¹.

Nutritional Status

No specific nutrition scoring system tailored for ICU patients has been validated to date. Existing nutritional screening tools like NRS 2002 and the Malnutrition Universal Screening Tool (MUST) were not specifically designed for critically ill patients. Recently, a new risk assessment tool called NUTRIC has been proposed, which considers factors such as age, disease severity assessed by APACHE II and Sequential Organ Failure Assessment (SOFA) scores, comorbidities, duration from hospital to ICU admission, and presence of inflammation as indicated by interleukin-6 levels. The composite NUTRIC score has shown correlation with mortality, and there's evidence suggesting that nutritional intervention may reduce mortality in patients with a high NUTRIC score (>5)¹².

Nutritional therapy plays a crucial role in managing critical illness by mitigating the metabolic response to stress, preventing oxidative cellular damage, and modulating the immune response. Strategies for nutritional modulation of the stress response include early initiation of enteral nutrition, provision of appropriate macro- and micronutrients, and meticulous glycemic control¹³.

However, it's essential to avoid overfeeding, as it can have adverse effects. Excessive nutrient intake can exacerbate respiratory failure by increasing carbon dioxide production. A surplus of calories (rather than an excess of carbohydrates specifically) leads to increased CO₂ production and, consequently, heightened respiratory workload. Indirect calorimetry is a valuable tool for accurately assessing energy requirements and identifying cases of underfeeding or overfeeding¹³.

The Relationship between Malnutrition and Respiratory Disorders

Patients experiencing acute or chronic respiratory failure are susceptible to, or may already present with, nutrition-related complications. Nutritional support plays a crucial role in their treatment, as further deterioration can directly impact respiratory function, leading to worsened outcomes. Specific nutritional guidelines exist for the management and treatment of both acute and chronic respiratory failure¹³.

Critical patients suffering from respiratory system failure or circulatory dysfunction often experience hypermetabolic and hypercatabolic reactions, leading to malnutrition. This is characterized by significant reductions in energy and protein levels, particularly due to muscle wasting, including the diaphragm, which can result in muscle atrophy and respiratory muscle fatigue. These complications contribute to prolonged mechanical ventilation, increasing the risk of infections, delayed recovery, and extended hospitalization^{2,4,14,15}.

Implementing low-carbohydrate, high-fat nutritional therapy can mitigate exogenous glucose loads, enhance glycemic control, reduce inflammation, and improve clinical outcomes, including respiratory function. Administering such therapy to critical patients has the potential to alleviate hyperglycemia, enhance ventilation, and shorten hospital stays¹⁶. Lowering carbohydrate intake can decrease insulin levels, a pivotal hormone involved in promoting anabolic states and fat storage, thereby improving cardiometabolic function and facilitating weight loss¹⁷.

MATERIAL AND METHODS

Study design and participation: This study was conducted at Wahidin Sudirohusodo Hospital, Makassar in September 2023 – February 2024. This study design is a retrospective cohort with an analytical observational approach in critical patients using mechanical ventilation who were hospitalized in the Intensive Care Unit (ICU) of Wahidin Sudirohusodo Hospital.

The research sample comprised all critical patients undergoing mechanical ventilation treatment in the ICU at Wahidin Sudirohusodo Hospital from January 2020 to December 2022, who met the inclusion criteria. Out of 551 ICU patients meeting the inclusion criteria, 37 patients underwent mechanical ventilation for ≥ 8 days. A total of 514 patients were excluded, including 19 pediatric patients, 357 deceased patients, and 47 patients who could not be assessed for the

mNutric score. Additionally, 24 patients were ventilated for less than 2 days, and 67 patients were ventilated for 2-7 days.

The research was divided into two groups: the first group comprised patients who collaborated with clinical nutrition and received nutritional therapy through both enteral and parenteral intake, while the second group consisted of patients who did not engage in clinical nutrition collaboration and received enteral nutrition only. Data collection involved recording 24-hour food intake, routine blood tests, electrolyte levels, total bilirubin, urea, creatinine, blood sugar, Glasgow Coma Scale (GCS), blood gas analysis, assessment, and calculation of the duration of mechanical ventilation in days.

The study's inclusion criteria encompass patients aged 18 years or older who are treated in the ICU and require mechanical ventilation for both medical and surgical reasons. Additionally, it includes patients in the ICU regardless of whether they are receiving clinical nutrition. Specifically, patients who have been using mechanical ventilation for 8 days or more are eligible.

On the other hand, the exclusion criteria rule out patients who have died, those with incomplete data, individuals younger than 18 years, patients with a mean arterial pressure (MAP) below 64, those with an average nutritional intake of zero, patients who have used mechanical ventilation for one day or less due to short weaning, and those with a Sequential Organ Failure Assessment (SOFA) score greater than 20, indicating a severe condition and signs of failure.

Research variables: In this study, there are nutritional variables as independent variables consisting of energy intake (kcal), protein intake (%), carbohydrate intake (%), and fat intake (%). Meanwhile, the dependent variable in this study was the duration of mechanical ventilation use (days).

Ethical consideration: This research has received approval from the Health Research Ethics Commission (HREC) of the Faculty of Medicine, Hasanuddin University.

Statistical analysis: The data obtained are collected according to the type of data, and then the appropriate statistical method is selected. Independent t-test and Mann-Whitney test were used to analyze the nutritional intake of both groups. To evaluate the correlation between the nutritional intake and the duration of the use of mechanical ventilation (per day), the Spearman correlation test was performed.

RESULTS

From the results of the research, as depicted in Table 1, shows the characteristics, two main groups emerged: the first (cooperative) group and the second (non-cooperative) group. There were 21 patients (56.8%) in the first group, compared to 16 patients (43.2%) in the second group, indicating a majority of patients in the study were cooperative.

Regarding gender distribution, 24 patients (64.9%) were males, while 13 patients (35.1%) were females, suggesting a

Table 1. Characteristics of Respondents Based on Category

Characteristics		n	%
Group	First	21	56.8
	Second	16	43.2
Gender	Man	24	64.9
	Woman	13	35.1
Age	18-60	30	81.1
	> 60	7	18.9
Education	No school - elementary school	10	27.0
	Middle School - High School	17	45.9
	Bachelor	10	27.0
Upper Arm Circumference	19 - 21.9	4	10.8
	22 - 23	2	5.4
	> 23	31	83.8
BMI	< 18.5	4	10.8
	18.5 - 22.9	15	40.5
	23 - 25	10	27.0
	25 - 29.9	7	18.9
	> 30	1	2.7
Diagnosis	Surgery	26	70.3
	Neurology	7	18.9
	Airway disease	4	10.8
Comorbid	0 - 1	32	86.5
	> 1	5	13.5
Vasopressors	Yes	29	78.4
	No	8	21.6
APACHE	< 15	14	37.8
	15 - 19	12	32.4
	20 - 28	11	29.7
SOFA	< 6	20	54.1
	6 - 9	15	40.5
	> 9	2	5.4
Amount		37	100.0

slight male predominance. In terms of age, the majority of patients (81.1%) fell between the ages of 18 and 60 years, with only 7 patients (18.9%) being aged above 60 years.

Education-wise, 10 patients (27.0%) had received no formal education or attended elementary school, 17 patients (45.9%) had completed middle to high school education, and 10 patients (27.0%) had higher education (college level or above).

Based on Upper Arm Circumference and BMI (Body Mass Index) parameters, the majority of patients had Upper Arm Circumference measurements exceeding 23 (83.8%), while the BMI ranged between 18.5 to 22.9 for 40.5% of patients.

The diagnoses recorded in the table indicated that the majority of patients (70.3%) were diagnosed with surgical issues, followed by neurology (18.9%) and respiratory tract diseases (10.8%).

Regarding the number of comorbidities, most patients (86.5%) had 0-1 comorbidities. Furthermore, 29 patients (78.4%) utilized vasopressors.

Based on the APACHE (Acute Physiology and Chronic Health Evaluation) and SOFA (Sequential Organ Failure Assessment) scores, the majority of APACHE scores fell within the range of 15-19 (32.4%), while most SOFA scores were below 6 (54.1%)

Table 2 illustrates the distribution of patients based on energy, protein, carbohydrate, and fat intake in specific studies or populations. For energy intake, it is noted that 20 patients (54.1%) had an intake of less than 1000 calories, while 17 patients (45.9%) had an intake exceeding 1000 calories. Regarding protein intake, 18 patients (48.6%) consumed less than 56 grams, whereas 19 patients (51.4%) consumed more than 56 grams. In terms of carbohydrate intake, 21 patients (56.8%) consumed less than 149.88 grams, and 16 patients (43.2%) consumed more than 149.88 grams. Lastly, for fat intake, 21 patients (56.8%) consumed less than 28.04 grams, while 16 patients (43.2%) consumed more than 28.04 grams, which is a notable finding

Table 2. Table of patient distribution based on energy, protein, carbohydrate and fat intake

Variables		n	%
Energy (kcal)	< 1000	20	54.1
	≥ 1000	17	45.9
Proteins (gr)	< 56	18	48.6
	≥ 56	19	51.4
Carbohydrate (gr)	< 149.88	21	56.8
	≥ 149.88	16	43.2
Fat (gr)	< 28.04	21	56.8
	≥ 28.04	16	43.2
Duration of mechanical ventilation (per day)	8-15	24	64,9
	> 15	13	35,1
Amount		37	100.0

The results of the analysis in table 3 show that there are significant differences in energy and macronutrient intake between the first and second groups. The first group had significantly higher energy and protein intake, while the second group had significantly higher carbohydrate intake. These differences in intake patterns can provide important information regarding eating habits and potential health risks in the two groups.

Based on the results of the correlation analysis, significant relationships were observed between nutritional intake and the duration of mechanical ventilation as seen on table 4 below. A significant negative relationship was found between energy intake and the duration of mechanical ventilation ($r = -0.389$, $p = 0.017$). This indicates that lower energy intake is associated with longer mechanical ventilation use.

Table 3. Comparison of Nutrition Consumption between First Group and Second Group

Group	First Group			Second Group			p value
	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	
Energy (kcal)	1199.70	404.44	1266.00	848.73	243.42	819.30	0.017**
Protein %	22.38	4.81	20.40	17.29	4.41	16.85	0.002*
Carbohydrate %	55.30	8.49	52.87	63.86	7.41	64.66	0.003*
Fat %	22.62	7.87	21.54	15.31	4.09	15.36	0.002**

* Independent t test. ** Mann Whitney test.

Similarly, there was a significant negative relationship between the percentage of protein intake and the duration of mechanical ventilation ($r = -0.394$, $p = 0.016$), suggesting that lower protein intake is correlated with longer mechanical ventilation use.

Conversely, a significant positive relationship was observed between the percentage of carbohydrate intake and the duration of mechanical ventilation ($r = 0.338$, $p = 0.041$). This implies that higher carbohydrate intake is associated with longer mechanical ventilation use.

Furthermore, a significant negative relationship was found between the percentage of fat intake and the duration of mechanical ventilation ($r = -0.427$, $p = 0.008$), indicating that lower fat intake is correlated with longer mechanical ventilation use. All of these results are the same when compared between the first and second groups.

DISCUSSION

Differences between energy, protein, carbohydrate and fat intake and the duration of mechanical ventilation use in critical patients with clinical nutrition collaboration (first group) and non-cooperation with clinical nutrition (second group) in the intensive care unit (ICU)

The analysis reveals that the first (cooperation) group exhibits higher nutritional intake compared to the second group. Specifically, the first group demonstrates higher energy, protein, and fat intake, albeit with lower carbohydrate intake. These differences are statistically significant, indicating a distinct nutritional profile between the first group and second groups.

This analysis underscores the significance of closely monitoring nutritional intake in mechanically ventilated patients, particularly concerning carbohydrates and fats. Disparities in nutritional intake between the first and second groups offer valuable insights for the nutritional management of patients undergoing mechanical ventilation therapy.

This research aligns with Hellena's 2018 study on ventilator utilization in critical patients at Arifin Achmad Hospital Pekanbaru, which also highlights the significant association between patients' nutritional status and ventilator use. Hellena's findings reveal that among 475 ventilated patients, malnutrition was prevalent, with 40% of adult hospital patients and 60% of hospitalized patients experiencing worsening nutritional status. Moreover, severe malnutrition was observed in 30% of critical patients on ventilators. Thus, nutritional status emerges as a critical factor influencing both ventilator use and patient health.

Protein helps repair the patient's body tissues and speeds up the recovery process. Proper nutritional intake can help patients reduce the risk of post-surgical complications and speed up the recovery process. Proper nutritional intake can also help patients correct electrolyte and fluid imbalances that may occur after surgery. Proper nutritional intake can help patients restore optimal body function after surgery. To pay attention to nutritional intake in patients undergoing mechanical ventilation, strategies can be implemented such as paying attention to food intake, micronutrient intake, energy intake, protein intake, and fluid intake. Ensure that patients consume foods that contain the necessary carbohydrates, proteins, fats, fibre and vitamins. Ensure patients consume micronutrients such as selenium, zinc, magnesium, iron, calcium, copper, carotene, vitamin B6, vitamin B12, and vitamin E necessary for the body. Ensure that patients consume proteins necessary for repairing body tissues and improving metabolism. Ensure patients consume the necessary fluids to reduce the risk of dehydration and electrolyte disturbances. Paying attention to the nutritional intake of patients undergoing mechanical ventilation can help patients restore normal body condition and reduce the risk of post-surgical complications.

The optimal protein requirement for critically ill patients is 1.2 - 2.0 g/kg. Smith et al indicated that a nitrogen intake of 300 mg/kg (~1.8 g/kg protein) is required for gastroenterological patients to maintain nitrogen balance. Shaw et al

Table 4. Correlation of nutritional intake (energy, protein, carbohydrate and fat) intake with duration of mechanical ventilation use (per day)

Nutritional intake	Duration of mechanical ventilation (per day)					
	First group		Second group		All groups	
	r value*	p value*	r value*	p value*	r value*	p value*
Energy (kcal)	-0.396	0.076	-0.543	0.030	-0.389	0.017
Protein (%)	-0.450	0.041	-0.473	0.064	-0.394	0.016
Carbohydrates (%)	0.238	0.298	0.579	0.019	0.338	0.041
Fat (%)	-0.650	0.001	-0.307	0.247	-0.427	0.008

* Spearman correlation test

showed that when 1.5 g/kg protein per day was given to patients with fallow sepsis, maximum protein stimulation could be achieved. Nitrogen balance reflects energy and protein intake. Nitrogen balance checks should be carried out regularly in the supervised care of critical patients to restore to an anabolic state. A negative nitrogen balance indicates protein catabolism and reflects inadequate protein intake. In critically ill patients, the goal of nutritional support is to achieve nitrogen balance in the range of + 2 to + 4 g per day. However, several studies have shown that nitrogen balance tests (urine urea nitrogen (UUN)) are not always sensitive for determining total urine nitrogen, which may significantly impair the prediction of nitrogen balance^{18,19}.

The American Society of Parenteral and Enteral Nutrition (ASPEN) recommends that ICU patients should begin enteral nutrition (EN) support within 24 to 48 hours of admission or after resuscitation to maintain systemic immune function and major organ structures. Therefore, the American Society of Parenteral and Enteral Nutrition (ASPEN) recommends that 75.6% of patients receive sufficient protein and 61.2% meet energy needs within the first 7 days. Thereby improving respiratory function, structure, improving weaning ability and reducing the length of use of mechanical ventilation⁴.

Nutritional support is essential for mechanically ventilated patients to meet their energy requirements and to maintain or even to enhance their muscle strength for facilitating ventilator weaning. Carbon dioxide production may be determined in part by the composition of enteral or parenteral nutrition, which in turn may affect the weaning process. Published reports of respiratory failure precipitated by high carbohydrate feeding have drawn attention to the carbohydrate and fat content of the patient's diet. In patients with chronic or acute retention of carbon dioxide (Hypercapnia), one goal of dietary therapy is to decrease carbon dioxide production²⁰. High carbohydrate intake in mechanically ventilated patients leads to excessive carbon dioxide production, so 50% carbohydrate intake is given to replenish respiratory muscle glycogen²¹. High carbon dioxide production can precipitate acute respiratory failure in patients with chronic pulmonary disease and can complicate weaning in ventilator dependent patients. Because the complete combustion of fat yields less carbon dioxide than combustion of either carbohydrate or protein, a high fat diet may be preferable for patients with pulmonary disease²⁰.

Excess carbohydrate intake leads to increased CO₂ production, which will delay the successful discontinuation of mechanical ventilation and will prolong the length of hospitalisation²². Fat is an important source of energy and plays a role in maintaining healthy cells and cell membranes. In addition, fat is also required for the absorption of fat-soluble vitamins, which are important for respiratory and immune system functions. Thus, adequate nutritional intake, especially energy, protein, carbohydrate, and fat, can contribute to pa-

tient recovery and influence the length of mechanical ventilation use.

Sindhvani, 2006. Enteral feeding is given as early as possible, to avoid loss of muscle mass. Protein intake is 15%-20% (1- 2 g/kg) body weight. Fat intake in mechanically ventilated patients is more moderate at 20%-40% fat to avoid high carbohydrate intake²³. Metabolism of macronutrients yields carbon dioxide (CO₂) oxidative end products with CHO producing the greatest amount. The respiratory quotient [RQ, CO₂ produced over oxygen (O₂) consumed] is a measure that reflects substrate utilization. When the value exceeds 1.0, O₂ consumption must increase, resulting in an increased work of breathing²⁰.

The relationship between energy, protein, carbohydrate, and fat intake and duration of mechanical ventilation use in non-cooperative clinical nutrition patients in the intensive care unit (ICU) of Wahidin Sudirohusodo Hospital in 2020-2022

The results of the analysis highlight a significant impact of mechanical ventilation duration on nutritional intake. Prolonged use of mechanical ventilation correlates with lower energy, protein, and fat intake, while carbohydrate intake tends to increase. Specifically, as the duration of mechanical ventilation extends, energy and protein intake decrease, carbohydrate intake rises, and fat intake declines. This suggests that mechanical ventilation can influence an individual's eating patterns and overall nutritional intake, underscoring the importance of monitoring its use.

Understanding the relationship between energy, protein, carbohydrate, and fat intake and the duration of mechanical ventilation in non-cooperating patients receiving clinical nutrition is crucial in the context of caring for patients requiring respiratory support. Adequate nutritional intake plays a vital role in maintaining patient health and supporting the healing process. Energy intake, in particular, is essential for meeting the body's metabolic demands, including respiratory function maintenance. Patients with sufficient energy intake tend to exhibit better resilience to stress and infection, factors that can impact the duration of mechanical ventilation.

A cross-sectional study by Sutrisnawati (2021), emphasizes the correlation between Nutric score and the duration of mechanical ventilation in the ICU. Adequate energy and protein intake were found to be significantly negatively correlated with mechanical ventilation duration. Prolonged mechanical ventilation is a critical outcome parameter used to assess ICU care quality. Malnutrition among ICU patients not only increases morbidity, mortality, and costs but also prolongs the duration of mechanical ventilation⁵.

Previous study by Koontalay (2021) to identify the impact of nutritional factors on mechanical ventilation duration for criti-

cal patients. As a result of this study, patients with high risk malnutrition may require longer duration, about 50.34 days for mechanical ventilation. However, if adequate calories target requirement is quicker than 1 hour, it can decrease mechanical ventilation duration used by 8 days⁴.

CONCLUSION

The results of the analysis indicate that the first group exhibited a higher nutritional intake compared to the second group. The first group exhibited a higher energy intake, as well as a higher protein and fat intake. However, the first group exhibited a lower carbohydrate intake. This difference was statistically significant, indicating that the first group had a different nutritional profile than the second group. Nutritional intake also had a significant influence on mechanical ventilation (per day). The lower the energy, protein, and fat intake, while the carbohydrate intake increased, the longer the use of mechanical ventilation.

ACKNOWLEDGMENT

The authors would like to thank Hasanuddin University for their support during the conduction of this research.

REFERENCES

- Kayambankadzanja RK, Schell CO, Wärnberg MG, et al. Towards definitions of critical illness and critical care using concept analysis. *BMJ Open* 2022;12(9):e060972; doi: 10.1136/bmjopen-2022-060972.
- Setiawan J, Puruhita N, Fasitasari M, et al. Correlation Between Energy-Protein Deficits and Length of Stay in Critically Ill Patients in the Intensive Care Unit (ICU). *J Nutr Health* 2020;8(2):100–108.
- Maskoen TT, Redjeki IS, Pangalila FJV, et al. Clinical nutrition guidelines for critically ill patients. 1st ed. Indonesian Intensive Care Doctors Association: Jakarta, Indonesia; 2021.
- Koontalay A, Suksatan W, Sadang JM, et al. Optimal Nutritional Factors Influencing the Duration of Mechanical Ventilation Among Adult Patients with Critical Illnesses in an Intensive Care Unit. *J Multidiscip Healthc* 2021;14:1385–1393; doi: 10.2147/JMDH.S319553.
- Sutrisnawati I, Darmono D, Murbawani EA, et al. Correlation between nutric score and adequacy of energy and protein intake with duration of mechanical ventilation in the intensive care unit Dr. Kariadi Hospital, Semarang-Indonesia. *Bali Med J* 2021;10(1):392–396; doi: 10.15562/bmj.v10i1.2196.
- Mulyantari A, Sunardi D, Sinaga W. Role of Nutrition Therapy for Respiratory failure in Critically ill with Comorbidities. University of Indonesia: Jakarta; 2019.
- Ambrosino N, Vitacca M. The patient needing prolonged mechanical ventilation: a narrative review. *Multidiscip Respir Med* 2018;13:6; doi: 10.1186/s40248-018-0118-7.
- Huang H-Y, Huang C-Y, Li L-F. Prolonged Mechanical Ventilation: Outcomes and Management. *J Clin Med* 2022;11(9):2451; doi: 10.3390/jcm11092451.
- Khan ZH, Ceriana P, Donner CF. Ventilator associated pneumonia or ventilator induced pneumonia. *Multidiscip Respir Med* 2017;12(1):5; doi: 10.1186/s40248-017-0086-3.
- Fan E, Del Sorbo L, Goligher EC, et al. An Official American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine Clinical Practice Guideline: Mechanical Ventilation in Adult Patients with Acute Respiratory Distress Syndrome. *Am J Respir Crit Care Med* 2017;195(9):1253–1263; doi: 10.1164/rccm.201703-0548ST.
- Vetrugno L, Guadagnin GM, Brussa A, et al. Mechanical ventilation weaning issues can be counted on the fingers of just one hand: part 1. *Ultrasound J* 2020;12(1):9; doi: 10.1186/s13089-020-00161-y.
- Singer P, Blaser AR, Berger MM, et al. ESPEN guideline on clinical nutrition in the intensive care unit. *Clin Nutr* 2019;38(1):48–79; doi: 10.1016/j.clnu.2018.08.037.
- Siobal MS, Baltz JE, Wright J. Nutritional Assessment and Treatment of the Critically Ill Patient. 2nd ed. American Association for Respiratory Care; n.d.
- Ndahimana D, Kim E-K. Energy Requirements in Critically Ill Patients. *Clin Nutr Res* 2018;7(2):81–90; doi: 10.7762/cnr.2018.7.2.81.
- Balasubramanian S, Tran DH, Serra M, et al. Assessing calorie and protein recommendations for survivors of critical illness weaning from prolonged mechanical ventilation – can we find a proper balance? *Clin Nutr ESPEN* 2021;45:449–453; doi: 10.1016/j.clnesp.2021.07.001.
- Hajjar J, Dziegielewska C, Dickson S, et al. The role of low-carbohydrate diets in the intensive care unit. *Nutr Health* 2023;29(3):377–381; doi: 10.1177/02601060221149088.
- Oh R, Gilani B, Uppaluri KR. Low-Carbohydrate Diet. In: *StatPearls StatPearls Publishing: Treasure Island (FL); 2024.*
- Tignanelli CJ, Bukowiec JC. Hospital Based Nutrition Support: A Review of the Latest Evidence. *J Clin Nutr Diet* 2017;03(03); doi: 10.4172/2472-1921.100057.
- Carro MLF. Proteins, Catabolism and Sepsis: A Literature Review. *EC Nutr* 2018;13(3):126–134.
- Faramawy MAES, Allah AA, Batrawy SE, et al. Impact of high fat low carbohydrate enteral feeding on weaning from mechanical ventilation. *Egypt J Chest Dis Tuberc* 2014;63(4):931–938; doi: 10.1016/j.ejcdt.2014.07.004.
- Ambrosino N, Clini E. Long-term mechanical ventilation and nutrition. *Respir Med* 2004;98(5):413–420; doi: 10.1016/j.rmed.2003.11.008.
- Kan M-N, Chang H-H, Sheu W-F, et al. Estimation of energy requirements for mechanically ventilated, critically ill patients using nutritional status. *Crit Care* 2003;7(5):R108–R115; doi: 10.1186/cc2366.
- Sindhvani G, Rawat J. Ventilator dependence: role of nutrition and airway clearance therapy. *Lung India* 2006;23(1):39; doi: 10.4103/0970-2113.44429.

Higher mortality rate in postoperative icu patients is associated with combination of early enteral and parenteral nutrition

Raymond LIEM¹, Nurpudji A TASLIM^{1,2}, A Yasmin SYAUKI^{1,2}, Yulia WULLUR¹, Rury L. SAPTARI¹, Suryani AS'AD^{1,2,3}, Agussalim BUKHARI^{1,2}, MARDIANA^{1,2}

1 Department of Nutrition, Hasanuddin University, Makassar, Indonesia.

2 Wahidin Sudirohusodo Hospital, Makassar, Indonesia.

3 School of Medicine, Muhammadiyah University, Makassar, Indonesia.

Recibido: 8/mayo/2024. Aceptado: 3/julio/2024.

ABSTRACT

Introduction: Postoperative intensive care unit (ICU) patients often experience increased metabolic demands and are at risk of malnutrition, making early nutritional support crucial for recovery. Despite the existing body of literature, the impact of different modes of early nutrition on mortality in postoperative ICU patients remains unclear. Previous studies have produced mixed results, with some suggesting that early parenteral nutrition is associated with worse outcomes, while others have found no significant differences between the different modes of nutrition. This study aims to examine the impact of early nutrition on mortality in postoperative ICU patients. The study also seeks to explore the impact of early nutrition on other clinical outcomes.

Methods: This retrospective observational study included 361 postoperative ICU patients and divided by four groups based on their early nutritional support (early enteral, early parenteral, early mixed enteral and parenteral, and no early nutrition). Baseline characteristics, nutritional intake was assessed using 24hours food recall, length of stay in ICU, hospital LOS, duration of mechanical ventilation, and mortality were evaluated. Statistical analyses included univariate and multivariate models to assess the relationship between early nutrition and clinical outcomes.

Result: The early PN and EN & PN groups had higher ICU mortality rates (33.6% and 26.5%, respectively) compared to

the EN group (19.1%) and no early nutrition group (11.1%). Early PN was associated with an increased odds ratio for mortality (OR = 3.03, 95% CI = 0.83, 11.09). The EN & PN group also showed increased odds (OR = 4.82, 95% CI = 1.10, 21.11). The highest median calorie intake was in the PN group, while the longest ICU LOS was in the EN & PN group.

Conclusion: Early supplemental parenteral nutrition, particularly when combined with enteral nutrition, is associated with higher mortality in postoperative ICU patients. Early enteral nutrition appears to be a safer option, and careful consideration should be given to the risks and benefits of different nutritional interventions in this patient population.

KEYWORDS

Early nutrition, critical illness, surgical patients, hospital mortality.

INTRODUCTION

Postoperative care in intensive care units (ICUs) presents challenges and opportunities for improving patient outcomes. In the critical phase following surgery, patients experience increased metabolic demands and are at risk of malnutrition. Nutrition support is a fundamental component of postoperative care, aiming to meet the metabolic needs of critically ill patients, enhance recovery, reduce the risk of infections, and shorten the length of hospital stay^{1,2}. The timing and optimal route of nutrition remains a topic of debate. Enteral nutrition, delivered directly into the gastrointestinal tract, is often favored due to its physiological benefits, including maintaining gut integrity and function. Parenteral nutrition, delivered intravenously, is reserved for patients who cannot tolerate or adequately receive enteral feeding. Despite its benefits, par-

Correspondencia:
Nurpudji A Taslim
pudji_taslim@yahoo.com

enteral nutrition has been associated with an increased risk of complications, such as infections, metabolic disturbances, and liver dysfunction, leading to concerns about its routine use in ICU patients. Given these issues, clinicians often employ a combination of enteral and parenteral nutrition (EN & PN) to achieve optimal nutrient delivery, particularly in patients with complex nutritional needs^{3,4}.

Despite the existing body of literature, the impact of different modes of early nutrition on mortality in postoperative ICU patients remains unclear. Previous studies have produced mixed results, with some suggesting that early parenteral nutrition is associated with worse outcomes, while others have found no significant differences between the different modes of nutrition. The existing guidelines are often based on mixed evidence, leading to variations in clinical practice and uncertainty among healthcare providers about the best approach to nutritional support in postoperative ICU patients^{5,6}.

Given the uncertainties and gaps in the current literature, this study aims to examine the impact of early nutrition on mortality in postoperative ICU patients^{7,8}. The specific objectives of the study are to evaluate the association between early enteral, parenteral, and combined enteral and parenteral nutrition and mortality, and to identify potential predictors of mortality in this patient population. The study also seeks to explore the impact of early nutrition on other clinical outcomes, such as ICU and hospital length of stay and duration of mechanical ventilation, to provide a more comprehensive understanding of the effects of different modes of early nutrition.

METHODS

Study Design

Retrospective observational study was conducted in the intensive care unit (ICU) of Wahidin Sudirohusodo Hospital, Makassar, Indonesia. The study was conducted over a 12-month period, from April 2022 to March 2023, and aimed to evaluate the association between different types of early nutrition and clinical outcomes, particularly mortality. The study adhered to the ethical guidelines of the institutional review board, which approved the study protocol and ensured that patient confidentiality was maintained throughout the research process. The Ethic protocol number is 966/UN4.6.4.5.31/PP36/2023.

Patient Selection

The study population included all postoperative patients admitted to the ICU during the study period. Exclusion criteria for the study were, patients below 18 years old, patients who died within 48 hours of ICU admission and patients who were discharged from the ICU within 48 hours.

Data Collection

Data for the study were collected from medical records, which provided detailed information on patient demographics, clinical characteristics, nutritional intake, and clinical outcomes. Demographic data included age, sex, height, weight, and body mass index (BMI). The clinical characteristics collected included the type of surgery, severity of illness, and nutritional risk. The type of surgery was categorized based on the primary surgical procedure performed, while the severity of illness was assessed using the APACHE II and SOFA scores, both of which are widely used tools for evaluating the severity of illness in ICU patients. The nutritional risk was assessed using the mNutric score, which is a validated tool for identifying ICU patients who may benefit from nutritional support. Nutritional intake was assessed based on the average calorie and protein intake during ICU stay. The clinical outcomes assessed included ICU and hospital length of stay (LOS), duration of mechanical ventilation, and ICU mortality.

Statistical Analysis

The normality of continuous data was assessed using the Shapiro-Wilk test, which is a statistical test that evaluates whether a dataset follows a normal distribution. Depending on the distribution, continuous variables were expressed as either mean \pm standard deviation (SD) or median and interquartile range (IQR). Categorical variables were presented as numbers and percentages. For continuous variables, the Student's t-test or Mann-Whitney U test was used for two-group comparisons, while one-way ANOVA or Kruskal-Wallis test was used for more than two groups. For categorical variables, the chi-square test or Fisher's exact test was used, depending on the sample size and distribution of the categories. To identify independent predictors of mortality, a multivariate logistic regression analysis was performed. Unadjusted and Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were reported to measure the strength and precision of the association between early nutrition and mortality. A p-value of < 0.05 was considered statistically significant. Statistical analysis for the study was performed using SPSS 25.0 (IBM Corp., Armonk, NY).

RESULTS

A total of 889 postoperative patients were admitted to the ICU from April 2022 to March 2023. Among these patients, 677 were excluded due to various reasons, including being under 18 years of age ($n = 83$), death within 48 hours of admission ($n = 49$), and discharge from the ICU less than 48 hours ($n = 516$). The final analysis included 361 patients, divided into four groups based on their early nutrition intake: no early nutrition ($n = 36$), early enteral nutrition ($n = 89$), early parenteral nutrition ($n = 134$), and early enteral and parenteral nutrition ($n = 102$). The me-

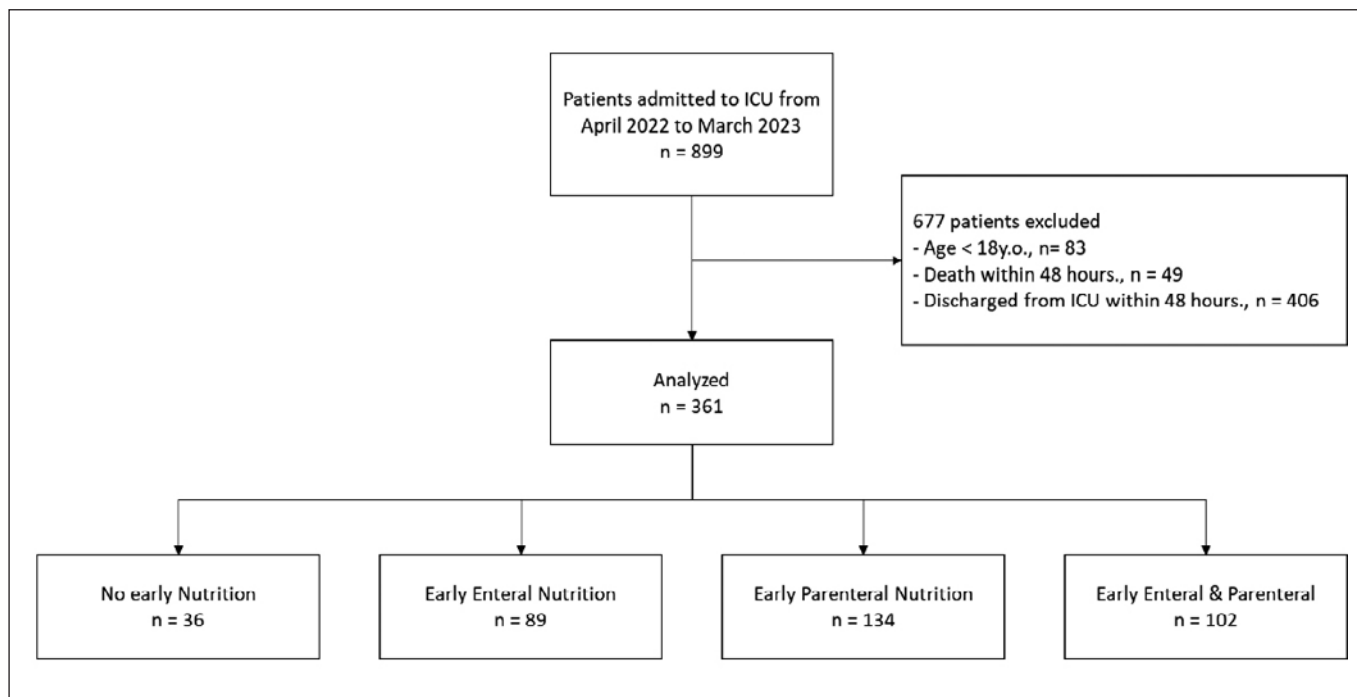


Figure 1. Flowchart of the study patients

dian age of the patients across the groups was similar, with no significant differences observed ($p = 0.293$). Likewise, the gender distribution was comparable across all groups ($p = 0.474$). Additionally, the height ($p = 0.895$), weight ($p = 0.552$), and BMI ($p = 0.34$) were not significantly different among the groups. The majority of patients had a BMI in the range of 18.5 to 29.9, with no significant differences in BMI distribution across the groups ($p = 0.538$). However, significant differences were observed in the types of surgeries performed among the groups ($p < 0.001$). Significant differences were also found in the APACHE II score, SOFA score, and mNutric score among the groups (all $p < 0.05$). The Early Parenteral group had the highest median APACHE II score (8 [6, 10]) and SOFA score (7 [5, 9]), indicating a higher severity of illness in this group. Conversely, the No Early Nutrition group had the highest median mNutric score (5 [3, 6]), suggesting a higher risk of malnutrition in this group.

The median calorie intake significantly differed among the groups ($p < 0.001$). The Early Parenteral group had the highest median calorie intake (12.2 [7.15, 16.8]), while the Early Enteral group had the lowest (5.5 [3.2, 9.25]). Protein intake also varied significantly among the groups ($p < 0.001$), with the Early Parenteral group having the highest median protein intake (0.6 [0.4, 0.8]) and the Early Enteral group having the lowest (0.3 [0.2, 0.5]). The ICU length of stay (ICU LOS) differed significantly across the groups ($p = 0.032$). The Early Parenteral group had the

longest median ICU LOS (6 [3, 11]), while the No Early Nutrition group had the shortest (3 [1, 6.75]). However, there were no significant differences in the hospital length of stay (Hospital LOS) among the groups ($p = 0.348$). The duration of mechanical ventilation was significantly different among the groups ($p = 0.051$). The Early Parenteral group had the longest median duration (2.5 [1, 7]), while the No Early Nutrition group had the shortest (1 [1, 3.5]). Finally, ICU mortality rates were significantly different among the groups ($p = 0.015$). The Early Parenteral group had the highest ICU mortality rate (33.6%), followed by the Early Enteral & Parenteral group (26.5%). The Early Enteral group had the lowest ICU mortality rate (19.1%), while the No Early Nutrition group had a rate of 11.1%.

In the unadjusted analysis, early parenteral nutrition was associated with a significantly higher odds ratio (OR) for mortality (1.88 [95% CI: 0.58, 6.062], $p = 0.163$) compared to early enteral nutrition, but the result was not statistically significant. The combined early enteral and parenteral nutrition group had a similarly high OR for mortality (4.04 [95% CI: 1.34, 12.41], $p = 0.013$), which was statistically significant. The adjusted analysis, which considered potential confounders, provided a clearer picture. After adjustment, early parenteral nutrition remained associated with an increased odds ratio for mortality (1.73 [95% CI: 1.026, 10.48], $p = 0.376$), while the early enteral and parenteral nutrition also showed an increased odd ratio for mortality (3.28 [95% CI: 1.02, 10.48], $p = 0.045$).

Table 1. Baseline characteristics of the study patients

	Early Enteral (n=89)	Early Parenteral (n=134)	Early Enteral & Parenteral (n=102)	No Early Nutrition (n=36)	p Value
Age, year	51 [38, 59.5]	51 [39, 62.65]	49 [36, 57]	48 [30.25, 60.5]	0,293
Sex					0,474
Men	43 (48.3)	65 (48.5)	59 (57.8)	19 (52.8)	
Woman	46 (51.7)	69 (51.5)	43 (42.2)	17 (47.2)	
Height, cm	160 [155, 165]	160 [155, 165]	160 [155, 165]	160 [155, 161.75]	0,895
Weight, kg	60 [50, 65]	60 [50, 65]	58 [50, 65]	57.5 [50.5, 64.5]	0,552
BMI, kg/m ²	22.8 [20.7, 24.8]	22.0 [20.6, 23.8]	22.6 [20.7, 24.5]	22.8 [21.1, 24.9]	0,34
BMI Category					0,538
<18.5	8 (9)	12 (9)	7 (6.9)	3 (8.3)	
18.5 - 22.9	37 (41.6)	69 (51.5)	49 (48)	17 (47.2)	
23 - 24.9	22 (24.7)	30 (22.4)	23 (22.5)	6 (16.7)	
25 - 29.9	22 (24.7)	21 (15.7)	19 (18.6)	10 (27.8)	
>30	0 (0)	2 (1.5)	4 (3.9)	0 (0)	
Type of Surgery					<0,001
Digestive	5 (5.6)	77 (57.5)	18 (17.6)	9 (25)	
Brain	35 (39.3)	26 (19.4)	38 (37.3)	10 (27.8)	
Orthopedic	22 (24.7)	9 (6.7)	20 (19.6)	4 (11.1)	
Oncology	14 (15.7)	4 (3)	10 (9.8)	4 (11.1)	
Urology	3 (3.4)	2 (1.5)	2 (2)	1 (2.8)	
ENT	7 (7.9)	2 (1.5)	3 (2.9)	1 (2.8)	
Plastic	1 (1.1)	1 (0.7)	0 (0)	0 (0)	
Vaskular	0 (0)	0 (0)	1 (1)	0 (0)	
Ophthalmology	1 (1.1)	0 (0)	0 (0)	0 (0)	
Obstetric	1 (1.1)	13 (9.7)	10 (9.8)	7 (19.4)	
APACHE II Score	7 [5, 8.5]	8 [6, 10]	6 [5, 8]	5 [2.75, 6]	<0,001
SOFA Score	7 [5, 9]	7 [5, 9]	5 [5, 7]	5 [3.5, 6]	<0,001
mNutric Score					0,029
Low Risk	80 (89.9)	111 (82.8)	96 (94.1)	34 (94.4)	
High Risk	9 (10.1)	23 (17.2)	6 (5.9)	2 (5.6)	

Data are presented as n (%) or median (interquartile range).

BMI, Body Mass Index; ENT, Ear Nose Throat; APACHE II, Acute Physiology and Chronic Health Evaluation II ; SOFA, Sequential Organ Failure Assessment ; mNutric, modified Nutrition Risk in the Critically III.

Table 2. Intake and clinical outcome according to initiation of nutrition

	Early Enteral (n=89)	Early Parenteral (n=134)	Early Enteral & Parenteral (n=102)	No Early Nutrition (n=36)	p Value
Calorie Intake, kcal/kg/d	5.5 [3.2, 9.25]	12.2 [7.15, 16.8]	9 [5.6, 13.92]	6.6 [5.72, 8.52]	<0.001
Protein Intake, kcal/kg/d	0.3 [0.2, 0.5]	0.6 [0.4, 0.8]	0.45 [0.3, 0.7]	0.4 [0.3, 0.4]	<0.001
ICU LOS, days	4 [3, 8]	6 [3, 11]	6 [3, 11]	5 [3, 6.75]	0.032
Hospital LOS, days	15 [9, 27.5]	15.5 [10, 28]	19 [11, 31.25]	18.5 [10, 29.75]	0.348
Mechanical Ventilation, days	2 [1, 5.5]	2.5 [1, 7]	2 [1, 8.25]	3 [1, 7.9]	0.051
ICU Mortality, n(%)	17 (19.1)	45 (33.6)	27 (26.5)	4 (11.1)	0,015

Data are presented as n (%) or median (interquartile range).
ICU, Intensive Care Unit; LOS, Length of stay.

Table 3. Relationship between early nutrition and mortality

	Unadjusted			Adjusted*		
	Hazard ratio	95% CI	p Value	Hazard ratio	95% CI	p Value
Early Enteral (n=89)						
Early Parenteral (n=134)	1.889	0.589 - 6.062	0.285	1.738	0.511 - 5.908	0.376
Early Enteral & Parenteral (n=102)	4.045	1.347 - 12.416	0.013	3.280	1.026 - 10.482	0.045
No Early Nutrition (n=36)	2.880	0.932 - 8.904	0.066	3.070	0.943 - 9.992	0.062
Energy Intake, kcal/kg/d	1.045	1.010 - 1.080	0.011	1.046	1.009 - 1.084	0.014
Protein Intake, kcal/kg/d	1.910	1.088 - 3.352	0.024	2.019	1.115 - 3.656	0.020

*Adjusted for age, sex, BMI, Type of Surgery, and mNutric Score.

DISCUSSION

The results of this study provide important insights into the association between early nutritional interventions and clinical outcomes in postoperative ICU patients. The key finding that early parenteral nutrition, particularly when used as a supplement to enteral nutrition, is associated with higher ICU mortality⁹⁻¹¹. In contrast, early enteral nutrition appears to be associated with better outcomes, supporting the notion that enteral feeding should be the preferred mode of early nutrition in critically ill postoperative patients¹¹⁻¹³. These results align with the concept that the gastrointestinal tract plays a crucial role in immune function and metabolic regulation, and that preserving its integrity through enteral feeding can have beneficial effects on patient outcomes¹⁴. The increased mortality observed in the early parenteral nutrition group, even when combined with enteral nutrition, suggests that the risks associated with parenteral feeding may outweigh the benefits in certain patient populations^{7,15,16}. The reasons for this in-

creased mortality are likely multifactorial, including the risk of infections, metabolic complications, and liver dysfunction associated with parenteral nutrition^{10,17,18}. Additionally, the potential for overfeeding or inappropriate nutrient composition in parenteral solutions could contribute to adverse outcomes¹⁸⁻²⁰. The findings of this study highlight the need for careful consideration of the risks and benefits of parenteral nutrition in postoperative ICU patients, and suggest that early enteral feeding should be prioritized whenever possible²¹.

The findings of this study are consistent with some previous studies that have suggested an association between early parenteral nutrition and worse outcomes in critically ill patients. For example, several randomized controlled trials have shown that early parenteral nutrition, compared with enteral nutrition or delayed parenteral nutrition, is associated with an increased risk of infections and other complications^{9-11,19}. However, other studies have found no significant difference between the modes of nutrition, highlighting the heterogene-

ity of the critically ill population and the potential for patient-specific factors to influence outcomes^{15,20}. The current study adds to the existing literature by specifically focusing on postoperative ICU patients, a population that is often excluded from broader studies of nutritional support in critical illness. The focus on surgical patients allows for a more nuanced understanding of the impact of early nutrition in this population, which may have different nutritional needs and risks compared with medical ICU patients^{11,18,21}. The findings also align with guidelines from organizations such as the American Society for Parenteral and Enteral Nutrition (ASPEN), which recommend early enteral nutrition as the preferred mode of feeding in critically ill patients¹⁷.

The findings of this study have important implications for clinical practice and future research. The increased mortality associated with early parenteral nutrition suggests that this mode of feeding should be used with caution in postoperative ICU patients, and that early enteral feeding should be prioritized whenever possible^{22,23}. The results also highlight the potential risks of combined enteral and parenteral nutrition, suggesting that this approach should be reserved for patients who cannot meet their nutritional needs with enteral feeding alone^{23,24}. The study also highlights the importance of individualized nutritional support in critically ill patients. While early enteral feeding appears to be beneficial for most postoperative ICU patients, there may be cases where parenteral nutrition is necessary or where combined enteral and parenteral feeding is appropriate^{11,14,17}. Clinicians should carefully consider the risks and benefits of different nutritional interventions and tailor their approach to the individual needs and preferences of their patients.

There are several limitations that should be acknowledged. First, the retrospective observational design limits the ability to establish causality between early nutritional interventions and outcomes. While the study identified associations between early parenteral nutrition and increased mortality, other factors such as patient severity of illness or preexisting comorbidities could also contribute to these outcomes. Future prospective studies or randomized controlled trials are needed to confirm these findings and establish causality. Second, the study relied on medical records for data collection, which may be subject to inaccuracies or missing data. While the researchers took steps to validate the data, the potential for errors in documentation or coding could affect the results. Third, the study population consisted of postoperative ICU patients, which may limit the generalizability of the findings to other patient populations. While the focus on surgical patients is a strength of the study, it also means that the results may not apply to medical ICU patients or other critically ill populations. Future studies should examine the impact of early nutrition in different patient populations to determine whether the findings are consistent across different types of critical illness.

CONCLUSION

In conclusion, this study provides important insights into the association between early nutritional interventions and clinical outcomes in postoperative ICU patients. The findings suggest that early parenteral nutrition, particularly when used as a supplement to enteral nutrition, is associated with higher ICU mortality, while early enteral feeding is associated with better outcomes. These results support the prioritization of enteral nutrition in postoperative ICU patients and highlight the need for careful consideration of the risks and benefits of parenteral nutrition in this population. Future research should focus on prospective studies or randomized controlled trials to confirm these findings and establish causality, as well as exploring the impact of early nutrition in different patient populations and subgroups.

Acknowledgements

The author would like to express gratitude to all teachers at the Nutrition Department, Faculty of Medicine, Hasanuddin University

REFERENCES

1. Puzio TJ, Kozar RA. Nutrition in the critically ill surgical patient. *Curr Opin Crit Care*. 2020 Dec;26(6):622–7.
2. Kozienicki M, Fritzshall R. Enteral Nutrition for Adults in the Hospital Setting. *Nutrition in Clinical Practice*. 2015 Oct 22;30(5):634–51.
3. Reintam Blaser A, Starkopf J, Alhazzani W, Berger MM, Casaer MP, Deane AM, et al. Early enteral nutrition in critically ill patients: ES-ICM clinical practice guidelines. *Intensive Care Med*. 2017 Mar 6;43(3):380–98.
4. Reigner J, Boisramé-Helms J, Brisard L, Lascarrou JB, Ait Hssain A, Anguel N, et al. Enteral versus parenteral early nutrition in ventilated adults with shock: a randomised, controlled, multicentre, open-label, parallel-group study (NUTRIREA-2). *The Lancet*. 2018 Jan;391(10116):133–43.
5. Wischmeyer PE, Carli F, Evans DC, Guilbert S, Kozar R, Pryor A, et al. American Society for Enhanced Recovery and Perioperative Quality Initiative Joint Consensus Statement on Nutrition Screening and Therapy Within a Surgical Enhanced Recovery Pathway. *Anesth Analg*. 2018 Jun;126(6):1883–95.
6. Elke G, van Zanten ARH, Lemieux M, McCall M, Jeejeebhoy KN, Kott M, et al. Enteral versus parenteral nutrition in critically ill patients: an updated systematic review and meta-analysis of randomized controlled trials. *Crit Care*. 2016 Dec 29;20(1):117.
7. Talebi S, Zeraattalab Motlagh S, Vajdi M, Nielsen SM, Talebi A, Ghavami A, et al. Early vs delayed enteral nutrition or parenteral nutrition in hospitalized patients: An umbrella review of systematic reviews and meta analyses of randomized trials. *Nutrition in Clinical Practice*. 2023 Jun 12;38(3):564–79.
8. Zou B, Xi F, Yu W. Early parenteral nutrition comparing to enteral nutrition cannot reduce 28-day mortality in critically ill patients: a

- retrospective comparative cohort study based on the MIMIC-IV database. *Ann Transl Med.* 2023 Jan;11(2):77–77.
9. Pardo E, Lescot T, Preiser JC, Massanet P, Pons A, Jaber S, et al. Association between early nutrition support and 28-day mortality in critically ill patients: the FRANS prospective nutrition cohort study. *Crit Care.* 2023 Jan 7;27(1):7.
 10. El Meligy BS, El-sherbini SA, Soliman MM, abd El-Ghany HM, Ahmed ES. Early enteral versus early parenteral nutrition in critically ill patients with respiratory distress: a case–control study. *Egyptian Pediatric Association Gazette.* 2023 Apr 3;71(1):20.
 11. Brisard L, Le Gouge A, Lascarrou JB, Dupont H, Asfar P, Sirodot M, et al. Impact of early enteral versus parenteral nutrition on mortality in patients requiring mechanical ventilation and catecholamines: study protocol for a randomized controlled trial (NUTRIREA-2). *Trials.* 2014 Dec 23;15(1):507.
 12. Chen S, Hu C. Association between early enteral nutrition and mortality in critically ill patients. *Crit Care.* 2023 Oct 23;27(1):405.
 13. Choi YK, Kim HJ, Ahn J, Ryu JA. Impact of early nutrition and feeding route on clinical outcomes of neurocritically ill patients. *PLoS One.* 2023 Mar 23;18(3):e0283593.
 14. Zaragoza-García I, Arias-Rivera S, Frade-Mera MJ, Martí JD, Gallart E, San José-Arribas A, et al. Enteral nutrition management in critically ill adult patients and its relationship with intensive care unit-acquired muscle weakness: A national cohort study. *PLoS One.* 2023 Jun 7;18(6):e0286598.
 15. Fizez T, Kerklaan D, Verbruggen S, Vanhorebeek I, Verstraete S, Tibboel D, et al. Impact of withholding early parenteral nutrition completing enteral nutrition in pediatric critically ill patients (PEPaNIC trial): study protocol for a randomized controlled trial. *Trials.* 2015 Dec 1;16(1):202.
 16. Preiser JC, Arabi YM, Berger MM, Casaer M, McClave S, Montejo-González JC, et al. A guide to enteral nutrition in intensive care units: 10 expert tips for the daily practice. *Crit Care.* 2021 Dec 14;25(1):424.
 17. Singer P. Preserving the quality of life: nutrition in the ICU. *Crit Care.* 2019 Jun 14;23(S1):139.
 18. Piwowarczyk P, Kutnik P, Borys M, Rypulak E, Potręć-Studzińska B, Sysiak-Sławecka J, et al. Influence of Early versus Late supplemental Parenteral Nutrition on long-term quality of life in ICU patients after gastrointestinal oncological surgery (hELPLiNe): study protocol for a randomized controlled trial. *Trials.* 2019 Dec 27;20(1):777.
 19. Ortiz-Reyes L, Patel JJ, Jiang X, Coz Yataco A, Day AG, Shah F, et al. Early versus delayed enteral nutrition in mechanically ventilated patients with circulatory shock: a nested cohort analysis of an international multicenter, pragmatic clinical trial. *Crit Care.* 2022 Jun 9;26(1):173.
 20. Moon SJ, Ko RE, Park CM, Suh GY, Hwang J, Chung CR. The Effectiveness of Early Enteral Nutrition on Clinical Outcomes in Critically Ill Sepsis Patients: A Systematic Review. *Nutrients.* 2023 Jul 19;15(14):3201.
 21. Lopez-Delgado JC, Servia-Goixart L, Grau-Carmona T, Bordeje-Laguna L, Portugal-Rodríguez E, Lorenzo-Cardenas C, et al. Factors associated with the need of parenteral nutrition in critically ill patients after the initiation of enteral nutrition therapy. *Front Nutr.* 2023 Aug 24;10.
 22. Casaer MP, Mesotten D, Hermans G, Wouters PJ, Schetz M, Meyfroidt G, et al. Early versus Late Parenteral Nutrition in Critically Ill Adults. *New England Journal of Medicine.* 2011 Aug 11;365(6):506–17.
 23. Thong D, Halim Z, Chia J, Chua F, Wong A. Systematic review and meta analysis of the effectiveness of continuous vs intermittent enteral nutrition in critically ill adults. *Journal of Parenteral and Enteral Nutrition.* 2022 Aug 13;46(6):1243–57.
 24. Doig GS. Early Parenteral Nutrition in Critically Ill Patients With Short-term Relative Contraindications to Early Enteral Nutrition. *JAMA.* 2013 May 22;309(20):2130.

Identifying risk factors and recommending interventions to reduce stunting in Sigi Regency

Nasrul NASRUL¹, Fahmi HAFID², T. Iskandar FAISAL¹, Taufiqurrahman TAUFIQURRAHMAN², Kadar RAMADHAN³

1 Department of Nursing, Poltekkes Kemenkes Palu, City of Palu, Indonesia.

2 Department of Nutrition, Poltekkes Kemenkes Surabaya, City of Surabaya, Indonesia.

3 Department of Midwifery, Poltekkes Kemenkes Palu, City of Palu, Indonesia.

Recibido: 14/mayo/2024. Aceptado: 3/julio/2024.

ABSTRACT

Background: Stunting is a significant health issue in children and Sigi Regency has been recognized as a hotspot for stunting in Central Sulawesi since 2021. The objective of this study is to analyze the determinants of stunting among children aged 0-24 months in Sigi Regency.

Methods: This analytical research utilizes a cross-sectional design. The sample comprises 436 children aged 0-24 months, with their mothers as respondents. Data collection is scheduled for September-October 2022. The primary outcome variable in this study is stunting status, while the potential risk factors, or independent variables. Data analysis was carried out using SPSS and multivariate analysis was carried out using backward logistic regression and was significant with $p < 0.05$.

Results: The study found that the significant determinants contributing to stunting in children under two in the stunting area of Sigi District are maternal education < 9 years (AOR=2.3, 95% CI: 1.4-3.9), male gender of the child (AOR=1.8, 95% CI: 1.1-2.8), birth length < 48 cm (AOR=1.7, 95% CI: 1.0-2.8), low birth weight (AOR=2.2, 95% CI: 1.1-4.5).

Conclusion: Implementing educational programs targeting mothers with less than 9 years of education enhances their understanding of nutrition and childcare practices. Emphasize the importance of a balanced diet, with a focus on increasing the intake of animal protein sources.

KEYWORDS

Growth, Community, Prevention, Intervention, Strategies, Malnutrition.

INTRODUCTION

Stunting is a significant health issue in children and is characterized by a child's anthropometric measurement showing a height-for-age indicator Z-score < -2 SD based on the WHO standard¹. Stunting typically appears early in life, inhibiting long-term linear growth and posing challenges for subsequent growth recovery². There has been a decreasing trend in the prevalence of stunting among children under five in Indonesia, from 37.2% in 2013 to 30.8% in 2018³. Likewise, in the province of Central Sulawesi, the occurrence of stunting in children aged 6-23 months decreased from 32.3% in 2007 to 31.5% in 2011 and further to 26.0% in 2016⁴. The causes of child stunting are multifactorial⁵.

At the national level, research in Indonesia by Beal et al. (2018) identified various factors contributing to stunting, including non-exclusive breastfeeding during the first six months of life, low socioeconomic status of households, premature birth, low birth length, short maternal stature, low maternal education level, inadequate sanitation facilities, untreated drinking water, limited access to healthcare, and residing in rural areas⁶. Provincial-level research by Nasrul et al. (2018) revealed that risk factors for stunting in Central Sulawesi are low birth weight, lack of handwashing practices, and lack of access to sanitation facilities⁷. In a district-level study by Nasrul et al. (2017), the prevalence of stunting in Sigi Regency was found to be 43.8%⁸.

The study conducted in Kinovaro, Sigi Regency, identified factors contributing to stunting, including low birth weight, exclusive breastfeeding, immunization history, and infec-

Correspondencia:
Fahmi Hafid
hafid.fahmi79@gmail.com

tious diseases⁹. Meanwhile, in Biromaru, Sigi Regency, factors contributing to stunting were birth length and parity¹⁰ and the City of Palu in Central Sulawesi shows that risk factors for the incidence of stunting macro nutritional intake (protein and fat), mother's education, maternal work, family income and household food security^{11,12}. Latest studies in Indonesia^{13,14}, show that the factors influencing child stunting are diverse and multifaceted. Searching for the "Publish or Perish" software reveals that there has been no research conducted on the factors influencing stunting among children aged 0-24 months in Sigi Regency. Nevertheless, Sigi Regency has been recognized as a hotspot for stunting in Central Sulawesi since 2021¹⁵.

This research aims to examine the factors influencing stunting in children aged 0-24 months in Sigi Regency. The research is important because it will provide insights into the determinants of stunting among children aged 0-24 months in Sigi Regency, which can be used to develop interventions to reduce the problem of stunting in this region. The findings of the research could have implications for policy and programming aimed at reducing stunting in Sigi Regency and other regions with high rates of stunting.

METHOD

This research utilizes an analytical research design a cross-sectional approach. The study will be conducted in Sigi Regency, involving a sample size of 436 children aged 0-24 months. Sigi Regency is one of the districts in Central Sulawesi Province, Indonesia (Figure 1). Sigi District Health Service, the 25 villages designated as the locus for handling stunting are in nine sub-districts, including Sigi Biromaru, Nokilalaki, Palolo, South Dolo, West Marawola, Kulawi, Gumbasa, South Dolo and Dolo sub-districts. Determining the number of research samples used the Slovin formula and obtained a total of 436 research respondents. The participants will consist of mothers with children aged 0-24 months, and the inclusion criteria encompass the child's age falling within 0-24 months, residence in Sigi Regency, the child being in good health, and the parent's willingness to participate as a respondent. Exclusion criteria involve the child having a chronic illness or disability.

Data collection is scheduled for September-October 2022. Research data collection was assisted by research enumerators who had passed the selection and participated in full enu-

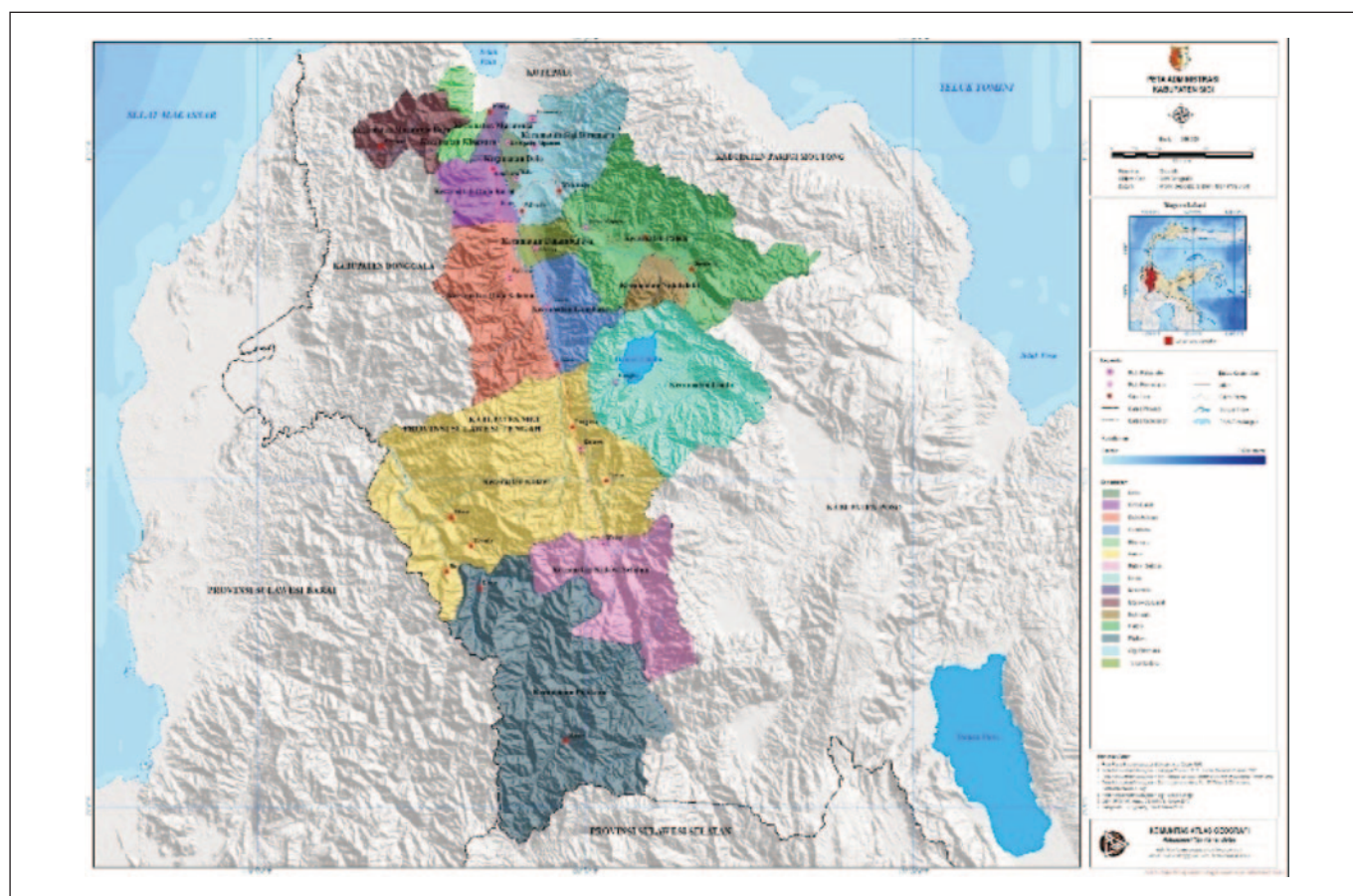


Figure 1. Administrative Map of Sigi Regency, Central Sulawesi Province, Indonesia (<https://sulteng.bpk.go.id/peta-administrasi-kabupaten-sigi/>)

erator training with enumerator criteria, namely having a D3 education in nutrition, serving for more than 2 years, not being pregnant for women, being over 20 years old, domiciled in Sigi district, having health insurance, and There is no ethnic, religious or racial conflict. The primary outcome variable in this study is stunting status, while the potential risk factors, or independent variables, include maternal characteristics such as age and education level, delivery mode, child's gender and age, household factors such as drinking water source and toilet ownership, infant feeding practices such as early breastfeeding initiation, birth length, birth weight, exclusive breastfeeding history, and current breastfeeding status during the study period, socioeconomic factors such as food insecurity, number of children, and birth spacing, healthcare utilization, complementary feeding practices, and smoking exposure within the household. Additionally, a comprehensive medical history will be collected, including information on past illnesses, acute respiratory infections, diarrhea, pneumonia, pulmonary tuberculosis, measles, and intestinal parasitic infections. Stunting status will be assessed directly by measuring

the child's length using a Length Board Measuring tool, while the child's age will be obtained from their birth certificate or Child Health Card. Other relevant data will be gathered.

Data analysis used the SPSS program and statistical tests, namely bivariate tests using Chi-Square and multivariate tests using logistic regression with the backward method, and was significant with $p < 0.05$.

This study has obtained ethical approval from the Ethics Committee of Poltekkes Kemenkes Palu (number 0011/KEPK-KPK/IV/2022 dated April 7, 2022) and research permission from the Central Sulawesi provincial government's Regional Unity and Community Affairs Agency (number 071/0204/Bid.III-BKBPD/2022 dated March 13, 2022).

RESULTS

In 2023, the Sigi Regency Government designated 38 village areas as stunting focus locations, spread across 13 districts. In this study, it was found that 28.2% of children in Sigi Regency experienced stunting in 2023. Table 1 indicates that variables

Table 1. Cross-tabulation of stunting in children under 2 years in the stunting locus of Sigi Regency

Variable	Nutritional Status				p-value
	Normal		Stunting		
	n (313)	% (71.8)	n (123)	% (28.2)	
Mother's Age in years					
<20	18	64.3	10	35.7	0.362
≥20	295	72.3	113	27.7	
Mother's Education in Years					
<9	53	54.6	44	45.4	<0.001
≥9	260	76.7	79	23.3	
Child's Gender					
Boys	157	68.6	72	31.4	0.115
Girls	156	75.4	51	24.6	
Type of Delivery					
Normal	226	68.3	105	31.7	0.004
Caesarean Section	87	82.9	18	17.1	
Child's Age In Month					
0-6	12	85.7	2	14.3	0.239
7-24	301	71.3	121	28.7	

Table 1 continuation. Cross-tabulation of stunting in children under 2 years in the stunting locus of Sigi Regency

Variable	Nutritional Status				p-value
	Normal		Stunting		
	n (313)	% (71.8)	n (123)	% (28.2)	
Source of Drinking Water					
Not Improved	27	65.9	14	34.1	0.375
Improved	286	72.4	109	27.6	
Family Toilet Ownership					
No	37	52.9	33	47.1	<0.001
Yes	276	75.4	90	24.6	
Early Initiation of Breastfeeding					
No	115	66.9	57	33.1	0.065
Yes	198	75.0	66	25.0	
Birth Length					
<48 cm	97	64.7	53	35.3	0.019
≥48 cm	211	75.4	69	24.6	
Birth Weight					
Low	28	54.9	23	45.1	0.004
Normal	285	74.0	100	26.0	
Exclusive Breastfeeding					
No	190	70.6	79	29.4	0.468
Exclusive	123	69.9	53	30.1	
Current Breastfeeding					
No	111	76.6	34	23.4	0.119
Yes	202	69.4	89	30.6	
Food Security					
Yes	7	77.8	2	22.2	0.687
No	306	71.7	121	28.3	
Number of Children					
>3	27	69.2	12	30.8	0.710
≤3	286	72.0	111	28.0	
Birth Interval In Years					
First Children	134	77.9	38	22.1	0.062
≤3	80	66.1	41	33.9	
>3	99	69.2	44	30.8	
Health Facility Utilization					
No	28	77.8	8	22.2	0.404
Yes	285	71.3	115	28.8	

Table 1 continuation. Cross-tabulation of stunting in children under 2 years in the stunting locus of Sigi Regency

Variable	Nutritional Status				p-value
	Normal		Stunting		
	n (313)	% (71.8)	n (123)	% (28.2)	
PMT Provision					
No	237	72.3	91	27.7	0.706
Yes	76	70.4	32	29.6	
Stimulation Provision					
No	84	64.1	47	35.9	0.020
Yes	229	75.1	76	24.9	
Family Members Smoking					
No	77	76.2	24	23.8	0.257
Yes	236	70.4	99	29.6	
History of Acute Respiratory Infections					
No	54	81.8	12	18.2	0.049
Yes	259	70.0	111	30.0	
History of Diarrhea					
No	232	71.8	91	28.2	0.976
Yes	81	71.7	32	28.3	
History of Pneumonia					
No	261	73.3	95	26.7	0.135
Yes	52	65.0	28	35.0	
History of Pulmonary Tuberculosis (TB)					
No	309	71.9	121	28.1	0.779
Yes	4	66.7	2	33.3	
History of Measles					
No	311	71.7	123	28.3	0.374
Yes	2	0.0	0	0.0	
History of Intestinal Parasitic Infections					
No	299	71.4	120	28.6	0.323
Yes	14	82.4	3	17.6	
Child's Condition during the Study					
Mild Illness	313	72.0	122	28.0	0.110
Healthy	0	0.0	1	100.0	

significantly associated with stunting status in Sigi Regency include the mother's education in years ($p < 0.001$, where mothers with < 9 years of education had more stunted children, 45.4%). The type of delivery also showed a significant relationship with stunting incidence, with a p -value of 0.004. Family toilet ownership demonstrated a significant association with stunting status ($p < 0.001$, with families without toilets having more stunted children, 47.1%). Birth length exhibited a significant relationship with stunting status ($p = 0.019$, where children born with a length < 48 cm had more stunted children, 35.3%). Stimulation provision had a significant association with stunting status ($p = 0.020$, with children who did not receive stimulation provision having more stunted children, 35.9%). The history of acute respiratory infections had a significant relationship with stunting incidence ($p = 0.049$, with children having a history of acute respiratory infections having more stunted children, 30.0%).

The results of multivariate analysis showed that the main determinant of stunting incidence was maternal education below 9 years with an adjusted odds ratio (AOR) of 2.3. The second determinant was low birth weight with an AOR of 2.2. The third determinant was male sex with an AOR of 1.8. The fourth determinant was birth length < 48 cm with an AOR of 1.7 (Table 2).

DISCUSSION

The determinants of stunting in the Stunting Focus Areas of Sigi, Indonesia. The significant factors contributing to stunting are identified as follows: maternal education below 9 years, low birth weight, male sex, and birth length < 48 cm. Maternal education exhibits the most robust correlation with the occurrence of stunting. Mothers with limited educational backgrounds have a higher likelihood of delivering children who experience stunting. Findings from additional research studies suggest that mothers with lower levels of education elevate the risk of stunting in children under the age of five by 3.01 times compared to mothers with higher educational levels (OR = 3.01; 95% CI = 1.92 to 4.73), demonstrating statistical significance ($p = 0.000$)¹⁶. This is due to the fact that mothers with a lower level of education are more prone to having insufficient knowledge and awareness regarding the significance of nutrition for both pregnant women and children. Furthermore, mothers with limited education are also more inclined to face constraints in accessing high-quality healthcare and food¹⁷.

Low birth weight (LBW) is a condition in which a baby is born weighing less than 2.5 kg. LBW is a major risk factor for stunting. Babies with LBW are more likely to experience growth and developmental problems later in life. Babies with LBW have experienced stunted growth and development during the prenatal period¹⁸. Infants with low birth weight (LBW) have a 20-fold higher likelihood of experiencing complications and mortality compared to babies with normal weight¹⁹. LBW infants face potential risks of cognitive deficits, delays in mo-

Table 2. Multivariate analysis of determinants of stunting in children under 2 years of age in the stunting locus of Sigi Regency

Variables	p	AOR	95%CI	
			Lower	Upper
Mother's Education in years				
<9	0.002	2.3	1.4	3.9
≥9		1.0		
Sex				
Boys	0.014	1.8	1.1	2.8
Girls		1.0		
Birth Length				
<48 cm	0.040	1.7	1.0	2.8
≥48 cm		1.0		
Low Birth Weight (LBW)				
Yes	0.024	2.2	1.1	4.5
No		1.0		
Stimulation Provision				
No	0.095	1.5	0.9	2.4
Yes		1.0		

tor development, cerebral palsy, and other behavioral and psychological issues²⁰.

Boys are more at risk of experiencing stunting than girls. Several studies exploring concurrent wasting and stunting have also shown that, overall, boys are more likely to be affected than girls²¹. A recent analysis of DHS data from Africa explored sex differences in undernutrition and found that though differences were small, overall, boys were more susceptible to undernutrition than girls²². This is likely due to a combination of biological and environmental factors. Boys tend to have higher muscle mass and metabolism than girls, which requires more energy and nutrients to support growth and development. Additionally, boys are more likely to engage in physically demanding activities, which can increase the risk of injury and infection.

Birth length is the measurement of the length of a child at birth. Birth length less than 48 cm is one of the indicators of low birth weight (LBW). Children with birth length less than 48 cm are at increased risk of stunting. Infants born with a length less than 48 centimeters (short) are 15.0 times more

likely to suffer from stunting ($p < 0.05$; 95% CI: 2.58– 87.9) compared to newborns with a length of 48 centimeters or more (normal)²³. The length of a child's body is inseparable from the growth and development of the fetus during the neonatal period.

To combat the issue of stunting in Sigi Regency, early prevention strategies should be targeted towards breastfeeding mothers, pregnant women, and preconception women. Additionally, efforts to prevent low birth weight and being born short are crucial in reducing stunting prevalence. These findings align with the goals of the health transformation program in the Ministry of Health in Indonesia, which aims to combat stunting and improve the overall health and well-being of children in the country. By focusing on preventive measures during early stages of life, interventions can be tailored to address the specific determinants identified in this study, ultimately contributing to a reduction in stunting prevalence in the region. The most prevalent public health strategies employed to diminish stunting in toddlers are health education, counseling, collaboration, and community organizing²⁴. This finding underscores the importance of focusing on interventions to improve nutrition and growth during the critical window of the first two years of life. Investing in adolescent nutrition is essential for creating a healthy generation²⁵. However, nutrition-specific interventions alone are not enough to address the challenges of the nutrition transition. Integrated nutrition programs that address the social and economic factors that influence adolescent nutrition, coupled with behavior change interventions, are urgently needed²⁵.

Short birth length and low birth weight are also recognized as notable factors contributing to stunting. This underscores the significance of sufficient prenatal care and nutrition for expectant mothers to promote the healthy development of the fetus. Additionally, targeted interventions for infants with low birth weight are essential in preventing stunting during early childhood. Conversely, the examination did not reveal a substantial correlation between stunting and issues such as food insecurity, diarrhea, and intestinal parasitic infections. However, it is essential to interpret these results with caution, as the sample size or other confounding factors may influence the findings. In the context of efforts to reduce stunting in Sigi Regency and Indonesia as a whole, these findings can guide policymakers and public health authorities in designing targeted interventions. Focusing on nutrition and healthcare interventions during the critical stages of early childhood, particularly for children aged 7-24 months, can have a significant impact on reducing the prevalence of stunting. In order to address child stunting, governmental intervention is necessary for mothers with low educational levels and those residing in rural areas²⁶. Intervention involves thorough education on enhancing nutritional well-being during pregnancy, as well as promoting practices related to complementary feeding and breastfeeding until the child reaches 24 months of age²⁶.

Furthermore, addressing the determinants of low birth weight and birth length, such as improving maternal health and nutrition, can contribute to reducing the risk of stunting from early life. Integrating nutrition-sensitive interventions into existing health and social programs can help combat food insecurity and improve overall nutrition outcomes for vulnerable populations. Moreover, programs that promote exclusive breastfeeding and appropriate complementary feeding practices are crucial in preventing stunting. Existing knowledge regarding the role of protein in managing stunting, and emphasizes the importance of appropriate protein intake in promoting optimal growth while mitigating associated risks²⁷. Providing access to clean water, sanitation facilities, and proper hygiene practices can help reduce the risk of infections, including diarrhea and intestinal parasitic infections, which can contribute to stunting.

To achieve a comprehensive approach to reducing stunting, collaboration between various stakeholders, including the Ministry of Health, local governments, non-governmental organizations, and community members, is essential. Implementing evidence-based strategies, monitoring progress, and continuously evaluating interventions will be crucial in achieving the goal of reducing stunting in Sigi Regency and Indonesia as a whole.

CONCLUSION AND RECOMMENDATIONS

The significant determinants contributing to stunting in children under 2 years in the stunting area of Sigi District are maternal education <9 years, boys gender of the child, birth length <48 cm, and low birth weight.

We suggest implementing educational programs targeting mothers with less than 9 years of education to enhance their understanding of nutrition and childcare practices. Emphasize the importance of a balanced diet, with a focus on increasing the intake of animal protein sources. Enhance prenatal care services to reduce the number of low birth weight infants and promote the health of both mothers and newborns. Promote gender equality to ensure that both boys and girls children receive equal care and nutrition. Establish a monitoring and evaluation system to track the progress of interventions and assess their impact in reducing stunting rates in the Sigi District stunting locus area. Conduct research to understand the specific challenges and barriers faced by the community in addressing the issue of stunting and adapt interventions accordingly.

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the honorable Director Poltekkes Kemenkes Palu, Indonesia, the participants, and all the people who helped us in conducting this research. This work is supported by the by Poltekkes Kemenkes Palu, Indonesia with the number 024.12.632331.054.

REFERENCES

- Nasrul, Hafid F, Razak Thaha A, Suriah. Faktor Risiko Stunting Usia 6-23 Bulan di Kecamatan Bontoramba Kabupaten Jeneponto. *Media Kesehatan Masyarakat Indonesia*. 2015;11(3): 139–46.
- Holdsworth EA, Schell LM. Stunting. *The International Encyclopedia of Biological Anthropology*. 2018;1–3.
- Kementerian kesehatan RI. Hasil Utama Riskesdas 2018. Jakarta; 2018.
- Nasrul, Maudu R, Hafid F. Trend and Prevalence of Stunting in Children Under Two Years From 2007- 2016 In Central Sulawesi. *Preventif: Jurnal Kesehatan Masyarakat*. 2017;8(2):73–8.
- Stewart CP, Iannotti L, Dewey KG, Michaelsen KF, Onyango AW. Contextualising complementary feeding in a broader framework for stunting prevention. *Maternal and Child Nutrition*. 2013;9(S2): 27–45.
- Beal T, Tumilowicz A, Sutrisna A, Izwardy D, Neufeld LM. A review of child stunting determinants in Indonesia. *Maternal and Child Nutrition*. 2018;14(4):1–10.
- Nasrul. Pengendalian Faktor Risiko Stunting Anak Baduta di Sulawesi Tengah. *Promotif: Jurnal Kesehatan Masyarakat*. 2018; 8(2):131–46.
- Nasrul N, Taqwin T, Hafid F. The Prevention Against Morbidity and Stunting Through Vitamin A Supplementation In Sigi and Touna Districts. In: *Pontianak International Health Conference (PIHC)*. ISBN 978-602-51424-0-6; 2017. p. 317–25.
- Miranti, Mutiarasari D, Arsin AA, Hadju V, Mallongi A, Nur R, et al. Determinants of the incidence of stunting in the working area of Kinovaro Sigi Health Center. *Enfermería Clínica*. 2020;30:246–52.
- Lewa Abdf, Kusika SY, Muliani, Rahmawati, Jannah I. Risk factors of stunting events in child 6–23 months old in Biromaru Public Health Center Sigi. *Enfermería Clínica*. 2020;30:131–5.
- A M, Rahman N. Risk Factors for Stunting in School Children at Poboya Elementary School. *Journal of Health and Nutrition Research*. 2022;1(1):1–5.
- Palinggi M, Rau MJ, Buchair NH, Jannah AR, Rahmania, Sirata MFD. Factors Associated with Decreasing Incidence of Stunting in the Working Area of the Palu Health Center. *Journal of Health and Nutrition Research*. 2023;2(1):27–32.
- Eryando T, Sipahutar T, Budhiharsana MP, Siregar KN, Nur Aidi M, Minarto, et al. Spatial analysis of stunting determinants in 514 Indonesian districts/cities: Implications for intervention and setting of priority. *Geospatial Health*. 2022;17(1).
- Widyaningsih, Mulyaningsih, Rahmawati, Adhitya. Determinants of socioeconomic and rural-urban disparities in stunting: evidence from Indonesia. *Rural and Remote Health*. 2022;22(1):1–9.
- Menteri Perencanaan Pembangunan Nasional/Kepala Badan Perencanaan Pembangunan Nasional. Keputusan Menteri Perencanaan Pembangunan Nasional/ Kepala Badan Perencanaan Pembangunan Nasional Nomor Kep 42/M.PPN/Hk/04/2020 Tentang Penetapan Perluasan Kabupaten/Kota Lokasi Fokus Intervensi Penurunan Stunting Terintegrasi Tahun 2021. Indonesia; 2020 p. 4.
- Azizah AM, Nurmala I, Devy SR. Meta Analisis: Pengaruh Tingkat Pendidikan Ibu Terhadap Kejadian Stunting Pada Anak Balita. *Amerta Nutrition*. 2022;6(4):369–75.
- Vikram K, Vanneman R. Maternal Education and the Multidimensionality of Child Health Outcomes in India. *J Biosoc Sci*. 2020; 52(1):57–77.
- Setiawan AS, Indriyanti R, Suryanti N, Rahayuwati L, Juniarti N. Neonatal stunting and early childhood caries: A mini-review. *Front Pediatr*. 2022;10:871862.
- Wardlaw TM. Low Birthweight: Country, Regional and Global Estimates. UNICEF; 2004. 31 p.
- Mathewson KJ, Chow CHT, Dobson KG, Pope EI, Schmidt LA, Van Lieshout RJ. Mental health of extremely low birth weight survivors: A systematic review and meta-analysis. *Psychol Bull*. 2017;143(4):347–83.
- Khara T, Mwangome M, Ngari M, Dolan C. Children concurrently wasted and stunted: A meta-analysis of prevalence data of children 6-59 months from 84 countries. *Matern Child Nutr*. 2018; 14(2):e12516.
- Garenne M. Sex differences in health indicators among children in African DHS surveys. *Journal of Biosocial Science*. 2003;35(4): 601–14.
- Lukman TNE, Anwar F, Riyadi H, Harjomidjojo H, Martianto D. Birth Weight and Length Associated with Stunting among Children Under-Five in Indonesia. *J Gizi Pangan*. 2021;16(Supp 1):99–108.
- Rahmadiyah D, Sahar J, Widyatuti W. Public Health Interventions to Reduce Stunting in Toddlers: A Systematic Review. *Open Access Maced J Med Sci*. 2022;10(F):158–67.
- Sparrow R, Agustina R, Bras H, Sheila G, Rieger M, Yumna A, et al. Adolescent Nutrition—Developing a Research Agenda for the Second Window of Opportunity in Indonesia. *Food Nutr Bull*. 2021;42(1_suppl):S9–20.
- Suratri MAL, Putro G, Rachmat B, Nurhayati, Ristrini, Pracoyo NE, et al. Risk Factors for Stunting among Children under Five Years in the Province of East Nusa Tenggara (NTT), Indonesia. *International Journal of Environmental Research and Public Health*. 2023;20(2):1640.
- Fikri AM, Astuti W, Nurhidayati VA, Prameswari FSP, Ismail NH. Protein intake recommendation for stunted children: an update review. *Nutrición Clínica y Dietética Hospitalaria*. 2024;44(3): 117–23.

Modeling hidden hunger in toddlers to determine the most influential micronutrients in stunting

Iseu Siti AISYAH^{1,3}, Ali KHOMSAN², Ikeu TANZIHA², Hadi RIYADI²

1 Postgraduate in Nutrition Science, Department of Community Nutrition, IPB University, Bogor, Indonesia.

2 Departement of Community Nutrition, IPB University, Bogor, Indonesia.

3 Departement of Nutrition, Faculty of Health Science, Siliwangi University, Tasikmalaya, Indonesia.

Recibido: 29/abril/2024. Aceptado: 12/julio/2024.

ABSTRACT

Background: Risk factors that directly influence the incidence of stunting are the level of macronutrient and micronutrient intake. Micronutrient deficiencies cause about 1.1 million of the 3.1 million annual child deaths. This condition leads to hidden hunger, a condition of insufficient intake of micronutrients (especially iron, zinc, and iodine deficiencies). This study aimed to analyze hidden hunger in stunted and non-stunting toddlers with a multivariate model.

Methods: A comparative cross-sectional study. A total of 71 toddlers were taken as respondents for the stunting group and 71 toddlers for the non-stunting group. The study used data collection was 2 x 24-hour food recall, FFQ, and blood serum collection to check zinc deficiency, iodine, hemoglobin, and urine tests. For data analysis, multivariate logistic regression and then bivariate analysis were used. The regression method used is "backward". Data was considered statistically significant with a p-value of <0.05.

Results: Toddlers with stunting were much more likely to have inadequate iron (92.95%) and zinc intake (91.54%) compared to the non-stunting group (78.87% and 77.46% respectively). A significantly higher proportion of the stunting group (40.84%) had anemia compared to the non-stunting group (5.63%). Unlike iron, zinc, and anemia, there wasn't a statistically significant relationship between iodine deficiency ($p = 0.459$) or hidden hunger ($p = 0.058$) and stunting. The results of the multivariate analysis suggest that iron intake, anemia status, and zinc deficiency are all important risk fac-

tors for stunting in toddlers. The anemia status variable was the most dominant cause of stunting because it had the highest OR value of 41.733.

Conclusion: Toddlers with stunting are significantly more likely to have inadequate iron and zinc intake and suffer from anemia compared to non-stunted toddlers, with anemia being the most dominant risk factor for stunting, evidenced by the highest OR value of 41.733.

KEYWORDS

Malnutrition, Growth Impairment, Biomarkers, Risk Factors, Nutritional Deficiency.

INTRODUCTION

Some Indonesians are known to still have nutritional problems until now, one of which is the low fulfillment of micronutrients, leading to hidden hunger. According to data from the Global Hunger Index in 2020, Indonesia is in position 70 out of 107 countries, and around 20-40 percent of people in Indonesia experience micronutrient deficiencies¹. In addition, other malnutrition problems include stunting, wasting, and underweight, which are growth disorders in children under 5 years old due to malnutrition^{2,3}.

Based on the Indonesian Basic Health Study of 2018 carried out by the Ministry of Health of Indonesia, the prevalence of stunting problems in toddlers was 30.79%, the prevalence of wasting in toddlers was 10.19%, and the prevalence of underweight was 17.68%⁴. Based on the results of the Indonesian Nutritional Status Survey, known as SSGI, in 2019⁵, the prevalence of stunting was 27.7%; in 2021, it was 24.4%; while in 2022, stunting toddlers decreased by 2.8%; then, the stunting rate in 2022 was 21.6%. There are 18 provinces with high prevalence (30-40%), and according to the SSGI Data of 2021,

Correspondencia:

Ali Khomsan

khomsanali@apps.ipb.ac.id

the stunting prevalence of West Java Province reached 24.5%, slightly above the national average stunting rate of 24.4%⁶.

According to Marivoet et al. (2021), hidden hunger is the presence of multiple micronutrient deficiencies (particularly iron, zinc, iodine, and vitamin A), which can occur in the absence of an energy intake deficit as a result of consuming an energy-dense but nutrient-poor diet⁷. Iron, zinc, and iodine are micronutrient deficiencies of global concern due to their high prevalence and associated health consequences⁸. According to Godecke (2018), common proxies used in measuring hidden hunger include stunting children, wasting, micronutrient availability below recommended thresholds of micronutrient intake, and deficiency status in the body⁹.

The high prevalence of stunting in Indonesia is also followed by a high prevalence of wasting in toddlers and malnutrition in toddlers¹⁰. West Java is the province with a stunting rate above the average Indonesian stunting rate. Tasikmalaya City has three urban villages with above-average stunting rates and is now facing severe public health problems related to hidden hunger, a condition of insufficient micronutrient intake (vitamins and minerals) in toddlers. This study was conducted to determine the effect of hidden hunger (micronutrient deficiencies) on the incidence of stunting in children under five in Tasikmalaya City.

METHOD

Study Design

A comparative cross-sectional study was conducted over four months in Karanganyar village, Kawalu sub-district, which has the highest prevalence of stunting. The selected toddlers

must meet the inclusion criteria, such as the chosen stunting toddlers being in good health and their mothers being willing to participate, as evidenced by the mother signing informed consent. The chosen non-stunting toddlers were not obese or in good health, and their mothers were willing to participate, as evidenced by the mother signing informed consent. The population in this study were all toddlers aged 1-5 years in Karanganyar village, Kawalu sub-district, which had the highest prevalence of stunting (26.42%), totaling 822 toddlers.

The sample calculation was determined by the sample size formula to estimate the proportion of the population with absolute precision (Lwanga and Lemeshow 1991), and a sample that met the inclusion criteria of 71 people for one stunting group (case) was obtained. For the control group (non-stunting), as many as 71 people, the total sample size was 142. The sampling technique was purposive sampling. The flow-chart of the participant selection procedure is described in Figure 1.

Data Collection

Demographic data included the toddler's age (in months), gender of the toddler, mother's age, mother's latest education, and family income level. Anthropometric data, micronutrient intake, iron, zinc, and iodine deficiency as hidden hunger modeling were conducted with the following details.

Quantitative Data

Micronutrient Intake

The method used to determine the intake of micronutrients and macronutrients was using the food frequency method

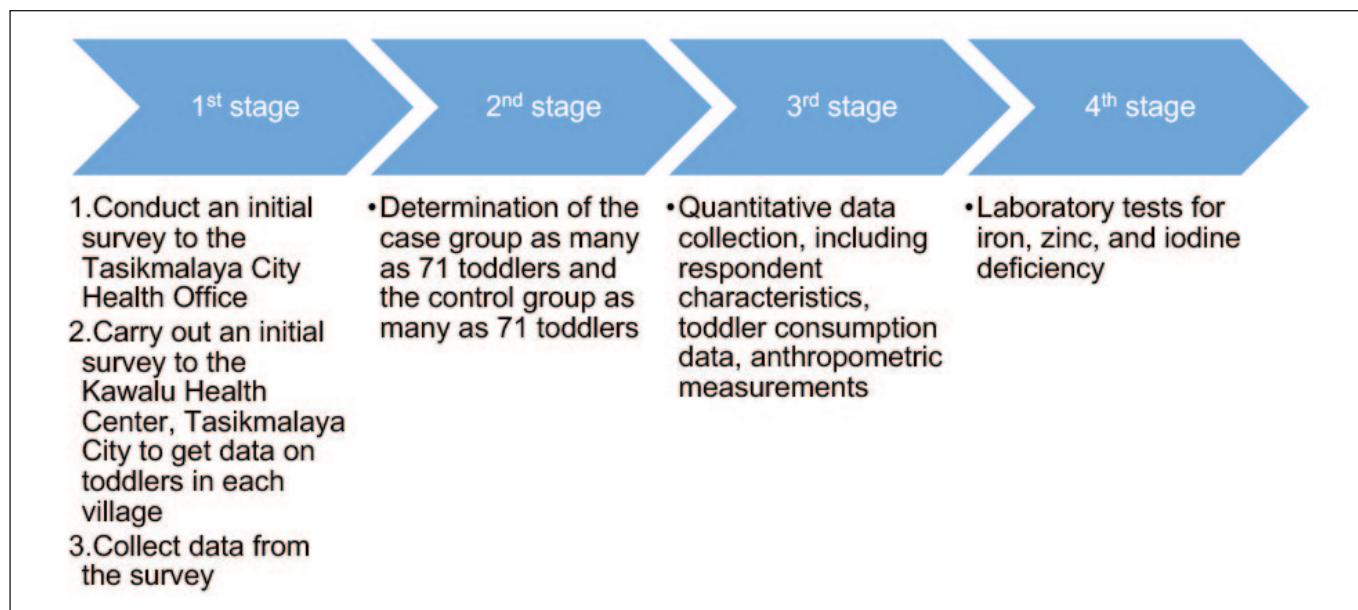


Figure 1. Flow chart of the whole research.

(Food Frequency Questionnaire). The FFQ method was used to find out or obtain data about individuals' eating patterns and habits at a certain time. The information obtained was eating patterns and habits (habitual intakes). Food consumption that was asked is food containing micronutrients such as iron, zinc, and iodine. The steps in collecting data using the food frequency method were:

- a. Prepare the FFQ form.
- b. Introduce and explain the purpose of data collection to the respondents.
- c. Ask for the types of food that could be eaten in the last month. The officer invited the respondents to mark the list of foods on the questionnaire.
- d. If the respondent was unable to mark on the form, the officer asked for details of the food that was usually eaten, starting from daily, weekly, and monthly, and then marked in the time column.
- e. Columns were filled in only in one-time groups. For example, if the sample usually eats rice 3 times a day, the week and month columns should not be filled in. Conversely, if the sample eats meat 3 times a month, the day and week columns do not need to be filled in.
- f. Repeat asking back what has been marked on the fill-in format.

To strengthen the FFQ data, food intake of calories (kcal), protein (g), and iron (mg) were measured using 3×24-hour food recall, and average intake was calculated. We used food photos to improve the accuracy of household size estimates (teaspoons, tablespoons, and other eating utensils). Nutri Survey was used to analyze the food intake data. Food intake was measured by four trained students from the Department of Nutrition.

Iodine Deficiency

Data on iodine deficiency was collected through urine collection to test for iodine with the help of Prodia laboratory medical personnel. Data was categorized as normal with 20-30 µg/dl levels and deficiency if <20 µg/dl.

Iron Deficiency

Iron deficiency/anemia data was collected by taking blood serum to test hemoglobin with the help of Prodia laboratory medical personnel. Categorical data, with categories of anemia and not anemia, declare as anemia for toddlers with below 11 g/dl hemoglobin level.

Zinc Deficiency

Data on zinc deficiency was collected by taking blood serum to test for Zn with the help of Prodia laboratory medical per-

sonnel. A level of 70-150 µg/dL (10.7-22.9 µmol/L) of serum Zn was categorized as normal, and serum level <70 µg/dl was categorized as deficiency.

Anthropometric Data

Body weight measurements used a scale with an accuracy of 0.1 kg for two replicates. While for height, using a stadiometer. Stunting status will be assessed directly by measuring the child's length using a stadiometer. Then analyzed using WHO Anthro Survey Analyzer Software. Height for age (Normal (z-score ≥ -2.0); Stunting (z-score -3.0 to -2.0 or z-score < -3.0).

Hidden Hunger

If a toddler experienced three micronutrient deficiency conditions, including iron, zinc, and iodine, then the toddler was categorized as experiencing hidden hunger; if experiencing only one or two of those micronutrient deficiencies, it was not declared as hidden hunger.

Ethical Approval

The Research Ethics Committee of the Faculty of Nutritional Sciences, IPB University, Indonesia, approved this study (Protocol Number: 855/IT3.KEPMSM-IPB/SK/2023).

Statistical Analysis

Raw Data was entered into Excel 2019. Statistical analysis was conducted using Statistical Package for Social Science (SPSS). Descriptive analysis included (1) estimation of basic statistics (mean and standard deviation) for all quantitative variables and (2) estimation of proportions for all categorical variables. Univariate analysis was used to describe the frequency distribution of both independent-dependent variables and the description of respondent characteristics. Bivariate analysis was used to test the relationship between the independent and dependent variables using the Chi-Square or Fisher Exact Test/Continuity Correction because it uses categorical-categorical data. Logistic regression (categorical data/odds ratio) was conducted to analyze the factors that influence the determinants of stunting. Data was considered statistically significant with a p-value of <0.05. Meanwhile, categorical data was identified using the odds ratio (OR) value.

RESULTS

Characteristics of Mothers and Toddlers

More toddlers were 36-47 months (45.1%) in the case group and 24-25 months (45.1%) in the control group. Most of the toddlers in the case group were female (57.7%), and the control group was male at 53.5%. Based on the mother's age characteristics, most were 26-35 years old, which was in-

cluded in the early adulthood category (42.3%) in the case group and 46.5% in the control group. The last education of mothers with the highest number was elementary school both in the case group (57.7%) and in the control group (38.4%), with the majority income being low or below city district minimum wage both in the case group (73.2%) and the control group (64.6%) shown in (Table 1).

Bivariate Analysis

The relationship between independent variables, namely iron intake, zinc intake, iodine intake, anemia status, zinc deficiency, iodine deficiency, and hidden hunger, with the de-

pendent variable, the incidence of stunting. For hidden hunger variables based on the combined variables of anemia status, zinc deficiency, and iodine deficiency. If respondents experienced all three conditions, they would be declared to experience hidden hunger (Table 2).

Table 2 shows that toddlers with stunting conditions mostly had iron intake that did not meet (92.95%), and the non-stunting group mostly did not meet 78.87%. The chi-square statistical test results obtained a value of $p=0.030 (<0.05)$, indicating a relationship between iron intake and the incidence of stunting in toddlers in Karanganyar Village, Kawalu District, Tasikmalaya City.

Table 1. Frequency Distribution of Mother and Toddler Characteristics (n=142)

Variable	Stunting (Cases)		Non-stunting (Control)		P-Value
	n	%	n	%	
Toddler Age (months)					0.240
24 – 35	17	23.9	32	45.1	
36 – 47	32	45.1	22	31.0	
48 – 59	22	31.0	17	23.9	
Gender					0.029
Male	30	42.3	38	53.5	
Female	41	57.7	33	46.5	
Mother’s Age (years*)					0.169
17 – 25 (late teens)	9	12.7	13	18.3	
26 – 35 (early adulthood)	30	42.3	33	46.5	
36 – 45 (late adulthood)	29	40.8	18	25.4	
> 45 (elderly)	3	4.2	7	9.9	
Mother’s Last Education					0.113
Not completed in elementary school	0	0.0	1	1.4	
Elementary school	41	57.7	28	39.4	
Junior high school	19	26.8	23	32.4	
Senior high school	11	15.5	19	26.8	
Family Income					0.364
Low (<city district minimum wage)	52	73.2	46	64.8	
High (≥city district minimum wage)	19	26.8	25	35.2	

* = Republic of Indonesia Ministry of Health, 2009

Table 2. Chi-square Test Results

Variable	Toddlers				Total n	P Value	OR (95% CI)
	Stunting		Non Stunting				
	n	(%)	n	(%)			
Iron intake							
insufficient	66	92.95	56	78.87	122	0.03	3.356 (1.209-10.338)
Sufficient	5	7.04	15	21.13	20		
Zinc intake							
Insufficient	65	91.54	55	77.46	120	0.037	2.255 (1.145-4.441)
Sufficient	6	8.46	16	22.54	22		
Iodine Intake							
Insufficient	47	66.2	33	46.48	80	0.028	3.661 (1.709-7.841)
Sufficient	24	33.8	38	53.52	62		
Status Anemia							
Anemia	29	40.84	4	5.63	33	0.001	11.565(3.795-35.244)
Not anemic	42	59.16	67	94.37	109		
Zinc Deficiency							
Deficiency	32	45.07	13	18.31	33	0.001	3.661
Not Deficiency	39	54.93	48	81.69	109		(1.709-7.841)
Iodine Deficiency							
Deficiency	18	25.35	23	56.1	41	0.459	-
Not Deficiency	53	74.65	48	32.39	101		
Hidden Hunger							
Yes	5	7.04	0	0	5	0.058	-
No	66	92.96	71	100	137		

For zinc intake, toddlers with stunting and non-stunting conditions mostly had insufficient zinc intake (91.54%) in the case group and (77.46%) in the control group. The chi-square statistical test results obtained a value of $p=0.037$ (<0.05), indicating a relationship between zinc intake and the incidence of stunting in toddlers in Karanganyar Village, Kawalu Subdistrict, Tasikmalaya City. For iodine intake, toddlers with stunting conditions mostly had iodine intake that did not meet (66.2%), while toddlers with non-stunting conditions had iodine intake that met (53.52%). The statistical test results using chi-square

obtained a value of $p=0.028$ (<0.05), indicating a relationship between iodine intake and the incidence of stunting in toddlers in Karanganyar Village, Kawalu Subdistrict, Tasikmalaya City.

From the results of laboratory tests, for anemia status, toddlers with stunting conditions mostly had a non-anemia status (59.16%), and the control group had a non-anemia status of 94.37%. The statistical test results using chi-square obtained a value of $p=0.000$ (<0.05), indicating a relationship between anemia status and the incidence of stunting in toddlers in Karanganyar Village, Kawalu District, Tasikmalaya

City. In zinc deficiency, toddlers with stunting conditions mostly had a status of no zinc deficiency (54.93%), and the control group had a status of no zinc deficiency of 81.69%.

The statistical test results using chi-square obtained a p-value = 0.001 (<0.05), indicating a relationship between zinc deficiency and the incidence of stunting in toddlers in Karanganyar Village, Kawalu District, Tasikmalaya City. For iodine deficiency variables (p = 0.459) and hidden hunger (p = 0.058), because the p-value => 0.05, there was no relationship between iodine deficiency and hidden hunger with the incidence of stunting in Karanganyar Village, Kawalu District, Tasikmalaya City.

Logistic Regression Modeling

Logistic regression modeling was performed to determine the most dominant variables associated with the incidence of stunting in children under five years of age, which was carried out in stages:

Selection of Model Candidates

The selection of candidate variables that enter the model was carried out using bivariate analysis of each independent variable with the dependent variable. Variables that enter the modeling variable should be with a p-value ≤ 0.25.

Table 3 shows that iron intake, zinc intake, iodine intake, zinc deficiency, anemia status, and hidden hunger were included in the multivariate model. Iodine deficiency was not included in the model.

Multivariate Modeling of Factors Causing Stunting Incidence

Variables that enter the candidate model would then be analyzed simultaneously with the dependent variable. Variables with a p-value > 0.05 would be removed gradually, starting from the variable with the largest value, so the variables entered in the next model were variables with a p-value ≤ 0.05.

Table 3. Results of Bivariate Analysis of Independent Variables with Dependent Variables

Variable	P-value	Multivariate Candidates
Iron Intake	0.030	Enter modeling
Zinc Intake	0.037	Enter modeling
Iodine Intake	0.028	Enter modeling
Zinc Deficiency	0.001	Enter modeling
Anemia Status	0.000	Enter modeling
Iodine Deficiency	0.459	No Entry modeling
Hidden Hunger	0.058	Enter modeling

The results of the multivariate model analysis for the incidence of stunting in children under five are presented (Table 4). Four models were analyzed, with different independent variables in each model. Model 1 only included the variables of iron intake, zinc intake, iodine intake, anemia status, zinc deficiency, and hidden hunger. The results showed that there was a significant relationship for all variables. Model 2 showed that iron intake, zinc intake, iodine intake, anemia status, and zinc deficiency were significantly associated, but hidden hunger did not have a significant association with the incidence of stunting. Model 3 showed that only the variables of iron intake, zinc intake, anemia status, and zinc deficiency had a significant relationship with the incidence of stunting. Model 4 showed that iron intake, anemia status, and zinc deficiency had a significant relationship with the incidence of stunting.

Final Modeling

After analyzing the results of the multivariate model up to the 4th model, the 4th model was finally found to be all significant and presented in table 5.

Table 4. Results of Multivariate Model Analysis of Stunting Incidence

Variblae	Multivariate Model 1	Multivariate Model 2	Multivariate Model 3	Multivariate Model 4
Iron Intake	0.003	0.004	0.003	0.004
Zinc Intake	0.068	0.068	0.095	-
Iodine Intake	0.113	0.089	-	-
Anemia Status	0.001	0.001	0.000	0.000
Zinc Deficiency	0.047	0.030	0.022	0.014
Hidden Hunger	0.999	-	-	-

Table 5. Final Model of Multivariate Analysis of the Incidence of Stunting in Toddlers

Variables	β	p-value	OR	95% CI
Iron Intake	3.278	0.004	26.530	2.842-247.665
Anemia Status	3.731	0.000	41.733	5.349-325.603
Zinc Deficiency	1.072	0.014	2.923	1.248-6.846

It is known that the variables of iron intake, anemia status, and zinc deficiency had a significant relationship with the incidence of stunting in toddlers (Table 5). The results also show that the anemia status variable was the most dominant cause of stunting because it had the highest OR value of 41.733. The OR value indicated that toddlers with anemia would be 41.733 times more likely to have a stunted nutritional status. It is also known from the statistical test results that the Nagelkerke R Square value was 0.399 and Cox & Snell R Square was 0.300, which indicated that the ability of the independent variable to explain the dependent variable is 0.399 or 39.9%, and there were 100% - 39.9% = 60.1% other factors outside the model that explain the dependent variable.

DISCUSSION

According to our findings, toddlers with anemia will have a 41.733 times greater risk of having a stunted nutritional status. Iron intake, anemia status, and zinc deficiency are significantly related to the incidence of stunting in toddlers. From the model, it was found that iron intake, anemia status, and zinc deficiency had a significant relationship with the incidence of stunting. Our findings are in line with research conducted by Yudhistira et al. Iron deficiency anemia occurs due to iron deficiency in the blood, meaning that the concentration of hemoglobin in the body is reduced due to disruption of the formation of red blood cells due to a lack of iron levels in the blood¹¹.

Sirajuddin et al. 2020 examined iron intake on stunting. Their findings support our research that the lack of iron intake in toddlers causes growth retardation, so if this event continues for a long time, it can cause stunting¹². Iron intake plays an important role because iron is the core of hemoglobin¹³. The function of iron is to help hemoglobin circulate oxygen to all body tissues and carry oxygen in red blood cells to the brain¹⁴.

The results of this study are in line with the research of Mutiara et al. (2021) on 32 children in the Cibeber Health Center Working Area, Cimahi City, which showed that there was a relationship between iron intake and the incidence of stunting in toddlers aged 1-3 years with a value of $p = 0.028$ ($p < \alpha$)¹⁵. Research by Mutiara et al. (2021) also shows that iron intake is lacking more in toddlers who suffer from stunting

(75%)¹⁵. In line with the research of Sunardi et al. (2021) on 612 toddlers aged 6-59 months in Babakan Madang District, Bogor City, in 2019, it showed a significant relationship between iron intake and the incidence of stunting in toddlers¹⁶. Toddlers who experience insufficient iron intake have a chance of suffering from stunting 1.807 times greater than toddlers who have adequate iron intake. Supporting these findings, other studies have employed multivariate analysis to identify iron deficiency as the most significant factor influencing children's nutritional status¹⁷⁻¹⁹. This highlights a potential link between inadequate iron intake and stunting in toddlers, as proper nutrition is crucial during this critical growth period. Moringa leaves, which are rich in health benefits, should be utilized as well as possible by including them in various nutritious recipes which can function as an iron supplement for growing children²⁰.

Zinc is an essential mineral that has an important role in synthesizing and degrading carbohydrates, lipids, proteins, and nucleic acids²¹. In addition, zinc also plays a role in activating and synthesizing Growth hormone (GH), maintaining immunity, as an antioxidant, taste and reproductive function, and membrane stabilization²². Zinc absorption occurs in the small intestine; after being absorbed, zinc is transported by albumin and transferrin into the bloodstream and taken to the liver²³. Excess zinc will be stored in the liver as metallothionein, while the rest will be carried to the pancreas and other body tissues such as skin, hair, nails, bones, retina, and other reproductive organs²⁴.

Zinc requirements increase rapidly during the toddler years to support growth and development²⁵. This further affects the occurrence of zinc deficiency in toddlers if they do not get adequate food intake, especially foods derived from animal sources. Some signs of zinc deficiency, such as impaired growth, impaired sexual maturity, impaired digestive function, impaired immune function, impaired appetite, and slowed wound healing, can even interfere with the central nervous system and brain function in chronic zinc deficiency^{26,27}. This will also affect the nutritional status of toddlers, including stunting.

STUDY LIMITATIONS

There are several limitations in this study. The number of samples is limited due to expensive laboratory tests and the

difficulty of getting toddlers who want to take blood samples. Also, even though blood samples from toddlers have been taken, some samples have been lysed, broken, and clotted so that the samples cannot be examined, which is also a potential limitation. Finally, although we have accounted for and controlled for several confounding variables, other potential confounding variables, such as health conditions at the time of blood draw, may have influenced the results and the toddler's history of infectious diseases. We suggest that future research be conducted with a large sample size, considering confounding variables that have not been measured in our study. The advantage of this research is that it measures hidden hunger in toddlers, which is still rarely done because it uses laboratory tests by taking blood and urine; with the data related to hidden hunger and its association with stunting, we expected that it could become a comprehensive recommendation for dealing with the problem of stunted toddlers.

CONCLUSION AND RECOMMENDATIONS

Our results indicate that inadequate iron and zinc intake, as well as anemia, are significant risk factors for stunting. Specifically, toddlers with stunting were significantly more likely to have inadequate iron (92.95%) and zinc intake (91.54%) compared to their non-stunting counterparts (78.87% and 77.46%, respectively). Additionally, a higher proportion of stunted toddlers (40.84%) were found to have anemia compared to non-stunted toddlers (5.63%). Our multivariate analysis revealed that iron intake, anemia status, and zinc deficiency are critical predictors of stunting, with anemia emerging as the most dominant factor, as evidenced by an OR value of 41.733. This suggests that toddlers with anemia are 41.733 times more likely to experience stunting. However, no statistically significant relationship was found between iodine deficiency or hidden hunger and stunting. The statistical test results, including the chi-square test, reinforced these findings, showing a significant relationship between zinc deficiency and stunting ($p = 0.001$). The Nagelkerke R Square value of 0.399 and Cox & Snell R Square value of 0.300 indicate that the independent variables in our model explain 39.9% of the variability in stunting incidence, leaving 60.1% to other factors outside the model.

These findings underscore the importance of addressing iron intake, anemia, and zinc deficiency in efforts to reduce stunting in toddlers. Future research should focus on quantifying nutrient deficits more precisely to further refine these predictive models. The recommended strategy is providing iron and zinc supplements, which can be recommended as an effective program to reduce hidden hunger, influencing the prevalence of stunting in toddlers.

ACKNOWLEDGEMENTS

Our gratitude to all participants who took part in this research. Besides, the Neys-van Hoogstraten Foundation and

the IPB University for the major funding of this research with the "Research Grant Proposal Inter-University Collaboration Program in Food and Nutrition Security" funding with contract Number 02/NHF-IPB/2022 dated 17 February 2022.

REFERENCES

1. The Global Hunger Index. Global Hunger Index Scores by 2023 GHI Rank [Internet]. Global Hunger Index (GHI) - peer-reviewed annual publication designed to comprehensively measure and track hunger at the global, regional, and country levels. 2023. Available from: <https://www.globalhungerindex.org/ranking.html>
2. Govender I, Rangiah S, Kaswa R, Nzaumvila D. Malnutrition in children under the age of 5 years in a primary health care setting. *S Afr Fam Pract* (2004). 2021;63(1):5337.
3. Abri N. Identification of Socio-Demographic Factors with the Incidence of Stunting in Elementary School Children in Rural Enrekang. *Journal of Health and Nutrition Research*. 2022;1(2): 88–94.
4. Kementerian Kesehatan Republik Indonesia. Laporan Riset Kesehatan Dasar Tahun 2018 (Indonesian National Basic Health Survey in 2018). Jakarta: Kementerian Kesehatan Republik Indonesia; 2018.
5. Kemenkes RI. Buku Saku Hasil Studi Status Gizi Indonesia (SSGI) Tahun 2019. Badan Kebijakan Pembangunan Kesehatan (BKPK). Kementerian Kesehatan Republik Indonesia; 2019.
6. Kemenkes RI. Buku Saku Hasil Studi Status Gizi Indonesia (SSGI) Tahun 2022. Badan Kebijakan Pembangunan Kesehatan (BKPK). Kementerian Kesehatan Republik Indonesia; 2022.
7. Marivoet W, Ulimwengu J, Sall L, Gueye A, Savadogo K, Dia K. Hidden Hunger: Understanding Dietary Adequacy in Urban and Rural Food Consumption in Senegal. India: International Food Policy Research Institute (IFPRI); 2021.
8. Hernández-Gallardo D, Moreno RA, Bosques-Cotelo JJ, Pérez-Iribar G, Nuñez-Peña CR. Ingesta de micronutrientes en estudiantes de enfermería de la Universidad Laica Eloy Alfaro de Manabí, Ecuador: Ingesta de micronutrientes en universitarios. *Nutrición Clínica y Dietética Hospitalaria*. 2021;41(3). Available from: <https://revista.nutricion.org/index.php/ncdh/article/view/157>
9. Gödecke T, Stein AJ, Qaim M. The global burden of chronic and hidden hunger: Trends and determinants. *Global Food Security*. 2018;17:21–9.
10. Laksono AD, Wulandari RD, Amaliah N, Wisnuwardani RW. Stunting among children under two years in Indonesia: Does maternal education matter? *PLoS One*. 2022;17(7):e0271509.
11. Yudhistira B, Sari T ratna, Affandi DR. Karakteristik Fisik, Kimia dan Organoleptik Cookies Bayam Hijau (*Amaranthus tricolor*) dengan Penambahan Tomat (*Solanum lycopersicum*) sebagai Upaya Pemenuhan Defisiensi Zat Besi pada Anak-Anak. *Warta Industri Hasil Pertanian*. 2019;36(2):83–95.
12. Kurniati I. Anemia Defisiensi Zat Besi (Fe). *Jurnal Kedokteran Universitas Lampung*. 2020;4(1):18–33.

13. Sirajuddin S, Rauf S, Nursalim N. Asupan Zat Besi Berkorelasi dengan Kejadian Stunting Balita di Kecamatan Maros Baru. *Gizindo*. 2020;43(2):109–18.
14. Damayanti D, Gulo NS, Anuhgerah DE, Handayani D. Efektivitas Tablet Zat Besi terhadap Perubahan Tekanan Darah Ibu Hamil. *JKK*. 2021;3(2):149–57.
15. Mutiara D, Rusman AA, Ruhiman RS. Hubungan Stunting dengan Karakteristik Anak, Asupan Gizi, dan Anemia pada Batita di Wilayah Puskesmas Cibeber. *Medika Kartika: Jurnal Kedokteran dan Kesehatan*. 2021;4(3):293–304.
16. Sunardi D, Bardosono S, Basrowi RW, Wasito E, Vandenplas Y. Dietary Determinants of Anemia in Children Aged 6–36 Months: A Cross-Sectional Study in Indonesia. *Nutrients*. 2021;13(7):2397.
17. Umami R, Flora R, Sitorus RJ, Zulkarnain M. The Relationship between Iron Deficiency and Nutritional Status of Elementary School Children in the Tuah Negeri District. *Budapest International Research and Critics Institute-Journal (BIRCI-Journal)*. 2021;4(3): 5486–91.
18. A M, Rahman N. Risk Factors for Stunting in School Children at Poboya Elementary School. *Journal of Health and Nutrition Research*. 2022;1(1):1–5.
19. Utami MMH, Kustiyah L, Dwiriani CM. Risk Factors of Stunting, Iron Deficiency Anemia, and Their Coexistence among Children Aged 6-9 Years in Indonesia: Results from the Indonesian Family Life Survey-5 (IFLS-5) in 2014-2015. *AMNT*. 2023;7(1):120–30.
20. Sandhya J, Chinnathambi K. Ms Development of Millet Based Moringa - Amla Snack Bar for Iron Deficiency in Adolescents. *Nutrición Clínica y Dietética Hospitalaria*. 2024;44(2). Available from: <https://revista.nutricion.org/index.php/ncdh/article/view/583>
21. Skrajnowska D, Bobrowska-Korczak B. Role of Zinc in Immune System and Anti-Cancer Defense Mechanisms. *Nutrients*. 2019; 11(10):2273.
22. Kiouri DP, Tsoupra E, Peana M, Perlepes SP, Stefanidou ME, Chasapis CT. Multifunctional role of zinc in human health: an update. *EXCLI J*. 2023;22:809–27.
23. Maares M, Haase H. A Guide to Human Zinc Absorption: General Overview and Recent Advances of In Vitro Intestinal Models. *Nutrients*. 2020;12(3):762.
24. Almatsier S. *Prinsip Dasar Ilmu Gizi*. Jakarta: PT Gramedia Pustaka Utama; 2009.
25. Goyena EA, Maniego ML V, Ducay AJD, Musa MCA, Angeles-agdeppa I. Dietary Zinc Intake and the Underlying Factors of Serum Zinc Deficiency among Preschool Children in the Philippines. *Philippine journal of science*. 2021;150(3):799–812.
26. Maxfield L, Shukla S, Crane JS. Zinc Deficiency. In: *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; 2024. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK493231/>
27. Hassan A, Sada KK, Ketheeswaran S, Dubey AK, Bhat MS. Role of Zinc in Mucosal Health and Disease: A Review of Physiological, Biochemical, and Molecular Processes. *Cureus*. 2020;12(5):e8197.

Effect of extra virgin olive oil on inflammatory markers and intestinal microbiota in chronic kidney disease patients

Ruwyatul ALIYAH¹, Nurpudji Astuti DAUD², Suryani AS'AD^{2,3}, Mely MARITA¹, Haerani RASYID², Agussalim BUKHARI², AMINUDDIN²

¹ Clinical Nutrition Medical Specialty Education Program, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

² Department of Clinical Nutrition, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

³ Faculty of Medicine, Muhammadiyah University, Makassar, South Sulawesi, Indonesia.

Recibido: 10/mayo/2024. Aceptado: 12/julio/2024.

ABSTRACT

Introduction: The global prevalence of Chronic Kidney Disease (CKD) is 9.1%, with an increase of 29.3% from 1990 to 2018. A healthy diet with Extra Virgin Olive Oil (EVOO) consumption play a role in reducing inflammation and modulating gut microbiota in CKD patients. This study aims to assess the effect of extra virgin olive oil on immune system *platelet-to-lymphocyte ratio* (PLR) and *Short Chain Fatty Acids* (SCFA) in patients with Chronic Kidney Disease (CKD).

Methods: *Randomized clinical trial* at Dr. Wahidin Sudirohusodo Hospital Makassar on December 2022. The total sample was 30 and divided by two groups, each group both intervention with EVOO 40 ml / day and control group with normal diet (15 patients). Data were collected through questionnaires and direct measurements for anthropometric (Body weight and Body height). Energy intake with twenty four hours recall. *platelet-to-lymphocyte ratio* (PLR) through routine blood test and *Short chain fatty acids* (SCFA) through Pro Healthy Gut tests. Data were analyzed using SPSS version 26 with t-test analysis.

Results: EVOO administration had a significant result on inflammatory markers and gut microbiota. The intervention group had increased energy composition (1370.63±147.76 to 1690.63±147.76; p=0.000) and fat (19.93±7.25 to 57.93±7.25; p=0.000), accompanied by a decrease in *Platelet-Lymphocyte Ratio* (PLR) (210.76±80.20 to 169.89±54.22; p=0.026) and an increase in *Short Chain Fatty Acids* (SCFA) in feces (6.86±4.42

to 16.98±15.47; p=0.021). While the control group showed no significant changes.

Conclusion: Extra virgin olive oil (EVOO) had no significant effect on the nutritional status of patients with Chronic Kidney Disease (CKD), but reduced inflammation (decreased PLR). In addition improved gut microbiota health (increased SCFA).

KEYWORDS

Nutraceutical intervention, gut microbiome, renal function, oxidative stress, kidney function, probiotic modulation, gut health, microbial diversity.

INTRODUCTION

Chronic kidney disease (CKD) is a medical condition that poses a serious challenge to global health^{1,2}. As the number of cases increases in various parts of the world, CKD has become one of the chronic diseases that affect the quality of life of millions of people^{3,4}. CKD is characterized by progressive deterioration in kidney function, which over time can lead to complete loss of kidney function⁵⁻⁷. Lifestyle factors such as unhealthy diet, lack of physical activity, and smoking also play an important role in the development of CKD^{8,9}. In addition, genetic factors and genetic predisposition may also play a role in the emergence of CKD in an individual^{10,11}.

The impact of CKD on health is significant. Patients with CKD are prone to various serious complications such as heart disease, stroke, bone disorders, and anemia¹²⁻¹⁴. The management of CKD involves various strategies, including blood pressure control, blood sugar regulation, the use of certain medications, as well as changing to a healthier lifestyle¹⁵. In 2017, 1.2 million people died worldwide from CKD. The global all-age mortality rate from CKD increased by 41.5% between

Correspondencia:
Nurpudji Astuti Daud
pudji_taslim@gmail.com

1990 and 2017. In 2017, 697.5 million cases of all-stage CKD were reported, with a global prevalence of 9.1%. The global all-age prevalence of CKD increased by 29.3% since 1990.

Based on the 2018 Basic Health Research (Risikesdas), the prevalence of non-communicable diseases has increased, for CKD there was an increase of 1.8%, from 2% to 3.8% compared to the 2013 Risikesdas. One of the largest provinces in eastern Indonesia, South Sulawesi, also has a high prevalence of CKD at 0.8% in 2018 in South Sulawesi province¹⁶. According to Pongsibidang, there were 858 patient visits due to CKD in 2012, 638 patient visits in 2013, and an increase to 1181 visits in 2014 at Dr. Wahidin Sudirohusodo General Hospital.

Chronic kidney disease (CKD) is characterized by immune activation that can be caused by various factors, including kidney damage, increased systemic inflammation and changes in the gut microbiota^{17,18}. Some studies suggest that gut dysbiosis may be a risk factor for CKD¹⁹. In the early stages of CKD, there are quantitative and qualitative changes in the gut microbiota, characterized by an increase in the number of pathogenic bacteria, a decrease in the number of beneficial bacteria, and changes in the metabolic activity of the microbiota²⁰. Changes in the gut microbiota in CKD may contribute to the immune activation that occurs in this disease. Pathogenic bacteria can release substances that can cause inflammation, while beneficial bacteria can help reduce inflammation²¹.

Previous studies have shown that a healthy diet, characterized by a high intake of vegetables, fruit, nuts, seeds, legumes, and fish, and a low intake of saturated fat and sodium, can benefit chronic kidney disease (CKD) patients in the early stages²². One component of a healthy diet that has potential benefits for CKD patients is Extra Virgin Olive Oil (EVOO). EVOO, which is the main source of vegetable fat in the Mediterranean diet, has been shown to have antioxidant, anti-inflammatory, and gut microbiota modulating properties²³.

METHODOLOGY

Type of Study: This study is a randomized clinical trial with the administration of Extra Virgin Olive Oil (EVOO) and *placebo* (without EVOO). This method allows researchers to compare the effects of using EVOO with the effects of not using EVOO (placebo) to identify potential benefits or side effects of olive oil use on the parameters measured.

Place and Time of Study: This study was conducted at Dr. Wahidin Sudirohusodo Hospital Makassar on December 10-24, 2022, which is for 14 days of intervention.

Study Subjects: The population of this study were patients admitted to Dr. Wahidin Sudirohusodo with a diagnosis of Chronic Kidney Disease (CKD). Subjects were taken using the Lemeshow formula, 1998, namely:

Based on this formula, 15 research subjects were selected for each group who met the criteria, namely:

$$= \frac{\sigma^2(Z_{1-\alpha/2} + Z_{1-\beta})^2}{(\mu_0 - \mu_a)^2} = \frac{23.20^2(1.96 + 1.65)^2}{(64.25 - 42.40)^2}$$

$$n = 15$$

Research Subject Criteria is participants eligible for inclusion in the study were male or female, aged between 18 and 60 years old, diagnosed as Chronic Kidney Disease (CKD) undergoing routine hemodialysis at an outpatient installation for 1-6 months and did not have more than 3 comorbidities. They had to provide written consent to participate in the study by signing the consent form. Patients were excluded from the study if they were not eligible for the study, consumed yogurt, Probiotics or similar in the last 3 months, had Gastrointestinal symptoms and disorders (Diarrhea, vomiting, IBD and gastrointestinal bleeding). Participants were considered to have dropped out of the study if they refused to adhere to the research guidelines, EVOO consumption compliance < 80% and declined to continue participating.

Data collection: Personal information such as name, age, gender, address, phone number, number of family members, occupation, monthly income, and consent to participate in the study were recorded. Anthropometric data and physical activity information were also collected, using questionnaires and direct measurements.

Research Permit and Ethical Clearance: This study was conducted after reviewing and obtaining approval from the Health Research Ethics Committee of the Faculty of Medicine, Hasanuddin University with ethical number No. 580/UN4.6.4.5.31/PP36/2A22 and obtaining permission from Dr. Wahidin Sudirohusodo Hospital.

Operational Definition:

- EVOO administration:** Extra Virgin Olive Oil was administered at a dose of 40 mL/day to patients in the intervention group²².
- Platelet to Lymphocyte Ratio (PLR):** *Platelet to Lymphocyte Ratio* (PLR) is a marker of inflammation and is calculated from platelet count divided by lymphocyte count, cut off point is high PLR value ≥ 202 , low < 202.
- Short chain fatty acid (SCFA):** SCFAs are short chain fatty acids (carbon atoms less than 6) derived from fermentation products of the gut microbiota from indigestible food. These products are acetate, propionate, butyrate and valerate.

Data processing and analysis: The collected data were organized based on their purpose and type, and then analyzed using appropriate statistical methods with the help of SPSS software version 26 (IBM Corp., 2019). The T-Test was used for normally distributed data, while the Mann-Whitney

test was chosen if the data were not normally distributed. To compare two or more groups on classified data, the Chi-square test was used. The relationship between the dependent and independent variables was analyzed with a scatter plot graph. Hypothesis testing decisions were made based on p values: results were not significant if $p > 0.05$, significant if $p \leq 0.05$, and highly significant if $p < 0.001$.

RESULTS

Chronic kidney disease can develop asymptotically at first but has the potential to progress to kidney failure. Early detection is important to prevent this and obtain more effective therapy. The pathophysiology of chronic kidney disease is dependent on the underlying disease, with similar processes in subsequent progression. Reduction in renal mass causes structural and functional hypertrophy of the remaining nephrons in an attempt to compensate, triggered by vasoactive molecules such as cytokine growth factors, resulting in hyperfiltration and increased capillary pressure and glomerular blood flow^{20,24}.

Nutritional status assessment, monitoring and intervention are important components in the management of chronic kidney disease (CKD) patients. The changes in metabolism cause CKD stages 1 to 5 to require different nutritional management

that requires specific evaluation and therapy. In addition, each individual patient has specific nutritional problems due to differences in metabolism, etiology of CKD, genetic and environmental CKD stages. Nutritional management in CKD aims to slow the progression of kidney disease, improve quality of life, and reduce cardiovascular morbidity and mortality in CKD²⁴.

The distribution of samples based on general characteristics can be seen in Table 1. The distribution of samples showed that the majority of respondents were over 45 years old, with almost equal numbers between the control and intervention groups (52.4% and 47.6%). Statistical test results showed a value of $P=0.690$, confirming the age trend of 46-65 years in CKD cases. The majority of respondents were female, with no significant difference between groups (56.3% and 43.8%). Most also had hypertension as a comorbid disease, with no significant difference between the groups (53.3% and 43.8%). The majority of respondents had been on hemodialysis for less than 3 months, with no significant difference between groups (61.1% and 38.9%). Although the majority of respondents were employed, there was no significant difference between the intervention and control groups in terms of occupation (64.7% and 35.3%).

Characteristics of Research Subjects

Table 1. Characteristics of Research Subjects

Characteristics	Intervention	Control	P-value
	(n=15)	(n=15)	
Age			
18-45 Years	5 (55.6%)	4 (44.4%)	0.690
>45 Years	10 (47.6%)	11 (52.4%)	
Gender			
Male	8 (57.1%)	6(42.9%)	0.472
Female	7 (43.8%)	9(56.3%)	
Comorbid			
Hypertension	8(53.3%)	7(46.7%)	0.394
Diabetes Mellitus	1(3.3%)	0	
Hypertension and Diabetes	4(0%)	4(50%)	
Hypertension and BSK	1(3.3%)	0	
Hypertension/Dyslipidemia	1(50%)	1(50%)	
Hypertension/BPH	0	1(3.3%)	
Hypertension/Hyperuricemia	0	1(3.3%)	
Diabetes/Obesity	0	1(3.3%)	

Independent t-test.

Table 1 continuation. Characteristics of Research Subjects

Characteristics	Intervention	Control	P-value
	(n=15)	(n=15)	
Length of HD (Months)			
<3 months	7(38.9%)	11(61.1%)	0.136
>3 months	8 (66.7%)	4 (33.3%)	
Jobs			
Work	11(64.7%)	6(35.3%)	0.065
Not Working	4(30.8%)	9(69.2%)	

Independent t-test.

Differences in Nutritional Status Pre and Post Intervention

Anthropometric measurements in this study consisted of Body Height, Body Weight (BW), and Body Mass Index (BMI). And the determination of the nutritional status of respondents using BMI calculations. Table 2 shows that the average nutritional status in the pre and post intervention group had no difference before treatment with a Mean \pm SD value of 21.34 ± 3.59 and 21.34 ± 3.59 after treatment. the results of statistical tests using the t-independent test showed a p value of $0.175 > 0.05$ which means there was no significant difference before and after in the intervention group.

Furthermore, before and after treatment in the control group showed no difference with a Mean \pm SD value of 23.27 ± 4.08 and 23.27 ± 4.08 after treatment. the results of statistical tests using the *Mann Whitney test* showed a p value of $0.223 > 0.05$ which means there is no significant difference before and after treatment in the control group.

Assessing the Pre and Post Intervention food composition of Extra Virgin Olive Oil (EVOO) diet

Based on table 3, it is known that the food composition of the energy sub variable has a difference before and after treatment with a Mean \pm SD value of 1370.63 ± 147.76 be-

Table 2. Differences in Nutritional Status of the two groups Pre and Post Intervention

Group	EVOO (n=15)		P-value	Control (n=15)		P-value
	Mean \pm SD (Pre)	Mean \pm SD (Post)		Mean \pm SD (Pre)	Mean \pm SD (Post)	
Height (cm)	163.80 \pm 6.44	163.80 \pm 6.44	0.900*	156.26 \pm 8.18	156.26 \pm 8.18	0.900*
Weight (kg)	57.33 \pm 9.99	57.80 \pm 9.92	0.878*	56.76 \pm 10.02	56.70 \pm 10.08	0.766*
BMI (kg/m ²)	21.34 \pm 3.59	21.52 \pm 3.57	0.175*	23.28 \pm 4.01	23.27 \pm 4.08	0.223**

Independent t-test*; *Mann Whitney test***.

Table 3. Pre and Post Intervention Dietary Composition (EVOO)

Group	EVOO (n=15)		P-value	Control (n=15)		P-value
	Mean \pm SD (Pre)	Mean \pm SD (Post)		Mean \pm SD (Pre)	Mean \pm SD (Post)	
Energy (Kcal)	1370.63 \pm 147.76	1690.63 \pm 147.76	0.000*	1235.90 \pm 160.26	1225.57 \pm 175.94	0.868*
Protein (g)	48.04 \pm 8.47	48.95 \pm 8.58	0.279*	44.99 \pm 6.47	46.59 \pm 6.66	0.408*
Carbohydrate (g)	228.34 \pm 32.58	236.88 \pm 34.77	0.154*	207.82 \pm 43.34	213.30 \pm 42.58	0.108*
Fat (g)	19.93 \pm 7.25	57.93 \pm 7.25	0.000*	15.59 \pm 4.19	17.31 \pm 4.28	0.276*

n = number of subjects; Kcal = kilocalories; g = grams; Mean \pm SD. * Independent t test; ** *Mann Whitney test*.

fore and 1690.63 ± 147.76 after treatment in the intervention group with a value of $p = 0.000 < 0.05$. This is because EVOO was given at a dose of 40 mL / day to patients in the intervention group. while in the control group there was no difference with a value of $p = 0.0868 > 0.05$.

In the food composition of the fat sub variable, there were differences before and after treatment with a Mean \pm SD value of 19.93 ± 7.25 before and 57.93 ± 7.25 after treatment in the intervention group with a value of $p = 0.000 < 0.05$. This is because *Extra Virgin Olive Oil* was given at a dose of 40 mL / day to patients in the intervention group. while in the control group there was no difference with a value of $p = 0.276 > 0.05$.

Assessing Platelet-Lymphocyte Ratio (PLR) levels in routine blood samples Pre and Post Intervention administration of Extra Virgin Olive Oil (EVOO)

The results of this study on pre and post examinations (EVOO group) had Platelet Mean \pm SD values (228.06 ± 69.59 and 106.16 ± 49.69) $p=0.000$. Lymphocytes (1.08 ± 0.86 and 0.68 ± 0.91) $p=0.007$ and PLR (210.76 ± 80.20 and

169.89 ± 54.22) $p=0.026$ and on pre-post examinations in the control group had Platelet Mean \pm SD values (246.66 ± 87.41 and 214.51 ± 69.59), with a value of $p=0.550$, Lymphocytes (1.45 ± 1.26 and 1.11 ± 0.85 , with a value of $p=0.362$, PLR (169.80 ± 69.08 and 106.16 ± 49.69) $p=0.163$, which means there is a significant difference between the two groups in the value of platelets, Lymphocytes and PLR with post examination in the EVOO and control groups.

Assessing Short Chain Fatty Acids (SCFA) levels in feces samples Pre and Post Intervention with Extra Virgin Olive Oil (EVOO).

The results of this study showed the value of SCFA levels in feces examination before and after in the intervention group (EVOO) obtained the results of Mean \pm SD Acetate (57.74 ± 18.22 and 61.53 ± 10.70) with a value of $P = 0.842$. while with the control group obtained the results of Mean \pm SD Acetate before and after (61.13 ± 9.32 and 61.13 ± 9.32) with a value of $P = 0.413 > 0.05$. Propionate in the intervention group showed a decrease from Mean \pm SD (27.47 ± 34.04 to 17.33 ± 6.15) with $P=0.232 > 0.05$, while in

Table 4. Platelet-Lymphocyte Ratio (PLR) levels in routine blood samples pre and post intervention with Extra Virgin Olive Oil (EVOO)

Group	EVOO (n=15)		Mean Δ	P-value	Control (n=15)		Mean Δ	P-value
	Mean \pm SD (Pre)	Mean \pm SD (Post)			Mean \pm SD (Pre)	Mean \pm SD (Post)		
PLR	210.76 \pm 80.20	169.89 \pm 54.22	40.87	0.026**	169.80 \pm 69.08	106.16 \pm 49.69	63.64	0.163**

n = number of subjects; PLR = *Platelet-Lymphocyte Ratio*, Mean \pm SD. * Independent t test; **Mann Whitney test.

Table 5. Short Chain Fatty Acids (SCFA) levels in feces samples Pre and Post Intervention with Extra Virgin Olive Oil (EVOO)

Group	EVOO (n=15)		Mean Δ	P-value	Control (n=15)		Mean Δ	P-value
	Pre	The post			Pre	The post		
	Mean \pm SD				Mean \pm SD			
Acetate (%)	57.74 \pm 18.22	61.53 \pm 10.70	3.79	0.842**	10.458.13 \pm 1	61.13 \pm 9.32	3	0.413**
Propionate (%)	27.47 \pm 34.04	17.33 \pm 6.15	10.14	0.232**	18.73 \pm 6.08	20.47 \pm 6.81	1.74	0.469**
Butirat (%)	5.68 \pm 5.10	22.65 \pm 36.11	16.97	0.007**	7.66 \pm 5.08	21.78 \pm 36.21	14.12	0.146**
Valerat (%)	2.25 \pm 1.40	2.57 \pm 1.45	0.32	0.490*	1.78 \pm 1.63	2.46 \pm 2.12	0.68	0.334**
Absolute butyrate (mg/mL)	1.13 \pm 1.43	1.37 \pm 1.62	0.24	0.096**	1.10 \pm 0.55	1.35 \pm 1.06	0.25	0.437**
SCFA (mg/mL)	7.21 \pm 5.17	17.68 \pm 17.85	10.47	0.038*	7.86 \pm 4.68	7.87 \pm 4.80	0.01	0.127**

* Paired t test. ** Wilcoxon test.

the control group it was not significant, namely Mean±SD (18.73±6.81 to 20.47±6.81) with P=0.469 > 0.05. Butyrate in the intervention group increased significantly from Mean±SD (5.68±5.10 to 22.65±36.11) with P=0.007 < 0.05, while in the control group it was not significant, namely Mean±SD (7.66±5.08 to 21.78±36.21) with P=0.146 > 0.05. Valerate in the intervention group showed no significant change from Mean±SD (2.25±1.40 to 2.57±1.45) with P=0.490 > 0.05, while in the control group it was also not significant, namely Mean±SD (1.78±1.63 to 2.46±2.12) with P=0.334 > 0.05. Absolute butyrate in the intervention group showed no significant change from Mean±SD (1.13±1.43 to 1.37±1.62) with P=0.096 > 0.05, while in the control group it was also not significant, namely Mean±SD (1.10±0.55 to 1.35±1.06) with P=0.437 > 0.05. SCFA in the intervention group showed a significant increase from Mean±SD (7.21±5.17 to 17.68±17.85) with P=0.038 < 0.05, while in the control group it was not significant, namely Mean±SD (7.86±4.68 to 7.87±4.80) with P=0.127 > 0.05.

The results of this study found that there was a significant difference between the intervention group before and after treatment. and can be seen the mean value of SCFA levels which shows that there was an increase in the intervention group, this can be caused because the intervention group was given a diet of Extra Virgin Olive Oil (EVOO) for consumption at a dose of 40 ml given 4 times a day for 2 weeks.

Assessing Short Chain Fatty Acids (SCFA) levels between EVOO groups in feces samples Pre and Post Intervention of Extra Virgin Olive Oil (EVOO) administration

The results of this study showed the Mean ± SD value of SCFA in pre and post fecal examination in the intervention

group obtained results on the Acetate sub variable (57.74 ± 18.21 and 61.53 ± 10.69) with a value of P = 0.492, Propionate (27.47 ± 34.04 and 17.33 ± 6.15) with P=0.266, Butyrate (10.00±8.07 and 21.78±36.21) with P=0.000, Valerate (2.25±1.40 and 2.57±1.45) with P=0.543, Absolute Butyrate (1.13±1.43 and 1.90±12.31) with P=0.280, and SCFA (6.86±4.42 and 16.98±15.47) with P=0.021.

Furthermore, the results of this study showed the Mean ± SD value of SCFA in pre and post feces examination in the control group obtained results in the Acetate sub variable (58.06 ± 10.02 and 61.13 ± 9.32) with a value of P = 0.393, Propionate (18.73 ± 6.38 and 20.47 ± 6.81) with P=0.478, Butyrate (11.66±7.61 and 8.93±5.22) with P=0.261, Valerate (1.69±1.55 and 2.46±2.12) with P=0.268, Absolute Butyrate (1.44±1.34 and 1.31±1.09) with P=0.133, and SCFA (8.53±4.50 and 8.46±4.30) with P=0.666. From the results of this study obtained differences in SCFA levels in both groups where in the EVOO group there was an increase while in the control group there was a decrease in SCFA levels.

DISCUSSION

Differences in Nutritional Status Pre and Post Intervention

This study on the administration of extra virgin olive oil to the immune system *platelet-to-lymphocyte ratio* (PLR) and *Short Chain Fatty Acids* (SCFA) in patients with *Chronic Kidney Disease* (CKD). showed that there was no difference in nutritional status before and after administration of EVOO. Nutritional and metabolic disorders in patients with *chronic kidney disease* (CKD) are characterized by the simultaneous loss of systematic body protein and energy storage, which ultimately leads to loss of muscle and fat mass and cachexia²⁵.

Table 6. Short Chain Fatty Acids (SCFA) levels in feces samples Pre and Post Intervention of Extra Virgin Olive Oil (EVOO) administration

Group	EVOO (n=15)		Mean Δ	P-value	Control (n=15)		Mean Δ	P-value
	Pre	The post			Pre	The post		
	Mean±SD				Mean±SD			
Acetate (%)	57.74±18.21	61.53±10.69	3.79	0.492*	58.06±10.02	61.13±9.32	3.07	0.393**
Propionate (%)	27.47±34.04	17.33±6.15	10.14	0.266*	18.73±6.38	20.47±6.81	1.74	0.478**
Butirat (%)	10.00±8.07	21.78±36.21	11.78	0.000*	11.66±7.61	8.93±5.22	2.73	0.261**
Valerat (%)	2.25±1.40	2.57±1.45	0.32	0.543*	1.69±1.55	2.46±2.12	0.77	0.268**
ButyrateAbsolute (mg/mL)	1.13±1.43	1.90±12.31	0.77	0.280*	1.44±1.34	1.31±1.09	0.13	0.133**
SCFA (mg/mL)	6.86±4.42	16.98±15.47	10.12	0.021*	8.53±4.50	8.46±4.30	0.07	0.666**

* Paired t test; ** Wilcoxon test.

Low energy and/or protein intake was found to be associated with significant reductions in nutritional parameters such as serum albumin levels and an increased risk of higher morbidity and mortality in patients with advanced CKD. Loss of appetite often leads to inadequate protein and energy intake and contributes to poor quality of life. Spontaneous decline in food intake occurs during progressive decline in renal function, and this decline correlates with accumulation of nitrogen-derived uremic toxins. Factors affecting food intake involve not only metabolic disorders but also abnormalities in the digestive system²⁶.

Assessing the Pre and Post Intervention food composition of Extra Virgin Olive Oil (EVOO) diet

The results of this study indicate that there are differences in food composition in energy and fat before and after in the intervention group (EVOO), which means that there is an increase before and after. While in the control group there were no changes.

Consumption pattern is a way of organizing the amount, type, and frequency of food to maintain health and prevent or help cure disease. Normal fat requirements are around 20-25% of total energy, with variations depending on the disease. Diets for heart disease, for example, recommend 20-25% fat, with 10% saturated fat and 10-15% unsaturated fat²⁷. Fatty acids are distinguished by the length of the carbon tail, namely short chain (less than 6 carbons), medium (6-12 carbons), and long (more than 12 carbons). Short-chain fatty acids (SCFAs) such as acetate, propionate and butyrate are produced from the fermentation of undigested carbohydrates in the distal gut by gut bacteria such as bacteroides and bifidobacteria. SCFAs have benefits such as maintaining gut integrity, regulating glucose and lipid metabolism, and supporting the immune system and antioxidant activity²⁸.

Assessing Platelet-Lymphocyte Ratio (PLR) levels in routine blood samples pre and post intervention with Extra Virgin Olive Oil (EVOO)

The results of this study found that PLR in the intervention group (EVOO) before and after treatment showed a significant difference compared to the control group. The results of this study are similar to the research of Jiaxian Liao (2022) that the inflammatory scoring system with a combination of NLR, MLR and PLR. We found an independent association between higher inflammation scores and all-cause mortality in HD patients²⁸. The study by Turkmen, et al. showed that Platelet to Lymphocyte Ratio (PLR) was significantly increased in dialysis patients with chronic kidney disease (CKD). PLR was also positively correlated with inflammatory markers such as NLR, IL-6, and TNF- α . CKD patients with higher PLR had higher levels of inflammation. This study found that PLR was superior to NLR in assessing inflammation in CKD patients. The reduction in PLR in the control group was higher (63.64%

difference) compared to the intervention group (40.87% difference). This may be due to the use of heparin or blood dilution in patients who have been on hemodialysis for less than 3 months. PLR is an inflammatory marker that can be used to predict inflammation and mortality in various diseases, including CKD. High PLR indicates platelet overactivation and lymphopenia, conditions associated with prothrombotic status and ischemia or reperfusion damage²⁹.

Assessing Short Chain Fatty Acids (SCFA) levels in feces samples Pre and Post Intervention with Extra Virgin Olive Oil (EVOO)

In this study, there was a significant difference in *Short Chain Fatty Acids* (SCFA) levels in fecal samples before and after Extra Virgin Olive Oil (EVOO) consumption. EVOO consumption increased α -diversity, a measure of species richness, as well as β -diversity, a measure of compositional differences between samples compared to controls. These results were attributed to beneficial effects on metabolic health, as reduced microbial diversity is associated with increased chronic inflammation and later development of metabolic diseases. The ability of EVOO to act as a prebiotic, stimulating the growth of beneficial bacteria, and as an antibacterial, suppressing the growth of pathogenic bacteria, is most likely due to the suite of phenolic compounds that EVOO contains. The phenolic compounds in EVOO are not consumed in isolation; rather they are consumed as part of the food matrix and may function synergistically together with other components in EVOO. In addition to the phenolic compounds and their known interactions and effects on the microbiota, other minor components in EVOO such as sterols and tocopherols may influence the composition of the gut microbiota³⁰.

Analyzing the comparison of Short Chain Fatty Acids (SCFA) Pre and Post Intervention of Extra Virgin Olive Oil (EVOO) in Chronic Kidney Disease (CKD)

The gut microbiota has co-existed with humans for a mutually beneficial life and plays an important role in health and disease. The normal gut microbiota influences host health by contributing to nutrition, metabolism, physiology and immune function. Disruption of the normal gut microbiota (dysbiosis) has been implicated in the pathogenesis of various diseases, such as obesity, type 2 diabetes, *inflammatory bowel disease* and cardiovascular disease. Quantitative and qualitative changes in the gut microbiota are also found in patients with CKD and ESRD³⁰. The results of this study found that there were differences in SCFA levels before and after in both groups where in the EVOO group there was an increase while in the control group there was a decrease in SCFA levels. A normal kidney contains about 1 million nephrons, each of which contributes to the total glomerular filtration rate (GFR). In the face of renal injury (regardless of its etiology), the kidney has an innate ability to maintain GFR, despite progressive

nephron destruction, as the remaining healthy nephrons are capable of compensatory hyperfiltration and hypertrophy. This nephron adaptation allows for sustained normal clearance of plasma solutes.

The mechanism of hyperfiltration and residual nephron hypertrophy is beneficial, but has been hypothesized to be the main cause of progressive renal dysfunction. Disruption of the kidney due to chemical or physical causes ultimately activates inflammatory and fibrotic responses will disrupt the recovery process and lead to irreversible degeneration of renal tissue. Diseases that cause glomerular or tubular disruption eventually activate responses that damage other nephron structures and lead to a vicious cycle causing gradual nephron loss and replacement by scar tissue. Cellular damage causes inflammation and cytokine imbalance, which contributes to fibrosis, mesangial and vascular contractions leading to decreased GFR, tubular degeneration and scarring.

EVOO consumption has shown positive effects on gut microbiota and gut health in human and animal studies such as mice. However, in particular, in humans, EVOO has a prebiotic effect, promoting the growth of beneficial bacteria such as *Lactobacillus* and *Bifidobacterium*. The important role of the gut microbiota in shaping the mucosal immune system and its influence on overall inflammatory status and cardiovascular, metabolic and brain health is becoming increasingly clear³⁰.

Limitations

Limitations This study has several limitations, the risk of over or under reporting and memory bias in 24-hour food recall cannot be ruled out. In addition the study's sample size was relatively small.

CONCLUSION

This study evaluates the effectiveness of extra virgin olive oil (EVOO) in patients with chronic kidney disease (CKD) undergoing hemodialysis. While EVOO did not show a significant impact on the patients' nutritional status, it was proven to be beneficial in reducing inflammation (as indicated by a decrease in the Platelet-Lymphocyte Ratio (PLR)) and in improving gut microbiota health (as indicated by an increase in Short Chain Fatty Acids (SCFA)). These findings suggest the potential benefits of EVOO in helping manage CKD, although further research is needed to confirm its long-term effects.

REFERENCES

- Shrestha N, Gautam S, Mishra SR, Virani SS, Dhungana RR. Burden of chronic kidney disease in the general population and high-risk groups in South Asia: A systematic review and meta-analysis. *PLoS One*. 2021 Oct 14;16(10):e0258494.
- Glurich I, Shimpi N, Acharya A. Interdisciplinary care model: chronic kidney disease and oral health. *Integration of Medical and Dental Care and Patient Data*. 2019:87-107.
- Fletcher BR, Damery S, Aiyegbusi OL, Anderson N, Calvert M, Cockwell P, Ferguson J, Horton M, Paap MC, Sidey-Gibbons C, Slade A. Symptom burden and health-related quality of life in chronic kidney disease: A global systematic review and meta-analysis. *PLoS medicine*. 2022 Apr 6;19(4):e1003954.
- Ng JK, Li PK. Chronic kidney disease epidemic: how do we deal with it? *Nephrology*. 2018 Oct;23:116-20.
- Ammirati AL. Chronic kidney disease. *Revista da Associação Médica Brasileira*. 2020 Jan 13;66:s03-9.
- Yan MT, Chao CT, Lin SH. Chronic kidney disease: strategies to retard progression. *International journal of molecular sciences*. 2021 Sep 18;22(18):10084.
- Lv JC, Zhang LX. Prevalence and disease burden of chronic kidney disease. *Renal fibrosis: mechanisms and therapies*. 2019:3-15.
- Jones P, Karim Sulaiman S, Gamage KN, Tokas T, Jamnadass E, Somani BK. Do lifestyle factors including smoking, alcohol, and exercise impact your risk of developing kidney stone disease? Outcomes of a systematic review. *Journal of endourology*. 2021 Jan 1;35(1):1-7.
- Schrauben SJ, Apple BJ, Chang AR. Modifiable lifestyle behaviors and CKD progression: a narrative review. *Kidney360*. 2022 Apr 28;3(4):752-78.
- Stern-Zimmer M, Calderon-Margalit R, Skorecki K, Vivante A. Childhood risk factors for adulthood chronic kidney disease. *Pediatric Nephrology*. 2021 Jun;36(6):1387-96.
- Limou S, Vince N, Parsa A. Lessons from CKD-related genetic association studies-moving forward. *Clinical journal of the American Society of Nephrology*. 2018 Jan 1;13(1):140-52.
- Podkowińska A, Formanowicz D. Chronic kidney disease as oxidative stress-and inflammatory-mediated cardiovascular disease. *Antioxidants*. 2020 Aug 14;9(8):752.
- Carney EF. The impact of chronic kidney disease on global health. *Nature Reviews Nephrology*. May 2020;16(5):251-2.
- Elshahat S, Cockwell P, Maxwell AP, Griffin M, O'Brien T, O'Neill C. The impact of chronic kidney disease on developed countries from a health economics perspective: a systematic scoping review. *PLoS one*. 2020 Mar 24;15(3):e0230512.
- Luyckx VA, Cherney DZ, Bello AK. Preventing CKD in developed countries. *Kidney international reports*. 2020 Mar 1;5(3):263-77.
- Indonesian Ministry of Health. Basic Health Research Results 2018. Ministry of Health. 2018;53(9):1689-99.
- Syed-Ahmed M, Narayanan M. Immune dysfunction and risk of infection in chronic kidney disease. *Advances in chronic kidney disease*. 2019 Jan 1;26(1):8-15.
- Thaha M, Widiana IG. The role of inflammation in chronic kidney disease. *Indonesian Journal of Kidney and Hypertension*. 2019;2(3):4-13.
- Li, F., Wang, M., Wang, J., Li, R. and Zhang, Y., 2019. Alterations to the gut microbiota and their correlation with inflammatory factors in chronic kidney disease. *Frontiers in Cellular and Infection Microbiology*, 9, p.206.

20. Rysz J, Franczyk B, Ławiński J, Olszewski R, Ciałkowska-Rysz A, Gluba-Brzózka A. The impact of CKD on uremic toxins and gut microbiota. *Toxins*. 2021 Mar 31;13(4):252.
21. Mertowska P, Mertowski S, Wojnicka J, Korona-Główniak I, Grywalska E, Błażewicz A, Załuska W. A link between chronic kidney disease and gut microbiota in immunological and nutritional aspects. *Nutrients*. 2021 Oct 17;13(10):3637.
22. Noce A, Marrone G, Urciuoli S, Di Daniele F, Di Lauro M, Pietroboni Zaitseva A, Di Daniele N, Romani A. Usefulness of extra virgin olive oil minor polar compounds in the management of chronic kidney disease patients. *Nutrients*. 2021 Feb 10;13(2):581.
23. Marrone G, Urciuoli S, Di Lauro M, Ruzzolini J, Ieri F, Vignolini P, Di Daniele F, Guerriero C, Nediani C, Di Daniele N, Noce A. Extra Virgin Olive Oil and Cardiovascular Protection in Chronic Kidney Disease. *Nutrients*. 2022 Oct 12;14(20):4265.
24. Kandarini Y, SpPD-KGH FI. Nutritional Management in Prilysis and Dialysis CKD Patients. Udayana Repository. 2018.
25. Hanna RM, Ghobry L, Wassef O, Rhee CM, Kalantar-Zadeh K. A practical approach to nutrition, protein-energy wasting, sarcopenia, and cachexia in patients with chronic kidney disease. *Blood purification*. 2020 Dec 18;49(1-2):202-11.
26. Velasquez MT, Centron P, Barrows I, Dwivedi R, Raj DS. Gut microbiota and cardiovascular uremic toxicities. *Toxins*. 2018 Jul 11;10(7):287.
27. Sacks FM, Lichtenstein AH, Wu JH, Appel LJ, Creager MA, Kris-Etherton PM, Miller M, Rimm EB, Rudel LL, Robinson JG, Stone NJ. Dietary fats and cardiovascular disease: a presidential advisory from the American Heart Association. *Circulation*. 2017 Jul 18;136(3):e1-23.
28. Liao J, Wei D, Sun C, Yang Y, Wei Y, Liu X. Prognostic value of the combination of neutrophil-to-lymphocyte ratio, monocyte-to-lymphocyte ratio and platelet-to-lymphocyte ratio on mortality in patients on maintenance hemodialysis. *BMC nephrology*. 2022 Dec 8;23(1):393.
29. Zhang LY, Zhang J, Li D, Liu Y, Zhang DL, Liu CF, Wang N, Wu SR, Lu WQ, Guo JZ, Shi YQ. Bile reflux is an independent risk factor for precancerous gastric lesions and gastric cancer: An observational cross-sectional study. *Journal of Digestive Diseases*. 2021 May;22(5):282-90.
30. Millman JF, Okamoto S, Teruya T, Uema T, Ikematsu S, Shimabukuro M, Masuzaki H. Extra-virgin olive oil and the gut-brain axis: Influence on gut microbiota, mucosal immunity, and cardiometabolic and cognitive health. *Nutrition reviews*. 2021 Dec 1;79(12):1362-74.

Neutrophil-Lymphocyte Ratio, prognostic nutritional index and CRP - Albumin Ratio significantly predict mortality in ICU patients with low nutrition risk

Yulia WULLUR¹, Nurpudji A TASLIM^{1,2}, A Yasmin SYAUKI^{1,2}, Raymond LIEM¹, Rury L. SAPTARI¹, Haerani RASYID^{1,2}, AMINUDDIN^{1,2}, Andi FARADILAH^{1,2}

1 Department of Nutrition, Hasanuddin University, Makassar, Indonesia.

2 Wahidin Sudirohusodo Hospital, Makassar, Indonesia.

Recibido: 10/mayo/2024. Aceptado: 12/julio/2024.

ABSTRACT

Introduction: The dynamic ICU environment requires the use of accurate prognostic indicators to assess patient outcomes and guide clinical interventions. Nutritional status and inflammation are important factors influencing patient outcomes in the ICU. Several prognostic indicators have been proposed to evaluate the prognostic value of NLR, PNI, and CRP to Albumin Ratio in predicting mortality in ICU patients with different levels of nutritional risk.

Methods: This observational retrospective cohort study was conducted in the ICU of Wahidin Sudirohusodo Hospital, Indonesia, from April 2022 to March 2023. All patients admitted to the ICU during the study period were considered. Data collected from medical records included patient demographics, clinical characteristics, prognostic indicators, and outcomes. Bivariate and multivariate regression analysis was used to evaluate the associations between prognostic indicators and mortality both in low-risk and high-risk subgroup. The results were presented as hazard ratios (HRs) with 95% confidence intervals (CIs). To predict accuracy of prognostic biomarker, Receiver Operating Characteristic (ROC) curve analysis was conducted. The area under the ROC curve (AUC) was calculated to evaluate the discriminative ability of each biomarker

Result: In a study of 1,106 ICU patients. The length of stay in the ICU and hospital for survivors is shorter than for non-survivors. Hazard ratio analysis showed that higher PNI

significantly reduced the risk of death (unadjusted HR 0.914, adjusted HR 0.910), whereas higher CAR and NLR were associated with increased risk of death (CAR unadjusted HR 1.020, adjusted HR 1.017; unadjusted NLR HR 1.018, adjusted HR 1.014). This effect was less pronounced in patients at high nutritional risk, with nonsignificant HR values. ROC curve analysis showed that CRP/Albumin (AUC: 0.696), NLR (AUC: 0.575), and PNI (AUC: 0.325).

Conclusion: NLR, PNI, and CAR are valuable prognostic indicators in ICU settings, providing crucial information on mortality risk especially in patients with low nutritional risk. The data supports their use in clinical assessments to tailor interventions that address inflammation and nutritional deficits.

KEYWORDS

Intensive Care, mortality, Inflammation, biomarker panel.

INTRODUCTION

Intensive Care Unit (ICU) patients often experience severe physiological stress due to underlying conditions, surgery, or trauma, which can affect immune responses and nutritional status. The dynamic environment of the ICU necessitates the use of accurate prognostic indicators to assess patient outcomes and guide clinical interventions. Nutritional status and inflammation are critical factors influencing patient outcomes in the ICU. Malnutrition is prevalent among critically ill patients and is associated with increased morbidity and mortality^{1,2}. Simultaneously, inflammatory responses reflect the body's reaction to infection, trauma, or surgery. The interplay between nutrition and inflammation in critically ill patients underscores the importance of understanding how these factors impact patient outcomes^{3,4}.

Correspondencia:

Nurpudji A Taslim
pudji_taslim@yahoo.com

Several prognostic indicators have been proposed to evaluate the outcomes of critically ill patients, including the Neutrophil-to-Lymphocyte Ratio (NLR), Prognostic Nutritional Index (PNI), and CRP-to-Albumin Ratio (CAR). NLR is a simple marker that represents the ratio of neutrophils to lymphocytes. Elevated NLR has been associated with poor outcomes in various clinical settings, including sepsis, cardiovascular diseases, and cancer^{3,5,6}. In ICU patients, NLR serves as a marker of systemic inflammation, with higher values indicating a heightened inflammatory response and worse prognosis^{7,8}. The PNI is calculated based on serum albumin levels and lymphocyte count. It serves as an indicator of nutritional and immune status. Lower PNI values are associated with malnutrition and poorer outcomes in surgical and critically ill patients^{1,9,10}. The PNI reflects both the patient's nutritional reserves and immune function. The CAR combines CRP, an acute-phase reactant, and albumin, a marker of nutritional status. The ratio provides insight into the balance between inflammation and nutrition. Elevated CAR has been linked to increased mortality in ICU patients, as well as in patients with sepsis, cancer, and cardiovascular diseases^{11,12}. The CAR is particularly useful because it accounts for both inflammatory and nutritional aspects of patient health^{13,14}.

While previous research has established the prognostic value of NLR, PNI, and CAR in various clinical settings, there is limited information on their predictive capabilities in ICU patients with different levels of nutritional risk. The objective of this study is to evaluate the prognostic value of the Neutrophil-to-Lymphocyte Ratio, Prognostic Nutritional Index, and CRP-to-Albumin Ratio in predicting mortality in ICU patients with different levels of nutritional risk.

METHODS

Study Design

An observational retrospective cohort study conducted in the Intensive Care Unit (ICU) of Wahidin Sudirohusodo from April 2022 to March 2023. Participants were all the patients admitted to the ICU during the study period. Patients were excluded if they were younger than 18 years of age or lacking necessary data for the analysis. The study was approved by the ethics committee of the university and hospital which ensure the confidentiality of all the patient's data throughout the research process. The ethic protocol number No: 969/UN4.6.4.5.31/ PP36/ 2023.

Data Collection

Data for the study were collected from medical records, which provided detailed information on patient demographics, clinical characteristics, prognostic indicators and clinical outcomes. Demographic data included age, sex, height, weight, and body mass index (BMI). The clinical characteristics collected included the admission category and nutritional risk. The nutritional risk

was assessed using the mNutric score. Prognostic indicator data included NLR, PNI, and CAR. The clinical outcomes assessed included ICU and hospital length of stay (LOS), duration of mechanical ventilation, and ICU mortality.

Statistical Analysis

The normality of continuous data was assessed using the Shapiro-Wilk test to evaluate normal distribution of dataset. Depending on the distribution, continuous variables were expressed as either mean \pm standard deviation (SD) or median and interquartile range (IQR). Categorical variables were presented as numbers and percentages. For continuous variables, the Student's t-test or Mann-Whitney U test was used for two-group comparisons, while one-way ANOVA or Kruskal-Wallis test was used for more than two groups. For categorical variables, the chi-square test was used, depending on the sample size and distribution of the categories. Bivariate and multivariate regression analysis was used to evaluate the associations between prognostic indicators and mortality both in low-risk and high-risk subgroup. The results were presented as hazard ratios (HRs) with 95% confidence intervals (CIs). Both unadjusted and adjusted models were used, with adjustments made for potential confounders, including age, sex, BMI, and admission type. To assess the predictive accuracy of the Neutrophil-to-Lymphocyte Ratio (NLR), Prognostic Nutritional Index (PNI), and C-reactive Protein to Albumin Ratio (CAR) in forecasting ICU mortality, Receiver Operating Characteristic (ROC) curve analysis was conducted. The area under the ROC curve (AUC) was calculated to evaluate the discriminative ability of each biomarker. AUC values closer to 1 indicate excellent predictive accuracy, whereas values near 0.5 suggest no predictive benefit over random chance. This analysis helps to elucidate which biomarkers can effectively distinguish between patient outcomes, particularly in terms of mortality risk. Statistical analysis for the study was performed using SPSS 25.0 (IBM Corp., Armonk, NY). A p-value of < 0.05 was considered statistically significant.

RESULTS

A total of 1,189 patients were admitted to the ICU from April 2022 to March 2023. Among these, 83 patients were excluded from the study due to being under 18 years of age, leaving a final sample size of 1,106 patients for analysis. The demographic and clinical characteristics of the study population are summarized in Table 1.

The patients' median age was 50 years (IQR: 37–60) for survivors and 55.5 years (IQR: 41–67) for non-survivors, with a significant difference ($p < 0.001$). Regarding sex, 54.4% of the survivors were women, whereas the majority of non-survivors (58%) were men, highlighting a statistically significant difference ($p < 0.001$). The survivors and non-survivors had similar heights, with median heights of 160 cm (IQR: 155–165) in both groups, showing no significant dif-

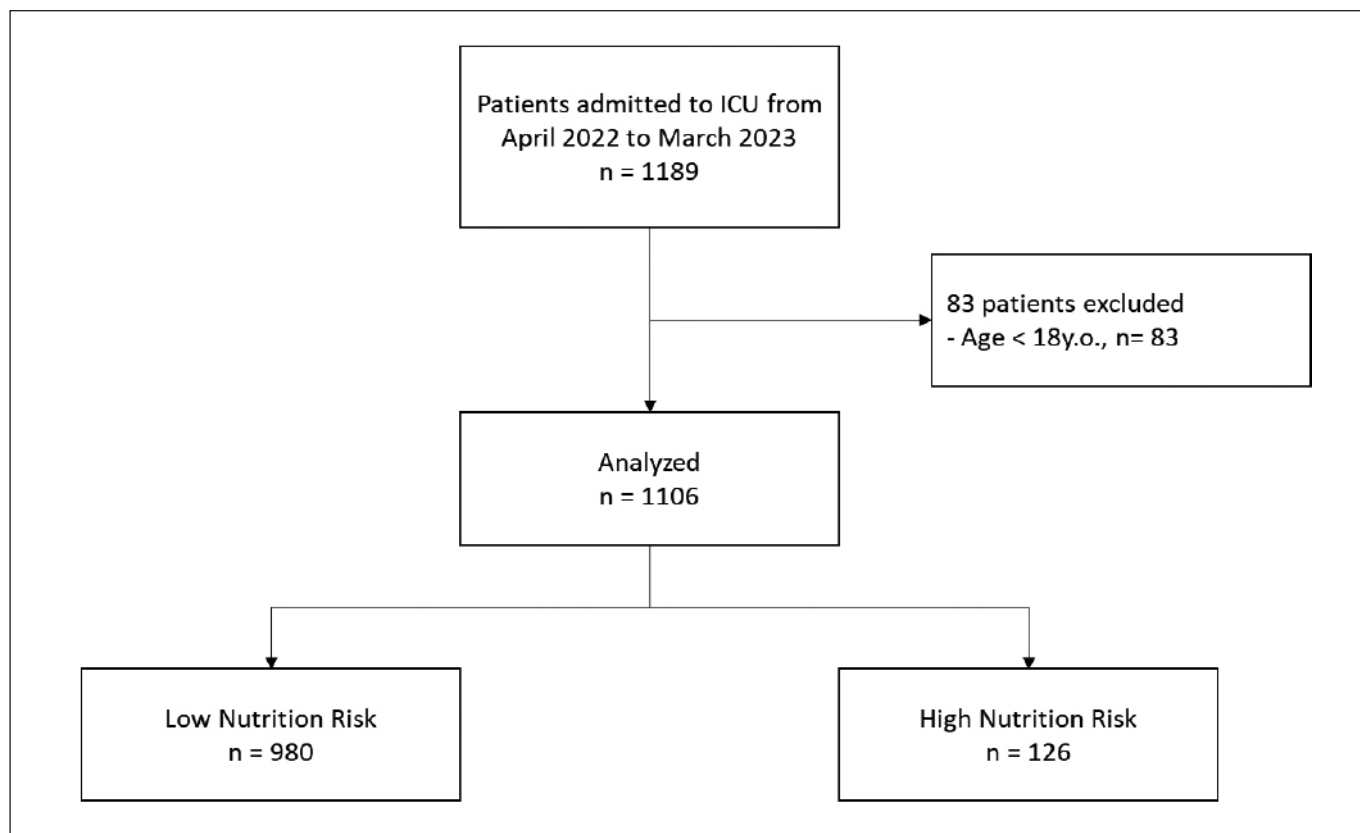


Figure 1. Flowchart of the study patients

Table 1. Baseline characteristics of the study patients

	Survivors	Non Survivors	p Value
Age, year	50 [37, 60]	55.5 [41, 67]	<0.001
Sex			<0.001
Men	401 (45.6)	131 (58)	
Woman	479 (54.4)	95 (42)	
Height, cm	160 [155, 165]	160 [155, 165]	0.105
Weight, kg	60 [50, 63]	60 [50, 64]	0.235
BMI, kg/m ²	22.22 [20.56, 24.61]	22.22 [20.81, 23.92]	0.690
BMI Category			0.921
<18.5	94 (10.7)	21 (9.3)	
18.5 - 22.9	412 (46.8)	102 (45.1)	
23 - 24.9	192 (21.8)	53 (23.5)	
25 - 29.9	165(18.8)	46 (20.4)	
>30	17 (1.9)	4 (1.8)	

Data are presented as n (%) or median (interquartile range).
BMI, Body Mass Index.

Table 1 continuation. Baseline characteristics of the study patients

	Survivors	Non Survivors	p Value
Admission Type			<0.001
Medical	84 (37.2)	123 (14)	
Surgical	142 (62.8)	757 (86)	
mNutric Score			<0.001
Low Risk	830 (94.3)	150 (66.4)	
High Risk	50 (5.7)	76 (33.6)	
Total Lymphocyte Count	939 [663, 1340]	792 [485, 1185]	0.001
Neutrophil to Lymphocyte Ratio	12.73 [8.38, 20.1]	16.58 [9.42, 25.51]	0.034
Prognostic Nutritional Index	34.2 (6.8)	29.7 (6.8)	<0.001
CRP to Albumin Ratio	5.36 [4.33, 37.41]	9.39 [19.23, 64.11]	<0.001
ICU LOS, days	1 [1, 5]	6 [2, 11]	<0.001
Hospital LOS, days	8 [6, 20]	16 [9, 28]	<0.001
Mechanical Ventilation, days	0 [0, 2]	4 [1, 10]	<0.001

Data are presented as n (%) or median (interquartile range).

ICU, Intensive Care Unit; LOS, Length of Stay; CRP, C-Reactive Protein; mNutric Score, modified Nutrition risk in critically ill.

Table 2. Relationship between Prognostic Indicator and Mortality

	Unadjusted			Adjusted*		
	Hazard ratio	95% CI	p Value	Hazard ratio	95% CI	p Value
Total Study Population						
PNI	0.914	0.892 - 0.937	<0.001	0.910	0.887 - 0.934	<0.001
CAR	1.020	1.013 - 1.026	<0.001	1.017	1.011 - 1.024	<0.001
NLR	1.018	1.008 - 1.027	<0.001	1.014	1.005 - 1.023	0.002
Subgroup Analysis						
Low Nutrition Risk						
PNI	0.917	0.892 - 0.944	<0.001	0.909	0.882 - 0.937	<0.001
CAR	1.021	1.013 - 1.028	<0.001	1.019	1.011 - 1.027	<0.001
NLR	1.015	1.003 - 1.026	<0.001	1.015	1.003 - 1.027	0.011
High Nutrition Risk						
PNI	0.961	0.907 - 1.019	0.188	0.978	0.948 - 1.008	0.148
CAR	0.999	0.984 - 1.014	0.880	0.997	0.981 - 1.014	0.751
NLR	1.004	0.992 - 1.017	0.507	1.005	0.990 - 1.020	0.541

* Adjusted for age, sex, BMI, Admission Type.

PNI, Prognostic Nutritional Index; CAR, CRP to Albumin Ratio; Neutrophil to Lymphocyte Ratio.

ference ($p = 0.105$). The survivors and non-survivors had similar median weights of 60 kg, although the distribution was slightly different, and this was not statistically significant ($p = 0.235$). The BMI of both groups was also similar, with a median of 22.22 kg/m², and no significant difference ($p = 0.690$). The admission type differed significantly between survivors and non-survivors ($p < 0.001$). Among survivors, 37.2% were medical admissions, while 62.8% were surgical. In contrast, among non-survivors, 14% were medical, and 86% were surgical. Nutrition risk, assessed using the mNUTRIC score, was significantly different between the groups ($p < 0.001$). The majority of survivors (94.3%) had low nutrition risk, while most non-survivors (86%) had high nutrition risk. The median total lymphocyte count was significantly higher in survivors (939, IQR: 663–1340) compared to non-survivors (792, IQR: 485–1185), with a significant difference ($p < 0.001$). The median Neutrophil-to-Lymphocyte Ratio (NLR) was lower in survivors (12.73, IQR: 8.38–21.00) than in non-survivors (16.58, IQR: 9.42–25.71), also significantly different ($p = 0.003$). The Prognostic Nutritional Index (PNI) was higher in survivors (34.2, IQR: 6.8) compared to non-survivors (29.7, IQR: 6.8), with a significant difference ($p < 0.001$). The CRP-to-Albumin Ratio (CAR) was lower in survivors (5.36, IQR: 3.43–7.41) compared to non-survivors (9.39, IQR: 3.71–19.23), also significantly different ($p < 0.001$). The median length of stay in the ICU was shorter for survivors (1 day, IQR: 1–5) compared to non-survivors (6 days, IQR: 2–11), with a significant difference ($p < 0.001$). The median hospital length of stay was shorter for survivors (8 days, IQR: 2–20) compared to non-survivors (16 days, IQR: 8–28), also significantly different ($p < 0.001$). The median duration of mechanical ventilation was shorter for survivors (0 days, IQR: 0–1) compared to non-survivors (4 days, IQR: 1–10), with a significant difference ($p < 0.001$).

For the total study population, the unadjusted HR for Prognostic Nutritional Index (PNI) was 0.914 (95% CI: 0.892–0.937; $p < 0.001$). This indicates that higher PNI is associated with lower mortality. The adjusted HR for PNI, which accounts for potential confounding factors such as age, sex, BMI, and admission type, remained significant at 0.910 (95% CI: 0.887–0.934; $p < 0.001$). The unadjusted and adjusted HRs for CRP-to-Albumin Ratio (CAR) were 1.020 (95% CI: 1.013–1.026; $p < 0.001$) and 1.017 (95% CI: 1.011–1.024; $p < 0.001$), respectively, suggesting that higher CAR is associated with increased mortality. Similarly, the Neutrophil-to-Lymphocyte Ratio (NLR) showed significant associations with mortality, with unadjusted and adjusted HRs of 1.018 (95% CI: 1.008–1.027; $p < 0.001$) and 1.014 (95% CI: 1.005–1.023; $p = 0.002$), respectively. In the low nutrition risk group, all three indicators (PNI, CAR, and NLR) were significantly associated with mortality both in the unadjusted and adjusted models. For example, the unadjusted HR for PNI was 0.917 (95% CI: 0.892–0.944; $p < 0.001$) and the adjusted HR was 0.909 (95% CI: 0.882–0.937;

$p < 0.001$). However, in the high nutrition risk group, the associations were less pronounced. The unadjusted and adjusted HRs for PNI were not significant, with values of 0.961 (95% CI: 0.907–1.019; $p = 0.188$) and 0.978 (95% CI: 0.948–1.008; $p = 0.148$), respectively. The unadjusted and adjusted HRs for CAR were also non-significant, with values of 0.999 (95% CI: 0.984–1.014; $p = 0.880$) and 0.997 (95% CI: 0.981–1.014; $p = 0.751$), respectively. The unadjusted and adjusted HRs for NLR were similarly non-significant, with values of 1.004 (95% CI: 0.992–1.017; $p = 0.507$) and 1.005 (95% CI: 0.990–1.020; $p = 0.541$), respectively.

The predictive factor accuracy of C-reactive protein to albumin ratio (CRP/Albumin), neutrophil to lymphocyte ratio (NLR), and Prognostic Nutritional Index (PNI) was assessed using Receiver Operating Characteristic (ROC) curve analysis. Figure 2 depicts the ROC curves for each test variable to predict mortality. The area under the ROC curve (AUC) for CRP/Albumin was 0.696, indicating a good diagnostic ability to differentiate between patient groups. NLR demonstrated a fair diagnostic performance with an AUC of 0.575. The PNI showed a poor discriminative ability with an AUC of only 0.325

DISCUSSION

In this observational cohort study, we evaluated the prognostic value of the Neutrophil-to-Lymphocyte Ratio (NLR), Prognostic Nutritional Index (PNI), and CRP-to-Albumin Ratio (CAR) in predicting mortality among ICU patients. Our findings indicate that all three indicators significantly predict mortality in this population, particularly among those with low nutrition risk. The unadjusted and adjusted hazard ratios for NLR, PNI, and CAR were all significant in the total population and among patients with low nutrition risk. However, among patients with high nutrition risk, the prognostic significance of these indicators was less pronounced^{15–17}.

In critically ill patients, the intricate interplay between inflammation, immune function, and nutritional status plays a pivotal role in determining clinical outcomes. Elevated NLR may signify an exaggerated inflammatory response in patients with low nutrition risk, characterized by an imbalance between pro-inflammatory neutrophils and anti-inflammatory lymphocytes, contributing to tissue damage, organ dysfunction, and increased mortality risk^{18–21}. Similarly, the CRP-albumin ratio reflects the balance between inflammatory markers and nutritional status. Elevated levels of CRP, indicative of systemic inflammation, coupled with decreased levels of albumin, suggestive of malnutrition, underscore the multifaceted nature of critical illness in these patients^{22,23}. These biomarkers not only reflect the severity of the inflammatory response but also provide insights into the nutritional adequacy and immune competence of the individual, crucial determinants of clinical outcomes.

The differences in prognostic predictability between patients with low and high nutrition risk may stem from the un-

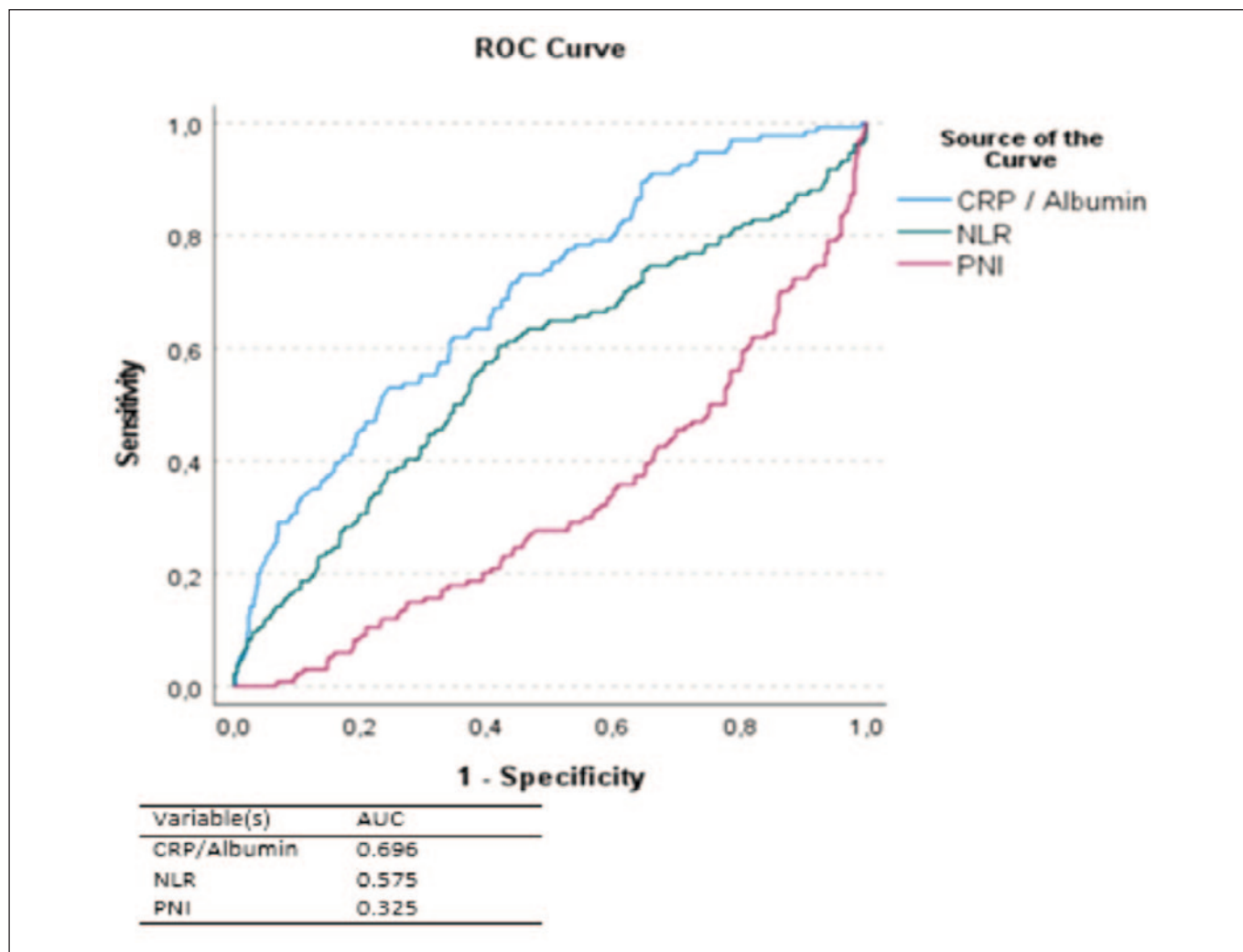


Figure 2. ROC Curve Analysis of CRP/Albumin, NLR, and PNI to Predict Mortality

derlying pathophysiology of critical illness and the dynamic interplay between inflammation, immune function, and nutritional status. Patients with high nutrition risk may exhibit more profound and persistent inflammation, reflecting a dysregulated immune response and systemic inflammatory cascade, potentially overshadowing the effectiveness of traditional prognostic markers such as NLR, PNI, and CRP-albumin ratio in predicting mortality risk²⁴⁻²⁷. Moreover, the impact of nutritional status on immune function may be more pronounced in patients with high nutrition risk, further complicating the prognostic assessment. Malnutrition-induced immune dysfunction can exacerbate the inflammatory response and predispose patients to adverse outcomes, making it challenging to discern the independent prognostic significance of individual biomarkers^{28,29}.

The demonstrated predictability of NLR, PNI, and CAR as mortality indicators in ICU patients with low nutritional risk suggests significant clinical implications for monitoring and inter-

vention. The utility of these markers can be extended to devise personalized treatment strategies, where the inflammation and nutritional status of each patient are regularly assessed and addressed. For instance, elevated NLR and CAR values might prompt immediate anti-inflammatory interventions, while low PNI could necessitate nutritional support measures. Integrating these indicators into routine clinical practice could potentially accelerate decision-making processes, enhance patient monitoring, and improve outcomes by enabling more tailored and timely interventions. Future studies could explore the integration of these markers into clinical protocols and examine their impact on the management strategies and recovery rates of ICU patients³⁰⁻³³.

Our study has several limitations. First, this was an observational cohort study, which limits our ability to establish causality between the prognostic indicators and mortality. Future randomized controlled trials are needed to further investigate these relationships. Second, our study was con-

ducted in a single centre hospital, which may limit the generalizability of our findings to other settings. However, the large sample size and diverse patient population enhance the external validity of our results. Third, we used retrospective data from medical records, which may be subject to data quality issues. However, the use of standardized clinical measurements and robust statistical analyses mitigates this limitation. Finally, while we adjusted for several potential confounders, residual confounding cannot be ruled out. Future studies should consider additional confounding factors, such as comorbidities and treatment interventions, to further elucidate the relationships between these prognostic indicators and mortality.

CONCLUSION

Study demonstrates that the Neutrophil-to-Lymphocyte Ratio, Prognostic Nutritional Index, and CRP-to-Albumin Ratio are significant predictors of mortality in ICU patients with low nutrition risk. These indicators provide valuable prognostic information and underscore the importance of addressing both inflammation and nutritional status in critically ill patients.

ACKNOWLEDGEMENTS

The author would like to express gratitude to all teachers at the Nutrition Department, Faculty of Medicine, Hasanuddin University

REFERENCES

- Huang Y, Zhang Q, Li P, Chen M, Wang R, Hu J, et al. The prognostic nutritional index predicts all-cause mortality in critically ill patients with acute myocardial infarction. *BMC Cardiovasc Disord.* 2023 Jul 4;23(1):339.
- Xu T, Zhang SM, Wu HM, Wen XM, Qiu DQ, Yang YY, et al. Prognostic significance of prognostic nutritional index and systemic immune-inflammation index in patients after curative breast cancer resection: a retrospective cohort study. *BMC Cancer.* 2022 Nov 3;22(1):1128.
- Regolo M, Vaccaro M, Sorce A, Stancanelli B, Colaci M, Natoli G, et al. Neutrophil-to-Lymphocyte Ratio (NLR) Is a Promising Predictor of Mortality and Admission to Intensive Care Unit of COVID-19 Patients. *J Clin Med.* 2022 Apr 16;11(8):2235.
- Chen L, Bai P, Kong X, Huang S, Wang Z, Wang X, et al. Prognostic Nutritional Index (PNI) in Patients With Breast Cancer Treated With Neoadjuvant Chemotherapy as a Useful Prognostic Indicator. *Front Cell Dev Biol.* 2021 Mar 30;9.
- Zinellu A, Zinellu E, Mangoni AA, Pau MC, Carru C, Pirina P, et al. Clinical significance of the neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio in acute exacerbations of COPD: present and future. *European Respiratory Review.* 2022 Dec 31;31(166):220095.
- Zhang X, Wei R, Wang X, Zhang W, Li M, Ni T, et al. The neutrophil-to-lymphocyte ratio is associated with all-cause and cardiovascular mortality among individuals with hypertension. *Cardiovasc Diabetol.* 2024 Apr 2;23(1):117.
- Asghar MS, Akram M, Yasmin F, Najeeb H, Naeem U, Gaddam M, et al. Comparative analysis of neutrophil to lymphocyte ratio and derived neutrophil to lymphocyte ratio with respect to outcomes of in-hospital coronavirus disease 2019 patients: A retrospective study. *Front Med (Lausanne).* 2022 Jul 22;9.
- Man MA, Rajnoveanu RM, Motoc NS, Bondor CI, Chis AF, Lesan A, et al. Neutrophil-to-lymphocyte ratio, platelets-to-lymphocyte ratio, and eosinophils correlation with high-resolution computer tomography severity score in COVID-19 patients. *PLoS One.* 2021 Jun 28;16(6):e0252599.
- Liu M, Sun M, Zhang T, Li P, Liu J, Liu Y, et al. Prognostic Nutritional Index (PNI) as a potential predictor and intervention target for perioperative ischemic stroke: a retrospective cohort study. *BMC Anesthesiol.* 2023 Aug 10;23(1):268.
- Wang HB, Xu XT, Tian MX, Ding CC, Tang J, Qian Y, et al. Prognostic values of the prognostic nutritional index, geriatric nutritional risk index, and systemic inflammatory indexes in patients with stage IIB–III cervical cancer receiving radiotherapy. *Front Nutr.* 2023 Mar 2;10.
- Buonacera A, Stancanelli B, Colaci M, Malatino L. Neutrophil to Lymphocyte Ratio: An Emerging Marker of the Relationships between the Immune System and Diseases. *Int J Mol Sci.* 2022 Mar 26;23(7):3636.
- Shi Y, Zhang Y, Niu Y, Chen Y, Kou C. Prognostic role of the prognostic nutritional index (PNI) in patients with head and neck neoplasms undergoing radiotherapy: A meta-analysis. *PLoS One.* 2021 Sep 14;16(9):e0257425.
- Liu B, Lv D. Prognostic value of C-reactive protein to albumin ratio for mortality in acute kidney injury. *BMC Nephrol.* 2023 Feb 25;24(1):44.
- Jang JH, Hong S, Ryu JA. Prognostic Value of C-Reactive Protein and Albumin in Neurocritically Ill Patients with Acute Stroke. *J Clin Med.* 2022 Aug 29;11(17):5067.
- Buonacera A, Stancanelli B, Colaci M, Malatino L. Neutrophil to Lymphocyte Ratio: An Emerging Marker of the Relationships between the Immune System and Diseases. *Int J Mol Sci.* 2022 Mar 26;23(7):3636.
- Regolo M, Vaccaro M, Sorce A, Stancanelli B, Colaci M, Natoli G, et al. Neutrophil-to-Lymphocyte Ratio (NLR) Is a Promising Predictor of Mortality and Admission to Intensive Care Unit of COVID-19 Patients. *J Clin Med.* 2022 Apr 16;11(8):2235.
- Huang Y, Zhang Q, Li P, Chen M, Wang R, Hu J, et al. The prognostic nutritional index predicts all-cause mortality in critically ill patients with acute myocardial infarction. *BMC Cardiovasc Disord.* 2023 Jul 4;23(1):339.
- Wu X, Luo Q, Su Z, Li Y, Wang H, Liu Q, et al. Neutrophil-to-lymphocyte ratio as a predictor of mortality in intensive care unit patients: a retrospective analysis of the Medical Information Mart for Intensive Care III Database. *BMJ Open.* 2021 Nov 11;11(11):e053548.

19. Liu J, Liu Y, Xiang P, Pu L, Xiong H, Li C, et al. Neutrophil-to-lymphocyte ratio predicts critical illness patients with 2019 coronavirus disease in the early stage. *J Transl Med.* 2020 Dec 20;18(1):206.
20. Tanik VO, Akdeniz E, Çınar T, Şimşek B, İnan D, Kıvrak A, et al. Higher C-Reactive Protein to Albumin Ratio Portends Long-Term Mortality in Patients with Chronic Heart Failure and Reduced Ejection Fraction. *Medicina (B Aires).* 2024 Mar 7;60(3):441.
21. Jang JH, Hong S, Ryu JA. Prognostic Value of C-Reactive Protein and Albumin in Neurocritically Ill Patients with Acute Stroke. *J Clin Med.* 2022 Aug 29;11(17):5067.
22. Liu B, Lv D. Prognostic value of C-reactive protein to albumin ratio for mortality in acute kidney injury. *BMC Nephrol.* 2023 Feb 25;24(1):44.
23. Uzum Y, Turkkan E. Predictivity of CRP, Albumin, and CRP to Albumin Ratio on the Development of Intensive Care Requirement, Mortality, and Disease Severity in COVID-19. *Cureus.* 2023 Jan 10;
24. Sarejloo S, Shojaei N, Lucke-Wold B, Zelmanovich R, Khanzadeh S. Neutrophil to lymphocyte ratio and platelet to lymphocyte ratio as prognostic predictors for delirium in critically ill patients: a systematic review and meta-analysis. *BMC Anesthesiol.* 2023 Feb 21;23(1):58.
25. Di Rosa M, Sabbatinelli J, Soraci L, Corsonello A, Bonfigli AR, Cherubini A, et al. Neutrophil-to-lymphocyte ratio (NLR) predicts mortality in hospitalized geriatric patients independent of the admission diagnosis: a multicenter prospective cohort study. *J Transl Med.* 2023 Nov 21;21(1):835.
26. Akkaya S, Cakmak U. Association between C-Reactive Protein to Albumin Ratio and Multi-Vessel Coronary Artery Disease in Patients with Stable Coronary Artery Disease. *J Pers Med.* 2024 Mar 31;14(4):378.
27. Li J, Zhu P, Li Y, Yan K, Tang X, Xu J, et al. A novel inflammatory biomarker, high-sensitivity C-reactive protein-to-albumin ratio, is associated with 5-year outcomes in patients with type 2 diabetes who undergo percutaneous coronary intervention. *Diabetol Metab Syndr.* 2023 Feb 6;15(1):14.
28. Drăgoescu AN, Pădureanu V, Stănculescu AD, Chiuțu LC, Tomescu P, Geormăneanu C, et al. Neutrophil to Lymphocyte Ratio (NLR)—A Useful Tool for the Prognosis of Sepsis in the ICU. *Biomedicines.* 2021 Dec 30;10(1):75.
29. Dolapoglu A, Avci E, Kiris T. The predictive value of C-reactive protein to albumin ratio for ascending aort progression in patients with ascending aortic diameter of 40–50 mm. *J Cardiothorac Surg.* 2022 Oct 4;17(1):254.
30. Toyokawa T, Muguruma K, Yoshii M, Tamura T, Sakurai K, Kubo N, et al. Clinical significance of prognostic inflammation-based and/or nutritional markers in patients with stage III gastric cancer. *BMC Cancer.* 2020 Dec 3;20(1):517.
31. Shao Y, Lai Q, Cheng Duan Q, Ge P, Ye L. Nutritional indices at admission are associated with mortality rates of patients in the intensive care unit. *Eur J Clin Nutr.* 2022 Apr 17;76(4):557–63.
32. Wu X, Luo Q, Su Z, Li Y, Wang H, Liu Q, et al. Neutrophil-to-lymphocyte ratio as a predictor of mortality in intensive care unit patients: a retrospective analysis of the Medical Information Mart for Intensive Care III Database. *BMJ Open.* 2021 Nov 11;11(11):e053548.
33. Regolo M, Vaccaro M, Sorce A, Stancanelli B, Colaci M, Natoli G, et al. Neutrophil-to-Lymphocyte Ratio (NLR) Is a Promising Predictor of Mortality and Admission to Intensive Care Unit of COVID-19 Patients. *J Clin Med.* 2022 Apr 16;11(8):2235.

The relationship between energy intake and infections in critical patients in intensive care unit (ICU) receiving medical nutrition therapy at Wahidin Sudirohusodo Hospital

JEFFRY¹, Suryani AS'AD^{1,2,3}, Nurpudji A TASLIM^{1,2}, Desi VERA¹, HUSMIANI¹, Tien Muliawati ABADI¹, YUNITA¹, Agussalim BUKHARI², AMINUDDIN², Haerani RASYID²

1 Clinical Nutrition Specialist Program, Department of Nutrition, Hasanuddin University School of Medicine, Makassar, Indonesia.

2 Department of Nutrition, Hasanuddin University School of Medicine, Makassar, Indonesia.

3 Muhammadiyah University School of Medicine, Makassar, Indonesia.

Recibido: 6/mayo/2024. Aceptado: 12/julio/2024.

ABSTRACT

Introduction: Patients admitted to the ICU tend to experience malnutrition, so nutrition is needed in this case energy intake to help reduce the incidence of infection, closely linked to poor prognosis in ICU treatment. This study aims to establish the correlation between energy intake and infection occurrence among critically ill ICU patients undergoing medical nutrition therapy at Central General Hospital (RSUP) Dr. Wahidin Sudirohusodo.

Methods: This is a retrospective cohort study on critically ill ICU patients at Dr. Wahidin Sudirohusodo Hospital Makassar. Data were collected through medical records from September 2020 - December 2022. Total 551 patients was divided into two groups, first group received enteral, parenteral, and mixed combined enteral and parenteral nutrition, while second group only enteral or parenteral nutrition, Lymphocyte count and leucocyte as a predictor infection for both groups.

Results: this study found out, a significant correlation between the use of enteral and parenteral nutrition methods first group and second group ($p < 0.000$). Specifically, enteral nutrition methods showed a significant relationship with first group or second group ($p < 0.000$), while parenteral nutrition methods also displayed a significant association ($p < 0.007$).

Correspondencia:

Suryani As'ad
suryani_fkuh@yahoo.com

Adequate energy intake is crucial for the recovery of ICU patients at RSUP dr. Wahidin Sudirohusodo, with medical nutritional therapy, including enteral or parenteral nutrition, playing a supportive role in ensuring patients receive sufficient nutrition.

Conclusions: The First Group with Enteral, Parenteral, and mixed Combined of parenteral and parenteral has lower infection and higher food intake compared to second group.

KEYWORDS

Critical care, nutritional support, parenteral nutrition, clinical nutrition, enteral nutrition.

INTRODUCTION

Nutrition is an important component in the care of critically ill patients. The condition of malnutrition is closely related to the poor prognosis experienced by patients treated in the *intensive care unit* (ICU), including increased morbidity, mortality and length of stay¹. Critically ill patients treated in the ICU mostly face death, multiple organ failure, use ventilators, and require assistive devices to maintain life.

Patients receiving treatment in the ICU have hypermetabolism and increased catabolism, causing malnutrition. In conditions of malnutrition, individuals will experience a decline in the body's immune system making them more susceptible to infection². Adequate immunological status will also result in a good level of health. Nutrients obtained from food intake have a strong effect on the body's immune reactions and resistance to infection.

In conditions of protein energy malnutrition (PEM), it can cause the body's resistance to decrease and the virulence of pathogens to be stronger, causing the balance to be disturbed and infection to occur, while one of the main determinants in maintaining this balance is nutritional status³.

In this study, an attempt was made to compare two groups of cases, namely the cooperative group (KJS) and the non-cooperative group (Non-KJS). Collaboration groups (KJS) are groups that receive medical therapy and other therapeutic treatment from other specialist doctors related to the patient's condition. On the other hand, the non-cooperating group (Non-KJS) is a group of patients who only receive nutritional therapy without any intervention from other doctors.

In Makassar, until now there has not been much research or publication of data showing the relationship between energy intake and the incidence of infection in critical ICU patients receiving medical nutrition therapy, so we will conduct research to analyze it.

LITERATURE REVIEW

Critically

Critical illness is a life-threatening process that, without medical intervention, is expected to result in death. Initially from one or more underlying pathophysiological processes, giving rise to a multisystem developmental process that ultimately involves respiratory, cardiovascular and neurological disorders³.

Critical illness is a life-threatening catabolic condition caused by excessive infection, trauma, or other types of severe tissue injury (e.g., pancreatitis). Relates to coordinated neuroendocrine and cytokine responses that alter energy expenditure and protein catabolism⁴.

Medical Nutrition Therapy

Medical nutritional therapy (MNT) is an important part of care for critically ill patients, but optimal feeding strategies for patients in intensive care units (ICUs) are still debated and often pose a challenge for ICU teams in clinical practice. Recommendations for MNT in critically ill patients vary between the DGEM (German Society for Nutritional Medicine), ESPEN (European Society of Enteral and Parenteral Nutrition), ASPEN (American Society of Enteral and Parenteral Nutrition), and societal guidelines, and their implementation into clinical practice. can be considered a challenge⁵.

Nutritional support during critical illness attenuates metabolic responses to stress, prevents oxidative cellular injury, and modulates the immune system. The stress response to critical illness causes wide fluctuations in metabolic levels. The hypercatabolic phase can last for 7-10 days and is manifested by increased oxygen demand, cardiac output and carbon dioxide production.

Incidence of Infection in Critical Patients in the ICU

Critically ill patients have an increased risk of developing infections and infectious complications, sometimes followed by death. Infections are common in critically ill patients and often occur due to the severity of the patient's illness. Several factors (age, underlying disease, disease severity, poor infection control, etc.). The cause is infection acquired in the intensive care unit, and malnutrition is one of the most common and severe reasons⁶.

Nosocomial infections are infections that appear while a person is being treated in hospital and begin to show symptoms while the person is being treated or after being treated. In general, patients who are admitted to hospital with signs of infection that appear less than 3 times 24 hours, indicate that the incubation period of the disease has occurred before the patient enters the hospital, while infections with symptoms appear 3 times 24 hours after the patient is in hospital without clinical signs. infection when the patient begins to be treated, and the signs of infection are not remnants of a previous infection, then this is called a nosocomial infection⁷.

Relationship between Energy Intake and Infection Events

Critical patients, such as those resulting from trauma or severe sepsis, experience metabolic changes that cause an increase in the body's energy needs. Insufficient food intake and hypermetabolism lead to the risk of nutritional deficiencies, worsening the condition by weakening the immune system, making it difficult to heal wounds, and increasing the risk of nosocomial infections. Proper nutritional support is essential to prevent infection and improve the patient's condition. Underfeeding can have negative impacts, lengthening treatment time, increasing the risk of infection, and increasing mortality. Hyperinflammatory conditions in critical patients are also triggered by nutritional deficiencies, increasing the risk of infection and serious complications such as sepsis and organ failure. Therefore, it is important to provide adequate nutritional support to improve the patient's condition and prevent further complications⁸.

MATERIAL AND METHODS

Study design and participation: This type of research is a retrospective cohort with an analytic observational approach in critically ill patients treated in the ICU of Dr. Wahidin Sudirohusodo Hospital Makassar. This research was conducted in the medical records section of Dr. RSUP. Wahidin Sudirohusodo Hospital Makassar in September - November 2023. The research sample was all critical patients treated in the ICU at Dr. Wahidin Sudirohusodo Hospital Makassar in January 2020 - December 2022. who meet the inclusion criteria.

The inclusion criteria encompassed critical patients over 18 years of age receiving treatment in the Intensive Care Unit (ICU) at Dr. Wahidin Sudirohusodo Hospital. To be included, patients were required to have laboratory examination results, specifically routine blood tests including leucocyte and lymphocyte counts. Additionally, all eligible participants needed to be receiving the same Clinical Nutrition treatment protocol. The exclusion criteria were designed to maintain data quality and consistency. Patients were excluded if their medical documents could not be located or if the available data was incomplete. The study also excluded patients under 18 years of age, aligning with the lower age limit specified in the inclusion criteria. Furthermore, patients who were treated for less than 48 hours in the ICU and those who only participated in the collaborative group (KJS) once were not included in the study population. These carefully defined criteria ensured that the study focused on a specific group of adult ICU patients with adequate treatment duration and consistent participation in collaborative care, allowing for a more robust analysis of the relationship between nutritional interventions and patient outcomes in the critical care setting.

Research variables: Critical patients face life-threatening conditions. Their energy intake is measured as a percentage of needs. Infections are assessed by leukocyte counts, with $>10,000 \mu\text{l}$ indicating leukocytosis. Comorbidities like diabetes or heart disease increase mortality risk. Both genders are included. Patients are categorized as adults (18-60 years) or elderly (>60 years). These factors are crucial in managing critically ill patients.

Ethical consideration: This research has received approval from the Health Research Ethics Commission (HREC) of the Faculty of Medicine, Hasanuddin University.

Statistical analysis: The data obtained is collected based on the type of data and then the appropriate statistical method is selected. One Way Anova test and T-Test, if the data is normally distributed, or the Kruskal Wallis and Mann Whitney test, if the data is not normally distributed.

RESULTS

The KJS group are patients who receive medical therapy as well as additional care from specialist doctors according to their condition. Meanwhile, the Non-KJS group only received nutritional therapy without any additional intervention from other doctors.

In table 1, the total number of data observed is 499 patients, which includes the entire population studied in the Intensive Care Unit (ICU) who received nutritional medical therapy at the Central General Hospital (RSUP) Dr. Wahidin Sudirohusodo.

In terms of characteristics of the collaboration group (KJS), the majority of patients, namely 75.4%, had collaboration

Table 1. Characteristics of Respondents in the *Intensive Care Unit* (ICU) who received Enteral and Parenteral Medical Nutrition Therapy at the Central General Hospital (RSUP) Dr. Wahidin Sudirohusodo

Characteristics		n	%
Group	Cooperation	376	75.4
	Non Cooperation	123	24.6
Gender	Man	262	52.5
	Woman	237	47.5
Loss of consciousness	Yes	489	98.0
	No	10	2.0
Enteral & parenteral	Yes	52	10.4
	No	447	89.6
Enteral	Yes	359	71.9
	No	140	28.1
Parenteral	Yes	451	90.4
	No	48	9.6
Amount		499	100.0

with related parties, while the other 24.6% of patients did not have collaboration (non KJS).

Based on gender characteristics, there are slight differences between men and women. Of the total respondents, 52.5% were men, while 47.5% were women.

The majority of patients, namely 98.0%, experienced decreased consciousness, while only 2.0% did not experience this.

Based on the characteristics of feeding, only a small proportion of patients, namely 10.4%, received food via enteral & parenteral methods. The majority, namely 89.6%, did not receive food via enteral & parenteral methods. Furthermore, 71.9% of patients received enteral feeding, while 28.1% did not. In addition, the majority of patients, namely 90.4%, received parenteral feeding, while only 9.6% did not.

Table 2 provides an overview of the characteristics of ICU patients at Dr. Wahidin Sudirohusodo who received medical nutritional therapy. Data shows the average age of patients is 49.40 years, with an age range of 18-85 years. The average length of stay in the ICU was 21.03 days, with a range of 1-93 days. The average duration of nutritional therapy was 13.38 days, with a range of 1-91 days. The average energy intake percentage was 80.37%, with a wide range from 5.60% to 3924.00%. The number of leukocytes varied, with

Table 2. Average Category Values for *Intensive Care Unit* (ICU) Patients Receiving Medical and Nutritional Therapy at the Central General Hospital (RSUP) Dr. Wahidin Sudirohusodo

Category	Mean	Elementary school	Median	Minimum	Maximum
Age	49.40	15.61	51.00	18.00	85.00
Length of Maintenance	21.03	13.00	19.00	1.00	93.00
Length of_Nutritional_Therapy	13.38	12.85	8.00	1.00	91.00
Percentage of Energy Intake	80.37	175.34	74.60	5.60	3924.00
Leukocyte	16061.98	7449.22	14600.00	2900.00	64400.00
Lymphocyte	25%	30%	35%	33%	28%

the first average being 16061.98 μ l and the second average 12470.26 μ l. From these data, it can be concluded that ICU patients have varying characteristics, which need to be considered in nutritional care and therapy.

Table 3 shows that data analysis shows there is no relationship between patient gender and nutritional cooperation ($p = 1,000$). The majority of patients with decreased consciousness were included in the cooperation group (97.9%),

Table 3. Variable Relationships with First Group and second Groups in *Intensive Care Unit* (ICU) Patients Receiving Medical and Nutritional Therapy at the Central General Hospital Dr. Wahidin Sudirohusodo*

Variables/Categories			Group		Amount	p value
			First	Second		
Gender	Man	n	197	65	262	1.000
		%	52.4%	52.8%	52.5%	
	Woman	n	179	58	237	
		%	47.6%	47.2%	47.5%	
Loss of consciousness	Yes	n	368	121	489	1.000
		%	97.9%	98.4%	98.0%	
	No	n	8	2	10	
		%	2.1%	1.6%	2.0%	
Enteral & Parenteral	Yes	n	29	23	52	0.000
		%	7.7%	18.7%	10.4%	
	No	n	347	100	447	
		%	92.3%	81.3%	89.6%	
Enteral	Yes	n	287	72	359	0.000
		%	76.3%	58.5%	71.9%	
	No	n	89	51	140	
		%	23.7%	41.5%	28.1%	

Enteral: Nutrition. Parenteral: Nutrition. Mixed Enteral Parenteral: Nutrition. Significant *: $P < 0,05$.

Table 3 continuation. Variable Relationships with First Group and second Groups in *Intensive Care Unit (ICU)* Patients Receiving Medical and Nutritional Therapy at the Central General Hospital Dr. Wahidin Sudirohusodo*

Variables/Categories			Group		Amount	p value
			First	Second		
Parenteral	Yes	n	348	103	451	0.007
		%	92.6%	83.7%	90.4%	
	No	n	28	20	48	
		%	7.4%	16.3%	9.6%	
Amount		n	376	123	499	
		%	100.0%	100.0%	100.0%	

Parenteral: Nutrition. Mixed Enteral Parenteral: Nutrition. Significant *: $P < 0,05$.

but there was no significant association ($p = 1.000$). However, there was a significant relationship between the use of enteral & parenteral nutrition methods and nutritional cooperation ($p < 0.05$), as well as between the use of enteral ($p < 0.05$) and parenteral nutrition methods ($p < 0.05$). This shows that the pattern of nutritional collaboration with other units varies depending on the type of nutritional method used by the patient.

Table 4 compares research variables in ICU patients at Dr. RSUP. Wahidin Sudirohusodo who received medical nutrition therapy, between first and second groups. There were no significant differences in age ($p = 0.163$) and length of treatment ($p = 0.314$) between the two groups.

However, there were significant differences in the duration of nutritional therapy ($p = 0.010$) and leukocyte count and Lymphocyte ($p < 0.05$). The percentage of nutritional intake did not show a significant difference ($p = 0.971$). So, the duration of nutritional therapy and the number of leukocytes and Lymphocyte showed differences between the two groups, while age, length of treatment, and percentage of nutritional intake did not show significant differences

This table compares two groups of patients based on several parameters. The average age of both groups was around 48-50 years. Length of treatment and nutritional therapy varied between the two groups. The percentage of energy intake showed large variations, especially in the first group. The aver-

Table 4. Comparison of research variables between the KJS and non-KJS groups in *Intensive Care Unit (ICU)* patients receiving medical and nutritional therapy at the Central General Hospital (RSUP) Dr. Wahidin Sudirohusodo*

Group	First Group				Second Group				p value
	Mean	Elementary school	Minimum	Maximum	Mean	Elementary school	Minimum	Maximum	
Age	49.91	15.52	18.00	85.00	47.85	15.86	18.00	82.00	0.163
Length of Maintenance	21.52	13.50	2.00	93.00	19.51	11.27	1.00	71.00	0.314
Length of Nutritional Therapy	12.90	13.04	1.00	91.00	14.83	12.19	1.00	69.00	0.010
Percentage of energy intake	83.17	201.70	5.60	3924.00	71.80	18.54	29.70	156.70	0.971
Leukocyte	16539.34	7597.68	3400.00	64400.00	14602.76	6799.29	2900.00	56200.00	0.009
Lymphocyte	25%	30%	35%	33%	40%	39%	42%	43%	0.001

* Mann Whitney test. Significant * $P < 0,05$.

age leukocyte count was higher in the first group. The percentage of lymphocytes tended to be higher in the second group. Significant differences ($p < 0.05$) were seen in the duration of nutritional therapy, leukocyte count, and lymphocyte percentage. Mann Whitney test was used for statistical analysis.

DISCUSSION

Description of energy intake in critical intensive care unit (ICU) patients receiving medical nutrition therapy at the Central General Hospital (RSUP) dr. Wahidin Sudirohusodo

The results of research at Dr. Wahidin Sudirohusodo Hospital pointed out that the majority of ICU patients (75.4%) belong to nutrition First group, which may receive more intensive nutritional care. There were no significant differences between gender and first or second groups. The majority of patients (98.0%) experienced decreased consciousness, affecting their ability to accept food orally. Most patients received nutrition via enteral (71.9%) and parenteral (90.4%) methods.

The duration of nutritional therapy had a significant difference between the KJS and non-KJS groups, with the KJS group having a shorter average duration of nutritional therapy compared to non-KJS. This may suggest that patients in the KJS group may have received appropriate nutritional intervention more quickly, which could have helped speed recovery and improve their energy intake.

Thus, based on the data above, energy intake in critical patients undergoing treatment in the ICU at RSUP dr. Wahidin Sudirohusodo is influenced by various factors, including nutritional collaboration with other units, gender, medical conditions such as decreased consciousness, and the nutritional delivery method used. Efforts to ensure energy intake that is adequate and appropriate to the needs of critical patients is important in their care management

The duration of nutritional therapy was different between the two groups, with the first group having a shorter duration of therapy. Energy intake is influenced by medical conditions and type of nutritional method. Other research shows the importance of optimal nutritional intake in improving survival and recovery in critically ill patients. Therefore, appropriate nutritional monitoring and intervention is essential to improve the clinical outcomes of ICU patients.

Description of infection in critical intensive care unit (ICU) patients receiving medical nutrition therapy at the Central General Hospital (RSUP) dr. Wahidin Sudirohusodo

The results of research on critical patients in the ICU at dr. Wahidin Sudirohusodo Hospital showed the impact of nutritional medical therapy on infections. The leukocyte count, an indicator of the immune response, decreased after therapy, indicating the impact of nutritional therapy on the patient's

immune response. The majority of patients with decreased consciousness belonged to the first group, which has a higher risk of infection. Patients receiving nutrition via enteral and parenteral methods may be more susceptible to infection due to the risk of contamination. Infection monitoring and appropriate management are essential in the management of ICU patients to reduce the risk of infectious complications.

From these data, it can be concluded that critical patients undergoing nutritional medical therapy in the ICU at RSUP Dr. Wahidin Sudirohusodo has a significant risk of infection, especially related to the condition of decreased consciousness and the nutritional method used. Therefore, infection monitoring and appropriate management are essential in the management of ICU patients to reduce the risk of infectious complications and improve treatment outcomes.

Critically ill patients are at increased risk of infection and infectious complications, sometimes followed by death. Infections are common in critically ill patients and often occur due to the severity of the patient's illness. Several factors (age, underlying disease, disease severity, poor infection control, etc.). The cause is infection acquired in the intensive care unit, and malnutrition is one of the most common and severe reasons⁹.

Research at various US universities shows that ICU patients have a 5-8 times higher risk of nosocomial infections compared to patients in regular wards. This infection often occurs post-surgery and in patients with IVs and catheters that are not installed according to standard infection prevention procedures. Surveys by the Indonesian Ministry of Health and WHO show that Infection Prevention and Control Committees in Hospitals are not functioning optimally^{9,10}.

Correlation between energy intake and the incidence of infection in critical intensive care unit (ICU) patients receiving medical nutrition therapy at the Central General Hospital dr. Wahidin Sudirohusodo

Correlation study between energy intake and the incidence of infection in critical patients in the ICU at Hospital Dr. Wahidin Sudirohusodo highlighted the importance of nutrition in supporting healing. Medical nutritional therapy, such as enteral or parenteral, is important to meet patient needs. A correlation was found between low energy intake and a higher risk of infection. Nutrition methods (oral, enteral, parenteral) are associated with the Nutrition First Group, indicating the importance of this collaboration. Decreased awareness or gender did not affect nutritional cooperation. There are differences in the duration of nutritional therapy and the number of leukocytes and Lymphocyte between first and Second Group. First Group patients had shorter duration of therapy and higher leukocyte counts and Lymphocyte, indicating the benefits of nutritional cooperation. These findings are important for improving the clinical outcomes of ICU patients. Further studies are needed to better understand this relationship.

In ICU patients, hyperinflammatory conditions due to critical illness can reduce immune system function, cause oxidative stress and mitochondrial dysfunction. Nutritional deficiencies resulting from insufficient food intake and the patient's stress response accelerate the development of this condition. Nutritional deficiencies increase hyperinflammation and increase the risk of infection. Poor nutritional status also suppresses the immune system, increasing the risk of infection, sepsis, and multiple organ failure, and can lead to death, depending on the severity and duration of the disease^{11,12}.

Comparison of research variables on two groups of patients in the intensive care unit (ICU) at the Central General Hospital (RSUP) dr. Wahidin Sudirohusodo

Based on the analysis of table 4 from research on Intensive Care Unit (ICU) patients at the Central General Hospital (RSUP) dr. Wahidin Sudirohusodo, it appears that there are significant differences between two groups of patients, namely the group that participates in nutritional collaboration with First Group and the Second group. Although there were no significant differences in age and length of treatment, there were significant differences in the duration of nutritional therapy. First Group have a shorter duration of nutritional therapy, indicating efficiency in determining and administering nutritional therapy. In addition, although the percentage of nutritional intake was relatively similar between the two groups, there were significant differences in leukocyte counts. First Group patients showed a better body response, with higher leukocyte counts, lower Lymphocyte count both before and after nutritional therapy. These findings indicate that nutritional cooperation can influence the efficiency of treatment and the patient's body response, although some factors such as age and length of treatment do not significantly influence it. Therefore, increasing nutritional collaboration in intensive care units may help improve patient clinical outcomes¹².

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded as follows: Energy intake is influenced by nutritional first group, gender, and awareness. KJS patients receive treatment more quickly, it is important to ensure adequate energy intake for recovery. Critical patient in the ICU at dr. Wahidin Sudirohusodo Hospital is susceptible to infections. Medical nutritional therapy affects leukocyte counts and lymphocyte count, with a decrease after therapy. Enteral and parenteral nutrition increases the risk of infection, it is important for proper monitoring of infection. Energy intake is important for the recovery of critical patients. Medical nutritional therapy supports patients to receive adequate nutrition. The first group plays a role in medical therapy, speeding up recovery and reducing the risk of infection. First Group patients have shorter nutritional therapy and better body re-

sponse. Nutritional collaboration influences the efficiency of nutritional therapy and overall clinical outcomes.

ACKNOWLEDGMENT

Thank you to Hasanuddin University for helping facilitate this research.

REFERENCES

1. Khalid I, Doshi P, DiGiovine B. Early enteral nutrition and outcomes of critically ill patients treated with vasopressors and mechanical ventilation. *Am J Crit Care*. 2010;19(3):261-8. Available from: <https://doi.org/10.4037/ajcc2010197>
2. Calder PC, Jackson AA. Undernutrition, infection and immune function. *Nutr Res Rev*. 2000;13(1):3-29. Available from: <https://doi.org/10.1079/095442200108728981>
3. Barker LA, Gout BS, Crowe TC. Hospital Malnutrition: Prevalence, Identification and Impact on Patients and the Healthcare System. *Int J Environ Res Public Health*. 2011;8(2):514-27. Available from: <https://doi.org/10.3390/ijerph8020514>
4. Appelgren P, Hellström I, Weitzberg E, Söderlund V, Bindsvle L, Ransjö U. Risk factors for nosocomial intensive care infections: A long-term prospective analysis. *Acta Anaesthesiol Scand*. 2001;45(6):710-9. Available from: <https://doi.org/10.1034/j.1399-6576.2001.045006710.x>
5. Hill A, Elke G, Weimann A. Nutrition in the intensive care unit—a narrative review. *Nutrients*. 2021;13(8):2851. Available from: <https://doi.org/10.3390/nu13082851>
6. Rodríguez L, Cervantes E, Ortiz R. Malnutrition and gastrointestinal and respiratory infections in children: a public health problem. *Int J Environ Res Public Health*. 2011;8(4):1174-205. Available from: <https://doi.org/10.3390/ijerph8041174>
7. Santosa B, Suwarman, Pradian E. Nutritional Therapy for Patients in the Intensive Care Unit (Icu). *J Anesth Complicat*. 2020;7(1):1-10.
8. Van Zanten ARH. Should We Increase Protein Delivery During Critical Illness? *JPEN J Parenter Enteral Nutr*. 2016;40(6):756-62. Available from: <https://doi.org/10.1177/0148607115626905>
9. Martin SJ, Yost RJ. Infectious Diseases in the Critically Ill Patient. *J Pharm Pract*. 2011;24(1):35-43. Available from: <https://doi.org/10.1177/0897190010388906>
10. Haley RW, Culver DH, White JW, Morgan WM, Emori TG, Munn VP, et al. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. *Am J Epidemiol*. 1985;121(2):182-205. Available from: <https://doi.org/10.1093/oxfordjournals.aje.a113990>
11. Angele MK, Chaudry IH. Surgical trauma and immunosuppression: Pathophysiology and potential immunomodulatory approaches. *Langenbecks Arch Surg*. 2005;390(4):333-41. Available from: <https://doi.org/10.1007/s00423-005-0557-4>
12. Pierre JF, Heneghan AF, Lawson CM, Wischmeyer PE, Kozar RA, Kudsk KA. Pharmacconutrition Review: Physiological Mechanisms. *JPEN J Parenter Enteral Nutr*. 2013;37(5 Suppl):51S-65S. Available from: <https://doi.org/10.1177/0148607113493326>

Food security of farmer households in Central Lombok Regency

Lalu Juntra UTAMA¹, Lalu Khairul ABDI¹, Lina YUNITA², Baiq Eka Putri SAUDIA³, Kiki KRISTIANDI⁴, Astuti NUR⁵

1 Department of Nutrition, Poltekkes Kemenkes Mataram, Mataram City, Indonesia.

2 Department of Nutrition, Universitas Bumigora Mataram, Mataram City, Indonesia.

3 Department of Midwifery, Poltekkes Kemenkes Mataram, Mataram City, Indonesia.

4 Department of Food Agroindustry, Politeknik Negeri Sambas, Sambas City, Indonesia.

5 Department of Nutrition, Poltekkes Kemenkes Kupang, Kupang City, Indonesia.

Recibido: 15/mayo/2024. Aceptado: 14/julio/2024.

ABSTRACT

Background: Food security is a key issue in fulfilling community welfare because it will determine a country's economic, social, and political stability. Food security is a condition where food is met down to the individual level, reflected in the availability of sufficient quantity and quality and safe, diverse, and affordable food. This research analyzed the status and situation of food security of farming households and examined the determinants of food security of farming households in Central Lombok Regency.

Methods: The design of this research was a cross-sectional study; data collection was carried out in Central Lombok Regency, West Nusa Tenggara Province. This research involved two groups of subjects: toddlers and mothers. The total number of subjects was 359, consisting of mothers and children. Subjects were taken at each community health center using a simple random method without replacement. All primary data was collected through an interview process using a structured questionnaire and direct measurements. The analysis process for all types of data was carried out with the help of the SPSS for Windows program with the Pearson correlation test and One Way Anova test.

Results: The intake of micronutrients for toddlers, including Vitamin C, iron, iodine, and calcium in Central Lombok Regency, is generally still insufficient; only vitamin A intake is categorized as sufficient on average. Intake of macronutrients, namely energy, protein, and carbohydrates, is generally above

adequate; only fat intake is in the severe deficiency category. The majority of toddlers in Central Lombok Regency have good weight, height, and nutritional status. Demographic conditions, including education and the number of family members in Central Lombok Regency, are related to the Food Insecurity Scale. In Central Lombok Regency, no significant relationship was found between HDDS and overcoming food insecurity.

Conclusions: Even though the intake of micronutrients in toddlers is low, the majority have good nutritional status. Food security is related to demographic conditions, and income plays an important role in overcoming food insecurity. However, nutritional status is not directly influenced by household resources.

KEYWORDS

Micronutrient, Farmer households, Food security, Nutritional status, Toddlers.

INTRODUCTION

Issues related to food security have become a challenge for all countries because they are directly related to improving the economy and achieving the quality of human life¹. According to FAO (2009), understanding the concept of food security is the condition of providing food for everyone in terms of quantity and nutritional quality. Fulfilling the right to food is the primary key to overcoming hunger. Conditions of food insecurity will indirectly lead to malnutrition problems².

Achieving food and nutritional security, especially with various resources, is not easy because food and nutritional security is a complex problem. That the various metrics and indicators that have been proposed are not equivalent, convey different information for food security, and are difficult to ap-

Correspondencia:

Lalu Juntra Utama
lalujuntra@gmail.com

ply will affect validity and reliability, thereby limiting potential empirical relevance. Food security and nutrition is a system consisting of 3 pillars: availability, access, and utilization^{3,4}.

These three pillars are fundamental determinants of food security and are related hierarchically. Food availability is necessary but not enough to guarantee access to sufficient food. Food availability refers to the physical availability of food in the environment where people live in sufficient quantities and which can be reached by all residents⁵. Food access refers to the ability to obtain readily available foodstuffs either through exchange media (markets) or through transfers (institutional)⁶. Food utilization refers to allocating and processing food that has been obtained (accessed) so that each individual obtains sufficient food intake as a dimension to be included and analyzed in the food security index.

Methods for measuring food security and nutrition exist both at the global level such as GFSI (Global Food Security Index), HANCI (Hunger And Undernutrition Index), and at the national level, which have been issued by the Ministry of Agriculture and World Food such as FSVA (Food Security and Vulnerability Atlas of Indonesia) indicators are still fragmented by sub-systems and not all indicators can be applied in different regions, so methods for measuring food and nutrition security that are appropriate to regional characteristics are needed. Several single indicators are strong predictors of food security at the household level, such as the proportion of food expenditure and diversity of household diet. The proportion of food expenditure is quite sensitive to important aspects of food security such as dietary diversity and income level⁷. In addition, the HDDS score or diet diversity is the best proxy for assessing food security conditions at the household level. These two single indicators can be used as a standard reference in developing a new instrument, such as a composite index. One of the age groups at greatest risk of undernutrition due to food insecure household situations is children under five years old/toddlers⁸. Then, referring to the UNICEF framework, food security at the household level is one of the indirect factors causing nutritional status through the intake of food nutrients.

Based on the problems research's, this research aims to develop a household food security index concerning nutritional intake and nutritional status of children under five and analyze regional food security in Central Lombok Regency.

MATERIAL AND METHOD

Design, Location, and Time

The design of this research was a cross-sectional study; data collection was carried out in Central Lombok Regency, West Nusa Tenggara Province. The location selection was carried out purposively with the consideration that Central Lombok Regency was the district that has the highest prevalence of stunting nutritional problems by selecting seven health centers, including Teratak Batukliang Utara Health

Center, Kopang Health Center, Pengadang Praya Tengah Health Center, East Mujur Praya Health Center, Batu Health Center Jangkik Praya Barat Daya, Kuta Pujut Community Health Center, Ubung Jonggat Community Health Center. Researchers chose these seven community health centers as research locations because of their representation in mountainous, lowland, and coastal areas, and they carried out their research purposively. The research was conducted for 5 months, from May to September 2023.

Population and Sample

This research involved two groups of subjects: toddlers and mothers. The inclusion criteria considered in determining children as subjects were children aged 12 to 59 months, the condition of the child who was not seriously ill or undergoing routine treatment, and consent from the mother as proven by signing an informed consent sheet. Meanwhile, the inclusion criteria considered in determining the mother as a subject were: the subject is the child's biological mother, has a husband with the status of head of the household, the mother subject has full responsibility in arranging or preparing family food, has an age range from 17 to 50 years, and the subject agrees to interview as evidenced by signing an informed consent sheet. The minimum number of subjects based on the calculation formula was 359 toddlers. The number of subjects was calculated using proportional allocation by considering each health center's food vulnerability level/stratum. The total number of subjects was 359, consisting of mothers and children. Subjects were taken at each community health center using a simple random method without replacement, with the help of the Microsoft Excel 2013 program.

Data Types and Collection Methods

All primary data was collected through an interview process using a structured questionnaire and direct measurements. The nutritional intake in children consists of the Level of nutritional adequacy and Dietary diversity (Individual Dietary Diversity Score/IDDS. Measured using a structured interview with 2 x 24-hour food recall. Then the measurement results are divided into adequacy levels of micronutrients (Deficient and Sufficient) and Adequacy levels of macronutrients (Above Adequacy; Good; Mild Deficiency; Moderate Deficiency; Severe Deficiency). The child's nutritional status consists of 3 indices, namely Body weight for age; Height/body length, and Body weight for height. Nutritional status was measured by direct measurement of body weight using a digital step scale, while body height used a length board. Then analyzed using WHO Anthro Survey Analyzer Software (Windows, Mac). Then the measurement results are divided into 3 nutritional status indices, namely⁹: 1) Body weight for age (Overweight (z-score >2); Normal (z-score > -2.0 to +2.0); Deficient (z-score -3.0 to -2.0); Very deficient (z-score < -3.0). 2) Height for age (Normal (z-score ≥ -2.0); Stunting (z-score -3.0 to -2.0); Very Stunting

(z-score < -3.0). 3) Body weight for height (Overweight (z-score > +2.0); Normal (z-score > -2.0 to +2.0); Malnutrition (z-score -3.0 to -2.0); Severe malnutrition (z-score < -3.0)). General household characteristics consisting of father's education, mother's education, gender, family number which were collected using the Structured interview method guided by a questionnaire. The Food Insecurity Experience Scale (FIES) is measured using the FIES Survey Module (FIES-SM) consisting of 8 questions on access to food and the measurement results are categorized into 3 categories, namely¹⁰: Moderate Food Insecurity, Light Food Insecurity, Food security. Household Dietary Diversity Score (HDDS) is measured using a structured interview with 1 x 24-hour recall and the measurement results are categorized into 2 categories, namely: Medium (4-5 Types of Food); High (>6 Types of Food). Individual Dietary Diversity Score (IDDS) is measured using a structured interview with 1 x 24-hour recall and the measurement results are categorized into 2 categories, namely: Good (> 4 types/food groups); Less (< 4 types of food groups).

In general, two levels of social organization were analyzed in this research: households and individuals/children. At the household level, the analyzed variables were all selected indicators of social, economic, and physical access. All these variables were combined into a composite index to measure the level of food security at the household level. At the household level, the variables collected were diet diversity and the proportion of household food expenditure.

Data processing

The analysis process for all data types was carried out with the help of the SPSS for the Windows program. This research also applies a composite index score validation test through the Spearman correlation test against two standard benchmark indicators: the HDDS score and the proportion of food expenditure. Another relationship test was to examine the relationship between the index score and nutritional status, level of nutritional adequacy, and dietary diversity (IDDS) in children. The correlation test was applied using Spearman or Pearson, depending on the normality of the data. Another bivariate analysis in this research used the One Way Anova difference test followed by the Tukey test to examine differences in index scores based on the regional food insecurity vulnerability level.

This research has received approval from the Poltekkes Kemenkes Mataram Ethical Commission with number: LB.01.03/6/115/2023.

RESULTS

Based on the results of this study, data regarding food security in the Central Lombok Regency area involving toddlers and mothers was obtained. The distribution of toddler subjects based on the level of micronutrient adequacy consisting of vitamin A, vitamin C, iron, iodine, and calcium is presented in Table 1. The level of micronutrient adequacy for toddlers is identified as insufficient and sufficient. Regarding vitamin A adequacy, more than 50% of subjects were classified as sufficient (57.3%), while for vitamin C, most were deficient (70.6%). Then, regarding iron, iodine, and calcium adequacy, more than 50% of subjects were categorized as deficient (59.9%, 76.1%, and 76.7%, respectively).

Table 2 presents data on the distribution of toddler subjects based on the adequacy of macronutrients consisting of energy, protein, fat, and carbohydrates. At the energy, protein, and carbohydrate adequacy level, more than 50% of subjects fell into the category above adequacy (52.4%, 89.0%, and 52.4%, respectively). However, regarding the fat adequacy level, most subjects were categorized as severely deficient (34.0%).

The distribution of toddler subjects based on nutritional status classification can be seen in Table 3. Based on this data, the majority of male toddlers have normal body weight (based on body weight for age), about 73.9%; have normal height (based on height for age), about 56.5%; good nutritional status (based on body weight/height), about 82.6%. In female subjects, the majority had normal weight (based on body weight for age), about 70.1%; normal height (based on height for age), about 55.5%; good nutritional status (based on body weight for height), about 91.5%.

In this research, the demographic relationship (father's education, mother's education, gender, and family size) with the Food Insecurity Scale (moderate food insecurity, mild food insecurity, not food insecurity) is studied, which can be seen in Table 4. It is known that the father's education, mother's education level, and family size have a significant relationship to FIES, with p-value = 0.000. However, there was no signif-

Table 1. Distribution of toddler subjects based on adequacy level of micronutrients

Category	Vit A		Vit C		Fe		Iodine		Ca	
	n	%	n	%	n	%	n	%	n	%
Deficient	148	42.7	245	70.6	208	59.9	264	76.1	266	76.7
Sufficient	199	57.3	102	29.4	139	40.1	83	23.9	81	23.3
Average ± SD	206 ± 376		92 ± 146		152 ± 344		68 ± 110		60 ± 68	

Table 2. Distribution of toddler subjects based on adequacy levels of macronutrients

Category	Energy		Protein		Fat		Carbohydrate	
	n	%	n	%	n	%	n	%
Above Adequacy	182	52.4	309	89.0	98	28.2	182	52.4
Good	100	28.8	23	6.6	69	19.9	105	30.3
Mild Deficiency	20	5.8	4	1.2	23	6.6	12	3.5
Moderate Deficiency	13	3.8	3	0.9	39	11.3	17	4.9
Severe Deficiency	32	9.2	8	2.3	118	34.0	31	8.9
Average ± SD	130 ± 78		241 ± 144		101 ± 66		146 ± 42	

Table 3. Distribution of toddler subjects based on nutritional status classification

Category	Gender				Total	
	Male		Female			
	n	%	n	%	n	%
Body weight for age						
Very deficient	6	3.3	4	2.4	10	2.9
Deficient	42	22.8	45	27.4	87	25.0
Normal	136	73.9	115	70.1	251	72.1
Average ± SD	-1.4 ± 1.0		-1.6 ± 2.2		-1.5 ± 1.7	
Height for age						
Very short	15	8.2	17	10.4	32	9.2
Short	62	33.7	54	32.9	116	33.3
Normal	104	56.5	91	55.5	195	56.0
Tall	3	1.6	2	1.2	5	1.4
Average ± SD	-1.5 ± 1.5		-1.7 ± 1.3		-1.6 ± 1.4	
Body weight for height						
Severe malnutrition	2	1.1	1	0.6	3	0.9
Malnutrition	8	4.3	6	3.7	14	4.0
Normal	152	82.6	150	91.5	302	86.8
Risk of Over-Nutrition	4	2.2	0	0.0	4	1.1
Overweight	17	9.2	7	4.3	24	6.9
Obese	1	0.5	0	0	1	0.3
Average ± SD	-0.3 ± 1.3		-0.5 ± 0.9		-0.4 ± 1.1	

Table 4. Demographic relationship with the food insecurity experience scale (FIES)

Category	Food Insecurity Experience Scale (FIES)								p-value
	Moderate Food Insecurity		Light Food Insecurity		Food security		Total		
	n	%	n	%	n	%	n	%	
Father's Education									
No/never been to school	0	0	22	6.6	0	0.0	22	6.3	0.000
Not completed in primary school	1	100.0	35	10.5	1	8.3	37	10.7	
Finished elementary school	0	0	83	24.9	2	16.7	85	24.5	
Finished junior high school	0	0	74	22.2	1	8.3	75	21.6	
Finished senior high school	0	0	97	29.0	2	16.7	99	28.5	
Completed Diploma	0	0	10	3.0	3	25.0	13	3.7	
Completed bachelor degree	0	0	13	3.9	3	25.0	16	4.6	
Total	1	100.0	334	100.0	12	100.0	347	100.0	
Mother's Education									
No/never been to school	0	0	17	5.1	0	0.0	17	4.9	0.000
Not completed in primary school	1	100.0	30	9.0	0	0.0	31	8.9	
Finished elementary school	0	0	49	14.7	0	0.0	49	14.1	
Finished junior high school	0	0	121	36.2	5	41.7	126	36.3	
Finished senior high school	0	0	105	31.4	4	33.3	109	31.4	
Completed Diploma	0	0	6	1.8	3	25.0	9	2.6	
Completed bachelor degree	0	0	6	1.8	0	0	6	1.7	
Total	1	100.0	334	100.0	12	100.0	347	100.0	
Gender									
Male	0	0	178	53.3	6	50.0	184	53.0	0.554
Female	1	100.0	158	46.7	6	50.0	163	47.0	
Total	1	100.0	334	100.0	12	100.0	347	100.0	
Family Number									
2	0	0	3	0.9	0	0.0	3	0.9	0.000
3	0	0	97	29.0	4	33.3	101	29.1	
4	0	0	153	45.8	6	50.0	159	45.8	
5	0	0	65	19.5	2	16.7	67	19.3	
6	1	100.0	9	2.7	0	0	10	2.9	
7	0	0	7	2.1	0	0	7	2.0	
Total	1	100.0	334	100.0	12	100.0	347	100.0	

icant relationship between gender category and FIES (P-value = 0.554). Specifically, in the father’s education category, in the moderate food insecurity group, 100% of subjects had not completed elementary school; in the mild food insecurity group, the majority of subjects (29.0%) only completed high school. In the non-food insecure group, 50% of subjects had >high school education. In the maternal education category, in the moderate food insecurity group, 100% of subjects had not completed elementary school; in the mild food insecurity group, the majority of subjects (36.2%) had only completed junior high school; in the non-food insecure group, 41.7% of subjects had secondary school education. Then, in the family size category, in the moderate food insecurity group, 100% of subjects had 6 household members; in the mild food insecurity group, the majority of subjects (45.8%) had 4 family members; in the food insecure group, as many as 50% of subjects also had family members of 4 people.

The relationship between overcoming food insecurity (low, medium, and high categories) on the Household Dietary Diversity Score (medium (4-5 types of food) and high (>6 types of food)) and Individual Dietary Diversity Score (low (<4 food groups) and good (>=4 food groups), can be seen in Table 5. No significant relationship was found between HDDS and overcoming food insecurity, p-value = 0.615. However, IDDS and overcoming food insecurity had a significant relationship, with a p-value of 0.001. Specifically, the majority of the IDDS group is good (>=4 types of food groups), reaching 98.4% in the low category of food insecurity, 86.7% in the medium category of food insecurity, and 100% in the high category of food insecurity.

Table 6 presents data on the relationship between the Household Dietary Diversity Score (HDDS), which consists of medium (4-5 types of food) and high (>= 6 types of food) categories with nutritional status. In all HDDS categories, there was no statistically significant relationship with each category of nutritional status, with P-values of 0.615, 0.982, and 0.891, respectively.

The relationship between the Individual Dietary Diversity Score (poor (<4 types of food groups) and good (>=4 types of food groups) on nutritional status (body weight for age, height for age, and body weight for height) is presented in Table 7. IDDS for each category of nutritional status did not identify a statistically significant relationship, with P-values of 0.880, 0.759, and 0.578, respectively.

DISCUSSION

Food security is a fundamental right of every individual and household. Food security can at least show nutritional intake¹¹. By achieving food security, it is considered that food needs are met so that nutritional intake is sufficient. Various complex factors, including economics and education, influence food security, reflecting the knowledge level and family size¹²⁻¹⁴.

Farming communities in Indonesia are synonymous with low socio-economic conditions. This group tends to have a high probability of being food insecure, affecting their intake of macro and micronutrients¹⁵. Based on this research, the intake of micronutrients for toddlers, including Vitamin C, iron, iodine, and calcium in Central Lombok Regency, is generally still insufficient; only vitamin A intake is categorized as sufficient on average. Intake of macronutrients, namely energy, protein,

Table 5. Relationship between reducing food insecurity and the Household Dietary Diversity Score (HDDS) and the Individual Dietary Diversity Score (IDDS)

Category	Food Insecurity Management								p-value
	Low		Middle		High		Total		
	n	%	n	%	n	%	n	%	
HDDS									
Medium (4-5 Types of Food)	9	2.9	0	0	0	0	9	2.6	0.615
High (>6 Types of Food)	305	97.1	30	100.0	3	100.0	338	97.4	
Total	314	100.0	30	100.0	3	100.0	347	100.0	
IDDS									
Less (<4 Types of Food Groups)	5	1.6	4	13.3	0	0	9	2.6	0.001
Good (>=4 Types of Food Groups)	309	98.4	26	86.7	3	100.0	338	97.4	
Total	314	100.0	30	100.0	3	100.0	347	100.0	

Table 6. Relationship between the household dietary diversity score (HDDS) and nutritional status

Category	HDDS						p-value
	Medium (4-5 types of food)		High (>=6 types of food)		Total		
	n	%	n	%	n	%	
Body weight for age							
Very deficient	0	0	10	3.0	10	2.9	0,615
Deficient	3	33.3	84	24.9	87	25.1	
Normal	6	66.7	239	70.7	245	70.6	
Over	0	0	5	1.5	5	1.4	
Total	9	100.0	338	100.0	347	100.0	
Height for age							
Very short	1	11.1	31	9.2	32	9.2	0.982
Short	3	33.3	113	33.4	116	33.4	
Normal	5	55.6	189	55.9	194	55.9	
Tall	0	0	5	1.5	5	1.4	
Total	9	100.0	338	100.0	347	100.0	
Body weight for height							
Severe malnutrition	0	0	3	0.9	3	0.9	0.891
Malnutrition	1	11.1	13	3.8	14	4.0	
normal	7	77.8	294	87.0	301	86.7	
Risk of Over-Nutrition	1	11.1	23	6.8	24	6.9	
Overweight	0	0	4	1.2	4	1.2	
Obese	0	0	1	0.3	1	0.3	
Total	9	100.0	338	100.0	347	100.0	

and carbohydrates, is generally above adequate; only fat intake is in the severe deficiency category. Nutrient intake based on food security conditions impacts a person's nutritional status. A study shows that the risk of delays in children's neurodevelopment is 4.4 times higher in children who live in families with mild and moderate food insecurity¹⁶. Severe food insecurity which can affect the anthropometric nutritional status of newborns such as premature birth¹⁷. Based on our data, most toddlers, both boys and girls in Central Lombok Regency, have good weight, height, and nutritional status.

Demographic conditions, including education and the number of family members in Central Lombok Regency, are related to the Food Insecurities Scale. The lower a person's education,

the more severe the food insecurity they face. Education level reflects a person's knowledge level and influences income. The level of education plays an important role in increasing household income sources and food security¹⁸. Then, the more family members there are, the more a household's need for food will increase. Likewise, in Central Lombok Regency, a large number of family members are in the food insecure group.

Both directly and indirectly, household access to food is an important element in food security¹⁹. Overall, all these single indicators describe the dimension of household food access, both directly and indirectly, which is an important element in food security¹⁹. Food insecurity occurs when people or individuals do not have adequate access to food at the household

Table 7. Relationship between the individual dietary diversity score (IDDS) and nutritional status

Category	IDDS						p-value
	Less (<4 types of food group)		Good (>=4 types of food group)		Total		
	n	%	n	%	n	%	
Body weight for age							
Very deficient	0	0	10	3.0	10	2.9	0.880
Deficient	3	33.3	84	24.9	87	25.1	
Normal	6	66.7	239	70.7	245	70.6	
Over	0	0	5	1.5	5	1.4	
Total	9	100.0	338	100.0	347	100.0	
Height for age							
Very short	0	0	32	9.5	32	9.2	0.759
Short	3	33.3	113	33.4	116	33.4	
Normal	6	66.7	188	55.6	194	55.9	
Tall	0	0	5	1.5	5	1.4	
Total	9	100.0	338	100.0	347	100.0	
Body weight for height							
Severe malnutrition	0	0	3	0.9	3	0.9	0.578
Malnutrition	0	0	14	4.1	14	4.0	
normal	7	77.8	294	87.0	301	86.7	
Risk of Over-Nutrition	2	22.2	22	6.5	24	6.9	
Overweight	0	0	4	1.2	4	1.2	
Obese	0	0	1	0.3	1	0.3	
Total	9	100.0	338	100.0	347	100.0	

level²⁰. Food access in households acts as a link between regional food availability and individual food consumption. In addition, household affordability of various types of food (food access) can reflect food consumption at the household level. Several single indicators have been developed to assess household food security, including the Household Food Security Scale Module (HFSSM), The Household Dietary Diversity Score (HDDS), The Food Consumption Score (FCS), The Coping Strategy Index (CSI), The Household Food Insecurity Access Scale (HFIAS) and Household Hunger Scale (HHS) can represent the food security status of a household²¹⁻²³. Our data shows that there was no significant relationship between HDDS and overcoming food insecurity in Central Lombok Regency.

However, IDDS and overcoming food insecurity have a significant relationship. Based on the nutritional status category, all nutritional status categories, including weight for age, height for age, and weight for height, did not show a statistically significant relationship with each HDDS or IDDS category.

CONCLUSION AND RECOMMENDATIONS

Based on this research, the intake of micronutrients for toddlers, including Vitamin C, iron, iodine, and calcium in Central Lombok Regency, is generally still insufficient; only vitamin A intake is categorized as sufficient on average. Intake of macronutrients, namely energy, protein, and carbohydrates, is generally above adequate; only fat intake is in the severe

deficiency category. The majority of toddlers in Central Lombok Regency have good weight, height, and nutritional status. Demographic conditions, including education and the number of family members in Central Lombok Regency, are related to the Food Insecurity Scale. In Central Lombok Regency, no significant relationship was found between HDDS and overcoming food insecurity. However, IDDS and overcoming food insecurity have a significant relationship. Based on the nutritional status category, no relationship was found between nutritional status and each HDDS or IDDS category.

ACKNOWLEDGEMENTS

The author would like to thank the including Teratak Batukliang Utara Health Center, Kopang Health Center, Pengadang Praya Tengah Health Center, East Mujur Praya Health Center, Batu Health Center Jangkih Praya Barat Daya, Kuta Pujut Community Health Center, Ubung Jonggat Community Health Center for permission to conduct research and guidance. The authors also thank the study participants and their parents. Thank you we convey to Poltekkes Kemenkes Mataram which has funded this research with Funding "Penelitian Dasar Unggulan Perguruan Tinggi" with number DP.04.03/XXXIV/1180/2023.

REFERENCE

- Gibson M. Food Security—A Commentary: What Is It and Why Is It So Complicated? *Foods*. 2012;1(1):18-27. doi:10.3390/foods1010018
- Gödecke T, Stein AJ, Qaim M. The global burden of chronic and hidden hunger: Trends and determinants. *Global Food Security*. 2018;17:21-29. doi:10.1016/j.gfs.2018.03.004
- Mbow C, Rosenzweig CE, Barioni LG, et al. Chapter 5: Food Security. 2020. <https://ntrs.nasa.gov/citations/20200001724>
- Pangaribowo EH, Gerber N, Torero M. Food and Nutrition Security Indicators: A Review. ZEF Working Paper. 2013;108. doi:10.2139/ssrn.2237992
- Simatupang P. Analisis Kritis terhadap Paradigma dan Kerangka Dasar Kebijakan Ketahanan Pangan Nasional. *Forum penelitian Agro Ekonomi*. 2007;25:1-18. doi:10.21082/fae.v25n1.2007.1-18
- Purwanti P. *Model Ekonomi Rumah Tangga Nelayan Skala Kecil dalam Mencapai Ketahanan Pangan: Analisis Simulasi Kebijakan*. Universitas Brawijaya Press; 2010.
- Ilham N, Sinaga BM. Penggunaan pangsa pengeluaran sebagai indikator komposit ketahanan pangan. *SOCA: Jurnal Sosial Ekonomi Pertanian*. 2007;7(3):1-22.
- Chuwa C, Dhiman AK, Kathuria D. General Overview of Malnutrition under five children in low income countries and solution to mitigate. *Current Journal of Applied Science and Technology*. 2020;39(48):466-482. doi:10.9734/cjast/2020/v39i4831266
- Menteri Kesehatan RI. *Peraturan Menteri Kesehatan Republik Indonesia Nomor 2 Tahun 2020 Tentang Standar Antropometri Anak*; 2020:1-78. http://hukor.kemkes.go.id/uploads/produk_hukum/PMK_No__2_Th_2020_ttg_Standar_Antropometri_Anak.pdf
- Reagan HA. Measuring Food Insecurity Experience Scale (FIES) In Indonesia. In: Vol 2018. The United Nations Statistics Division (UNSD); 2018:1-18.
- Burchi F, De Muro P. From food availability to nutritional capabilities: Advancing food security analysis. *Food Policy*. 2016;60:10-19. doi:10.1016/j.foodpol.2015.03.008
- Abafita J, Kim KR. Children's Schooling in Rural Ethiopia: The Role of Household Food Security, Parental Education and Income. *Journal of Economics and Sustainable Development*. 2014; 5(14):19.
- Junaidi J, Amir A, Amril A. Analysis of the Socio-Economic-Demographic Characteristics of the Family, Social Capital and Economic Coping Strategy in Increasing Food Security for Urban Poor Households in Jambi Province, Indonesia. *Dirasat: Human and Social Sciences*. 2020;47(2).
- Njeri A. Socio-Economic Factors Affecting Food Security Among The Elderly. A Critical Literature Review. *Journal of Food Sciences*. 2021;2(1):51-64. doi:10.47941/jfs.625
- Yousaf H, Zafar MI, Anjum F, Adil SA. Food security status and its determinants: A case of farmer and non-farmer rural households of the Punjab, Pakistan. *Pakistan Journal of Agricultural Sciences*. 2018;55:217-225. doi:10.21162/PAKJAS/18.6766
- Guadalupe ERH, Gutarra DM, Cesar CHM. Seguridad alimentaria nutricional y neurodesarrollo de niños menores de tres años de las familias del Valle del Canipac. *Nutrición Clínica y Dietética Hospitalaria*. 2022;42(3):172-181. doi:10.12873/423huaman
- Torres RM, Chávez ÁMC, Ocádiz GV, Sánchez JN. Food insecurity in homes of mothers of premature newborns with anthropometric alterations at birth. *Nutrición Clínica y Dietética Hospitalaria*. 2020;40(4):63-69. doi:10.12873/404monroy
- Nwokolo EE. The Influence of Educational Level on Sources of Income and Household Food Security in Alice, Eastern Cape, South Africa. *Journal of Human Ecology*. 2017;52(3):208-217. doi:10.1080/09709274.2015.11906944
- Rachman HPS. Aksesibilitas Pangan: Faktor Kunci Pencapaian Ketahanan Pangan di Indonesia. *JURNAL PANGAN*. 2010;19(2): 147-156. doi:10.33964/jp.v19i2.128
- FAO. *The State of Food Insecurity in the World Economic Crises Impacts and Lessons Learned*. Food and Agriculture Organization; 2009.
- Leroy JL, Frongillo EA. Perspective: What Does Stunting Really Mean? A Critical Review of the Evidence. *Advances in Nutrition*. 2019;10(2):196-204. doi:10.1093/advances/nmy101
- Manikas I, Ali BM, Sundarakani B. A systematic literature review of indicators measuring food security. *Agric & Food Secur*. 2023; 12(1):10. doi:10.1186/s40066-023-00415-7
- Maxwell D, Vaitla B, Coates J. How do indicators of household food insecurity measure up? An empirical comparison from Ethiopia. *Food Policy*. 2014;47:107-116. doi:10.1016/j.foodpol.2014.04.003

Conocimientos y consumo de alimentos andinos en universitarios del Perú

Knowledge and consumption of Andean foods in Peruvian university students

Gabriela VIDAL HUAMÁN, María SÁNCHEZ CHARCAPE, Miguel CASTRO MATTOS, Yuliana GOMEZ RUTTI

Escuela Profesional de Nutrición Humana - Universidad Nacional de Educación Enrique Guzmán y Valle, Lima, Perú.

Recibido: 28/marzo/2024. Aceptado: 17/julio/2024.

RESUMEN

Introducción: El conocimiento es un proceso de adquirir información valiosa para comprender la realidad por medio de la razón y el consumo es una actividad esencial que el hombre desarrolla diariamente mediante la selección y preparación de los alimentos. Es necesario que los alimentos andinos que se producen en el Perú de épocas antiguas sean consumidos por su valioso aporte nutricional.

Objetivo: Identificar la asociación entre los conocimientos y el consumo de alimentos andinos en universitarios del Perú.

Material y métodos: El estudio fue de corte transversal, participaron 408 estudiantes peruanos de universidades públicas y privadas, con una edad promedio de 23.76 ± 6.16 años. Se diseñó el instrumento de conocimientos sobre alimentos andinos con 15 ítems y sobre consumo de alimentos andinos se elaboró una frecuencia de consumo con 7 grupos de alimentos andinos. Ambos instrumentos fueron validados con 7 jueces y el KR20 del instrumento de conocimiento fue de 0,87, mientras que el cuestionario de consumo de alimentos tuvo un alfa de cronbach de 0,89. Se empleó la prueba de Chi-cuadrado, entre las variables nivel de conocimiento y el consumo de los alimentos andinos.

Resultados: El 75,25% de los estudiantes fueron mujeres y el 24,75% varones. El 71,6% presentaron un conocimiento regular de los alimentos andinos. Existe relación entre el conocimiento y consumo de alimentos andinos entre ellos las hierbas andinas como llantén, fruta: el airampo, las carnes de

alpaca, trucha y llama, tienen valores significativos con $p < 0,05$. Así mismo, con algunas frutas andinas como tumbo, sancayo, sachatomate, lúcuma, guindas y tuna ($p < 0,05$). Además, los tubérculos y raíces andinos, como mashua y chuño negro también fueron significativos. Los resultados son relevantes para comprender los patrones alimenticios y orientar estrategias de promoción de alimentos saludables en la población peruana.

Conclusiones: Los conocimientos de los alimentos andinos en los universitarios peruanos se asocian con el consumo de hierbas, frutas y tubérculos andinos.

PALABRAS CLAVE

Cognitivo, consumo alimentario, carnes andinas, vegetales andinos, adultos.

LISTA DE ABREVIATURAS

DHA: Acido Docosahexanoico

ABSTRACT

Introduction: Knowledge is a process of acquiring valuable information to understand reality through reason and consumption is an essential activity that man develops daily through the selection and preparation of food. It is necessary that Andean foods produced in Peru from ancient times be consumed for their valuable nutritional contribution.

Objective: To identify the association between knowledge and consumption of Andean foods in Peruvian university students.

Material and methods: The study was cross-sectional, 408 Peruvian students from public and private universities

Correspondencia:
Gabriela Vidal Huamán
fvidalh@une.edu.pe

participated, with an average age of 23.76 ± 6.16 years. An instrument of knowledge about Andean foods was designed with 15 items and a frequency of consumption of Andean foods was elaborated with 7 groups of Andean foods. Both instruments were validated with 7 judges and the KR20 of the knowledge instrument was 0.87, while the food consumption questionnaire had a cronbach's alpha of 0.89. The Chi-square test was used between the variables level of knowledge and the consumption of Andean foods.

Results: 75.25% of the students were female and 24.75% were male. The 71.6% presented a regular knowledge of Andean foods. There is a relationship between knowledge and consumption of Andean foods among them Andean herbs such as llantén, fruit: airampo, alpaca, trout and llama meats, have significant values with $p < 0.05$. Likewise, with some Andean fruits such as tumbo, sancayo, sachatomate, lúcuma, guindas and tuna ($p < 0.05$). In addition, Andean tubers and roots, such as mashua and black chuño were also significant. The results are relevant to understand dietary patterns and guide strategies for the promotion of healthy foods in the Peruvian population.

Conclusions: Knowledge of Andean foods in Peruvian university students is associated with the consumption of Andean herbs, fruits and tubers.

KEY WORDS

Cognitive, food consumption, andean meats, andean vegetables, adults.

INTRODUCCIÓN

Existe la necesidad de estudiar a los cultivos andinos los cuales no han sido suficientemente estudiados en términos de comercialización y consumo¹. Existe una variabilidad en formas, colores y tamaños, además presentan macronutrientes y micronutrientes y otros compuestos como saponinas, alcaloides, taninos, oxalatos, carotenos, antocianinas, betacianinas².

La poca disponibilidad, decisión de compra y la percepción de precios elevados, limita su acceso y consumo de los alimentos andinos en todos los hogares peruanos, por lo que optan por elegir alimentos industrializados de bajo costo y poco nutritivos; teniendo la mejor opción los alimentos andinos porque presentan nutrientes³ y compuestos fitoquímicos⁴ que favorecen la salud y bienestar^{5,6} no son consumidos masivamente.

Un estudio realizado en Bolivia, refieren que los alimentos andinos de mayor consumo de forma semanal y mensual fueron la quinua, cañihua, tarwi y amaranto, además la mayoría de las personas no consumen alimentos andinos por el costo elevado y por no tener el hábito de consumo⁷. Por otro lado, estudios de Fano, H., Benavides, M.⁸ y Fries, A., Tapia, M.⁹, identificaron un conjunto de factores que en las zonas urbanas los precios limitan el mayor consumo de alimentos andi-

nos porque tienen mayor costo a comparación con los fideos y el pan, otro aspecto es que no se encuentran los alimentos andinos en todos los mercados del país.

Los universitarios presentan bajo conocimiento sobre alimentos saludables, los factores que influyen en la selección de alimentos son: el tiempo de preparación, recursos económicos, influencia del entorno social, familiar y preferencias alimentarias¹⁰, además adquieren prácticas culinarias y hábitos alimentarios poco saludables^{11,12}. Por lo que es probable que el consumo de alimentos andinos no sean parte de su alimentación y exista desconocimiento tanto en los alimentos que existen, así como la calidad nutricional y formas de preparación. Por tanto, la investigación tiene como objetivo determinar la relación entre el conocimiento y consumo de alimentos andinos en universitarios del Perú.

MÉTODOS

Es un estudio observacional de corte transversal. La población estuvo conformada por estudiantes de las universidades privadas y públicas del Perú.

La muestra fue de 408 estudiantes de las carreras de ciencias de la salud, ciencias básicas, ciencias económicas, ciencias sociales y jurídicas, ingeniería y arquitectura. Se empleó un muestreo no probabilístico por conveniencia.

Se excluyeron a estudiantes que consumen fármacos ansiolíticos, antidepresivos, o con modificación de dieta por enfermedad o condición clínica (diabetes, hipertensión, pos cirugía), así como a mujeres gestantes o lactantes.

Durante la recolección de datos, los universitarios realizaron clases en modalidad semipresencial, por este motivo se desarrolló una encuesta por Google forms, y se difundió a través de grupos de WhatsApp y Facebook de los estudiantes universitarios.

La encuesta de conocimientos de alimentos andinos tuvo 3 dimensiones: nutricionales, conocimientos y gastronomía (Tabla 1). Para evaluar la variable consumo se empleó una frecuencia de consumo de alimentos considerando los grupos de alimentos (cereales, tubérculos, leguminosas, hortalizas, hierbas, carnes y frutas andinas). Las respuestas correctas tienen un puntaje=1 y las incorrectas= 0.

Este instrumento cuenta con validación por juicio de expertos, fue validado por 8 nutricionistas. Los resultados de los jueces se evaluaron mediante el estadístico V de Aiken. Se revisó cada ítem de ambos instrumentos de acuerdo a una escala dicotómica, con cinco criterios (claridad, coherencia, objetividad, pertinencia y relevancia). El promedio del V de Aiken del cuestionario conocimientos sobre alimentos andinos fue $V=0,81$ y el promedio del V Aiken del cuestionario sobre frecuencia de consumo de alimentos andinos $V=0,97$. Respecto al nivel de confiabilidad fue adecuado para su uso en estudiantes universitarios siendo el KR 20=0,71.

Tabla 1. Cuestionario sobre conocimiento de los alimentos andinos

<p>Dimensión: Conocimientos Nutricionales</p> <p>1. ¿Qué son los alimentos andinos?</p> <p>a) Son alimentos cultivados y originarios del continente sudamericano crecen a partir de los 1000 metros sobre el nivel del mar.</p> <p>b) Son alimentos consumidos por todas las culturas antiguas del mundo desde épocas anteriores al siglo XII después de Cristo.</p> <p>c) Son alimentos que se producen en la región sierra y de elevado costo en el mercado nacional y mundial.</p> <p>d) Son preparaciones culinarias que nuestros ancestros consumían con frecuencia y que eran exclusivos para realizar trueques.</p> <p>e) Son alimentos elaborados con el fin de hacer conocer la cultura andina.</p> <p>2. ¿Por qué son importantes los alimentos andinos?</p> <p>a) Porque son agradables, de bajo costo e ideales para el consumo de los niños menores de un año.</p> <p>b) Porque son alimentos de costo alto en el mercado, pero solo algunos son importantes.</p> <p>c) Porque son alimentos que aportan nutrientes para la salud de los humanos</p> <p>d) Porque disminuye la obesidad y es necesario que los adultos consuman todos los días.</p> <p>3. En el siguiente grupo de alimentos (oca, olluco, camote). ¿Qué nutriente principal aporta?</p> <p>a) Proteínas</p> <p>b) Carbohidratos</p> <p>c) Lípidos</p> <p>d) Vitaminas y minerales</p> <p>4. En el siguiente grupo de alimentos (cuy, alpaca, trucha). ¿Qué nutriente principal aporta?</p> <p>a) Proteínas</p> <p>b) Carbohidratos</p> <p>c) Lípidos</p> <p>d) Vitaminas y minerales</p> <p>5. En el siguiente grupo de alimentos (yuyo, capulí, aguaymanto). ¿Qué nutrientes principales nos aportan?</p> <p>a) Proteínas</p> <p>b) Carbohidratos</p> <p>c) Lípidos</p> <p>d) Vitaminas y minerales</p> <p>e) No conozco</p> <p>6. En el siguiente grupo de alimentos (ataco, coca, muña). ¿Qué nutriente principal posee?</p> <p>a) Yodo</p> <p>b) Vitamina C</p> <p>c) Selenio</p> <p>d) Calcio</p> <p>7. Del siguiente grupo de alimentos, marca cual es una leguminosa andina:</p> <p>a) Quinua</p> <p>b) Tarwi</p> <p>c) Mashua</p> <p>d) Cushuro</p>	<p>8. ¿Cuál de los cereales andinos contiene carbohidratos?:</p> <p>a) Tarwi o chocho</p> <p>b) Quinua</p> <p>c) Trigo</p> <p>d) Habas</p> <p>9. ¿Cuál de estos alimentos tiene bajo contenido de calorías?</p> <p>a) Olluco</p> <p>b) Kiwicha</p> <p>c) Tarwi o chocho</p> <p>d) Frijol</p> <p>Dimensión: Conocimientos Gastronómicos</p> <p>10. ¿Cómo eliminar el sabor amargo de la quinua?</p> <p>a) Remojarla durante la noche</p> <p>b) Hervir con sal</p> <p>c) Lavarla con agua</p> <p>d) Almacenar por una semana</p> <p>11. Complete: La oca debe ser _____ por varios días para que sea más dulce al momento de consumirse.</p> <p>a) Hervida</p> <p>b) Soleada</p> <p>c) Tostada</p> <p>d) Guardada en la sombra</p> <p>12. Para la elaboración de la sopa de paico, este alimento andino debe ser añadido previamente:</p> <p>a) Picado</p> <p>b) Licuado</p> <p>c) Troceado</p> <p>d) Hervido</p> <p>13. El puré de tarwi es una preparación deliciosa que generalmente es acompañada con alguna carne, como pescado o pollo. Sin embargo, el tarwi presenta un sabor amargo, por lo cual debe ser tratado antes de su preparación, para ello se recomienda:</p> <p>a) Remojar la noche anterior</p> <p>b) Lavar</p> <p>c) Tostar</p> <p>d) Hervir</p> <p>14. Complete el párrafo: Para la elaboración de guisos con cuy se recomienda utilizar carne proveniente de cuyes maduros. Se conoce la madurez de la carne porque presenta una coloración _____ y grasa _____:</p> <p>a) Oscura - blanquecina</p> <p>b) Oscura - amarilla</p> <p>c) Rosada - amarilla</p> <p>d) Rosada - blanquecina</p>
---	--

Tabla 1 continuación. Cuestionario sobre conocimiento de los alimentos andinos

Dimensión: Conoce los alimentos andinos											
15. Complete el siguiente cuadro marcando con una x, según corresponda SI conoces los siguientes alimentos andinos o NO.											
Alimentos andinos	CONOCES		Alimentos andinos	CONOCES		Alimentos andinos	CONOCES		Alimentos andinos	CONOCES	
	SI	NO		SI	NO		SI	NO		SI	NO
Tarwi			Camote			Huacatay			Llama (charqui)		
Quinua			Chuño negro			Nabo silvestre			Sacha tomate		
Kiwicha			Arracacha			Salvia			Aguaymanto		
Cañihua			Ataco			Llantén			Capulí		
Oca			Muña			Airampo			Tumbo		
Olluco			Verdolaga			Alpaca			Sanqui		
Yacón			Achicoria			Cuy			Tuna		
Mashua			Paico			Trucha			Lúcuma		
Maca			Ortiga								

Luego de la recolección de datos, fueron exportados al software Microsoft Excel y SPSS versión 27, para su análisis. Para el análisis descriptivo de las variables categóricas se presentaron las frecuencias absolutas y relativas, las variables numéricas fueron representadas con la mediana, cuartil 1 y 3. El análisis bivariado se realizó mediante la prueba de Chi-cuadrado, entre las variables nivel de conocimiento y el consumo de los alimentos andinos.

El protocolo de investigación fue aprobado por el comité de ética de la Universidad Nacional de Educación Enrique Guzmán y Valle con el Certificado N°0781-2023-R-UNE.

RESULTADOS

Se aplicó el instrumento a un total de 408 estudiantes, con una edad promedio de 23,76 ± 6,16 años, provenientes de diversas regiones del país. El 75,25% de los estudiantes fueron mujeres y el 24,75% varones. El 64,71% pertenecían a una universidad privada y el 35,29% pública. Los estudiantes pertenecían del primer al séptimo año de estudio. A su vez el 83,33% convive con su familia, un 12,75% no convive con su familia y el 3,92% convive por temporadas.

La mayoría de los encuestados tienen un conocimiento regular, representando el 71,6%, el 8,6% tiene un conocimiento bajo, mientras que el 19,9% tiene un conocimiento alto sobre los alimentos andinos. El 50,74% conocen los alimentos andinos, el 89,46% conocen su importancia, conocen

los beneficios de los tubérculos (7,7%), carnes (86,27%), verduras (81,62%) y hierbas andinas (51,47%).

En la Tabla 2, se muestra que en el grupo de los cereales y leguminosas el 41,67% consume quinua de 1 a 2 veces por semana, 38,97% consume kiwicha de 1 a 3 veces por mes, además el 38,48% nunca come cañihua y el 59,21% nunca come chocho. Por otro parte, los tubérculos que la mayoría de los estudiantes nunca consumieron fueron: el 62,01% nabo silvestre, yacón (57,35%), mashua (51,96%), arracacha (68,14%), tocosh (58,09%) y chuño negro (57,6%) respectivamente. Sin embargo, los de mayor consumo durante el mes y por semana fueron la maca, camote y olluco.

Además, son muy pocos los estudiantes que consumen diariamente los alimentos andinos mencionados. Así mismo, la mayoría de los estudiantes nunca consumieron carne de llama (74,26%), alpaca (71,32%) y trucha (55,64%).

La mayoría de los estudiantes nunca consumieron las hortalizas andinas como la verdolaga (71,81%), la achicoria (70,59%) y el paico (53,43%). Las hierbas andinas que la mayoría nunca consumió fueron la salvia (63,48%), ortiga (64,46%). Sin embargo, el huacatay y la muña fueron las hierbas de mayor consumo por mes y semanas en comparación con el resto de hierbas. Respecto a las frutas andinas, la mayoría de los estudiantes nunca consumieron el airampo (71,57%), el tumbo (54,41%), el sancayo (79,9%) y las guindas (58,33%). El sachatomate (59,31%), lúcuma

Tabla 2. Frecuencia de consumo de cereales, leguminosas, tubérculos, raíces y carnes andinos

Alimentos andinos	Nunca	1 a 3 veces por mes	1 a 2 veces por semana	3 a 6 veces por semana	Diario
	n (%)	n (%)	n (%)	n (%)	n (%)
Cereales y leguminosas					
Quinua	8 (1,96)	123 (30,15)	170 (41,67)	100 (21,51)	7 (1,72)
Kiwicha	62 (15,20)	159 (38,97)	120 (29,41)	64 (15,69)	3 (0,74)
Cañihua	157 (38,48)	98 (24,02)	97 (23,77)	49 (12,01)	7 (1,72)
Chocho	241 (59,21)	132 (32,43)	29 (7,13)	5 (1,23)	0 (0)
Tubérculos y raíces					
Oca	188 (46,08)	122 (29,90)	61 (14,95)	35 (8,58)	2 (0,49)
Nabo silvestre	253 (62,01)	78 (19,12)	42 (10,29)	33 (8,09)	2 (0,49)
Olluco	21 (5,15)	206 (50,49)	111 (27,21)	67 (16,42)	3 (0,74)
Yacón	234 (57,35)	99 (24,26)	49 (12,01)	21 (5,15)	5 (1,23)
Mashua	212 (51,96)	104 (25,49)	54 (13,24)	36 (8,82)	2 (0,49)
Maca	61 (14,95)	136 (33,33)	114 (27,94)	87 (21,32)	10 (2,45)
Camote	14 (3,43)	119 (29,17)	135 (33,09)	131 (32,11)	9 (2,21)
Arracacha	278 (68,14)	56 (13,73)	42 (10,29)	27 (6,62)	5 (1,23)
Tocosh	237 (58,09)	86 (21,08)	52 (12,75)	29 (7,11)	4 (0,98)
Chuño negro	235 (57,60)	82 (20,10)	54 (13,24)	33 (8,09)	4 (0,98)
Carnes					
Llama	303 (74,26)	59 (14,46)	30 (7,35)	15 (3,68)	1 (0,25)
Trucha	227 (55,64)	227 (55,64)	54 (13,24)	38 (9,31)	4 (0,98)
Cuy	167 (40,93)	176 (43,14)	35 (8,58)	28 (6,86)	2 (0,49)
Alpaca	291 (71,32)	68 (16,67)	27 (6,62)	17 (4,17)	5 (1,23)

(59,31%) y tuna (50,49%) fueron consumidos de 1 a 3 veces por mes (Tabla 3).

A continuación, se detalla referente a la asociación entre el conocimiento de alimentos andinos y el consumo o empleo de la hierba andina (llantén), carnes andinas (alpaca, trucha y llama), frutas andinas (airampo, tumbo, sancayo, sachamato, lúcuma, guinda, tunas), tubérculos (mashua y chuño negro, tocosh), con un nivel de significancia < 0,05.

Referente a las hierbas nativas la asociación entre el nivel de conocimiento y consumo del llantén el 46,9% (n=137) es regular pero nunca consumen. En el grupo de las carnes, la

alpaca en un 69,9% indicaron que nunca consumen, pero tienen un nivel de conocimiento alto a diferencia de la trucha que es consumido una vez al mes en un 36,6% y presenta un nivel de conocimiento alto, sin embargo, existen similares porcentajes del 34,5% de consumo con un nivel de conocimiento bajo y 35,8% de consumo con un nivel de conocimiento alto. La carne de llama en un 82,7% no consumen, pero tienen un nivel de conocimiento también alto.

En el grupo de alimentos de tubérculos y raíces andinos, el tocosh no es consumido en un 63%, también el chuño negro no es consumido en un 66,7% y la mashua tampoco es con-

Tabla 3. Frecuencia de consumo de hortalizas, hierbas y frutas andinos

Alimentos andinos	Nunca	1 a 3 veces por mes	1 a 2 veces por semana	3 a 6 veces por semana	Diario
	n (%)	n (%)	n (%)	n (%)	n (%)
Hortalizas					
Verdolaga	293 (71,81)	43 (10,54)	43 (10,54)	27 (6,62)	2 (0,49)
Achicoria	288 (70,59)	49 (12,01)	43 (10,54)	25 (6,13)	3 (0,74)
Paico	218 (53,43)	98 (24,02)	57 (13,97)	34 (8,33)	1 (0,25)
Hierbas andinas					
Llanten	185 (45,34)	130 (31,86)	50 (12,26)	40 (9,80)	3 (0,74)
Salvia	259 (63,48)	69 (16,91)	51 (12,50)	27 (6,62)	2 (0,49)
Huacatay	77 (18,87)	180 (44,12)	91 (22,30)	55 (13,48)	5 (1,23)
Ortiga	263 (64,46)	60 (14,71)	54 (13,24)	27 (6,62)	4 (0,98)
Muña	70 (17,16)	154 (37,75)	78 (19,12)	101 (24,75)	5 (1,23)
Frutas andinas					
Airampo	292 (71,57)	47 (11,52)	40 (9,80)	26 (6,37)	3 (0,74)
Aguaymanto	111 (27,21)	183 (44,85)	57 (13,97)	52 (12,75)	5 (1,23)
Tumbo	222 (54,41)	127 (31,13)	32 (7,84)	25 (6,13)	2 (0,49)
Sancayo	326 (79,90)	52 (12,75)	9 (2,21)	20 (4,90)	1 (0,25)
Sachatomate	311 (76,65)	58 (14,31)	17 (4,18)	21 (5,17)	1 (0,25)
Lúcuma	72 (17,65)	242 (59,31)	55 (13,48)	37 (9,07)	2 (0,49)
Guindas	238 (58,33)	119 (29,17)	24 (5,88)	23 (5,64)	4 (0,98)
Tuna	90 (22,06)	206 (50,49)	57 (13,97)	49 (12,01)	6 (1,47)

sumida en un 58% sin embargo los estudiantes tienen un nivel de conocimiento alto referente a este grupo de alimentos.

En el grupo de frutas andinas no es consumido el tumbo en un 56,5%, el sancayo en 84%, el sachatomate un 78,8%, las guindas un 61% y sin embargo tienen un nivel de conocimiento regular, a diferencia de la lúcuma que es consumido una vez al mes en 43,2% y la tuna en 31,2% es consumido de 2 a 3 veces al mes con un nivel de conocimiento alto.

DISCUSIÓN

Hace algunos lustros, se ha revalorizado¹³ el consumo de los alimentos andinos en el mundo, especialmente en países de la región andina, como Bolivia y Perú.

Uno de los efectos de dicha valoración ha sido el crecimiento del consumo de alimentos andinos, en diversas for-

mas sea como insumo directo de comida casera, como aditivo en procesamiento industrial o como sustituto de insumos tradicionales¹⁴. Sin embargo, el crecimiento del consumo de los alimentos andinos no está necesariamente correlacionado con el conocimiento sobre los mismos. Un estudio sobre alimentos andinos demostró que el conocimiento y el consumo de estos alimentos está relacionado con la presencia de oferta de los mismos¹⁵. En este sentido, para poder evaluar adecuadamente la correlación entre consumo y conocimiento se debe tener en cuenta el binomio urbano/rural para contrastar los resultados. En efecto se encontró que en las ciudades de provincias (recordemos que son ciudades de la sierra) hay más oferta y mayor conocimiento de estos productos, y por eso es más común que formen parte de la dieta¹⁵. Así mismo, la cuestión de género es importante para comprender el consumo de alimentos andinos, pues en re-

giones donde hay producción de estos alimentos, el conocimiento de los mismos tiene un vínculo con el género, son las mujeres las que están relacionadas directamente con las acciones de cuidado del hogar¹⁶.

Respecto al nivel del conocimiento obtenido en los estudiantes participantes en este estudio, los resultados están en consonancia con los análisis contextuales, es decir aquellos que toman en cuenta el espacio social donde habita el estudiante¹⁵. Es decir que el conocimiento es mayor mientras menos urbano sea el espacio de habitación. Este hecho no se ve influido por la convivencia de los estudiantes con la familia.

Ahora bien, respecto al conocimiento de los alimentos andinos, su importancia y beneficios no guarda relación. Cerca de la mitad de estudiantes conoce los alimentos andinos, pero más del 80% conoce la importancia de los alimentos andinos. De la misma manera, hay una gran cantidad de estudiantes que conocen los beneficios de los alimentos (tubérculos, carnes y frutas). Esta diferencia entre conocimiento y beneficios se explica por el boom gastronómico acaecido en el país¹⁷, gracias al cual se conocieron los beneficios de los alimentos andinos, aunque no necesariamente se conocían cuáles eran los alimentos andinos. En el mismo sentido, los hábitos alimentarios se han visto influenciados por el autocuidado alimentario producido durante y después del confinamiento producido en la pandemia¹⁸.

Respecto a los alimentos en los cuales se encontró una correlación entre conocimiento y consumo en determinados alimentos andinos (llantén, airampo, alpaca, trucha, llama, tumbo, sancayo, sachatomate, lúcuma, guindas, tuna, to-cosh, mashua, chuño negro). Resulta significativo que la quinua no presente tal correlación¹⁹. Esto se debe al consumo habitual de gran parte de la población asociado a un nivel elevado de desconocimiento de sus beneficios²⁰. Por otro lado, este resultado se explica a partir de la identidad cultural de los estudiantes. En efecto, cuando la identidad cultural del consumidor es clara y no se halla sometida a la presión modificatoria de la urbanización o el consumismo, tanto el consumo como el conocimiento del alimento guarda una estrecha relación²¹, así factores sociales como la migración suelen modificar profundamente los patrones y hábitos de consumo de los estudiantes, hecho que se ve fortalecido cuando el estudiante vive solo o lejos de su familia. Finalmente, no se debe perder de vista la influencia de factores subjetivos al momento del consumo de alimentos andinos²².

Los otros alimentos andinos encontrados, existe una amplia literatura que confirma el uso y conocimiento de dichos alimentos, así como de sus beneficios. Por ejemplo, el llantén²³⁻²⁶. En efecto, esta hierba posee muchos beneficios en el ámbito de la salud, aprovechados por los consumidores. En este sentido, la importancia medicinal está relacionada con usos renales y digestivos, así como dérmicos²⁵. Se sabe que el llantén posee propiedades astringentes, sirve como expectorante y tiene acción hemostática²⁵.

Esta correlación es explicada también por factores socio-culturales que fusiona tanto el conocimiento recibido ancestralmente como los potenciales beneficios percibidos actualmente. Un estudio realizado en Guayaquil comprobó cómo la tradición sociocultural asociada al uso del llantén como producto terapéutico ha creado un circuito comercial en la ciudad, que retroalimenta tanto el uso como el conocimiento de los beneficios. De esta manera existe una alta correlación entre consumo y conocimiento²⁷. Por tal razón es de suma importancia incorporar a los análisis cuantitativos, la mirada cualitativa, específicamente el análisis antropológico, cultural y social para poder explicar el por qué teniendo un nivel de conocimiento alto en algunos alimentos andinos estos no son consumidos en sus dietas.

Así mismo, el 55,64% consumen trucha, afirmaron consumir por lo menos una vez a la semana. Este consumo se explica por las propiedades nutricionales y tecnológicas de la trucha. Se sabe que contienen un aporte significativo de ácidos grasos, especialmente DHA, así como de fósforo²⁸. Por otro lado, las cualidades tecnológicas inherentes a la trucha hacen de este un producto versátil a la hora de elaborar diferentes tipos de productos (como el marinado, el frito, el secado y también el ahumado, sin considerar los platos típicos y los productos procesados como conservas). Estas características benefician a la cadena productiva de la trucha y, por lo tanto, a la seguridad alimentaria de las regiones donde se comercializa este alimento²⁹.

En general, se puede afirmar que la correlación entre el conocimiento de alimentos andinos y su consumo es explicada por factores culturales, nutricionales, alimentarios y sociales, los cuales impulsan su consumo en personas con raíces o influencia andina, pero también constituye un freno para personas que poseen distinta cultura alimentaria, aunque esta limitación ha sido disminuida en los últimos años en el Perú¹⁷. Este hecho debe ser analizado en profundidad y de manera multidisciplinaria, pues, no es solo una cuestión gastronómica sino también un fenómeno político.

El estudio tuvo como limitación la no realización del recordatorio de 24 horas para cuantificar la cantidad del consumo de alimentos andinos y los resultados no podrán ser extrapolado a otros contextos.

CONCLUSIÓN

Existe relación entre el conocimiento sobre alimentos andinos con el consumo de las hierbas andinas (llantén, airampo), carnes andinas (alpaca, trucha y llama), tubérculos y raíces andinos, frutas andinas (lúcuma, guinda, tunas) y tubérculos (mashua y chuño negro). Es importante desarrollar estrategias de promoción de los alimentos andinos para incluirlo dentro de la alimentación y apoyar al agricultor andino con la compra y consumo a fin de contribuir con la seguridad alimentaria y nutricional.

AGRADECIMIENTOS

A los docentes que nos brindaron el apoyo, estudiantes de las diferentes universidades del Perú que desarrollaron las encuestas con responsabilidad y a la estudiante de Nutrición Humana de la Universidad Nacional "Enrique Guzmán y Valle", Andrea Quiñones Tello, quien apoyó en la recolección de la muestra.

REFERENCIAS

- Rosales, Giovanni y Mercado, Waldemar. Efecto de los cambios en el precio de los alimentos sobre el consumo de la quinua y la seguridad alimentaria rural en el Perú. *Scientia Agropecuaria*. 2020; 11(1), 83-93. <https://dx.doi.org/10.17268/sci.agropecu.2020.01.10>
- Jacobsen, S; Mujica, A; Ortiz, R. La importancia de los cultivos andinos *Fermentum*. *Revista Venezolana de Sociología y Antropología*. 2003;13(36),14 - 24. <https://www.redalyc.org/pdf/705/70503603.pdf>
- Rosales, Giovanni y Mercado, Waldemar. Efecto de los cambios en el precio de los alimentos sobre el consumo de la quinua y la seguridad alimentaria rural en el Perú. *Scientia Agropecuaria*. 2020; 11(1), 83-93. <https://dx.doi.org/10.17268/sci.agropecu.2020.01.10>
- Repo-Carrasco, R. & Encina C. (2008). Determinación de la capacidad antioxidante y compuestos fenólicos de cereales andinos: Quinoa (*Chenopodium quinoa*), Kañiwa (*Chenopodium pallidicaule*) y Kiwicha (*Amaranthus caudatus*). *Rev Soc Quím Perú* 74 (2): 85- 99.
- Heilbron E, Martin O, Fumagalli E. Efectos protectores de los alimentos andinos contra el daño producido por el alcohol a nivel del epitelio intestinal, una aproximación estadística. *Cienc DocenciaTecnol*. 2020;31(61):195-210. <http://dx.doi.org/https://doi.org/10.33255/3161/747>
- Pilco-Quesada S, Tian Y, Yang B, Repo-Carrasco-Valencia R, Suomela JP. Effects of germination and kilning on the phenolic compounds and nutritional properties of quinoa (*Chenopodium quinoa*) and kiwicha (*Amaranthus caudatus*). *J Cereal Sci*. 2020; 94:102996. <https://doi.org/10.1016/j.jcs.2020.102996>
- Jordán de Guzmán M, Paye-Huanca E O, Espejo-Choquetarqui M G, Torrico R R. Consumo familiar de alimentos andinos, en las ciudades de La Paz y El Alto, gestión 2019. *Cuad.Hosp. Clín*. 2020; 61(2):9-16. http://www.scielo.org.bo/scielo.php?script=sci_arttext&pid=S1652-67762020000200002&lng=es.
- Fano, Hugo, y Marisela Benavides. *Los Cultivos Andinos en Perspectiva: Producción y Utilización en el Cusco*. Centro de Estudios Regionales Andinos "Bartolomé de la Casas", Cusco y Centro Internacional de la Papa, Lima. 1992.
- Fries, Ana María, y Mario Tapia N. *Los Cultivos Andinos en El Perú*. Lima: Instituto Nacional de Investigación y Promoción Agropecuaria, Programa Nacional de Sistemas Andinos de Producción Agropecuaria, Boletín No. 1.
- Vidal Huamán F, Vidal Pozo M, Huilca Maldonado H, Gutiérrez Ludeña De Castro E, Castro Mattos M, Gómez Rutti Y. Hábitos alimentarios y calidad de sueño en universitarios en tiempos de COVID- 19, Lima-Perú. *Nutr Clín Diet Hosp* [Internet]. 7 de enero de 2022 [citado 15 de enero de 2023];41(4). <https://doi.org/10.12873/414vidal>
- Manjarres Nauñay TI, Lozada Lara LM. Hábitos alimenticios y rendimiento académico en estudiantes universitarios. *LATAM*. 2023; 4(1):40-53. <https://doi.org/10.56712/latam.v4i1.222>
- Maza-Ávila, Francisco Javier, Caneda-Bermejo, María Carolina, y Vivas-Castillo, Angie Cecilia. Hábitos alimenticios y sus efectos en la salud de los estudiantes universitarios. Una revisión sistemática de la literatura. *Psicogente*. 2022; 25(47), 110-140. <https://doi.org/10.17081/psico.25.47.4861>
- Mygind, Thomas Peter, Mercado, Geovana, & Aruquipa, Rosmery. Un nuevo rol - la revalorización de los cultivos andinos nativos en los medios de subsistencia de los agricultores bolivianos. *Revista de Investigación e Innovación Agropecuaria y de Recursos Naturales*, 2016; 3(2), 179-187. http://www.scielo.org.bo/scielo.php?script=sci_arttext&pid=S2409-16182016000200007&lng=es&tlng=es
- Gruére, G. P, Giuliani, A., & Smale, M. Marketing underutilized plant species for the benefit of the poor: A conceptual framework. *Environmental and Protection Technology (EPT)* 2006; (154). <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=30645e38b021f0d8b837c092594919fa8f905cab>
- Smith SM, Trivelli Avila C. *El consumo urbano de los alimentos andinos tradicionales*. 1. ed. Lima: Inst. de Estudios Peruanos; 2001.
- Morón C. Importancia de los cultivos andinos en la seguridad alimentaria y nutrición. En: *Memorias reunión técnica y taller de formulación de proyectos regionales sobre producción y nutrición humana en base a cultivos andinos*. Arequipa, Perú. Editorial FAO, UNA, CIP, Universidad Nacional San Agustín. Lima, 2008.
- García, M. *Gastropolítica: una mirada alternativa al auge de la cocina peruana*. Instituto de estudios peruanos, 2023.
- Payehuanca Erick; Espejo-Choquetarqui, María. Prácticas de autocuidado al momento de comprar víveres y frecuencia de consumo de alimentos en tiempos de pandemia por covid-19 de familias de la ciudad de La Paz y El Alto. *Revista "Cuadernos"*, 2022, 63(2): 35-44; http://www.scielo.org.bo/pdf/chc/v63n2/v63n2_a05.pdf
- Jordán de Guzmán M, Paye-Huanca E O, Espejo-Choquetarqui M G, Torrico R R. Consumo familiar de alimentos andinos, en las ciudades de La Paz y El Alto, gestión 2019. *Cuad. - Hosp. Clín*. 2020; 61(2): 9-16. http://www.scielo.org.bo/scielo.php?script=sci_arttext&pid=S1652-67762020000200002&lng=es.
- Bravo B, Miranda M, López J. Economic Impact of Quinoa Consumption in the Diet of University Students Case: ESPOCH Agroindustry Career. *ESPOCH Congresses: The Ecuadorian Journal of S.T.E.A.M.*, 2021; 1(1), 648-664. <https://doi.org/10.18502/esPOCH.v1i1.9600>
- Maraza, B., Condori, W; Condori, J. La identidad cultural en los estudiantes migrantes y su nivel de adaptación en la universidad nacional del altiplano Puno. 2017, 6(3); <https://revistaepguna.puno.org/index.php/investigaciones/article/view/105>
- Soria Mendo C, Vicente Armas E, Espinoza Villanueva LE. Factores asociados a la intención de consumo de alimentos nativos en estudiantes de una universidad peruana. *Gest. terc. milen*. 2021;

- 24(47):9-18. <https://revistasinvestigacion.unmsm.edu.pe/index.php/administrativas/article/view/20575>
23. Bustamante Mariela A, Guerrero Padilla A. Efecto antifúngico del extracto acuoso de *Plantago major* L. "llantén" (Plantaginaceae) en *Lasiodiplodia theobromae* (Pat.) Griffon & Maubl. *Arnaldoa*. 2022;29(3): 401-414. <http://dx.doi.org/10.22497/arnaldoa.293.29302>.
24. Hammami, S; H. Debbabi; I. Jlassi; R.K. Joshi & R. El Mokni. Chemical composition and antimicrobial activity of essential oil from the aerial parts of *Plantago afra* L. (Plantaginaceae) growing wild in Tunisia. *South African Journal of Botany*.2020; 132:410-414. <https://doi.org/10.1016/j.sajb.2020.05.012>
25. Acosta de la Luz Lérida, Fuentes Fiallo Víctor R, Martín Guillermo, Rodríguez Ferradá Carlos A. Investigaciones agrícolas en especies de uso frecuente en la medicina tradicional. I. Llantén (*plantago major* L.). *Rev Cubana Plant Med*. 2000; 5(1): 6-9. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1028-47962000000100002&lng=es.
26. Pinto Dávalos, Jenny; Bustamante García, Zulema. Evaluación de la actividad gastroprotectora de los extractos de llantén (*Plantago major*). *Biofarbo* 2008; 16: 36-41. <https://pesquisa.bvsalud.org/portal/resource/pt/biblio-1006607>
27. Contreras-Miranda Javier Antonio, Ramirez Marin, Miguel Angel. Uso de plantas medicinales que se comercializan en Guayaquil, Ecuador. *Manglar*. 2022; 19(4): 309-316. <http://dx.doi.org/10.57188/manglar.2022.039>.
28. Perea Aide, Gómez Elieth, Mayorga Yamile, Triana Cora Yohanna. Caracterización nutricional de pescados de producción y consumo regional en Bucaramanga, Colombia. *ALAN*. 2008; 58(1): 91-97. Disponible en: http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0004-06222008000100013&lng=es.
29. Florez-Jalixto Marco Antonio, Roldán-Acero David Julián. La trucha (*Oncorhynchus mykiss*): Potenciales productos alimenticios derivados del principal recurso acuícola en regiones altoandinas. *Rev. investig. Altoandin*. 2021; 23(3): 159-170. <http://dx.doi.org/10.18271/ria.2021.279>

Stability of liquid smoked nano-encapsulated on the foodborne pathogens and histamine-forming bacteria's growth in tuna loin sashimi

Henny Adeleida DIEN¹, Roike Iwan MONTOLALU¹, Feny MENTANG¹, Siegfried BERHIMPON²

1 Faculty of Fisheries and Marine Science, Sam Ratulangi University, Jl. Kampus Unsrat Bahu Manado, Indonesia.

2 Artha Wacana Christian University, Kupang, Indonesia.

Recibido: 27/diciembre/2023. Aceptado: 17/julio/2024.

ABSTRACT

Introduction: In Japan, sashimi, a distinctive and straightforward meal of fresh fish, is frequently offered for dinner with family or at restaurants. Since sashimi is made from raw tuna loin, infections and spoiling microorganisms can readily damage it, especially if it is served without refrigeration. In addition to ice, novel preservatives need to be researched to prevent the growth of harmful and histamine-producing microbes. Carbonyl, phenols from burning coconut shells, and organic acids are among the antibacterial substances found in liquid smoke (LS). However, more study on liquid smoke nano-encapsulation is needed because there is a lack of evidence about the physicochemical properties of LS.

Aims: The goal of the study was to determine the production process of liquid smoke nano-encapsulation (LSN), the level of total histamine in LSN-coated sashimi stored at room temperature, and the effectiveness of LSN against pathogenic microorganisms.

Materials and Methods: The following parameters were measured: pH levels, water content, Salmonella, *E. coli*, total microbial count (TPC), histamine concentration, and antibacterial inhibitory action.

Results: The findings demonstrated that LSN with maltodextrin: sago flour: 1% LS ratio of 10: 1: 5 effectively inhibited the growth of *E. coli* and Salmonella and decreased the amount of histamine in sashimi that was refrigerated for ten days.

Conclusions: LSN was effective in preventing the growth of pathogenic bacteria and reducing the histamine content in tuna sashimi.

KEYWORDS

Liquid smoke, tuna loin, nanoencapsulation, pathogenic, histamine.

HIGHLIGHTS

- The use of liquid smoke nanoencapsulation (LSN) in sashimi made with tuna loin is new.
- LSN successfully decreased the amount of histamine in tuna sashimi and stopped the formation of harmful microorganisms.
- A novel component for the LSN is flour made from the sago Baruk palm (*Arenga microcarpha* Becc.).

INTRODUCTION

Tuna-based sashimi stands as a sought-after culinary delight in various Indonesian urban centers, including Jakarta, Surabaya, Manado, and Bitung. The essence of this delectable dish lies in its utilization of fresh tuna flesh. However, the inherent challenge lies in maintaining the freshness and safety of raw meat, given its susceptibility to contamination by harmful bacteria and spoilage during the handling and serving processes¹. Preserving the integrity of fresh tuna is paramount, demanding a meticulous and thorough approach to handling. Establishing stringent standards for frozen tuna loin becomes imperative to ensure the quality and safety of the end product. These standards encompass a multifaceted framework, addressing raw material classification, ingredients, food additives,

Correspondencia:

Henny A. Dien
hennydien@unsrat.ac.id

handling and processing methods, sanitation and hygiene practices, food safety considerations, sampling and testing methodologies, as well as criteria for labeling and packaging².

While standardized techniques for tuna loin production exist, the practical implementation of these measures remains a challenge for numerous industries. Notably, in the Maluku region of Indonesia, the tuna loin supply chain grapples with issues of sanitation and hygiene, contributing to lapses in meeting established criteria³. The situation is exacerbated by high microbial counts, highlighting a considerable risk to food safety⁴. The presence of intracellular bacteria, including *E. coli*, *Salmonella*, *Listeria monocytogenes*, *Vibrio parahaemolyticus*, *Staphylococcus aureus*, *Vibrio cholerae*, and *Bacillus cereus*, poses a serious threat to the safety of fishing products. Studies, such as that conducted by Dien et al., reveal the prevalence of harmful bacteria like *E. coli*, *Vibrio cholerae*, *Vibrio parahaemolyticus*, and *Salmonella* in fish sourced from Manado Bay⁵. However, the most commonly detected were *E. coli* and *Salmonella*, serving as crucial indicators of potential contamination.

Addressing these challenges demands a concerted effort across the tuna supply chain, from stringent adherence to established standards to comprehensive sanitation and hygiene practices. Such measures are essential not only for safeguarding consumer health but also for sustaining the reputation and viability of the tuna-based sashimi industry in Indonesia. The consumption of Scombroid fish, encompassing varieties like skipjack, tuna, blue marlin, and mackerel, is frequently associated with the risk of scombroid-toxin poisoning⁶. This type of poisoning is attributed to histamine, a toxic compound produced during the degradation of histidine amino acids in fish meat. The enzymatic action of histidine decarboxylase, facilitated by histamine-forming bacteria (HFB), catalyzes this conversion. Notably, histamine is prevalent in the Scombroid group of fish, making it imperative to understand the underlying mechanisms that contribute to its formation⁷. Histamine-producing microbes, including but not limited to *Pseudomonas sp.*, *Morganella morganii*, and *E. coli*, play a crucial role in this process. These microbes are commonly found in environments such as waste, unclean surfaces, and on the hands of workers involved in the handling of fish. The histidine decarboxylase enzyme, produced by these bacteria, is responsible for the transformation of histidine into histamine, thereby rendering the fish toxic when consumed⁸.

Given the aforementioned considerations, a critical exploration into the preservation of tuna through the utilization of liquid smoke (LS) derived from natural coconut shells (CS) becomes interesting⁹. The challenge lies in the inherent susceptibility of LS characteristics to alterations over time. To safeguard its effectiveness as a preservative, it is crucial to employ nano-encapsulation techniques. In this context, the combination of maltodextrin and sago starch (MD-SS) with CS-derived liquid smoke (CS-LS) was undertaken to formulate coconut shell

nano-encapsulated liquid smoke (LSN). Subsequently, this innovative LSN was applied to tuna sashimi in the course of this research, marking a pioneering endeavor as the application of LSN in tuna loin sashimi has not been previously explored. Nano-encapsulation serves as a sophisticated approach to enhance the stability and efficacy of liquid smoke, particularly when derived from natural sources such as coconut shells. The combination of MD-SS and CS-LS in the creation of LSN provides a protective matrix that not only preserves the essential properties of liquid smoke but also facilitates its controlled release, ensuring optimal application to tuna sashimi.

LS is utilized not only as a colorant and flavor enhancer in protein-rich fish products but also for its inherent antimicrobial and antioxidant properties¹⁰. The introduction of various phenolic chemicals and organic acids into the LS solution leads to a reduction in pH, resulting in the destruction of bacterial cell walls¹¹. The coconut shell-derived LS contains bioactive substances such as phenol, carbonyl, and organic acids, endowing it with significant potential to extend the shelf life of food products. It is noteworthy that a higher concentration of phenol correlates with an extended shelf life for these products. Nevertheless, it is crucial to be mindful of the potential drawbacks, as an elevated phenol level has been associated with an increase in polycyclic aromatic hydrocarbons (PAH) in traditionally smoked products¹². This is particularly significant considering that a PAH concentration exceeding 5 ppb is deemed hazardous to human health.

In the course of processing and storage, it is imperative to shield the bioactive constituents within LS from degradation and volatilization. An increasingly favored method for accomplishing this is flavor encapsulation technology, encompassing the use of core and wall materials to safeguard the taste components. The careful regulation and maintenance of the nano-encapsulation composition serve to shield the material from exposure to oxygen during storage¹³. Several considerations come into play when opting for encapsulation technology, including the sensitivity of the primary material, its physiochemical attributes, capsule dimensions, the intended application, the mechanism for material release, and the associated costs¹⁴. These factors collectively contribute to the decision-making process in selecting an appropriate encapsulation technology.

Maltodextrin is commonly employed for encapsulating bioactive substances due to its water solubility and protective qualities against oxidation¹⁵. In this study, sago flour is introduced as an additional component alongside maltodextrin to enhance the stability of the encapsulation. The combination of liquid smoke (LSM) with maltodextrin-sago starch (MD-SS) forms a naturally antibacterial agent, presenting opportunities to enhance the quality, safety, and shelf life of food products by influencing the growth of spoilage microbes.

Liquid smoke exhibits sensitivity to various foodborne pathogens both in vitro and in food matrices, including

Salmonella, *Listeria monocytogenes*, Staphylococcus, and *Escherichia coli*¹⁶. Consequently, LSM emerges as a promising natural antimicrobial agent with potential commercial applications, particularly when a smoky flavor profile is desired. The objectives of this study are threefold: (1) to formulate LSM, with a specific emphasis on determining the optimal ratio of maltodextrin, sago starch, and liquid smoke; (2) to assess the inhibitory effects of LSM on pathogenic bacteria during a 6-day refrigerated storage period of sashimi; and (3) to evaluate the total histamine content in LSM-coated sashimi over the same refrigerated duration of 6 days.

MATERIALS AND METHODS

Material

The high-quality tuna loins were purchased from Blue Ocean Grace International enterprise in Bitung. The tuna loin was put into a plastic bag and sealed, and then together with ice was put into a cold box with a ratio loin: ice of 1: 2 to keep the quality unchanged. It requires two hours to be transported to the Laboratory in the Faculty of Fisheries and Marine Science, Sam Ratulangi University, in Manado.

Production of Liquid Smoke and Nano-Encapsulation

Low PAH liquid smoke (benzo(a)pyrene 0.25 ppb) was produced using smoke condensation equipment and coconut shell as fuel¹⁷. Since SS was made from the sago Baruk palm *Arenga microcarpha* Becc., a food-grade MD was obtained from Lansida Herbal Technology Indonesia; for analysis, analytical grade, high-media brand chemicals, and media were used. The raw material used was coconut shells; 10 kg produced 2.8 L of LS with a concentration of 60–70%. Whatman paper number 40 was utilized to filter the crude LS after it had undergone distillation. Previous studies found that 1% was the ideal LS concentration for smoked fish¹⁷.

Treatments Design

This research continues the research carried out by Dien et al., which obtained the best microencapsulation formula, namely: maltodextrin 50g, sago 5g, and 1% LS 25 mL⁹. To produce nanoparticles, the same formula was used and the formula was homogenized using a WisetStir-HS30E homogenizer at 2000 rpm rotation (Figure 1).

After being gathered and separated from the starch granules, the crystal powders were put in an amber container and maintained in a desiccator at room temperature. Tuna loin was coated with LS nano-encapsulation as one of the treatments, and as a control, no coating was applied. All samples were kept in a refrigerator at 5 degrees Celsius for 10 days, with samples being removed every 2 days and evaluated right away. It was at a temperature appropriate for storing sashimi. The refrigerator's side was equipped with a centi-

grade thermometer, which was used to check the temperature twice a day.

Microbiological Count Analysis

For five minutes, 25 g of material was homogenized in 225 mL of buffered peptone water containing 0.1 percent (w/v) using a magnetic stirrer (BPW). TPC was determined using the pour plate technique and high-media plate count agar (PCA), which were incubated at 37 °C for one day¹⁸.

Isolation and Identification of *E. coli*

A technique for determining the amount of viable *E. coli* present is the most probable number (MPN). From each of the positive Durham tubes, take one loopful of material, spread it out on Eosin Methylene Blue Agar (EMBA), and incubate it for the predetermined amount of time at a temperature that is comparable to that of Salmonella. Such pure cultures were used for gram stain, the IMVIC test, cell morphology and colony, and both oxidase and catalase activity analyses¹⁸.

Isolation and Identification of Salmonella

Samples from BPW samples were collected, and pre-enriched cultures using lactose broth (LB) were carried out to screen for Salmonella. Then, one loopful of the broth was distributed over Bismuth Sulfite Agar (BSA) plates and incubated at 37 °C for a day. After that, 0.1 of the pre-enriched cultures were transferred to RV broth and incubated at 42 °C for an entire day. Indole synthesis, motility, carbohydrate fermentation, and lysine decarboxylase are among the biochemical assays that must be carried out to authenticate any suspected Salmonella colonies that appear on the BSA medium¹⁹.

Antibacterial Inhibitory Activity

Disk diffusion was used to test the isolates of *E. coli* and Salmonella for their inhibitory activity. The isolation codes were EcI4 for *E. coli* and SI6 for Salmonella. A susceptibility test for antibacterial activity was performed using the Kirby Bauer method on a nutrient agar medium²⁰. Using the spread plate approach, cultures of *E. coli* (EcI4) and Salmonella (SI6) were aseptically injected over the solid agar surface of several Petri plates. Subsequently, the contaminated agar surface was covered aseptically with a saturated filter paper disc that contained nano-encapsulate LS. After labeling and a full day of incubation at 37 °C, the inhibitory zone was measured on the Petri plates.

Histamine Analysis

Histamine was changed to a hydroxyl form in the macerated material. Spectrophotometric analysis was used to measure the histamine level²¹. Additionally, histamine was converted to a derivative using o-phthalaldehyde 1 percent as the reagent, and the fluorescence of the end product was measured at a wavelength of 444 nm using a spectrofluorometer.

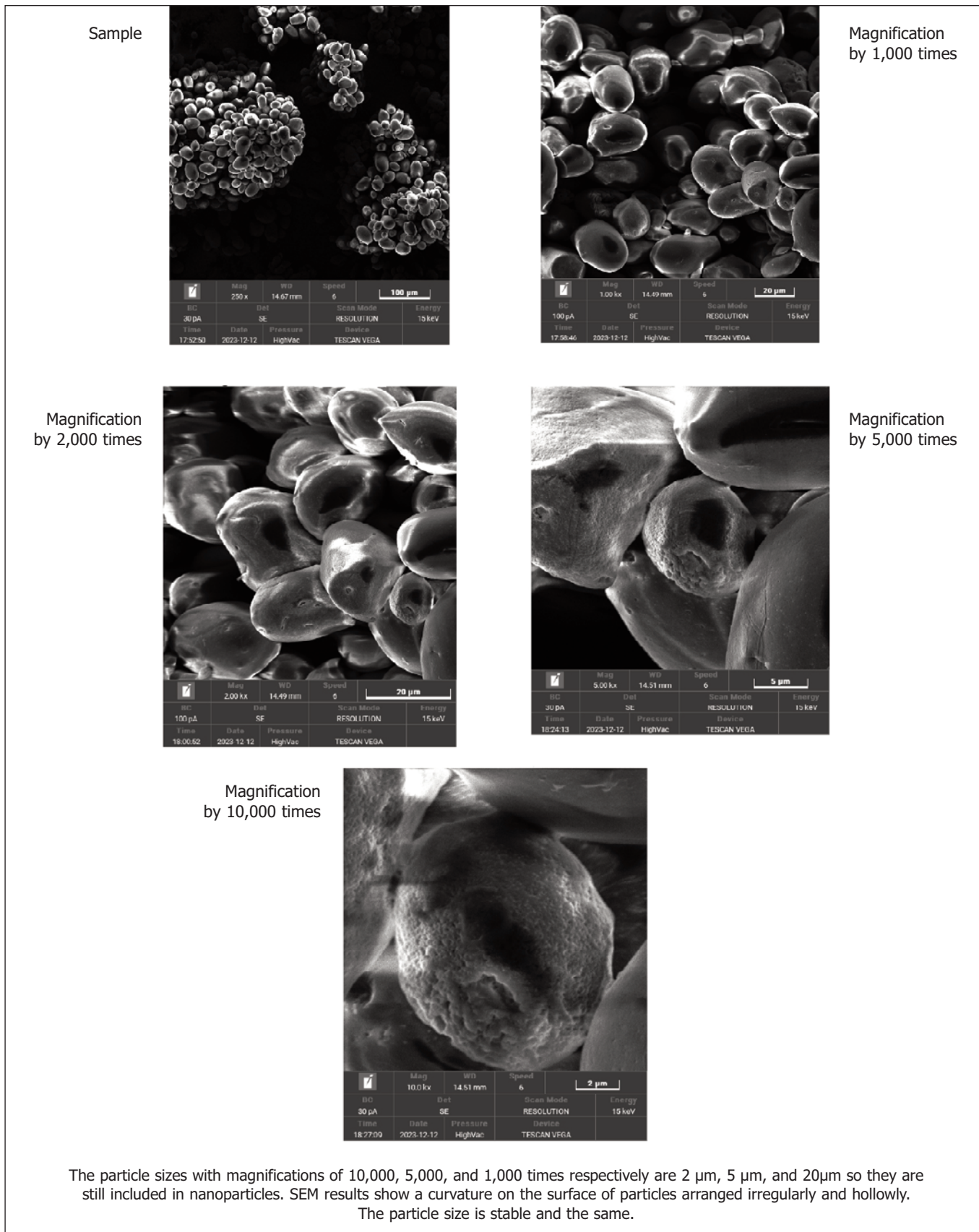


Figure 1. Particle Size Resulted from SEM

pH Measurements

To find the pH, an Adwa AD 1000 pH/mV pH meter was utilized. A pH meter was used to assess 20 mL of the homogenized sample after 25 g of the sample had been dissolved in 25 mL of distilled water.

Moisture Content

The moisture content was determined by the gravimetric method, adapted from research by Fardisi et al.²². Samples weighing three to five grams were dried in an oven set at 105 degrees Celsius.

Statistical Analysis

Microbiological data were transformed using log₁₀ CFU/g values. We calculated and plotted the mean and standard deviation. A factorial (2 x 4) experimental design was used in the completely randomized design. ANOVA was used to assess the data, and a p-value of less than 0.05 was considered significant. A significant difference was then determined using the Tukey test. Excel 2010 was used to examine the data.

RESULTS

Formulation of Nano-Encapsulated Liquid Smoke

This investigation represents a continuation of the work initiated by Dien et al., where they successfully identified the optimal microencapsulation formula⁹. The established formula, consisting of 50g of maltodextrin, 5g of sago, and 25 ml of 1% LS, served as the foundation for the present study. To ensure uniformity, the components were subjected to homogenization using the WisetStir-HS30E homogenizer, operating at a rotation speed of 2000 rpm. Building upon the groundwork laid by Dien et al., this research sought to replicate and further validate the efficacy of the established microencapsulation formula. The ho-

mogenization process, facilitated by the advanced WisetStir-HS30E homogenizer, played a crucial role in achieving a consistent and well-blended formulation. Upon completion of the research, a notable yield of 85.6% was attained, signifying a successful and efficient encapsulation process.

Microbial Count (Total Plate Count)

TPC represents the cumulative count of all microorganisms present in a sample, encompassing both harmful microbes and those responsible for spoilage. The TPC readings in various samples, including fresh fillets, non-coated control samples, and encapsulated-coated samples, were documented as 4.0×10^1 CFU/g, ranging from 4.0×10^1 to 4.3×10^4 CFU/g, and from 4.4×10^0 to 8.0×10^0 CFU/g, respectively, as detailed in Table 1. Notably, the TPC in uncoated sashimi fillets demonstrated a significant increase; however, it remained within acceptable limits according to the standards outlined in SNI²³. The application of coating treatments exhibited a substantial impact ($p < 0.05$), as indicated by the analysis of variance. Significant differences ($p < 0.05$) were observed in all interactions between uncoated and coated samples. The highest TPC value considered safe for consumption is 5.0×10^5 CFU/g²⁴.

Escherichia coli

The *E. coli* levels in fillets, whether coated or non-coated with nano-encapsulated LS, over a 10-day storage period are detailed in Table 2. Initially, the non-coated fillets exhibited *E. coli* levels ranging from 3.0 to 3.2 MPN/g, which increased significantly during storage. Conversely, the fillets coated with nano-encapsulated LS maintained levels below 3.0 MPN/g throughout the 10-day storage period. This signifies a noteworthy inhibitory effect on the growth of *E. coli* due to the application of nano-encapsulation, showcasing the potency of this method.

Table 1. TPC of Fresh Sashimi Fillet Coated, and Non-Coated by Nano-Encapsulation, Stored Up to 10 Days in Refrigerated Condition

Day of Storage	TPC (CFU/g – CFU/mL)					
	Non-Coated			Coated		
	1	2	3	1	2	3
Day 0	4.0×10^1	4.7×10^1	3.3×10^1	5.0×10^0	4.1×10^0	4.0×10^0
Day 2	8.7×10^1	6.9×10^1	6.5×10^1	1.2×10^0	5.0×10^0	2.7×10^1
Day 4	2.9×10^2	1.5×10^2	1.9×10^2	2.4×10^0	6.7×10^0	1.3×10^0
Day 6	3.2×10^3	6.0×10^3	5.0×10^3	3.8×10^1	8.5×10^0	7.5×10^0
Day 8	3.5×10^3	4.7×10^3	4.9×10^3	4.0×10^0	2.1×10^1	2.0×10^1
Day 10	4.0×10^4	2.0×10^4	6.8×10^4	5.0×10^0	3.9×10^0	1.5×10^1

Table 2. *Escherichia coli* of Nano-Encapsulation-Coated and Non-Coated Fillet, Up to 10 Days of Storage

Day of Storage	<i>Escherichia coli</i> (MPN/g)					
	Non-Coated					
	1	2	3	1	2	3
Day 0	3.2	<3.0	<3.0	<3.0	<3.0	<3.0
Day 2	<3.0	3.2	3.6	<3.0	<3.0	<3.0
Day 4	4.2	4.2	3.6	<3.0	<3.0	<3.0
Day 6	5.2	5.4	6.2	<3.0	<3.0	<3.0
Day 8	7.4	7.4	6.8	<3.0	<3.0	<3.0
Day 10	6.2	7.8	7.0	<3.0	<3.0	<3.0

Salmonella sp.

The presence of *Salmonella* was determined to be negative in both the control and LSN samples when cultured on the BSA medium. This result aligns with the current trend of utilizing natural antimicrobials to enhance the quality and prolong the shelf life of food products by actively hindering the growth of spoilage bacteria and mitigating the risk of food-borne diseases.

Antibacterial Inhibitory

Table 3 illustrates the inhibition zones of LSN on *E. coli* and *Salmonella* strains, providing insightful data on the impact of LS concentration and incubation period on the antibacterial properties of LSN. A clear trend emerges from the table, indicating that higher LS concentrations and prolonged incubation periods result in stronger antibacterial effects, evident from the increasing width of the inhibitory zones across all treatment dosages.

Table 3. *E. coli* and *Salmonella* Inhibition Zone using LS Nano-Encapsulation

	Diameter of Inhibition Zone (mm)					
	1% LS Nano-Encapsulation		2% LS Nano-Encapsulation		3% LS Nano-Encapsulation	
<i>E. coli</i>						
1	24	22	30	31	41	46
2	24	21	33	30	44	42
3	25	22	30	34	39	41
4	25	24	36	30	46	48
5	20	20	35	37	48	50
6	24	27	33	39	49	49
<i>Salmonella</i>						
1	23	24	34	35	37	36
2	24	26	36	33	36	37
3	25	25	37	37	37	35
4	26	27	37	39	38	41
5	23	27	32	30	39	40
6	25	27	35	36	39	44

A detailed analysis of the inhibitory zone data for *E. coli* and Salmonella, employing a highly significant impact assessment ($p < 0.01$), reveals the interactive influence of LS concentration and storage day. The table outlines inhibition zone data for three treatments and six storage day variables, leading to the conclusion that LSN, irrespective of LS concentrations (1%, 2%, and 3%), exhibits robust antibacterial properties against *E. coli* and Salmonella. All inhibition zones surpassed 14 mm, indicating a high sensitivity of the tested microorganisms.

Histamine Content

The data on histamine content are displayed in Table 4. The results are significantly impacted ($p < 0.05$) by the coating procedure and significantly impacted ($p < 0.05$) by the interaction between LS concentration and storage time. Total histamine in non-coated fillets after 10 days of storage was 35.0 mg/kg and grew considerably with time, but total histamine in LSN-coated fillets after 10 days of storage was only 6.3 mg/kg and during 1 day of storage demonstrated stationarity.

pH Level

Table 5 presents the pH data, and the subsequent data analysis underscores the significant influence of the coating treatment as well as the interaction between LS concentration and storage period, both of which exhibited a noteworthy significance level of $p < 0.01$. Upon scrutinizing the pH values of fresh fillets coated with LSN and stored in the refrigerator for 10 days, it is evident that they remained consistently within the range of 5.0 to 6.0. Specifically, after 8 to 10 days of storage, the average pH for LSN-coated fillets stabilized at 5.7.

Moisture Content

The water content of fresh fillets, coated and uncoated, is displayed in Table 6. Coated fillets have a highly significant ($p < 0.01$) effect on moisture, according to the data analysis. However, there is no significant effect ($p \geq 0.05$) from the interaction between the LS concentration and storage period. The water content of non-coated fresh fillets dropped after be-

Table 4. Histamine Content of Fillet Coated and Non-Coated by Nano-Encapsulated, Up to 10 Days of Storage

Day of Storage	Histamine (mg/kg)					
	Non-Coated			Coated		
	1	2	3	1	2	3
Day 0	10.0	12.0	9.5	5.0	10.0	7.5
Day 2	15.5	18.8	20.0	5.7	6.0	6.5
Day 4	20.2	19.5	22.2	5.0	5.7	5.5
Day 6	25.6	30.7	32.2	6.2	6.5	7.1
Day 8	29.3	29.5	30.1	5.0	5.5	6.5
Day 10	35.7	38.8	30.5	6.5	7.0	5.4

Table 5. The pH of Fillet Coated and Non-Coated by Nano-Encapsulated, Up to 10 Days of Storage

Day of Storage	pH					
	Non-Coated			Coated		
	1	2	3	1	2	3
Day 0	5.5	5.2	6.0	5.6	5.6	5.7
Day 2	5.9	6.1	6.0	6.0	5.0	5.5
Day 4	6.2	6.5	6.7	5.9	5.8	5.8
Day 6	6.5	6.8	6.9	6.0	5.8	5.7
Day 8	7.0	6.5	7.5	5.5	5.7	5.9
Day 10	7.0	6.9	7.2	5.5	6.0	5.7

ing refrigerated for 6 days but then increased to a similar water content of 10 days of storage. This is probably caused by an increase in the amount of TPC during storage, from an average of 7.4×10^1 on day 0 to 4.3×10^4 on day 10 (Table 1). The samples are also nearly unwrapped. However, the water content of LSN samples decreased significantly. The average water content on day 0 (which was 76.2%) decreased to an average of 59.1% on day 8, and then 58.5% on day 10.

DISCUSSION

The comprehension of microbial development intricacies has unfolded, shedding light on the early stages characterized by the absence of cell division, followed by a phase of rapid expansion until cells attain their maximum size. Within this context, the potential of liquid smoke (LS) to prolong product shelf life by counteracting oxidative damage is underscored. This remarkable attribute is attributed to the combined effects of functional phenols and an abundance of organic acids inherent in LS, which effectively curtail and modulate microbial growth²⁵. However, it's essential to note that the diverse outcomes observed are intricately tied to optimal storage conditions, particularly pH and temperature, exerting notable influence over microbial development²⁶. The findings underscore the multifaceted nature of microbial interactions and the impact of preservation methods on ensuring the safety and shelf life of food products.

The observed effect is attributed to the presence of organic acids and phenolic compounds in LS, which, in combination with nanoparticle encapsulation, demonstrated efficacy in impeding the growth of *E. coli*. Notably, when comparing nano-encapsulation with microencapsulation LS, the former proves to be more potent, as indicated by the results presented by Dien et al.⁹. LS, recognized as a potent bactericide, exhibits the capability to halt the growth of *E. coli* and other pathogens effectively²⁷. Building on prior

research, fish products immersed in LS have consistently met Indonesian standards and demonstrated negativity for microbial presence. These findings underscore the robust antimicrobial properties of liquid smoke and its potential to serve as an effective safeguard against bacterial contamination in various fish products.

Studies have highlighted that the occurrence of *Salmonella* in food items is often linked to inadequate manufacturing hygiene, including factors such as cross-contamination^{28,29}. Conversely, an investigation specific to the components of liquid smoke used in Katsuobushi revealed the absence of *Salmonella* sp. and *Staphylococcus aureus* germs, reinforcing the safety of liquid smoke in this context. Furthermore, liquid smoke emerges as a versatile antibacterial agent suitable for commercial applications where a smoky flavor is desired. Beyond its antimicrobial properties, liquid smoke offers additional benefits such as lower concentrations of PAH and improved product quality, including enhanced taste and flavor³⁰. This underscores the potential of liquid smoke not only as a preservative but also as a flavor-enhancing agent with broader implications for the food industry.

Notably, this aligns with previous research by Dien et al., which utilized LS microencapsulation⁹. The antibacterial efficacy of LSN can be attributed to the prevalence of phenolic chemicals in liquid smoke. Phenolic chemicals, found abundantly in LS, have been observed to damage the cytoplasmic membrane of gram-negative bacteria. Their effectiveness is heightened during bacterial division when the phospholipid layer around the cell is thin³¹. For instance, skipjack fillets dipped in 0.8% LS exhibited a phenolic chemical concentration of 12.6 mg and 0.25 ppb benzo(a) pyrene¹⁷. A higher LS concentration, such as 2%, led to a phenol concentration of 24.21 mg/kg. The antibacterial mechanism of phenol involves disrupting bacterial cell structure, inhibiting cell wall production, and inducing cell wall lysis. Phenol denatures proteins,

Table 6. Water Content of Fillet Coated and Non-Coated by Nano-Encapsulated, Up to 10 Days of Storage

Day of Storage	Water Content					
	Non-Coated			Coated		
	1	2	3	1	2	3
Day 0	76.1	78.2	75.3	76.2	76.5	76.0
Day 2	74.2	75.4	75.5	75.1	74.8	74.5
Day 4	72.1	69.7	70.5	72.2	72.4	73.5
Day 6	60.5	60.7	65.2	65.2	66.0	68.3
Day 8	74.0	73.9	74.5	60.2	60.1	57.0
Day 10	75.0	76.2	75.8	57.5	60.0	58.0

induces apoptosis, and disrupts cytoplasmic integrity, leading to the escape of macronutrients and ions from bacterial cells, ultimately causing disintegration and lysis. The primary target of the antibacterial mechanism is the bacterial cell structure, impacting the cytoplasmic membrane, ion stability, and coagulation within the cell constituents³².

Several parameters influence antibacterial activity, including concentration, antibacterial component content, extract diffusion power, and the type of suppressed bacteria. Encapsulated LS, akin to LS solution, demonstrates that higher LS concentrations result in larger inhibitory zone widths for *E. coli* and *Salmonella*³³. This supports the rationale that increased concentration leads to the production of more antibacterial chemicals, and reducing particle size to the nanoscale enhances their penetration into bacterial cells³⁴, further fortifying the antibacterial effects of LSN.

The result showed that the effectiveness of LSN in preventing histamine production was higher than the results obtained from microencapsulation in previous work⁹. Until 10 days of storage, the quality of the fillets was still excellent, according to histamine content, because it was maintained lower than 10 mg/kg. According to European regulations, fisheries products may contain up to 40 mg/100 g of histamine³⁵. During the process of preserving fresh fish, glutamate and histamine are generated by the enzymes histidine decarboxylase and L-histidine ammonia-lyase. Bacteria that produce histamine, such as *E. coli*, *Micrococcus luteus*, and *Pseudomonas* sp., cause the decarboxylase process⁸.

The low pH in LSN-coated fillets is attributed to the presence of organic acids in the LS, and these organic acids also contribute to the preservation of fish and meat products. Notably, liquid smoke itself has a pH in the range of 2.8 to 3.1, qualifying it for use as a preservative. In a related study, when LS was diluted from 0.4 percent to 0.8 percent and applied to skipjack fillets, the resulting pH ranged from 4.8 to 5.5¹⁷. This inherent acidic nature of LS imparts a preservative impact, inhibiting the growth of pathogens and spoilage microbes. The acidic environment created by LS, with its organic acid content, serves as a deterrent to microbial proliferation, thereby enhancing the safety and extending the shelf life of coated fish fillets. This dual role of pH regulation and antimicrobial action further accentuates the potential of LS coatings in preserving the quality and safety of fish products during storage³⁶. To sum up, nano-encapsulation can help prevent the growth of bacteria.

CONCLUSIONS

Total microbiological count (TPC), *Salmonella*, *E. coli*, antibacterial inhibitory, histamine content, pH, and moisture content are all significantly to highly significantly impacted by the LSN. The results showed that LSN with maltodextrin: sago flour: 1% LS ratio of 10: 1: 5 effectively inhibited the growth of *E. coli* and *Salmonella* and decreased the level of histamine in sashimi that was refrigerated for up to ten days. In tuna

sashimi, LSN successfully inhibited the development of harmful germs and lowered the histamine content. As a result, it is unique to apply LSN to tuna loin sashimi.

ACKNOWLEDGMENTS

We give our regards to the Ministry of Education, Culture, Research, and Technology, Indonesia for the financial support for this research, through the "Riset Mapalus" project of Sam Ratulangi University.

REFERENCES

- Sheng L, Wang L. The microbial safety of fish and fish products: Recent advances in understanding its significance, contamination sources, and control strategies. *Comprehensive Reviews in Food Science and Food Safety* 2021;20:738–86. <https://doi.org/10.1111/1541-4337.12671>.
- Lee JC, Daraba A, Voidarou C, Rozos G, Enshasy HA El, Varzakas T. Implementation of Food Safety Management Systems along with Other Management Tools (HAZOP, FMEA, Ishikawa, Pareto). The Case Study of *Listeria monocytogenes* and Correlation with Microbiological Criteria. *Foods* 2021;10. <https://doi.org/10.3390/foods10092169>.
- Jati AK, Nurani TW, Iskandar BH. Sistem Rantai Pasok Tuna Loin di Perairan Maluku (Supply Chain System of Tuna Loin in Maluku Waters). *Marine Fisheries: Jurnal Teknologi Dan Manajemen Perikanan Laut* 2014;5. <https://doi.org/10.29244/jmf.5.2.171-180>.
- Chakma S, Saha S, Hossain N, Rahman MA, Akter M, Hoque MS, et al. Effect of frozen storage on the biochemical, microbial and sensory attributes of Skipjack Tuna (*Katsuwonus pelamis*) fish loins. *Journal of Applied Biology & Biotechnology* 2020;8:58–64. <https://doi.org/10.7324/JABB.2020.80409>.
- Dien HA, Montolalu RI, Mentang F, Mandang ASK, Rahmi AD, Berhimpon S. Microbiological Studies of Semi-Preserved Natural Condiments Paste Stored in Refrigerator and Ambient Temperature. *Journal of Physics: Conference Series* 2018;953:12014. <https://doi.org/10.1088/1742-6596/953/1/012014>.
- Rodríguez-Caravaca G, Hijas-Gómez AI, Tejedor-Alonso MÁ, Del-Moral-Luque JA, Delgado-Iribarren A, Valverde-Cánovas JF, et al. Food poisoning caused by scombroids: A case-control study. *Journal of Infection and Public Health* 2019;12:591–3. <https://doi.org/10.1016/j.jiph.2018.09.010>.
- Mercogliano R, Santonicola S. Scombroid fish poisoning: Factors influencing the production of histamine in tuna supply chain. A review. *LWT* 2019;114:108374. <https://doi.org/10.1016/j.lwt.2019.108374>.
- Oktariani AF, Ramona Y, Sudaryatma PE, Dewi IA, Shetty K. Role of Marine Bacterial Contaminants in Histamine Formation in Seafood Products: A Review. *Microorganisms* 2022;10. <https://doi.org/10.3390/microorganisms10061197>.
- Dien HA, Montolalu RI, Mentang F, Berhimpon S, Nurkolis F. Inhibition of Microencapsulated Liquid Smoke on the Foodborne Pathogens and Histamine-Forming Bacteria's Growth in Tuna Loin Sashimi: Inhibition of Liquid Smoke Microencapsulation. *Open Access Macedonian Journal of Medical Sciences* 2022;10:1200–6. <https://doi.org/10.3889/oamjms.2022.10182>.

10. Keryanti, Permanasari AR, Yulistiani F, Sihombing RP, Wibisono W. Applications of Liquid Smoke from Biomass on Food Products: A Review. *Proceedings of the International Seminar of Science and Applied Technology (ISSAT 2020)*, Atlantis Press; 2020, p. 518–24. <https://doi.org/10.2991/aer.k.201221.086>.
11. Desvita H, Faisal M, Mahidin, Suhendrayatna. Preservation of meatballs with edible coating of chitosan dissolved in rice hull-based liquid smoke. *Heliyon* 2020;6:e05228. <https://doi.org/10.1016/j.heliyon.2020.e05228>.
12. Mastanjević K, Kartalović B, Petrović J, Novakov N, Puljić L, Kovačević D, et al. Polycyclic aromatic hydrocarbons in the traditional smoked sausage Slavonska kobasica. *Journal of Food Composition and Analysis* 2019;83:103282. <https://doi.org/10.1016/j.jfca.2019.103282>.
13. Saifullah Md, Shishir MRI, Ferdowsi R, Tanver Rahman MR, Van Vuong Q. Micro and nano encapsulation, retention and controlled release of flavor and aroma compounds: A critical review. *Trends in Food Science & Technology* 2019;86:230–51. <https://doi.org/10.1016/j.tifs.2019.02.030>.
14. Timilsena YP, Akanbi TO, Khalid N, Adhikari B, Barrow CJ. Complex coacervation: Principles, mechanisms and applications in microencapsulation. *International Journal of Biological Macromolecules* 2019;121:1276–86. <https://doi.org/10.1016/j.ijbiomac.2018.10.144>.
15. Laureanti EJJ, Paiva TS, de Matos Jorge LM, Jorge RMM. Microencapsulation of bioactive compound extracts using maltodextrin and gum arabic by spray and freeze-drying techniques. *International Journal of Biological Macromolecules* 2023; 253:126969. <https://doi.org/10.1016/j.ijbiomac.2023.126969>.
16. Mansur D, Sugiwati S, Rizal WA, Suryani R, Maryana R. Pyrolysis of cajuput (*Melaleuca leucadendron*) twigs and rice (*Oryza sativa*) husks to produce liquid smoke-containing fine chemicals for antibacterial agent application. *Biomass Conversion and Biorefinery* 2023;13:10561–74. <https://doi.org/10.1007/s13399-021-01896-x>.
17. Berhimpon S, Montolalu RI, Dien HA, Mentang F, Meko AUI. Concentration and application methods of liquid smoke for exotic smoked Skipjack (*Katsuwonus pelamis* L.). *International Food Research Journal* 2018;25.
18. Badan Standarisasi Nasional. Metode pengujian cemaran mikroba dalam daging, telur dan susu, serta hasil olahannya. Badan Standarisasi Nasional; 2008.
19. Badan Standarisasi Nasional. Cara uji mikrobiologi bagian 2: Penentuan Salmonella pada produk perikanan. 2006.
20. Semeniuc CA, Pop CR, Rotar AM. Antibacterial activity and interactions of plant essential oil combinations against Gram-positive and Gram-negative bacteria. *Journal of Food and Drug Analysis* 2017;25:403–8. <https://doi.org/10.1016/j.jfda.2016.06.002>.
21. Elik A, Altunay N, Gürkan R. Ultrasound-Assisted Low-Density Solvent-Based Dispersive Liquid-Liquid Microextraction Coupled to Spectrophotometry for the Determination of Low Levels of Histamine in Fish and Meat Products. *Food Analytical Methods* 2019;12:489–502. <https://doi.org/10.1007/s12161-018-1380-1>.
22. Fardisi M, Mason LJ, Ileleji KE, Richmond DS. Effect of chemical and physical properties of Dried Distillers Grains with solubles (DDGS) on *Tribolium castaneum* (Herbst) development. *Journal of Stored Products Research* 2019;80:57–64. <https://doi.org/10.1016/j.jspr.2018.11.008>.
23. Badan Standarisasi Nasional. Tuna segar untuk Sashimi. 2006.
24. Badan Standarisasi Nasional. Cara uji mikrobiologi bagian 3: Penentuan angka lempeng total (ALT) pada produk perikanan. 2006.
25. Kalogianni AI, Lazou T, Bossis I, Gelasakis AI. Natural Phenolic Compounds for the Control of Oxidation, Bacterial Spoilage, and Foodborne Pathogens in Meat. *Foods* 2020;9. <https://doi.org/10.3390/foods9060794>.
26. Gassem MA. Microbiological and chemical quality of a traditional salted-fermented fish (Hout-Kasef) product of Jazan Region, Saudi Arabia. *Saudi Journal of Biological Sciences* 2019;26:137–40. <https://doi.org/10.1016/j.sjbs.2017.04.003>.
27. Tuesta-Chavez T, Monteza J, Silva Jaimes MI, Ruiz -Pacco GA, Changanauqui K, Espinoza – Suarez JB, et al. Characterization and evaluation of antioxidant and antimicrobial capacity of prepared liquid smoke-loaded chitosan nanoparticles. *Journal of Food Engineering* 2022;319:110912. <https://doi.org/10.1016/j.jfoodeng.2021.110912>.
28. Aquilanti L, Clementi F, Osimani A. Salmonellosis associated with mass catering: a survey of European Union cases over a 15-year period. *Epidemiology and Infection* 2016;144:3000–12. <https://doi.org/10.1017/S0950268816001540>.
29. Ehuwa O, Jaiswal AK, Jaiswal S. Salmonella, Food Safety and Food Handling Practices. *Foods* 2021;10. <https://doi.org/10.3390/foods10050907>.
30. Kaloti S. Effect of cold smoking on polycyclic aromatic hydrocarbon content and sensory properties in selected foods. Auckland University of Technology, 2022.
31. Khorsandi K, Keyvani-Ghamsari S, Khatibi Shahidi F, Hosseinzadeh R, Kanwal S. A mechanistic perspective on targeting bacterial drug resistance with nanoparticles. *Journal of Drug Targeting* 2021; 29:941–59. <https://doi.org/10.1080/1061186X.2021.1895818>.
32. Rempe CS, Burris KP, Lenaghan SC, Stewart CN. The Potential of Systems Biology to Discover Antibacterial Mechanisms of Plant Phenolics. *Frontiers in Microbiology* 2017;8. <https://doi.org/10.3389/fmicb.2017.00422>.
33. Rahmasari Y, Yemiş GP. Characterization of ginger starch-based edible films incorporated with coconut shell liquid smoke by ultrasound treatment and application for ground beef. *Meat Science* 2022;188:108799. <https://doi.org/10.1016/j.meatsci.2022.108799>.
34. Islam MA, Barua S, Barua D. A multiscale modeling study of particle size effects on the tissue penetration efficacy of drug-delivery nanoparticles. *BMC Systems Biology* 2017;11:113. <https://doi.org/10.1186/s12918-017-0491-4>.
35. DeBeeR J, Bell JW, Nolte F, Arcieri J, Correa G. Histamine Limits by Country: A Survey and Review. *Journal of Food Protection* 2021;84:1610–28. <https://doi.org/10.4315/JFP-21-129>.
36. Chakraborty S, Dutta H. Use of nature-derived antimicrobial substances as safe disinfectants and preservatives in food processing industries: A review. *Journal of Food Processing and Preservation* 2022;46:e15999. <https://doi.org/10.1111/jfpp.15999>.

Effects of an interdisciplinary program to promote the health of overweight or obese adolescents on the consumption of inflammatory and anti-inflammatory foods

Isabelle Zanqueta CARVALHO^{1,2}, Isabella Sartori Alvares ACETI², Déborah Cristina de Souza MARQUES^{1,2}, Braulio Henrique Magnani BRANCO^{1,2}, Paulo Leonardo Marotti SICILIANO, Isabela Cabral MARTINS, Ana Carolina Vieira COMAR²

1 Interdisciplinary Laboratory of Intervention in Health Promotion, Cesumar Institute of Science, Technology and Innovation, Maringá, PR, Brazil.
2 Cesumar University, Maringá, PR, Brazil.

Recibido: 18/mayo/2024. Aceptado: 20/julio/2024.

ABSTRACT

Background: Being overweight is a significant public health problem. Due to the complexity of obesity in adolescence, the treatment in health recovery must be interdisciplinary.

Goals: the present study aimed to investigate the effects of an interdisciplinary intervention program in overweight adolescents on the consumption of inflammatory and anti-inflammatory foods.

Methods: the project lasted 14 weeks and was divided into three stages: recruitment of participants and initial assessments; interdisciplinary interventions, which included the simultaneous participation of their parents and, finally, the reassessments. Food intake was measured at the beginning and end of the interventions using a three-day food record. The average values of calories and nutrients were used to generate the Dietary Inflammatory Index (DII®), a numerical score that assesses a diet for its effect on several biomarkers linked to inflammation. For the categorization of the DII®, high values (+1) for the pro-inflammatory effect and lower values (-1) for the anti-inflammatory effect were considered. For all analyses, a $p < 0.05$ was considered.

Results: The consumption of carbohydrates, lipids, total cholesterol, and saturated fat was reduced ($p < 0.05$). On the

other hand, there was an increase in the consumption of fiber, proteins, and vitamins A, D, E, B3, B6, B9, B12, and C, in addition to an increase in the consumption of iron, selenium, magnesium and zinc ($p < 0.05$). The level of inflammation in IBD was significantly decreased for saturated fat, vitamins B6, B9, and C, as well as magnesium ($p < 0.05$).

Conclusion: Based on the results, the interdisciplinary intervention promoted a positive response with reduced lipids, total cholesterol, saturated fat, and reduced inflammatory food. New interventions with large groups and different samples are recommended to encourage possible extrapolation of our findings.

KEYWORDS

Parental influence, lifestyle changes, nutritional education, eating patterns, family programs.

INTRODUCTION

Adolescence is a complex period of human development in which young people are susceptible to unhealthy behaviors, such as physical inactivity and an unbalanced diet¹. Given the great vulnerability of this group, it is noteworthy that the prevalence of overweight has increased epidemically in the last four decades and currently represents a major public health problem in the world². The 2021 Food and Nutrition Surveillance System revealed that 19.75% of adolescents in Brazil showed overweight and obesity³. Being overweight contributes to health and biopsychosocial complications both immediately and in the long term. Therefore, the prevention of obesity is a public health issue⁴. According to Neves *et al.*⁵,

Correspondencia:
Isabelle Zanqueta Carvalho
isabellezanquetta@gmail.com

the advancement of technology has allowed the time spent on social media, *games*, and in front of the television to skyrocket. Associated with this fact, the increase in hypercaloric diets and greater access to ultra-processed foods rich in fats and carbohydrates contributed to the worsening of the problem. In addition to being a crucial factor in perpetuating obesity, poor diet also influences inflammatory responses. Some nutrients are known to contribute to the development of chronic low-grade inflammation⁶.

Dietary patterns characterized by higher consumption of red and processed meats, fried foods, and lower intake of whole grains contribute to higher rates of inflammatory markers. Meanwhile, a diet rich in fruits and vegetables has been recommended to combat oxidative stress, decrease pro-inflammatory mediators, and increase the spectrum of immune cells⁷. Cavicchia *et al.*⁸, described the Dietary Inflammatory Index (DII®) to evaluate the inflammatory potential of diet. This index was improved and validated by Shivappa *et al.*⁹ and aims to establish a quantitative classification of foods' anti-inflammatory and inflammatory potential, which are currently associated with a series of outcomes, including cancer, metabolic syndrome, and asthma^{9,10}.

To this end, in 2010, a literature search was conducted using 1,943 peer-reviewed articles to find nutrients and food bioactives that affect the levels of inflammation markers, such as interleukin-1b, interleukin-4, interleukin-6, interleukin-10, tumor necrosis factor- α , and C-reactive protein. Each of the 45 substances found was assigned a score. Negative values suggest that the meal or food intake may have anti-inflammatory effects, while positive values indicate inflammatory effects⁹. It should be noted that interdisciplinary intervention promotes adolescent health and improves psychological, nutritional, social, body composition, and biochemical parameters¹¹. It is also noteworthy that the family exerts a primary influence on the formation of eating habits and can directly influence the choices of adolescents¹².

It is also known that studies using the DII® directed to adolescents are scarce¹³. In this sense, this study aimed to investigate the effects of an interdisciplinary intervention program on adolescents' consumption of inflammatory and anti-inflammatory foods in overweight adolescents.

METHODOLOGY

This is a pre-experimental, descriptive, analytical study with a non-probabilistic sample, and the interdisciplinary intervention project took place at Cesumar University (UniCesumar) on the premises of the Laboratory of Interdisciplinary Intervention in Health Promotion (LIIPS) and the institution's multi-sport complex. The population consisted of overweight adolescents enrolled in the Obesity Treatment Project, living in Maringa, Parana, Brazil. Adolescents enrolled in the Obesity Treatment Project who met the following inclusion criteria

were invited to participate in the study: a) age greater than or equal to 10 years up to 19 years¹⁴; b) overweight as determined by the body mass index for age (BMI/A) when Z-score $\geq +1$, cut-off point adapted from the Food and Nutrition Surveillance System - SISVAN¹⁴ and c) availability to participate in theoretical-practical interventions 3x a week. The exclusion criteria were: a) use of glucocorticoids and/or psychotropic medications that can regulate appetite; b) attendance lower than 75% in the different theoretical-practical activities carried out; c) musculoskeletal limitations that would prevent the regular and systematic practice of physical exercises; d) participation in another nutritional orientation program or other physical exercise proposals, as well as the performance of a low-calorie, *low-carb* or *low-fat* diet. After the project was publicized on social media, 67 adolescents signed up to participate in it; however, 13 (19.40%) did not meet the inclusion criteria, and 33 (49.25%) had a frequency lower than 75% or dropped out of the project, resulting in 21 (31.35%) participants in the research (Figure 1).

Regarding the ethical issues, this study was approved by the Research Ethics Committee of UniCesumar, with opinion number 4.913.453/2021. The research followed all the recommendations proposed by resolution 466/2012 of the Ministry of Health of the Brazilian Government and the Declaration of Helsinki.

The project took place in the second half of 2021, on Mondays, Wednesdays, and Fridays, for 14 weeks, i.e., one week of assessments, 12 weeks of intervention, and one week of reassessments. The interventions were carried out in groups and simultaneously in the presence of adolescents and their parents/guardians. Physical education, nutrition, and psychology professionals participated. Physical exercises were performed three times a week for 60 minutes, nutrition education sessions twice a week, and cognitive-behavioral therapy sessions once a week lasting 20 minutes each. Figure 1 presents the flowchart diagram of the present study.

The adolescents were recruited through posters and pamphlets in schools and Basic Health Units (BHU) in Maringa and pediatric clinics. The study was disseminated on the social networks of Instagram and Facebook of health professionals and LIIPS, in addition to dissemination on websites, television, and radio programs. After recruiting the participants, an initial meeting was scheduled to explain the technical procedures of the research project to all those interested in participating, along with their guardians.

Nutritional status was assessed by calculating body mass index (BMI). Height was measured using a standard stadiometer (Sanny®, São Paulo, Brazil). Next, body weight was measured using a mechanical scale (Welmy®, São Paulo, Brazil) with a 150 kg capacity and an accuracy of 100 g. Subsequently, BMI was calculated, in which body weight (BW) in kilograms was divided by height (H) in meters squared ($BMI = BW/(H^2)$). For

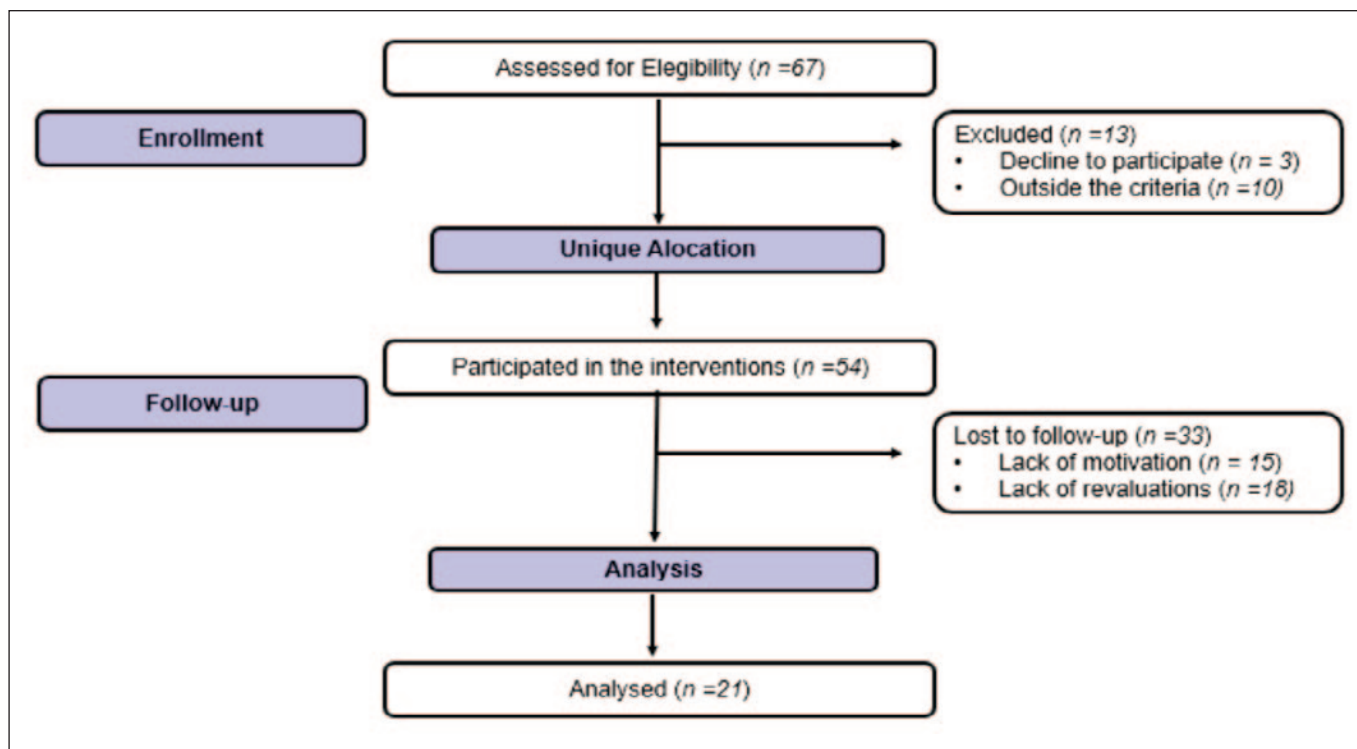


Figure 1. Flowchart diagram of the participants of the present study

adolescents, the World Health Organization (WHO) z-score tables for BMI/A were used^{14,15}. Nutritional status was classified using the following cut-off points: Z-score $\geq +1$ and $< Z$ -score $+2$ (indicative of overweight), Z-score $\geq +2$ (indicative of obesity). For analysis, overweight refers to the sum of the overweight and obesity classifications for the BMI/H index.

Food intake was measured in all adolescents at the beginning and end of the interventions using a three-day food record. The adolescents were instructed to write down all their meals during three non-consecutive days, two days during the week and one day on the weekend, and to fill in all the food and the appropriate quantities in detail (via home measurements), using measuring utensils, or to provide the best estimate of the portion size if they were away from home. In addition, all participants were told to specifically detail each food item, such as brand or restaurant names and labeling of specific items. To this end, support material was delivered for information on household measures and the correct completion of the food record. Finally, to help the adolescents, theoretical classes were held at the beginning of the project and in the final collections on how to fill in the material and what the homemade measurements are.

With the food records collected, the macro and micronutrients ingested were calculated using the Avanutri software (2004® version, Avanutri Equipamentos de Avaliação Ltda, Três Rios, Rio de Janeiro, Brazil). To estimate β -carotene and

flavonoids (flavonol-3-ol, flavones, flavonols, flavonoids, anthocyanidins, and isoflavones), we used the Rodriguez-Amaya¹⁶ and PhenolExplorer¹⁷ databases, respectively.

The mean values of the three days of the food records were used in the pre- and post-intervention moments of the following nutrients: carbohydrates, proteins, total fats, fiber, cholesterol, saturated fat, monounsaturated fat (omega 9), polyunsaturated fats (omega 3 and omega 6), vitamins (A, B1, B3, B6, B9, B12, C, D, E), minerals (iron, magnesium, zinc, selenium) and flavonoids (flavonol-3-ol, flavones, flavanols, flavonoids). The responses of the food registry, such as total intake of macronutrients, micronutrients, flavonoids, and calories, were subsequently tabulated in the Excel program (version 2013, Microsoft, United States of America).

The mean values of calories and nutrients consumed by each adolescent, found through the three-day food record, were used to create the DII® of the present study. The DII® was calculated using a scoring algorithm based on a review of 1,943 articles linking 45 dietary parameters and six inflammatory biomarkers (IL-1 β , IL-4, IL-6, IL-10, TNF- α , and C-reactive protein). To calculate the IDI®, we used the global mean and the standard deviation developed for the global composition database, which was derived from 11 countries, including 4 Asian countries, mentioned in the study by Shivappa⁹. The calculation of the DII® is explained in Figure 2. Thus, the values obtained were used to create a DII® score for each participant. With the values found, the

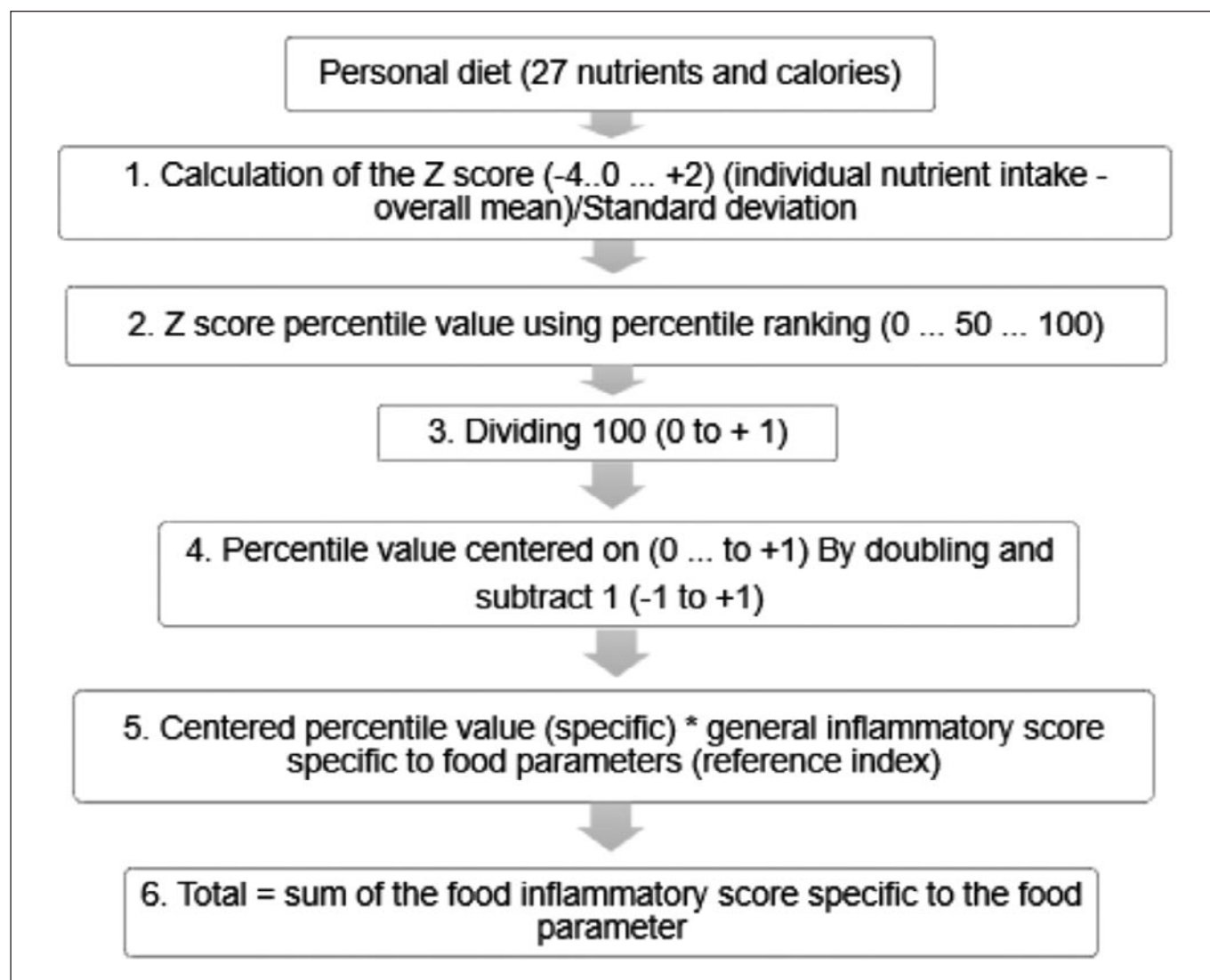


Figure 2. Flowchart of the stages of the calculation of the inflammatory index of the diet (DII®)

percentile value was converted to 10°, 25°, 50°, 75° and 90° in the SPSS statistical software.

Subsequently, the percentiles were divided by 100 to calculate the 0-1 score. After converting the centered percentile score, which ranged from -1 to +1 for each food parameter, it was multiplied by the overall food-specific inflammatory parameters of the worldwide effect score. The present study used the following 27 components: calories, carbohydrates, fiber, proteins, total lipids, cholesterol, saturated fat, monounsaturated fat, polyunsaturated fat, vitamins (A, D, E, B1, B2, B3, B6, B9, B12, C), minerals (iron, selenium, magnesium, zinc) and antioxidants (flavonol-3-ol, flavones, flavanol's, flavonoids). Figure 2 presents the flowchart of the stages of calculating the DII®.

Data were presented as mean and standard deviation (SD) after testing for normality using the Shapiro-Wilk test. A

paired t-test was used to compare the pre- and post-intervention moments. All analyses assumed a significance level of 5%. Statistical analyses were performed using SPSS version 20.0 (IBM, United States of America).

RESULTS

Of the 21 adolescents evaluated, 11 (52.38%) were male. Regarding nutritional status, according to BMI/A, it is noteworthy that 12 (57.14%) adolescents were classified as obese and 9 (42.86%) as overweight, both in the pre- and post-intervention moments. When evaluating food intake, it was found that the intake of carbohydrates, total lipids, cholesterol, and saturated fat was significantly reduced in the post-intervention moment, and on the other hand, fiber, protein, vitamins A, D, E, B3, B6, B9, B12 and C and the minerals iron, selenium, magnesium, and zinc, increased significantly after

the 12 weeks of intervention. Also noteworthy is the reduced calorie intake and increase in polyunsaturated fats, flavonol-3-ol, flavones, flavanol, and flavonoids in the post-intervention moment, but without statistical significance. Table 1 compares adolescents' dietary consumption of certain nutrients pre- and post-intervention moments.

Regarding the analysis of the DII®, according to Table 2, the general DII®, DII® for calories, DII® for cholesterol, and polyunsaturated fat did not present significant differences after the 12 weeks of intervention ($p>0.05$). However, they became less inflammatory. The DII® for calories, total lipids, and saturated fat was shown to be anti-inflammatory in the

Table 1. Comparison between adolescents' dietary consumption of certain nutrients pre- and post-intervention moments

Nutrient	Pre-intervention		Post-intervention		p-value
	Mean	Dp	Mean	Dp	
Calories (kcal)	1555.02	788.19	1394.11	632.09	0.1157
Carbohydrate (g)	180.77	101.53	164.50	79.38	0.0286*
Fibers (g)	10.88	8.80	15.43	9.90	0.0001*
Proteins (g)	76.89	42.33	80.88	29.49	0.0286*
Total lipids (g)	61.99	35.02	47.78	25.49	0.0013*
Cholesterol (mg)	442.39	384.15	346.12	181.36	0.0011*
Saturated fat (g)	23.60	11.31	16.31	7.67	0.0001*
Monounsaturated fat (g)	18.04	10.28	14.66	9.02	0.3008
Polyunsaturated fat (g)	10.05	7.01	10.65	8.27	0.0921
Vitamin A (mcg)	396.73	239.29	447.76	258.42	0.0187*
Vitamin D (mcg)	2.644	34.94	11.3	2.41	0.0421*
Vitamin E (mg)	5.40	4.38	8.55	7.21	0.0001*
Vitamin B1 (mg)	1.16	0.70	1.00	0.55	0.6742
Vitamin B2 (mg)	1.23	0.62	1.29	0.78	0.1152
Vitamin B3 (mg)	7.54	10.83	10.46	14.03	0.0001*
Vitamin B6 (mg)	1.00	0.58	1.33	0.66	0.0002*
Vitamin B9 (mcg)	106.67	83.89	228.28	232.16	0.0001*
Vitamin B12 (mcg)	2.29	2.00	5.36	8.15	0.0001*
Vitamin C (mg)	66.04	97.53	95.63	112.24	0.0001*
Iron (mcg)	10.48	4.53	14.20	6.59	0.0001*
Selenium (mcg)	49.94	27.52	64.03	34.92	0.0001*
Magnesium (mg)	136.69	71.25	194.69	98.52	0.0001*
Zinc (mg)	7.89	4.58	9.68	5.25	0.0061*
Flavonol-3-ol (mg)	4.50	5.87	10.35	18.58	0.3910
Flavones (mg)	2.43	3.59	7.27	17.39	0.9854
Flavonols (mg)	58.59	70.41	120.23	359.42	0.3591
Flavonoids (mg)	93.98	107.78	152.85	375.24	0.8469

kcal = calories; g = grams; mcg = micrograms; Dp = standard deviation; * = significant difference = $p<0.05$.

Table 2. General Dietary Inflammatory Index (DII®) in adolescents in pre- and post-intervention moments

DII® for Calories and macronutrients	Pre-intervention	Post-intervention	p-value
General DII®	2.25 ± 1.57	2.12 ± 1.89	0.5000
Calories	-0.08 ± 0.14	-0.12 ± 0.11	0.2708
Carbohydrate	-0.06 ± 0.06	-0.06 ± 0.06	0.5000
Fibers	0.44 ± 0.41	0.44 ± 0.41	0.5000
Proteins	0.00 ± 0.02	0.00 ± 0.02	0.2721
Total Lipids	-0.08 ± 0.25	-0.16 ± 0.19	0.0912
Cholesterol	0.02 ± 0.09	0.01 ± 0.09	0.3326
Saturated Fat	-0.12 ± 0.24	-0.27 ± 0.14	0.0076*
Monounsaturated fat	0.10 ± 0.13	0.14 ± 0.11	0.1313
Polyunsaturated fat	0.18 ± 0.22	0.17 ± 0.24	0.4649

DII®: Dietary Inflammatory Index; ± = standard deviation; * = significant difference = $p < 0.05$.

Table 3. Dietary Inflammatory Index (DII®) for consuming vitamins, minerals, and antioxidants before and after the 12 weeks of intervention of the adolescents

DII® for Vitamins, Minerals and Antioxidants	Pre-intervention	Post-intervention	p-value
Vitamin A	0.28 ± 0.09	0.26 ± 0.10	0.2366
Vitamin D	0.35 ± 0.26	0.31 ± 0.20	0.4103
Vitamin E	0.25 ± 0.32	0.11 ± 0.39	0.0560
Vitamin B1	0.05 ± 0.05	0.06 ± 0.04	0.3436
Vitamin B2	0.02 ± 0.03	0.02 ± 0.04	0.4699
Vitamin B3	0.18 ± 0.11	0.15 ± 0.14	0.1360
Vitamin B6	0.14 ± 0.17	0.04 ± 0.20	0.0370*
Vitamin B9	0.16 ± 0.08	0.09 ± 0.15	0.0091*
Vitamin B12	-0.05 ± 0.09	-0.07 ± 0.05	0.0931
Vitamin C	0.24 ± 0.28	0.12 ± 0.32	0.0015*
Iron	0.01 ± 0.13	-0.01 ± 0.02	0.1814
Selenium	0.07 ± 0.31	0.05 ± 0.11	0.0594
Magnesium	0.25 ± 0.21	0.15 ± 0.21	0.0296*
Zinc	0.30 ± 0.01	0.07 ± 0.26	0.1181
Flavonol-3-ol	0.28 ± 0.61	0.15 ± 0.05	0.3983
Flavones	0.10 ± 0.46	-0.15 ± 0.61	0.4767
Flavonols	0.06 ± 0.25	-0.15 ± 0.61	0.2888
Flavonoids	0.01 ± 0.13	-0.09 ± 0.23	0.4124

DII®: Dietary Inflammatory Index; ± = standard deviation; * = significant difference = $p < 0.05$.

pre-intervention moment. After 12 weeks, the DII® values became more anti-inflammatory, but only significantly for saturated fat ($p < 0.05$). On the other hand, the DII® for monounsaturated fat became more inflammatory. Table 2 presents DII® in adolescents in pre- and post-intervention moments.

The data in Table 3 show that although the DII®s are still inflammatory after the intervention, there was an improvement for vitamins (A, D, E, B3, B6, B9, and C), minerals (selenium, magnesium, and zinc) and antioxidants (flavonol-3-ol), but significantly for B6, B9, C, and magnesium ($p < 0.05$). There was an improvement in the DII® of vitamin B12, which has already started to be anti-inflammatory. The mineral iron and the antioxidants flavones, flavanol, and flavonoids started inflammatory and became anti-inflammatory, but without significance ($p > 0.05$). The DII® for vitamin B1 became more inflammatory after the 12 weeks of intervention ($p < 0.05$). Table 3 presents DII® for consuming vitamins, minerals, and antioxidants before and after the 12 weeks of intervention of the adolescents.

DISCUSSION

Regarding the analysis of the general DII®, it was found that it became less inflammatory after the 12 weeks of intervention, although without statistical significance. This finding is relevant because adolescents who are overweight and obese have a dietary pattern with high inflammatory potential¹⁸. It was also evidenced that nutritional education contributed to reduced caloric intake and a less inflammatory DII® of calories. Although not statistically significant, these results are positive since the recommended treatments for overweight people should include a healthy eating pattern promoting a calorie deficit associated with regular physical activity to induce weight loss¹⁹.

As for carbohydrate intake, the significant reduction in the consumption of this macronutrient stands out. Soft drinks are among the main sources of simple carbohydrates in adolescents' diets. Due to their high caloric content, these beverages favor the development of obesity²⁰. By inducing significant weight gain, sweetened beverages also contribute to the development of type 2 diabetes mellitus and a higher risk of cardiovascular disease. In addition, the high and habitual consumption of refined carbohydrates correlates with inflammatory stages and chronic diseases²¹.

Twelve weeks of intervention contributed to a significant increase in protein intake. In the short

term, a diet with higher protein levels helps more effectively with weight loss. It is believed that the mechanisms that support the effects of proteins on the efficacy of weight loss are related to increased satiety and resting metabolic rate²². Other favorable results after the interventions include significantly reducing total lipids, saturated fat, and cholesterol consumption. Saturated fatty acids induce greater insulin resistance and increased gene expression related to adipose tissue inflammatory pathways. Excessive consumption of saturated fat also elevates total cholesterol, *low-density lipoprotein*, and *high-density lipoproteins*. However, the observed elevation in HDL-c may not be sufficient to overcome the deleterious effects of LDL-c on cardiovascular risk. In addition, by modulating the transcription factors involved in the synthesis of lipogenic enzymes, saturated fatty acids favor the synthesis of triglycerides²³.

On the other hand, there was an increase in the consumption of omega-3 polyunsaturated fatty acids. This nutrient can potentially alter the production of pro- and anti-inflammatory cytokines, reducing inflammatory markers and platelet aggregation, improving endothelial function, and reducing blood pressure and triglyceridemia²³. It is important to note that the results of the study by Pereira *et al.*¹⁹, in overweight adolescents also showed a reduction in total caloric intake, carbohydrates, and lipids at the end of 20 weeks of intervention. The authors also showed that long-term interdisciplinarity, with therapy combined with education, contributed to reducing obesity and associated inflammatory processes.

Therefore, the increases in the intake of fiber, vitamins (A, D, E, B3, B6, B9, B12, and C), minerals (iron, selenium, magnesium, and zinc), and antioxidants (flavonol-3-ol, flavones, flavanol's and flavonoids) found in this study are considered favorable. Mendes *et al.*⁷, state that eating habits rich in fruits and vegetables, as they are rich in fiber, vitamins, minerals, and antioxidants, help combat oxidative stress, being recommended to reduce the levels of pro-inflammatory mediators and improve immune cells. These authors conclude that a healthy lifestyle can modify oxidative stress and systemic inflammation.

Fliet *et al.*²⁴ report that ultra-processed foods are increasingly present in adolescents' diets. These foods, besides having high energy density and contributing to obesity, are low in vitamins, minerals, and fiber and are considered inflammatory foods. In addition, unhealthy eating patterns, such as the Western diet, high in fat and refined carbohydrates, are usually associated with higher concentrations of inflammatory markers, while healthy eating patterns, such as the Mediterranean diet, rich in fish, fruits, and vegetables, are associated with lower levels of inflammation²⁵.

Given the data exposed, it was found that the 12 weeks of interdisciplinary intervention contributed favorably to most of the nutrients evaluated, but regarding the DII® of the satu-

rated fat, vitamins B6, B9, C, and magnesium became significantly less inflammatory. Pear tree *et al.*¹⁸, argue that the results from the calculation of the DII® can be used to improve health conditions in obese adolescents. Borges *et al.*²⁶, also reaffirm the importance of using the DII® in research with obese adolescents, emphasizing that the higher the consumption of fast food, biscuits, and crackers, the more inflammatory the DII® is.

Finally, guidelines for preventing and treating childhood obesity must be based on lifestyle changes. Parental involvement and intensive follow-up are essential factors for a positive treatment outcome. Progress in combating childhood obesity has been slow and inconsistent. Investing in access and treatment possibilities and acting in prevention are necessary and urgent measures²⁷.

CONCLUSION

In conclusion, the interdisciplinary intervention performed for 12 weeks in overweight/obese adolescents reduced carbohydrate, lipid, total cholesterol, and saturated fat consumption after the intervention. Besides that, there was an improvement in vitamins A, D, E, B3, B6, B12, and C consumption and an improvement in iron, selenium, and zinc ingestion. After the interdisciplinary intervention, the DII® index reduced significantly for saturated fat, showing a positive impact on the adolescent's food consumption. It is well known that educating adolescents to consume anti-inflammatory foods can help maintain their health and well-being. Thus, it is hoped that this research will contribute to the increase of knowledge in the area and the interest of new studies, considering that few interdisciplinary projects with their respective heads have investigated inflammatory food consumption in adolescents. Thus, it is encouraged to invest in low-cost longitudinal intervention models to improve the quality of life of the young population through physical exercises and good choices for a healthy diet, reaching more and more adolescents who need a health promotion program. Finally, new studies with probabilistic samples, other age groups, and a control group could be relevant to driving assertive actions in health nutrition and health promotion.

REFERENCES

1. de Souza Marques DC, Moraes LRS, Marques MGS, Ryal JJ, Santos IC, Lalucci MPPS, et al. Effects of 12 Weeks of Family and Individual Multi-Disciplinary Intervention in Overweight and Obese Adolescents under Cardiometabolic Risk Parameters: A Clinical Trial. *Int J Environ Res Saúde Pública*.2023; 20(20):6954. <https://doi.org/10.3390/ijerph20206954>
2. Ministério da Saúde (BR). Secretaria de Atenção Primária à Saúde. Departamento de Promoção da Saúde. PROTEJA: Estratégia Nacional para Prevenção e Atenção à Obesidade Infantil: orientações técnicas [recurso eletrônico]. [Brasília]: Ministério da Saúde(BR); 2022; 1:1-41.

3. Ministry of Health. Food and Nutritional Surveillance System [Internet]. Nutritional Status Report 2021 [access on June 20, 2021]. Available from: <https://sisaps.saude.gov.br/sisvan/relatorio-publico/index>
4. Dettlaff-Dunowska M, Brzeziński M, Zagierska A, Borkowska A, Zagierski M, Szlagatys-Sidorkiewicz A. Changes in Body Composition and Physical Performance in Children with Excessive Body Weight Participating in an Integrated Weight-Loss Programme. *Nutrients*. 2022; 14(17):3647. doi: 10.3390/nu14173647.
5. Neves SC, Rodrigues LM, São Bento PAS, Minayo MCS. Os fatores de risco envolvidos na obesidade no adolescente: uma revisão integrativa. *Ciênc. saúde coletiva*. 2021; 26(3):4871-4884.
6. Kotemori A, Sawada N, Iwasaki M, Yamaji T, Shivappa N, Hebert JR, et al. Dietary Inflammatory Index Is Associated With Inflammation in Japanese Men. *Front Nutr*. 2021; 8:604296. doi: 10.3389/fnut.2021.604296
7. Mendes FC, Paciência I, Cavaleiro RJ, Farraia M, Silva D, Padrão P, et al. Higher Diversity of Vegetable Consumption Is Associated With Less Airway Inflammation and Prevalence of Asthma in School-Aged Children. *Pediatr Allergy Immunol*. 2021; 32:925–36. doi: 10.1111/pai.13446
8. Cavicchini PP, Steck SE, Hurley TG, Hussey JR, Ma Y, Ockene IS, et al. A new dietary inflammatory index predicts interval changes in high-sensitivity c-reactive protein. *J. Nutr*. 2009; 139:2365–2372.
9. Shivappa N, Steck SE, Hurley TG, Hussey JR, Hébert JR. Designing and Developing a Literature-Derived, Population-Based Dietary Inflammatory Index. *Publ Health Nutr*. 2014; 17:1689–1696. doi: 10.1017/S1368980013002115
10. Shivappa N, Hebert JR, Rietzschel ER, De Buyzere ML, Langlois M, Debruyne E, et al. Associations Between Dietary Inflammatory Index and Inflammatory Markers in the Asklepios Study. *Br J Nutr*. 2015; 113:665–671. doi: 10.1017/S000711451400395X
11. Branco BHM, Mariano IR, Oliveira LP, Bertolini SMMG, De Oliveira FM, Araújo CGA, et al. Sports and Functional Training Improve a Subset of Obesity-Related Health Parameters in Adolescents: a randomized controlled trial. *Front Psychol*. 2020; 11:1–15.
12. Grzymisławska M, Puch EA, Zawada A, Grzymisłowski M. Do nutritional behaviors depend on biological sex and cultural gender? *Adv. Clin. Exp. Med*. 2020; 26:165–172.
13. Suhett LG, Hermsdorff HHM, Cota BC, Ribeiro SAV, Shivappa N, Hébert R, et al. Dietary inflammatory potential, cardiometabolic risk and inflammation in children and adolescents: a systematic review. *Crit Rev Food Sci Nutr*. 2021; 61(3):407–416. doi: 10.1080/10408398.2020.1734911.
14. BRASIL. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Orientações para a coleta e análise de dados antropométricos em serviços de saúde: Norma Técnica do Sistema de Vigilância Alimentar e Nutricional - SISVAN / Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Atenção Básica. Brasília: Ministério da Saúde, 2011. 76 p.: il. – (Série G. Estatística e Informação em Saúde).
15. Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmanna J. Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization*. 2007; 85 (9):660-667.
16. Tabela Brasileira de Composição de Alimentos (TBCA). Tabelas Complementares – Flavonoides. Universidade de São Paulo (USP). Food Research Center (FoRC). Versão 7.0. São Paulo, 2019. [access on Feb 05, 2023]. Available from: <http://www.fcf.usp.br/tbca/>
17. Neveu V, Perez-Jiménez J, Vos F, Crespy V, Du Chaffaut L, Mennen L, et al. Phenol-Explorer: an online comprehensive database on polyphenol contents in foods. *Database*. 2010; 2010:1-9.
18. Pereira NO, Abreu-de-Carvalho C, Sperandio N, Marques KDS, Viola PC de AF, Shivappa N, et al. Factors Associated with the Inflammatory Potential of the Brazilian Population's Diet. *Br J Nutr*. 2021; 126(2):285–94. doi:10.1017/S0007114520004079.
19. Wharton S, Lau DCW, Vallis M, Sharma AM, Biertho L, Campbell-Scherer D, et al. Obesity in adults: A practice guideline. *CMAJ*. 2020; 192(31):875–891.
20. Flieh S, Gil EG, Miguel-Berges ML, Aznar LAM. Food portion sizes, obesity, and related metabolic complications in children and adolescents. *Nutr Hosp* 2021; 38:169–76.
21. Malik VS, Hu FB. Sugar-sweetened beverages and cardiometabolic health: An update of the evidence. *Nutrients*. 2019; 11(8):1840.
22. Moon J, Koh G. Clinical Evidence and Mechanisms of High-Protein Diet-Induced Weight Loss. *J. Obes. Metab. Syndr*. 2020; 29:166–173. [access Mar 31, 2024]. Available from: <https://doi=10.7570/jomes20028>
23. Izar MCO, Lottenberg AM, Giraldez VZR, Santos Filho RDS, Machado RM, Bertolami A, et al. Posicionamento sobre o Consumo de Gorduras e Saúde Cardiovascular. *Arq Bras Cardiol*. 2021; 116(1):160-212.
24. Flieh S, Gil EG, Miguel-Berges M, Aznar LAM. Food portion sizes, obesity, and related metabolic complications in children and adolescents. *Nutr Hosp* 2021; 38:169–76
25. Almeida-de-Souza J, Santos R, Barros R, Abreu S, Moreira C, Lopes L, et al. Dietary inflammatory index and inflammatory biomarkers in adolescents from LabMed physical activity study. *Eur J Clin Nutr*. 2018; 72(5):710–719. doi: 10.1038/s41430-017-0013-x.
26. Borges CA, Marchioni DML, Levy RB, Slater B. Dietary patterns associated with overweight among Brazilian adolescents. *Appetite*. 2018; 1(123):402–409.
27. Pepe RB, Lottenberg AMP, Fujiwara CTH, Beyruti M, Cintra DEC, Machado RM, et al. Position statement on nutrition therapy for overweight and obesity: nutrition department of the Brazilian association for the study of obesity and metabolic syndrome (ABESO-2022). *Diabetol Metab Syndr*. 2023; 15(1):124.

Cambios en el índice de masa corporal según estado de madurez en adolescentes de una región de Chile durante un periodo de 20 años

Changes in body mass index according to maturity status in adolescents from a region of Chile during a 20-year period

Fernando ALVEAR-VÁSQUEZ¹, José Francisco GUZMÁN-LUJAN¹, Ana Belén GUZMÁN², José FUENTES-LÓPEZ³, Nicolás VIDAL-FERNÁNDEZ², Rossana GÓMEZ-CAMPOS², Marco COSSIO-BOLAÑOS²

1 Universidad de Valencia, Valencia, España.

2 Universidad Católica del Maule, Talca, Chile.

3 Universidad Nacional del Altiplano, Puno, Perú.

Recibido: 1/mayo/2024. Aceptado: 28/julio/2024.

RESUMEN

Introducción: Los índices antropométricos son herramientas esenciales en la evaluación del estado de salud y pueden ser útiles para analizar los cambios a lo largo del tiempo.

Objetivo: Determinar si existen cambios significativos en el índice de masa corporal (IMC) según el estado de madurez (EM) en adolescentes en un intervalo de 20 años.

Metodología: Se diseñó un estudio de cohorte en escolares de 11,0 a 17,0 años. La muestra estuvo compuesta de dos cohortes correspondientes al año 1997 y 2017. La selección de la muestra fue de tipo probabilística (aleatoria), para la cohorte de 1997 se seleccionó 939 adolescentes y para el 2017 fueron 1026 adolescentes. Se evaluó el peso y estatura. Se calculó el IMC y EM a partir de variables antropométricas.

Resultados: Los adolescentes de ambos sexos de la cohorte 2017 evidenciaron mayor IMC en relación a sus contrapartes de 1997. No hubo diferencias significativas en el EM entre ambas cohortes. La correlación entre el IMC y el EM en hombres aumentó de $r = 0,25$ ($r^2 = 0,062$) a $r = 0,27$

($r^2 = 0,067$) en 20 años, mientras tanto, en mujeres fue de $r = 0,19$ ($r^2 = 0,036$) a $r = 0,26$ ($r^2 = 0,070$). Esto refleja incrementos del IMC en ambos sexos, aunque ligeramente más en mujeres que en hombres.

Conclusión: Este estudio verificó un aumento significativo en el IMC en todos los EM a lo largo de un período de 20 años, con un incremento mayor en mujeres que en hombres. Estos hallazgos resaltan la urgencia de intervenir a esta población para abordar el problema del sobrepeso y la obesidad.

PALABRAS CLAVE

Tendencia, condición nutricional, madurez biológica, crecimiento.

ABSTRACT

Introduction: Anthropometric indices are essential tools in the assessment of health status and can be useful to analyze changes over time.

Objective: To determine if there are significant changes in body mass index (BMI) according to maturity status (MS) in adolescents over a 30-year interval.

Methodology: A cohort study was designed in schoolchildren aged 11.0 to 17.0 years. The sample was composed of two cohorts corresponding to the year 1997 and 2017. The sample selection was probabilistic (random), for the 1997 co-

Correspondencia:
Marco Cossio Bolaños
mcossio1972@hotmail.com

hort 939 adolescents were selected and for 2017 there were 1026 adolescents. Weight and height were assessed. BMI and MS were calculated from anthropometric variables.

Results: Adolescents of both sexes in the 2017 cohort evidenced higher BMI relative to their 1997 counterparts. There were no significant differences in MS between the two cohorts. The correlation between BMI and MS in males increased from $r = 0.25$ ($r^2 = 0.062$) to $r = 0.27$ ($r^2 = 0.067$) over 20 years, while in females it was from $r = 0.19$ ($r^2 = 0.036$) to $r = 0.26$ ($r^2 = 0.070$). This reflects increases in BMI in both sexes, although slightly more in females than in males.

Conclusion: This study verified a significant increase in BMI in all MS over a 20-year period, with a greater increase in women than in males. These findings highlight the urgency of intervening in this population to address the problem of overweight and obesity.

KEY WORDS

Trend, nutritional condition, biological maturity, growth.

INTRODUCCIÓN

La antropometría implica la medición externa de los rasgos morfológicos de los seres humanos¹. Esta técnica proporciona importantes indicadores de crecimiento físico, estado nutricional², así como la predicción del estado de madurez a partir de un método práctico y no invasivo que predice años a partir de la velocidad máxima de altura (un valor de compensación de madurez) mediante el uso de variables antropométricas^{3,4}.

En general, las mediciones antropométricas permiten reflejar el estado general de salud, la adecuación de la dieta, la monitorización del del crecimiento y el desarrollo a lo largo del tiempo⁵. Por el ello, el uso de indicadores antropométricos clásicamente ha sido la piedra angular de la vigilancia nutricional en niños, adolescentes y adultos, aunque, siempre ha sido un tema de debate⁶.

Por ello, las mediciones antropométricas clásicas, como la altura y el peso corporal, se utilizan ampliamente como componentes de medida de la forma corporal⁷. De hecho, la medición del peso y la estatura es una práctica común y fundamental en el ámbito de la salud pública, la pediatría y la nutrición clínica, especialmente en adolescentes⁸.

La combinación de estas dos medidas se refleja en índices antropométricos, como el índice de masa corporal (IMC) o el índice tri-ponderal (ITP), cuyas, medidas sirven para evaluar la adiposidad corporal en los distintos grupos de edad⁹.

En general, los índices antropométricos, como el IMC y el ITP, son herramientas esenciales en la evaluación del estado del peso y el tamaño corporal en personas de todas las edades. Estas medidas proporcionan una forma cuantitativa de

evaluar el estado de salud y pueden ser útiles para analizar los cambios a lo largo del tiempo.

El IMC, al relacionar el peso con la estatura, proporciona una categorización general del estado ponderal de una persona y se utiliza ampliamente como herramienta de detección para identificar posibles problemas de peso, como el sobrepeso y la obesidad¹⁰. El ITP, por su parte, ofrece una alternativa al IMC y se ha sugerido que puede ser más preciso en la evaluación de la adiposidad corporal y riesgo metabólico en ciertos grupos, como los niños y adolescentes^{11,12}.

En esencia, es alentador saber que se han realizado varios estudios en diferentes regiones geográficas del mundo para investigar los cambios seculares del tamaño corporal e índices antropométricos en niños y adolescentes. Estos estudios son de gran importancia ya que proporcionan información valiosa sobre las tendencias en el crecimiento y desarrollo físico de la población juvenil a lo largo del tiempo¹³⁻¹⁶, sin embargo, hasta donde se sabe son nulos los estudios que analicen estos patrones según el estado de madurez. Por lo que se necesita información sobre estas tendencias para analizar los cambios positivos o negativos que se han producido, bajo este contexto entre los años 1997 y 2017 en Chile. Además, algunos estudios efectuados en Chile, en los últimos años han reportado una transición nutricional extremadamente rápida¹⁷⁻¹⁹ y consecuentemente, elevadas prevalencias de obesidad²⁰.

Dada esta situación, es razonable esperar que los adolescentes evaluados en 2017 muestren un mayor IMC en comparación con los evaluados en 1997. Estas diferencias podrían reflejar tanto los cambios en los patrones de alimentación y estilo de vida como las políticas de salud pública implementadas a lo largo del tiempo.

Por lo tanto, el objetivo del estudio fue determinar si existen cambios significativos en el IMC según el estado de madurez en adolescentes de una región del centro-sur de Chile en un intervalo de 20 años. Esta información podría ayudar a comprender mejor la evolución de la salud y el estado del peso corporal en una población regional de Chile.

METODOLOGÍA

Tipo de estudio y muestra

Se diseñó un estudio de cohorte en adolescentes escolares de ambos sexos con edades entre los 11,0 a 17,0 años. La muestra estuvo compuesta de dos cohortes correspondientes al año 1997 y 2017. Los participantes (ambas cohortes) pertenecían a establecimientos educacionales de cuatro provincias de la región del Maule ubicada en el centro-sur de Chile. (Cauquenes, Curicó, Linares y Talca). Los datos fueron recolectados por el mismo grupo de investigación.

La selección de la muestra fue de tipo probabilística (aleatoria) para las dos cohortes (1997 y 2017). Para la cohorte

1997 el universo fue de 9000 adolescentes (4530 hombres y 4470 mujeres), se seleccionaron 939 adolescentes (10,4%) [471 hombres (5,2%) y 468 mujeres (5,2%)]. Para la cohorte 2017, el universo fue de 9900 adolescentes (5370 hombres y 4530 mujeres), se seleccionaron 1026 adolescentes (10,4%) [555 hombres (5,6%) y 471 mujeres (4,8%)].

Los participantes de ambas cohortes del estudio en general eran escolares pertenecientes a colegios públicos y de zonas urbanas de la región. En Chile generalmente los escolares de colegios públicos pertenecen a una condición socioeconómica media²¹.

Todos los adolescentes contaban con consentimiento informado firmado por sus padres y/o tutores correspondientes en ambas cohortes, del mismo modo, cada uno de los participantes dieron su consentimiento por escrito. También se contó con la aprobación del Comité de Ética de la Universidad Autónoma de Chile (certificado # 2413) para la cohorte 2017, no hubo registro al respecto para la cohorte de 1997. Ambas cohortes fueron evaluadas de acuerdo a la Declaración de Helsinki para seres Humanos²².

Se incluyeron en el estudio a todos los adolescentes escolares cuyos padres autorizaron la participación voluntaria en el mismo y a los adolescentes que estaban dentro del rango de edad establecido (11 y 17 años). Se excluyeron a quienes vivían en zonas rurales de la región y a los que presentaban algún tipo de impedimento físico que dificultara la evaluación antropométrica.

Técnicas y procedimientos

La edad decimal se calculó con la fecha de nacimiento (día, mes, año) y la fecha en que se tomaron las evaluaciones. Las mediciones antropométricas se evaluaron siguiendo las recomendaciones de Ross & Marfell-Jones²³. El peso corporal y la estatura se midieron con la menor cantidad de ropa posible (pantalón corto, camiseta y sin zapatos). El peso (kg) se evaluó con una balanza digital de marca Seca con precisión de (100g) y una escala de (0 a 150kg). La estatura (m) se evaluó de acuerdo al plano de Frankfort a través de un estadiómetro de aluminio de marca Seca graduado en milímetros con una escala de (0 a 2,50m). Se calculó el Índice de Masa Corporal (kg/m^2) a través de la fórmula: $[\text{IMC}=\text{Peso}(\text{kg})/\text{Estatura}(\text{m})^2]$.

El estado de madurez (EM) se evaluó a través de las ecuaciones propuestas por Moore et al.⁴ para ambos sexos. Las ecuaciones consideran, por ejemplo, la edad cronológica y estatura de pie para su estimación para ambos sexos (Mujeres: Estado de madurez (APVC) = $-7,709133 + (0,0042232 \times (\text{edad} \times \text{estatura}))$ y para hombres: Estado de madurez (APVC) = $7,999994 + (0,0036124 \times (\text{edad} \times \text{estatura}))$), donde APVC: años de pico de velocidad de crecimiento). Para clasificar el EM, se utilizó la sugerencia descrita por Malina y Koziel²⁴, considerando a los adolescentes con maduración promedio

(Púber) dentro de -1 a $+1$ APVC; inferiores a -1 APVC (Pre púber); y superiores a $+1$ APVC (Post púber).

Estadística

La distribución normal de los datos del peso y estatura de ambas cohortes se verificó mediante la prueba de Kolmogorov-Smirnov. Se efectuó los cálculos de estadística descriptiva: promedio, desviación estándar, frecuencias, porcentajes y rango. Las diferencias entre ambas cohortes se efectuaron mediante test t para muestras independientes. Para relacionar las variables en cada cohorte se utilizó el coeficiente de Pearson y para el poder de explicación se utilizó R^2 . Para todos los casos, se adoptó $p < 0,05$ y los cálculos se efectuaron en planillas de Excel, SPSS 18.0 y en MedCalc 11.1.0.

RESULTADOS

En la tabla 1 se observa las variables antropométricas y los niveles del estado de madurez en adolescentes de ambos sexos. No hubo diferencias significativas en la edad cronológica y estatura entre ambas cohortes y en ambos sexos ($p > 0,05$). El estado de madurez se mantuvo estable en ambas cohortes y en ambos sexos, no hubo diferencias significativas ($p > 0,05$). En cuanto al peso y el IMC, si hubo diferencias significativas en ambas cohortes, donde los adolescentes de ambos sexos evidenciaron mayor peso e IMC en el año 2017 ($p < 0,05$).

Las comparaciones del IMC según niveles del estado de madurez se observan en la figura 1. Los adolescentes de ambos sexos de la cohorte 1997, reflejan valores significativamente inferiores de IMC en comparación con la cohorte 2017 ($p < 0,05$). En la figura 2, se observa la relación entre el estado de madurez con los valores del IMC de ambas cohortes y ambos sexos. La correlación entre el IMC y el estado de madurez en hombres aumentó de $r = 0,25$ ($r^2 = 0,062$) a $r = 0,27$ ($r^2 = 0,067$) en 20 años, mientras tanto, en mujeres fue de $r = 0,19$ ($r^2 = 0,036$) a $r = 0,26$ ($r^2 = 0,070$). Esto refleja incrementos del IMC en ambos sexos, aunque ligeramente más en mujeres que en hombres.

DISCUSIÓN

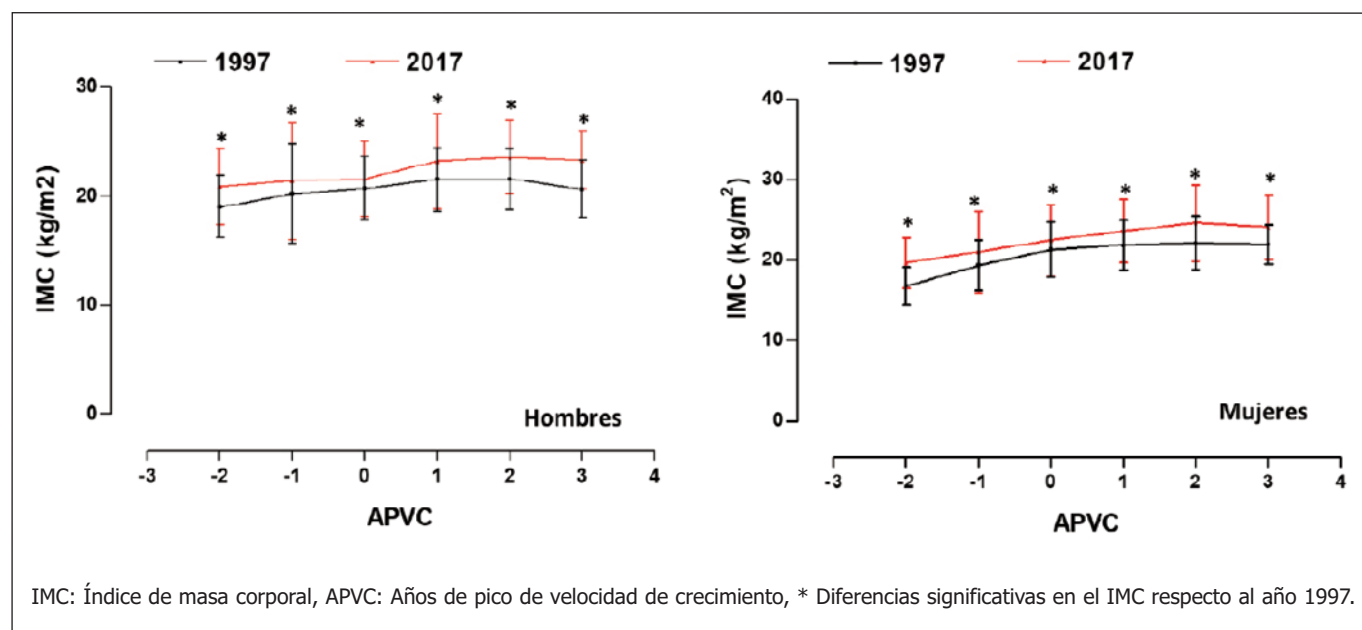
Este estudio tuvo como objetivo determinar si existe cambios significativos en el IMC según el estado de madurez en adolescentes de una región de Chile. Los resultados indican que hubo cambios significativos en el IMC en todos los APVC (estados de madurez) y en ambos sexos en la población regional de Chile durante un período de 20 años.

Este hallazgo refleja tendencias globales en el aumento del peso corporal. Pues varios estudios a nivel internacional han evidenciado incrementos significativos a lo largo de diferentes períodos de tiempo^{25,26}, incluso, en los últimos años, algunos

Tabla 1. Características antropométricas y estado de madurez de adolescentes chilenos de 1997 y 2017

Variables	Hombres							Mujeres						
	1997			2017			p-valor	1997			2017			p-valor
	n	Media	DE	n	Media	DE		n	Media	DE	n	Media	DE	
Edad (años)		14,1	2,0		14,0	2,1	0,320		13,9	2,0		13,9	2,2	0,560
Antropometría														
Peso (kg)		55,1	12,4		60,0	15	0,001		52,3	9,8		57,2	13,0	0,001
Estatura (cm)		162,1	12,2		163,7	12	0,050		155,4	7,5		155,9	7,8	0,250
IMC (kg/m ²)		20,8	3,2		22,2	4,1	0,001		21,6	3,2		23,4	4,5	0,001
E. Madurez														
Pre púber (APVC)	119	-2,0	0,6	141	-1,9	0,6	0,182	36	-1,4	0,4	44	-1,6	0,3	0,260
Púber (APVC)	153	0,2	0,6	190	0,1	0,6	0,126	149	0,1	0,6	141	0,1	0,5	>0,99
Post púber (APVC)	199	1,9	0,6	224	2,0	0,6	0,078	283	2,5	0,8	286	2,6	0,9	0,162

DE: Desviación estándar, E: Estado, IMC: Índice de masa corporal, APVC: años de pico de velocidad de crecimiento.

**Figura 1.** Comparación del IMC en dos cohortes (1997 y 2017) según estado de madurez (APVC) en adolescentes de ambos sexos

estudios efectuados en Chile han reportado incrementos positivos del IMC y la adiposidad corporal²⁷⁻²⁹.

Este aumento en el IMC puede atribuirse a una serie de factores, como cambios en la alimentación y la nutrición, aumento del sedentarismo, fácil acceso a los alimentos procesados y al-

tos en calorías, mejoramiento del nivel socioeconómico, del estilo de vida y las opciones de salud de la población³⁰⁻³².

Un IMC elevado es un factor de riesgo de enfermedades no transmisibles como la diabetes, las enfermedades cardiovasculares y los trastornos musculoesqueléticos, lo que re-

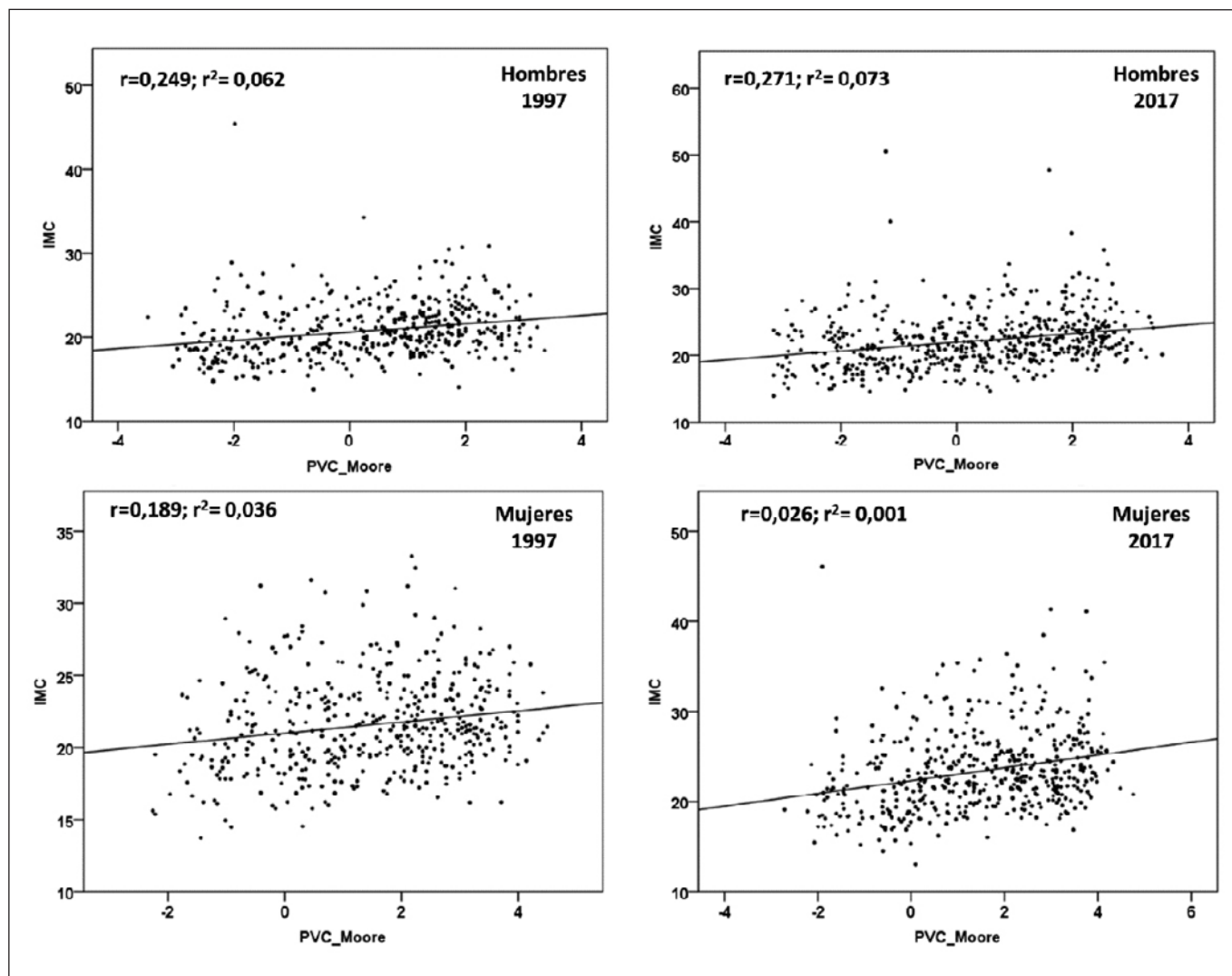


Figura 2. Relación entre los valores del IMC con el estado de madurez (APVC) en adolescentes de ambos sexos

sulta en una disminución dramática de la calidad y la esperanza de vida³³.

Por ello, es necesario fomentar una alimentación equilibrada y la práctica regular de ejercicio físico, así como la educación sobre la importancia del mantenimiento de un peso corporal adecuado desde la adolescencia³⁴.

De hecho, en un país como Chile, donde el aumento de la prevalencia de sobrepeso en niños y adolescentes es casi el 40% y de obesidad alrededor del 31%^{35,19} es plausible que el IMC haya aumentado en los últimos 20 años.

También cabe resaltar que, en Chile en las últimas décadas, se han producido cambios importantes en las condiciones socioeconómicas de la población, por lo que el crecimiento económico, la urbanización y la globalización han modificado profundamente el modo de vivir de los chilenos³⁶. Estos cambios pueden haber contribuido a las tendencias observadas en

este estudio, por lo que es necesario desarrollar estrategias de salud pública que aborden los determinantes sociales de la salud y promuevan entornos que favorezcan estilos de vida saludables para los adolescentes.

En general, el aumento del sobrepeso y la obesidad en niños y adolescentes es un problema de salud pública importante que puede tener consecuencias a largo plazo para la salud de la población. Estas tendencias están causando graves problemas de salud pública y en muchos países amenazan la viabilidad de la prestación de atención sanitaria básica³⁷, aumenta también el riesgo de enfermedades crónicas como la diabetes tipo 2, enfermedades cardíacas y ciertos tipos de cáncer³⁸.

Estas enfermedades pueden requerir tratamientos prolongados y costosos, y pueden tener un impacto negativo en la calidad de vida de los adolescentes estudiados. Esto implica no solo tratar las enfermedades una vez que se desarrollan,

sino también implementar estrategias de prevención que promuevan estilos de vida saludables y opciones de salud positivas desde edades tempranas.

El estudio presenta algunas limitaciones que tienen que ver con las medidas antropométricas recolectadas en las dos cohortes. Por ejemplo, no fue posible evaluar medidas de adiposidad corporal como pliegues cutáneos y circunferencia del abdomen, además, no fue posible recolectar información sobre los niveles de actividad física. Esta información hubiera contribuido en discutir mejor los hallazgos de este estudio. Por ello, es necesario que futuros estudios incluyan en sus diseños estas variables. También el estudio presenta algunas fortalezas, estas tienen que ver que es un estudio que abarca la región central de Chile, presenta un tamaño de muestra grande y la selección de la muestra fue probabilística en ambas cohortes.

CONCLUSIONES

Este estudio verificó un aumento significativo en el IMC en todos los estados de madurez en adolescentes a lo largo de un período de 20 años, con un incremento mayor en mujeres que en hombres. Estos hallazgos resaltan la urgencia de intervenir a esta población de adolescentes para abordar el problema del sobrepeso y la obesidad. Se sugiere que, en el corto plazo, es necesario implementar medidas concretas y específicas para enfrentar este desafío de salud pública como programas de actividad física, así como intervenciones relacionadas con la dieta, la educación y el apoyo psicológico para lograr resultados óptimos en la salud y el bienestar de los adolescentes.

AGRADECIMIENTOS

Los autores agradecen a ANID-PFCHA/Doctorado Becas Chile/2020- folio 72210418, por la beca otorgada a Fernando Alvear.

REFERENCIAS

1. Ulijaszek SJ, Kerr DA. Anthropometric measurement error and the assessment of nutritional status. *British Journal of Nutrition*. 1999;82(3):165-77. doi:10.1017/S0007114599001348
2. Gibson, Rosalind S. Principles of nutritional assessment. Oxford university press, USA, 2005.
3. Mirwald RL, Baxter-Jones AD, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements. *Med Sci Sports Exerc*. 2002;34(4):689-694. doi:10.1097/00005768-200204000-00020
4. Moore SA, McKay HA, Macdonald H, et al. Enhancing a Somatic Maturity Prediction Model. *Med Sci Sports Exerc*. 2015;47(8):1755-1764. doi:10.1249/MSS.0000000000000588
5. Fryar CD, Gu Q, Ogden CL, Flegal KM. Anthropometric Reference Data for Children and Adults: United States, 2011-2014. *Vital Health Stat 3 Anal Stud*. 2016;(39):1-46.
6. Lelijveld N, Benedict RK, Wrottesley SV, et al. Towards standardised and valid anthropometric indicators of nutritional status in middle childhood and adolescence. *Lancet Child Adolesc Health*. 2022;6(10):738-746. doi:10.1016/S2352-4642(22)00196-1
7. Hwaung P, Heo M, Kennedy S, et al. Optimum waist circumference-height indices for evaluating adult adiposity: An analytic review. *Obes Rev*. 2020;21(1):e12947. doi:10.1111/obr.12947
8. Madden AM, Smith S. Body composition and morphological assessment of nutritional status in adults: a review of anthropometric variables. *J Hum Nutr Diet*. 2016;29(1):7-25. doi:10.1111/jhn.12278
9. Khoshhali M, Heidari-Beni M, Qorbani M, et al. Tri-ponderal mass index and body mass index in prediction of pediatric metabolic syndrome: the CASPIAN-V study. *Arch Endocrinol Metab*. 2020;64(2):171-178. doi:10.20945/2359-399700000206
10. Khanna D, Peltzer C, Kahar P, Parmar MS. Body Mass Index (BMI): A Screening Tool Analysis. *Cureus*. 2022;14(2):e22119. Published 2022 Feb 11. doi:10.7759/cureus.22119
11. Peterson CM, Su H, Thomas DM, et al. Tri-Ponderal Mass Index vs Body Mass Index in Estimating Body Fat During Adolescence. *JAMA Pediatr*. 2017;171(7):629-636. doi:10.1001/jamapediatrics.2017.0460
12. Wang X, Dong B, Ma J, Song Y, Zou Z, Arnold L. Role of tri-ponderal mass index in cardio-metabolic risk assessment in children and adolescents: compared with body mass index. *Int J Obes (Lond)*. 2020;44(4):886-894. doi:10.1038/s41366-019-0416-y
13. Freedman DS, Srinivasan SR, Valdez RA, Williamson DF, Berenson GS. Secular increases in relative weight and adiposity among children over two decades: the Bogalusa Heart Study. *Pediatrics*. 1997;99(3):420-426. doi:10.1542/peds.99.3.420
14. Kimm SY, Barton BA, Obarzanek E, et al. Racial divergence in adiposity during adolescence: The NHLBI Growth and Health Study. *Pediatrics*. 2001;107(3):E34. doi:10.1542/peds.107.3.e34
15. Nagel G, Wabitsch M, Galm C, et al. Secular changes of anthropometric measures for the past 30 years in South-West Germany. *Eur J Clin Nutr*. 2009;63(12):1440-1443. doi:10.1038/ejcn.2009.86
16. Guimarey LM, Castro LE, Torres MF, et al. Secular changes in body size and body composition in schoolchildren from La Plata City (Argentina). *Anthropol Anz*. 2014;71(3):287-301. doi:10.1127/0003-5548/2014/0364
17. Albala C, Vio F, Kain J, Uauy R. Nutrition transition in Latin America: the case of Chile. *Nutr Rev*. 2001;59(6):170-176. doi:10.1111/j.1753-4887.2001.tb07008.x
18. Vio F, Albala C, Kain J. Nutrition transition in Chile revisited: mid-term evaluation of obesity goals for the period 2000-2010. *Public Health Nutr*. 2008;11(4):405-412. doi:10.1017/S136898000700050X
19. Mujica-Coopman MF, Navarro-Rosenblatt D, López-Arana S, Corvalán C. Nutrition status in adult Chilean population: economic, ethnic and sex inequalities in a post-transitional country. *Public Health Nutr*. 2020;23(S1):s39-s50. doi:10.1017/S1368980019004439

20. GBD 2015 Obesity Collaborators, Afshin A, Forouzanfar MH, et al. Health Effects of Overweight and Obesity in 195 Countries over 25 Years. *N Engl J Med*. 2017;377(1):13-27. doi:10.1056/NEJMoa1614362
21. Cossio-Bolaños M, Vasquez P, Luarte-Rocha C, Sulla-Torres J, Gómez Campos R. Assessment of self-perception of physical fitness and proposal for standards among Chilean adolescent students: the EAPAF study. Evaluación de la autopercepción de la aptitud física y propuesta de normativas en adolescentes escolares chilenos: estudio EAPAF. *Arch Argent Pediatr*. 2016;114(4):319-328. doi:10.5546/aap.2016.eng.319
22. Asociación Médica Mundial. Declaración de Helsinki de la AMM - Principios éticos para las investigaciones médicas en seres humanos. 48ª Asamblea General, Somerset West, Sudáfrica. 1996. Disponible en: https://www.wma.net/wp-content/uploads/2024/05/DoH-Oct_1996_S.pdf
23. Ross WD, Marfell-Jones MJ. Kinanthropometry. In J. D. MacDougall, H. A. Wenger, & H. J. Geeny (Eds.), *Physiological testing of elite athlete*. Human Kinetics. 1991; 223:308-314.
24. Malina RM, Kozielec SM. Validation of maturity offset in a longitudinal sample of Polish boys. *J Sports Sci*. 2014;32(5):424-437. doi:10.1080/02640414.2013.828850
25. Patalay P, Gage SH. Changes in millennial adolescent mental health and health-related behaviours over 10 years: a population cohort comparison study. *Int J Epidemiol*. 2019;48(5):1650-1664. doi:10.1093/ije/dyz006
26. Blundell E, De Stavola BL, Kellock MD, et al. Longitudinal pathways between childhood BMI, body dissatisfaction, and adolescent depression: an observational study using the UK Millenium Cohort Study [published correction appears in *Lancet Psychiatry*. 2024 Feb;11(2):e3]. *Lancet Psychiatry*. 2024;11(1):47-55. doi:10.1016/S2215-0366(23)00365-6
27. Gatica-Mandiola P, Vargas-Vitoria R, Jirón Amaro O, et al. Cambios en la adiposidad corporal de adolescentes escolares (1997-2007). *Nutrición Clínica y Dietética Hospitalaria*. 2013; 33(3):23-29. doi:10.12873/333bodyfat
28. Herrera JC, Lira M, Kain J. Vulnerabilidad socioeconómica y obesidad en escolares chilenos de primero básico: comparación entre los años 2009 y 2013. *Revista chilena de Pediatría*. 2017;88(6):736-743. doi:http://dx.doi.org/10.4067/S0370-41062017000600736
29. East P, Delker E, Blanco E, et al. BMI Trajectories from Birth to 23 Years by Cardiometabolic Risks in Young Adulthood. *Obesity (Silver Spring)*. 2020;28(4):813-821. doi:10.1002/oby.22754
30. Agrawal P, Gupta K, Mishra V, Agrawal S. Effects of sedentary lifestyle and dietary habits on body mass index change among adult women in India: findings from a follow-up study. *Ecol Food Nutr*. 2013;52(5):387-406. doi:10.1080/03670244.2012.719346
31. Fox A, Feng W, Asal V. What is driving global obesity trends? Globalization or "modernization"? *Global Health*. 2019;15(1):32. Published 2019 Apr 27. doi:10.1186/s12992-019-0457-y
32. Kerkadi A, Sadig AH, Bawadi H, et al. The Relationship between Lifestyle Factors and Obesity Indices among Adolescents in Qatar. *Int J Environ Res Public Health*. 2019;16(22):4428. Published 2019 Nov 13. doi:10.3390/ijerph16224428
33. Lin X, Li H. Obesity: Epidemiology, Pathophysiology, and Therapeutics. *Front Endocrinol (Lausanne)*. 2021;12:706978. Published 2021 Sep 6. doi:10.3389/fendo.2021.706978
34. Oukheda M, Bouaouda K, Mohtadi K, et al. Association between nutritional status, body composition, and fitness level of adolescents in physical education in Casablanca, Morocco. *Front Nutr*. 2023;10:1268369. Published 2023 Nov 7. doi:10.3389/fnut.2023.1268369
35. MINSAL (Ministerio de Salud, Gobierno de Chile). Encuesta Nacional de Salud de Chile 2016-2017. 2018. Recuperado de [http://inta.cl/wp-content/uploads/2018/01/ENS-2016-17_PRIME ROSRESULTADOS-1.pdf](http://inta.cl/wp-content/uploads/2018/01/ENS-2016-17_PRIME_ROSRESULTADOS-1.pdf)
36. Kain J, Uauy R, Lera L, Taibo M, Espejo F, Albala C. Evolución del estado del estado nutricional de escolares chilenos de 6 años (1987-2003) [Evolution of the nutritional status of six years old Chilean children (1987-2003)]. *Rev Med Chil*. 2005;133(9):1013-1020. doi:10.4067/s0034-98872005000900003
37. Raj M, Kumar RK. Obesity in children & adolescents. *Indian J Med Res*. 2010;132(5):598-607.
38. Scully T, Ettela A, LeRoith D, Gallagher EJ. Obesity, Type 2 Diabetes, and Cancer Risk. *Front Oncol*. 2021;10:615375. Published 2021 Feb 2. doi:10.3389/fonc.2020.615375

Physical and chemical properties of instant porridge with added moringa leaf flour

Zakaria ZAKARIA¹, Suriani RAUF¹, Sirajuddin SIRAJUDDIN¹, Andi SALIM², Bohari BOHARI³

1 Department of Nutrition, Poltekkes Kemenkes Makassar, Makassar, Indonesia.

2 Department of Nutrition, Poltekkes Kemenkes Mamuju, Mamuju, Indonesia.

3 Department of Nutrition, Universitas Sultan Ageng Tirtayasa, Serang, Indonesia.

Recibido: 30/junio/2024. Aceptado: 2/agosto/2024.

ABSTRACT

Background: Moringa leaves are rich in macro and micronutrients; it is expected to produce weaning food that meets nutritional needs. This study aimed to produce an instant porridge formula that meets the terms and conditions of weaning food, including physical characteristics and nutrient contents.

Methods: This study employed a completely randomized design experiment with three replications to evaluate the impact of moringa leaf flour (0, 5, 7.5, and 10 g/recipe) on infant weaning food prepared from soybeans and wheat. Soybean and moringa leaf flours were prepared following established protocols. Instant porridge production involved mixing, baking, drying, and grinding, followed by density and water absorption analysis using standard methods. Nutritional content was analyzed by a certified laboratory. Descriptive statistics and data visualization will be used to present the findings.

Results: Formula F1 (5 g) has a preference category above 88% of panelists who accepted it based on aspects of color, texture, aroma, and taste. The average density of instant porridge is 0.53 g/ml, and the water absorption capacity is 1.74 ml/g. The nutritional content per 100 g of energy is 471 Kcal, protein 19.7 g, total fat 19.7 g, linolenic fatty acid 464 mg, total carbohydrates 54.7 g, sucrose 21.24 g, water content 3.5 g, iron 44.6 g, and calcium 117.2 mg.

Correspondencia:

Zakaria Zakaria
zakaria.gizi.poltekkes@gmail.com

Conclusion: The instant porridge produced meets the essential physical characteristics required for infant weaning foods. Additionally, its nutritional profile, except for total fat, satisfies the energy and nutrient needs for infants aged 6-11 months.

KEYWORDS

Organoleptic Properties, Food Enrichment, Nutritional Composition, Fortification.

INTRODUCTION

Adequate food and nutrition intake is very important for the growth and development of infants and toddlers. Breast milk (in Indonesia: ASI) is the main source of nutrition for infants, but starting at six months, the nutrient content of breast milk is no longer sufficient, while the infants' energy needs increase by 24-30% compared to needs according to age. There are two types of weaning foods (in Indonesia: MP-ASI) in the community: homemade weaning foods and ready-to-eat (instant) weaning foods. The basic ingredients for making ready-to-eat weaning food usually come from instant flour, made from a mixture of rice or brown rice, green beans or soybeans, milk, sugar, and vegetable oil addition with vitamins and minerals, added with flavor and aroma. Requirements for the main nutritional composition in 100 g of this weaning food instant powder for infants aged 6-11 months, contains 400-440 calories of energy, 15-22 g of protein, 10-15 g of fat, carbohydrates (sucrose) maximum 30 g, and maximum fiber 5 g¹.

Grains such as rice and wheat are energy sources with relatively low protein content, so animal and vegetable food sources can supplement their nutritional content. Legumes have long been known as a source of protein and vitamins

complementary to grains. It has protein, including lysine, leucine, and isoleucine, but is limited in methionine and cysteine. Meanwhile, whole grains are high in methionine and cysteine but low in lysine². However, the anti-nutrient content of legumes causes poor digestion, preventing these nutrients from being properly absorbed. Anti-Nutrient compounds in legumes can be significantly reduced by microorganisms such as soybean tempeh, germination, and/or fermentation processes³.

Soybean tempeh has been widely used for formulations in research and food products to help overcome nutritional problems in toddlers, such as the lack of calories and protein, by combining wheat flour and other food sources. The tempeh formula was also listed as a local food for weaning food formula issued by the Ministry of Health of the Republic of Indonesia in 2002. A study found that a tempeh-based weaning formula provided no additional growth benefits for well-nourished infants aged 6-11 months compared to a non-tempeh formula⁴. This means that the tempeh formula has not provided maximum results for changes in nutritional status in children under five. For this reason, nutrient enrichment is still needed from other food sources that are rich in protein, minerals, and vitamins.

Local food ingredients from vegetable sources whose utilization is relatively low in enrichment in food additives such as tempeh formula are Moringa leaves. Moringa leaves are quite common in various areas, which only function as fences and landslide barriers and are only occasionally used as a source of vegetables when there are no other vegetables. Overseas, Moringa leaves have been used to treat nutritional problems in children and pregnant women, and the children show significant weight gain⁵. Adding 3-5 g of moringa leaf powder to food or drink for under-five children can trigger appetite⁶. Pregnant women given moringa leaf extract can increase hemoglobin levels¹⁰. Breastfeeding mothers who are given moringa leaf extract and powder can increase the volume of breast milk [Click or tap here to enter text](#)^{7,8}, and the nutritional status of infants at the age of 4 months is better⁹.

The nutritional composition of Moringa leaves, enriching it into instant complimentary food porridge, can enrich the nutritional composition needed by infants in growth and development, especially protein, essential amino acids, and micronutrients (vitamins and minerals). Tempe formula biscuit products with moringa leaf flour substitution increased protein, iron, and zinc along with the amount of moringa leaf flour added¹⁰. The researchers are interested in reformulating instant porridge using various cereal and legume formulas enriched with moringa leaf flour as weaning foods for infants aged 6-11 months. It is expected to obtain instant porridge with a balanced nutritional composition according to adequacy standards, meet physical characteristics, be safe for consumption, and be accepted by consumers.

The research problem is to determine the optimal level of enrichment of Moringa leaf flour in instant porridge for babies aged 6-11 months in order to achieve balanced nutritional content according to standards. This study aimed to determine the physical characteristics (density, water absorption) and macro-nutrient content of instant porridge enriched with moringa leaf flour.

METHOD

This research was an experiment using a one-factor of completely randomized design (CRD) with three replications. The treatment reformulation was addition moringa leaf flour 0 g, 5 g, 7.5 g, and 10 g per recipe. The fortification formulation of Moringa leaf flour in instant porridge as weaning food is shown in Table 1.

The materials used in this study consisted of the main materials and supporting materials. Soybeans were purchased from the Transmark Supermarket, and fresh young Moringa leaves were obtained from the Moringa garden in Maros under the guidance of CV. Brilliant Production. Other ingredients, such as full cream flour and powdered sugar, vegetable oil, wheat flour, mocaf flour, sugar, salt, baking powder, and ovalet. Materials for physical analysis included distilled water.

Table 1. The formula for Moringa leaf flour fortification and the composition of the basic ingredients for making instant porridge

Ingredients	Formula composition (g)			
	F0 (g)	F1(g)	F2 (g)	F3 (g)
Moringa Leaf Powder (TDK)	0	5	7,5	10
Wheat Flour (TTg)	20	20	20	20
Mocaf flour (TMc)	20	20	20	20
Soybean flour (TKK)	30	30	30	30
Full cream milk flour (TSFc)	10	10	10	10
Refined Sugar (GHS)	25	25	25	25
Egg	40	40	40	40
butter	10	10	10	10
Baking powder (BF)	1	1	1	1
ovalet	1	1	1	1
Salt	0.5	0.5	0.5	0.5
Total	157.5	162.5	165.0	167.5

Note: F0 = Formula without moringa flour; F1 = Addition formula 5 g/recipe; F2 = Addition Formula 7.5 g//recipe; F3 = Addition Formula 10 g/recipe.

Soybean flour was prepared by soaking for 12 hours. Moringa leaf powder was prepared according to the procedure by Zakaria (2012), which was modified by an oven temperature of 55 °C¹¹. The equipment used in the study consisted of drying cabinets, 80 mesh sieve. For analysis of physical properties and completeness of sensory analysis of acceptability, it used measuring cups, test tubes, centrifuges, vibrators.

Production of Moringa leaf flour and soybean flour, also analysis of physical characteristics, was carried out in the Food and Nutrition technology laboratory of the Makassar Polytechnic of Health by trained panelists. Making instant porridge successively prepared all the ingredients in powder and weighs each ingredient according to the formula dosage. Mixed and stirred until it became a smooth dough in a basin. The dough was formed as desired (thin rectangles) evenly on the baking sheet with a thickness of 0.5 cm. Bake in the oven at 180 °C until cooked \pm 20 minutes. Cut into small pieces for drying in the oven at 60 °C for approximately 8 hours. Mashed using a flour meal disk, sifted using 80 mesh size. Instant porridge was packaged using aluminum foil clamps 60 g/sachet.

Density was determined by putting the product material into a measuring cup until the volume reached 100 ml, then the material was weighed. The density of instant flour was expressed in g/ml. Modified water absorption analysis from Rauf and Sarbini (2015) was conducted by weighing 3 g of instant powder, putting it into the Sanites tube, adding 15 ml of distilled water, and then homogenizing using a vibrator until it was evenly dispersed¹². The tube was centrifuged at 200 rpm for 15 minutes. The supernatant obtained was poured into another container while the centrifuge tube and the residue were heated in the oven. The tube was placed in an oblique position (25°), and the oven was set at 50 °C for 25 minutes, and the final stage was the centrifuge tube which was weighed to determine the residual weight. Water absorption was determined by the equation of the weight of the tube plus residue after the oven minus the tube plus the initial sediment divided by the weight of the sample (ml/g).

Sensory Evaluation

The level of preference is analyzed by panelists based on the aspects of color, aroma, texture and taste. The panelists used were somewhat trained panelists who were selected from final year Nutrition Department students who had passed the Food Sensory Analysis course. The selected panelists must meet the requirements, including being willing to spend time willingly, not being sick (fever), and liking Moringa leaf vegetables. The assessment attributes according to the panelists' level of liking use a hedonic scale, namely: really like (4), like (3), don't like (2), really don't like (1) which the researcher then divides into two categories, namely like (scale 3 and 4) and Dislike (scale 1 and 2).

Data Analysis

The nutritional content examined was Energy (Kcal/100 g), Protein (c), Fat (g), Linoleic acid (mg), Total carbohydrates (g), Sucrose (g), Water (g), Iron (mg/ kg), Calcium (mg/kg) and analyzed at the Laboratory of PT. Sukopindo Center in Ciburung-Bekasi West Java (KAN (National Accreditation Committee) certified laboratory as the implementation of the duties and functions of the Indonesian National Standardization Agency (BSN). Methods and analysis procedures adapted to the methods that apply in the laboratory. Data were analyzed descriptively, then presented in tabular form accompanied by narration.

RESULTS

Physical Characteristics (Density and Water Absorption)

The average density in the instant porridge study with the addition of selected moringa leaf flour was 0.54 g/ml, and the water absorption capacity was 1.63 ml/g. The selected instant slurry formula has a 0.53 g/ml density and a water absorption capacity of 1.74 ml/g. The density and water absorption are presented in Table 2.

Table 2. Density and water absorption of Instant Porridge formula with addition Moringa leaf flour

Moringa leaf fortification	Density (g/ml)			Water absorption (ml/g)		
	U1	U2	Average	U1	U2	Average
F0 (0 g)	0.52	0.53	0.53	1.46	1.89	1.68
F1 (5 g)	0.55	0.51	0.53	1.69	1.78	1.74
F2 (7.5 g)	0.57	0.53	0.55	1.60	1.39	1.50
F3 (10 g)	0.55	0.52	0.54	1.91	1.27	1.60
Average			0.54			1.63

The nutritional content

The nutritional content of instant powder products with addition moringa leaf flour was selected presented in Table 3. Table 3. shows the macro and micronutrient content of instant porridge with addition moringa leaf flour 5 g, which was selected as weaning food for babies 6-11 months consecutively energy 471 Kcal/100 g, protein 19.7 g, fat 19.7 g, linoleic fatty acid 464 mg, total carbohydrates 54.7 g, sucrose 21.2 g, water content 3.5 g, iron 44.7 mg, and calcium 117.2 mg.

Table 3. Macro and micro - nutrient content of selected instant porridge with addition moringa leaf flour

Selected instant porridge		Standard in Indonesia
Parameter	Total	
Energy (Kcal/100g)	471	400-440
Protein (g)	19.7	15-22
Fat (g)	19.7	10-15
Linoleic acid (mg)	464	300
Carbohydrate total (g)	54.7	-
Sucrose (g)	21.2	Max 30
Water (g)	3.5	5
Iron (mg/kg)	44.6	5-8
Calcium (mg/kg)	117.2	200-400

Sensory Evaluation

Figure 1 shows that there is a tendency for panelists' acceptance of formula to increase in F0, namely the formula without the addition of Moringa leaf flour and F1 with the addition of 5 g Moringa leaf flour per standard recipe, namely above 88% of panelists accepted it from all aspects assessed, namely color, texture, aroma and taste.

DISCUSSION

Physical Characteristics (Density and Water Absorption)

Density is the weight of the material in a certain volume, including the air volume in the space between the materials (g/ml). Density is influenced by particle size, material properties, material composition, and degradation of molecules in the material due to processing¹³. The density of instant porridge for addition Moringa leaf flour is about 0.53 g/ml; the density of this instant porridge is

close to instant baby porridge produced between 0.543-0.588 g/ml¹⁴. The density is in the range of commercial instant porridge, generally 0.30-0.70¹⁵. Instant porridge with a low density below 0.30 is not recommended because it has a large volume but a low nutritional density. This is because it will impact the baby quickly feeling full while the nutritional intake is insufficient. The higher the density, the denser the product (concise).

The low water content is due to the large volume of water that evaporates during drying, resulting in the lower the water content that is formed, the smaller the volume of the flour grains so that the resulting density is greater¹⁶. Addition moringa flour instant slurry is around 3.52%, related to the resulting density. One of the characteristics of instant porridge is water absorption (rehydration). Water absorption is the ability of a material to absorb water. According to Farida SN, 2016¹⁷ good water absorption means that the rehydration time will be shorter so that the product absorbs water more quickly. The water absorption capacity of this selected instant powder is about 1.74 ml/g lower than the results of research by Farida SN, 2016; Premesta, 2014^{17,18}, which ranges from 3.60 to 6.20 ml/g. The ingredients used in making weaning food instant porridge are generally hygroscopic, such as wheat flour, mofaf flour, soybean flour, and milk flour. Fortification of moringa leaf flour does not affect water absorption because the composition is relatively small. Carbohydrate levels in the form of sugar, sucrose, and protein can increase water absorption¹⁸. Water absorption is related to the constituents' solubility and the material's composition.

The nutritional content

Requirements for the nutritional composition of instant porridge as weaning food, according to Kementerian Kesehatan RI (2019)¹⁹, in 100 g for infants 6-11 months should include energy 400-440 kcal, protein (quality protein not less than 70% of the quality of casein) 15-22 g, fat 10-15 g, carbohydrates (maximum sucrose 30 g, fiber maximum 5 g), iron 5-8 mg, calcium 200-400 mg, and water a maximum of 4 g. The purpose of giving weaning food is to meet the nutritional needs of infants aged 6-11 months due to decreased milk production after six months²⁰.

The nutritional content of instant powder with the addition of Moringa leaf flour as selected weaning food for babies 6-11 months contains energy 471 kcal/100 g, protein 19.7 g, total fat 19.7%, linoleic fatty acid 464 mg, total carbohydrates 54.70 g, sugar (sucrose) 21.24 g, water content 3.5 g, iron (Fe) 44.6 mg/kg, calcium (Ca) 117.2 mg/kg. The nutritional content meets the nutritional requirements according to the standards of the Indonesian Ministry of Health (2007) (16). Energy is one of the results of the metabolism of carbohydrates, proteins and fats; it serves as a power substance for metabolism, growth, temperature regulation, and physical activity²¹. Giving too many calories to babies can lead to obesity

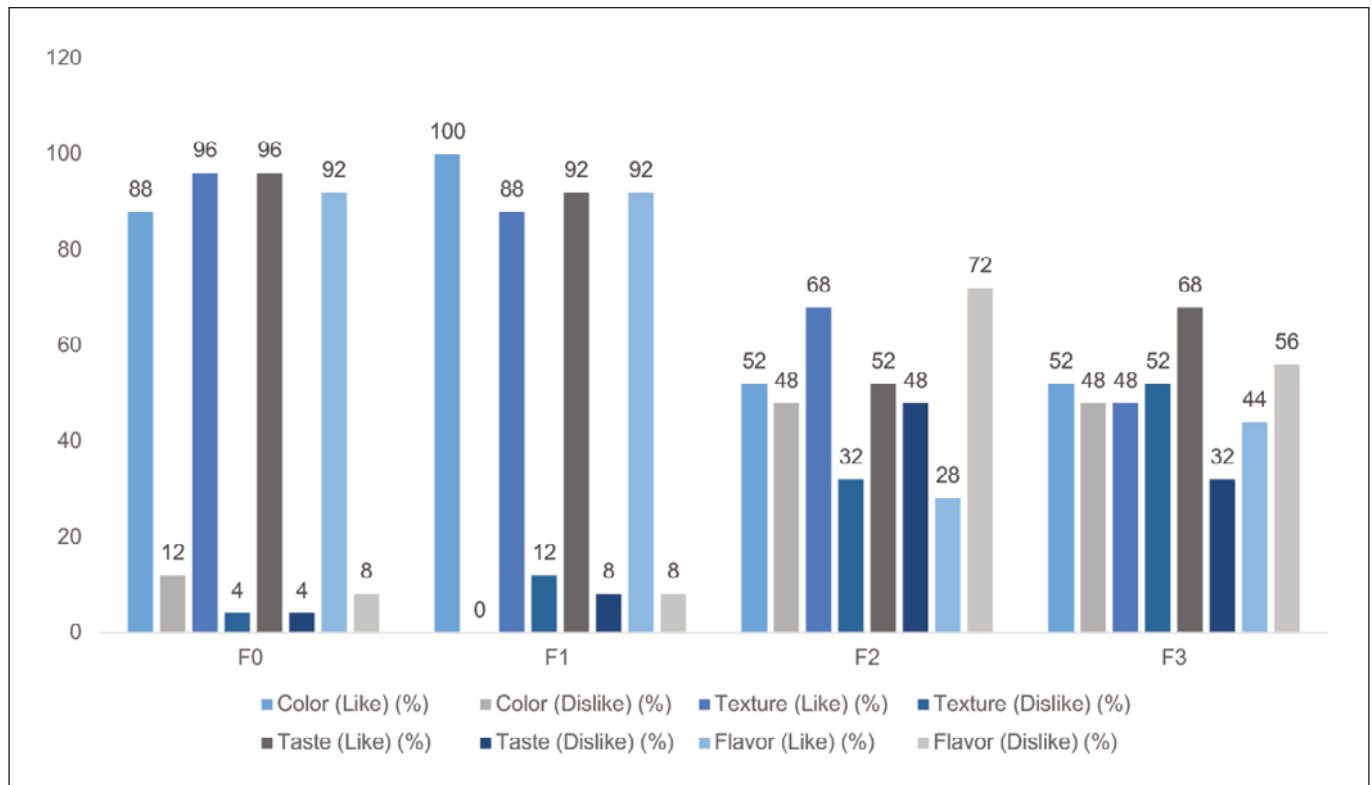


Figure 1. Sensory Evaluation of instant flour porridge (%)

or overweight, especially if children eat lots of foods that only contain many calories without important nutrients.

The energy balance of carbohydrates, protein, and fat in this instant porridge is contributed by ingredients that make up instant porridge, including wheat flour, mofaf, refined sugar, soybean flour, eggs, milk, vitamins, and minerals. Moringa leaves can prevent stunting in the first 1000 years of birth²². Zakaria's research (2022) shows that giving moringa extract to breastfeeding mothers can positively affect the baby's weight, health, and exclusive breastfeeding²³. Other research shows that consumption of achira porridge with heme iron affects increasing hemoglobin levels in children aged 6 to 11 months, during six weeks of intervention²⁴. Then, providing Moringa leaves with nutritional content must be utilized as well as possible by including them in various nutritious recipes which can function as iron supplements for growing teenagers. Then, providing Moringa leaves with nutritional content must be utilized as well as possible by including them in various nutritious recipes which can function as iron supplements for growing teenagers²⁵.

Instant powder with the addition of Moringa leaf flour after brewing with water ready for consumption was tested by somewhat tired panelists from final year applied nutrition and dietetics undergraduate students. Panelists accepted/liked (88-100%) the concentration of adding 5 g Moringa leaf flour per standard recipe (F0) for instant porridge based on aspects

of color, texture, aroma and taste, almost comparable to instant powder without adding Moringa leaf flour (F0).

CONCLUSION AND RECOMMENDATIONS

The physical characteristics of the instant porridge produced meet the requirements as weaning foods for infants aged 6-11 months based on density (0.53 ml/g) and water absorption (1.74 ml/g). The nutritional content per 100 g of instant porridge produced fulfills the energy requirements of 471 kcal; protein 19.7 g; linolenic fatty acid 464 mg; sucrose 21.24 g; water content 3.5 g, iron 44.6 g; except for total fat 19.7 g. However, the calcium content of 117.2 mg is still low. Instant porridge addition with Moringa leaves as a weaning food for babies aged 6-11 months can be utilized for babies after exclusive breastfeeding at least once a week to introduce the natural taste of Moringa while at the same time contributing to nutritional intake.

ACKNOWLEDGEMENTS

We would like to express our thanks to the Kementerian Kesehatan Republik Indonesia, Badan Pengembangan Dan Pemberdayaan SDM Kesehatan, and Politeknik Kesehatan Makassar. The study was funded by Kementerian Kesehatan Republik Indonesia, Badan Pengembangan Dan SDM Kesehatan, Politeknik Kesehatan Makassar (LB. 02.03 / 4.3 / / 2021)

REFERENCES

1. Menteri Kesehatan RI. Keputusan Menteri Kesehatan RI No.224/Menkes/SK/II/2007. Jakarta; 2007.
2. Muchtadi TR. Ilmu Pengetahuan Bahan Pangan. Bogor: IPB Prees; 2010.
3. Mubarak AE. Nutritional composition and antinutritional factors of mung bean seeds (*Phaseolus aureus*) as affected by some home traditional processes. *Food Chemistry*. 2005;89(4):489–95.
4. Atmawikarta A. Pengaruh Pemberian Makanan Pendamping Air Susu Ibu (MP-ASI) Formula Tempe Terhadap Diare, Aktivitas Fisik, dan Pertumbuhan, Bayi Status Gizi Anak Usia 6 - 12 Bulan. *Gizi Indonesia*. 2007;30(2):73–97.
5. Zakaria Z, Hadju V, Rosmini R. Infant Nutritional Status of 0-6 Months of Exclusive Breastfeed Due to The Application of Moringa Leaf Extract in Breastfeeding Mothers. *Health Notions*. 2018; 2(6):669–74.
6. Zakaria, Thamrin A, Sirajuddin, Hartono R. Penambahan tepung daun kelor pada menu makanan sehari-hari dalam upaya penanggulangan gizi kurang pada anak balita. *Media Gizi Pangan*. 2012;13(1):41–7.
7. Zakaria, Hadju V, As'ad S, Bahar B. The Effect of Moringa Leaf Extract in Breastfeeding Mothers against Anemia Status and Breast Milk Iron Content. *Internasional Journal of Sciences Basic and Applied Research (IJSBAR)*. 2015;24(1):321–9.
8. Zakaria, Rauf S, Salim A, Rahman N, Bohari. Development of instant powder with the addition of Moringa oleifera leaf powder as complementary food for infants 6-12 months old. *Systematic Reviews in Pharmacy*. 2020;11(7):61–4.
9. Zakaria, Hadju V, Rosmini. Infant Nutritional Status of 0-6 Months of Exclusive Breastfeed Due to The Application of Moringa Leaf Extract in Breastfeeding Mothers 669 | Publisher: Humanistic Network for Science and Technology Health. 2018;2(6):669–74.
10. Suhartini T, Zakaria Z, Pakhri A, Mustamin M. Kandungan Protein dan Kalsium Pada Biskuit Formula Tempe dengan Penambahan Tepung Daun Kelor (*Moringa oleifera*) Sebagai Makanan Pendamping ASI (MP-ASI). *Media Gizi Pangan*. 2018; 25(1):64–8.
11. Zakaria, Abdullah Thamrin, Retno Sri Lestari RH. Pemanfaatan Tepung Daun kelor (*Moringa oleifera*) dalam Formulasi Pembuatan Makanan Tambahan untuk Balita Gizi Kurang. *Media Gizi Pangan*. 2013;XV(1):1–6.
12. Rauf R, Sarbini D. Water Absorption as Reference to Determine the Volume of Water in Dough Making from Wheat Flour and Cassava Flour Mixture. *Jurnal Agritech*. 2015;35(03):324.
13. Darmayanti, Rika Wahyu, Suwita IK. Effect Of Length Blanching Steam on Betakaroten Contens, Water Contens, Water Absorption, Density Kamba And Rendemen Of Yellow Sweet Potato Flour (*Ipomea Batatas L.*). *Agromix*. 2018;9(2):99–110.
14. Tamrin R, Pujilestari S. Karakteristik Bubur Bayi Instan Berbahan Dasar Tepung Garut Dan Tepung Kacang Merah. *Jurnal Konversi*. 2016;5(2):49.
15. Hardiningsih N. "Optimasi Formula Makanan Pendamping ASI Dengan Menggunakan Response Surface Methodology." Sekolah Pascasarjana Institute Pertanian Bogor. Sekolah Pasca Sarjana Institut Pertanian Bogor; 2004.
16. Hussain S, Anjum FM, Butt MS, Sheikh MA. Chemical compositions and functional properties of flaxseed flour. *Sarhad J Agric*. 2008;24(4):649–53.
17. Farida SN, Ishartani D, Affandi DR. Kajian Sifat Fisik, Kimia dan Sensoris Bubur Bayi Instan Berbahan Dasar Tepung Tempe Koro Glinding (*Phaseolus lunatus*), Tepung Beras Merah (*Oryza nivara*) dan Tepung Labu Kuning (*Cucurbita moschata*). *Jurnal Teknosains Pangan*. 2016;V(2):32–9.
18. Pramesta, Laras Dianti, Rahmawanti, Dian, Kawiji ABK. Karakteristik bubur bayi instan berbahan dasar tepung millet (*Panicum sp*) dan tepung kacang merah (*Phaseolus vulgaris L.* dengan flavor alami pisang ambon (*Musa paradisiacal var. sapientum L.*). *Jurnal Teknosains Pangan*. 2014;1(1):41–8.
19. Kementerian Kesehatan RI. kepmenkes RI Nomor 224/Menkes/SK/II/2007 tentang spesifikasi Tehnis Makanan Pendamping ASI. 2007. p. 1–10.
20. Mufida L, Widyaningsih TD, Maligan JM. Prinsip Dasar Makanan Pendamping Air Susu Ibu (MP-ASI) untuk Bayi 6 – 24 Bulan: Kajian Pustaka. *Basic Principles of Complementary Feeding for Infant 6 - 24 Months: A Review*. *Jurnal Pangan dan Agroindustri*. 2015;3(4):1646–51.
21. Hardinsyah, Napitupulu V, Riyadi H. Kecukupan energi, protein, lemak dan karbohidrat [Internet]. Departemen Gizi Masyarakat FEMA IPB. Departemen Gizi. Fakultas Kedokteran Universitas Indonesia.; 2012. Available from: https://www.researchgate.net/publication/301749209_KECUKUPAN_ENERGI_PROTEIN_LEMAK_DAN_KARBOHIDRAT#fullTextFileContent
22. Nadimin. Nutritional Intervention Based on Moringa Leaf Flour to Prevent Stunting in First 1000 Days of Life (1000 HPK): Review Articles. 2021;12(1):1333–9.
23. Zakaria, Sirajuddin, Veni H, Burhanuddin B, Rosmini, Suryani A, et al. Linear growth of infants aged 0-6 months in breastfeeding mothers who consume Moringa oleifera leaf extract capsules: randomized controlled double-blind design. *Food Research*. 2022; 6(5):135–43.
24. Tejada RMC, Tomaylla XNC, Quispe LPP. Efecto del consumo de la achira en polvo fortificado con hierro hemínico en el nivel de hemoglobina de niños menores de un año. *Nutrición Clínica y Dietética Hospitalaria*. 2024;44(3):106–11.
25. Sandhya J, Chinnathambi K. Ms Development of Millet Based Moringa - Amla Snack Bar for Iron Deficiency in Adolescents. *Nutrición Clínica y Dietética Hospitalaria* [Internet]. 2024;44(2). Available from: <https://revista.nutricion.org/index.php/ncdh/article/view/583>

Green algae *Caulerpa racemosa* inhibit proliferation and promote apoptosis in human HT-29 colon cancer by suppressing PI3K/AKT pathway

Happy KURNIA PERMATASARI¹, Nurlinah AMALIA², Hikmawan WAHYU SULISTOMO³, Kenty WANTRI ANITA⁴, Husnul KHOTIMAH³, Rudy KURNIAWAN⁵, Fahrul NURKOLIS⁶

1 Department of Biochemistry and Biomolecular, Faculty of Medicine, Brawijaya University, Malang, Indonesia.

2 Master Program of Biomedical Science, Faculty of Medicine, Brawijaya University, Malang, Indonesia.

3 Department of Pharmacology, Faculty of Medicine, Brawijaya University, Malang, Indonesia.

4 Department of Pathology Anatomy, Faculty of Medicine, Brawijaya University, Malang, Indonesia.

5 Alumnus of Internal Medicine, Faculty of Medicine, University of Indonesia-Cipto Mangunkusumo Hospital, Jakarta, Indonesia.

6 Department of Biological Sciences, State Islamic University of Sunan Kalijaga (UIN Sunan Kalijaga), Yogyakarta, Indonesia.

Recibido: 19/junio/2024. Aceptado: 6/agosto/2024.

ABSTRACT

Introduction: Colon cancer is a malignancy of the gastrointestinal which is one of the most common causes of death worldwide. Tumorigenesis involved oncologic pathway such as PI3K/AKT as the common pathway with the challenges is therapy resistance. Therefore, an alternative colon cancer treatments is needed that comes from biological resources such as sea grapes.

Objective: This study aims to determine anticancer potency of hexane extract from sea grapes (*Caulerpa racemosa*) on HT-29 cell line colon cancer based on suppressing PI3K/AKT pathway.

Method: The study was conducted in vitro using the extract of *Caulerpa racemosa* at concentrations of (0, 400, 800, and 1.200) µg/mL on the HT-29 cell line based on the level expression of p-akt related to PI3K/AKT pathway, cleaved caspase 3 related to apoptosis, and viable cells related to proliferation.

Results: The research results was found that the hexane extract of *Caulerpa racemosa* decreased the expression level of p-akt (Kruskal wallis, $p=0,027$), increased the cleaved caspase 3 (Kruskal wallis, $p=0,016$), and decreased

the viable cells (Kruskal wallis, 24 and 48 hours: $p=0,024$ and $0,034$).

Conclusion: *Caulerpa racemosa* hexane extract can inhibit colon cancer cells growth by suppressing PI3K/AKT pathway based on inhibition proliferation and induce apoptosis.

KEYWORDS

Caulerpa racemosa, sea grapes, HT-29, colon cancer, PI3K/AKT, proliferation, apoptosis.

ABBREVIATION LIST

Caspase: CysteinyL Aspartate Specific Proteinase-3.

CCND1: Cyclin D1.

GSK: Glycogen Synthase Kinase-3.

IARC: International Agency for Research on Cancer.

P-Akt: Phosphorylated Serine/threonine kinase.

PI3K/AKT: Phosphatidylinositol-3-Kinase/Serine-Threonine Kinase.

PIP₂: Phosphatidylinositol 4,5-biphosphate.

PIP₃: Phosphatidylinositol 3,4,5-biphosphate.

PTEN: Phosphatase and Tensin homolog.

RTK: Receptor Tyrosine Kinase.

TNF-α: Tumor Necrosis Factor-α.

WHO: World Health Organization.

Correspondencia:

Fahrul Nurkolis

fahrul.nurkolis.mail@gmail.com

INTRODUCTION

Colon cancer is a malignancy of the gastrointestinal system which is one of the most common causes of death worldwide. According to WHO, colon cancer is in third position as the most common malignancy affecting men (1.03 million new cases/year) after lung cancer and prostate cancer while women are in second place (0.82 million new cases/year) after breast cancer¹. Based on statistical data from the International Agency for Research on Cancer (IARC), colon cancer occupies the third position as the most common malignancy that attacks the world's population, namely 1.85 million new cases/year and includes 10.2% of the total other malignancies². In the next few years, colon cancer is expected to continue to increase by 2.15 times the number of new cases this year³.

Pathophysiologically, the incidence of colon cancer is strongly influenced by the path of oncology. One of the oncological pathways that often induce cancer is the Phosphatidylinositol-3-Kinase/Serine-threonine kinase (PI3K/AKT) pathway. The majority of the PI3K/AKT pathways contribute to colon cancer⁴. Dysregulation of the PI3K/AKT pathway induces continuous cell proliferation and inhibits apoptosis so that cell growth becomes uncontrollable and turns into malignancy. Obstacles in cancer treatment are the emergence of side effects that attack healthy cells due to drugs that are not on target, resistant, or do not target the appropriate oncological pathways⁵.

Utilizing the potential of natural ingredients is an alternative to colon cancer therapy. In fact, many cancer patients avoid treatments such as chemotherapy and radiotherapy because they are afraid of failure, fear side effects, are expensive, and last a long⁶. Based on these conditions, utilizing natural materials as an alternative to cancer treatment, one of which is sea grapes (*Caulerpa racemosa*) is very realizable. In Indonesia, sea grapes are often used by the community as a food source and are quite easy to find in several Indonesian waters⁷. In previous research by Dissanayake, *et al.*, (2018) *Caulerpa racemosa* has been shown to have anticancer potential in breast cancer⁸.

OBJECTIVES

This study aims to determine anticancer potency of hexane extract from sea grapes (*Caulerpa racemosa*) on HT-29 cell line colon cancer based on suppressing PI3K/AKT pathway. This is interesting to study based on the involvement of the PI3K/AKT pathway in influencing colon cancer tumorigenesis. In addition, utilizing biological resources as an alternative therapy for colon cancer is believed to be appropriate and reliable because there has been no previous research examining the potential of *Caulerpa racemosa* extract against colon cancer via the PI3K/AKT pathway.

MATERIAL AND METHODS

Sample preparation

Sea grapes were obtained from Jepara sea, Central Java, Indonesia at more or less 10-20 m above sea level. The sea grapes were air-dried at 24 °C without direct sunlight, then dried in an oven at 40 °C for three days to reduce the water content. After drying, the sea grapes were crushed using an electric mill, and 400 grams of dry sea grape powder was obtained from 1.75 kg of wet sea grapes.

Sea grapes coarse powder is macerated in an n-hexane solution with the ratio of sea grape powder: solvent is 1:10 (100 g powder: 1 L solvent). Stirring was carried out using a stirrer for 15 minutes at a speed of 400 rpm and then tightly closed using aluminum foil. The initial maceration mixture was allowed to stand at room temperature and stored for 1 x 24 hours, then filtered. The maceration procedure was repeated three times. The resulting macerate was concentrated using a vacuum rotary evaporator with a speed of 50-70 rpm at 40°C until the macerate was in the form of a paste. The thick extract was dried in an oven at 40°C for 24 hours. The *Caulerpa racemosa* extraction produced a thick extract of 0.6 g with a yield of 0.15%.

Cell line

The colon cancer cell line (HT-29) was randomly obtained from the Biomedical Central Laboratory, Faculty of Medicine, Brawijaya University. The cell line was purchased from American Type Culture Collection (USA). HT-29 cells were cultured in Mc Coy's medium with 10% fetal bovine serum and 1% penicillin-streptomycin antibiotic. Cells were maintained in a humidified incubator with 5% CO₂ at 37°C.

Trypan blue test

The harvested HT-29 cells were centrifuged at 1,000 rpm for 5 minutes, removing the supernatant. Take 20 µl centrifuged pellet cells to eppendorf. Add 20 µl of trypan blue solution to the pellet in eppendorf, and homogenize. Take 10 µl of mixed cells and trypan blue solution into the hemocytometer. Observe using a microscope and count cells that do not absorb the blue color (viable cells). Cell counts were performed at 24 and 48 hours to assess cell proliferation.

(Viable cell) = a Total number of viable cells x 2 x 10.000

Immunofluorescence assay

Cells grown on coverslips were washed three times with PBS, washed with PBS Triton-X 100 0,2%, and then washed with PBS again three times. Incubated with 1% bovine serum albumin (BSA) at room temperature, and washed with PBS three times. Incubated with primary antibody overnight (p-Akt S473 rabbit was purchased from Cell Signaling Technology-USA; cleaved caspase 3 D175 rabbit was purchased from Cell Signaling Technology-USA). After that incubated with a sec-

ondary antibody (goat anti-rabbit IgG ab6718-red) at room temperature, cells washed with PBS three times. Finally, cells were incubated with DAPI, washed with PBS again three times, and covered with an antifade mounting medium. Observed under the microscope fluorescence.

Statistical analysis

Each experiment was performed at least in triplicate, and the results are expressed as the mean. The normality test saphirowilk was performed to check the data normality. Between two variables, compared test using one-way anova or kruskal-wallis test. Whereas the correlation of two variables using pearson or spearman. $p < 0.05$ was considered statistically significant.

RESULTS

The hexane extract of *Caulerpa racemosa* yielded significant results ($p < 0.05$) in inhibiting the growth of the HT-29 cell line through several mechanisms: 1) inhibition of HT-29 cell line proliferation; 2) inhibition of the PI3K/AKT pathway; and 3) induction of apoptosis.

Caulerpa racemosa inhibits proliferation HT-29

Proliferation test on the HT-29 cell line was carried out using the trypan blue test method which was measured at the 24th and 48th hours. This test aims to see the effect of the hexane extract of *Caulerpa racemosa* in inhibiting HT-29 cell proliferation. The results showed that *Caulerpa racemosa* ex-

tract significantly inhibited HT-29 cell proliferation. The statistical test results are shown in **(Figure 1)**.

Based on the results of the cell proliferation statistical test at the 24th hour, the data distribution was not normal ($p < 0.05$). The results of the statistical test between the dose and the number of cell proliferation at 24 hours with kruskal wallis showed a significant relationship, $p = 0.024$ ($p < 0.05$) whereas with the spearman correlation test, it was significant $p = 0.000$ ($p < 0.05$) with a correlation value coefficient ($r = -0.907$), a very strong negative correlation (> 0.8).

Based on the results of the cell proliferation statistical test at the 48th hour, the data distribution was not normal ($p < 0.05$). The statistical test results between the dose and the number of cell proliferation at 48 hours with kruskal wallis showed a significant relationship, $p = 0.034$ ($p < 0.05$) whereas with the spearman correlation test, it was significant $p = 0.000$ ($p < 0.05$) with a correlation value coefficient ($r = -0.848$), a very strong negative correlation (> 0.8).

Caulerpa racemosa suppressing PI3K/AKT pathway

The effect of *Caulerpa racemosa* inhibits PI3K/AKT pathway was carried out using the immunofluorescence assay method which measured the expression level of p-Akt. The results showed that *Caulerpa racemosa* extract significantly decreased the expression level of p-Akt. The immunofluorescence result is shown in **(Figure 2)** and the statistical test are shown in **(Figure 1)**.

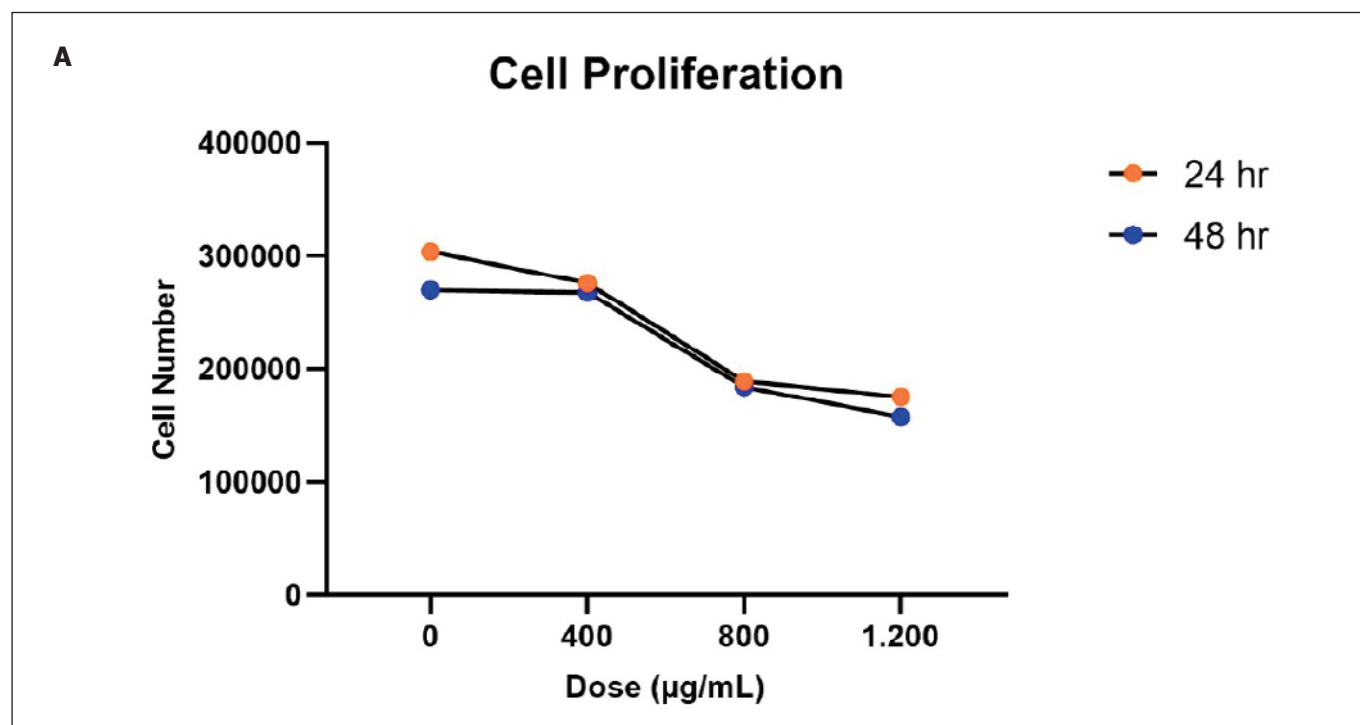


Figure 1. Statistical Analysis. a) summary of cell proliferation for 24 and 48 hours

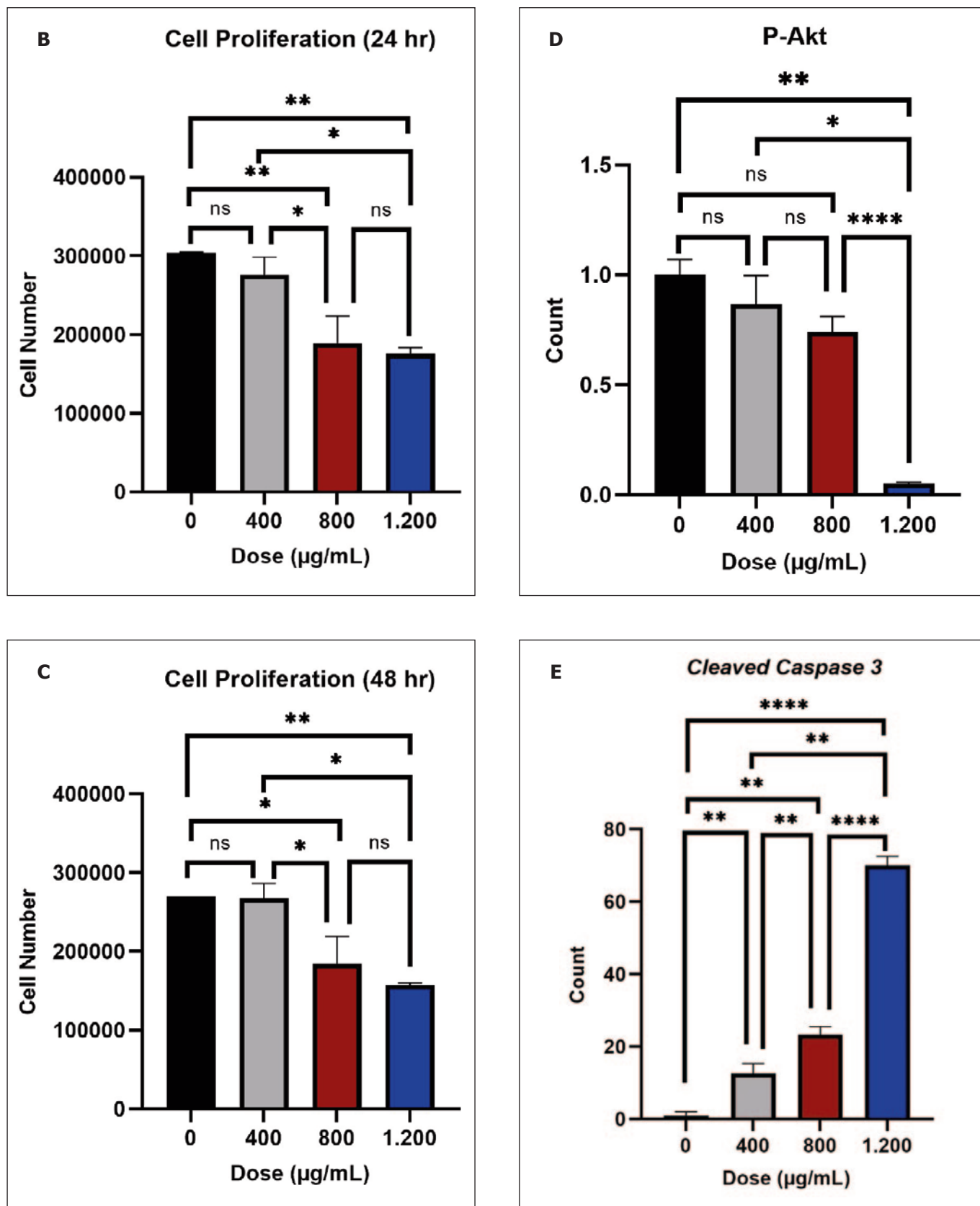


Figure 1 continuation. Statistical Analysis. b) cell proliferation for 24 hour; c) cell proliferation for 48 hour; d) expression intensity of p-akt; e) expression intensity of cleaved caspase 3; *significant ($p < 0,05$)

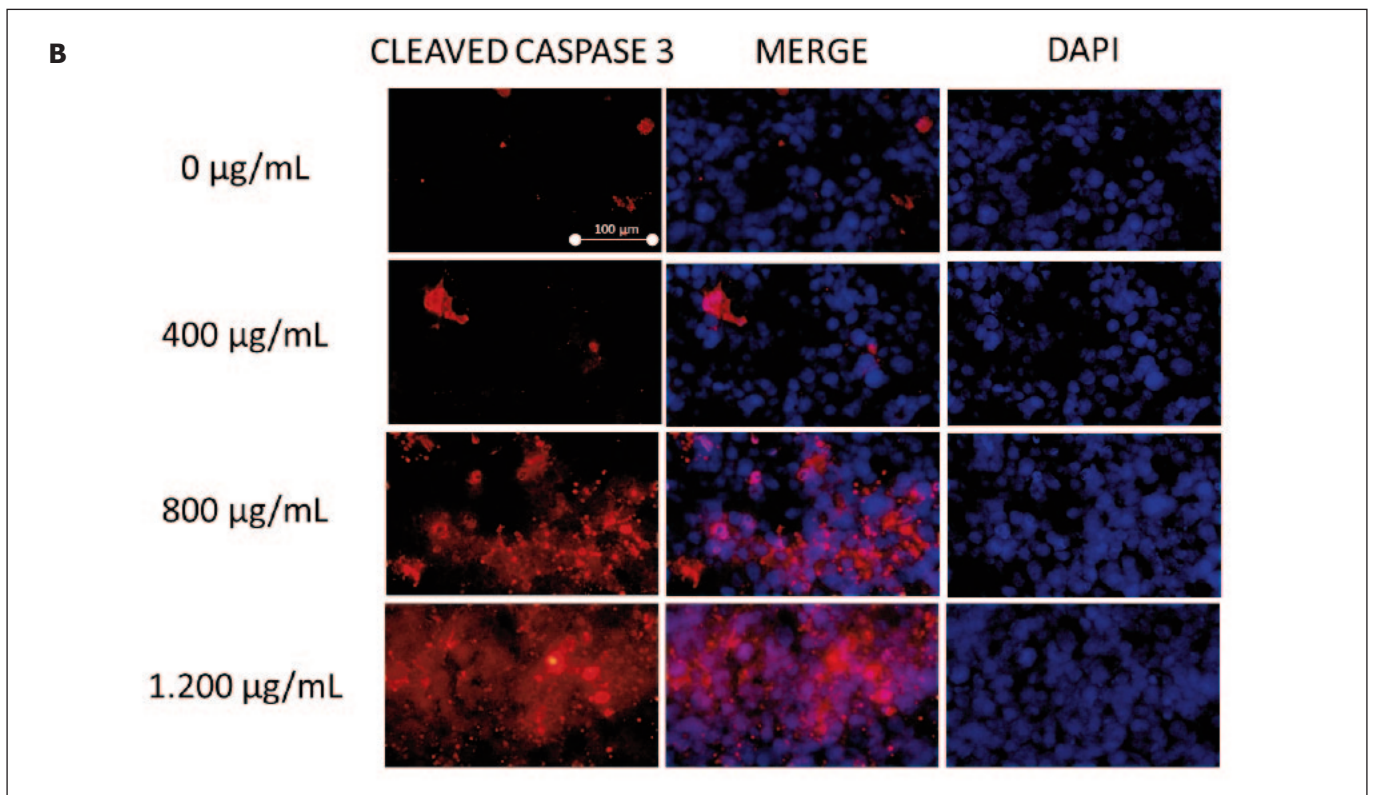
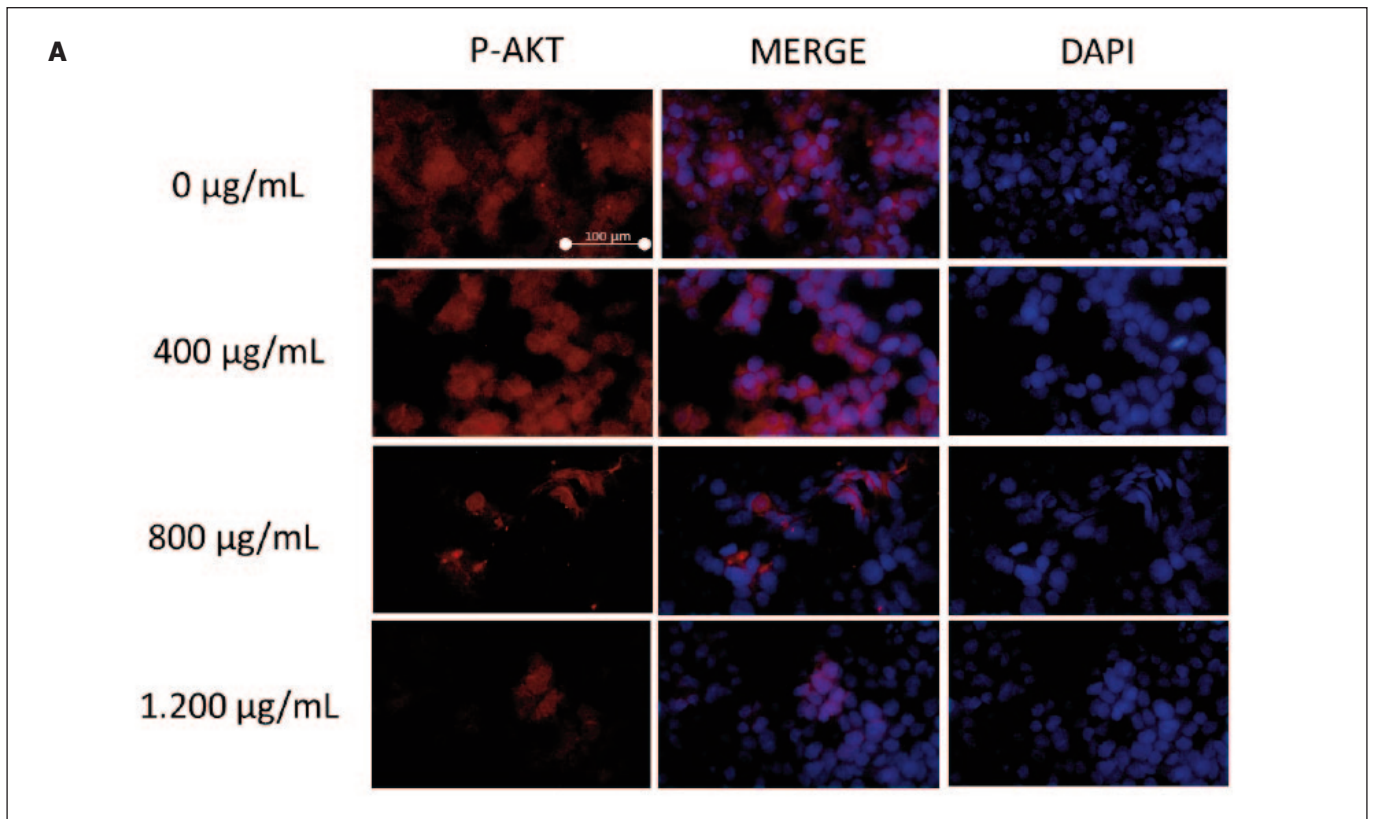


Figure 2. Immunofluorescence. a) increasing doses can decreased expression of p-akt; b) increasing doses can increased expression of cleaved caspase 3

Based on the results of the expression level of p-Akt, the data quantification using ImageJ software and the distribution was not normal ($p < 0.05$). The statistical test results between the dose and p-Akt level with kruskal wallis showed a significant relationship, $p = 0.027$ ($p < 0.05$) whereas with the spearman correlation test, it was significant $p = 0.000$ ($p < 0.05$) with a correlation value coefficient ($r = -0.907$), a very strong negative correlation (> 0.8).

***Caulerpa racemosa* induces apoptosis HT-29**

The effect of *Caulerpa racemosa* induces apoptosis was carried out using the immunofluorescence assay method which measured the expression level of cleaved caspase 3. The results showed that *Caulerpa racemosa* extract significantly increased the expression level of cleaved caspase 3. The immunofluorescence result is shown in **(Figure 3)** and the statistical test are shown in **(Figure 1)**.

Based on the results of the expression level of cleaved caspase 3, the data quantification using ImageJ software and the distribution was not normal ($p < 0.05$). The statistical test results between the dose and cleaved caspase 3 level with kruskal wallis showed a significant relationship, $p = 0.016$ ($p < 0.05$) whereas with the spearman correlation test, it was significant $p = 0.000$ ($p < 0.05$) with a correlation value coefficient ($r = 0.972$), a very strong positive correlation (> 0.8).

DISCUSSION

The proliferation test was carried out using the trypan blue test method for 24 and 48 hours. As the dose increased, the number of HT-29 cell proliferation at the 24th and 48th hours was effectively inhibited by *Caulerpa racemosa* hexane extract. This is based on a decrease in HT-29 cells 24 and 48 hours after intervention with *Caulerpa racemosa* hexane extract. Based on previous research conducted by Manikandakrishnan *et al.*, (2019) regarding the proliferation test using the MTT assay method on HT-29 cells, it was found that *Caulerpa racemosa* significantly inhibited the viability of HT-29 cells at 24 hours⁹. Based on another study conducted by Mert-Ozuppek *et al.*, (2022) regarding the HT-29 cell proliferation test, it was found that *Caulerpa* extract significantly inhibited HT-29 cell proliferation at 48 hours¹⁰.

In this study, dead cells will absorb the trypan blue color because the cell membranes are not intact, so when observed under a microscope, dead cells will turn blue. In contrast, cells that are still viable will not absorb the blue color because the cell membranes remain intact¹¹. The decrease in the number of proliferating HT-29 cells can be through mechanisms that inhibit the expression of proteins that play a role in cell proliferation and agents that induce cells to apoptosis. The antiproliferative effect on HT-29 cells can be generated by the induction of apoptosis in the PI3K/AKT pathway. Induction of apoptosis involves the role of caspase both as initiator and ex-

ecutor, which causes an increase in the number of dead cells resulting in a decrease in the number of cells¹².

The antiproliferative effect of *Caulerpa racemosa* hexane extract is related to its association with the PI3K/AKT pathway, which inhibits the expression of myc and CCND1, which play a role in cell proliferation. If there is a decrease in the expression of myc and CCND1, then the proliferation process will be hampered and have an impact on reducing the number of HT-29 cells. Myc and CCND1 are regulators in the cell cycle's G1/S phase, which will encourage cells to enter the S phase of G1. If there is a decrease in the expression of myc and CCND1, the cell cycle will stop and cannot continue to the next stage, reducing the number of cells (suppresses proliferation)¹³. In this study, *Caulerpa racemosa* hexane extract significantly inhibited HT-29 cell proliferation for 24 hours.

Observation of the PI3K/AKT pathway of HT-29 cells was investigated based on the amount of p-Akt expression through the immunofluorescence method. Administration of *Caulerpa racemosa* hexane extract aims to inhibit the PI3K/AKT pathway in the hope that there will be a decrease in p-Akt expression along with increasing doses of *Caulerpa racemosa* hexane extract. In this study, significant results were obtained that there was a decrease in p-Akt expression after HT-29 cells were intervened with *Caulerpa racemosa* hexane extract. Based on previous research conducted by Manandhar *et al.* (2020) found that *Caulerpa* significantly inhibited the PI3K/AKT pathway based on p-akt expression¹⁴.

The PI3K/AKT pathway plays a role in regulating proliferation and apoptosis. In cancer cells, this pathway is dysregulated, leading to increased proliferation and inhibition of the apoptotic process. In this study, the effect of inhibition on the PI3K/AKT pathway was assessed directly by looking at the amount of p-akt expression. The expression of p-Akt is stimulated by PI3K when the growth factor attaches to the tyrosine kinase receptor on the cell membrane. P-Akt is the primary regulators of the PI3K/AKT pathway; when its expression decreases, there is a decrease in proliferation and an increase in apoptosis of cancer cells. This effect is the goal of this research so that the tumorigenesis of colon cancer cells can be stopped. This happened because the decrease in p-Akt expression resulted in the absence of p-Akt, which inhibited GSK-3 β and caspase expression. GSK-3 β plays a role in inhibiting myc and CCND1 to benefit the cell cycle. If the amount of GSK-3 β increases due to the absence of p-Akt, which inhibits it, then myc and CCND1 will be hampered by GSK-3 β , resulting in a decrease in cell proliferation. In addition, the decreased expression of p-Akt causes caspase to work to induce apoptosis¹⁵.

The apoptotic test in this study was investigated using the amount of cleaved caspase 3 expression using the immunofluorescence method. The expected result is an increase in the amount of caspase 3 expression along with an increase

in the dose of *Caulerpa racemosa* hexane extract. In this study, significant results were obtained that there was an increase in the expression of caspase 3, which induces apoptosis in HT-29 cells after intervention with *Caulerpa racemosa* hexane extract. Based on previous research conducted by Ferdous, *et al.*, (2021), the caulerpin content found in *Caulerpa racemosa* significantly induces apoptosis in cancer cells by increasing caspase expression, which plays a role in the apoptotic process¹⁶.

Cleaved caspase 3 is one of the primary executor proteins in the process of apoptosis that acts directly on target cells. In this study, the effect of inducing apoptosis of *Caulerpa racemosa* hexane extract was observed by looking at the increased expression of cleaved caspase 3. Endogenous and exogenous pathways can stimulate the high expression of cleaved caspase 3. In the endogenous pathway, mitochondrial damage occurs, causing cytochrome c to be released into the cytoplasm from the mitochondria. Cytochrome c converts caspase 9 into the active form (cleaved caspase 9), then cleaved caspase 9 activates and increases cleaved caspase 3 expression. Meanwhile, cleaved caspase 3 expression increases in the exogenous pathway through stimulation of Tumor Necrosis Factor- α (TNF- α). Cleaved caspase 3 is the last executor protein among other types of caspase in the apoptotic process, so it acts directly on target cells and gives the effect of the induced apoptotic process. Induction of apoptosis by cleaved caspase 3 occurs through the mechanism of nuclear fragmentation of cancer cells (chromatin condensation and DNA cleavage), causing swelling of the cell membrane, continuing to rupture until the cell finally dies¹⁷.

In addition, the effect of *Caulerpa racemosa* hexane extract on increasing cleaved caspase 3 expression was also induced by the influence of *C. racemosa* in inhibiting the PI3K/AKT pathway. It is known that the primary regulator of the PI3K/AKT pathway is p-Akt. P-Akt plays a role in inhibiting caspase expression, so p-Akt can be said to be upstream of caspase expression. Suppose there is a decrease in p-Akt expression due to being inhibited by *C. racemosa*. In that case, the expression of cleaved caspase 3 will not deter it, thus triggering an increase in cleaved caspase 3 expression and encouraging cancer cells to apoptosis^{18,19}. Therefore, the effects of antiproliferation and induction of apoptosis that we wish to observe in this study indirectly illustrate the results of inhibition of the PI3K/AKT pathway by *Caulerpa racemosa*.

The limitations of this study did not explore the bioactive compound of *Caulerpa racemosa* that have an anticancer effect and did not explore the anticancer effect on the other hallmarks of cancer.

CONCLUSION

Caulerpa racemosa has potential as an anticancer agent in colon cancer because it inhibits cancer cell growth by sup-

pressing the PI3K/AKT pathway so that the effects are antiproliferation and induction of apoptosis. Based on the antiproliferation effect, *C. racemosa* decreased the number of viable count cells since 24-48 hours. Whereas on inducing apoptosis effect, *C. racemosa* increased the level expression of cleaved caspase 3 as the executioner of apoptosis process.

FUNDING STATEMENTS

This research was supported by Brawijaya University's research grant.

ACKNOWLEDGMENTS

We offer a great thank you to Happy Kurnia Permatasari, MD., Ph.D., Hikmawan Wahyu Sulistomo, MD., Ph.D., with motivational support and provided suggestions to us. The author thanks to Brawijaya University for the research grant in this paper.

REFERENCES

1. Mattiuzzi C, Sanchis-Gomar F, Lippi G. Concise update on colorectal cancer epidemiology. *Annals of translational medicine*. 2019 Nov;7(21). doi: 10.21037/atm.2019.07.91
2. Baidoun F, Elshiwiy K, Elkeraiye Y, Merjaneh Z, Khoudari G, Sarmini MT, Gad M, Al-Husseini M, Saad A. Colorectal cancer epidemiology: recent trends and impact on outcomes. *Current drug targets*. 2021 Jul 1;22(9):998-1009. doi: 10.2174/1389450121999201117115717
3. Mattiuzzi C, Lippi G. Current cancer epidemiology. *Journal of epidemiology and global health*. 2019 Dec;9(4):217. doi: 10.2991/jegh.k.191008.001
4. Xue C, Li G, Lu J, Li L. Crosstalk between circRNAs and the PI3K/AKT signaling pathway in cancer progression. *Signal transduction and targeted therapy*. 2021 Nov 24;6(1):400. doi: 10.1038/s41392-021-00788-w
5. Ma Z, Lou S, Jiang Z. PHLDA2 regulates EMT and autophagy in colorectal cancer via the PI3K/AKT signaling pathway. *Aging (Albany NY)*. 2020 May 5;12(9):7985. doi: 10.18632/aging.103117
6. Rodenbach RA, Althouse AD, Schenker Y, Smith TJ, Chu E, White DB, Bakitas M, Arnold RM. Relationships between advanced cancer patients' worry about dying and illness understanding, treatment preferences, and advance care planning. *Journal of pain and symptom management*. 2021 Apr 1;61(4):723-31. doi: 10.1016/j.jpainsymman.2020.09.004
7. Yap WF, Tay V, Tan SH, Yow YY, Chew J. Decoding antioxidant and antibacterial potentials of Malaysian green seaweeds: *Caulerpa racemosa* and *Caulerpa lentillifera*. *Antibiotics*. 2019 Sep 17;8(3):152. doi: 10.3390/antibiotics8030152
8. Dissanayake IH, Bandaranayake U, Keerthirathna LR, Manawadu C, Silva RM, Mohamed B, Ali R, Peiris DC. Integration of in vitro and in-silico analysis of *Caulerpa racemosa* against antioxidant, antidiabetic, and anticancer activities. *Scientific Reports*. 2022 Dec 2;12(1):20848. doi: 10.1038/s41598-022-24021-y

9. Manikandakrishnan M, Palanisamy S, Vinosha M, Kalanjaraja B, Mohandoss S, Manikandan R, Tabarsa M, You S, Prabhu NM. Facile green route synthesis of gold nanoparticles using *Caulerpa racemosa* for biomedical applications. *Journal of Drug Delivery Science and Technology*. 2019 Dec 1;54:101345.
10. Mert-Ozuek N, Calibasi-Kocal G, Olgun N, Basbinar Y, Cavas L, Ellidokuz H. An Efficient and Quick Analytical Method for the Quantification of an Algal Alkaloid Caulerpin Showed In-Vitro Anticancer Activity against Colorectal Cancer. *Marine Drugs*. 2022 Nov 30;20(12):757. doi: 10.3390/md20120757
11. Kerschbaum HH, Tasa BA, Schürz M, Oberascher K, Bresgen N. Trypan blue—Adapting a dye used for labelling dead cells to visualize pinocytosis in viable cells. *Cell. Physiol. Biochem*. 2021 Jun 1;55:171-84. doi: 10.33594/000000380
12. Yang H, Liu JX, Shang HX, Lin S, Zhao JY, Lin JM. Qingjie Fuzheng granules inhibit colorectal cancer cell growth by the PI3K/AKT and ERK pathways. *World Journal of Gastrointestinal Oncology*. 2019 May 5;11(5):377. doi: 10.4251/wjgo.v11.i5.377
13. Wei R, Xiao Y, Song Y, Yuan H, Luo J, Xu W. FAT4 regulates the EMT and autophagy in colorectal cancer cells in part via the PI3K-AKT signaling axis. *Journal of Experimental & Clinical Cancer Research*. 2019 Dec;38(1):1-4. doi: 10.1186/s13046-019-1043-0
14. Manandhar B, Kim HJ, Rhyu DY. *Caulerpa okamurae* extract attenuates inflammatory interaction, regulates glucose metabolism and increases insulin sensitivity in 3T3-L1 adipocytes and RAW 264.7 macrophages. *Journal of Integrative Medicine*. 2020 May 1;18(3):253-64. doi: 10.1016/j.joim.2020.02.001
15. Pradhan B, Patra S, Nayak R, Behera C, Dash SR, Nayak S, Sahu BB, Bhutia SK, Jena M. Multifunctional role of fucoidan, sulfated polysaccharides in human health and disease: A journey under the sea in pursuit of potent therapeutic agents. *International Journal of Biological Macromolecules*. 2020 Dec 1;164:4263-78. doi: 10.1016/j.ijbiomac.2020.09.019
16. Ferdous UT, Yusof ZN. Algal terpenoids: A potential source of antioxidants for cancer therapy. *Terpenes and Terpenoids-Recent Advances*. 2021 Jan 5:63-76.
17. Jiang M, Qi L, Li L, Li Y. The caspase-3/GSDME signal pathway as a switch between apoptosis and pyroptosis in cancer. *Cell death discovery*. 2020 Oct 28;6(1):112. doi: 10.1038/s41420-020-00349-0
18. Li ZL, Mi J, Lu L, Luo Q, Liu X, Yan YM, Jin B, Cao YL, Zeng XX, Ran LW. The main anthocyanin monomer of *Lycium ruthenicum* Murray induces apoptosis through the ROS/PTEN/PI3K/Akt/caspase 3 signaling pathway in prostate cancer DU-145 cells. *Food & Function*. 2021;12(4):1818-28. doi: 10.1039/d0fo02382e
19. Stefani C, Miricescu D, Stanescu-Spinu II, Nica RI, Greabu M, Totan AR, Jinga M. Growth factors, PI3K/AKT/mTOR and MAPK signaling pathways in colorectal cancer pathogenesis: where are we now?. *International journal of molecular sciences*. 2021 Sep 23;22(19):10260. doi: 10.3390/ijms221910260

Índice de masa corporal y preeclampsia en embarazadas atendidas en un hospital público de Lima

Body mass index and preeclampsia in pregnant women treated in a public hospital in Lima

Yonathan Josué ORTIZ MONTALVO¹, Geraldine Brenda GALARZA UBALDO², Melani Rossidel CAMPOS ZEVALLOS², Katherine Jenny ORTIZ ROMANÍ³, Nancy Jenny CAMPOMANES CHULLUNCUY⁴

1 Universidad Privada del Norte. Lima, Perú.

2 Facultad de Ciencias de la Salud. Universidad Católica Sedes Sapientiae. Lima, Perú.

3 Departamento de investigación de la Facultad de Ciencias de la Salud. Universidad Católica Sedes Sapientiae. Lima, Perú.

4 Hospital Nacional Sergio E. Bernales. Lima, Perú.

Recibido: 7/junio/2024. Aceptado: 6/agosto/2024.

RESUMEN

Introducción: La obesidad es considerada una epidemia en los países desarrollados, pero ahora se está extendiendo a los países en desarrollo. Además, las gestantes con obesidad tienen un mayor riesgo a presentar preeclampsia que contribuye significativamente a la morbilidad y mortalidad materna y perinatal.

Objetivo: Evaluar la relación entre el índice de masa corporal y la preeclampsia en gestantes atendidas en el hospital nacional Sergio E. Bernales, Lima 2021.

Metodología: Se realizó un estudio de casos y controles no pareados. La muestra fue de 219 gestantes de todas las edades distribuidas en un grupo de casos (115 gestantes con preeclampsia) y un grupo control no pareado (104 gestantes sin preeclampsia). El muestreo probabilístico fue aleatorio en ambos grupos. A través de la historia clínica se obtuvo información del diagnóstico médico, el índice de masa corporal y otras características sociodemográficas y obstétricas de las gestantes. Se realizó un análisis estadístico bivariado con la prueba de Chi-Cuadrado.

Resultados: El IMC se relaciona significativamente con la preeclampsia, ya que el 64,13% de las mujeres con obesidad presentaron este suceso. Asimismo, el antecedente de preeclampsia resultó significativo ($p: 0,012$).

Conclusiones: El índice de masa corporal y el antecedente de preeclampsia se relacionan con la preeclampsia. Además, existe un gran porcentaje de gestantes con obesidad y con antecedente de preeclampsia que presentan dicha complicación. Se recomienda que los profesionales de salud y otras partes interesadas consideren estos hallazgos en sus actividades de detección temprana para evitar complicaciones evitables.

PALABRAS CLAVE

IMC, riesgos obstétricos, salud materna, gestación, epidemiología obstétrica.

ABSTRACT

Introduction: Obesity is considered a major epidemic in developed countries, but is now spreading to developing countries. Furthermore, pregnant women with obesity have a higher risk of preeclampsia, which contributes significantly to maternal and perinatal morbidity and mortality.

Objective: To evaluate the relationship between body mass index and preeclampsia in pregnant women treated at the Sergio E. Bernales national hospital, Lima 2021.

Correspondencia:

Yonathan Josué Ortiz Montalvo
yonatanortiz79@gmail.com

Methodology: An unpaired case-control study was carried out. The sample consisted of 219 pregnant women of all ages distributed into a case group (115 pregnant women with preeclampsia) and an unmatched control group (104 pregnant women without preeclampsia). Probabilistic sampling was random in both groups. Through the clinical history, information on the medical diagnosis, body mass index and other sociodemographic and obstetric characteristics of the pregnant women was obtained. A bivariate statistical analysis was performed with the Chi-Square test.

Results: body mass index is significantly related to preeclampsia ($p: 0.004$), since 64.13% of women with obesity presented this event. Likewise, the history of preeclampsia was significant ($p: 0.012$).

Conclusions: body mass index and history of preeclampsia are related to preeclampsia. Furthermore, there is a large percentage of pregnant women with obesity and a history of preeclampsia who present this complication. It is recommended that healthcare professionals and other stakeholders consider these findings in their early detection activities to avoid preventable complications.

KEYWORDS

BMI, obstetric risks, maternal health, pregnancy, obstetric epidemiology.

INTRODUCCIÓN

La salud materna es el pleno potencial de salud de las mujeres durante las etapas del embarazo, el parto y el puerperio. Aunque en las últimas décadas ha progresado notablemente, aún existe una elevada cifra de muertes evitables. En el año 2017 se reportaron 295 000 muertes de mujeres durante y después del embarazo cuya causa directa fue la presión arterial alta. A nivel mundial, los trastornos hipertensivos representan aproximadamente un 14% de todas las muertes maternas¹, mientras que en el Perú, en el año 2022, fueron considerados como primera causa directa de la mortalidad materna (30,0%)².

Entre los trastornos hipertensivos, la preeclampsia sobresale como una de las causas principales de la morbimortalidad materna y neonatal, especialmente en los países de ingresos medios y bajos. Esta complicación afecta alrededor del 2 al 10% de todas las mujeres a nivel mundial, pero puede variar en cada país o población³. Asimismo, la preeclampsia es caracterizada por la presión arterial elevada de aparición repentina después de las 20 semanas de gestación y está asociada a la proteinuria (≥ 300 mg/día) y otros signos y síntomas como la hinchazón (cara, manos o pies), el aumento repentino de peso, los dolores de cabeza y los cambios en la visión⁴.

La preeclampsia puede progresar a eclampsia, muerte materna y otras consecuencias a largo plazo para la salud

tanto de la madre como del niño. Las mujeres que han presentado preeclampsia tienen menos esperanza de vida porque están expuestas a un mayor riesgo de accidentes cerebrovasculares, enfermedades cardiovasculares y mentales⁵. Respecto al feto o el recién nacido, las consecuencias son la muerte perinatal, la prematurez, el retraso en el desarrollo neurológico y la aparición de enfermedades cardiovasculares y metabólicas^{6,7}.

No existe ninguna causa y cura exacta para la preeclampsia aparte del parto, sin embargo, el diagnóstico temprano y la consideración de factores relacionados existentes⁸, pueden ayudar a controlar la preeclampsia durante el embarazo. Especialmente tomar atención cuando se trata de una gestante con estilos de vida de nutrición no saludables debido a que las modificaciones dietéticas en la mayoría de ellas son difíciles de cumplir y más aún cuando se trata de una gestante con difícil acceso a una seguridad alimentaria. Asimismo, la obesidad está aumentando en los países de ingresos medios y bajos, y por el hecho de que la preeclampsia es una causa importante de morbilidad y mortalidad materna y perinatal en estos países, es de crucial importancia comprender cómo la obesidad afecta la patogénesis de esta complicación⁸. Incluso, tener previsión en las gestantes con antecedentes patológicos personales porque la preeclampsia previa aumentaría el riesgo de preeclampsia recurrente^{9,10}.

La presente investigación es importante porque parte de los Objetivos de Desarrollo Sostenible de las Naciones Unidas (2018-2030), cuyo objetivo 3.1 es reducir la mortalidad materna¹¹. Asimismo, en el Perú, la salud materna, perinatal y neonatal es una de las prioridades de investigación en salud¹². Aunque existe una amplia literatura sobre los factores asociados a la preeclampsia a nivel mundial, en el Perú todavía es escasa, específicamente en lugares donde la mayoría de los gestantes tienen desigualdades socioeconómicas. Por último, para prevenir este trastorno en las gestantes se requiere de asistencia oportuna de un profesional de salud capacitado en un ambiente propicio que considere el riesgo individual para ejecutar intervenciones preventivas basadas en la evidencia y con equidad. Por esta razón, el objetivo del estudio es evaluar la relación entre el índice de masa corporal y la preeclampsia en gestantes atendidas en el hospital nacional Sergio E. Bernales, Lima 2021.

MÉTODOS

Se realizó un estudio de casos y controles no pareados a gestantes atendidas entre el periodo de 01 de enero hasta el 31 de diciembre de 2021 en el Hospital Nacional Sergio E. Bernales (HNSEB) que se encuentra ubicado en el distrito de Comas, Lima-Perú. Este hospital es una institución pública de tercer nivel de atención con categoría III-1 y tiene el reto de asumir una gran demanda de pacientes que provienen de tres distritos aledaños de gran densidad poblacional y pacientes que derivan de dos provincias de Lima. La mayoría de

los pacientes cuentan con un seguro de salud subvencionado por el Estado porque viven en condiciones de pobreza y de vulnerabilidad¹³.

La población fue 7108 gestantes donde 285 gestantes presentaron preeclampsia y 6823 gestantes no presentaron preeclampsia. El cálculo de la muestra se realizó con la ayuda del software estadístico OpenEpi donde se consideraron antecedentes para obtener las proporciones de los controles y los casos expuestos para su medición. Estas proporciones fueron las más altas, 23% para los casos expuestos y 8,1% para los controles expuestos¹⁴. Además, se consideraron un poder estadístico superior al 80% y un intervalo de confianza al 95% siendo datos válidos debido a que usa un estudio de simulación¹⁵. El grupo de casos fue conformado por 115 gestantes con preeclampsia leve o severa de un total de 285 porque se excluyeron 22 registros que no se encontraron en archivo y 16 por estar incompletas. En este grupo se realizó un muestreo aleatorio simple. Referente al grupo control no pareado (gestantes sin preeclampsia), se seleccionaron a 104 controles de forma aleatoria simple de un total de 6823 controles excluyéndose a siete registros que no se encontraban en el departamento de archivo y 13 por estar incompletas. Asimismo, se excluyeron a gestantes con menos de 20 semanas y con hipertensión arterial y enfermedad renal. La muestra final de 219 gestantes (figura 1). La aleatorización se realizó a través del Microsoft Excel 2016 con la siguiente fórmula: " =ALEATORIO.ENTRE"

A través de la historia clínica se obtuvieron las variables como la preeclampsia, que fue medida por el diagnóstico mé-

dico registrado en el 2021, y los datos sociodemográficos: edad de la gestante, grado de instrucción (primaria, secundaria, superior técnico, superior universitario), ocupación (independiente, dependiente y ama de casa). Asimismo, los datos obstétricos fueron: edad gestacional (menor de 37 semanas y de 37 a 42 semanas), antecedentes de paridad (nulípara, primípara y multípara), número de hijos vivos, número de controles prenatales (ninguno, menor de seis controles y mayor o igual de seis controles prenatales), periodo intergenésico (ninguno, corto y largo), antecedentes de preeclampsia (no y sí), antecedentes de diabetes (no y sí) y antecedentes de aborto (no y sí).

En cuanto índice de masa corporal, los obstetras o los nutricionistas se encargan de tallar y pesar a las gestantes, los registra y los clasifica según lo establece la Organización Mundial de la Salud en: delgadez <18,5; normal 18,5-25; sobrepeso 25,0-29,9; obesidad 30,0 a más^{16,17}.

Se recolectó información de las pacientes a través de las historias clínicas en papel que se encontraban en archivo de historias clínicas del HNSEB, previamente seleccionadas al azar. Luego se digitalizaron en un Excel para que posteriormente se analicen con el paquete estadístico Stata versión 17. Se calcularon frecuencias y porcentajes y en el análisis bivariado se utilizó la prueba de Chi-cuadrado con una significancia menor a 0,05.

El estudio contó con la aprobación del Comité Institucional de Ética en Investigación del HNSEB (N°0019-2023). De igual manera se consideró el requisito de la Declaración de Helsinki

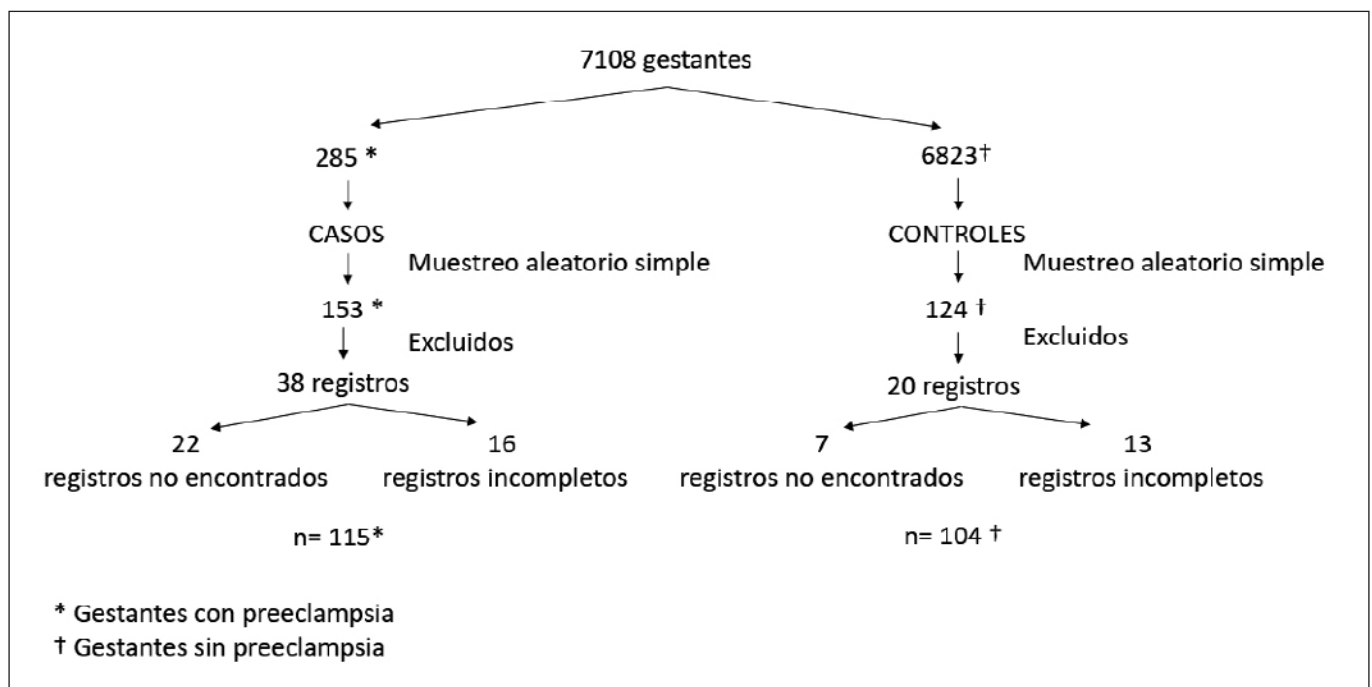


Figura 1. Diagrama de flujo de participación

de la confidencialidad de información de los pacientes, por ello se crearon códigos a los números de las historias clínicas para respetar el anonimato de las personas.

RESULTADOS

Respecto a las características de las gestantes, la edad promedio resultó 28 años, la mayoría tuvo grado de secundaria (73,39%) y fue ama de casa (88,88%). Respecto a las características obstétricas, las gestantes tuvieron un promedio de 2,01 hijos, además, el 78,87 de todas ellas tuvo de 37 a 42 semanas, el 43,19% fue obesa, solo el 7,34% presentó antecedentes de preeclampsia y el 27,40% tuvo antecedentes de aborto. El resto de los resultados se observa en la tabla 1.

A través de la prueba de Chi-cuadrado, se observa que solo los factores: índice de masa corporal ($p=0,012$) y anteceden-

tes de preeclampsia ($p=0,004$) se relacionaron significativamente con la preeclampsia. El resto de factores no se relacionaron con la preeclampsia y se puede apreciar en la tabla 2.

DISCUSIÓN

En el estudio se evidencia que una gran proporción de las participantes tiene sobrepeso y obesidad, lo que puede ser un posible factor subyacente de una mayor prevalencia de preeclampsia^{8,18}. Esto podría deberse a que la obesidad se relaciona con un mayor estrés oxidativo y aumenta las posibilidades del desarrollo de este trastorno por una inflamación sistémica resultante del exceso de adiposidad. Asimismo, el aumento excesivo de peso gestacional es un signo de alerta en la preexistencia de hipertensión arterial^{19,20}. Por otro lado, antes se creía que la obesidad era un problema de los países

Tabla 1. Características sociodemográficas, obstétricas- clínicas de las gestantes

		n	%
Características sociodemográficas			
Edad (media aritmética±Desviación estándar)		27,78 ±6,26	
Grado de instrucción	Primaria	14	6,42
	Secundaria	160	73,39
	Superior Técnico	21	9,63
	Superior Universitario	23	10,55
Ocupación	Independiente	13	5,94
	Dependiente	12	5,48
	Ama de casa	194	88,58
Características obstétricas-clínicas			
Edad gestacional	Menor de 37 semanas	45	21,13
	De 37 a 42 semanas	168	78,87
Antecedentes de paridad	Nulípara	89	40,64
	Primípara	50	22,83
	Múltipara	80	36,53
Número de hijos		2,01±1,13	
Número de controles prenatales	Ninguno	19	9,05
	Menor de 6 controles	89	42,38
	Mayor o igual de 6 controles prenatales	102	48,57

		n	%
Características obstétricas-clínicas			
Índice de masa corporal	Delgadez	4	1,88
	Normal	40	18,78
	Sobrepeso	77	36,15
	Obesidad	92	43,19
Periodo intergenésico	Ninguno	84	39,25
	Corto	22	10,28
	Largo	108	50,47
Antecedente de preeclampsia	No	202	92,66
	Sí	16	7,34
Antecedentes de diabetes	No	216	99,08
	Sí	2	0,92
Antecedente de aborto	No	159	72,60
	Sí	60	27,40
Grupo	Gestante sin preeclampsia	104	47,49
	Gestante con preeclampsia	115	52,51

Tabla 2. Análisis bivariado entre los factores obstétricos-clínicos y la preeclampsia en gestantes

Factores	Controles		Casos		valor de p
	n	%	n	%	
Índice de masa corporal					
Delgadez <18,5	2	50,00	2	50,00	0,012
Normal 18,5 – 24,9	26	65,00	14	35,00	
Sobrepeso 25,0 – 29,9	41	53,25	36	46,75	
Obesidad 30,0 a más	33	35,87	59	64,13	
Antecedente de preeclampsia					
No	101	50,00	101	50,00	0,004
Sí	2	12,50	14	87,50	
Antecedente de aborto					
No	80	50,31	79	49,69	0,173
Sí	24	40,00	36	60,00	
Edad gestacional					
Menor de 37 semanas	16	35,56	29	64,44	0,073
De 37 a 42 semanas	85	50,60	83	49,40	

desarrollados, sin embargo, se observa un aumento de prevalencia en países de ingresos bajos y medios^{21,22}. Es importante resaltar que la mayoría de la población estudiada no cuenta con estudios superiores y no tienen trabajo y, por ende, depende económicamente de su pareja, cuyo sueldo oscila entre 501 a 1000 soles, es decir menos de una remuneración mínima al mes establecida en Perú²³. Por lo tanto, estas gestantes pudieran tener menos posibilidades de una adecuada seguridad alimentaria^{19,20} e incluso tener menos conocimientos sobre hipertensión arterial sobre la importancia de los estilos de vida para prevenir los efectos nocivos del sobrepeso y la obesidad^{20,24}.

La preeclampsia y la obesidad son factores de riesgo del desarrollo de enfermedades cardiovasculares en la vejez, por lo que podría evitarse con la profilaxis y el tratamiento de la obesidad como una dieta adecuada y la actividad física regular. Además, se debe limitar el exceso de peso durante el embarazo y crear condiciones metabólicas favorables para evitar el desarrollo de la preeclampsia. Además, son fácilmente disponibles, sin contraindicaciones para su realización y seguros para la madre y el feto. Sin embargo, para que esta forma de prevención sea eficaz, debe aplicarse en las primeras etapas del embarazo y en el caso de las mujeres con sobrepeso y obesidad que desean tener hijos deben tenerlo en cuenta

para reducir la incidencia de la preeclampsia y mejorar el bienestar materno-fetal²⁵.

Un factor obstétrico relacionado a la preeclampsia fue el antecedente de este trastorno⁹. Esta relación es consistente con estudios realizados en China⁹, Perú^{26,27}, y Etiopía²⁸. Una plausible explicación es por naturaleza recurrente de la enfermedad, es decir, por la incapacidad del sistema cardiovascular para recuperarse de la preeclampsia anterior. Aunque la preeclampsia puede presentarse durante el embarazo posterior con menos signos y síntomas, las mujeres podrían tener un mayor riesgo de morbilidad a largo plazo. Por ende, los proveedores de salud deben revelar y concientizar sobre el riesgo de recurrencia en mujeres que tienen antecedentes de preeclampsia en su embarazo anterior y que es importante tanto en el manejo clínico de un embarazo posterior como en el asesoramiento de los pacientes sobre su futuro reproductivo^{24,29}.

Una limitación del estudio es que no se pudieron incluir en el estudio la gravedad de la preeclampsia y ciertos factores como el nivel socioeconómico, los ambientales, los culturales, marcadores serológicos, los antecedentes familiares de preeclampsia por parte de la madre o la hermana y el cambio de paternidad entre embarazos debido a que no se consideraron o estuvieron exactamente registradas en la historia clínica.

CONCLUSIONES

El índice de masa corporal y el antecedente de preeclampsia se relacionaron con la preeclampsia. Asimismo, la mayoría de todas las gestantes presentan sobrepeso y obesidad. Frente a los hallazgos del estudio se recomienda que los proveedores de salud y otras partes interesadas promuevan los estilos de vida saludables antes y durante la gestación, específicamente en lugares donde existen desigualdades en materia de salud. Asimismo, se debe tomar en cuenta el estado nutricional en la detección temprana de la preeclampsia y que en el primer control prenatal se realice la detección de la proteinuria como la prueba de turbidez con ácido sulfosalicílico (ASS). Por último, se deben identificar, vigilar y realizar un seguimiento cuidadoso, personalizado y holístico a las gestantes que han tenido antecedente de este trastorno para evitar la recurrencia y, por ende, otras complicaciones graves.

BIBLIOGRAFÍA

- Organización Panamericana de la Salud. Recomendaciones de la OMS sobre el tratamiento farmacológico de la hipertensión arterial leve o moderada en el embarazo [Internet]. Washington, DC: OPS; 2022 [Citado el 28 de agosto del 2023]. DOI: <https://doi.org/10.37774/9789275326350>
- Centro Nacional de Epidemiología, Prevención y Control de Enfermedades. Boletín Epidemiológico [Internet]. Lima: MINSa; 2022 [Citado el 28 de agosto del 2023]. Disponible en: https://www.dge.gob.pe/epublic/uploads/boletin/boletin_202213_29_141926.pdf
- Vargas VM, Acosta G, Moreno MA. La preeclampsia es un problema de salud pública mundial. *Rev. Chil. Obstet. Ginecol.* 2012;77(6):471-476. DOI: <http://dx.doi.org/10.4067/S0717-75262012000600013>.
- Dimitriadis E, Rolnik DL, Zhou W, Estrada-Gutiérrez G, Koga K, Francisco RPV, et al. Pre-eclampsia. *Nat. Rev. Dis. Prim.* 2023; 9(8):1-22. DOI: <https://doi.org/10.1038/s41572-023-00417-6>
- Pankiewicz K, Szzxerba, Maciejewski T, Fijalkowska A. Non-obstetric complications in preeclampsia. *Prz Menopauzalny.* 2019; 18(2):99-109. DOI: 10.5114/pm.2019.85785. PubMed PMID: 31485207. PubMed Central PMCID: PMC6719635.
- Pittara T, Vyrides A, Lamnisis D, Giannakou K. Pre-clampsia and long-term health outcomes for mother and infant: an umbrella review. *Rev. BJOG.* 2021; 128(9):1421-1430. DOI: <https://doi.org/10.1111/1471-0528.16683>
- World Health Organization. SDH Target 3.1 Reduce the global maternal mortality ratio to less than 70 per 100 000 live [Internet]. WHO [cited 2023 Aug 28]. Available from: <https://www.who.int/data/gho/data/themes/topics/sdg-target-3-1-maternal-mortality>
- Alvarez VA, Martos FD. El sobrepeso y la obesidad como factores de riesgo para la preeclampsia. *Rev. Cubana de Obstetricia y Ginecología.* 2017;43(2):e208. Disponible en: <https://revginecobstetricia.sld.cu/index.php/gin/article/view/272/430>
- Yang Y, Le Ray I, Zhu J, Zhang J, Hua J, Reilly M. Preeclampsia prevalence, risk factors, and pregnancy outcomes in Sweden and China. *JAMA Netw Open.* 2021;4(5):e218401. DOI: 10.1001/jamanetworkopen.2021.8401
- Checya-Segura J, Moquillaza-Alcántara VH. Factores asociados con preeclampsia severa en pacientes atendidas en dos hospitales de Huánuco, Perú. *Rev. Ginecol Obstet. Méx.* 2021;87(5):295-301. DOI: <https://doi.org/10.24245/gom.v87i5.2753>
- Programa de las Naciones Unidas para el Desarrollo. Objetivos de Desarrollo Sostenible. PNUD [Citado el 28 de agosto del 2023] Disponible en: https://www.undp.org/es/sustainable-development-goals?gclid=Cj0KCQjwi7GnBhDXARIsAFLvH4ktgk9SFgwJhFJN8uY4KJfOL46F_OQkbnM0Divs9f7_mLrnsnMQEwaAnzPEALw_wcB
- Ministerio de Salud [Internet]. Lima: MINSa; 2019 [citado el 05 de enero de 2020]. Resolución Ministerial 658-2019/MINSa sobre prioridades nacionales de investigación en salud para el periodo 2019-2023; [aprox. 7 pantallas]. Disponible en: https://cdn.www.gob.pe/uploads/document/file/343478/Resoluci%C3%B3n_Ministerial_N__658-2019-MINSA.PDF?v=1563814986
- Ministerio de Salud. Hospital Nacional "Sergio E. Bernales" [Internet]. Comas: MINSa; 2022 [Citado el 02 de mayo del 2024]. Plan Operativo Institucional Anual 2023. Disponible en: <https://hnseb.gob.pe/repositorio-principal/resoluciones-directorales/2022/RD2022-295.pdf>
- Paré E, Parry S, McElrath TF, Pucci D, Newton A, Lim KH. Clinical risk factors for preeclampsia in the 21st century. *Obstet Gynecol.* 2014;124(4):763-770. DOI: 10.1097/AOG.0000000000000451
- Ventura-León J, Caycho-Rodríguez T, Barboza-Palomino M. ¿Cuántos participantes son necesarios? Un método para estimar el tamaño muestral. *Rev. AAP.* 2020;118(5): e510-e513. Disponible en: <https://pesquisa.bvsalud.org/portal/resource/pt/biblio-1122551>
- Valoración Nutricional Antropométrica de la Gestante. Guía Técnica [Internet]. Lima: MINSa; 2019. [Citado el 19 de julio del 2024]. Disponible en: <https://alimentacionsaludable.ins.gob.pe/sites/default/files/2024-03/Guia%20T%C3%A9cnica%20Valoracion%20Nutricional%20Antropometrica%20Gestante.pdf>
- World Health Organization. Global data base on body mass index. WHO [Cited 2024 July 19] Available from: <https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/body-mass-index>
- Thilaganathan B, Kalafat E. Cardiovascular system in Preeclampsia and beyond. *Journal American Heart Association.* 2019;73(3):522-531. DOI: <https://doi.org/10.1161/HYPERTENSIONAHA.118.11191>
- Schiavone MJ, Perez MP, Aquieri A, Nosetto D, Pronotti MV, Mazzei M, et al. The Role of Obesity in the Development of Preeclampsia. *Current Hypertension Reports* [Internet]. 2024. [Citado el 02 de mayo del 2024]. Disponible en: <https://link.springer.com/article/10.1007/s11906-024-01299-z#citeas>
- Fajardo YL, Millán MM, Ferrer AM, Marzo ET. Prevalencia y caracterización de la Preeclampsia. *Rev. Cub. Obstet. Ginecol.* 2021;47(3):e889. Disponible en: <https://www.medigraphic.com/pdfs/revcubobsgin/cog-2021/cog213b.pdf>
- Acosta-Mogrovejo KE, Gomez-Rutti YY, Palomino-Quispe LP, Vidal-Huaman FG. Estado nutricional y prácticas alimentarias en gestantes peruanas a término. *Nutr Clín Diet Hosp.* 2023; 43(4):72-

79. Disponible en: <https://revista.nutricion.org/index.php/ncdh/article/view/425/346>
22. Loaiza MS, Marrodan SMD, Gonzales MEM. Peso al nacer y estado nutricional de gestantes controladas en la Atención Primaria de Salud, Puntas Arenas, Chile. *Nutr Clín Diet Hosp.* 2024; 44(1): 261-268. Disponible en: <https://revista.nutricion.org/index.php/ncdh/article/view/510/412>
23. Guerrero-Rosa A, Diaz-Tinoco CM. Factores asociados a preeclampsia en gestantes atendidas en un Hospital Peruano, 2019. *Rev, Int Salud Materno Fetal.* 2019;4(4):27-34. Disponible en: <http://ojs.revistamaternofetal.com/index.php/RISMF/article/view/143/173>
24. Ortiz KJ, Alvaro JM, Gonzales MC, Ortiz YJ. Level of knowledge about prevention of arterial hypertension in patients without this disease. *Rev. Latinoamericana de hipertensión.* 2022; 17(6): 431-435. DOI: <https://doi.org/10.5281/zenodo.7410642>
25. Poniedziałek-Czajkowska E, Mierzyński R, Leszczyńska-Gorzela B. Preeclampsia and Obesity-The Preventive Role of Exercise. *International Journal of Environmental Research and Public Health.* 2023; 20(2):1267. DOI: <https://doi.org/10.3390/ijerph20021267>
26. Ayala FD, Morales S, Valdivieso V, Moreno KF. Influencia del periodo intergenésico largo en el riesgo de preeclampsia. *Rev. PIMP.* 2022;11(2):21-26. DOI: <https://doi.org/10.33421/inmp.2022273>
27. Checya-Segura J, Moquillaza-Alcántara VH. Factores asociados con preeclampsia severa en pacientes atendidas en dos hospitales de Huánuco, Perú. *Rev. Ginecol Obstet. Méx.* 2021;87(5):295-301. DOI: <https://doi.org/10.24245/gom.v87i5.2753>
28. Andarge RB, Anshebo AA, Halil HM, Kebede BA, Abdo RA. Prevalence and Associated Factors of Pre-eclampsia among Pregnant Women at Antenatal Booking in the Halaba Kullito General Hospital, Southern Ethiopia. *Journal of Women's Health Care.* 2020;9:496. DOI: 10.35248/2167-0420.20.9.496
29. Wheeler SM, Myers SO, Swamy GK, Myers ER. Estimated Prevalence of Risk Factors for Preeclampsia Among Individuals Giving Birth in the US in 2019. *JAMA Netw Open.* 2022;5(1): e2142343. DOI: 10.1001/jamanetworkopen.2021.42343

Estado nutricional materno, lactancia materna y desnutrición crónica en niños peruanos menores de 5 años

Maternal nutritional status, breastfeeding and chronic malnutrition in peruvian children under 5 years

Yuliana Yessy GOMEZ RUTTI¹, Marco Alexi TABOADA GARCÍA², Isabel Margot ACEVEDO RIQUE², Janet del Rocio GORDILLO CORTAZA³, Eduardo Edison VÉLEZ PILLCO⁴, Yanina Teresa OCHOA MONTOYA⁵, Walter Adalberto GONZÁLEZ GARCÍA⁶

1 Universidad Privada del Norte.

2 Universidad Peruana Cayetano Heredia.

3 Universidad de Guayaquil.

4 Universidad Estatal de Milagro; Milagro-Ecuador.

5 Universidad Católica de Santiago de Guayaquil.

6 Universidad Técnica de Babahoyo.

Recibido: 10/junio/2024. Aceptado: 6/agosto/2024.

RESUMEN

Introducción: La optimización de la nutrición durante los mil días que transcurren desde la concepción garantiza beneficios a largo plazo, sin embargo, el retraso del crecimiento infantil hasta la obesidad adulta es una amenaza a la salud integral.

Objetivo: Determinar la relación entre el estado nutricional de la madre, la lactancia materna y desnutrición crónica en niños peruanos menores de 5 años.

Métodos: Estudio cuantitativo, descriptivo con enfoque transversal. Con una muestra de 11583 de madres con hijos menores de 5 años de la base de datos de la Encuesta Nacional Demográfica y Salud Familiar (2022) del Perú. Se utilizó la prueba de Chi cuadrado, para determinar la relación entre el IMC, anemia de la madre, lactancia materna con la desnutrición crónica de los niños. Además, se utilizó la prueba de U de Mann-Whitney para determinar si existe diferencias entre la desnutrición crónica (si/no) con la hemoglobina de la madre y talla para la edad con la lactancia materna (si/no). Se aplicó un nivel de significancia $p < 0,05$.

Resultados: El 60,4% de las madres presentaron exceso de peso y el 22,9% presentaron anemia. El 46,8% de los niños presentaron desnutrición crónica y el 64,3% recibieron lactancia materna. Existe relación entre el IMC de la madre ($p=0,001$), anemia de la madre ($p=0,001$), la lactancia materna ($p=0,001$) con la desnutrición crónica. La hemoglobina de la madre es mayor en los niños que tienen desnutrición crónica ($p=0,001$). El 54,3% de las madres sin anemia tienen niños con desnutrición crónica. Los niños que no tuvieron lactancia materna tienen desnutrición crónica que aquellos que lactaron ($p=0,001$). El 55,5% que no recibieron lactancia materna tienen niños con desnutrición crónica.

Conclusión: Las madres que presentan exceso de peso y delgadez, sus hijos presentaron mayor prevalencia de desnutrición crónica. La hemoglobina de la madre es mayor en los niños que tienen desnutrición crónica y los que no tuvieron lactancia materna tienen mayor prevalencia de desnutrición crónica que aquellos que recibieron.

PALABRAS CLAVE

Salud materna; Antropometría; Lactación.

ABSTRACT

Introduction: Optimizing nutrition during the thousand days that elapse from conception guarantees long-term ben-

Correspondencia:

Yuliana Yessy Gomez Rutti
yuliana.gomez@upn.pe

efits, however, childhood growth retardation to adult obesity is a threat to comprehensive health.

Objective: Determine the relationship between the mother's nutritional status, breastfeeding, and chronic malnutrition in Peruvian children under 5.

Methods: A quantitative, descriptive study with a transversal approach. A sample of 11,583 mothers with children under 5 years of age was obtained from the database of the National Demographic and Family Health Survey (2022) of Peru. The Chi-square test was used to determine the relationship between BMI, maternal anemia, breastfeeding, and chronic malnutrition in children. Additionally, the Mann-Whitney U test was used to determine if there are differences between chronic malnutrition (yes/no) with maternal hemoglobin and height for age with breastfeeding (yes/no). A significance level of $p < 0.05$ was applied.

Results: 60.4% of mothers were overweight and 22.9% had anemia. 46.8% of the children presented chronic malnutrition and 64.3% were breastfed. There is a relationship between the mother's BMI ($p=0.001$), maternal anemia ($p=0.001$), breastfeeding ($p=0.001$), and chronic malnutrition. Mother's hemoglobin is higher in children who have chronic malnutrition ($p=0.001$). 54.3% of mothers without anemia have children with chronic malnutrition. Children who were not breastfed had more chronic malnutrition than those who breastfed ($p=0.001$). 55.5% who did not receive breastfeeding have children with chronic malnutrition.

Conclusion: Mothers who are overweight and thin, children had a higher prevalence of chronic malnutrition. The mother's hemoglobin is higher in children who have chronic malnutrition and those who were not breastfed have a higher prevalence of chronic malnutrition than those who were breastfed.

KEYWORDS

Obesity; Size; Infant; Mother.

LISTA DE ABREVIATURAS

ENDES: Encuesta Nacional Demográfica y Salud Familiar.

INTRODUCCIÓN

El retardo en el crecimiento del niño constituye es multicausal, sin embargo, de una mala nutrición que se origina desde un control prenatal limitado hasta los primeros 36 meses de edad, afecta el desarrollo del niño e incrementa el riesgo de mortalidad¹. La influencia de la lactancia materna en el primer año de vida es importante para evaluar el crecimiento infantil, muchos estudios muestran diferencias de crecimiento, tanto en peso como en estatura, según el tipo de lactancia^{2,3}.

La nutrición durante los mil días que transcurren desde la concepción asegura el mejor inicio de la vida, con beneficios a largo plazo, sin embargo, desde el retraso del crecimiento infantil hasta la obesidad adulta, amenaza la salud de cientos de millones de personas⁴.

El crecimiento del niño afecta en el impacto económico, ya que se sufrirán pérdidas de productividad en la etapa adulta por limitado desarrollo cognoscitivo⁵, así mismo, presentan un bajo nivel educativo, la limitación de servicios básicos y los pocos ingresos de la familia⁶.

Por otro lado, el factor de la desnutrición se relaciona con la inseguridad alimentaria, el consumo de una dieta no variada, hogares con limitación al saneamiento (agua y desagüe) y el trabajo informal de las madres; es una situación alarmante, ya que la desnutrición ocasiona un tercio de las muertes en los menores de cinco años⁷. Así mismo la lactancia materna no solo está asociada a una mejor nutrición infantil, sino que además es un factor de protección para mortalidad y diversas enfermedades⁸.

Existe poca evidencia actual sobre las variables de estudio en niños menores de 5 años, los cambios continuos de políticas nacionales e internacionales, así como las intervenciones nutricionales deben ser analizados para buscar alternativas que mejoren la salud integral de la madre y el niño. Por lo expuesto, el objetivo de la investigación es determinar la relación el estado nutricional de la madre, la lactancia materna y desnutrición crónica en niños peruanos menores de 5 años.

MÉTODOS

Estudio cuantitativo, descriptivo con enfoque transversal; es un análisis secundario de la base de datos de la Encuesta Nacional Demográfica y Salud Familiar (ENDES) del año 2022⁹.

Población y muestra

La población para este estudio son madres peruanas mayores de 18 años, con hijos menores de 5 años, de la base de datos de la ENDES del año 2022, desarrollado en los meses de enero a diciembre⁹.

La muestra se caracteriza por ser bietápica, probabilística de tipo equilibrado, estratificada e independiente, a nivel departamental, por área urbana y rural. El tamaño de la muestra anual de la ENDES es de 35787 viviendas del Perú⁹.

Para el estudio se eliminaron 24204 casos entre ellos datos perdidos, respuestas no sabe/no recuerda y madres menores de 15 años, por lo que se obtuvo una muestra de 11583 madres mayores de 18 años con sus hijos menores de 5 años.

Variable e Instrumentos

El peso y la talla de la madre fueron desarrollados con la ayuda de la báscula, donde se realiza el pesaje exacto de ma-

nera digital; estimando así, el índice de masa corporal (IMC) y, con el estadiómetro, se midió la distancia vertical desde la coronilla de la cabeza hasta la base de los pies, tomada con el sujeto de pie y sin zapatos¹⁰. Para el peso del menor de 5 años se utilizó una balanza pediátrica de bandeja Seca con sensibilidad de 50 gramos y la medición de longitud de los menores de 2 años se realizó sobre una superficie horizontal dura con una cinta métrica graduada en milímetros a lo largo de la mesa¹¹. La medición de la longitud para los niños mayores de 2 años fue realizada con el tallímetro de pie^{12,13}.

Las variables maternas, como los niveles de hemoglobina se clasificaron en grave <7g/dL; moderada 7,1-9,9 g/dL; leve 10-11,9 g/dL, sin anemia >12 g/dL¹⁴; y el índice de masa corporal se clasificó de acuerdo a la OMS en bajo peso <18,49; normal 18,5 – 24,99; sobrepeso de 25 – 29; obesidad leve de 30 – 34,99; obesidad moderada 35 – 39,99; obesidad severa >40¹⁵.

Las variables desnutrición crónica se categorizó 1 ausencia; 2 presencia y la variable talla para la edad se realizó cuatro grupos; 1= desnutrición crónica severa; 2= Desnutrición crónica; 3 = Riesgo de desnutrición y 4= Normal¹⁶; y la variable lactancia materna 0=no recibió; 1= sí recibió.

Recopilación de los datos

La ENDES es una encuesta nacional anual, realizada por el Instituto Nacional de Estadística e Informática (INEI). La base de datos se obtuvo en la sección «consulta por encuestas» encuesta ENDES del año 2022, microdatos, código módulo 1634 encuesta de salud sobre inmunización y salud, del portal web del Instituto Nacional de Estadística e Informática (INEI), disponible en el siguiente enlace: <https://proyectos.inei.gov.pe/microdatos/index.htm>⁹. Luego se exportó la data del programa SPSS. Finalmente se seleccionaron las variables del estudio para su análisis descriptivo e inferencial, de los que fueron significativos.

La base de datos fue tomada de fuente secundaria del INEI-ENDES 2022 de acceso libre y autoriza el uso de la información.

Análisis estadístico

Se utilizó el Software SPSS 26 para el desarrollo del análisis de datos. Se realizó un análisis descriptivo de los datos. Se usó la prueba de Chi cuadrado, para determinar la relación entre el IMC, anemia de la madre, lactancia materna y desnutrición crónica de los niños. La prueba de U de Mann-Whitney para determinar si existe diferencias entre la hemoglobina de la madre con la desnutrición crónica y la talla para la edad con la lactancia materna. Se aplicó un nivel de significancia $p < 0,05$.

RESULTADOS

El 60,4% de las madres presentaron exceso de peso y el 31,4% IMC normal. Así mismo, el 22,9% presentaron anemia.

Tabla 1. Estado nutricional de la madre y del niño menor de 5 años

Variables	n	%
IMC de la madre		
Bajo peso	125	1,1
Normal	3633	31,4
Sobrepeso	4633	40,0
Obesidad leve	2363	20,4
Obesidad moderada	821	7,1
Obesidad mórbida	8	0,1
Nivel de anemia de la madre		
Anemia grave	12	0,1
Anemia moderada	222	1,9
Anemia leve	2420	20,9
Sin anemia	8929	77,1
Talla para la edad del niño		
Desnutrición crónica severa	1331	11,5
Desnutrición crónica	4091	35,3
Riesgo de desnutrición	4266	36,8
Normal	1895	16,4
Lactancia materna		
No	4137	35,7
Si	7446	64,3
TOTAL	11583	100,0

El 46,8% de los niños presentaron desnutrición crónica y el 64,3% recibieron lactancia materna.

En la tabla 2, se muestra que existe relación entre la talla para la edad de los niños con el IMC de las madres ($p=0,001$), en el cual se evidencia que las madres que presentan exceso de peso y delgadez sus hijos presentan mayor prevalencia de desnutrición crónica comparado con los niños de talla adecuada.

Por otro lado, existe relación entre la desnutrición crónica del niño con la anemia de las madres ($p=0,001$), las madres que no tienen anemia más del 50% de sus hijos presentan desnutrición crónica. Existe relación entre la lactancia materna con la desnutrición crónica ($p=0,001$), se evidencia que

Tabla 2. Relación entre el IMC, anemia de la madre, lactancia materna con la desnutrición crónica de los niños menores de 5 años

Variables	Desnutrición crónica				Total	*p-valor
	Ausencia		Presencia			
IMC de la madre	Delgadez	n (%)	39 (31,2)	86 (68,8)	125 (100)	0,001
	Normal	n (%)	1709 (47,0)	1924 (53,0)	3633 (100)	
	Sobrepeso	n (%)	2206 (47,6)	2427 (52,4)	4633 (100)	
	Obesidad I	n (%)	1129 (47,8)	1234 (52,2)	2363 (100)	
	Obesidad II	n (%)	267 (41,1)	383 (58,9)	650 (100)	
	Obesidad III	n (%)	72 (40,2)	107 (59,8)	179 (100)	
Anemia de la madre	Grave	n (%)	6 (50,0)	6 (50,0)	12 (100)	0,001
	Moderado	n (%)	113 (50,9)	109 (49,1)	222 (100)	
	Leve	n (%)	1221 (50,5)	1199 (49,5)	2420 (100)	
	Sin anemia	n (%)	4082 (45,7)	4847 (54,3)	8929 (100)	
Lactancia materna	No	n (%)	1841 (44,5)	2296 (55,5)	4137 (100)	0,001
	Sí	n (%)	3581 (48,1)	3865 (51,9)	7446 (100)	
Total		n (%)	5422 (46,8)	6161 (53,2)	11583 (100)	

*Chi cuadrado $p < 0,05$.

los niños que no lactaron tienen más prevalencia de desnutrición crónica (Tabla 2).

En la figura 1 se observa que hay diferencia entre los niños que presentan desnutrición crónica con los que no presentan según la hemoglobina de la madre. La hemoglobina de la madre es mayor en los niños que tienen desnutrición crónica. El 54,3% de las madres sin anemia tienen niños con desnutrición crónica (Tabla 2).

En la figura 2, se muestra que hay diferencia entre los niños que recibieron lactancia materna respecto a su talla para la edad ($p=0,001$). El 55,5% que no recibieron lactancia materna tienen niños con desnutrición crónica (Tabla 2).

DISCUSIÓN

La desnutrición, la falta de energía y nutrientes pueden afectar al cuerpo humano, esta condición puede tener manifestaciones clínicas que incluyen cambios en la morfología, fisiología, crecimiento y desarrollo tanto del cuerpo como del sistema nervioso⁴.

El sobrepeso y la obesidad han incrementado las enfermedades no transmisibles en todas las edades y en todo el mundo¹⁷. En la investigación se evidenció que un 60,4% de las madres presentaron exceso de peso. Así mismo, el 22,9%

presentaron anemia. El 46,8% de los niños presentaron desnutrición crónica y el 64,3% recibieron lactancia materna.

Los factores más importantes del retraso en el crecimiento de los niños menores de 5 años fueron las medidas antropométricas de las madres (bajo peso/altura < 160 cm), el estado civil, el bajo nivel educativo, la ausencia de seguro médico y las condiciones socioeconómicas bajas¹⁸. Así mismo, una mayor educación materna se asoció con un crecimiento y desarrollo en niños menores de 2 años¹⁹. Suyanto et al., identificaron cinco temas relacionados con los riesgos de retraso del crecimiento: antes del embarazo, durante el embarazo, postnatal, factores de enfermedades infecciosas y factores sociodemográficos²⁰.

El retraso en el crecimiento nutricional infantil se asocia con una alteración de la oxidación de grasas, un factor que predice la obesidad en otras poblaciones en riesgo. Este hallazgo puede ayudar a explicar los recientes aumentos en la grasa corporal y la prevalencia de la obesidad entre adultos y adolescentes con retraso en el crecimiento en los países en desarrollo²¹.

Los niños con retraso en el crecimiento tienen una mayor susceptibilidad a los efectos de dietas ricas en grasas, menor oxidación de grasas, mayor grasa central y mayor aumento de

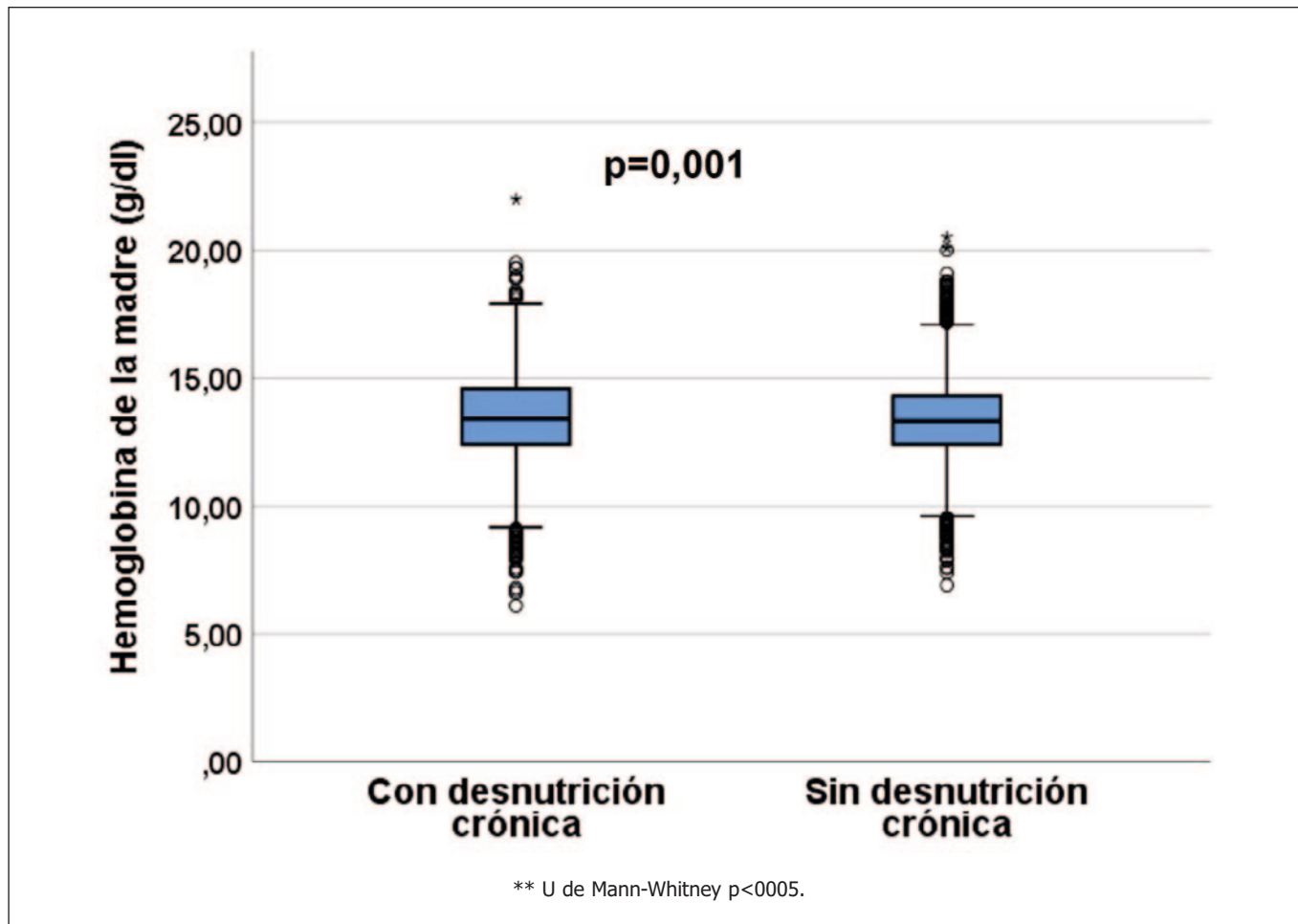


Figura 1. Diferencia entre los que presentan o no desnutrición crónica según la hemoglobina de la madre

grasa corporal. La desnutrición temprana altera el equilibrio energético en los adultos. En presencia de una insuficiencia relativa de ingesta de alimentos, una relación cortisol: insulina más alta, asociada con niveles más bajos de IGF-1, conducirá a una menor ganancia muscular y un crecimiento lineal, deterioro de la lipólisis y oxidación de grasas. Cuando estos cambios hormonales se combinan con un mayor nivel de grasas/carbohidratos y/o una marcada disminución de la actividad física, se producirá obesidad con baja estatura²², con ello prevalece la doble carga nutricional en las diferentes etapas del niño.

Existe relación entre la lactancia materna con la talla para la edad ($p=0,001$). Al respecto Brito et al.²³, encontraron que el estado nutricional del niño no existe relación alguna con el hecho de estar lactando o no, aunque el porcentaje mayor existe en los normopesos con el 38,0 % de niños lactando y el 25,3 % no lactando. De igual manera la investigación de Torres et al.²⁴, no encontraron relación significativa ($p = 0,353$) entre lactancia materna y talla para la edad entre niños de 1 a 3 años de edad. Otro estudio, realizado en niños de todos los grupos socioeconómicos, no hubo asociación importante entre la lactancia ma-

terna actual y el estado antropométrico a los 12 meses de edad. Los niños que todavía eran amamantados a los 20 meses (y, en menor medida, a los 43 meses), presentaban un estado antropométrico más deficiente que sus homólogos no amamantados²⁵. Al respecto un estudio refirió que los determinantes del crecimiento lineal fueron la longitud al nacer, la altura materna y el historial de lactancia materna exclusiva en niños menores de 2 años^{26,19}.

El estudio evidenció que los niños que no lactaron tienen más prevalencia de desnutrición crónica, así mismo la hemoglobina de la madre es mayor en los niños que tienen desnutrición crónica ($p=0,001$), esto puede ser explicado por diversos factores como los conocimientos y prácticas alimentarias principalmente de ingesta de proteínas, por otro lado, el nivel socioeconómico y acceso es importante para garantizar un crecimiento adecuado del niño. El estudio de Colian et al.²⁷, el 47,6% de niños que abandonaron la lactancia materna exclusiva, posteriormente presentaron anemia, a su vez el 69% de madre presentaron anemia. Otro estudio menciona otros factores de la alta prevalencia de retraso en el crecimiento es el resultado combinado de prácticas prolongadas de lactancia

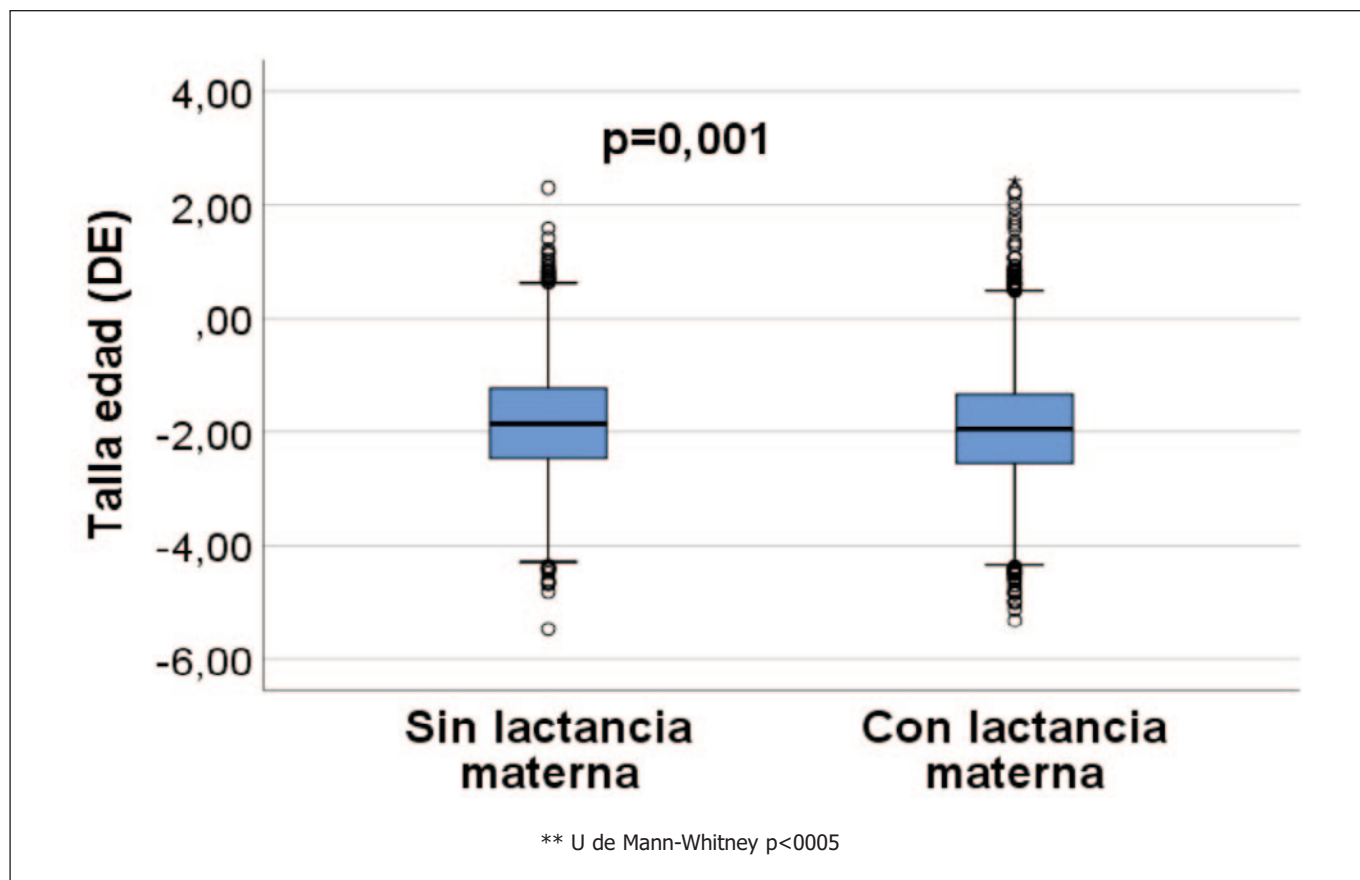


Figura 2. Diferencia entre los que presentan o no lactancia materna según la hemoglobina de la madre

materna, malas prácticas de alimentación complementaria, alto consumo de azúcar y malas prácticas de higiene bucal²⁸.

El amamantamiento es la forma óptima y natural de alimentar al lactante, la leche humana posee componentes que contribuyen al crecimiento y desarrollo, a la protección contra enfermedades y a la reducción del riesgo de muerte, la duración de la lactancia materna es más corta en los países de altos ingresos que en los de bajos recursos²⁹. En entornos de altos ingresos, la lactancia materna protege contra la otitis media, probablemente protege contra la diabetes tipo 2 y el sobrepeso y la obesidad³⁰.

La limitación del estudio fue que la encuesta no consideró la hemoglobina del niño y la estimación económica para un mejor análisis de la investigación.

CONCLUSIÓN

Las madres que presentan exceso de peso y delgadez, sus hijos presentaron mayor prevalencia de desnutrición crónica. La hemoglobina de la madre es mayor en los niños que tienen desnutrición crónica y los que no tuvieron lactancia materna tienen mayor prevalencia de desnutrición crónica que aquellos que recibieron. Es importante desarrollar y modificar

las estrategias e intervenciones sobre alimentación y nutrición dirigida a las madres para garantizar una salud integral del niño y madre.

AGRADECIMIENTOS

Agradecemos al Instituto Nacional de Estadística e Informática, por el acceso a la base de datos ENDES 2022.

REFERENCIAS

1. Antezana Marlene Inés Huaylinos. Desnutrición crónica infantil en Perú: Avances y perspectivas. *Vive Rev. Salud.* 2023; 6(18): 859-869. <https://doi.org/10.33996/revistavive.v6i18.269>.
2. Haschke F, Van't Hof MA. Euro-growth references for BF boys and girls: influence of breast-feeding and solids on growth until 36 months of age. *J Pediatr Gastroenterol Nutr.* 2000; 31 (Supl. 1): S60-71. <https://doi.org/10.1097/00005176-200007001-00006>
3. De Onis M, Onyango AW. The Centers for Disease Control and Prevention 2000 growth charts and the growth of breastfed infants. *Acta Paediatr* 2003; 92: 413-5. <https://doi.org/10.1111/j.1651-2227.2003.tb00570.x>
4. Cortez Figueroa DK, Pérez Ruiz ME. Desnutrición crónica infantil y sus efectos en el crecimiento y desarrollo. *RECIAMUC.* 2023;

- 7(2):677-86. [https://doi.org/10.26820/reciamuc/7.\(2\).abril.2023.677-686](https://doi.org/10.26820/reciamuc/7.(2).abril.2023.677-686)
5. Montenegro C, Gómez G, Hincapie O. The pediatric global burden of stunting: Focus on Latin America. *Lifestyle Med.* 2022; 3: e67. <https://doi.org/10.1002/lim2.67>
 6. Flores-Quispe M, Restrepo-Méndez M, Maia M. Trends in socioeconomic inequalities in stunting prevalence in Latin America and the Caribbean countries: differences between quintiles and deciles. *Int J Equity Health.* 2019; 18, 156. <https://doi.org/10.1186/s12939-019-1046-7>
 7. Lee H, Murimi M, Dawson J. Factors Associate with Child Malnutrition in the Somali Region of Ethiopia: A Cross-Sectional Survey, *Global Social Welfare.* 2022; 9(02) 69-77. <https://dx.doi.org/10.1007/s40609-021-00212-9>
 8. Paca-Palao Ada, Huayanay-Espinoza Carlos A, Parra Diana C, Velasquez-Melendez Gustavo, Miranda J Jaime. Asociación entre lactancia materna y probabilidad de obesidad en la infancia en tres países latinoamericanos. *Gac Sanit.* 2021; 35(2): 168-176. <https://dx.doi.org/10.1016/j.gaceta.2019.09.002>.
 9. Encuesta Nacional Demográfica y Salud Familiar. PERÚ: Enfermedades no transmisibles y transmisibles. 2022. https://proyectos.inei.gob.pe/endes/2022/SALUD/ENFERMEDADES_ENDES_2022.pdf
 10. Salazar-Medina N, Henrich-Saavedra M, Larios-Francia R, Reaño-Vera M, Schofield Bonello G. Diseño de un método para la determinación de las medidas antropométricas para ser usadas en el tallaje de la población peruana. *Ing. ind. (Lima).* 2018; 36(036): 67-3. <https://dx.doi.org/10.26439/ing.ind2018.n036.2447>
 11. Labourdette,V; Leiva, R; Morande, R; Zapata, J. Sociedad Argentina de Pediatría. Guía para la Evaluación del Crecimiento Físico. Sociedad Argentina de Pediatría; 2013.
 12. OPS. Manual de Procedimientos para la Toma de Medidas Antropométricas en Niños y Niñas Menores de Cinco Años de Edad. Honduras. Marzo 2010.
 13. Encuesta Demográfica y de Salud Familiar. Manual de la antropometrista. 2020. <https://proyectos.inei.gob.pe/iinei/srienaho/Descarga/DocumentosMetodologicos/2020-5/ManualAntropometrista.pdf>
 14. Organización Mundial de la Salud. Concentraciones de hemoglobina para diagnosticar la anemia y evaluar su gravedad. Ginebra. 2011.
 15. World Health Organization. Physical status: the use and interpretation of anthropometry. WHO Technical Report Series 854. Geneva: WHO; 1995.
 16. World Health Organization. WHO Child Growth Standars. Length/height-for-age, weight-for-length, weight-for-height and body mass index-for age. Methods and development. WHO. Switzerland, 2006
 17. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128· 9 million children, adolescents, and adults. *Lancet.* 2017;390:2627-42.
 18. Wand H, Naidoo S, Govender V, Reddy T, Moodley J. Preventing Stunting in South African Children Under 5: Evaluating the Combined Impacts of Maternal Characteristics and Low Socioeconomic Conditions. *J Prev.* 2024;45(3):339-355. <https://dx.doi.org/10.1007/s10935-024-00766-2>
 19. Cherkos AS, LaCourse SM, Kinuthia J, Mecha J, Enquobahrie DA, Escudero JN, et al. Maternal breastfeeding and education impact infant growth and development more than in-utero HIV/antiretroviral therapy exposure in context of universal antiretroviral therapy. *AIDS Lond Engl.* 2024;38(4):537-46. <https://dx.doi.org/10.1097/QAD.0000000000003785>
 20. Suyanto S, Wahyuni S, Zulharman Z, et al. Understanding stunting risk factors in Kampar Regency: Insights from mothers with stunted children (qualitative study). *SAGE Open Med.* 2024; 12:2050 3121241244662. <https://dx.doi.org/10.1177/205031212412444662>
 21. Hoffman DJ, Sawaya AL, Verreschi I, Tucker KL, Roberts SB. Why are nutritionally stunted children at increased risk of obesity? Studies of metabolic rate and fat oxidation in shantytown children from São Paulo, Brazil. *Am J Clin Nutr.* 2000;72(3):702-707. <https://dx.doi.org/10.1093/ajcn/72.3.702>
 22. Sawaya AL, Martins PA, Grillo LP, Florêncio TT. Long-term effects of early malnutrition on body weight regulation. *Nutr Rev.* 2004;62(7 Pt 2):S127-S133. <https://dx.doi.org/10.1111/j.1753-4887.2004.tb00082.x>
 23. Brito Hernández Margarita L, Barreras Meneses Katia, Quintero Fleitas Fe, López Callejo Hiorj-Lorezen Magda. Estudio sobre la influencia de la lactancia materna y su duración en la salud del niño. *Rev Cubana Enfermer.* 1995; 11(1):3-4. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-03191995000100002&lng=es.
 24. Torres-Cárdenas MH, Moya-Sifontes MZ. Lactancia materna y estado nutricional de niños entre 1 y 3 años de edad. *Rev Digit Postgrado.* 2013;1(2):6-18. http://saber.ucv.ve/ojs/index.php/rev_dp/article/view/4131
 25. Victora CG, Huttly SR, Barros FC, Martines JC, Vaughan JP. Prolonged breastfeeding and malnutrition: confounding and effect modification in a Brazilian cohort study. *Epidemiology.* 1991; 2(3):175-181.
 26. Nadhiroh SR, Ayuningtyas H, Salsabil IS. Linear growth determinants of under two years old children in Surabaya, Indonesia. *Clin Epidemiol Glob Health.* 2024;27. <https://dx.doi.org/10.1016/j.cegh.2024.101605>
 27. Colina, J., Mendiola, J., Colina, M. Factores de riesgo asociados a la anemia ferropénica en niños menores de dos años. *Medimay.* 2020; 27(4):521-30.
 28. Abdulaziz R, Suryanti N, Setiawan AS. A Review on Maternal Parenting, Child's Growth Stunting, and Oral Health. *Eur J Dent.* 2024;18(1):26-40. <https://dx.doi.org/10.1055/s-0043-1764428>
 29. Victora CG, Bahl R, Barros AJ, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *Lancet.* 2016;387(10017):475-490. [https://dx.doi.org/10.1016/S0140-6736\(15\)01024-7](https://dx.doi.org/10.1016/S0140-6736(15)01024-7)
 30. Prentice AM. Breastfeeding in the Modern World. *Ann Nutr Metab.* 2022;78 Suppl 2:29-38. <https://dx.doi.org/10.1159/000524354>

Evolução do estado nutricional de pacientes com fibrose cística durante o acompanhamento ambulatorial

Evolution of the nutritional status of patients with cystic fibrosis during outpatient

Nathalia Maria Cavalcanti DOS SANTOS¹, Marcela Do Rego Barros Carneiro MONTEIRO¹,
Jaqueline Vasconcelos da Silva GUSMÃO¹, Derberson José do Nascimento MACÊDO²

¹ Faculdade Pernambucana de Saúde (FPS) – Estudante de Nutrição, Recife-PE.

² Faculdade Pernambucana de Saúde (FPS)- Tutor de Nutrição, FPS.

Recibido: 3/junio/2024. Aceptado: 9/agosto/2024.

RESUMO

INTRODUÇÃO: Fibrose Cística (FC) é uma doença genética autossômica recessiva causada pela mutação do gene CFTR (Cystic Fibrosis Transmembrane Regulator) que resulta em desequilíbrio do cloro e sódio. Nas últimas décadas ocorreram avanços para o entendimento da doença, o que tem determinado maior sobrevida dos pacientes.

OBJETIVO: Avaliar a evolução do estado nutricional de pacientes com FC durante o acompanhamento ambulatorial.

MÉTODO: Foi realizado um estudo descritivo retrospectivo a partir da análise de formulários de acompanhamento nutricional de crianças e adolescentes com FC no ambulatório materno infantil de um hospital de referência do nordeste brasileiro, os dados foram organizados no excel com informações analisadas no software SPSS v 23.0. foram realizadas avaliações em três momentos distintos, na primeira consulta, na consulta da metade do tratamento e na última.

RESULTADOS: Observou-se uma prevalência do sexo masculino, e idade média abaixo dos 10 anos, com tempo de acompanhamento médio de 13 meses, as correlações do parâmetro peso para idade (P/I) identificaram aumento de 17,2%, havendo uma redução do déficit nutricional para

50%. Já o índice estatura para idade (E/I) apresentou uma redução no percentil de 2% e o Índice de massa corporal para idade (IMC/I) uma redução de 13,6% no déficit.

CONCLUSÃO: Com a realização deste estudo, foi possível constatar a importância do acompanhamento ambulatorial nutricional através de suas repercussões no estado nutricional de pacientes com FC, onde obtiveram evolução clínica positiva, quando comparado o estado nutricional do paciente no início e fim do acompanhamento.

PALAVRAS-CHAVE

Fibrose Cística; Avaliação Nutricional; Antropometria; Dietoterapia.

ABSTRACT

INTRODUCTION: Cystic Fibrosis (CF) is an autosomal recessive genetic disease caused by a mutation in the CFTR (Cystic Fibrosis Transmembrane Regulator) gene, which results in an imbalance of chlorine and sodium. In recent decades, advances have been made in understanding the disease, which has led to longer patient survival.

OBJECTIVE: To assess the evolution of the nutritional status of patients with CF during outpatient follow-up.

METHOD: A retrospective descriptive study was carried out based on the analysis of nutritional monitoring forms of children and adolescents with CF in the maternal and child outpatient clinic of a reference hospital in northeastern Brazil. The data were organized in excel with information analyzed in

Correspondencia:

Nathalia Maria Cavalcanti dos Santos
cavalcanti.s.nathalia@gmail.com

the SPSS v 23.0 software evaluations were carried out at three different times, at the first consultation, at the mid-treatment consultation and at the last consultation.

RESULTS: There was a prevalence of males, and an average age below 10 years, with an average follow-up time of 13 months, the correlations of the parameter weight for age (W/A) identified an increase of 17.2%, with reduction of nutritional deficit to 50%. The height-for-age index (H/A) showed a 2% reduction in the percentile and the body mass index for age (BMI/A) a 13.6% reduction in the deficit.

CONCLUSION: With this study, it was possible to verify the importance of outpatient nutritional monitoring through its repercussions on the nutritional status of patients with CF, where they obtained a positive clinical evolution, when comparing the nutritional status of the patient at the beginning and end of the follow-up.

KEYWORDS

Cystic Fibrosis; Nutritional Assessment; Anthropometry; Dietotherapy.

INTRODUÇÃO

A fibrose cística (FC) é uma doença genética autossômica recessiva com apresentação multissistêmica, podendo afetar os pulmões, pâncreas, fígado, intestinos, glândulas sudoríparas e aparelho reprodutor, sendo a doença pulmonar a maior causa de morbidade e mortalidade. Caracterizada por doença pulmonar obstrutiva supurativa crônica progressiva, insuficiência pancreática com má digestão e má absorção, desnutrição secundária, concentrações aumentadas de cloro e sódio no suor além de infertilidade masculina, na idade adulta¹⁻⁴.

Uma das explicações para a ampla gama de manifestações clínicas é o grande número de mutações para a FC conhecidas, gerando diferentes graus de perda funcional da proteína cystic fibrosis transmembrane conductance regulator (CFTR). A FC é causada pela ausência ou disfunção da proteína CFTR. Sabe-se que as mutações no gene CFTR alteram a regulação dos níveis de cloro e sódio causando uma produção excessiva de secreções e acúmulo nas vias respiratórias, causando a exacerbação da proliferação de bactérias e modificação no microambiente intestinal⁵⁻⁷.

Quando a fibrose cística foi descoberta, em 1938, poucas crianças chegavam até um ano de idade. A realidade hoje é bastante diferente, graças ao maior conhecimento sobre a fisiopatologia desta doença, principalmente por meio do diagnóstico precoce da FC, da contribuição de especialistas, de melhores tratamentos e de transplantes de órgãos, quase metade da população com FC tem 18 anos de idade ou mais. É uma doença que acomete mais os indivíduos caucasianos, mais rara nos negros e muito rara nos orientais^{3,5,8}.

A doença é diagnosticada pela presença de pelo menos um achado fenotípico ou história familiar com FC, ou triagem neonatal positiva, acompanhados de evidência laboratorial de disfunção da CFTR. O método padrão ouro para o diagnóstico da FC é realizado através da dosagem de eletrólitos no suor, níveis de cloro superiores a 60 milimoles por litro em 2 doses, associadas ao quadro clínico característico indicam que a pessoa é portadora da doença, teste do pezinho: feito de rotina apenas na maternidade para as doenças congênitas que inclui a triagem para fibrose cística. O Teste genético identifica apenas alguns tipos mais frequentes da doença, porque as mutações dos genes são muitas e os kits, padronizados, mesmo assim esses testes cobrem aproximadamente 80% dos casos^{1,8,9}.

Geralmente, o diagnóstico é feito a partir de manifestações clínicas e depende desta possibilidade diagnóstica ser identificado pelo médico diante de sinais e sintomas variados que ele pode encontrar em seu dia a dia. Os sintomas mais comuns da FC são tosse crônica, diarreia crônica e desnutrição; entretanto, pode se manifestar de várias outras maneiras, por ser uma doença que acomete vários sistemas ou órgãos. Os sintomas mais comuns de FC são tosse crônica, diarreia crônica e desnutrição, entretanto, pode se manifestar de outras maneiras, por ser uma doença que acomete vários sistemas ou órgãos^{1,6,10,11,3,10}.

O estado nutricional exerce influência no prognóstico da doença pulmonar de pacientes com FC. A desnutrição é resultado do aumento do requerimento de energia, da baixa ingestão de alimentos e da má absorção. A perda de massa muscular e, por consequência, a redução da força e resistência dos músculos respiratórios, compromete a função do diafragma, além de comprometer a função imunitária. Ainda, o prejuízo da função pulmonar favorece infecções recorrentes, o que aumenta a demanda energética, desencadeando piora do quadro pulmonar^{1,2,5}.

A relevância do acompanhamento nutricional é retratada através dos resultados positivos dos parâmetros antropométricos utilizados para avaliar o estado nutricional em crianças e adolescentes com FC, por se associarem à função pulmonar, sobrevida diminuição das intercorrências relacionadas com a patologia, estes são os indicadores peso-para-estatura (P/E), índice de massa corporal-para-idade (IMC/I) e peso-para-idade (P/I)^{2,5}.

O tratamento envolve terapia nutricional, uso de suplementos nutricionais, uso de dieta enteral via sonda nasointestinal numa fase aguda e via gastrostomia para uso prolongado. A atuação de equipe multidisciplinar de forma antecipada ao declínio do estado nutricional e a disponibilidade de medicamentos e suplementos nutricionais são fundamentais no tratamento da FC^{1,4,11}.

A prevenção dos distúrbios nutricionais pressupõe a ingestão de uma dieta hipercalórica e hiperproteica, suplementa-

ção vitamínica (Vitaminas A, E, K e D), terapia de reposição enzimática e controle das infecções/exacerbações/ outras comorbidades da fibrose cística, esses pacientes têm alto risco de desenvolver deficiência de vitaminas lipossolúveis por conta da insuficiência pancreática exócrina, é indicado que realizem a suplementação de vitaminas lipossolúveis em conjunto com uma refeição rica em lipídios e enzimas pancreáticas, para melhorar a absorção¹.

Diante do exposto, o presente trabalho objetivou avaliar a evolução do estado nutricional de pacientes com fibrose cística durante o acompanhamento ambulatorial.

MÉTODO

Tratou-se de uma pesquisa descritiva retrospectiva, que ocorreu no Recife, no Complexo Hospitalar do IMIP - Instituto de Medicina Integral Prof. Fernando Figueira, no ambulatório pediátrico, o qual é reconhecido como um centro de referência no tratamento da Fibrose cística. A coleta de dados foi realizada no período de maio de 2022 a agosto de 2022, através de uma análise de formulário de acompanhamento nutricional contendo dados antropométricos, clínicos, nutricionais e exames bioquímicos.

Para a amostra requereu-se os critérios de inclusão, crianças e adolescentes que já foram ou eram acompanhados no ambulatório de Nutrição Materno Infantil, diagnosticados com Fibrose Cística. Os critérios de exclusão foram as crianças e adolescentes que apresentam outras comorbidades que impactam o estado nutricional, participantes com menos de três consultas foram excluídos da pesquisa. Os dados foram coletados após a aceitação da pesquisa pelo comitê de ética em pesquisa do IMIP (CAAE: 53929921.0.0000.5201).

Os dados antropométricos foram avaliados de acordo com as curvas da OMS, e utilizou-se WHO Antroplus para serem obtidos os indicadores antropométricos de P/I, E/I, IMC/I, que foram extraídos a partir de cortes em três momentos de acompanhamento, na primeira consulta, na consulta da metade do tratamento e na última a partir das informações obtidas do prontuário.

Para a análise os dados obtidos foram digitados e armazenados em planilha no programa Microsoft Excel versão 2010 pelos pesquisadores principais do estudo, posteriormente os dados foram processados e analisados no software SPSS v 23.0.

As variáveis contínuas foram testadas quanto à normalidade da distribuição pelo teste de KolmogorovSmirnof, e aplicadas transformações logarítmicas (logn) quando necessárias. As variáveis com distribuição normal foram descritas sob a forma de médias e dos seus respectivos desvios padrões, e as variáveis com distribuição não Gaussiana apresentadas sob a forma de medianas e dos respectivos intervalos interquartílicos.

As variáveis com distribuição normal tiveram suas médias comparadas pelos testes de "t" Student (dois grupos inde-

pendentes) e ANOVA (mais de dois grupos independentes), quando os critérios de normalidade não forem atingidos utilizaremos os testes de MannWhitney (dois grupos independentes) e Kruskal Wallis (mais de dois grupos independentes). Foi adotado o nível de significância de 5% para rejeição de hipótese de nulidade.

Para a análise descritiva e inferencial, utilizaram os testes de Qui-quadrado de Pearson (associação entre as variáveis) e Fisher (para frequências esperadas, menores que cinco), com nível de significância estabelecido em $p < 0,05$.

RESULTADOS

No Ambulatório de nutrição Materno infantil foram identificados 49 pacientes com FC e após os critérios de exclusão foram selecionados dados de 39 pacientes, em relação à faixa etária, houve uma predominância de crianças que iniciaram o tratamento abaixo dos 10 anos de idade (59%), a idade em média das crianças e adolescentes obtida no início do acompanhamento da consulta foi de 54,9 meses, e a obtida na terceira consulta pelo estudo foi de 98,3 meses.

Com relação à idade média dos pacientes estudos como o de Forte, et al. (2018), realizado durante 1 ano e meio, em Pneumologia Pediátrica do Hospital de Clínicas de Porto Alegre (HCPA) e ambulatório de FC do Hospital São Lucas (HSL) da Pontifícia Universidade Católica, em que a idade dos pacientes da amostra era de 27 meses, assim como a presente pesquisa, a maioria dos pacientes incluídos estavam abaixo dos 10 anos.

Quanto ao sexo, nos achados desta pesquisa houve uma prevalência do sexo masculino (66,7%), o tempo médio de acompanhamento ambulatorial dos pacientes foi de 13 meses (2 - 37 meses). Quanto à procedência, a maior parte era do interior do estado de Pernambuco (60,9%), seguido pela região metropolitana do Recife ($n = 4; 17,4%$) e outros ($n = 4; 17,4%$).

Na figura 1 pode ser constatado a evolução dos escores dos três parâmetros antropométricos avaliados, desde o diagnóstico até a última consulta, dividida em três cortes avaliativos. As análises apontaram que o P/I e a E/I apresentaram uma evolução verdadeiramente positiva. Por sua vez, quando foi analisado o IMC/I ao longo dos cortes foi constatado uma variação, onde inicialmente tiveram um crescimento e posteriormente houve uma pequena queda.

Na Tabela 1 pode ser observada a evolução do diagnóstico nutricional entre a primeira e a última consulta na forma de frequência em relação ao parâmetro P/I houve uma melhora de 17,2%, mostrando uma redução do déficit nutricional, já o parâmetro E/I praticamente se mostrou estável nesse período, e em relação ao parâmetro IMC/I, foi constatado que embora tenha ocorrido uma queda no escore médio obtido entre o segundo e o terceiro corte avaliativo, na última consulta constatou-se uma redução do déficit nutricional de 6%

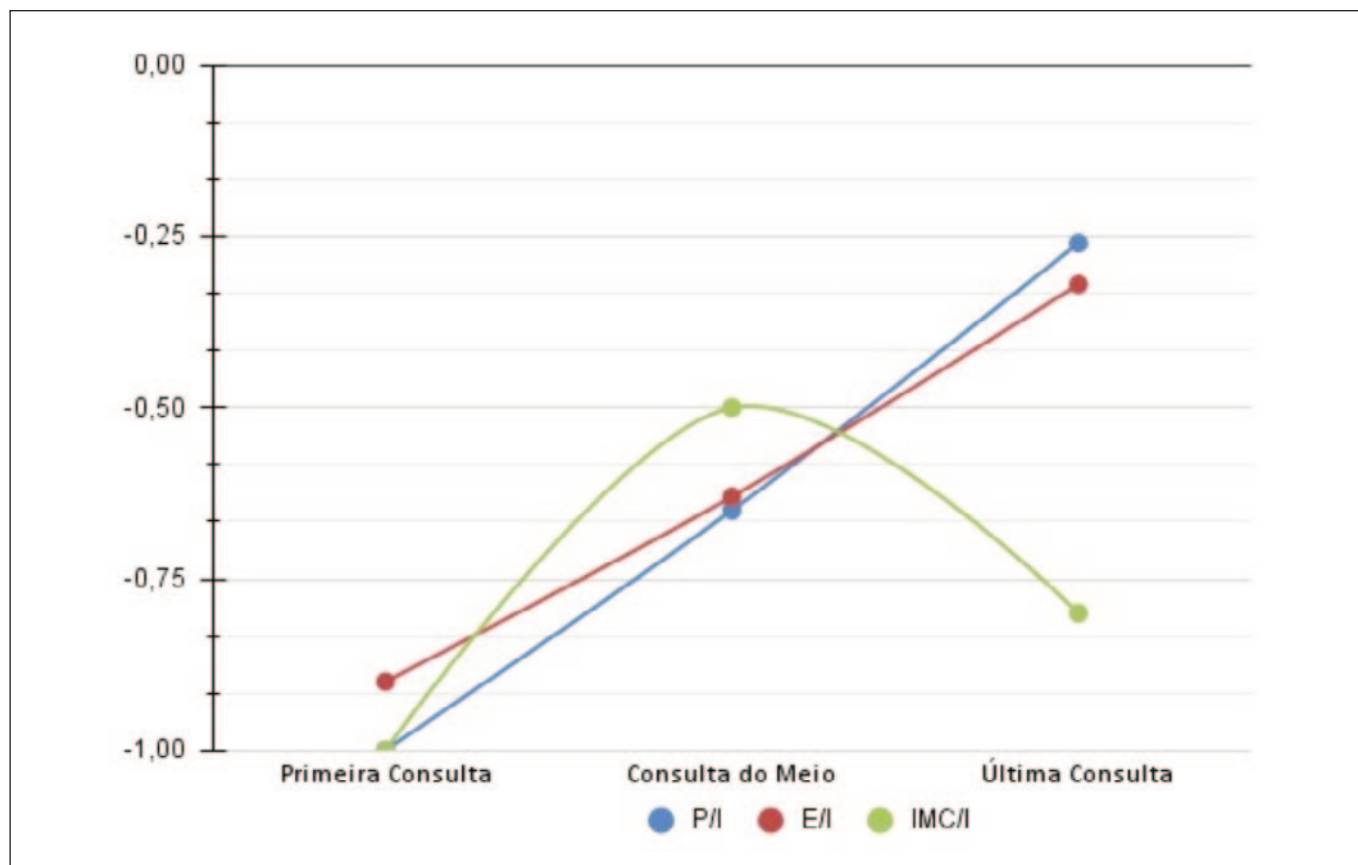


Figura 1. Evolução dos escores P/I, E/I e IMC/I durante, a primeira metade e a última consulta do acompanhamento nutricional de pacientes com FC em um hospital de referência no Recife Brasil (2022)

Tabela 1. Evolução do diagnóstico nutricional de crianças e adolescentes durante a primeira e a última consulta de acompanhamento

Parâmetros	Primeira consulta						Última consulta						P
	Déficit		Adequado		Excesso		Déficit		Adequado		Excesso		
	n	%	n	%	n	%	n	%	n	%	n	%	
P/I	7	26	19	70	1	3,7	3	13	18	82	22	4	0,009
E/I	10	28	26	72	-	-	11	30	26	70	-	-	
IMC/I	10	22	25	74	1	2,4	7	19	28	76	2	5	

*O tempo médio de intervalo entre as consultas foi de 13 meses, o número de consultas por ano foi de 3,1.

na última consulta quando comparado com a primeira consulta em razão da repercussão da terapia nutricional e o estímulo do crescimento nos incluídos na pesquisa.

DISCUSSÃO

Correlacionando o presente estudo com Yücel, et al (2022) e Chaves, et al (2015) num estudo realizado com 56 pacientes com idade entre 8 e 18 anos, em que foi avaliado o es-

tado nutricional e a distribuição da gordura corporal em crianças e adolescentes com fibrose cística, constatou-se que a maioria era do gênero feminino e com insuficiência pancreática exógena (IPE), discordando dos dados do presente estudo, que teve maior prevalência no sexo oposto.

A via da nutrição enteral é escolhida segundo Athanazio et al, (2019), como prevenção de distúrbios nutricionais da FC, que é realizado em casos mais graves quando o paciente não

consegue chegar na sua cota calórica pela via oral, depletando o seu estado nutricional em decorrência das repercussões da doença.

Na análise da presente pesquisa quando associado a evolução do estado nutricional com a via de alimentação, foi constatado que não houve diferença estatística significativa ($P = > 0,05$), não sendo um fator determinante para melhor ou pior evolução nutricional, pois os pacientes que precisaram utilizar a nutrição enteral por meio de sonda ou gastrostomia tiveram repercussões positivas no estado nutricional e evoluíram com um prognóstico positivo em relação à patologia, já os que não apresentam a necessidade da utilização tiveram uma evolução igualmente satisfatória, não sendo este um fator determinante em todos os casos para a melhora nutricional.

Um estudo realizado no Rio Grande do Sul, Forte, et al. (2018) apresentou diferença significativa no índice de massa corporal desde o momento do diagnóstico até 6 meses de tratamento, resultando num aumento do percentil de 22,99 e estabilização do estado nutricional no período subsequente de 12,48. Em relação ao escore P/I, houve uma melhora importante da evolução nutricional.

De maneira semelhante, correlacionando as análises anteriores que no parâmetro P/I obteve um crescimento linear dos escores e do percentual de evolução do diagnóstico nutricional, contínuo em todo o decorrer do estudo representado na figura 1 e na tabela 1.

Observou-se na figura 1 a evolução do estado nutricional dos pacientes durante os três momentos de acompanhamento, que pode ser justificada pela melhora no consumo alimentar dos pacientes, de acordo com suas respectivas necessidades nutricionais. Foi verificado um aumento da prevalência de déficit nutricional segundo o parâmetro E/I, por essa razão é importante o acompanhamento nutricional em pacientes com FC, uma vez que o déficit nutricional pode prejudicar o crescimento dos mesmos.

Quanto ao crescimento, os achados na pesquisa de Forte, et al. (2018) sugeriram que houve uma melhora na mediana do escore de E/I, o que diminui o comprometimento do crescimento linear das crianças do presente estudo. Com isso, é possível observar que poucos adolescentes que já haviam passado pelo estirão, tiveram seu crescimento comprometido pela falta de uma orientação nutricional, sendo apontada a importância do diagnóstico precoce. Os parâmetros de E/I mostraram um aumento linear, entre o diagnóstico e o primeiro corte onde teve um acréscimo de 16,42 no percentil e no segundo o aumento foi de 10,39, tendo um tempo de acompanhamento com diferença de 1 mês para o presente estudo.

Em relação ao presente estudo a pesquisa retratada teve resultados diferentes dos contatados pelo presente estudo,

onde de maneira semelhante houve um crescimento linear significativo do escore de E/I, porém no terceiro corte da consulta é possível observar uma redução do escore, podendo estar ligada a causas referidas pelo autor como o diagnóstico precoce ou a idade média dos incluídos que ainda não tiveram o estirão, ambos não foram explorados pelo presente estudo.

Referente ao déficit encontrado no nosso estudo de E/I foi também semelhante ao achado no estudo de Yücel1, et al (2022), onde realizaram um estudo transversal em que foi coletado em um centro, foram coletados 95 pacientes com FC no período de 2017 à 2018. Os dados antropométricos foram avaliados usando os padrões de crescimento da Organização Mundial da Saúde em que o estado nutricional era normal em 37,9% dos pacientes, sendo os valores do escore z das medidas antropométricas de todos pacientes (W-A z-score $-1,016 \pm 1,36$; H-A z-score $-0,862 \pm 1,38$; W-H z-score $-0,313 \pm 1,41$; IMC z-score $-0,706 \pm 1,35$; MUAC z-score $-1,116 \pm 1,44$; TSF z-score $-0,752 \pm 1,13$; SSF z-score $-0,458 \pm 1,18$).

Na avaliação conforme as classificações nutricionais, 31% dos pacientes <2 anos e 25,8% daqueles >2 anos foram determinados com desnutrição. Foi constatado a correlação entre os fatores de condições como inflamação, imobilização e má absorção, afetando negativamente o crescimento linear de pacientes com FC.

Assim como encontrado no presente estudo na primeira consulta alguns dos pacientes estavam com os índices antropométricos abaixo do esperado como foi observado na tabela 1 e no figura 1, porém ao longo do acompanhamento nutricional os parâmetros foram se estabilizando ao esperado dentro das condições clínicas de cada indivíduo.

Como também apresentado na pesquisa de Bonfim, et al (2020) em que foi realizado um estudo descritivo, incluindo indivíduos com idades entre 1-19 anos diagnosticados com fibrose cística. Conciliando o estado nutricional e correlacionado com variáveis clínicas e demográficas no estado da Bahia, em que de acordo com o IMC 87,8 dos pacientes que foram classificados com eutrofia e apenas um (2,4%) apresentavam magreza e (19,4%) apresentaram comprometimento da estatura pelo critério da E/I, além disso valores de E/I baixos foram associados a um maior número de hospitalizações e ao início de sintomas respiratórios, entre as crianças com baixa estatura, demonstrando um comprometimento crônico do estado nutricional. A desnutrição é uma achado frequente em pacientes com FC, tornando-se ainda mais prevalente em adultos, e é um indicador de pior prognóstico da doença.

De maneira semelhante ao nosso estudo, apresenta resultados semelhantes em relação aos parâmetros antropométricos, porém o atual mostra evolução desses dados como podem ser observados na tabela 1, concordando com a afirmação que o estudo desses indicadores associados a ou-

tros tipos de avaliação nutricional são importantes para o prognóstico da patologia.

Com relação ao IMC/I foi observado que houve uma evolução do escore no momento do diagnóstico até o término do tratamento, percebeu-se um avanço positivo até o segundo corte avaliativo, porém voltou o índice a diminuir de forma branda no corte subsequente, entretanto os pacientes permaneceram com uma melhora no diagnóstico.

A pesquisa de Marchis et al (2020) assim como a de Silva, et al (2020) em que 32 pacientes divididos em dois grupos sendo 19 praticavam atividade física e 13 não praticavam ambos diagnosticados com fibrose cística foram inscritos na Unidade de Fibrose Cística do Hospital Infantil Bambino Gesù, foi retratado que o IMC para o grupo que praticava exercícios foi maior do que o grupo que não praticava (9,92 vs 8,91). O estado nutricional foi constatado como um importante fator prognóstico para entender o futuro e a evolução da patologia. Essas correlações descritas confirmam dados da literatura, que bons níveis de atividade física refletem no melhor prognóstico da doença. A desnutrição e o retardo de crescimento foram por muito tempo dois aspectos fundamentais dos pacientes com FC. Com novas pesquisas, estão sendo criados novos conceitos sobre pacientes com FC proporcionando boas condições clínicas, onde os valores do IMC tiveram um aumento assim como os outros dados antropométricos, o que retrata um avanço na terapia nutricional e conseqüentemente num melhor prognóstico da doença.

Correlacionando com Chaves, et al (2015), o estado nutricional aferido obteve um resultado aceitável em 50% e 83% pelo IMC/I e E/I, respectivamente. Os resultados mostraram que os indivíduos com déficit nutricional apresentaram o menor acúmulo de gordura do tronco, como geralmente ocorre em crianças e adolescentes sem FC. Constatou que apenas 50% dos pacientes estavam com estado nutricional adequado (IMC/I > p 25).

Os resultados da pesquisa acima se mostraram mais preocupantes do que foram encontradas pelo presente artigo, uma vez que metade dos pacientes incluídos na pesquisa apresentavam o IMC/I adequado, exibindo uma vulnerabilidade e tendem a desenvolver o déficit nutricional nos indivíduos portadores de FC.

Já em outra pesquisa realizada no Ceará em 2017 por Freire, et al (2017), os adolescentes relataram as dificuldades que encontravam no seguimento da dieta e o grau de adesão autorreferida no seguimento das orientações nutricionais, e o estado nutricional foi diagnosticado segundo o Índice de Massa Corporal para Idade com déficit nutricional em 50% dos adolescentes.

A literatura sobre a adesão ao tratamento da FC mostra que a dieta é um dos itens com menor adesão. Assim como

pode-se observar no nosso estudo onde obteve uma porcentagem de 74% no IMC adequado do primeiro corte da pesquisa, o que sofreu variações conforme o avanço da terapia nutricional e conseqüentemente melhora dos dados antropométricos, trazendo benefícios para a sobrevida dos pacientes. Pode-se constatar também que uma das possíveis variáveis para a queda no percentual de escore observada no gráfico pode ser causada pela dificuldade de adesão ao tratamento nutricional.

Igualmente como o achado do IMC/I em Chaves, et al (2015) foi constatado um alto déficit nutricional, de maneira muito semelhante a este artigo é relatado variações no parâmetro analisado, com uma primeira melhora nos primeiros cortes e conforme o avanço do acompanhamento houve variações negativas para um melhor sobrevida do paciente o tratamento nutricional, trazendo a adesão como um dos fatores que podem ter influenciado essa inconstância.

Já em Hauschild, et al. (2018), no Ambulatório Interdisciplinar de Fibrose Cística de um centro de referência para o tratamento de FC do estado de Santa Catarina, relataram uma associação entre a carência do estado nutricional e IMC/I. Os indivíduos que iniciaram o estudo com a idade inferior a 2 anos de idade e com o estado nutricional adequado, apresentaram a mediana do IMC/I maior ao final do estudo em dezembro de 2012 quando comparado com aqueles que iniciaram o acompanhamento com déficit nutricional com idade de até 2 anos.

Assentindo com o presente estudo que após as análises e da literatura constatou que quanto mais precoce o diagnóstico e o acompanhamento nutricional menor será o déficit em todos os parâmetros nutricionais observados nesta pesquisa.

O trabalho conduzido por Neri, et al. (2019), em um estudo transversal com pacientes diagnosticados com fibrose cística, atendidos no ambulatório do Instituto da Criança do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (FMUSP), no período de janeiro a agosto de 2014, foi identificado na avaliação dos parâmetros antropométricos, que na faixa etária pré-escolar houve cerca de 10% de pacientes com perfil nutricional abaixo do esperado (Z IMC < -1), proporção que aumentou significativamente nos escolares (35,3%) e nos adolescentes (33,3%). Foi referido que a influência direta do tempo de tratamento no estado nutricional dos pacientes, indicando que estes foram mais beneficiados, proporcionando pouca oscilação negativa nos parâmetros avaliativos nos dois estudos, resultando em uma melhora na qualidade de vida.

Concordando com o que constataram em Hauschild, et al. (2018) e com o presente estudo o tempo tem influência direta no perfil nutricional, dos pacientes com FC associado juntamente com o tempo de acompanhamento nutricional, podendo ter oscilações decorrentes de fatores já discutidos que

podem causá-las, porém, nem sempre são o suficiente para anular a evolução alcançada pelo mesmo. Na pesquisa atual não foram analisadas a frequência da idade que teria o maior déficit nutricional

CONCLUSÃO

Foi possível constatar que os pacientes com FC que iniciaram o acompanhamento nutricional, foram orientados com recomendações nutricionais referentes ao prognóstico da doença adaptadas à necessidade individual, podendo o paciente necessitar ou não do uso de suplementos, ou da terapia nutricional enteral.

Como já discutido, foi comprovado que quando comparado o estado nutricional do início ao fim do acompanhamento nutricional, uma evolução dos pacientes analisados, com consequente a melhora nos parâmetros antropométricos, o que é um importante indicador para o tratamento da doença possibilitando a melhora da qualidade de vida, uma vez que tem forte influência na no número de intercorrências e no tempo de recuperação, colaborando com a prevenção e identificação precoce das deficiências nutricionais e de outras possíveis repercussões comuns à fisiopatologia da Fibrose cística.

Com isso foi possível constatar que o cuidado nutricional é de extrema importância no paciente com fibrose cística. Haja vista, a evolução dos pacientes analisados, apesar da inerente evolução da doença.

REFERÊNCIAS

- Athanzio RA, Silva Filho LVRF, Vergara AA, Ribeiro AF, Riedi CA, Procianoy EFA, Adde FV, Reis FJC, Ribeiro JD, Torres LA, Fuccio MB, Epifanio M, Firmida MC, Damaceno N, Ludwig-Neto N, Maróstica PJC, Rached SZ, Melo SFO. Brazilian guidelines for the diagnosis and treatment of cystic fibrosis. *J Bras Pneumol* [online]. 2019;43(3):219-245. Available from: <https://doi.org/10.1590/S1806-37562017000000065>.
- Hauschild DB, Rosa AF, Ventura JC, Barbosa E, Moreira EAM, Neto NL, Moreno YMF. Association of nutritional status with lung function and morbidity in children and adolescents with cystic fibrosis: 36-month follow-up. *Rev Paul Pediatr* [online]. 2018;36(1):31-38. Available from: <https://doi.org/10.1590/1984-0462/2018;36;1;00006>.
- Alves SP, Bueno D. The profile of caregivers of pediatric patients with cystic fibrosis. *Cienc Saude Colet* [online]. 2018;23(5):1451-1457. Available from: <https://doi.org/10.1590/1413-81232018235.18222016>.
- Martins JP, Forte GC, Simon MISS, Epifanio M, Pinto LA, Maróstica PJC. The role of neonatal screening in nutritional evolution in the first 12 months after diagnosis of cystic fibrosis. *Rev Assoc Med Bras* [online]. 2018;64(11):1032-1037. Available from: <https://doi.org/10.1590/1806-9282.64.11.1032>.
- Barni GC, Forte GC, Forgiarini LF, Abrahão CLO, Dalcin PTR. Factors associated with malnutrition in adolescent and adult patients with cystic fibrosis. *J Bras Pneumol* [online]. 2017;43(5):337-343. Available from: <https://doi.org/10.1590/S1806-37562016000000319>.
- Rafeeq MM, Murad HAS. Cystic fibrosis: current therapeutic targets and future approaches. *J Transl Med*. 2017;15(1):84. Available from: <https://doi.org/10.1186/s12967-017-1193-9>.
- Pinto FP, Souza GVP, Sarro KJ, Garcia CCB, Paro FM. Association between lung function, thoracoabdominal mobility, and posture in cystic fibrosis: a pilot study. *Fisioter Mov* [online]. 2020;33. Available from: <https://doi.org/10.1590/1980-5918.033.AO02>.
- Griebler EM, César MS, De Azeredo DG, Maróstica PJC, Harthmann AD. Physical exercise in the treatment of cystic fibrosis in children: a systematic review. *Clin Biomed Res* [online]. 2019;39(1). Available from: <https://seer.ufrgs.br/index.php/hcpa/article/view/87156>.
- Maciel LMZ, Magalhães PKR, Ciampo IRLD, Sousa MLB, Fernandes MIM, Sawamura R, Bittar RR, Molfetta Junior WAS. The first five-year evaluation of cystic fibrosis neonatal screening program in São Paulo State, Brazil. *Cad Saude Publica* [online]. 2020;36(10). Available from: <https://doi.org/10.1590/0102-311X00049719..>
- Neri LCL, Bergamaschi DP, Silva L, Vicente RF. Evaluation of nutritional profile in patients with cystic fibrosis according to age group. *Rev Paul Pediatr* [online]. 2019;37(1):58-64. Available from: <https://doi.org/10.1590/1984-0462/2019;37;1;00007>
- Lumertz MS, Moura A, Pinto LA, Camargos PAM, Maróstica PJC. Comparison between outcome of preschool children with cystic fibrosis identified by neonatal screening or clinical symptoms. *Sci Med*. 2018;28(2). Available from: <https://doi.org/10.15448/1980-6108.2018.2.29566>.
- Feiten TS, Flores JS, Rovedder PME, Dalcin PTR, Ziegler B. Physical activity and quality of life of children and adolescents with cystic fibrosis: a cross-sectional study. *Fisioter Mov* [online]. 2020;33. Available from: <https://doi.org/10.1590/1980-5918.032.AO70>.
- WHO. Anthro for personal computers, version 1.0.4, 2011: Software for assessing growth and development of the world's children. Geneva: WHO, 2010. Available from: <http://www.who.int/child-growth/software/en/>.
- Yücel A, Pekcan S, Eklioğlu SB, Yükksekaya HA, Ünal G, Yılmaz AI. Evaluation of nutritional status and related factors in children with cystic fibrosis. *Turk J Pediatr*. 2022;64:274-284. Available from: <https://doi.org/10.24953/turkjped.2021.415>
- Chaves CRM de M, Cunha ALP da, Costa AC da, Costa RSS da, Lacerda SV. Nutritional status and body fat distribution in children and adolescents with cystic fibrosis. *Cienc Saude Colet* [online]. 2015;20(11):3319-3328. Available from: <https://doi.org/10.1590/1413-812320152011.0324201>.
- Bomfim JC, Filho VMM, Jesus AS, Coqueiro FG, Souza EL. Anthropometric assessment and its association with clinical variables in pediatric patients with cystic fibrosis from a center in Northeast Brazil. *Rev Cienc Med Biol*. 2020;19(2):298-304.

17. De Marchis M, Ciarella M, Federici A, Di Giovanni D, Focchi AG, Bella S. Evaluation of nutritional status through bioimpedance analysis in a group of cystic fibrosis patients. *Clin Ter.* 2022;173(5):471-474. Available from: <https://doi.org/10.7417/CT.2022.2465>.
18. Silva LT, Pereira RS, Vidal P, Liberato FMG, Arpini LSB, Barbosa RRB. Exercise capacity and daily physical activity level of children and adolescents with cystic fibrosis: association with nutritional status, lung function, hospitalization, and use of antibiotics. *Fisioter Pesqui.* 2021;28(2):193-200. Available from: <https://doi.org/10.1590/1809-2950/20023328022021>.
19. Silva LT da, Pereira R da S, Vidal P, Liberato FMG, Arpini L da SB, Barbosa RRB. Exercise capacity and daily physical activity level of children and adolescents with cystic fibrosis: association with nutritional status, lung function, hospitalization, and use of antibiotics. *Fisioter Pesqui* [Internet]. 2021Apr;28(2):193–200. Available from: <https://doi.org/10.1590/1809-2950/20023328022021>.
20. Freire Salviano A, Nogueira Barreira FE, De Castro e Silva C, De Almeida PC, Do Nascimento de Oliveira V. Adesão ao tratamento dietético e estado nutricional de adolescentes com fibrose cística. *Rev Nutr. clín. diet. hosp.* 2017; 37(4):149-153. 2017;17(2):317-323. Available from: <https://doi.org/10.12873/374freire>

Efecto de la capsaicina en la conservación y características organolépticas de un embutido de cerdo

Effect of capsaicin on the preservation and organoleptic characteristics of a pork sausage

Frank Guillermo INTRIAGO FLOR¹, Luis Humberto VÁSQUEZ CORTEZ^{2,7}, Víctor Javier ZAMBRANO PINARGOTE³, Ángel Oliverio FERNÁNDEZ ESCOBAR⁴, Jonathan Estuardo ORTIZ QUIJIJE³, Sanyi Lorena RODRÍGUEZ CEVALLOS⁵, Juan Carlos GÓMEZ VILLALVA², Alexander Fernando COBOS MUÑOZ⁶

1 Docente Investigador. Universidad Técnica de Manabí, Facultad de Agrociencias. Chone. Manabí. Ecuador.

2 Docente Investigador. Universidad Técnica de Babahoyo, Facultad de Ciencias Agropecuarias, Carrera de Agroindustria. Babahoyo. Los Ríos. Ecuador.

3 Estudiante en la Universidad Técnica de Manabí, Facultad de Agrociencias, Carrera de Agroindustria. Chone. Manabí. Ecuador.

4 Docente Investigador. Universidad Técnica Estatal de Quevedo, Facultad de Ciencias de la Industria y Producción, Carrera de Ingeniería en Alimentos. Quevedo. Los Ríos. Ecuador.

5 Estudiante en la Universidad Técnica Estatal de Quevedo, Facultad de Ciencias de la Industria y Producción, Carrera de Ingeniería en Alimentos. Quevedo. Los Ríos. Ecuador.

6 Estudiante en la Universidad Católica de Santiago de Guayaquil, Facultad de Ciencias de Médicas, Carrera de Medicina. Guayas. Guayaquil. Ecuador.

7 Facultad de Ciencias Aplicadas a la Industria, Universidad Nacional de Cuyo. Doctorado Ingeniería de Productos y Procesos de la Industria Alimentaria. San Rafael. Mendoza. Argentina.

Recibido: 25/junio/2024. Aceptado: 9/agosto/2024.

RESUMEN

Introducción: El presente estudio evalúa el impacto de la capsaicina en la conservación y características organolépticas del embutido de cerdo. La investigación se llevó a cabo en el Laboratorio de Carnicos de la Facultad de Agrociencias Extensión Chone de la Universidad Técnica de Manabí. La capsaicina, conocida por sus propiedades antimicrobianas, se extrajo del ají criollo (*Capsicum annum*) para analizar su efectividad en diferentes concentraciones.

Objetivos:

1. Determinar el impacto de diferentes concentraciones de capsaicina (1%, 2%, y 3%) en la conservación del embutido de cerdo.

2. Evaluar las características organolépticas del producto tratado.

3. Verificar el cumplimiento de los estándares microbiológicos según la norma NTE INEN 1338.

Material y Métodos: Se utilizó un Diseño Experimental Completamente al Azar con cuatro tratamientos: tres concentraciones de capsaicina (1%, 2%, y 3%) y un control sin capsaicina. La capsaicina se obtuvo mediante maceración y rotovaporación del ají criollo, logrando un rendimiento del 2.53%. La vida útil del embutido de cerdo se evaluó microbiológicamente durante 28 días.

Resultados: Actividad Antimicrobiana: El tratamiento con 3% de capsaicina (T3) mostró una actividad antimicrobiana destacada, cumpliendo con los estándares microbiológicos establecidos por la norma NTE INEN 1338.

Evaluación Sensorial: En un panel no entrenado, el tratamiento T3 obtuvo una alta aceptación sensorial, con un 40% de evaluadores indicando "me gusta" y un 53% "me gusta mucho".

Conclusiones: La inclusión de un 3% de capsaicina en el embutido de cerdo mejora significativamente su conservación y mantiene buenas características organolépticas. Este tratamiento no solo cumple con los estándares microbiológicos, sino que también es bien recibido sensorialmente por los con-

Correspondencia:

Luis Humberto Vásquez Cortez
lvazquezc@utb.edu.ec

sumidores, lo que sugiere su potencial como una alternativa eficaz y aceptable para la conservación de productos cárnicos.

PALABRAS CLAVES

Antimicrobiano, capsaicina, cerdo, evaluación sensorial, vida útil.

ABSTRACT

Introduction: This study evaluates the impact of capsaicin on the preservation and organoleptic characteristics of pork button. The research was conducted at the Meat Products Laboratory of the Faculty of Agricultural Sciences, Chone Extension, Technical University of Manabí. Capsaicin, known for its antimicrobial properties, was extracted from criollo chili peppers (*Capsicum annuum*) to analyze its effectiveness at different concentrations.

Objectives:

1. Determine the impact of different concentrations of capsaicin (1%, 2%, and 3%) on the preservation of pork button.
2. Evaluate the organoleptic characteristics of the treated product.
3. Verify compliance with microbiological standards according to NTE INEN 1338.

Materials and Methods: A Completely Randomized Design was used with four treatments: three concentrations of capsaicin (1%, 2%, and 3%) and a control with no capsaicin. Capsaicin was obtained through maceration and rotary evaporation of the criollo chili pepper, achieving a yield of 2.53%. The shelf life of the pork button was microbiologically evaluated over 28 days.

Results: Antimicrobial Activity: The treatment with 3% capsaicin (T3) showed significant antimicrobial activity, meeting the microbiological standards established by NTE INEN 1338.

Sensory Evaluation: In a non-trained panel, the T3 treatment received high sensory acceptance, with 40% of evaluators indicating "like" and 53% "like a lot."

Conclusions: The inclusion of 3% capsaicin in pork button significantly improves its preservation while maintaining good organoleptic characteristics. This treatment not only meets microbiological standards but is also well-received sensorially by consumers, suggesting its potential as an effective and acceptable alternative for meat product preservation.

KEYWORDS

Antimicrobial, capsaicin, pork, sensory evaluation, shelf life.

INTRODUCCIÓN

La carne de cerdo ha sido considerada como una de las fuentes de alimento que adquirido una popularidad importante

a nivel mundial, siendo ampliamente utilizada en la producción de embutidos cárnicos, entre las que destacan el embutido de cerdo como un producto que en la actualidad es consumido por sus características sensoriales que lo hacen un producto atractivo para satisfacer las necesidades alimenticias¹.

En el Ecuador, la demanda del consumo de carne de cerdo se presenta en los diferentes mercados y empresas cárnicas que han presenciado un incremento en sus niveles de producción, siendo así, que durante el periodo del año 2019 este sector obtuvo un valor de producción de 180 mil toneladas de carne, no obstante, para el 2020 los niveles de producción alcanzaron una producción de 90 mil toneladas, sienten este nivel de producción influido por los efectos de pandemia².

En el caso de las carnes, uno de los criterios de calidad más importante después del pH, es el contenido de músculo (porcentaje magro). Es por ello que bajo estos criterios, la industria porcina ha establecido mecanismos que han permitido obtener una mejora genética que ha conllevado a aumentar proporcionalmente los rendimientos de carne magra. A su vez este desarrollo se ha ejecutado con el fin de mejorar los ingresos económicos y disminuir los costos de producción³.

La conservación de alimentos es un tema muy importante dentro del cuidado de la salud de las personas, dentro de este contexto se integra el embutido de cerdo, el cual es un alimento rico en proteínas, lo que lo hace susceptible a la contaminación bacteriana⁴. De otra manera, este parámetro se vincula con la calidad de los alimentos y se define como el conjunto de aquellas características que diferencian unidades individuales de un producto y tienen significado en la determinación del grado de aceptabilidad de esta unidad por el comprador⁵.

De igual forma se inmiscuye la capsaicina el cual es un compuesto activo del Ají, es famoso por sus interesantes aplicaciones medicinales. La aplicación tópica de capsaicina puede aliviar diferentes tipos de dolor, incluido el dolor neuropático, que es difícil de tratar porque los medicamentos antiinflamatorios u opioides no pueden aliviar este dolor, en este contexto puede ser un gran acompañamiento dentro de la condimentación de los alimentos conservados como son los embutidos de cerdo, el cual le dará el nivel de picante acorde al paladar del usuario, modificando de estas maneras sus características organolépticas⁶.

El presente estudio tiene como objetivo evaluar los efectos antimicrobianos que produce la capsaicina tanto en la conservación como en las características organoléptica de un embutido de cerdo.

La demanda actual de la sociedad por productos basados en embutido de cerdo ha forzado a la industria alimentaria a optar por condimentos naturales para el mantenimiento o extensión de la vida útil de sus productos removiendo los aditivos químicos, esto con el afán de buscar alternativas que permitan desarrollar productos nutritivos, sanos e inocuos⁷.

El efecto de la capsaicina en la conservación y características organolépticas de un embutido de cerdo tiene como finalidad sustituir la presencia de conservantes de origen sintético en la elaboración de este tipo de productos, los cuales representan un riesgo para la salud de los consumidores habituales de este tipo de productos cárnicos⁸. Desde este aspecto se busca aprovechar las propiedades conservantes de especies vegetales que se cultivan dentro de nuestro territorio las cuales poseen las cualidades necesarias para ser incluidas en este tipo de productos.

Adicional a ello se busca obtener nuevos conocimientos relacionadas a la conservación de productos y así mismo poder evaluar el efecto de la capsaicina características organolépticas de un embutido de cerdo las cuales se consideran factores importante que en la mayoría de los casos determinan la aceptación del mismo en los mercados y consigo aportar el desarrollo económico del cantón mediante el aprovechamiento de estas materias primas; se planteó la siguiente hipótesis; la capsaicina presenta aspectos positivos en la conservación y características organolépticas de un embutido de cerdo.

MATERIALES Y MÉTODOS

Localización de la Investigación

Esta investigación se la realizó en el Laboratorio de Cárnicos de la Facultad de Ciencias Zootécnicas Extensión Chone de la Universidad Técnica de Manabí ubicada en el km 2 ½, Sitio Ánima, vía Chone-Boyacá, el cual presta las condiciones adecuadas para llevar a cabo el desarrollo de los objetivos⁹.

Diseño de la Investigación

Para el desarrollo de la investigación se utilizó un Diseño Experimental Completamente al Azar compuesto por un total de cuatro tratamientos en el cual se estudió tres concentraciones de Capsaicina (1, 2 y 3%) más un tratamiento control (Sin Capsaicina). Para cada tratamiento se conformó por un total de tres réplicas y una unidad experimental¹⁰.

Obtención de la capsaicina

La obtención de la Capsaicina se la obtuvo siguiendo los procedimientos en el diagrama de flujo de la figura 1.

Descripción del proceso de elaboración del embutido de cerdo

Recepción de la materia prima

Se inicia con la recepción de los materiales e insumos, verificando que estos cumplan con los requisitos necesarios de calidad e inocuidad para el consumo humano¹¹.

Limpieza y pesado

Se procede a recibir los productos cárnicos (carnes de res, cerdo y el tocino) y se eliminan las venas, tejidos conjuntivos y cualquier materia extraña al producto cárnico. Posterior a ello se procede a pesar el producto cárnico mediante la utilización de una balanza digital de marca CAMRY con capacidad de peso de 12.000,00 gramos¹².

Troceado preliminar

Las carnes son troceadas mediante la utilización de una sierra eléctrica para cárnicos hasta obtener fragmentos de 5 a 10 cm.

Molido

Se muele la carne mediante la utilización de un molino de carnes, la cual se caracteriza por poseer una tolva que se compone de tornillo sin fin, el mismo que, el mismo que se encarga de empujar el producto a unas cuchillas giratorias para ser cortada y consecutivamente este conduce a un disco con orificios, obteniendo de esta manera fragmentos más pequeños.

Mezclado

Se procede a mezclar los productos cárnicos mediante la utilización de un cutter compuesto por un plato y cuchillas giratorias, en este proceso se le agregan las sustancias curantes, las especias y condimentos con el fin de entremezclar homogéneamente la pasta y obtener la granulosis deseada. En este caso se añade hielo con la finalidad de lograr bajar la temperatura a 7 o 10 °C. Este es un punto crítico, por lo que se debe hacer en el menor periodo de tiempo posible¹².

Tabla 1. Arreglo de los tratamientos de estudio

Tratamiento	Código	Factor	Réplicas	Unidad experimental	Total
1	T0	Sin capsaicina	3	1	3
2	T2	1% capsaicina	3	1	3
3	T3	2% capsaicina	3	1	3
4	T4	3% capsaicina	3	1	3
Total	-	-	-	-	12

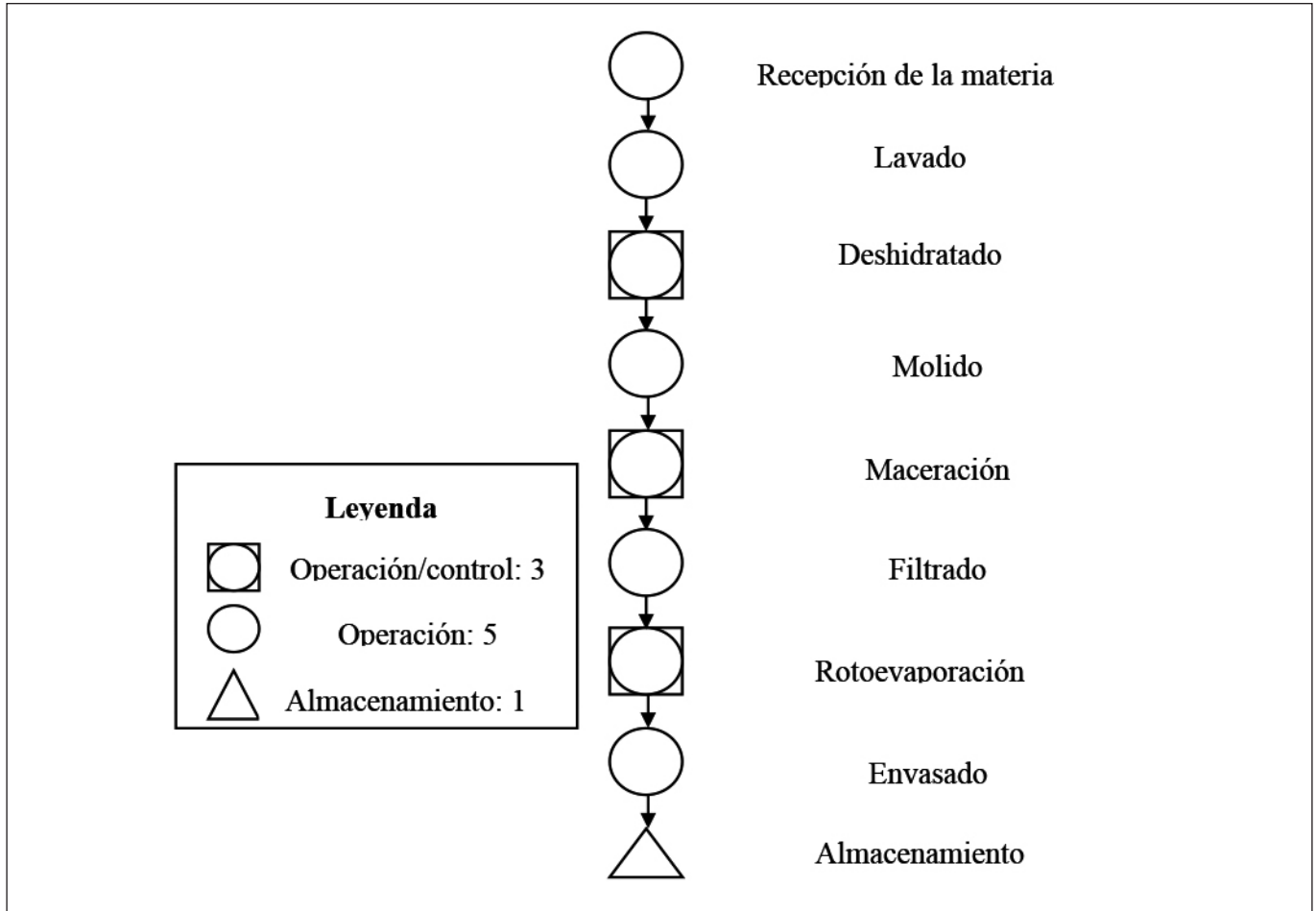


Figura 1. Diagrama de flujo para la obtención de la Capsaicina

Embutido

Se coloca la masa cárnica sobre el equipo de embutido y se conecta la tripa a boquilla del embudo y se efectúa el relleno, evitando que se hinche la tripa por la presión de la masa en el embudidor. De la misma manera se debe procurar que al realizar el embutido no queden espacios vacíos llenos de aire dentro de la tripa ya que esto afectaría su textura creando espacios huecos dentro de la masa cárnica del embutido.

Atado

Se debe desarrollar cuidadosamente para evitar daños en la tripa y consigo ocasionar el derramamiento de la masa. Este proceso se realiza a una distancia aproximada de 6 cm utilizando piolas de nylon.

Escaldado

Una vez atados los embutidos son introducidos en un recipiente con agua a 80°C manteniendo sumergidos en su totalidad y lograr escaldado uniforme. El tiempo de escaldado varía de 15 a 20 minutos, el mismo que depende del calibre del embutido¹³.

Ahumado

Se realiza en una cámara de ahumado en caliente a una temperatura promedio de 70°C, utilizando como fuente de combustión leña. Este proceso se realiza por un periodo de 2 a 3 horas, con la principal finalidad de lograr que el embutido de cerdo tome una consistencia firme derivado de una correcta coagulación de las proteínas de la masa cárnica¹⁴.

Enfriado de los Embutidos

Se procede a colocar el embutido de cerdo sobre agua fría o sobre trozos de hielo hasta que se enfríen en su totalidad.

Colgado

Luego del enfriado los embutidos son colgados a los espetones sin que se contacten para que escurran y se sequen.

Almacenamiento

Al final los productos son almacenados bajo refrigeración, a temperatura de 4°C¹⁴.

Evaluación del tiempo de vida útil de los tratamientos en estudio

Se efectuó una evaluación del tiempo de vida útil de los tratamientos en estudio mediante análisis microbiológicos, efectuados por un periodo de 28 días, efectuando evaluaciones cada 28 días. Previo al desarrollo del análisis se tomó una muestra de 100 gramos la misma que se colocó sobre una funda ziploc previamente higienizada con la finalidad de evitar la contaminación del producto cárnico. Para cada uno de los tratamientos en estudio se evaluaron los siguientes parámetros:

- Aerobios mesófilos mediante Recuento estándar En Placa (UFC/g) mediante el Método de la norma¹⁵.
- *Staphylococcus aureus* (UFC/g) mediante el método de ensayo de la norma NTE INEN-ISO 6888-3.
- *E. coli* (UFC/g) mediante los métodos de ensayo de la ISO¹⁶.
- Salmonella (/25g) aplicando los métodos de ensayo de la norma¹⁷.

Evaluación sensorial del mejor tratamiento

Se efectuó una evaluación sensorial del mejor tratamiento mediante la utilización de un test de escala hedónica con puntuaciones del 1 al 7. Se utilizó un total de 30 panelistas entre hombres y mujeres consumidores de productos cárnicos cocidos con un rango de edad de 20 a 50 años. A cada uno de los catadores se les entregó la respectiva hoja de evaluación y se procedió a dar una explicación sobre la evaluación del producto.

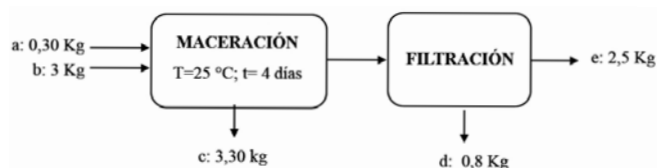
Análisis Estadístico

Los análisis estadísticos se desarrollaron mediante la utilización del programa estadístico InfoStat Versión libre. Los datos fueron analizados mediante la utilización de las pruebas de ANOVA y posterior comparación de medias utilizando las pruebas de Tukey con un intervalo de confianza del 95%.

RESULTADOS

Determinación del rendimiento de capsaicina extraída mediante el método de maceración de ají criollo.

Se obtuvieron los resultados de los procesos de maceración, filtrado y rotovaporación del extracto de capsaicina mostrando los siguientes valores:



- a: ají deshidratado
- b: aguardiente de caña

- c: Extracto bruto
- d: Torta de filtrado
- e: Extracto filtrado

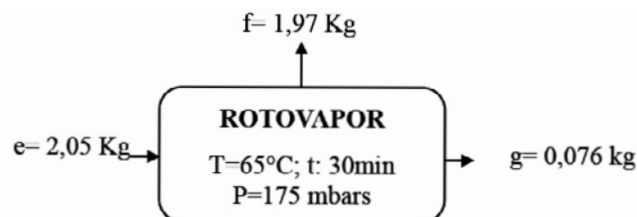
Balance para maceración

- $a + b = c$
- $0,3 \text{ Kg} + 3 \text{ Kg} = c$
- $c = 3,30 \text{ Kg}$

Balance para filtrado

- $c = d + e$
- $3,30 \text{ Kg} = d + 2,5 \text{ Kg}$
- $d = 1,05 \text{ Kg}$

Los resultados del proceso de maceración para la obtención de la capsaicina muestran como resultados que se obtuvo como extracto bruto un contenido de 3,30 kg que partía de la mezcla del solvente y los gramos de ají. Para el balance del filtrado se los resultados muestran un rendimiento de 2,5 kg de extracto libre.



Balance para rotovaporador

Donde:

- e: Extracto Filtrado.
- f: acetona.
- g: Extracto seco.

Balance para Rotovaporador

- $e = f + g$
- $2,05 \text{ Kg} = f + 0,076 \text{ Kg}$
- $f = 2,05 - 0,076 \text{ Kg}$
- $f = 1,974 \text{ kg}$

Los resultados del balance de masa de la rotovaporación para la obtención de la capsaicina muestran como resultados que se obtuvo un 0,076 kg de extracto seco.

Rendimiento de extracción

$$\% \text{Rendimiento} = \frac{i}{a} * 100 = \frac{\text{Extracto seco}}{\text{ají seco}} * 100$$

$$\% \text{Rendimiento} = \frac{0,076 \text{ Kg}}{3 \text{ Kg}} * 100\%$$

$$\% \text{Rendimiento} = 2,53\%$$

Los rendimientos obtenidos para la obtención de los extractos muestran como resultados un total de 2,53% el mismo que parte desde la maceración hasta la rotovaporación.

Determinación de la vida útil de anaquel en el embutido de cerdo mediante un estudio microbiológicos en base a la norma NTE INEN 1338

Como se puede apreciar en la Tabla 2 el comportamiento de los microorganismos aerobios mesófilos de los tratamientos en estudio muestra como resultados que durante cada una de las evaluaciones desarrolladas durante el periodo de los 28 días se obtuvo que en cada uno de los casos se obtuvo que no se encontraron diferencias significativas ($p < 0,05$) entre los valores promedios obtenidos en cada una de las semanas.

De acuerdo con los resultados obtenidos para este parámetro se puede apreciar que la inclusión de la capsaicina en la elabo-

ración del embutido de cerdo ejerció una actividad antimicrobiana en este tipo de producto con valores que se encontraron dentro de los requisitos expuestos por la norma NTE INEN 1338.

Curva de Determinación de Aerobios mesófilos

En la Figura 2, se aprecia que el T3 durante 21 días obtuvo una disminución en los valores promedios registrados valores promedios registrado para las unidades formadoras de colonia de cada uno de los tratamientos en estudio, siendo en este caso el tratamiento T3 el que mayor efecto ejerció sobre este tipo de microorganismo alcanzado un total de 171 UFC.

Determinación de la vida útil de anaquel en el embutido de cerdo mediante un estudio microbiológicos de *Staphylococcus aureus* (UFC/g)

De acuerdo con los resultados expuestos en la Tabla 3 de la evaluación de la presencia de *Staphylococcus aureus* (UFC/g) en las muestras de un embutido de cerdo con la inclusión de tres niveles de capsaicina y frente a un tratamiento control se puede apreciar que los valores muestran un com-

Tabla 2. Determinación de Aerobios mesófilos del embutido de cerdo (Vida útil)

Trat.	Día 1	Día 7	Día 14	Día 21	Día 28	MIN INEN	MAX INEN
T0	2,21E+03 a	1,53E+03 a	1,58E+03 a	1,20E+03 a	4,22E+02 a	5,00E+05	1,00E+07
T1	2,12E+03 a	1,56E+03 a	1,20E+03 a	1,18E+03 a	3,91E+02 a		
T2	2,17E+03 a	1,63E+03 a	1,23E+03 a	7,12E+02 a	3,97E+02 a		
T3	1,12E+03 a	1,60E+03 a	1,23E+03 a	5,29E+02 a	1,71E+02 a		
E.E.	891	110	310	560,66	211		
p-valor	0,7924	0,9126	0,7990	0,7835	0,8208		

Medias con una letra en común en la misma columna no son significativamente diferentes ($p < 0,05$).

Tabla 3. Determinación de *Staphylococcus aureus* (UFC/g) del embutido de cerdo (Vida útil)

Trat.	Día 1	Día 7	Día 14	Día 21	Día 28	MIN INEN	MAX INEN
T0	5,59E+03 a	2,18E+03 a	2,47E+03 a	4,09E+02 a	2,08E+02 a	1,00E+03	1,00E+04
T1	5,42E+03 a	2,03E+03 a	2,51E+03 a	3,49E+02 a	1,97E+02 a		
T2	5,73E+03 a	1,73E+03 a	1,71E+03 a	2,88E+02 a	1,88E+02 a		
T3	3,34E+03 a	1,23E+03 a	1,04E+03 a	2,73E+02 a	1,11E+02 a		
E.E.	1693	722	1149	124	75		
p-valor	0,7280	0,7991	0,7768	0,8600	0,7942		

Medias con una letra en común en la misma columna no son significativamente diferentes ($p < 0,05$).

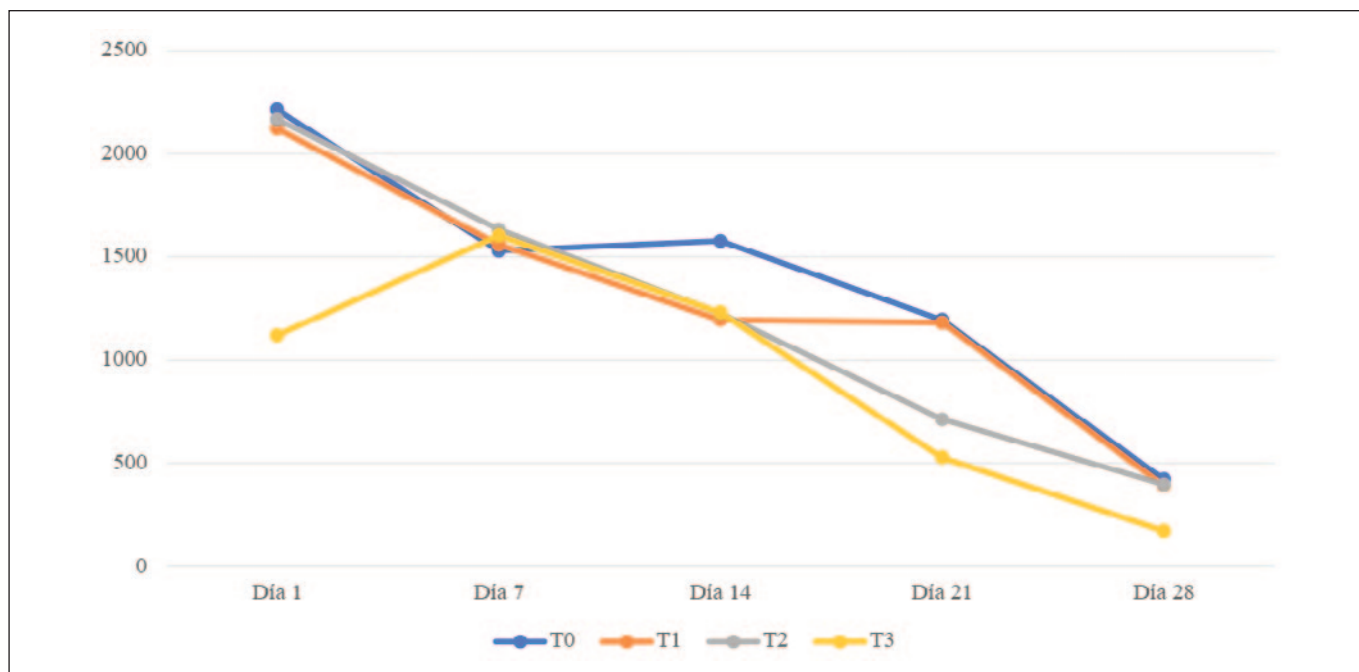


Figura 2. Curva de determinación de *Aerobios mesófilos*

portamiento similar entre los valores promedio de los tratamientos en estudio durante cinco semanas en que se desarrolló la evaluación de este parámetro microbiológico.

Desde el día 0 hasta el día 21 la capsaicina ejerció un efecto antimicrobiano en todos los tratamientos, los cuales se ubicaron por debajo del valor máximo permitido por la norma NTE INEN 1338.

Curva de Determinación de *Staphylococcus aureus* (UFC/g)

En la Figura 3, se muestra el comportamiento de *Staphylococcus aureus* (UFC/g) durante el periodo de almacenamiento del embutido de cerdo utilizando la capsaicina como conservante natural, de acuerdo con los resultados obtenidos se puede apreciar que en cada uno de los casos la

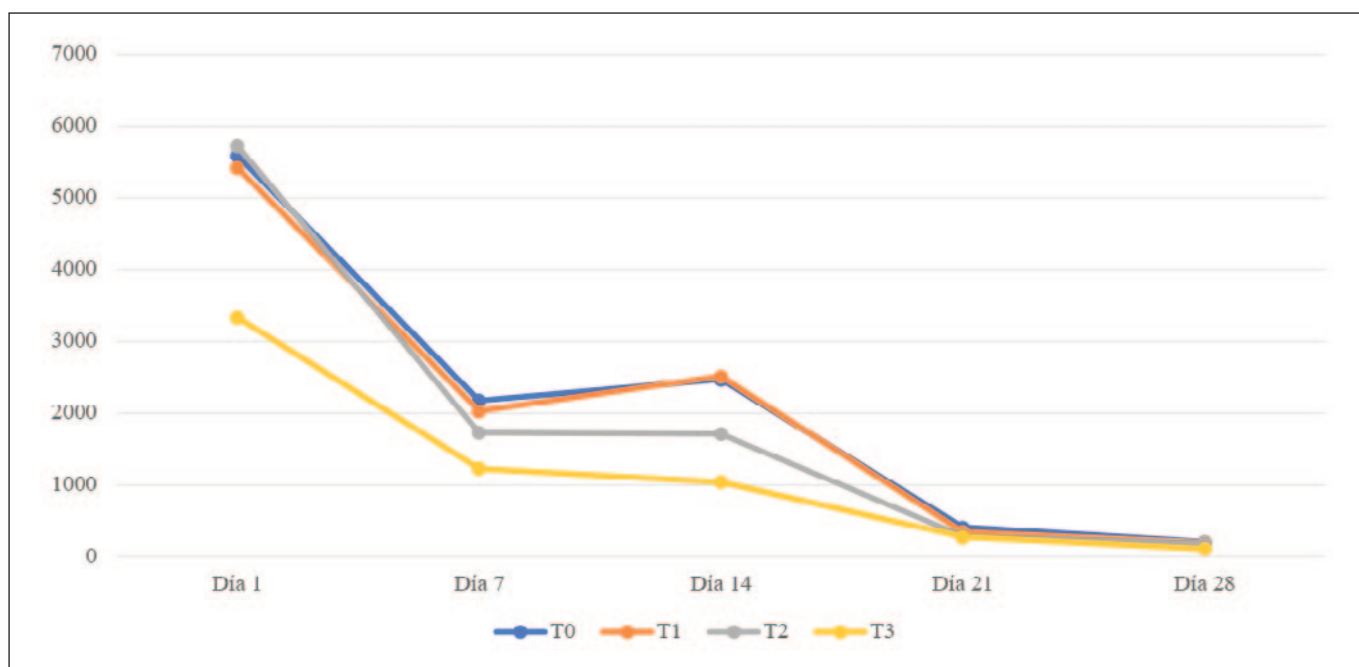


Figura 3. Curva de determinación de *Staphylococcus aureus* (UFC/g)

curva de UFC de este microorganismo presentan una tendencia negativa que encamina a la disminución del *S. aureus* en el producto hasta los 28 días encontrándose valores inferiores a 208 UFC/g, cantidades que de acuerdo con la norma NTE INEN 1338 no representan un riesgo para la salud de los consumidores.

En la Tabla 3 se describen los valores obtenidos con respecto a la producción de *E. coli* sobre el embutido de cerdo muestra que los valores registrados para los tratamientos T0 y T1 se encontraron por encima de los requisitos mínimos de la norma NTE INEN 1338, de la misma manera los tratamientos T2 y T3 muestran que hasta los 21 días los valores se encontraron por encima de los valores descritos por esta

norma, los que a su vez mostraron un comportamiento significativo ($p < 0,05$) con los demás tratamientos no obstante, se puede observar que para el día 28 los resultados fueron favorables para estos tratamientos con valores inferiores a 10 UFC/g, siendo a su vez los tratamientos que estadísticamente presentaron un mayor efecto antimicrobiano sobre el *E. coli* (UFC/g).

Curva de Determinación de *Staphylococcus aureus* (UFC/g)

Como se puede apreciar en a Figura 4, los resultados del conteo de *E. coli* en las muestras de embutido de cerdo dieron como resultados que el tratamiento control mostro valores que

Tabla 3. Determinación de *E. coli* (UFC/g) del embutido de cerdo (Vida útil)

Trat.	Día 1	Día 7	Día 14	Día 21	Día 28	MIN INEN	MAX INEN
T0	1,11E+02	9,13E+01 c	9,17E+01 c	6,20E+01 c	5,53E+01 c	1,00E+01	0,00E+00
T1	9,93E+01	4,20E+01 b	4,03E+01 b	3,40E+01 b	2,50E+01 b		
T2	1,09E+02	2,27E+01 a	2,20E+01 a	1,60E+01 a	8,00E+00 a		
T3	1,01E+02	2,13E+01 a	1,90E+01 a	1,23E+01 a	5,00E+00 a		
E.E.	5	1	1	1	1		
p-valor	0,2490	<0,0001	<0,0001	<0,0001	<0,0001		

Medias con una letra en común en la misma columna no son significativamente diferentes ($p < 0,05$).

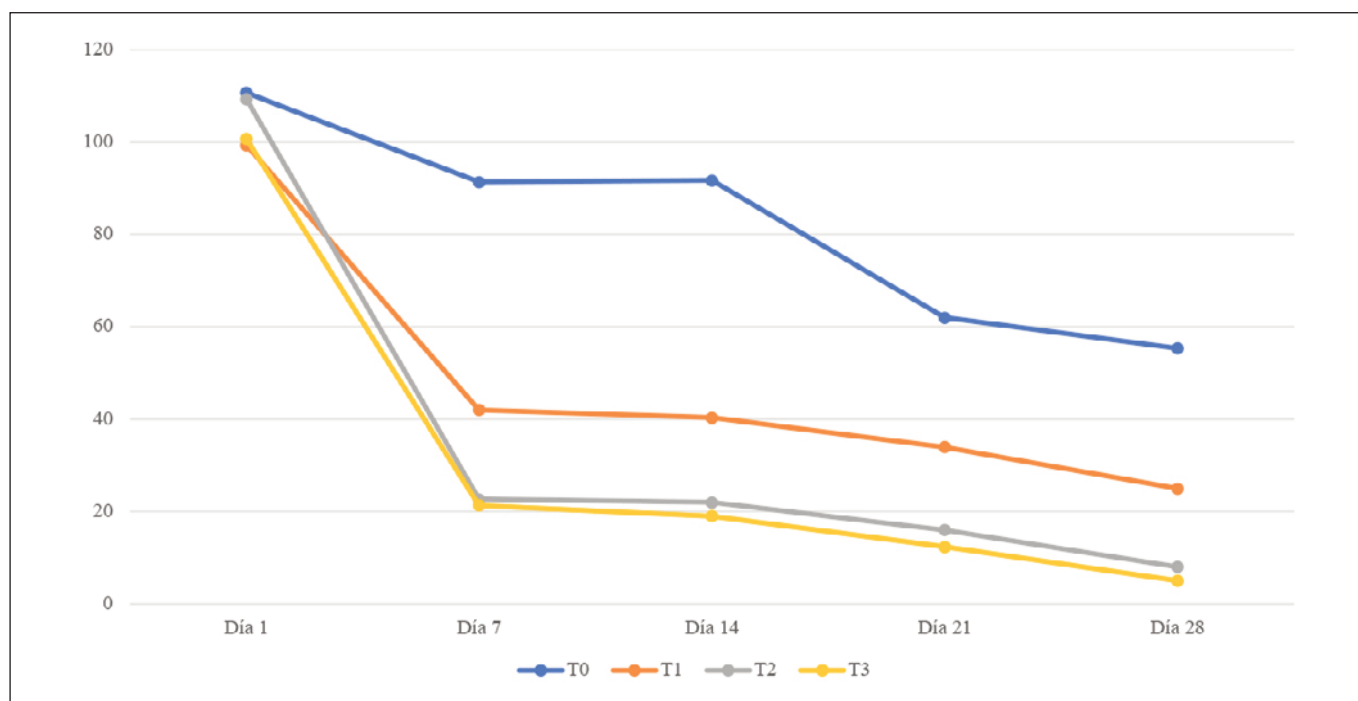


Figura 4. Determinación de *Staphylococcus aureus* (UFC/g) del embutido de cerdo (Vida útil)

no cumplen con los requisitos de la norma NTE INEN 1338, en tanto que para los tratamientos que incluyeron las tres concentraciones de la capsaicina los valores fueron menores en comparación con los registrados en el tratamiento control. No obstante, es importante mencionar que los tratamientos T2 y T3 en el día 28 mostraron resultados favorables para su consumo, con valores de 8 y 5 UFC/g, respectivamente.

Determinación de la vida útil de anaquel en el embutido de cerdo mediante un estudio microbiológicos de Salmonella (UFC/g)

Como se puede apreciar en la Tabla 4 el embutido de cerdo obtuvo como resultados el cumplimiento de los estándares de calidad en cuanto a la presencia de Salmonella durante el periodo de 28 días, los cuales indican la ausencia de este indicador microbiológico en el producto de acuerdo con los requisitos de la norma NTE INEN 1338, en la que se indica la ausencia de este indicador en productos cárnicos cocidos, indicando que las materias primas y el proceso de elaboración del embutido de cerdo fue elaborado de forma aséptica, siendo este uno de los elementos que garantiza que no se presenten este tipo de microorganismos en el producto final

Evaluación sensorial al mejor tratamiento conservado del embutido de cerdo

Como se puede apreciar en la Tabla 5, de la evaluación sensorial al tratamiento con mayor actividad antimicrobiana (T3), se puede apreciar que el parámetro con mayor aceptación obtuvo fue me gusta mucho con una frecuencia de 16 personas que representan el 53,33% del total de catadores, seguido del parámetro me gusta con una frecuencia de 12 personas que representan el 40%, siendo este un indicador de que este tratamiento mostro resultados favorables en relación a los parámetros sensoriales.

DISCUSIÓN

Investigaciones preliminares indican que variedades de ají C. chinense tiene un rendimiento de capsaicina de 11.34 g/kg de fruto; C. annum de 2.99 g/kg de fruto, C. frutescens de 2.05 g/kg de fruto, C. pubescens de 0.60 g/kg de fruto, indicando la variabilidad existente entre las variedades en estudio¹⁸. Sin embargo¹⁹, indican que los rendimientos entre las variedades en estudio son influenciados por el tipo solvente y la concentración de este compuesto en el materia vegetal.

Estos resultados muestran superioridad a los resultados reportados por²⁰, donde el rendimiento de Capsaicina (Producto

Tabla 4. Determinación de Salmonella (25/g) del embutido de cerdo (Vida útil)

Trat.	Día 1	Día 7	Día 14	Día 21	Día 28	MIN INEN	MAX INEN
T0	Ausencia	Ausencia	Ausencia	Ausencia	Ausencia	Ausencia	Ausencia
T1	Ausencia	Ausencia	Ausencia	Ausencia	Ausencia		
T2	Ausencia	Ausencia	Ausencia	Ausencia	Ausencia		
T3	Ausencia	Ausencia	Ausencia	Ausencia	Ausencia		

Tabla 5. Evaluación sensorial al mejor tratamiento

Parámetros	Frecuencia	Fr	%	Fa
No me gusta	0	0,00	0,00	0
Me disgusta	0	0,00	0,00	0
no me gusta mucho	0	0,00	0,00	0
No me gusta ni me disgusta	2	0,07	6,67	2
Me gusta poco	0	0,00	0,00	2
Me gusta	12	0,40	40,00	14
Me gusta mucho	16	0,53	53,33	30
Total	30	1	100	

Final) al utilizar como materia prima Ají Jalapeño entero obtuvo como resultados un 0.12% de rendimiento total, posiblemente asociado a la utilización de un solvente diferente al utilizado en nuestra investigación.

Por otra parte, Peña & Gómez¹⁹, al evaluar el porcentaje de capsaicina en la oleoresina obtenida en las dos especies de *Capsicum* Ají panca (*Capsicum chinense*) y Ají mirasol (*Capsicum baccatum*), documentan como resultados valores de 10,28 y 3,08% al utilizar etanol al 95% para ambas variedades en estudio.

Resultados expuestos por Salazar²¹, recuento de aerobios mesófilos totales (UFC/g) muestra como resultados un incremento de este microorganismo durante el tiempo de almacenamiento, el mismo que mostro un incremento significativo ($p < 0,05$) entre cada uno de los tratamientos en estudio con valores de $6.04 \pm 0.21 \log$ (1 096 478.20) y $7.27 \pm 0.33 \log$ (18 620 871. 37) a los 90 días.

Resultados expuestos por Herrera & Villa²², al evaluar las características microbiológicas de un producto cárnico procesado obtuvo como resultado valores de inferiores a 10 UFC/g, los cuales muestran el cumplimiento de los requisitos de la NTE INEN 1338:2012.

Investigaciones preliminares han documentado el efecto antimicrobiano de extractos de plantas, semillas y cáscaras de origen vegetal frente al desarrollo *Staphylococcus aureus*, indicando que este tipo de compuestos tienen la capacidad de inhibir el desarrollo de este tipo de microorganismos mediante el rompimiento de la pared celular del microorganismo y consigo se impide la reproducción del mismo y en ciertos casos la eliminación²³.

Resultados previos expuestos por Gutiérrez²⁴, Al evaluar el efecto de la concentración de ají panca muestra sobre *S. aureus* describe que al ser un tipo de bacterias gran positivas muestran como resultados que son más susceptibles a la presencia de este tipo de compuestos, debido a que impiden la captación de iones hierro e hidrógeno que son vitales para la síntesis de proteínas en la célula. De la misma manera para algunos metabolitos secundarios como los flavonoides, tienen efecto sobre la inhibición debido a que estos agentes generalmente evitan la síntesis del ADN y ARN y otras macromoléculas presentes en la masa cárnica, evitando de esta manera el desarrollo de este tipo de microorganismos.

Gutiérrez²⁴, al evaluar la presencia de *Escherichia coli* fueron de $3.12 \pm 0.31 \log$ 10 ufc/g, el cual superó al límite mayor del criterio microbiológico para embutidos frescos, describiendo que la presencia de este tipo de microorganismos representa un problema de inocuidad para el consumo humano, en comparación con otros microorganismos.

De la misma manera Chipantiza & Dugarte²⁵, al evaluar el efecto de la capsaicina muestra resultados favorables al aumentar la concentración frente a microorganismos *Aspergillus*

niger, *Bacillus cereus*, *Clostridium perfringens*, *Escherichia coli* y *Pseudomonas aeruginosa*, donde se observó la formación de halos de inhibición similares que van desde 1,1 a 1,6 cm de diámetro, lo que indica efectos sobre el desarrollo de estos microorganismos.

Coello & Morán²⁶, al evaluar el efecto antimicrobiano de *Moringa oleífera* obtuvo resultados favorables en cuanto al microorganismo *Salmonella sp*, mostrando la ausencia del mismo durante un periodo de 30 días, lo cual coincide con los resultados obtenidos en esta investigación.

Estudios desarrollados por Solórzano & Bonilla²⁷, al evaluar las características sensoriales de productos cárnicos embutidos muestran como resultados con puntuaciones de 4 a 5 puntos en diferentes escalas numéricas de evaluación, las cuales se encuentran dentro de los rangos de mayor aceptación sensorial en el producto cárnico.

Alcívar²⁸, al estudiar los parámetros sensoriales de un producto cárnico utilizando extractos de las plantas, en su prueba de aceptación del mejor tratamiento obtuvieron una frecuencia de aceptación del 93,33%, considerando únicamente como parámetro de evaluación acepta o no acepta el producto, destacando que la inclusión de este tipo de aditivos mejora las cualidades sensoriales de los productos cárnicos.

CONCLUSIONES

La determinación del rendimiento de la extracción de la capsaicina del ají criollo (*Capsicum annum*) obtuvo un total de 0,30 kg de material vegetal un rendimiento de 0,076 kg, dando un valor porcentual de 2,53%.

La inclusión del 3% de capsaicina en el embutido de cerdo mostró un mayor efecto inhibitor de microorganismos hasta los 28 días en que se almacenó el producto cárnico, cumpliendo con los requisitos de la norma NTE INEN 1338: 2012 con respecto a los parámetros *Aerobios mesófilos*, *Staphylococcus aureus*, *E. coli* y *Salmonella*, encontrándose una reducción significativa en las unidades formadoras de colonia y la ausencia de los microorganismos a finalizar la investigación.

La evaluación sensorial del mejor tratamiento mediante un panel sensorial arrojó que el producto obtuvo una buena aceptación encontrándose las mayores frecuencias en los parámetros me gusta y me gusta mucho, las cuales representaron el 93% de los panelistas.

REFERENCIA

1. Alvarado J, Puente A, Rubio M, Villarreal F. La Cadena de valor de embutidos y otras conservas de cerdo en Mexico. Com Económica para América Lat y el Caribe. 2017;1(1):1-103.
2. Angie J, González G. Tratamiento contable de la producción de cerdos de la empresa porcino del Ecuador Ecuapork S.A, Comuna Zapotal. Universidad Península de Santa Elena; 2021.

3. Segarra E, Salinas L, López G. Calidad de la canal de cerdos en la Industria porcina de Ecuador. *Rev Ecuatoriana Cienc Anim.* 2018;2(2):118–31.
4. Cargua D, Chuiza M. Diseño de un proceso para la elaboración de un botón parrillero tipo 1 a base de carne de cerdo en la empresa Miraflores S.A. Escuela Superior Politécnica de Chimborazo; 2021.
5. Lezcano P, Martínez M, Vázquez A, Perez O. Main methods of processing and preserving alternative feeds in tropical áreas. *Cuban experience.* *Cuba J Agric Sci.* 2017;51(1):1–10.
6. Bailón E, Pin R. Efecto del ahumado de botón de cerdo con diferentes especias en las características sensoriales del producto. Universidad Laica "Eloy Alfaro" de Manabí; 2015.
7. Guachamín C, Jibaja M. Investigación de los aditivos en productos cárnicos elaborados y su influencia en la calidad e inocuidad alimentaria. Universidad Central del Ecuador; 2022.
8. Palma G, Orozco C, Chávez A, Mixtega A, Castro R. Capsaicin content in red habanero chilli (*Capsicum chinense* Jacq.) and its preservation after drying process. *Futur Foods.* 2021;4(2):1–11.
9. Intriago F, Macías M, Napa B, Vázquez L, Alvarado K, Revilla K, et al. Inclusion of cocoa (*Theobroma cacao*) mucilage as a stabilizer in jackfruit (*Artocarpus heterophyllus*) nectar. *Agroindustrial Sci.* 2023;13(2):75–81.
10. Vázquez L, Vera J, Erazo C, Intriago F. Induction of rhizobium japonicum in the fermentative mass of two varieties of cacao (*Theobroma Cacao* L.) as a strategy for the decrease of cadmium. *Int J od Heal Sci.* 2022;6(3):11354–71.
11. Arispe I, Tapia M. Inocuidad y calidad: requisitos indispensables para la protección de la salud de los consumidores. *Agroalimentaria.* 2007;12(24):105–18.
12. FAO. Buenas prácticas para la industria de la carne. Jutzi S, editor. Roma: Fundación Internacional Carrefour; 2007.
13. Carballo J. Sausages: nutrition, safety, processing and quality improvement. *Foods.* 2021;10(4):1–9.
14. Tahir M, Salengke S, Mursalim A, Metusalach J, Caesarendra W. Performance of smokehouse designed for smoking fish with the indirect method. *Processes.* 2020;8(2):1–11.
15. NTE INEN 1529-5. Control microbiológico de los alimentos. Determinación de la cantidad de microorganismos aerobios mesófilos. *Inst Ecuatoriano Norm.* 2006;5:1–11.
16. ISO 16649-2. Microbiología de los alimentos para consumo humano y animal. *Organ Int Norm.* 2001;1–9.
17. INEN 1529-15. Control microbiológico de los alimentos. *Salmonella.* Método de detección. *Inst Norm.* 1996;1–24.
18. León J, Tripaldi P, Rojas C. Desarrollo y optimización del producto cárnico cotechino para la empresa de embutidos Don Belisario. Universidad del Azuay; 2021.
19. Peña F, Gómez N. Obtención y caracterización de capsaicina y oleoresina de dos especies de *Capsicum*, provenientes de la costa Peruana. *Prospect Univ.* 2011;8(2):30–5.
20. Ubillús J. Aprovechamiento de la semilla residual del ají jalapeño (*Capsicum Annuum* L) para la obtención de capaicina en la empresa Gandules Inc. Universidad Católica Santo Toribio de Mogrovejo; 2014.
21. Salazar E, Ramos D, Lucas J, Carhuallanqui A, Guevara J, Salazar M. Influencia de la oleoresina de *Capsicum chinense* en la vida útil de la carne de res empacada al vacío y almacenada en refrigeración. *Rev Investig Vet del Perú.* 2022;33(4):1–12.
22. Herrera K, Villa T. Desarrollo de un embutido de pasta fina a partir de las hojas de verdolaga (*Portulaca oleracea*). Universidad de Guayaquil; 2020.
23. Bloom N, Reenen J Van. Optimización del uso de semillas y cáscara de la naranja (*Citrus sinensis*) como factor inhibidor en *Staphylococcus Aureus*. *NBER Working Papers.* Universidad de Guayaquil; 2013.
24. Gutiérrez A, Silva M, Salvá B. Determinación de la concentración mínima inhibitoria del ají Panca (*Capsicum chinense*) en *Escherichia coli* y *Staphylococcus aureus*. *Univ Nac José Faustino Sánchez Carrión.* 2014;4(2):1–9.
25. Chipantiza H, Dugarte N. Extracción de capsaicina y evaluación de su actividad antimicrobiana frente a: *Aspergillus niger*, *Bacillus cereus*, *Clostridium perfringens*, *Escherichia coli*, *Pseudomonas aeruginosa*. Vol. 4, *Вестник Росздравнадзора.* Universidad Técnica de Ambato; 2017.
26. Coello N, Morán J. Capacidad antimicrobiana in vitro del aceite esencial de moringa (*moringa oleifera*) y su efecto sensorial en salchichas de pollo. Universidad Agraria del Ecuador; 2021.
27. Solórzano L, Bonilla M. Aceptabilidad de mortadela a base de carne de camarón blanco (*litopenaeus vannamei*) y carne de cerdo. *Rev Prod Ciencias e Investig.* 2019;3(18):24–8.
28. Alcívar M, Vargas P, Cuenca G, Talledo M. Determinación de propiedades antimicrobiaas y temofísicas en un producto cárnico con adición de hidrolato de romero (*Rosmarinus officinalis* L.) y tomillo (*Thymus vulgaris*). *Polo del Conoc.* 2021;6(3):1493–512.

Efecto de la chillangua (*Eryngium foetidum*) y varios niveles de soya (*Glycine max*) en polvo sobre las propiedades sensoriales y bromatológicas de discos de hamburguesas

Effect of chillangua (*Eryngium foetidum*) and various levels of soy (*Glycine max*) powder on the sensory and bromatological properties of hamburger discs

Gilson ZAMBRANO ZAMBRANO, Vicente ALCÍVAR ZAMBRANO, Patricio MUÑOZ MURILLO

Universidad Técnica de Manabí, Facultad de Agrociencias, Departamento de Procesos Agroindustriales, Chone, Ecuador.

Recibido: 4/junio/2024. Aceptado: 11/agosto/2024.

RESUMEN

Introducción: La chillangua es considerada una especie poco conocida en la industria de alimentos, esto se debe a que generalmente su empleo se da en la gastronomía tradicional, sin embargo, presenta una serie de compuestos organolépticos y nutricionales (hierro, riboflavina, calcio, fibra) de importancia en la alimentación. Por otra parte, la soya es una de las leguminosas con gran aporte de proteínas de alto valor biológico. Ambas materias primas son ideales para la formulación de productos cárnicos.

Objetivo: Evaluar el efecto de la chillangua (*Eryngium foetidum*) y varios niveles de soya (*Glycine max*) en polvo sobre las propiedades sensoriales y bromatológicas de discos de hamburguesas.

Materiales y métodos: Se aplicó un diseño completamente al azar basado en un análisis de varianza con lo que se pretendió comparar las medias para determinar si existieron diferencias significativas entre los tratamientos. El factor A correspondió a las concentraciones de soya en polvo al 5, 10, 15 y 20%, con la que se formularon 4 tratamientos con 3 réplicas, dando un total de 12 unidades experimentales. Posteriormente se aplicó una prueba de Tukey para realizar una comparación de múltiples pares de promedios entre los parámetros bromatológicos. Los valores del análisis sensorial, donde se evaluó

tanto la textura como el sabor, fueron trasladados a una tabla de datos, con lo que se compararon los resultados, utilizando la prueba no paramétrica de Kruskal Wallis. Para ambas pruebas se empleó el software estadístico InfoStat.

Resultados: Se determinó ausencia de *E. coli*, Salmonella y Clostridium sulfito reductores, no obstante, existió presencia de aerobios mesófilos y *Staphylococcus*

aureus, por otra parte, a nivel sensorial los atributos sabor y textura presentaron un $p < 0,05\%$, mientras que, las demás variables sensoriales presentaron un $p > 0,05\%$.

Conclusiones: El tratamiento con mayor propiedad bromatológica fue el T4. Todas las formulaciones experimentales cumplieron con la calidad microbiológica exigida en la norma INEN 1338. A nivel sensorial, la formulación T1 fue la que presentó mejor aceptación por parte de los catadores no entrenados, lo cual indica, que no es recomendable añadir más del 5% de soya en polvo en la masa cárnica para hamburguesa, sin embargo, a mayor cantidad de factor en estudio, mejores propiedades se presentaran en el producto cárnico.

PALABRAS CLAVES

Cárnicos, fibra, proteína, composición nutricional, perfil de sabor, proteínas vegetales, innovación alimentaria, propiedades organolépticas.

ABSTRACT

Introduction: Chillangua is considered a little-known species in the food industry, this is because its use generally occurs in traditional gastronomy, however, it presents a series

Correspondencia:
Gilson Zambrano Zambrano
gzambrano9240@utm.edu.ec

of organoleptic and nutritional compounds (iron, riboflavin, calcium, fiber) of importance in nutrition. On the other hand, soy is one of the legumes with a large contribution of proteins of high biological value. Both raw materials are ideal for the formulation of meat products.

Objective: To evaluate the effect of chillangua (*Eryngium foetidum*) and various levels of soy (*Glycine max*) powder on the sensory and bromatological properties of hamburger discs.

Materials and methods: A completely randomized design was applied based on an analysis of variance with which the aim was to compare the means to determine if there were significant differences between the treatments. Factor A corresponded to the concentrations of soy powder at 5, 10, 15 and 20%, with which 4 treatments were formulated with 3 replicates, giving a total of 12 experimental units. Subsequently, a Tukey test was applied to perform a comparison of multiple pairs of averages between the bromatological parameters. The values of the sensory analysis, where both texture and flavor were evaluated, were transferred to a data table, with which the results were compared, using the non-parametric Kruskal Wallis test. For both tests, the InfoStat statistical software was used.

Results: All experimental treatments presented statistical significance ($p < 0.05\%$) in the bromatological variables. Absence of *E. coli*, *Salmonella* and sulfite-reducing *Clostridium* was determined, however, there was presence of mesophilic aerobes and *Staphylococcus aureus*, on the other hand, at a sensory level, the flavor and texture attributes presented $p < 0.05\%$, while, the other sensory variables presented $p > 0.05\%$.

Conclusions: The treatment with the greatest bromatological property was T4. All experimental formulations met the microbiological quality required by the INEN 1338 standard. At a sensory level, the T1 formulation was the one that presented the best acceptance by untrained tasters, which indicates that it is not advisable to add more than 5% of soy powder in the meat dough for hamburger, however, the greater the amount of factor under study, the better properties were presented in the meat product.

KEYWORDS

Meat, fibre, protein, nutritional composition, flavour profile, vegetable proteins, food innovation, organoleptic properties.

INTRODUCCIÓN

Los discos de hamburguesa, o carne de res molida, son ampliamente consumidos en países de todo el mundo¹. Sin embargo, en los últimos años se ha dado principal atención en mejorar el valor funcional de los productos cárnicos, como la carne de res molida para hamburguesa, este producto es susceptible a la modificación, por lo que se han realizados varios estudios con el fin de mejorar o suplementar su perfil nutricional de diferentes formas². Es por ello que Saleh et al.³ in-

vestigaron el efecto de los aceites volátiles de cilantro e hinojo sobre la calidad y la vida útil de las hamburguesas de ternera, de igual manera Sedlacek et al.⁴ investigaron si la inclusión de diferentes especias en hamburguesa bovina afecta el crecimiento bacteriano, la oxidación de lípidos y las características sensoriales de los productos.

En la búsqueda constante de alternativas alimenticias que satisfagan las demandas nutricionales de una creciente población mundial, la investigación en la formulación de productos cárnicos ha tomado un papel crucial⁵. La incorporación de ingredientes vegetales, como la chillangua (*Eryngium foetidum*) y la soya (*Glycine max*) en polvo, representa una estrategia prometedora para mejorar las propiedades sensoriales y bromatológicas de discos de hamburguesas⁶.

En la provincia de Esmeraldas, situada al noroccidente de la república del Ecuador ubicada en la costa del Pacífico se reproduce de manera natural y de forma abundante la chillangua⁷, conocida por sus propiedades aromáticas y su riqueza en compuestos bioactivos⁸, además su fuerte aroma y sabor picante que posee le atribuye a la comida un distintivo muy peculiar, motivo por el cual en América Latina ha aumentado su uso⁹ y la soya en polvo, reconocida por su contenido proteico y versatilidad culinaria¹⁰, además contiene todos los aminoácidos esenciales requeridos en la nutrición humana como lo son; la isoleucina, leucina, lisina, metionina, cisteína, fenilalanina, tirosina, treonina, triptófano, valina e histidina, ofrecen un potencial sin explotar en la creación de productos cárnicos mejorados desde el punto de vista sensorial y nutricional.

Bajo este contexto, en el presente estudio se planteó evaluar el efecto de la chillangua y varios niveles de soya en polvo sobre las propiedades sensoriales y bromatológicas de discos de hamburguesa. Este enfoque no solo respondió a la necesidad de diversificar la oferta alimentaria, sino que también busca contribuir al desarrollo de opciones más saludables y sostenibles en el ámbito de la industria alimentaria.

A través de un análisis detallado de las características organolépticas y composicionales, se procuró proporcionar información valiosa que pueda ser utilizada por la comunidad científica, la industria alimentaria y los consumidores en general. Este estudio pretende ser un paso significativo hacia la comprensión y mejora de los productos cárnicos, abriendo nuevas perspectivas en la búsqueda de soluciones innovadoras y sostenibles en el ámbito alimentario; es por este motivo que el objetivo principal de esta investigación se centra en evaluar el efecto de la chillangua (*Eryngium foetidum*) y varios niveles de soya (*Glycine max*) en polvo sobre las propiedades sensoriales y bromatológicas de discos de hamburguesa.

MATERIALES Y MÉTODOS

La investigación propuesta se llevó a cabo durante el periodo Abril – Mayo del 2024 en el Laboratorio de Procesos Agroindustriales en el área de cárnicos, de la Facultad de

Agrociencias extensión Chone de la Universidad Técnica de Manabí. Geográficamente está ubicada en el cantón Chone Km 2 ½ vía Boyacá, sitio Ánima, a 0°41' y 17" de latitud Sur y 80° 7' 25.60" de longitud Oeste.

Los análisis fisicoquímicos, bromatológicos y microbiológicos de las formulaciones de discos de hamburguesa se desarrollaron en el Laboratorio de Bioquímica, Bromatología y Microbiología de la Universidad Técnica de Manabí, Facultad de Agrociencias extensión Chone.

Materias primas

Para la elaboración del producto se utilizó carne de res molida fresca (pulpa fina) proveniente del cantón Tosagua del frigorífico PEPÍN. La chillangua (*Eryngium foetidum*) se obtuvo de la finca Erika ubicada en el cantón Chone. La soya (*Glycine max*) en polvo se adquirió de forma caracterizada en el supermercado AKÍ de la ciudad de Bahía, provincia de Manabí. Los demás insumos se adquirieron en el supermercado local.

Diseño experimental

Se utilizó un diseño experimental completamente al azar con arreglo factorial. Se formularon 4 tratamientos con tres réplicas respectivamente, estableciendo un total de 12 unidades experimentales. El factor en estudio A: representó las concentraciones de soya en polvo (SP) al 5 % (T1), 10 % (T2), 15 % (T3) y 20 % (T4). En la tabla 1 se detalla la distribución del diseño experimental aplicado en la investigación.

Unidad experimental

La unidad experimental (U.E) estuvo conformada por 1000 g de masa de carne de res molida junto con, soya y chillangua en polvo más sal. En la tabla 2 se detalla la formulación del producto.

Procedimiento experimental

Obtención de la chillangua en polvo (CP)

Para la obtención del producto (CP), se receiptó y seleccionó las hojas de chillangua, sin ningún deterioro, ni presencia de

Tabla 1. Tratamientos en estudio del diseño experimental

Tratamientos	Símbolo	Factor A: SP	Réplicas
1	T1	5 %	3
2	T2	10 %	3
3	T3	15 %	3
4	T4	20 %	3

hongos; en una bandeja de acero inoxidable con capacidad de 10 litros de agua se procedió a llevar la materia prima, la cual se desinfectó mediante la aplicación de una solución de hipoclorito de sodio a 20 ppm; seguidamente se procedió con el escurrido, para luego colocarlas de forma ordenadas en las bandejas del deshidratador, continuamente se procedió a encender el equipo a una temperatura de 65 °C por un tiempo estimado de 80 minutos; deshidratadas las hojas de chillangua se llevaron a molienda en un molino eléctrico por un tiempo de 3 minutos; posteriormente se colocó la chillangua en polvo en una bandeja pequeña para seguidamente colocarla en una estufa durante un tiempo prolongado de 60 minutos a una temperatura de 65 °C, de forma continua se llevó a cabo el envasado de la CP en fundas de polietileno y posteriormente el producto fue sellado al vacío y almacenado a temperatura ambiente hasta su posterior utilización, esto con la finalidad de evitar cualquier agente patógeno.

Elaboración de los discos de hamburguesas

Para la elaboración del producto experimental se receiptó y seleccionó carne de res molida fresca (pulpa fina); posteriormente se procedió al pesaje de la carne molida, soya, chillangua en polvo y sal; seguidamente se procedió con la desinfección del área de trabajo con el fin de evitar cualquier contaminación en el producto final.

Se continuó con la homogenización y amasado de las materias primas e insumos de cada tratamiento presente en la tabla 2, proceso que se llevó a cabo en una mesa de acero

Tabla 2. Formulación de discos de hamburguesa con chillangua y soya en polvo

Materias primas e Insumos	T1		T2		T3		T4	
	%	g	%	g	%	g	%	G
Soya en polvo	5	50	10	100	15	150	20	200
Carne molida	91	910	86	860	81	810	76	760
Chillangua en polvo	2	20	2	20	2	20	2	20
Sal	2	20	2	20	2	20	2	20
Total	100	1000	100	1000	100	1000	100	1000

inoxidable; obtenida la masa de cada tratamiento se procedió al moldeado de los discos de hamburguesas; el envasado se lo realizó en funda de polietileno y almacenado a una temperatura de 4 °C.

Análisis de laboratorio

Se realizaron los análisis de las propiedades fisicoquímicas y microbiológicas de la chillangua en polvo; basándose en la norma NTE INEN 2532:2010 (Especias/condimentos), siendo los siguientes:

Humedad: el contenido de humedad se evaluó por medio del método NTE INEN-ISO 712

Materia seca: se determinó por medio del método NTE INEN-712

Grasa: se evaluó mediante el método de ensayo AOAC 2003.06

Ceniza: se determinó según el método de ensayo NTE INEN-ISO 2171

Fibra: el contenido de fibra se evaluó por medio del método AOAC 962.09

Proteína: los niveles de proteínas se evaluaron según el método de ensayo NTE INEN-ISO 937

A la vez, se realizó un análisis microbiológico para identificar los microorganismos existentes en el producto. Los parámetros analizados fueron los siguientes:

Aerobios mesófilos: el conteo de aerobios mesófilos se efectuó mediante el método de ensayo NTE INEN 1529-5

Mohos y levaduras: la carga de microorganismos mohos y levaduras se evaluó mediante el método NTE INEN 1529-10

Coliformes: el contenido de coliformes se determinó mediante el método de ensayo NTE INEN 1529-7

Salmonella: la presencia de salmonella se analizó mediante el ensayo NTE INEN 1529-15

En los productos experimentales, como lo son los discos de hamburguesas con soya y chillangua en polvo, se evaluaron los siguientes análisis de laboratorio:

Bromatológicos: proteína (método de ensayo NTE INEN-ISO 937); cenizas (método de ensayo NTE INEN-ISO 2171); humedad y sólidos totales (método de ensayo NTE INEN-ISO 1442); fibra (método de ensayo AOAC 962.09); grasa (método de ensayo NTE INEN-ISO 1443).

Microbiológicos: aerobios mesófilos (método de ensayo NTE INEN 1529-5); *E. coli* (método de ensayo AOAC 991.14); *Staphylococcus aureus* (método de ensayo NTE INEN 1529-14:2013); *Salmonella* (método de ensayo NTE INEN 1529-15) y *Clostridium sulfito reductores* (método de referencia NTE INEN 1529-18).

Análisis estadístico

Para el análisis de datos, se aplicó un análisis de varianza al 95 % de nivel de confianza, para observar las diferencias estadísticamente significativas en el experimento. Con el objetivo de realizar una comparación de múltiples pares de promedios, es decir, una comparación de dos a dos entre las medias de los parámetros bromatológicos de los tratamientos establecidos en el experimento, se aplicó la prueba de Tukey. Para el caso del análisis sensorial, que permitió evaluar las características sensoriales y posteriormente la aceptabilidad del producto, se aplicó la prueba de contraste no paramétrico de Kruskal Wallis, con el que se determinó si existían diferencias relevantes a nivel estadístico entre las medias de los tratamientos. Todos estos análisis, se realizaron empleando el software estadístico InfoStat. Los resultados se expresaron en media (\bar{x}) \pm desviación estándar (D.E).

Análisis sensorial

Para la evaluación de análisis sensorial se contó con la participación de 90 catadores no entrenados de la Facultad de Agrociencias, Universidad Técnica de Manabí, a los cuales se les entregó las muestras codificadas en platos plásticos, en orden aleatorio, más un vaso de agua y mediante un test hedónico con escala de 7 puntos (1 = me disgusta mucho; 2 = me disgusta moderadamente; 3 = me disgusta poco; 4 = ni me gusta – ni me disgusta; 5 = me gusta poco; 6 = me gusta moderadamente y 7 = me gusta mucho) evaluaron en términos de calidad, los atributos; sabor, olor, color, textura y apariencia general.

RESULTADOS

Caracterización fisicoquímica y microbiológica de la chillangua en polvo

Una vez realizado el análisis fisicoquímico y microbiológico de los componentes de la chillangua en polvo, se muestran los resultados detallados en la Tabla 3, en donde la chillangua en polvo presentó un 22,25% para fibra, y 6,73% en proteína. Los niveles de fibra y proteína presentes en la chillangua en polvo son ideales para una dieta saludable.

En el análisis microbiológico, se logró determinar la ausencia de microorganismos patógenos de coliformes y salmonella. En cuanto al contenido de aerobios mesófilos, mohos y levaduras, se presentó una carga microbiana de 2,21 x 10¹ UFC/g y 5,5 x 10⁰ UP/g. Sin embargo, a pesar del conteo de microorganismos presentes en la chillangua en polvo, todos los parámetros estuvieron dentro de la normativa ecuatoriana INEN 2532 para condimentos en polvo, siendo los límites máximos de 106 UFC/g (aerobios mesófilos), 104 UFC/g (mohos y levaduras), 103 UFC/g (coliformes) y ausencia (*Salmonella*). Aquello permitió verificar que el material experimental fue inocuo y adecuado para su utilización como aditivo en la formulación del producto.

Tabla 3. Resultados fisicoquímicos y microbiológicos de la chillangua en polvo

FISICOQUÍMICOS	
Parámetros	Resultados
Humedad	7,08 %
Ceniza	14,63 %
Materia seca	92,92 %
Grasa	11,13 %
Fibra	22,25 %
Proteína	6,73 %
MICROBIOLÓGICOS	
Microorganismos	Resultados
Aerobios mesófilos	2,21 x 10 ¹ UFC/g
Mohos y levaduras	5,5 x 10 UP/g
Coliformes	Ausencia
Salmonella	Ausencia

Determinación de análisis bromatológicos en discos de hamburguesa

En la tabla 4 se detalla el análisis de varianza paramétrico, el cual fue aplicado en las variables de perfil bromatológico de discos de hamburguesa con soya y chillangua en polvo.

Se determinó que todos los parámetros bromatológicos (proteína, cenizas, humedad, sólidos totales, fibra, grasa) presentaron significancia estadística entre los tratamientos

($p < 0,05$). Posteriormente, se aplicó la prueba de comparación múltiple de Tukey.

En la variable proteína la prueba de comparación de promedios Tukey, estableció que todos los tratamientos al compartir rangos distintos (A, B,C,D) presentaron significancia estadística entre sí. El tratamiento T1 (5% SP + 2% CP) fue la formulación con menor contenido proteico ($24,81 \pm 0,03\%$), mientras que, el tratamiento T4 (20% SP + 2% CP) presentó un mayor aporte de este nutriente, siendo su resultado $33,34 \pm 0,03\%$, siendo la soya, rica en proteínas de alto valor biológico, su contenido se encuentra entre 10,5 – 23,09 – 40,0 g de proteína¹¹.

El contenido de cenizas en las formulaciones cárnicas de discos de hamburguesas fue significativo entre el tratamiento T3 y T4, mientras que, los tratamientos T1 y T2 no fueron estadísticamente diferentes entre sí. Lo cual indica, que las concentraciones de 5% y 10% de soya en polvo, no generan un aumento significativo de cenizas en el producto experimental ($3,85 \pm 0,03 - 3,88 \pm 0,03\%$), no obstante, los tratamientos T3 y T4 presentaron un ligero incremento de cenizas en los discos de hamburguesas, cuyos resultados estuvieron entre $4,09 \pm 0,03 - 4,63 \pm 0,03\%$.

Respecto al contenido de humedad en los discos de hamburguesa la prueba de comparación de promedios Tukey determinó que el tratamiento T2 y T3 no presentaron significancia estadística entre sí, sin embargo, las formulaciones T1 y T4 si fueron estadísticamente diferentes frente a los tratamientos T2 y T3. Se logró determinar que el tratamiento T1 presentó el mayor valor en cuanto a humedad ($67,55 \pm 0,66\%$), y en menor resultado el tratamiento T4 ($53,47 \pm 0,66\%$).

De acuerdo a la prueba de comparación de promedios Tukey, se determinó que el contenido de sólidos totales en las formulaciones experimentales, fue significativamente diferente en los tratamientos T1 y T4, mientras que, el tratamiento T2 y T3 no

Tabla 4. Resultados bromatológicos de discos de hamburguesa con soya y chillangua en polvo

Parámetros Bromatológicos	Tratamientos				Sig. Tukey.
	T1x ± D.E	T2x ± D.E	T3x ± D.E	T4 x ± D.E	
Proteína (%)	24,81±0,03 ^A	25,91±0,03 ^B	27,36±0,03 ^C	33,34±0,03 ^D	0,0001
Cenizas (%)	3,85±0,03 ^A	3,88±0,03 ^A	4,09±0,03 ^B	4,63±0,03 ^C	0,0001
Humedad (%)	67,55±0,66 ^A	63,55±0,66 ^B	62,92±0,66 ^B	53,47±0,66 ^C	0,0001
Sólidos totales (%)	32,44±0,66 ^A	36,07±0,66 ^B	37,85±0,66 ^B	46,52±0,66 ^C	0,0001
Fibra (%)	0,42±0,02 ^A	0,63±0,02 ^B	1,29±0,02 ^C	1,44±0,02 ^D	0,0001
Grasa (%)	2,19±0,03 ^A	3,58±0,02 ^B	3,82±0,02 ^C	6,20±0,02 ^D	0,0001

Las medias que no comparten una letra en superíndices son significativamente diferentes ($p < 0,05$). Prueba de Tukey.

presentaron significancia estadística entre sí. Se logró observar que, a medida que aumentan las concentraciones de soya en polvo, los niveles de sólidos totales aumentaron en el producto cárnico, siendo la de menor valor T1 con $32,44 \pm 0,66\%$ y la de mayor valor el T4 con $46,52 \pm 0,66\%$.

En la variable bromatológica de fibra, la prueba de comparación múltiple de Tukey determinó que todos los tratamientos fueron significativamente diferentes entre sí. El tratamiento T4 presentó un mayor nivel de fibra ($1,44 \pm 0,02\%$) en discos de hamburguesa con 20% SP + 2% CP, mientras que, el tratamiento T1 fue el de menor valor con $0,42 \pm 0,02\%$.

De acuerdo a los resultados obtenidos mediante la prueba de comparación múltiple de Tukey, se determinó que la variable grasa presentó significancia estadística entre todos los tratamientos en estudio. El tratamiento con menor contenido graso es el T1 con $2,19 \pm 0,03\%$, y en mayor valor el T4 ($6,20 \pm 0,02\%$).

Determinación de análisis microbiológicos en discos de hamburguesa

En la Tabla 5 se evidenció el conteo de microorganismos patógenos presentes en los tratamientos en estudio, se logró

determinar ausencia de *E. coli*, Salmonella y Clostridium sulfito reductores, mientras que, en los parámetros aerobios mesófilos y *Staphylococcus aureus* se evidenció una carga microbiana entre $4,29 \times 10^2 - 1,60 \times 10^3$ UFC/mL y $1,32 \times 10^2 - 2,40 \times 10^2$ UFC/g.

Determinación de análisis sensorial en discos de hamburguesa

En la tabla 6 se detallan los resultados de análisis de varianza no paramétrico aplicado en las variables de perfil sensorial. Se determinó que los atributos olor, color y apariencia general no presentaron significancia estadística entre los tratamientos ($p > 0,05\%$), no obstante, los atributos sabor y textura si fueron significativamente diferentes entre sí ($p < 0,05\%$). Seguido de la Tabla 6 se describe la comparación de promedios según la prueba de Kruskal Wallis para las variables con diferencias significativas.

Sabor

En el atributo sabor, se determinó que mediante la prueba de comparación de promedios Kruskal Wallis, los tratamientos T2, T3 y T4 al compartir la misma letra en común (B) no pre-

Tabla 5. Resultados microbiológicos de discos de hamburguesas con soya y chillangua en polvo

Microorganismos	Tratamientos			
	T1	T2	T3	T4
Aerobios mesófilos (UFC/mL)	$1,60 \times 10^3$	$5,45 \times 10^2$	$4,29 \times 10^2$	$1,46 \times 10^3$
<i>E. coli</i> (UFC/g)	0×10	0×10	0×10	0×10
<i>Staphylococcus aureus</i> (UFC/g)	$1,67 \times 10^2$	$1,32 \times 10^2$	$2,40 \times 10^2$	$1,58 \times 10^2$
Salmonella (25g)	0×10	0×10	0×10	0×10
Clostridium sulfito reductores (UFC/g)	0×10	0×10	0×10	0×10

Tabla 6. Resultados de análisis sensorial en discos de hamburguesa con soya y chillangua en polvo

Parámetros sensoriales	Tratamientos				Sig. Kruskal Wallis
	T1 $\bar{x} \pm D.E$	T2 $\bar{x} \pm D.E$	T3 $\bar{x} \pm D.E$	T4 $\bar{x} \pm D.E$	
Sabor	$4,77 \pm 1,52^A$	$4,27 \pm 1,77^B$	$4,31 \pm 1,40^B$	$3,98 \pm 1,76^B$	0,0099
Olor	$4,70 \pm 1,39^A$	$4,44 \pm 1,42^A$	$4,22 \pm 1,44^A$	$4,11 \pm 1,78^A$	0,0618
Color	$4,14 \pm 1,67^A$	$4,24 \pm 1,56^A$	$4,29 \pm 1,54^A$	$4,11 \pm 1,80^A$	0,8748
Textura	$4,76 \pm 1,51^A$	$4,59 \pm 1,40^{AB}$	$4,42 \pm 1,44^{AB}$	$4,10 \pm 1,77^B$	0,0431
Apariencia general	$4,19 \pm 1,63^A$	$4,26 \pm 1,52^A$	$4,07 \pm 1,49^A$	$4,24 \pm 1,40^A$	0,7933

Las medias que no comparten una letra en superíndices son significativamente diferentes ($p < 0,05$). Prueba de Kruskal Wallis.

sentaron significancia estadística entre sí, sin embargo, si fueron significativamente diferentes frente al T1. El tratamiento con mayor aceptación a nivel sensorial por parte de los cataadores no entrenados fue la formulación de disco de hamburguesa T1 (5% SP + 2% CP), la cual presentó una calificación de $4,77 \pm 1,52$ y categoría de ni me gusta – ni me disgusta. En cuanto al tratamiento menos aceptable fue el T4 con una calificación de $3,98 \pm 1,76$ (me gusta poco).

Textura

Para el atributo textura la prueba de comparación de promedios Kruskal Wallis estableció que, los tratamientos T1, T2, y T3 al compartir el mismo rango (A) no fueron estadísticamente diferentes entre sí, de igual forma, el tratamiento T2, T3 y T4 no presentaron significancia estadística, sin embargo, el T1 y T4 si fueron significativamente diferentes a nivel estadístico. De acuerdo a los resultados, todos los tratamientos presentaron una aceptación de ni me gusta - ni me disgusta, no obstante, se pudo evidenciar que el T1 con promedio de $4,76 \pm 1,51$ fue la formulación de mayor aceptabilidad y el T4 con $4,10 \pm 1,77$ fue considerado el tratamiento menos aceptable por parte de los catadores no entrenados.

DISCUSIÓN

Análisis físico químico y microbiológico

La fibra y la proteína de la chillangua en polvo se presentó en un 22,25 y 6,73% respectivamente. Dichos valores se encuentran similares con los reportados por Lara y Torres⁷ quienes lograron determinar un promedio entre 23,90 – 24,20% (fibra) y 17,65 – 14,72% (proteína) en muestras secas de chillangua obtenidas mediante secado solar y en estufa, lo cual indica, que el método de deshidratación puede afectar la composición fisicoquímica de la chillangua.

En esta investigación, los valores de ceniza superan el límite máximo establecido en la normativa ecuatoriana. Esto se puede deber a una alta concentración de minerales presentes en las hojas de chillangua. Otros estudios demuestran que las hojas frescas de chillangua poseen una cantidad menor en cuanto a cenizas de 1,7%¹².

Respecto al contenido de materia seca se determinó un 92,92% en la chillangua en polvo cuyo valor es superior al expuesto por Maldonado y Morales¹³ quienes obtuvieron un promedio de 90,93 en hojas de ricino (*Ricinus communis*). Estudios reportados por Viteri et al.¹⁴ demostraron un resultado de 80,62% en flores de jamaica deshidratadas. La materia seca varía entorno a cada genotipo de plantas.

El material experimental presentó un contenido de grasa de 11,13%, al contrario, estudios como el de Tshering et al.¹⁵ determinaron una variación en grasa cruda entre el 1,27% - 2,63% en culantro de pozo, de acuerdo con los autores, los niveles de grasa en la chillangua pueden estar influenciados

por diferentes condiciones climáticas, especies, periodo de recolección, condiciones de almacenamiento, manipulación, instrumentos utilizados, estación y origen geográfico.

Análisis bromatológico en discos de hamburguesa

Con el análisis bromatológico se puede determinar que a medida que aumentan las concentraciones de soya en polvo, los niveles de proteínas aumentan en el producto cárnico. De acuerdo al tipo de materia prima que se añade a la formulación de alimentos cárnicos, la proteína puede aumentar o disminuir, así lo demuestran Badr y El-Waseif¹⁶, quienes obtuvieron un promedio de $18,80 \pm 0,97\%$ y $18,93 \pm 0,93\%$ de proteína en hamburguesas con 2% de polvo de semillas de alcaparra (*Capparis spinosa* L).

Los tratamientos presentaron un ligero incremento de cenizas en los discos de hamburguesas, contrastando con estudios como el de Ramírez et al.¹⁷ demuestran valores inferiores en cenizas entre $2,54 \pm 0,05$ – $2,81 \pm 0,17\%$ para carne cruda de hamburguesas con harina de quinchoncho (*Cajanus cajan*), de igual forma, Terrazas et al.¹⁸ reportaron bajos niveles de cenizas ($1,51 \pm 0,34$ – $1,90 \pm 0,23\%$) en formulaciones de hamburguesas con carne de toretes, nuez pecana y fibra de trigo.

Por otra lado, se mostró que, a medida que aumenta la concentración de soya en polvo, los niveles de humedad disminuyen significativamente, esto puede deberse a que el polvo de soya generó una mayor retención de agua en la masa cárnica, así lo afirman García et al.¹⁹ quienes obtuvieron resultados entre $66,42 \pm 0,96$ – $65,44 \pm 0,25\%$ de humedad al agregar 3, 6 y 9% de harina de soya texturizada en carne molida para hamburguesa.

Se pudo determinar que la formulación con menor valor fue el T1 con $32,44 \pm 0,66\%$ y en mayor valor el T4 con $46,52 \pm 0,66\%$. Aquellos resultados se encuentran similares a los expuestos por Piñero et al.²⁰ quienes determinaron un $30,48 \pm 1,91$ – $26,40 \pm 1,91\%$ de sólidos totales en carne para hamburguesas con fibra soluble de avena. Al contrario, Muñoz y Malagón²¹ reportaron 92,7% de sólidos totales en hamburguesas con sustitución parcial de carne por harina de insectos *Zophobas morio*.

La soya al igual que la chillangua en polvo son ricas fuentes de fibra, lo cual permite favorecer el valor nutricional del producto cárnico. Resultados similares obtuvieron Baldeón et al.²² quienes en su estudio lograron evidenciar que al añadir diferentes concentraciones de Sacha inchi al 10, 15 y 20% se generó un ligero aumento en fibra cruda de $0,28$ – $0,32\%$ para hamburguesas de res y grasa de cerdo. Gómez et al.²³ determinaron un valor de 2,2 g de fibra en formulaciones de hamburguesa con 15,3% de harina de chayote (*Sechium edule*).

Se pudo evidenciar que, a medida que aumentan las concentraciones de soya en polvo, existió un aumento significativo de grasa en los productos experimentales, esto se puede deber a la presencia de este compuesto en la harina de soya, la cual según estudios puede presentar entre 1,92 - 18,0% de grasa, así como grasas insaturadas oleicas y linoleicas^{24,25}. Otras investigaciones han demostrado un contenido de $3,4 \pm 0,41\%$ de grasa total en hamburguesas con 1,50% perejil + 2,50% albahaca en polvo²⁶.

Análisis microbiológico en discos de hamburguesa

Todas las formulaciones cárnicas de discos de hamburguesa presentaron un nivel microbiológico aceptable dentro de los límites que exige la norma técnica ecuatoriana INEN 1338. Cevallos et al.²⁷ determinaron niveles aceptables de *E. coli*, aerobios mesófilos y *Staphylococcus* durante 25 días de evaluación microbiológica en hamburguesas con diferentes mezclas de especias (pimiento rojo deshidratado, cúrcuma, orégano, polvo de apio), lo cual permitió corroborar, que el uso de este tipo de aditivos puede mejorar la conservación de productos cárnicos.

Análisis sensorial

Los tratamientos con mayor concentración de soya en polvo generaron un menor grado de aceptación por parte de los panelistas a nivel de sabor. Al contrario, Loyola et al.²⁸ determinaron un promedio de aceptación de 6,4 en hamburguesas de cerdo con 8% pulpa de cerezas más 4,3% proteína de soya. Otros estudios demostraron una aceptabilidad en sabor de 4,28 en hamburguesas de res con nisina, 2,00 puntos en hamburguesas con polvo de moringa y 6,00 en hamburguesa de cerdo con 15% texturizado de soya.

Castro et al. determinaron una aceptación en textura de $4,56 \pm 1,48$ en hamburguesas con 2,0% proteína de soya texturizada + 2% ajo en polvo, mientras que, López et al.²⁹ obtuvieron una aceptabilidad en textura de 0,90 en carne molida para hamburguesas con aceites esenciales de orégano de los incas. Resultados similares e inferiores a los expuestos en este estudio.

CONCLUSIONES

La chillangua en polvo fue microbiológicamente aceptable, en cuanto a los parámetros fisicoquímicos la humedad cumplió con el requisito establecido en la norma de referencia INEN 2532. El contenido de cenizas superó el límite máximo permitido por la normativa ecuatoriana, no obstante, el material experimental presentó niveles de proteína y fibra de interés para la industria de alimentos y salud del consumidor.

Respecto a las propiedades bromatológicas se logró determinar que la soya en polvo influyó significativamente sobre todos los parámetros evaluados (proteína, cenizas, humedad,

solidos totales, fibra y grasa) en los tratamientos experimentales, lo cual indicó que este tipo de leguminosa juega un papel importante en la composición nutricional de los productos cárnicos tipo hamburguesas. Por otra parte, todas las formulaciones cumplieron con la calidad microbiológica exigida en la norma de referencia INEN 1338.

En base a los resultados obtenidos en el análisis sensorial se logró determinar que, a excepción del tratamiento T4 en el atributo sabor, las demás formulaciones presentaron una aceptación por parte de los catadores no entrenados de ni me gusta – ni me disgusta, no obstante, el tratamiento con mayor aceptación fue el T1 a nivel de sabor, olor y textura. Lo cual indica, que, a menor concentración de soya en polvo, mejor aceptabilidad tendrá el producto cárnico. Por lo tanto, no es recomendable utilizar más del 5% de factor en estudio en el producto experimental, ya que afecta la percepción del consumidor.

BIBLIOGRAFÍA

1. Tonina FD, Fernandez CM, Hartman MG. Uso de transglutaminasa en la formulación de hamburguesas reducidas en sodio. *Jorn Jóvenes Investig AUGM*. 2018;1-13.
2. Urruzola N, Santana M, Gámbaro A. Aceptabilidad sensorial de una hamburguesa de carne vacuna y vegetales. *INNOTECH*. 2018;(15):15-22.
3. El-Desouky A, Sharoba ProfA, Osheba A. Vital Value of Coriander and Fennel Volatile Oils on Quality Beef Burger During Cryopreservation. *J Food Dairy Sci*. 2 de agosto de 2022;Vol. 13:109-17.
4. Sedlacek-Bassani J, Grassi TLM, Diniz JCP, Ponsano EHG. Spices as natural additives for beef burger production. *Food Sci Technol*. 8 de mayo de 2020;40:817-21; ISSN: 0101-2061, 1678-457X.
5. Gamonal-Ramírez HG. Elaboración y evaluación de hamburguesas con sustitución parcial de carne de res por quinua (*Chenopodium quinoa*) kiwicha (*Amaranthus caudatus*) y kañiwa (*Chenopodium pallidicaule*). 2018 [citado 30 de julio de 2024]; Disponible en: <https://hdl.handle.net/20.500.14292/2087>
6. Eccoña-Sota A. Estudio de la aplicación de la tecnología de altas presiones e incorporación de aditivos en el desarrollo de hamburguesas de carne bovina reducidas en sodio [Internet] [Tesis]. Universidad Nacional de La Plata; 2018 [citado 30 de julio de 2024]. Disponible en: <http://sedici.unlp.edu.ar/handle/10915/67944>
7. Lara-Tambaco RM, Torres-Mendoza KE. Determinación de las propiedades físico-químicas en las hojas del *Eryngium Foetidium* L. *Ibero-Am J Eng Technol Stud*. 15 de abril de 2023;3(1):163-72.
8. García-Mendoza J, Muñoz-Murillo J, Zambrano-Rodríguez V, Zambrano-Chica O. Evaluación de la calidad sensorial y microbiológica de una mayonesa de soya (*Glycine max*) con tres concentraciones de culantro de pozo (*Eryngium foetidum* L). 11 de agosto de 2022;1-11; ISBN: 9786525803951.
9. Rosero-Gómez CA, Zambrano ML, García KE, Viracocha LA. Nomenclatura y usos del culantro de monte (*Eryngium foetidum*

- L.) en la comunidad San Antonio de Padua, cantón Quinsaloma, Provincia de Los Ríos – Ecuador. Bol Latinoam Caribe Plantas Med Aromáticas. 30 de mayo de 2020;19(3):334-43; ISSN: 0717-7917.
10. Ayavaca-Morales EJ. Análisis proximal del agregado de soya en polvo (*Glycine max*) a carne molida para la elaboración de hamburguesas [Internet]. [Ecuador]: Universidad Nacional del Chimborazo; 2020. Disponible en: <http://dspace.unach.edu.ec/bitstream/51000/7249/2/trabajo%20de%20titulacion%20Erick%20Ayavaca%20%281%29.pdf>
 11. Cárdenas N, Romero E, Salazar J, Cevallos C, Ruiz G. Análisis comparativo de la composición nutricional del chocho, quinua y soya, y su aplicación en la elaboración de harinas. Cienc Al Serv Salud Nutr. 25 de julio de 2019;10(Ed. Esp.):260-9; ISSN: 1390-874X.
 12. Mohammad S, Haddadian Z, Mohd H. *Eryngium Foetidum* L. *Coriandrum Sativum* and *Persicaria Odorata* L.: A Review. J Asian Sci Res. 15 de agosto de 2012;2(8):410-26; ISSN: 2223-1331.
 13. Maldonado-Santoyo M, Morales-López G. Análisis químico y nutricional en hojas de *Ricinus communis*-. Rev Cuba Quím. abril de 2022;34(1):3-18; ISSN: 2224-5421.
 14. Viteri-Borja JG, Párraga-Alava RC, García-Mendoza JJ, Barre-Zambrano RL, Romero-Bravo JP. Calidad fisicoquímica y sensorial de cerveza artesanal estilo blonde ale con infusión de flor deshidratada de jamaica (*Hibiscus sabdariffa*). Manglar. octubre de 2022;19(4):331-9; ISSN: 2414-1046.
 15. Tshering T, Sujata U, Manivannan S, Bhutia KD, Sharma L, Muddarsu VR. Proximate and nutritional analysis of culantro (*Eryngium foetidum*). J Pharmacogn Phytochem. 2018;7(15):3129-34; ISSN: 2278-4136.
 16. Saed B, El-Waseif M. Influence of Caper (*Capparis spinosa* L) Seeds Powder Addition as Source of Bioactive Phytochemicals on Quality Attributes and Shelf Life Extension of Beef Burger Patties. Middle East J Agric Res. 17 de diciembre de 2017;06:1243-58; ISSN 2077-4605.
 17. García O, Ruiz J, Acevedo I. Evaluación físico-química de carnes para hamburguesas bajas en grasas con inclusión de harina de quinchoncho (*Cajanus cajan*) como extensor. Rev Científica Univ Zulia. 2012;22(6):497-506; ISSN: 0798-2259.
 18. Zumbado H, Terrazas S, Roca M. Desarrollo de hamburguesas con la adición de nuez criolla pecana (*Carya illinoensis*) y fibra de trigo (*Triticum aestivum*), empleando carne de toretes alimentados con dos sistemas de engorde. Rev Científica Fac Cienc Vet. 29 de julio de 2023;33:1-10.
 19. Ruiz J, García O. Análisis proximal, evaluación microbiológica y sensorial de carnes para hamburguesas elaboradas con cachama blanca (*Piaractus brachyomus*) y soya (*Glycine max*) texturizada. Rev Venez Cienc Tecnol Aliment. 4 de julio de 2013;4(2):219-36; ISSN: 2218-4384.
 20. Piñero MP, Ferrer MA, Moreno LA de, Leidenz NH, Parra K, Araujo S. Atributos sensoriales y químicos de un producto cárnico ligero formulado con fibra soluble de avena. Rev Científica Fac Cienc Vet Univ Zulia. 7 de junio de 2010;15(3):279-85; ISSN: 2521-9715.
 21. Muñoz-Castillo JS, Malagón-Alvira KO. El desarrollo de una hamburguesa suplementada parcialmente con harina de gusano rey (*Zophobas morio*) en Bogotá y municipios aledaños. Reto. 2022;10(1):58-67; ISSN: 2619-4112.
 22. Clavijo D, Rodríguez F, Estupiñán JE. Utilización de plukenetia volubilis (sacha inchi) para mejorar los componentes nutricionales de la hamburguesa. Enfoque UTE. junio de 2015;6(2):59-76; ISSN: 1390-6542.
 23. Gómez-Muriel LA, Benítez-Sepúlveda E, Velásquez-Henao A, Jaramillo-Yepes F. Desarrollo de una carne de hamburguesa de pechuga de pollo con adición de fibra y reducción de grasa. Perspect En Nutr Humana. 25 de junio de 2021;23(1):15-26; ISSN: 2248-454X.
 24. Moscoso J, Gomez-Quispe O, Guevara-Carrasco V. Metabolizable energy and net energy content of corn, wheat bran, soybean meal, fish meal and soybean oil for broilers. Sci Agropecu. 26 de agosto de 2020;11:335-44.
 25. Morán I, Mejía A, Beltrán F. Industrialización del cultivo de soya. Obs Econ Latinoam. 2019;1-19; ISSN: 1696-8352.
 26. Díaz R, Mogro L. Formulación de hamburguesa gourmet precocida-congelada, usando carne caprina, perejil (*Petroselinum crispum*) y albahaca (*Ocimum basilicum*). Cumbres. 21 de julio de 2020;3(2):51-9; ISSN 1390-9541.
 27. Cevallos K, Quiñonez M, Jimenez R, Taco J, Arellano J. Estudio de vida útil de una hamburguesa con especias en la planta de procesos del Instituto Superior Tecnológico Tsa'chila.: Shelf life study of a hamburger with spices in the process plant of the Tsa'chila Higher Technological Institute. Rev Científica Multidisciplinaria G-Nerando. 6 de septiembre de 2023;4(2):288-317; ISSN: 2806-5905.
 28. Loyola N, Acuña C, Arriola M. Sensory attributes, nutritional values and innocuousness of hamburgers made with cherry pulp, soy and pork meat. Rev Fac Agron. 2021;3(8):128-50; ISSN 2477-9407.
 29. Casignia R, Falconí P, Núñez T, Guerrero R. Utilización de aceites esenciales de la planta tipo (*Mintostachys mollis*) para la conservación de carne de hamburguesa. Cienc Digit. 15 de junio de 2019;3(2,6):332-48; ISSN: 2602-8085.

CARACTERÍSTICAS

Es la publicación científica oficial de la Sociedad Española de Dietética y Ciencias de la Alimentación (SEDCA). La Revista publica trabajos en español, portugués e inglés sobre temas del ámbito de la alimentación, la nutrición y la dietética. Exclusivamente se aceptan originales que no hayan sido publicados, ni estén siendo evaluados para su publicación, en cualquier otra revista sin importar el idioma de la misma.

MODALIDADES DE PUBLICACIÓN

Se admitirán originales que puedan adscribirse a las siguientes modalidades y tipos:

- **Artículos originales.** Descripción completa de una investigación básica o clínica que proporcione información suficiente para permitir una valoración crítica y rigurosa. La extensión máxima será de 12 páginas conteniendo un máximo de 6 tablas y 6 figuras.
- **Colaboraciones cortas.** Se tratará de artículos originales de menor entidad cuya extensión no supere las 6 páginas, 3 tablas y 3 figuras.
- **Revisiones.** Serán revisiones de publicaciones anteriores relacionadas con un tema de interés que contengan un análisis crítico que permita obtener conclusiones. Las revisiones normalmente serán solicitadas directamente por los Editores a sus autores y el texto tendrá que tener una extensión máxima de 12 páginas, 6 tablas y 10 figuras.
- **Cartas a la revista:** relacionadas con artículos aparecidos en la publicación. Su extensión máxima será de 2 páginas.
- **Otros.** Adicionalmente, se admitirán para su publicación noticias, informes, conferencias, cursos, convocatorias de reuniones y congresos así como de premios y becas. La extensión y forma de presentación de los textos recibidos para este apartado estarán sujetos sin notificación previa a las modificaciones que el Comité Editorial estime convenientes.

ELABORACIÓN DE ORIGINALES

La preparación del manuscrito original deberá de hacerse de acuerdo las Normas y Requisitos de Uniformidad del Comité Internacional de Directores de Revistas Médicas (versión oficial en inglés accesible en la dirección electrónica: <http://www.icmje.org>). Para la traducción en español puede revisarse el enlace URL: <http://www.metodo.uab.es/enlaces.htm>).

En la web de la revista (<http://www.nutricion.org>) están disponibles las presentes **Normas de publicación**. Para la correcta recepción de los originales deberá incluirse siempre:

1. Carta de presentación

Deberá hacer constar en la misma:

- Tipo de artículo que se remite.
- Declaración de que es un texto original y no se encuentra en proceso de evaluación por otra revista.
- Cualquier tipo de conflicto de intereses o la existencia de implicaciones económicas.
- La cesión a la Revista de los derechos exclusivos para editar, publicar, reproducir, distribuir copias, preparar trabajos derivados en papel, electrónicos o multimedia e incluir el artículo en índices nacionales e internacionales o bases de datos.
- Los trabajos con más de un autor deben ser leídos y aprobados por todos los firmantes.
- Los autores deben declarar como propias las figuras, dibujos, gráficos, ilustraciones o fotografías incorporadas en el texto. En caso contrario, deberán obtener y aportar autorización previa para su publicación y, en todo caso, siempre que se pueda identificar a personas.
- Datos de contacto del autor principal: nombre completo, dirección postal y electrónica, teléfono e institución.
- Si se tratase de estudios realizados en seres humanos, debe enunciarse el cumplimiento de las normas éticas del Comité de Investigación o de Ensayos Clínicos correspondiente y de la Declaración de Helsinki vigente, disponible en español en la URL: <http://www.metodo.uab.es/enlaces.htm>

2. Título

Se indicarán, en página independiente y en este orden, los siguientes datos:

- Título del artículo en español o portugués y en inglés.
- Apellidos y nombre de todos los autores, separados entre sí por punto y coma. Se aconseja que figure un máximo de ocho autores. Mediante números arábigos, en superíndice, se relacionará a cada autor, si procede, con el nombre de la institución a la que pertenecen.
- Dirección de correo-e que desean hacer constar como contacto en la publicación.

3. Resumen

Deberá ser comprensible por sí mismo sin contener citas bibliográficas. Será redactado obligatoriamente en los siguientes idiomas: a) español ó portugués y b) inglés, respetando en todo caso la estructura del trabajo remitido con un máximo de 250 palabras:

- Introducción
- Objetivos
- Métodos
- Resultados
- Discusión
- Conclusiones

4. Palabras clave

Debe incluirse al final de resumen un máximo de 5 palabras clave que coincidirán con los Descriptores del Medical Subjects Headings (MeSH) accesible en la URL siguiente:

<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=mesh>

5. Abreviaturas

Se incluirá un listado de las abreviaturas presentes en el trabajo con su correspondiente explicación.

6. Texto

De acuerdo a la estructura siguiente:

- Introducción
- Objetivos
- Métodos
- Resultados
- Discusión
- Conclusiones
- Bibliografía

Es necesario especificar, en la metodología, el diseño, la población estudiada, los sistemas estadísticos y cualesquiera otros datos necesarios para la comprensión perfecta del trabajo.

7. Agradecimientos

En esta sección se deben citar las ayudas materiales y económicas, de todo tipo, recibidas señalando la entidad o empresa que las facilitó. Estas menciones deben de ser conocidas y aceptadas para su inclusión en estos "agradecimientos".

8. Bibliografía

Tienen que cumplir los Requisitos de Uniformidad del Comité Internacional de Directores de Revistas Médicas, como se ha indicado anteriormente.

Las referencias bibliográficas se ordenarán y numerarán por orden de aparición en el texto, identificándose mediante números arábigos en superíndice. Para citar las revistas médicas se utilizarán las abreviaturas incluidas en el Journals Database, disponible en la URL: <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=journals>

9. Figuras y fotografías

Deben elaborarse teniendo en cuenta las siguientes indicaciones:

Se realizarán utilizando programas informáticos adecuados que garanticen una buena reproducción (300 píxeles de resolución por pulgada) en formato BMP, TIF ó JPG. No se admiten ficheros de Power-point ni similares. Los gráficos y las figuras podrán ser enviados preferiblemente en color o, en su defecto, en blanco y negro o en tonos de grises.

ENVÍO DE ORIGINALES

Los trabajos se remitirán por vía electrónica utilizando exclusivamente el formulario disponible en la web de la revista: **www.revista.nutricion.org**

EVALUACIÓN DE ORIGINALES

Los trabajos remitidos para publicación serán evaluados mediante el método de la **dobles revisión por pares**. El autor principal podrá proponer revisores que no estén vinculados al original remitido.

nutrición clínica

y

Dietética Hospitalaria