Association Between Body Mass Index and Triglyceride/High-Density Lipoprotein Ratio In Patients With Ischaemic Stroke

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Abstract..
Introduction:Stroke is a leading cause of long-term disability and mortality worldwide, particularly in developing countries. Dyslipidemia, especially the triglyceride to high-density lipoprotein ratio (TG/HDL), and body mass index (BMI) play important roles in cardiovascular disease pathogenesis, including ischemic stroke. Methods:This analytical observational study used a cross-sectional design based on medical records of ischemic stroke patients at RSUD Kabupaten Tangerang in 2025. A total of 50 patients were selected from 98 using purposive sampling. Variables included BMI, TG/HDL ratio, age, sex, hypertension, and diabetes mellitus. The data were analyzed using Chi-Square, Fisher's Exact tests, and risk estimate. Results:The mean age was 61.60±9.05 years. Most patients were male, with a high prevalence of hypertension and diabetes mellitus. A total of 68% were overweight/obese and 78% had high TG/HDL ratio. A significant association was found (p=0.011; Fisher's Exact p=0.024) with OR 5.833 (95% CI: 1.387–24.539). Discussion:The predominance of elderly patients with vascular comorbidities highlights the role of degenerative and metabolic factors in ischemic stroke. A higher TG/HDL ratio in overweight/obese patients reflects an atherogenic lipid profile associated with increased BMI. This condition, mediated by visceral fat accumulation, insulin resistance, and chronic inflammation, contributes to atherosclerosis underlying ischemic stroke.
Keywords: *ischemic stroke, body mass index, TG/HDL ratio, dyslipidemia*.

I. INTRODUCTION

Stroke is the second leading cause of disability and death in the world after heart disease. In Indonesia, stroke is the leading cause of disability and death, contributing 11.2% of total disability cases and 18.5% of the total national mortality rate.(1) Globally, based on the 2022 World Stroke Organization report, there are approximately 12.2 million new stroke sufferers each year, with 5.5 million deaths and more than 143 million people experiencing morbidity due to this disease.(2) Most stroke incidents are ischemic strokes, which account for approximately 80–85% of all cases.(1) The risk of stroke is known to increase with age, with an increase of approximately twofold in each decade after age ≥55 years.(3)

According to the American Stroke Association (ASA), stroke risk factors are classified into two groups, namely modifiable and non-modifiable factors. Modifiable risk factors include hypertension, smoking, diabetes mellitus, unhealthy diet, lack of physical activity, obesity, dyslipidemia, carotid artery disease, peripheral artery disease, atrial fibrillation, and other heart diseases.(3) Meanwhile, non-modifiable risk factors include age, gender, race, genetic factors, and a history of previous stroke.(4) Among these risk factors, obesity and dyslipidemia receive special attention because their prevalence continues to increase from year to year and their significant contribution to the formation of atherosclerosis and cardiovascular disease, including ischemic stroke.(5,6)

Dyslipidemia is a condition frequently found in ischemic stroke patients. Research by Gajurel et al. reported that the most common lipid abnormalities were decreased high-density lipoprotein (HDL) levels, followed by increased triglyceride levels.(7) The triglyceride to high-density lipoprotein (TG/HDL) ratio is known as a simple but meaningful indicator in assessing cardiovascular risk. Research by Sato et al. showed that increased triglyceride levels and decreased HDL are associated with an increased risk of ischemic stroke.(8) In addition, a high TG/HDL ratio has also been reported to be associated with clinical stroke outcomes, with higher values associated with a worse prognosis than lower values.(9)

The correlation between body mass index (BMI) and the triglyceride to high-density lipoprotein (TG/HDL-C) ratio has been widely studied, with BMI reported as the most dominant variable associated

with the ratio.[7] Increased BMI, especially in overweight and obese conditions, is closely related to insulin resistance, low-grade chronic inflammation, and atherogenic dyslipidemia.[10] Physiopathologically, visceral fat accumulation increases the release of free fatty acids to the liver which are then converted into triglycerides in the form of VLDL and reduce HDL levels, thereby increasing the TG/HDL-C ratio. [7,11] In addition, increased BMI also contributes to the risk of stroke through hypertension and diabetes mellitus.[10,12]

Several previous studies have shown a relationship between BMI and the TG/HDL ratio in various populations. However, research specifically evaluating this relationship in ischemic stroke patients, particularly in Indonesia, is still limited. Therefore, this study was conducted to analyze the relationship between body mass index and the TG/HDL ratio in ischemic stroke patients. This study is expected to contribute to understanding the metabolic risk factors that play a role in stroke patients.

II. METHODOLOGY

The research method used was quantitative. This is an observational analytical study with a cross-sectional design. The aim was to analyze the relationship between BMI and the TG/HDL ratio in ischemic stroke patients hospitalized at RSUD Kabupaten Tangerang in 2025.

The population in this study were all patients diagnosed with ischemic stroke who were treated at Tangerang Regency Hospital during the period of January 1 to December 31, 2025, with a total population of 98 people. The research sample was determined using the Slovin formula with a margin of error of 10%, resulting in a sample size of 50 subjects. The sampling technique was carried out using the consecutive sampling method, namely all subjects who met the inclusion criteria were taken until the sample size was met.

Inclusion criteria for this study included patients diagnosed with ischemic stroke based on medical records confirmed by non-contrast head CT scan, hospitalized or registered at Tangerang Regency Hospital between January 1 and December 31, 2025, aged ≥18 years, and having complete medical records related to the study variables (weight, height, triglyceride levels, and HDL). Exclusion criteria included incomplete medical records, stroke due to head trauma, and stroke caused by brain tumors or intracranial infections.

The independent variable in this study was BMI, obtained from weight and height data in the patient's medical records. BMI was calculated using the formula: body weight (kg) divided by the square of the height (m^2). BMI was classified into non-overweight (<23 kg/m^2) and overweight/obese (≥23 kg/m^2). The dependent variable was the TG/HDL ratio, obtained by dividing the triglyceride level by the HDL level recorded in the patient's medical records, then categorized into normal (<2) and high (≥2). Other data such as age, gender, history of hypertension, and history of diabetes mellitus were also collected as patient characteristics.

The data obtained were then processed and analyzed using the SPSS program. Univariate analysis was performed to describe the characteristics of the research subjects and the distribution and percentage of each variable. Numerical data were presented in the form of means and standard deviations, and categorized for further analysis and presented in the form of frequency distributions and percentages. Bivariate analysis was performed to assess the relationship between BMI and the TG/HDL ratio. Both variables were categorized according to the cut-off used, then analyzed using the Chi-Square test. If the Chi-Square test requirements were not met (expected count <20%), then an alternative test was used Fisher's Exact Test. In addition, a risk estimate was calculated to determine the magnitude of the risk. A p-value <0.05 was considered statistically significant.

III. RESULTS AND DISCUSSIONS

Results

A total of 50 ischemic stroke patients participated in this study and the average age of patients was 61.60±9.05 years with a median age of 60 years, more male gender as many as 28 patients (56%) and had comorbid hypertension as many as 38 patients (76%), and diabetes mellitus as many as 27 patients (54%). In ischemic stroke patients, most subjects had overweight/obese nutritional status as many as 34 patients (68%) with an average BMI of 24.43±4.07 kg/m^2 with a median of 23.98 kg/m^2 and a high TG/HDL ratio as many as 39 patients (78%) and an average TG/HDL ratio of 3.87±2.88 with a median of 3.07.

Characteristics	Frequency (n=50)	Percentage (%)	Average
Age			61.60±9.05
<60 years	22	44	
≥60 years	28	56	
Gender			
Man	28	56	
Woman	22	44	
Comorbidity			
Hypertension			
There is	38	76	
No	12	24	
Diabetes mellitus			
There is	27	54	
No	23	46	
BMI			24.43±4.07
Non-Overweight	16	32	
Overweight/Obesity	34	68	
TG/HDL ratio			3.87±2.88
Normal	11	22	
Tall	39	78	

In patients with a non-overweight BMI, a normal TG/HDL ratio of 43.8% and a high TG/HDL ratio of 56.3% were found. Meanwhile, in overweight/obese patients, a normal TG/HDL ratio of 11.8% and a high TG/HDL ratio of 88.2% were found.

BMI	Normal TG/HDL ratio	High TG/HDL ratio	Total	p-value	OR (CI 95%)
Non-Overweight	7 (43.8%)	9 (56.3%)	16 (100%)		
Overweight/Obesity	4 (11.8%)	30 (88.2%)	34 (100%)	0.024*	5,833 (1,387–24,539)
Total	11 (22.0%)	39 (78.0%)	50 (100%)		

*tested using Fisher's Exact Test.

Bivariate analysis using the Chi-Square test showed a significant relationship between body mass index (BMI) and the triglyceride to high-density lipoprotein (TG/HDL) ratio in stroke patients. The Pearson Chi-Square test showed a p-value of 0.011 ($p < 0.05$). However, because there were 25% of cells with an expected count of less than 5, an alternative Fisher's Exact Test was used, which showed a significant result with a p-value of 0.024 ($p < 0.05$).

Risk estimate analysis showed that patients with overweight/obese BMI had a 5.833 times greater chance of having a high TG/HDL ratio compared to patients with normal BMI (OR = 5.833; 95% CI: 1.387–24.539). The lower limit of the confidence interval, which was greater than 1 (lower limit = 1.387), indicated that this result was statistically significant.

Discussion

This study involved 50 ischemic stroke patients with a mean age of 61.60±9.05 years and a median of 60 years, reflecting that the majority of subjects were in the elderly age group (≥60 years). This is in line with the literature stating that the risk of ischemic stroke increases with age due to the degenerative process of blood vessels, decreased arterial elasticity, and accelerated atherosclerosis.[13,14] In addition, the gender distribution in this study showed a higher proportion of male patients than female (56% compared to 44%). This is consistent with the findings of several previous studies showing that men have a higher risk of experiencing ischemic stroke, which is associated with the protective effect of estrogen hormones in women

of productive age in preventing the process of cerebrovascular atherosclerosis, as well as the high prevalence of modifiable risk factors such as smoking and dyslipidemia in men.[15,16]

This study also found a high prevalence of comorbid hypertension (76%) and diabetes mellitus (54%). Pathophysiologically, chronic high blood pressure causes endothelial dysfunction and accelerates the process of atherosclerosis through thickening of the arterial walls and plaque formation, which ultimately increases the risk of thrombus or embolism formation in the cerebral blood vessels.[15] Diabetes mellitus also plays a role through chronic hyperglycemia, insulin resistance, and dyslipidemia which trigger endothelial dysfunction and atherosclerosis.[17,18] The combination of these two comorbidities synergistically worsens vascular conditions and increases the severity of ischemic stroke.[14]

Most subjects had overweight/obese nutritional status (68%) with a mean BMI of 24.43±4.07 kg/m², and a high TG/HDL ratio (78%) with a mean of 3.87±2.88. Based on various studies, there is no universal cut-off for the TG/HDL ratio because it is influenced by population differences. However, a value of ≥2–3 is generally used as an indicator of increased metabolic risk and atherogenic dyslipidemia. In this study, the TG/HDL ratio was categorized using a cut-off of ≥2 as an indicator of metabolic risk associated with atherogenic dyslipidemia, insulin resistance, and increased cardiovascular risk.[19,20,21]

The proportion of high TG/HDL ratio was higher in the overweight/obese BMI group (88.2%) compared to the non-overweight BMI group (56.3%). Bivariate analysis using the Chi-Square test showed a significant association between BMI and the TG/HDL ratio (p = 0.011), which was strengthened by the Fisher's Exact Test which showed a statistically significant association between BMI and the TG/HDL ratio (p = 0.024), indicating that increasing BMI to the overweight/obese category is associated with an increase in the TG/HDL ratio. Risk estimate analysis showed that patients with overweight/obese BMI had a 5.833 times greater risk of having a high TG/HDL ratio (OR = 5.833; 95% CI: 1.387–24.539), reflecting a strong association with atherogenic lipid profiles. This condition is associated with increased free fatty acids due to visceral fat accumulation, which stimulates triglyceride production in the liver and lowers HDL. This is consistent with previous research showing that increased BMI is associated with a more atherogenic lipid profile, including an increased TG/HDL ratio.[19,20]

These findings confirm that increased BMI plays a role in lipid metabolism disorders, particularly increased TG/HDL ratio, which has been associated with the risk of atherosclerosis and cardiovascular events, including ischemic stroke.(20,21,22,23) Therefore, weight control is an important strategy in reducing the risk of metabolic disorders and vascular complications.

Ethical Statement

This study has received approval from the Health Research Ethics Committee of RSUD Kabupaten Tangerang under permit number B000.9.2/-14-KEP RSUDTNG. This study uses secondary data from medical records that have been anonymized and kept confidential in accordance with research ethics principles.

IV. CONCLUSION

There is a significant association between body mass index (BMI) and the TG/HDL ratio in ischemic stroke patients. Patients with overweight/obese BMI have a higher risk of having an elevated TG/HDL ratio compared to the non-overweight group. This suggests that increased BMI plays a role in the development of atherogenic dyslipidemia in ischemic stroke patients.

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