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Original Research Article

The Relationship between Waist Circumference and Blood Triglyceride Levels in the Working Population at El Tari Airport in Kupang

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Abstract: ***Introduction*:** Dyslipidemia is defined as a lipid metabolism disorder characterized by one of the main abnormalities in the lipid fraction being an increase in triglycerides. Hypertriglyceridemia occurs with the accumulation of visceral fat and in the blood due to a decrease in the enzyme lipoprotein lipase. The accumulation of visceral fat is the cause of central obesity. Central obesity can be seen by measuring waist circumference. ***Aims*:** To determine the relationship between waist circumference with triglyceride levels in the working population at El Tari Airport, Kupang. ***Method*:** The type of research carried out was analytical observational with a cross sectional method. The respondents for this research were 60 people consisting of 41 men and 19 women workers at El Tari Kupang Airport aged 18-59 years. Data were collected using interviews and waist circumference using metline and blood samples were taken to measure triglyceride levels. The statistical tests used were the Kolmogorov-Smirnov normality test ($p > 0.05$) and the Pearson correlation test**.** ***Results*:** There were 68.3% of subjects with normal waist circumference, 31.7% with excessive waist circumference, 78.3% with normal triglyceride levels, 18.4% with slightly high triglyceride levels, and 3.3% with high triglyceride levels. The results showed that waist circumference had a positive relationship with triglyceride levels ($r=0.446$, $p=0.000$). Both showed a significant correlation with triglyceride levels ($p<0.05$). ***Conclusion*:** There is a significant relationship between waist circumference and triglyceride levels.

Keywords: Waist Circumference, Triglycerides, Central Obesity, Airport Workers, Cross-Sectional Study, Dyslipidemia.

INTRODUCTION

Dyslipidemia is defined as a disorder of lipid metabolism characterized by an increase or decrease in plasma lipid fractions. The main abnormalities of lipid fractions include increased total cholesterol, low-density lipoprotein (LDL) cholesterol, and/or triglycerides (TG), as well as decreased high-density lipoprotein (HDL) cholesterol. (PERKENI, 2021) Elevated triglyceride levels represent one of the lipid metabolism disorders that may act as a risk factor for dyslipidemia. Hypertriglyceridemia occurs due to the accumulation of visceral fat and triglycerides in the bloodstream as a result of decreased lipoprotein lipase enzyme activity. One of the causes of hypertriglyceridemia is visceral fat accumulation, which also contributes to the development of obesity, particularly central obesity. (PERKENI, 2021)

The global prevalence of central obesity among individuals aged ≥15 years is 41.5%. (Wong *et al*., 2020) In Indonesia, the prevalence of central obesity among individuals aged ≥15 years in 2018 was 31.0%. (Kemenkes RI, 2018) According to the Basic Health Research (Riskesdas 2018), Kupang City has the highest prevalence of adult obesity in East Nusa Tenggara Province at 20.09%, with central obesity prevalence reaching 31.10%. (Kemenkes RI, 2018) Based on sex, triglyceride levels are higher in males (16.3%) than in females (11.4%). (Kemenkes RI, 2018)

Obesity is recognized as a chronic low-grade systemic inflammatory disease that predisposes individuals to other chronic conditions, such as insulin resistance, dyslipidemia, hypertension, coronary artery disease, and musculoskeletal disorders. (Paley &

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Johnson, 2018) The World Health Organization (WHO) defines obesity as excessive or abnormal fat accumulation that may impair health if maintained over time. Based on fat distribution, obesity is classified into general obesity and central obesity. (Semlitsch *et al*., 2019) Adipose tissue located directly beneath the skin is known as subcutaneous fat, while fat located deeper within the abdominal cavity and not visible externally is referred to as visceral fat. (Aggarwal *et al.,* 2012)

General obesity is commonly determined by calculating body mass index (BMI), which is the most widely used and practical indicator for assessing overweight and obesity in adults. BMI is calculated by dividing body weight in kilograms by the square of height in meters. This condition is referred to as general obesity. (Setiati *et al*., 2019) Central obesity is defined as the accumulation of fat in the abdominal region, resulting from excessive fat in subcutaneous and visceral adipose tissue. Visceral fat accumulation reflects the inability of subcutaneous adipose tissue to adequately manage energy imbalance, which may arise from increased caloric intake and insufficient physical activity. (Tchernof & Després, 2013) According to the National Cholesterol Education Program–Adult Treatment Panel III (NCEP-ATP III), central obesity is more strongly associated with cardiovascular disorders than general obesity. (Lorenzo *et al*., 2007)

Individuals with obesity experience an increase in total body fat, which accumulates in both subcutaneous fat (general obesity) and visceral fat (central obesity). These fat depots contain enlarged adipocytes characterized by triglyceride storage in adipose tissue, which readily undergo lipolysis, leading to increased free fatty acid levels. Elevated free fatty acids may subsequently trigger hypertriglyceridemia. (Sitanggang *et al*., 2021; Amelinda & Wirawanni, 2014)

A previous study by André Tchernof and Jean-Pierre Després demonstrated that central obesity assessed by waist circumference provides more accurate metabolic risk information than BMI measurement. (Tchernof & Després, 2013) The assessment of central obesity is defined by waist circumference >90 cm in men and >80 cm in women. (Puspitasari & Puruhita, 2014) Increasing age is associated with increased visceral fat accumulation, which serves as a risk factor for diseases such as type 2 diabetes mellitus, cardiovascular disease, metabolic syndrome, hypertension, and dyslipidemia. (Puspitasari & Puruhita, 2014; Sudikno *et al*., 2016) One factor contributing to increased visceral fat and central obesity is triglycerides. Triglycerides represent stored fat and calories derived from carbohydrates that are not metabolized through daily physical activity. When the body is unable to utilize excess calories, triglycerides accumulate in the bloodstream, resulting in elevated triglyceride levels.

Previous research by Amelinda and Wirawanni (2014) reported a relationship between waist circumference and triglyceride levels, as individuals with obesity experience increased total body fat, particularly visceral fat measured through waist circumference. This fat depot contains enlarged adipocytes characterized by triglyceride accumulation. (Amelinda & Wirawanni, 2014)

These findings are consistent with a study by Sitanggang *et al*., (2021), which demonstrated that visceral fat measured by waist circumference undergoes increased lipolysis, leading to elevated free fatty acids that may trigger hypertriglyceridemia. (Sitanggang *et al*., 2021) However, a study by Puspitasari and Puruhita (2014) reported no association between waist circumference and triglyceride levels, suggesting that triglyceride levels are influenced by dietary intake and may decrease with reduced consumption of cholesterol-rich foods without necessarily affecting waist circumference. (Puspitasari & Puruhita, 2014) Preliminary observations conducted by the researchers among workers at El Tari Airport, Kupang, involving a population of 100 individuals, identified 54 individuals with obesity, indicating a potential increase in waist circumference among this population.

The novelty of this study lies in its focus on an occupational population in eastern Indonesia, specifically adult workers at El Tari Airport, Kupang, a population that remains underrepresented in studies on metabolic and cardiovascular risk factors. By investigating the association between waist circumference and triglyceride levels within a working population characterized by distinct occupational and lifestyle patterns, this study provides region-specific evidence that may support early risk identification and inform preventive strategies for dyslipidemia and central obesity in comparable occupational settings.

METHODS

This study was an analytical observational study employing a cross-sectional design conducted at El Tari Airport, Kupang, located on Jl. Adi Sucipto, Penfui, Maulafa District, Kupang City, East Nusa Tenggara, from September 9 to September 23, 2023. The study population consisted of all workers at El Tari Airport aged 18–59 years. A total of 60 subjects participated in this study, comprising 41 men and 19 women, all of whom met the inclusion and exclusion criteria. Inclusion criteria included airport workers aged 18–59 years who agreed to participate by signing informed consent, were in good general health and able to stand upright, were able to fast for at least 12 hours prior to blood sampling, were not currently taking cholesterol-lowering medications, had no metabolic diseases or history of metabolic disorders, were not pregnant, and did not have anasarca edema or ascites. The exclusion criterion was the inability to obtain a blood sample or failure to comply with the fasting requirement. This study received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine and Veterinary Medicine, Universitas Nusa Cendana (approval number 58/UN15.16/KEPK/2023).

Research Procedure

Informed consent was obtained one day prior to the fasting period. Subjects were instructed to fast for 12 hours, and those who did not comply with the fasting requirements were excluded even if previously registered. Fasting subjects were interviewed to confirm the timing of their last meal. Data collection during the study period included screening and education regarding fasting, followed by blood sampling conducted in the morning. Venous blood samples were collected by trained laboratory personnel, stored in blood collection tubes, and centrifuged at 3000 rpm for 3 minutes to obtain serum. The serum samples were immediately transported to the SK Lerik Hospital Laboratory for triglyceride analysis.

Blood triglyceride levels were measured using a spectrophotometric method and reported in mg/dL on an interval scale, and were categorized as normal (<150 mg/dL), borderline high (150–199 mg/dL), high (200–499 mg/dL), and very high (≥500 mg/dL). Following blood collection, waist circumference measurement was performed using a metline measuring tape with the subject standing upright and relaxed, with any clothing or obstacles interfering with the measurement removed. The measuring tape was placed horizontally and wrapped directly around the abdominal skin at the midpoint between the lowest rib margin and the iliac crest, and measurements were taken at the end of normal expiration. Waist circumference was recorded in centimeters (cm) on an interval scale, with normal values defined as <90 cm for men and <80 cm for women.

Data Analysis

Data analysis was performed using SPSS 25 software. Univariate analysis was conducted to describe the characteristics of the subjects, including age, sex, body mass index (BMI), waist circumference, and triglyceride levels. Data normality was assessed using the Kolmogorov–Smirnov test, with a significance value of $p > 0.05$ applied for samples exceeding 50 respondents. The relationship between waist circumference and triglyceride levels was analyzed using Pearson's correlation test, as the data were normally distributed.

RESULTS

Univariate Analysis

Univariate analysis was conducted to describe the characteristics of the study respondents, including the distribution of waist circumference, blood triglyceride levels, and the description of the relationship between waist circumference and blood triglyceride levels.

Table 1 : Characteristics of Respondent Based On Age

Age Range	Frequency	Percentage (%)
15-19	3	5
20-24	14	23,33
25-29	9	15
30-34	16	26,67
35-39	7	11,67
40-44	5	8,33
45-49	3	5
50-54	3	5
55-59	0	0,00

Table 1 demonstrates that the most common age range was 30–34 years, comprising 16 respondents (26.67%), while the least represented age ranges were 15–19 years, 45–49 years, and 50–54 years, each consisting of 3 respondents (5%).

Table 2 : Characteristics of Respondent Based on Gender

Gender	Frequency	Percentage (%)
Male	41	68,33
Female	19	31,67

Table 2 indicates that male respondents outnumbered female respondents, with 41 male respondents and 19 female respondents.

Table 3 : Characteristics of Respondent Based on Body Mass Index (BMI)

BMI	Frequency	Percentage (%)
Normal	32	53,33
Above normal	28	46,67

Table 3 shows that respondents with a normal body mass index were more numerous than those with an above-normal body mass index, with 32 respondents classified as having a normal body mass index and 28 respondents classified as having an above-normal body mass index.

Table 4 : Waist Circumference Frequency Distribution among Workers at El Tari Airport, Kupang

No.	Variable	Frequency	Percentage (%)
	Waist Circumference		
1.	Normal	41	68,3
2.	Increased	19	31,7
	Total	60	100

Based on the frequency distribution of waist circumference among workers at El Tari Airport, Kupang, the majority of respondents were classified as having a normal waist circumference. Out of 60 workers included in the study, 41 individuals (68.3%) had waist circumference values within the normal range. Meanwhile, 19 workers (31.7%) were categorized as having increased waist circumference. These findings indicate that although most workers exhibited normal waist circumference, nearly one-third of the study population showed increased waist circumference, suggesting the presence of central obesity risk among a considerable proportion of workers at El Tari Airport, Kupang.

Table 5 : Blood Triglyceride Level Frequency Distribution among Workers at El Tari Airport, Kupang

No.	Variable	Frequency	Percentage (%)
	Triglyceride Level		
1.	Normal (<150 mg/dl)	47	78,3
2.	Borderline High (150-199 mg/dl)	11	18,4
3.	High (200-499 mg/dl)	2	3,3
	Total	60	100

Based on the data presented, the majority of respondents had normal triglyceride levels, with 47 individuals (78.3%) showing triglyceride concentrations below 150 mg/dL. A smaller proportion of respondents, 11 individuals (18.4%), were classified as having borderline high triglyceride levels, ranging from 150 to 199 mg/dL. Only a limited number of respondents, 2 individuals (3.3%), exhibited high triglyceride levels within the range of 200–499 mg/dL. Overall, these findings indicate that most workers at El Tari Airport, Kupang, had triglyceride levels within the normal range, while a minority demonstrated elevated levels that may reflect an increased risk for dyslipidemia.

Table 6: Frequency Distribution of Waist Circumference Characteristics in Relation to Blood Triglyceride Levels among Workers at El Tari Airport, Kupang

		Triglyceride Level		
No.	**Variable**	**Normal**	**Borderline High**	**High**
	Waist Circumference			
1.	Normal	35	4	2
2.	Increased	12	7	0

Based on the frequency distribution of waist circumference characteristics in relation to blood triglyceride levels among workers at El Tari Airport, Kupang, most respondents with a normal waist circumference had normal triglyceride levels. Specifically, 35 individuals with normal waist circumference exhibited normal triglyceride levels, while 4 individuals were classified as having borderline high triglyceride levels and 2 individuals had high triglyceride levels.

Among respondents with increased waist circumference, the majority also demonstrated normal triglyceride levels, with 12 individuals falling into this category. However, a higher proportion of borderline high triglyceride levels was observed in this group, with 7 individuals classified as borderline high, and no respondents with increased waist circumference were found to have high triglyceride levels.

Overall, these findings suggest that normal triglyceride levels were more frequently observed among workers with normal waist circumference, whereas borderline high triglyceride levels were relatively more common among those with increased waist circumference, indicating a potential relationship between waist circumference and blood triglyceride levels in this occupational population.

Bivariate Analysis

Bivariate analysis was conducted to determine the relationship between waist circumference and blood triglyceride levels. The analysis was performed using a 95% confidence level ($\alpha \leq 0.05$). The results of the bivariate analysis are presented below.

Normality Test

The normality test was conducted to assess whether the data were normally distributed. Based on the Kolmogorov–Smirnov test, the significance value obtained was $p = 0.200$ ($p > 0.05$), indicating that the data were normally distributed. Therefore, bivariate analysis was performed using the Pearson correlation test.

Table 7 : Kolmogorov-Smirnov Test

N	60	
Normal Parameters	Mean	0,000000
P Value	0,200*	

*Significant P Value > 0.05

Relationship between Waist Circumference and Blood Triglyceride Levels

The results of the bivariate analysis examining the relationship between waist circumference and blood triglyceride levels showed a statistically significant result, with a p-value of 0.000. This finding indicates a significant association between waist circumference and triglyceride levels. The correlation coefficient (r) was 0.446, suggesting a positive correlation of moderate strength, meaning that an increase in waist circumference is associated with higher blood triglyceride levels.

Table 8 : Pearson Correlation Test

		Waist Circumference	Triglyceride Level
Waist Circumference	Pearson Correlation	1	0.446
	P Value		0.000*
	N	60	60
Triglyceride Level	Pearson Correlation	0.446	1
	P Value	0.000*	
	N	60	60

*Significant P Value <0.05

DISCUSSION

This study demonstrates a significant association between waist circumference measurements and triglyceride levels in the body, with a p-value of 0.000. These findings indicate that waist circumference can serve as a useful anthropometric parameter for detecting obesity. The correlation coefficient of 0.446 indicates a moderate positive relationship between waist circumference and triglyceride levels. Based on these results, it can be concluded that the larger an individual's waist circumference, the higher their blood triglyceride levels.

The findings of this study are consistent with research conducted by Amelinda (2014) among employees of SMP Negeri 9 Semarang and SMA Negeri 2 Semarang (≥45 years), which reported a significant relationship between waist circumference and blood triglyceride levels. This association was attributed to the increase in total body fat in individuals with obesity, particularly visceral fat measured through waist circumference. This fat depot is characterized by enlarged adipocytes resulting from triglyceride accumulation in adipose tissue. (Amelinda & Wirawanni, 2014) These results are also in line with the study by Sitanggang *et al.*, (2021) conducted among adolescents and young adults aged 15–24 years, which showed that visceral fat measured by waist circumference is prone to increased lipolysis, leading to elevated free fatty acid levels. This increase in free fatty acids may subsequently trigger hypertriglyceridemia. (Sitanggang *et al.*, 2021)

In contrast, the findings of this study are not consistent with the research conducted by Ajeng (2014) among elderly individuals (≥60 years), which reported no association between waist circumference and triglyceride levels. This discrepancy was attributed to the influence of dietary intake on triglyceride levels; triglyceride concentrations may decrease when cholesterol-rich food consumption is reduced, without necessarily affecting waist circumference. (Puspitasari & Puruhita, 2014) Ajeng (2014) further explained that changes in triglyceride levels may also be influenced by medications and comorbid conditions. That study involved individuals aged ≥60 years, an age group that commonly presents with comorbidities or chronic diseases such as chronic kidney disease and hypothyroidism. Patients with chronic kidney disease may have elevated triglyceride levels without corresponding increases in waist circumference; even underweight individuals with chronic kidney disease may exhibit high triglyceride levels. Chronic kidney failure disrupts triglyceride and cholesterol metabolism due to deficiencies in lipoprotein lipase activity and abnormalities in lipoprotein receptors, resulting in impaired lipoprotein clearance. Hypothyroidism is also frequently associated with elevated triglyceride levels, as thyroid hormones influence lipid metabolism and may increase free fatty acid concentrations. (Puspitasari & Puruhita, 2014; Listiyana *et al*., 2013; Prastyo, 2011)

With increasing age, the risk of elevated cholesterol levels also rises, as adults and older individuals tend to engage in less physical activity. Increased blood cholesterol levels are more commonly observed in individuals who are overweight, physically inactive, smokers, and older adults. (Arsenault *et al*., 2010)

Waist circumference is one of the most accurate measurements for assessing nutritional status and body fat distribution. Waist measurement provides information on body fat distribution and can identify health risks such as coronary heart disease. Currently, individuals with excess central fat are more likely to be overweight. An increase in waist circumference is also associated with an increased risk of developing various diseases, including dyslipidemia. (Andayani *et al*., 2023) Waist circumference is a more accurate measure of visceral fat distribution for estimating body fat distribution and is closely related to body mass index. Waist circumference is associated with morbidity and mortality related to central obesity. (Sitanggang *et al*., 2021; Nurohmi *et al*., 2021) According to a study conducted by Fang *et al*., (2018), waist circumference measurement is a simple and inexpensive method for identifying central obesity. (Fang *et al*., 2018)

Abdominal fat accumulation reflects several metabolic changes, including increased production of free fatty acids. These metabolic alterations provide insight into diseases associated with differences in body fat distribution. The larger a person's waist circumference, the higher their total cholesterol level tends to be. Excessive cholesterol levels can be harmful, as high concentrations in the blood may form deposits on the walls of blood vessels, leading to vessel narrowing known as atherosclerosis. Theoretically, excessive abdominal fat is associated with metabolic changes, including increased free fatty acid production. (Borén & Taskinen, 2021) Individuals with obesity also tend to engage in less physical activity. Physical activity influences blood triglyceride levels. While exercise does not directly burn cholesterol in the same way it burns adipose tissue, it can reduce triglyceride levels and stimulate metabolic enzyme systems in muscles and the liver to convert some cholesterol into beneficial HDL cholesterol. Physical activity reduces total cholesterol, LDL-C, HDL-C, and triglyceride levels, thereby lowering the risk of cardiovascular disease. (Islam *et al*., 2024)

Triglycerides are a type of fat found in the blood and stored in adipose tissue. They are formed from glycerol and fatty acids derived from food, stimulated by insulin or excess caloric intake due to overeating. Excess calories are converted into triglycerides and stored as subcutaneous fat. (Salim *et al*., 2021) Triglycerides consist of three free fatty acids and one glycerol molecule. (Alves-Bezerra & Cohen, 2018) The digestive tract processes free fatty acids obtained from food. Dietary triglycerides are emulsified by bile acids and subsequently undergo primary hydrolysis by pancreatic lipase, producing monoglycerides and free fatty acids. (Johnson *et al*., 2022) Upon entering enterocytes, these components are reassembled into chylomicrons. Chylomicrons are primarily taken up by muscle and adipose tissues through the action of lipoprotein lipase released on the endothelial surface of capillaries. During this process, triglycerides enter adipocytes and accumulate from subcutaneous to visceral fat, resulting in abdominal fat accumulation. Consequently, individuals with high fat levels tend to have larger waist circumferences. (Alves-Bezerra & Cohen, 2018)

Individuals with obesity experience an increase in total body fat, which accumulates in both subcutaneous and visceral fat depots. A large amount of visceral fat is located in the abdominal cavity and is reflected by increased waist circumference. This fat consists of enlarged adipocytes characterized by triglyceride accumulation in adipose tissue, which readily undergoes lipolysis, increasing free fatty acid levels. Elevated free fatty acids may trigger hypertriglyceridemia. (Sitanggang *et al*., 2021; Amelinda & Wirawanni, 2014) Excessive fat accumulation in individuals with obesity leads to increased free fatty acids hydrolyzed by lipoprotein lipase at the endothelial surface. This increase stimulates oxidant production, which negatively affects the endoplasmic reticulum and mitochondria. Free fatty acids released from excessive fat accumulation also inhibit lipogenesis, thereby impairing serum triglyceride clearance and resulting in elevated blood triglyceride levels. Hypertriglyceridemia is a known risk factor for coronary heart disease and stroke.

CONCLUSION

This study demonstrates that the majority of workers at El Tari Airport, Kupang, had normal waist circumference measurements, with 41 subjects classified as normal and 19 subjects presenting with increased waist circumference. Regarding blood lipid profiles, most participants exhibited normal triglyceride levels, with 47 subjects in the normal category, while 11 subjects had borderline high triglyceride levels and 2 subjects had high triglyceride levels. Bivariate analysis revealed a statistically significant relationship between waist circumference and blood triglyceride levels, showing a positive correlation. These findings indicate that an increase in waist circumference is associated with higher blood triglyceride levels among workers at El Tari Airport, Kupang, underscoring the importance of waist circumference as a simple anthropometric indicator for identifying the risk of hypertriglyceridemia and central obesity in working adult populations.

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