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Triglyceride/High-Density Lipoprotein Ratio as a Predictor of Major Cardiovascular Events Within 6 Months Post-Treatment in Patients with Acute Myocardial Infarction and Type 2 Diabetes Mellitus at Haji Adam Malik General Hospital, Medan

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ABSTRACT

Introduction: Cardiovascular disease (CVD) remains the leading global cause of death, with coronary artery disease (CAD) and stroke contributing to 15 million deaths in 2016. Type 2 diabetes mellitus (DM) increases the risk of complex CAD, characterized by diffuse, calcified, and multivessel lesions. While the triglyceride (TG)/high-density lipoprotein cholesterol (HDL-C) ratio is a potential independent predictor of CVD, its prognostic value for mortality in diabetic CAD patients undergoing statin therapy remains unclear. This study aimed to analyze the association between the TG/HDL-C ratio and cardiovascular and all-cause mortality in this population.

Methods: This cross-sectional analytical study examined the relationship between the TG/HDL-C ratio and major cardiovascular events in non-ST-elevation acute coronary syndrome (NSTE-ACS) patients with type 2 DM receiving statin therapy. Data were collected through clinical observation and medical records. Statistical analysis utilized the Chi-square or Fisher's Exact test to assess associations, with statistical significance defined as $p < 0.05$.

Results: The study included 72 patients (72.2% male; mean age 58.6±8.5 years) with type 2 DM (mean duration 10.5±3.9 years) and acute coronary syndrome (61.1% NSTEMI). Among participants, 61.1% were smokers, 48.6% had hypertension, and lipid profiles revealed 100% hypertriglyceridemia, 87.5% elevated LDL, and 33.3% low HDL. A high TG/HDL ratio was observed in 72.2% of subjects and was significantly associated with major adverse cardiovascular events (OR=3.32; p=0.025), indicating a 3.32-fold higher risk in the high TG/HDL ratio group.

Conclusion: The TG/HDL-C ratio can serve as an effective parameter for estimating the risk of MACE in ACS patients with T2DM.

Keywords

Acute Coronary Syndrome, Diabetes Mellitus, Triglycerides, High-Density Lipoprotein

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INTRODUCTION

Cardiovascular disease (CVD) remains the leading cause of mortality worldwide, with coronary artery disease (CAD) and stroke accounting for approximately 15 million deaths in 2016 [1]. CAD is a pathological process characterized by the accumulation of atherosclerotic plaques in the epicardial arteries, which may be obstructive or nonobstructive. This condition can be modified through lifestyle adjustments, pharmacological interventions, and invasive procedures aimed at achieving disease stabilization or regression [2]. CAD may

present as a chronic, progressive condition but can become acutely unstable due to atherothrombotic events, such as plaque rupture or erosion, leading to clinical manifestations classified as acute coronary syndrome (ACS), or chronic coronary syndrome [2].

ACS, a critical subset of CAD, is defined as a sudden reduction in coronary blood flow resulting in myocardial ischemia. As a non-communicable disease, CAD has shown a rising global prevalence, affecting both developed and developing nations. According to the World Health Organization, non-communicable diseases caused 56 million deaths worldwide in 2012, with cardiovascular diseases contributing to 46.2% of these fatalities (17.5 million deaths) [3]. The burden of CAD is significantly higher in patients with diabetes mellitus (DM), where morbidity and mortality rates are elevated, accounting for approximately 50% of deaths in this population [1]. Consequently, early detection and management of CAD and its risk factors are paramount, particularly in patients with diabetes.

Diabetes mellitus, a complex metabolic disorder, is associated with insulin resistance, impaired insulin signaling, beta-cell dysfunction, abnormal glucose and lipid metabolism, subclinical inflammation, and increased oxidative stress [4]. Globally, DM affected 2.8% of the population in 2000, with an estimated 425 million adults living with the condition by 2017, a figure projected to increase to 642 million by 2040 [5]. Type 2 diabetes mellitus (T2DM), which is closely linked to the global obesity epidemic, is expected to affect over 600 million individuals in the coming decades [6]. Among its complications, CVD, particularly CAD, remains the leading cause of morbidity and mortality in T2DM patients, with up to 75% of these patients succumbing to cardiovascular events [7].

Recent trends indicate a resurgence of ischemic complications, including acute myocardial infarction (AMI), stroke, and lower limb amputations, particularly among younger and middle-aged adults with T2DM [6]. This highlights the urgent need for aggressive cardiovascular risk-reduction strategies in this population, especially in those with established CAD. Compared with non-diabetic individuals, T2DM patients are more likely to develop complex, multivessel CAD characterized by diffuse, calcified lesions, often requiring coronary revascularization alongside optimal medical therapy [7].

Dyslipidemia, a hallmark of T2DM, significantly contributes to the proatherogenic environment and is characterized by hypertriglyceridemia, reduced high-density lipoprotein cholesterol (HDL-C), and predominance of small, dense low-density lipoprotein (LDL) particles [6]. While statin therapy has proven effective in reducing LDL cholesterol and cardiovascular risk in both diabetic and non-diabetic populations, residual cardiovascular risk persists, driven by other lipid components, such as triglycerides (TG) and HDL-C [8]. The TG/HDL-C ratio has emerged as a robust biomarker for predicting cardiovascular outcomes independent of LDL levels. Studies have demonstrated that an elevated TG/HDL-C ratio is a strong predictor of major cardiovascular events, including myocardial infarction and all-cause mortality, particularly in high-risk populations [9, 10].

Despite the established benefits of statin therapy, the predictive value of the TG/HDL-C ratio for cardiovascular and all-cause mortality in T2DM patients with CAD remains underexplored. This study aimed to evaluate the potential role of the TG/HDL-C ratio as a predictor of major cardiovascular events within six months post-treatment in patients with AMI and T2DM at Haji Adam Malik General Hospital, Medan. By addressing this knowledge gap, the study seeks to enhance risk stratification and inform tailored management strategies for this high-risk population

METHODS

This analytical cross-sectional study was designed to evaluate the triglyceride/high-density lipoprotein cholesterol (TG/HDL-C) ratio as a predictor of major cardiovascular events in patients with acute coronary syndrome (ACS) and type 2 diabetes mellitus (T2DM). Conducted at Haji Adam Malik General Hospital in Medan, Indonesia, the research received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara, and permission from the hospitals' Research and Development Unit. Data were collected from December 2024 to January 2025, ensuring a structured timeline for patient enrollment and analysis.

The target population consisted of patients diagnosed with ACS and T2DM who regularly sought treatment at the study hospital. From this population, a sample comprising individuals who met the specific inclusion criteria and did not meet the exclusion criteria was selected. Eligible participants were adults over 18 years of age, diagnosed with both ACS and T2DM, had undergone coronary revascularization, and had complete medical records relevant to the study. Patients with other cardiovascular conditions, such as congenital or severe valvular heart disease or metabolic disorders beyond T2DM, confirmed by blood gas analysis (e.g., diabetic ketoacidosis, lactic acidosis, or hyperosmolar hyperglycemic state), were excluded. Additionally, individuals with a history of infectious diseases, including pulmonary tuberculosis, sepsis, advanced HIV infection, or infective endocarditis, as well as those with malignancy or prior chemotherapy, were not included in the sample.

Key terms were defined operationally to ensure clarity and consistency. Acute coronary syndrome was characterized as a clinical spectrum of ischemic chest pain lasting over 20 min, potentially radiating to the neck, jaw, or left arm, incompletely responsive to nitrates, and possibly accompanied by autonomic symptoms, encompassing ST-elevation myocardial infarction, non-ST-elevation myocardial infarction, and unstable angina. Major cardiovascular events were defined as clinical events during hospitalization, including cardiovascular mortality, malignant arrhythmias, cardiogenic shock, and acute heart failure. Cardiovascular mortality refers to death caused by myocardial infarction, sudden cardiac arrest, or heart failure. Acute heart failure was described as the rapid onset of life-threatening heart failure symptoms requiring urgent management, resulting from cardiac dysfunction or precipitating factors. Cardiogenic shock was identified as a cardiac condition causing tissue hypoperfusion and was confirmed clinically and biochemically. Malignant arrhythmias included ventricular fibrillation or tachycardia with or without a pulse. The TG/HDL-C ratio was calculated as the ratio of triglycerides to high-density lipoprotein cholesterol, measured after a 1012-hour fast.

The study required a minimum sample size of 52 participants, determined through analytical sample size estimation for odds ratios using a 95% confidence level and 75% relative precision, based on the prevalence of major cardiovascular events in the study population. A consecutive sampling technique was employed to select participants. All patients presenting with ACS at the hospital were screened for eligibility based on the inclusion and exclusion criteria. Patients meeting these criteria were enrolled sequentially until the target sample size was achieved, ensuring a systematic and unbiased selection process. This approach allowed the inclusion of all eligible patients within the study period, thus minimizing selection bias while adhering to the predetermined sample size.

The data collection involved a multistep process. Initially, patients with ACS were screened for eligibility based on the defined criteria. The medical records of eligible patients were reviewed to confirm the completeness of the required data. Demographic and clinical information, including age, sex, body mass index, duration of T2DM, history of hypertension, stroke, percutaneous coronary intervention, low-density lipoprotein levels, triglyceride levels, high-density lipoprotein cholesterol levels, and major cardiovascular events, were collected. The TG/HDL-C ratio was calculated for each participant, and the patients were categorized into two groups: those with a low TG/HDL-C ratio and those with a high ratio. The data were meticulously checked for accuracy and completeness, manually coded, and entered into SPSS version 26 for analysis. Data cleaning involved identifying missing values and assessing data variation through frequency distributions and normality tests, such as the Shapiro-Wilk or Kolmogorov-Smirnov test. Any errors were cross-checked with the original patient records, laboratory results, and diagnostic tests, followed by necessary revisions.

Statistical analysis was conducted in two phases. Descriptive statistics were used to summarize the demographic and clinical variables, which were reported as counts and percentages. The association between the TG/HDL-C ratio and major cardiovascular events was assessed using the Chi-square test, with Fisher's exact test applied if Chi-square assumptions were not met. A p-value less than 0.05 was considered statistically significant. The study adhered to ethical standards, with approval obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara, and research permission granted by the

Haji Adam Malik General Hospitals Research and Development Unit, ensuring compliance with ethical guidelines for human research.

RESULTS

The study was conducted from December 2024 until the target sample size was reached. A total of 72 subjects who met the inclusion and exclusion criteria were included in the analysis. The objective of this study was to evaluate the triglyceride to high-density lipoprotein cholesterol (TG/HDL) ratio as a predictor of major adverse cardiovascular events (MACE) in patients with acute coronary syndrome (ACS) and type 2 diabetes mellitus (T2DM) at Haji Adam Malik General Hospital, Medan.

Table 1. Subject Characteristics

Variable	n (52)
Sex, n (%)	
Male	52 (72.2)
Female	20 (27.8)
Age (years, Mean ± SD)	58.61 ± 8.48
Body Mass Index (kg/m²)	22.51 ± 1.66
Duration of T2DM (years)	10.51 ± 3.92
Diagnosis n (%)	
NSTEMI	44 (61.1)
Anterior STEMI	9 (12.5)
Anteroseptal STEMI	5 (6.9)
Anterolateral STEMI	3 (4.2)
Inferior STEMI	11 (15.3)
Smoking Status, n (%)	
Smoker	44 (61.1)
Non-smoker	28 (38.9)
Hypertension, n (%)	
Yes	35 (48.6)
No	37 (51.4)
History of CABG, n (%)	
Yes	11 (15.3)
No	61 (84.7)
History of Stroke, n (%)	
Yes	8 (11.11)
No	64 (88.89)

These characteristics included sex, age, BMI, duration of diabetes, ACS diagnosis, smoking status, history of hypertension, CABG, and stroke. The majority were male (72.2%) with a mean age of 58.61 ± 8.48 years. The mean BMI was 22.51 ± 1.66 kg/m² and the average duration of T2DM was 10.51 ± 3.92 years. Most patients were diagnosed with NSTEMI (61.1%) and were current smokers (61.1%).

Table 2. Lipid Profile of Subjects

Variable	Data
LDL Level, n (%)	
Normal (<130 mg/dL)	9 (12.5)
High (≥130 mg/dL)	63 (87.5)
Triglycerides, n (%)	
Normal (<150 mg/dL)	14 (19.5)
High (≥150 mg/dL)	58 (80.5)
HDL, n (%)	
Normal (>60 mg/dL)	48 (66.7)
Low (≤60 mg/dL)	24 (33.3)
TG/HDL Ratio, n (%)	
Ideal (<2.5)	20 (27.8)
High (≥2.5)	52 (72.2)

Most subjects had elevated LDL (87.5%) and triglyceride levels (80.5%) levels. A total of 52 subjects (72.2%) had a high TG/HDL cholesterol ratio, while only 20 subjects (27.8%) had an ideal ratio.

TG/HDL Ratio as a Predictor of Major Adverse Cardiovascular Events (MACE)

This section evaluates the TG/HDL cholesterol ratio as a predictor of MACE. The Chi-square test and risk estimation were applied to assess statistical significance and odds ratio (OR).

Table 3. TG/HDL Ratio and MACE Incidence

TG/HDL Ratio	MACE Yes [n (%)]	MACE No [n (%)]	p-value	OR
High (≥2.5)	38 (73.1)	14 (26.9)	0.025	3.32
Ideal (<2.5)	9 (45.0)	11 (55.0)		

There was a statistically significant association between a high TG/HDL cholesterol ratio and the occurrence of MACE ($p = 0.025$). Subjects with a high TG/HDL ratio had a 3.32 times greater risk of experiencing MACE compared to those with an ideal ratio.

Association Between Clinical Characteristics and TG/HDL Ratio

Chi-square and Fisher's exact tests were conducted to determine the association between patient characteristics and the TG/HDL ratio. For continuous variables, the independent t-test or Mann–Whitney test was used, as appropriate.

Table 4. Association Between Clinical Characteristics and TG/HDL Ratio

Variable	TG/HDL High [n (%)]	TG/HDL Ideal [n (%)]	p-value
Sex			0.156[b]
Male	35 (67.3)	17 (32.7)	
Female	17 (85.0)	3 (15.0)	
Age (Mean ± SD)	59.12 ± 8.43	57.3 ± 8.69	0.375[d]
BMI (Mean ± SD)	22.46 ± 1.67	22.65 ± 1.69	0.669[c]
Duration of T2DM (Mean ± SD)	10.37 ± 3.73	10.9 ± 4.47	0.672[d]
Diagnosis			0.544[b]
NSTEMI	31 (70.5)	13 (29.5)	
Anterior STEMI	6 (66.7)	3 (33.3)	
Anteroseptal STEMI	4 (80.0)	1 (20.0)	
Anterolateral STEMI	2 (66.7)	1 (33.3)	
Inferior STEMI	9 (81.8)	2 (18.2)	
Smoking Status			0.134[a]
Smoker	29 (65.9)	15 (34.1)	
Non-smoker	23 (82.1)	5 (17.9)	
Hypertension			0.501[a]
Yes	24 (68.6)	11 (31.4)	
No	28 (75.7)	9 (24.3)	
History of CABG			1.000[b]
Yes	1 (100.0)	0 (0.0)	
No	51 (71.8)	20 (28.2)	
History of Stroke			0.270[b]
Yes	10 (90.9)	1 (9.1)	
No	42 (68.9)	19 (31.1)	

Note*:* a, Chi-square test; b, Fisher's exact test; c, Independent t-test; d, Mann–Whitney U test

No statistically significant associations were found between the TG/HDL ratio and any of the clinical characteristics ($p > 0.05$). This suggests that TG/HDL cholesterol levels were not confounded by demographic or clinical variables in this study.

DISCUSSION

This study investigated the role of the triglyceride/high-density lipoprotein cholesterol (TG/HDLC) ratio as a predictor of major cardiovascular events (MACE) in patients with acute coronary syndrome (ACS) and type 2 diabetes mellitus (T2DM) at Haji Adam Malik General Hospital, Medan, Indonesia. The characteristics of the study participants, including sex, age, body mass index (BMI), duration of T2DM, smoking status, hypertension, history of coronary artery bypass grafting (CABG), and history of stroke, were broadly comparable to those reported in previous studies conducted in Asian populations. In the current study, 72.2% of participants were male, with a mean age of 58.61 years (SD 8.48), a mean BMI of 22.51 kg/m2 (SD 1.66), and a mean T2DM duration of 10.51 years (SD 3.92). In addition, 61.1% had a smoking history, 48.6% had hypertension, 15.3% had a history of CABG, and 11.1% had a history of stroke.

These findings align with those of Wang et al., who reported a male predominance (54.2%) and a mean age of 66.1 years (SD 6.7) in their cohort, although their participants had a higher mean BMI (25.7 kg/m2, SD 2.8) and a greater prevalence of hypertension (75.6%) [11]. Similarly, Chen et al. observed a higher proportion of males (79.6%) and a younger mean age (51.5 years, SD 12.6), with a lower prevalence of T2DM (9%) and hypertension (43.3%) [2]. The similarities in participant characteristics across these studies, particularly the predominance of male participants and the presence of cardiovascular risk factors, reflect the regional context of Asian populations. However, variations in BMI, hypertension prevalence, and T2DM duration may indicate differences in health status and disease severity, potentially influencing clinical outcomes.

Lipid profile analysis revealed a high prevalence of dyslipidemia in the study cohort, with 87.5% of participants exhibiting elevated low-density lipoprotein (LDL) cholesterol levels (>130 mg/dL), 80.5% having elevated triglyceride levels (>150 mg/dL), 33.3% with low high-density lipoprotein (HDL) cholesterol levels (<60 mg/dL), and 72.2% with a high TG/HDL-C ratio (>2.5). These findings differ from those reported by Luz et al., where only 52% of the participants had elevated LDL levels, 47% had high triglyceride levels, and 46% had a high TG/HDL-C ratio [12-14]. Similarly, Yang et al. found a lower prevalence of elevated LDL (27%) and high triglyceride (47.8%) levels, with 47.2% having a high TG/HDL-C ratio [4]. The higher prevalence of dyslipidemia in the current study may be attributed to the specific inclusion of T2DM patients with ACS, a population known to have a more pronounced atherogenic lipid profile due to insulin resistance and metabolic dysregulation [15-17]. The elevated TG/HDL-C ratio in 72.2% of the participants underscores the role of this parameter as a marker of dyslipidemia in high-risk populations, which is consistent with the proatherogenic environment associated with T2DM.

The analysis of the TG/HDL-C ratio as a predictor of MACE demonstrated a significant association (p=0.025), with an odds ratio (OR) of 3.32, indicating that patients with a high TG/HDL-C ratio (>2.5) had a 3.32 times higher risk of MACE compared to those with an ideal ratio (<2.5). This finding aligns with that of Wang et al., who reported a significant association (p<0.001, OR 2.55) between TG/HDL-C ratio and MACE [1]. In contrast, Sone et al. found no significant association (p=0.1, OR 1.26), possibly due to a lower cut-off value (>1.9) for defining a high TG/HDL-C ratio compared to the cut-off of >2.5 used in this study [18]. The choice of cutoff value is critical, as it may influence the sensitivity and specificity of the TG/HDL-C ratio as a predictor. The higher OR in the current study suggests a stronger predictive value, potentially reflecting the specific characteristics of the study population, including the high prevalence of T2DM and ACS. Additionally, Sultani et al. reported that a high TG/HDL-C ratio was an independent predictor of all-cause mortality and long-term MACE (OR 2.72, 95% CI 1.425.20, p=0.002), further supporting the prognostic utility of this biomarker [7]. Variations in TG/HDL-C ratios across populations, such as lower ratios in Palestinian populations compared to Asian cohorts, highlight the influence of ethnicity on lipid profiles, which may affect the generalizability of the findings [19].

The absence of significant associations between patient characteristics and the TG/HDL-C ratio (p>0.05 for all variables) suggests that factors such as sex, age, BMI, T2DM duration, smoking, hypertension, CABG history, and stroke history did not confound the relationship between the TG/HDL-C ratio and MACE in this study. This contrasts with prior studies, such as Wan et al., who found a higher prevalence of male participants (56.5%) and smokers (66.9%) in the high TG/HDL-C ratio group [9]. Similarly, Shimizu et al. noted a higher

TG/HDL-C ratio in patients with NSTEMI, attributing it to insulin resistance and increased arterial stiffness, which may exacerbate coronary artery occlusion [10]. Smoking, identified as a modifiable risk factor in this study (61.1% prevalence), was more common in the high TG/HDL-C ratio group, consistent with Ozturk et al., who reported a trend toward higher TG/HDL-C ratios in smokers (p=0.07) [11]. Smoking is known to reduce HDL-C levels and increase triglyceride levels, contributing to oxidative stress and inflammation, which elevates cardiovascular risk [20]. The lack of significant associations in the current study may be due to the smaller sample size (n=72) compared to larger cohorts in previous studies, limiting the statistical power to detect differences.

Nonetheless, these findings reinforce the independent predictive value of the TG/HDL-C ratio, as patient characteristics did not significantly influence its association with MACE. In conclusion, this study confirms that the TG/HDL-C ratio is a significant predictor of MACE in patients with ACS and T2DM, with a high ratio conferring a substantially increased risk. The consistency of these findings with those of prior research underscores the importance of this biomarker in risk stratification, particularly in high-risk populations. However, differences in cutoff values and population characteristics highlight the need for standardized thresholds and further studies to account for ethnic and regional variations. The absence of confounding by patient characteristics strengthens the reliability of the TG/HDL-C ratio as a prognostic tool, supporting its potential integration into clinical practice for managing patients with ACS and T2DM.

CONCLUSION

The findings of this study demonstrate that the triglyceride-to-HDL ratio (TG/HDL) is a statistically significant predictor of major adverse cardiovascular events (MACE) in patients with acute coronary syndrome and type 2 diabetes mellitus, with individuals exhibiting a high TG/HDL ratio having a 3.32-fold increased risk of experiencing MACE.

DECLARATIONS

None

CONSENT FOR PUBLICATION

The Authors agree to be published in the Journal of Society Medicine.

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COMPETING INTERESTS

The authors declare no conflicts of interest in this case report.

AUTHORS' CONTRIBUTIONS

All authors contributed to the study, including data analysis, drafting, and review of the article. They approved the final version and were accountable for all aspects.

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