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Effect of Nusantara diet feeding with triglyceride glucose index as a measure of insulin resistance in individuals' metabolic syndrome risk

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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 (Riskesdas) 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 women[5]. 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

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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 adults[9].

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 milk[10]. 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 filtered[11]. 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 fat[12]. 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 intervention[13].

Coconuts are native to the coasts of the Indian Ocean, including Indonesia[14]. 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 Province[15]. 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 preparations[16]. In addition to West Sumatra, coconut milk and coconut products are also used in various regions in Indonesia such as Java[17]. 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 Medan[18].

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 interventions[19].

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/m2)	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 ΔTG -6.88 (p = 0.989), ΔGDP -5.08 (p = 0.012), and ΔTyG Index -0.07 (p = 0.459), although only ΔGDP was statistically significant. While in the control group, there was an increase in TG levels, and TyG Index where ΔTG 15.48 (p = 0.898), and ΔTyG Index 0.02 (p = 0.424), although there was a decrease in GDP where ΔGDP -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]
ΔTG	-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: Tryglycerides; 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 BW[20].

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 weight[21]. 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 Mellitus[22]. 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 loss[23].

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 body[24].

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 metabolism[25]. 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 significant[26]. 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 Gherlin and peptide YY[27].

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 resistance[28].

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) index[29]. 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-6 [30]. Nazarii Kobyliak's research (2020) also showed improvements in triglyceride levels in the group that received fish oil intervention as well as glucose and C-peptide[31].

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 cells[32].

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.

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