

The relationship of physical activity with nutritional status and body composition in traditional and modern populations in South Sulawesi, Indonesia

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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

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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

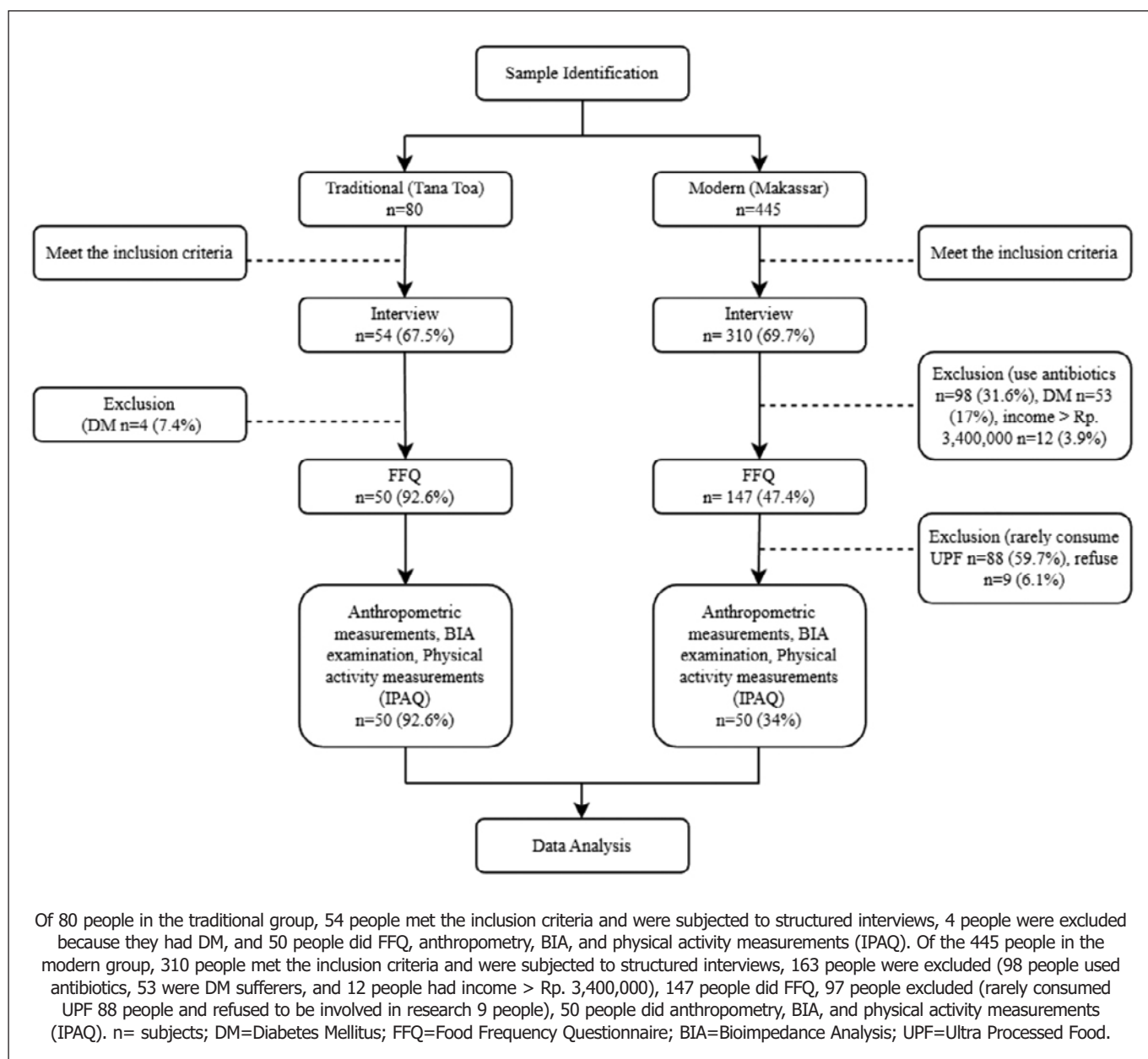


Figure 1. Flow chart of the study

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; * $p \leq 0.05$; ** $p < 0.001$.

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.

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