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Relationship of Body Fat Distribution and Anthropometric Status with Lipid Profiles in Ethnic Minang Adult Women

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Abstract:

Background: The prevalence of metabolic syndrome is increasing, and it is a risk factor for cardiovascular disease. One of the indicators of metabolic syndrome is dyslipidemia.

Objective: This study analyzes adult women's body fat distribution, anthropometric status, and lipid profiles.

Methods: This study used a cross-sectional design with simple random sampling. A total of 159 adult women aged 25-44 living in the Pesisir Selatan district participated in the study. Ethical approval was obtained, and the respondents were not taking cholesterol-lowering drugs. Body fat distribution, anthropometric status, and lipid profile data were assessed using standard procedures and compared with the categories recommended for Indonesian women.

Results: The average age of respondents was 36.6 years. 45.3% of the respondents suffered from dyslipidemia. Most of them were obese based on BMI and had central obesity based on WC. Additionally, 76% had an above-normal fat mass. Lipid profile data showed that some (45.3%) had high total cholesterol, 44% had high LDL, 8% had high TG, and a small proportion (15%) had low HDL levels. There was a significant relationship ($p < 0.01$) between body fat distribution and anthropometric status with lipid profiles, except for total cholesterol ($p < 0.05$). A negative correlation was found between body fat percentage, BMI, and WC with HDL, while a positive correlation existed between body fat percentage, BMI, and WC with TG and LDL levels.

Conclusions: Obesity is found to be higher, and dyslipidemia begins to occur in women at a younger age, increasing the risk of metabolic syndrome. Education and routine screening are necessary to prevent non-communicable diseases.

Keywords: Metabolic syndrome, Obesity abdominal, Adult women, Risk factor for CVD, Body fat, Cross-sectional design study.

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1. BACKGROUND/INTRODUCTION

Dyslipidemia, as a marker for metabolic syndrome, is a risk factor for cardiovascular disease. Metabolic syndrome refers to a group of risk factors for cardiovascular disease, including hypertension, obesity, dyslipidemia, and insulin resistance [1]. The prevalence of metabolic syndrome is increasing globally, along with the rising prevalence of obesity. Cardiovascular disease (CVD) affects the heart and circulatory system. Blood clotting is the most common cause of atherosclerosis. Increased levels of Low-Density Lipoprotein (LDL), triglycerides, and low high-density lipoprotein (HDL) are linked with a higher risk of CVD in both women and men [2].

Dyslipidemia refers to an abnormality in lipid metabolism characterized by increased or decreased values in plasma lipid fractions. Abnormalities in major lipid fractions can be seen from the increased value of total cholesterol, LDL cholesterol, triglycerides, and decreased HDL [3]. Dyslipidemia or plasma lipid disturbances play a major role in the pathogenesis of atherosclerosis within the blood vessels. Atherosclerosis is the main reason causing coronary heart disease and stroke that lead to death in the world [3]. According to the World Health Organization (WHO), the prevalence of dyslipidemia in Southeast Asia and the Western Pacific has sequentially reached 30.3% and 36.7%, respectively. In 2018, WHO reported that the prevalence of dyslipidemia in Indonesia adults was 36% (33.1% in men and 38.2% in women). Moreover, in 44.1% ethnic Minang adult women, dyslipidemia is closely linked to obesity [4, 5]

Obesity is caused by excessive fat accumulation due to unhealthy eating patterns, such as consuming high fat, high carbohydrates, less fiber, and low physical activity [6]. Over recent decades, the prevalence of obesity has increased globally [7]. Data from Indonesia's Basic Health Research (RISKESDAS) in 2018 shows an increase in obesity rates in adults over 18 years old from 14.8% in 2013 to 21.8% in 2018, while the prevalence of obesity rose from 26.6% in 2013 to 31% in 2018. Studies show that the Body Mass Intex (BMI) above normal in adolescence is linked with an increased risk of death from cardiovascular causes. Excessive fat accumulation occurs in people with obesity and is distributed throughout the body [8].

The measurement of obesity can be done by assessing an index body fat composition. A study found a significant correlation between index body fat composition and the risk of metabolic syndrome in obese women [8]. As one measure of obesity, intra-abdominal or visceral fat, as measured by waist circumference, plays an important role in insulin resistance. This lipolysis of visceral fat increases the supply of free fatty acids to the liver, thereby disrupting the fat metabolism process in the liver. This triggers an increase in triglyceride synthesis and LDL cholesterol production [1].

Body fat distribution is a strong risk for metabolic and cardiovascular conditions. Accumulation network adipose in the upper body (area stomach) is associated with the development of comorbidity obesity and can even become the reason for death [9]. Several studies have found a connection between nutritional status and lipid profiles and a connection between some measurement anthropometry and lipids [10, 11]. However, research that uses measurement of body fat distribution and measurement anthropometry simultaneously to determine lipid profiles is still limited.

This research aims to examine the relationships between the distribution of body fat and anthropometry with the lipid profiles of ethnic Minang adult women.

2. METHODS

2.1. Population and Sample

This study used a cross-sectional design. A total of 159 women participated in this study, with inclusion criteria including ages 25 – 44 years and willingness to become respondents. The respondent was of Minang ethnic origin, stating that both his parents and grandparents were of Minang descent. Exclusion criteria included pregnant women diagnosed with diabetes mellitus type 1 and 2, hypertension, hyperthyroidism, malignancy, consuming drugs that can lower blood pressure, cholesterol or glucose, and smoking.

2.2. Measurement of Body Fat Distribution and Anthropometrics

Body fat distribution was measured using Bioelectric Impedance Analysis (BIA) to assess the composition of body covers, fat percentage, fat mass, and visceral fat. Fat percentage was categorized into two groups. Fat percentage > 33% category excess fat and ≤33% normal [12]. Body mass index (BMI) is the results analysis of body weight (kg) for height $(m)^2$, body weight is obtained from results measurement using Bioelectric Impedance Analysis (BIA) Tanita, and body height was measured using a microtoise. Body Mass Index (BMI) is the Indonesian standard for nutritional status, with obesity as the category with a BMI > 25 kg/m^2 and the normal category with a BMI of 18.5-25 kg/m^2 [13]. Waist Circumference (WC) was measured using a tape waist circumference *SECA,* and the results measurement was categorized as normal if WC ≤80 cm and obesity central if WC > 80 cm.

2.3. Measurement of Lipid Profile

The lipid profile consists of total cholesterol, HDL, LDL, and triglyceride levels obtained from the blood samples analyzed using a spectrophotometer, with results measuring the unit's mg/dl. Blood samples were taken in the morning after respondents fasted for at least 10 hours by a registered laboratory technician. Total cholesterol measurement results are categorized into two, normal <200 mg/dl and high ≥200 mg/dl. Results in HDL cholesterol measurement are cate-gorized into two, normal ≥40 mg/dl and low < 40 mg/dl; LDL cholesterol is categorized into two, normal <130 mg/dl and high ≥130 mg/dl and triglycerides categorized into two high if TG ≥150 mg/dl, low < 150 mg/dl[3].

2.4. Statistical Analysis

Data analysis used Microsoft Excel and IBM SPSS version 22. A normality test was performed for each variable. Analysis was conducted to determine the average for each variable. Nonparametric statistical analysis with the Spearman correlation test was used to examine the relationships between index fat distribution and index measurement anthropometry with lipid profiles.

2.5. Ethical Approval

This study was ethically approved by The Research Ethics Committee of Medical Faculty Andalas University Indonesia on September 06, 2022, with No: 939/UN.16.2KEP-FK/2022. Recommendation for the study was also obtained from the Provincial Government Board of West Sumatra (Recommendation no: 570/503-Periz/DPM&PTSP/III/2022).

3. RESULTS

The research found that the average age of respondents was 36.6 ±5.37 years, 92% not working, 52% high school education, 27% middle school education, and 12% elementary school. A total of 45.3% of respondents suffered from dyslipidemia. Anthropometry measurements showed that the respondents' average body weight was 60 ± 13 kg, average height was 149.69 ± 5.34 cm, average waist circumference was 90.48 ±11.87 cm, and average body mass index was 26.83 ±5.22. BIA measurement revealed that the average fat percentage was 38%, the average fat mass was 24 kg, and the mean visceral fat was 7.40. Based on an analysis of the blood lipid profile, it was found that the average lipid profile of respondents was still within normal limits, with an average HDL level of 53 mg/dl, triglycerides at 91 mg/dl, LDL at 126 mg/dl, and total cholesterol at 197 mg/dl (Table **1**).

Table **2** presents the anthropometry and lipid profile of respondents. It was found that 76.1% had a high fat percentage, obesity by BMI was 63%, and central obesity was 79%. All of these categories were higher for the dyslipidemia group. Distribution respondents based on category lipid profile low HDL levels was 15.1%, high triglycerides accounting of 8%, high LDL level of 44%, and high total cholesterol of 45.3%. The lipid profile of LDL, TG, and total cholesterol are significantly higher in the group dyslipidemia. Energy, carbohydrate, fat, and protein intake, as measured from the results of interviews using a semi-quantitative food frequency questionnaire, were found to be within normal limits according to nutritional recommendations. However, the average intake was above normal when compared with the needs of each individual.

Diverse correlations were found between body fat distribution and measurement anthropometry with profile lipids, as indicated in Table **3**. Correlated fat distribution negative with HDL cholesterol (fat percentage r = -0.396; $p<0.01$, fat mass r = -0.398; $p<0.01$, visceral fat r = -0.361; $p<0.01$) and is correlated positively with LDL cholesterol (fat percentage r = 0.252; $p<0.01$, fat mass r = 0.234; $p<0.01$, visceral fat r=0.257; $p<0.01$), with triglycerides (percent fat r = 0.459; $p<0.01$, fat mass r = 0.449; $p<0.01$, visceral fat r= 0.463; $p<0.01$) but not on total cholesterol (percent fat r= 0.175; $p<0.05$, fat mass r = 0.150; $p>0.05$, visceral fat r = 0.190; $p<0.05$).

Measurement results anthropometry based on BMI and waist circumference negatively correlated with lipid profile HDL cholesterol (BMI r = -0.400; $p<0.01$, circumference waist r = -0.367; $p<0.01$) and correlated positively with other lipid profiles, namely LDL cholesterol (BMI r = 0.227; $p<0.01$, circumference waist r = 0.257; $p<0.01$), with triglycerides (BMI r=0.444; $p<0.01$, circumference waist r= 0.413; $p<0.01$), while total cholesterol (BMI r = 0.142; $p>0.05$, circumference waist 0.173; $P<0.05$). The results showed that the composition of body-related fat distribution and measurement anthropometry strongly correlate with blood triglyceride. The research results also show a close correlation between the distribution of at-mass and anthropometric status.

Table 1. Characteristics respondent based on condition dyslipidemia.

Characteristics (unit)	Total (avg ± SD) n=159	Dyslipidemia (avg ± SD) n=72	No Dyslipidemia (avg ± SD) n=87
Age (years)	36.62 ± 5.37	37.03 ± 54.66	36.28 ± 5.90
Body weight (kg)	60.10 ± 13.12	60.36 ± 12.82	59.88 ± 13.43
Height (cm)	149.69 ± 5.34	149.25 ± 5.79	150.06 ± 4.93
Energy intake (kcal)	1446 ± 271	1392 ± 240	1490 ± 289
Karbohidrat intake (g)	205.8 ± 37	200 ± 35.4	210.7 ± 37.7
Fat intake (g)	44.55 ±12.56	42.4 ± 10.8	46 ± 13.6
Protein intake (g)	54.11 ± 10.36	51.7 ± 9.1	56 ± 10.9
BMI (kg/m^2)	26.83 ± 5 .22	27.06 ± 4.85	26.63 ± 5.52
Waist circumference (cm)	90.48 ± 11.87	91.24 ± 10.96	89.85 ± 12.60
Fat percentage (%)	38.14 ± 7.90	38.91 ± 6.88	37.49 ± 8.64
Fat mass (kg)	23.85 ± 9.91	24.25 ± 9.43	23.53 ± 10.32
Visceral fat	7.40 ± 4.09	7.67 ± 3.86	7.17 ± 4.28
HDL cholesterol (mg/dl	52.89 ± 12.83 *	55.15 ± 12.49	51.01 ± 12.88
LDL cholesterol (mg/dl)	125.82 ± 32.30 **	152 ± 24.05	104.16 ± 19.7
Triglycerides (mg/dl)	90.72 ± 41.72 **	104.79 ± 49.20	79.07 ± 29.9
Total cholesterol (mg/dl)	196.88 ± 35.66 **	228.11 ± 24.41	171.03 ± 18.78

Note: Information:
**$p<0.01$
*$p<0.05$

Table 2. Distribution frequency respondent based on measurement anthropometrics, fat percent, and lipid profile.

Characteristics (unit)	Category	Dyslipidemia		No Dyslipidemia		Total	
		n=72	%	n=87	%	n=159	%
BMI	Overweight	48	66.7	52	59	100	63
	Normal	21	29.2	29	33.3	52	33
	Underweight	3	4.2	6	7	7	4
Waist circumference	Central obesity	62	86.1	64	73.6	126	79
	Normal	10	13.9	23	26.4	33	21
Fat percentage (%)	High	59	81.9	62	71.3	121	76.1
	Normal	13	18.1	25	28.7	38	23.9
HDL cholesterol (mg/dl)	Low	8	11.1	16	18.4	24	15.1
	Normal	64	88.9	71	81.6	135	84.9
LDL cholesterol (mg/dl)	High	63	87.5	7	8	12	8
	Normal	9	12.5	80	92	147	92
Triglycerides (mg/dl)	High	9	12.5	3	3,4	70	44
	Normal	63	87.5	84	96.6	89	56
Total cholesterol (mg/dl)	High	72	100	0	0	72	45.3
	Normal	0	0	87	100	87	54.7

Table 3. Spearman correlation of fat distribution and anthropometrics with lipid profile.

-	Fat percent		Fat mass	Visceral fat	BMI	Waist circumference	Total cholesterol	HDL	LDL	TG
Fat Percent	r	1,000	,977 **	,964 **	.983 **	.922**	,175 *	-.396 **	.262 **	.459 **
Fat Mass	r	-	1,000	,981 **	.974 **	,943**	,150	-.398 **	.234 **	.449 **
Visceral fat	r	-	-	1,000	.945 **	,928**	,190 *	-.362 **	.257 **	.463 **
BMI	r	-	-	-	1,000	,922**	,142	-.400 **	.227 **	.444 **
Circumference Waist	r	-	-	-	-	1,000	.173*	-367**	.257**	..413**
Total Cholesterol	r	-	-	-	-	-	1,000	.178 *	.913 **	,456 **
HDL	r	-	-	-	-	-	-	1,000	-.138	-.359 **
LDL	r	-	-	-	-	-	-	-	1,000	.424 **
Triglycerides	r	-	-	-	-	-	-	-	-	1,000

Note: Information:.
**p<0.01.
*p<0.05.

4. DISCUSSION

Dyslipidemia is the main risk factor for atherosclerosis. The results of this study align with the prevalence of dyslipidemia reported by Gusnedi in 20204. In Framingham's study, dyslipidemia was characterized by abnormal serum lipid concentrations, including total cholesterol, LDL, HDL, and triglycerides, which are important modifiable factors for the development of atherosclerosis and heart disease [4, 5]. The increasing value of triglycerides, LDL, and low HDL levels, accompanied by excess body weight, obesity, or diabetes mellitus, indicate the metabolic syndrome [14]. In this study, the average participant's body weight was 60 kg, the average height was 149.69 cm, and the average circumference waist was 90.48 cm, which is above the normal value for women. The occurrence of dyslipidemia is related to lifestyle factors, including eating patterns, especially excessive energy intake, which is not balanced with appropriate activities, resulting in a positive energy balance. This study found that respondents' energy and nutrient intake was above their needs, and data related to activities showed that the majority of respondents did not work or were housewives, only doing activities at home.

This study found a higher mean BMI compared to the result by Gonzales (2019). The prevalence of obesity by fat mass was higher than obesity by BMI. The research results of Gonzalez (2019) showed that the mean BMI in the obesity group was 24.3 kg/m^2, and the mean BMI in the group obesity accompanied by metabolic disorders was 26.75 kg/m^2 [15]. The mean body fat distribution and triglyceride lipid profile in this study were lower, while the mean HDL was higher than the findings by Radetti (2021), where the average body fat percentage was 50.84% and the average lipid profile triglycerides were 154.44 mg/dl and HDL was 46.8 mg/dl in the obesity group with metabolic disorders. Body mass index is one of the anthropometric indices used as a substitute indicator for fat mass to classify obesity, with a BMI >25 kg/m^2 being positively related to cardiovascular risk factors and metabolic disorders [9]. Given the average height of

149.69 and weight of 60 kg, respondents in this study were classified as obese, as well as an average abdominal circumference above normal, indicating excess calorie intake and low physical activity. The interview results show that the respondents' daily habits of processing food by frying it in palm oil and chili sauce resulted in high oil consumption.

Body fat distribution correlated negatively and significantly (p<0.01) with HDL cholesterol. Fat percentage (r = -0.396), fat mass (r = -0.398), and visceral fat (r = -0.361) were positively and significantly correlated (p<0.01) with other lipid profiles, namely LDL cholesterol and triglycerides, while weak correlated fat distribution with total cholesterol. Body fat distribution is a strong risk factor for metabolic and cardiovascular disease. Accumulation of the adipose network in the upper body (stomach area) is associated with the development of comorbidity obesity and can even become the reason for death [9].

Measurement result's anthropometry based on BMI and waist circumference negatively and significantly correlated with lipid profile HDL cholesterol that is with BMI: r = -0.400, waist circumference r = -0.367, and correlated positive and significant with other lipid profiles, namely LDL cholesterol with BMI r = 0.227, waist circumference r = 0.257, likewise with triglycerides correlated with BMI r = 0.444, and waist circumference r = 0.413, as well small with total cholesterol and not significant with BMI r = 0.142, but significant with waist circumference r = 0.173. These results are consistent with Gonzalez's findings (2019), which reported that BMI is negatively correlated with HDL (r: - 0.586) and is correlated positively with triglycerides (r: 0.556). Fat mass was negatively correlated with HDL (r: - 0.532) and positively correlated with triglycerides (r: 0.561). Fat percentage was negatively correlated with HDL (r: -0.498) and positively correlated with triglycerides (r: 0.569). Pesisir Selatan District is located on the west coast of Sumatra Island, so the availability of fish is quite easy for respondents to obtain. Almost every day, respondents consume fish, which contributes omega 3 to the body and the formation of HDL, so only 15% of respondents have low HDL levels. However, processing fish by frying with palm oil contributes excessive energy to respondents who consume it. Research by Xu (2018) also showed a positive correlation between visceral fat area and total cholesterol and LDL [16]. An increase in total cholesterol can occur due to an increase in LDL and HDL. High total cholesterol accompanied by high HDL will provide good health conditions.

This study found that the most significant correlation was between triglyceride and high visceral fat accumulation. High triglyceride levels in people with high visceral fat can occur because there are people with central obesity. An excess accumulation of visceral fat results in a disruption of insulin signaling and insulin resistance. Excess visceral fat is associated with the incidence of insulin resistance due to an increased tendency to lipolysis processes, increased glucocorticoid receptor activity, secretion of inflammatory cytokines, and decreased secretion of insulin sensitivity in adipocytes. Visceral fat lipolysis is associated with an increase in the supply of fatty acids to the liver, which causes increased triglyceride synthesis and apolipoprotein B production for the formation of triglyceride-rich very low-density lipoprotein (LDL) in the liver [1, 17].

Triglycerides are a type of blood fat derived from the source of food or exogenous sources, which is related to excess fat intake. Triglyceride food is emulsified by bile acid in the intestinal lumen after hydrolysis, especially by pancreatic lipase, producing 2-monoacylglycerol and free fatty acids. After emulsification, lipid molecules are taken up by cell enterocytes and synthesized to become triglycerides. Triglycerides packed become chylomicrons and are taken up by muscles and tissues adipose because lipoprotein lipase activity is expressed on the luminal surface of cells' endothelium capillary network. Remaining triglycerides in chylomicrons are sent to the liver, and receptor-mediated endocytosis fatty acids are released during the processing of particle lysosomes [18].

Temporarily, when there is an excess intake of carbohydrates, the liver changes glucose to become fatty acids; this process is called *De Novo Lipogenesis* (DNL). DNL control is, in nature, transcriptional. Plasma insulin activates endoplasmic reticulum transcription factors related to membrane element sterol regulatory binding protein 1C (SREBP1c) and enhances regulations of all the genes in track biosynthetic fatty acid. Absorption of excess plasma glucose by the liver pushes translocation, increasing regulation transcription. Many biosynthetic genes add fatty acids to pyruvate kinase, increasing citric availability to synthesize fatty acids [18]. Research by Araujo (2019) shows that the prevalence of health metabolism is the proportion of people with an optimal level of all risk factor variables without treatment. The analysis focused on five grouped risk factors : variable blood pressure (systolic and diastolic blood pressure), waist circumference, blood glucose, and triglycerides and HDL levels. Triglyceride and HDL cholesterol levels are the lipid profiles that become health metabolism guidelines [19].

BMI, visceral fat, and waist circumference can predict lipid profiles in women with nutritional status [10]. This study showed that BMI anthropometry is the strongest correlate with triglyceride levels between component measurements, with triglycerides increasing as BMI rises. Dyslipidemia in people with obesity may occur due to the increased release of free fatty acids from network adipose through the process of lipolysis, which raises free fatty acids in the liver, resulting in higher triglycerides levels and increased production of *Very Low-Density Lipoprotein* (VLDL) in the liver, as well inhibits lipoprotein lipase in adipose tissues and skeletal muscle, so that increase hypertriglyceridemia [10].

This study revealed a relationship between body fat distribution and measurement anthropometry with lipid profiles. The significant relationship between visceral fat and BMI with triglyceride levels suggests that visceral fat and BMI can be a fairly sensitive parameter to help determine incident hypertriglyceridemia. Furthermore, the correlation between body fat distribution and indicative anthropometric status is associated with increased BMI with excess fat mass, especially visceral fat. Reducing fat mass can be achieved by limiting calorie intake and regular exercise. Hushmandi's research (2023) indicates that regular exercise can significantly reduce anthropometric indices [20]

CONCLUSION

Fat distribution index and anthropometric measurements were negatively correlated with lipid profile HDL cholesterol and positively correlated with other lipid profiles, namely total cholesterol, LDL cholesterol, and triglycerides. The strongest correlation was found between fat distribution and anthropometric measurements with triglycerides. Triglyceride and HDL cholesterol levels become indicators for optimal health metabolism levels. Excess intake of calories and low physical activity impact the increase of glucose levels. It leads to excess energy intake and fat biosynthesis, thus worsening the blood lipid profile. Obesity is more prevalent and starts to cause dyslipidemia in younger women, increasing the risk of metabolic syndrome. Education, especially about food processing techniques by limiting the use of palm oil, and nutritional intake according to the body's needs and routine screening, monitoring nutritional status, and measuring body fat composition periodically are necessary to prevent non-communicable diseases.

AUTHORS' CONTRIBUTION

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to itssubmission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

LIST OF ABBREVIATIONS

CVD	=	Cardiovascular disease
LDL	=	Low-density lipoprotein
HDL	=	High-density lipoprotein

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was ethically approved by The Research Ethics Committee of Medical Faculty Andalas University, Indonesia on September 06, 2022, with No: 939/UN.16.2KEP- FK/2022.

HUMAN AND ANIMAL RIGHTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committees and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from the participants.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIAL

The data supporting the findings of the article is available in the Zenodo Repository at https://doi.org/10.5281/zenodo.14031210, reference number DOI/10.5281/zenodo.14031210.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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