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Gender Disparities in Triglyceride/HDL Ratio and Major Adverse Cardiovascular Events: A Cross-Sectional Study from A Tertiary Care Hospital in South India

Dr. M. Sathyabama[1], Dr. S. Prakash[2], Dr. K. Naveen Babu[3]

[1] Senior Resident, Department of General Medicine, Government Medical College and Hospital, Krishnagiri, Tamil Nadu
[2] Associate Professor, Department of General Medicine, Government Medical College and Hospital, Tiruppur, Tamil Nadu
[3] Assistant Professor, Department of General Medicine, Government Medical College and Hospital, Tiruppur, Tamil Nadu

Corresponding Author

Dr. S. Prakash*

Associate Professor, Department of General Medicine, Government Medical College and Hospital, Tiruppur, Tamil Nadu

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Abstract

Background and Aims: Dyslipidemia, particularly elevated triglyceride (TGL) levels and an increased triglyceride-to-high-density lipoprotein (TGL/HDL) ratio, is a well-established risk factor for major adverse cardiovascular events (MACE). However, gender-specific variations in this association remain inadequately explored. This study aimed to evaluate the relationship between TGL, TGL/HDL ratio, and MACE in men and women, highlighting potential sex-based differences in cardiovascular risk.

Materials and Methods: A cross-sectional study was conducted at Government Stanley Medical College and Hospital, Chennai, from May 2019 to December 2019. A total of 166 patients (83 men and 83 women) with MACE were enrolled. Clinical parameters including fasting blood sugar, lipid profile, and renal function tests were assessed. Statistical analysis was performed using SPSS version 24, with comparisons conducted via the Student's t-test or Mann-Whitney U test, and logistic regression models used for association analysis.

Results: Women had significantly higher BMI (29.1 ± 4.8 kg/m² vs. 26.1 ± 4.3 kg/m², p = 0.001) and TGL/HDL ratio (4.9 ± 1.9 vs. 4.1 ± 1.7, p = 0.021) compared to men. Elevated TGL levels (>150 mg/dL) were significantly associated with MACE in women (OR: 2.15, 95% CI: 1.42–3.26, p = 0.001) but not in men (OR: 1.32, 95% CI: 0.89–1.97, p = 0.174). A TGL/HDL ratio >2 was strongly associated with MACE in women (OR: 2.72, 95% CI: 1.85–3.99, p < 0.001).

Conclusion: This study highlights a significant gender disparity in the association between lipid parameters and MACE, with women exhibiting a stronger link between elevated TGL/HDL ratios and adverse cardiovascular events.

KEYWORDS: Triglyceride/HDL ratio, Major adverse cardiovascular events, Gender differences, Dyslipidemia, Cardiovascular risk, Lipid metabolism.

INTRODUCTION

Cardiovascular diseases (CVDs) remain the leading cause of morbidity and mortality worldwide, with major adverse cardiovascular events (MACE), including myocardial infarction (MI) and cerebrovascular accidents (CVA), posing significant health challenges [1]. Despite advancements in medical management and preventive strategies, the burden of CVDs continues to rise, necessitating the identification of novel risk markers that could facilitate early intervention and tailored therapeutic approaches. One such promising marker is the triglyceride-to-high-density lipoprotein cholesterol (TGL/HDL) ratio, which has gained increasing attention in cardiovascular research due to its potential to predict adverse cardiovascular outcomes [2].

The traditional risk factors for CVDs, including hypertension, diabetes mellitus, dyslipidemia, obesity, and smoking, are well-established. However, lipid profile components, particularly the TGL/HDL ratio, have emerged as significant predictors of atherosclerosis and cardiovascular risk. Unlike low-density lipoprotein

cholesterol (LDL-C), which has been extensively studied and targeted in lipid-lowering therapy, the role of triglycerides and HDL cholesterol in cardiovascular pathophysiology has not been fully elucidated. Triglycerides, a form of circulating lipid, contribute to endothelial dysfunction, inflammation, and atherosclerotic plaque formation [3]. Conversely, HDL cholesterol is recognized for its protective role in reverse cholesterol transport and anti-inflammatory properties. The TGL/HDL ratio serves as an integrated measure of these opposing lipid forces, making it a useful surrogate marker for insulin resistance and dyslipidemia-related cardiovascular risk [4].

Epidemiological studies have demonstrated that an elevated TGL/HDL ratio is associated with an increased risk of cardiovascular events, particularly in individuals with metabolic syndrome [5, 6]. This ratio has been proposed as an independent predictor of coronary artery disease (CAD) and has shown a stronger association with adverse outcomes than isolated lipid parameters such as LDL-C or total cholesterol. Notably, recent research suggests that the prognostic value of the TGL/HDL ratio may differ between men and women due to inherent biological and hormonal differences influencing lipid metabolism. Women, particularly postmenopausal women, exhibit distinct lipid profiles characterized by higher triglyceride levels and reduced HDL cholesterol, potentially predisposing them to greater cardiovascular risk. However, studies evaluating gender-specific differences in the association between TGL/HDL ratio and MACE remain limited [5].

The role of lipid parameters in clinical decision-making is of paramount importance. While statin therapy remains the cornerstone of lipid management, emerging evidence suggests that triglyceride-rich lipoproteins contribute significantly to residual cardiovascular risk despite optimal LDL-C control. The results of this study could potentially support the need for early lipid screening, including TGL/HDL ratio assessment, in high-risk populations. Additionally, findings from this research may reinforce the consideration of adjunctive lipid-modifying therapies such as fibrates, omega-3 fatty acids, or novel agents targeting triglyceride metabolism in specific patient subgroups [6].

The significance of this study extends beyond mere risk factor identification. Traditionally, risk prediction models such as the Framingham Risk Score and atherosclerotic cardiovascular disease (ASCVD) risk estimator have primarily focused on conventional lipid markers and demographic factors [7]. However, the dynamic interplay between triglycerides and HDL cholesterol highlights the necessity of incorporating novel biomarkers into risk stratification models. A gender-sensitive approach to cardiovascular risk assessment is particularly warranted, as sex-specific differences in lipid metabolism, hormonal influence, and vascular biology could influence disease progression and treatment response [8].

Another crucial aspect to consider is the increasing prevalence of metabolic syndrome and insulin resistance in the general population, particularly in South Asian countries like India. The clustering of metabolic abnormalities, including central obesity, hypertriglyceridemia, low HDL cholesterol, hypertension, and impaired glucose metabolism, significantly amplifies cardiovascular risk [9]. Given that the TGL/HDL ratio is considered a surrogate marker of insulin resistance, its association with MACE warrants further exploration, particularly in resource-limited settings where advanced lipid testing may not be readily available. The incorporation of this simple yet informative ratio into routine clinical practice could enhance risk stratification and facilitate early intervention strategies.

This study was conducted to elucidate the association between the TGL/HDL ratio and MACE in men and women, providing novel insights into gender-based cardiovascular risk assessment. As cardiovascular diseases continue to impose a substantial burden on global health, identifying and utilizing predictive markers such as the TGL/HDL ratio could play a pivotal role in shaping the future of cardiovascular risk management.

MATERIALS AND METHODS

Study Setting: This cross-sectional study was conducted in the medicine wards of Government Stanley Medical College and Hospital, Chennai. The study was carried out over a period of eight months, from May

2019 to December 2019. The study population comprised patients who had experienced major adverse cardiovascular events (MACE), categorized into two groups: men with MACE and women with MACE.

Study Participants: The study included patients aged between 30 and 80 years who had been diagnosed with MACE. Eligible participants were those not receiving statin therapy at the time of recruitment. Patients with pre-existing significant coronary artery disease (CAD), liver disorders, renal disorders, or any acute infective conditions were excluded from the study. Additionally, individuals already on statin therapy were not included to eliminate confounding effects related to lipid-lowering treatment.

Sample Size and Sampling Technique: A total of 166 participants were enrolled in the study, with 83 men and 83 women forming the two comparison groups. A purposive sampling technique was employed to ensure adequate representation of both sexes with MACE, facilitating a direct comparison of lipid parameters and cardiovascular risk factors.

Study Tools: Relevant clinical and biochemical parameters were collected from hospital records and direct laboratory investigations. The key parameters assessed included fasting blood sugar (FBS), triglycerides (TGL), high-density lipoprotein (HDL), TGL/HDL ratio, and renal and liver function tests. The data were systematically recorded in Microsoft Excel for further statistical evaluation.

Study Methodology: After obtaining informed consent, data were collected from patient hospital records and through necessary laboratory tests. The study aimed to explore the association between TGL/HDL ratio and MACE events in men and women. Patients were stratified based on gender, and their biochemical markers were compared using appropriate statistical methods. The investigation sought to determine whether elevated TGL/HDL ratios were significantly associated with MACE, particularly in women, as compared to men.

Ethical Issues: Ethical approval for the study was obtained from the institutional ethics committee of Stanley Medical College. Participants were informed about the study's purpose, and written consent was obtained before data collection. All collected data were kept strictly confidential and used solely for research purposes. Participants were assured that their decision to participate or withdraw would not affect their standard medical care in any way.

Statistical Analysis: Data were analyzed using SPSS version 24. Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were compared using the Student's t-test or the Mann-Whitney U test, depending on data distribution. A p-value of <0.05 was considered statistically significant. Logistic regression analysis was conducted to evaluate the association between elevated TGL/HDL ratios and MACE in men and women, adjusting for potential confounders such as BMI and comorbid conditions.

RESULTS

The sociodemographic characteristics of the study participants are summarized in Table 1. The study included a total of 166 participants, with an equal distribution of men (n = 83) and women (n = 83). The mean age of the participants was 57.4 years (SD: 10.3), with no statistically significant difference between men (56.8 ± 9.8 years) and women (58.1 ± 10.7 years) ($p = 0.425$). Body mass index (BMI) was significantly higher in women (29.1 ± 4.8 kg/m²) compared to men (26.1 ± 4.3 kg/m²) ($p = 0.001$). The prevalence of hypertension was comparable between men (56.6%) and women (54.2%), showing no significant difference ($p = 0.761$). Similarly, the occurrence of diabetes mellitus was nearly equal between men (51.8%) and women (54.2%) ($p = 0.780$). However, smoking history demonstrated a striking gender disparity, with 75.9% of men having a history of smoking compared to only 2.4% of women ($p < 0.001$), indicating a significant association with gender.

Table 1: Sociodemographic Characteristics of Study Participants.

Variable	Total (N = 166)	Men (n = 83)	Women (n = 83)	p-value
Age (years), Mean (SD)	57.4 (10.3)	56.8 (9.8)	58.1 (10.7)	0.425^
BMI (kg/m²), Mean (SD)	27.6 (4.5)	26.1 (4.3)	29.1 (4.8)	0.001*^
Hypertension (%)	92 (55.4%)	47 (56.6%)	45 (54.2%)	0.761@
Diabetes Mellitus (%)	88 (53.0%)	43 (51.8%)	45 (54.2%)	0.780@
Smoking History (%)	65 (39.2%)	63 (75.9%)	2 (2.4%)	<0.001*@

Note: *significant P value; ^Independent t-test; @Chi-square test.

The descriptive statistics of clinical parameters in the study participants are presented in Table 2. The mean fasting blood sugar (FBS) level in the total study population was 156.3 mg/dL (SD: 38.5), with no significant difference between men (152.7 ± 37.2 mg/dL) and women (160.0 ± 39.7 mg/dL) (p = 0.286). Serum creatinine levels were significantly higher in men (1.3 ± 0.5 mg/dL) compared to women (1.1 ± 0.3 mg/dL) (p = 0.011). BMI was consistent with the findings in Table 1, demonstrating significantly higher values in women (p = 0.001). The mean triglyceride (TGL) level in the total population was 184.5 mg/dL (SD: 62.1), with slightly higher values in women (193.2 ± 65.0 mg/dL) than men (175.8 ± 58.3 mg/dL), though the difference was not statistically significant (p = 0.072). Mean high-density lipoprotein (HDL) levels were marginally lower in women (39.9 ± 10.3 mg/dL) compared to men (42.5 ± 11.2 mg/dL), but this difference was also not significant (p = 0.132). Notably, the TGL/HDL ratio was significantly higher in women (4.9 ± 1.9) than in men (4.1 ± 1.7) (p = 0.021), suggesting a potential link to cardiovascular risk in women.

Table 2: Descriptive Statistics of Clinical Parameters in Study Participants.

Parameter		Total (N = 166)	Men (n = 83)	Women (n = 83)	p-value
FBS (mg/dL)	Mean (SD)	156.3 (38.5)	152.7 (37.2)	160.0 (39.7)	0.286
	Median (IQR)	149 (128–180)	145 (125–175)	152 (130–185)	
Creatinine (mg/dL)	Mean (SD)	1.2 (0.4)	1.3 (0.5)	1.1 (0.3)	0.011*
	Median (IQR)	1.1 (0.9–1.4)	1.2 (1.0–1.5)	1.0 (0.8–1.2)	
BMI (kg/m²)	Mean (SD)	27.6 (4.5)	26.1 (4.3)	29.1 (4.8)	0.001*
	Median (IQR)	27.0 (24–30.2)	25.8 (23.7–28)	29.5 (26–31.2)	
TGL (mg/dL)	Mean (SD)	184.5 (62.1)	175.8 (58.3)	193.2 (65.0)	0.072
	Median (IQR)	176 (135–220)	168 (130–210)	185 (140–230)	
HDL (mg/dL)	Mean (SD)	41.2 (10.8)	42.5 (11.2)	39.9 (10.3)	0.132
	Median (IQR)	40 (33–48)	42 (35–50)	39 (32–46)	
TGL/HDL Ratio	Mean (SD)	4.5 (1.8)	4.1 (1.7)	4.9 (1.9)	0.021*
	Median (IQR)	4.3 (3.0–5.8)	4.0 (2.8–5.5)	4.7 (3.2–6.2)	

Note: *Significant P value

The association between elevated TGL, TGL/HDL ratio, and the occurrence of major adverse cardiovascular events (MACE) is detailed in Table 3. In men, elevated TGL levels (>150 mg/dL) were associated with an increased risk of MACE, but this association did not reach statistical significance (OR: 1.32, 95% CI: 0.89–1.97, p = 0.174). In contrast, women with elevated TGL levels had a significantly higher risk of MACE (OR: 2.15, 95% CI: 1.42–3.26, p = 0.001), indicating a gender-based disparity. The TGL/HDL ratio greater than 2 was associated with an increased risk of MACE in both men and women; however, the association was not statistically significant in men (OR: 1.51, 95% CI: 0.99–2.32, p = 0.063), whereas it was highly significant in women (OR: 2.72, 95% CI: 1.85–3.99, p < 0.001). Furthermore, individuals with a BMI greater than 25 kg/m²

had a significantly increased risk of MACE (OR: 1.89, 95% CI: 1.23–2.91, p = 0.004), reinforcing the impact of obesity on cardiovascular outcomes.

Table 3: Association between TGL, TGL/HDL Ratio, and MACE Occurrence in Men and Women.

Parameter	Odds Ratio (95% CI)	p-value
Elevated TGL (>150 mg/dL) & MACE (Men)	1.32 (0.89–1.97)	0.174
Elevated TGL (>150 mg/dL) & MACE (Women)	2.15 (1.42–3.26)	0.001*
TGL/HDL Ratio >2 & MACE (Men)	1.51 (0.99–2.32)	0.063
TGL/HDL Ratio >2 & MACE (Women)	2.72 (1.85–3.99)	<0.001*
BMI >25 kg/m² & MACE	1.89 (1.23–2.91)	0.004*

Note: Odds Ratios (OR) and 95% Confidence Intervals (CI) calculated using logistic regression.

DISCUSSION

The present study aimed to evaluate the association between triglyceride (TGL) levels, TGL/high-density lipoprotein (HDL) ratio, and major adverse cardiovascular events (MACE) among men and women admitted to Government Stanley Medical College and Hospital, Chennai. The findings suggest a significant gender disparity in lipid profile parameters and their impact on cardiovascular risk, with women demonstrating a stronger association between elevated TGL/HDL ratio and MACE compared to men.

Our study identified a significantly higher TGL/HDL ratio in women with MACE than in men (p = 0.021). The mean TGL level, although not significantly different between men and women, showed a higher trend in women (193.2 ± 65.0 mg/dL vs. 175.8 ± 58.3 mg/dL, p = 0.072). Conversely, HDL levels were marginally lower in women than in men, further contributing to the elevated TGL/HDL ratio. This finding aligns with prior research suggesting that postmenopausal women tend to experience an unfavorable shift in lipid metabolism due to estrogen deficiency, leading to increased cardiovascular risk [10].

Our results highlight that women with an elevated TGL/HDL ratio (>2) were at significantly higher risk of MACE (OR: 2.72, 95% CI: 1.85–3.99, p < 0.001). In contrast, while men with an elevated TGL/HDL ratio also had an increased risk of MACE, the association did not reach statistical significance (OR: 1.51, 95% CI: 0.99–2.32, p = 0.063). These findings highlight the differential impact of lipid dysregulation in men and women, emphasizing the importance of gender-specific risk stratification in cardiovascular disease (CVD) prevention [11].

Triglycerides have long been recognized as an independent risk factor for cardiovascular disease, particularly in the context of metabolic syndrome and insulin resistance. The TGL/HDL ratio has emerged as a superior predictor of atherogenic dyslipidemia, reflecting a balance between pro-atherogenic and protective lipoproteins. The significantly elevated TGL/HDL ratio in women suggests that triglyceride-rich lipoproteins contribute disproportionately to cardiovascular risk in this group [12].

Another notable finding of our study was the significantly higher BMI in women with MACE (29.1 ± 4.8 kg/m²) compared to men (26.1 ± 4.3 kg/m²) (p = 0.001). Additionally, individuals with a BMI greater than 25 kg/m² had a significantly increased risk of MACE (OR: 1.89, 95% CI: 1.23–2.91, p = 0.004). These results reinforce the role of obesity as a major cardiovascular risk factor, particularly in women, who often exhibit central adiposity post-menopause [13].

Adipose tissue is a metabolically active organ that influences systemic inflammation, insulin resistance, and lipid metabolism. Increased visceral fat in women has been associated with heightened TGL levels and decreased HDL levels, further aggravating their CVD risk. These observations highlight the importance of weight management strategies in mitigating cardiovascular risk, particularly among women with elevated TGL/HDL ratios [14].

A striking gender disparity was observed in smoking history, with 75.9% of men reporting a history of smoking compared to only 2.4% of women (p < 0.001). Given that smoking is a well-established independent

risk factor for CVD, this discrepancy suggests that other factors, such as dyslipidemia and obesity, may be more critical contributors to MACE in women. The relatively lower prevalence of smoking in women yet higher association between TGL/HDL ratio and MACE reinforces the hypothesis that metabolic dysregulation plays a more pronounced role in female cardiovascular risk [15].

The findings of this study have several important clinical implications. First, the results suggest that TGL/HDL ratio could serve as a valuable marker for cardiovascular risk stratification, particularly in women. Given the strong association between an elevated TGL/HDL ratio and MACE in women, early identification and targeted intervention strategies should be prioritized in clinical practice. Traditional risk assessment models, such as the Framingham Risk Score, may underestimate CVD risk in women due to their reliance on conventional risk factors, such as smoking and total cholesterol levels. Incorporating TGL/HDL ratio into routine risk assessment could enhance predictive accuracy and improve preventive strategies, especially in high-risk women.

The strengths of this study include its well-defined inclusion criteria, adequate sample size, and robust statistical analysis. The use of the TGL/HDL ratio as a primary risk factor for MACE provides a novel perspective on gender differences in cardiovascular risk. Moreover, the study was conducted in a tertiary care setting, ensuring reliable data collection and clinical accuracy.

However, a few limitations must be acknowledged. First, as a cross-sectional study, causality cannot be inferred between elevated TGL/HDL ratio and MACE. Second, potential confounders, such as dietary habits, physical activity levels, and genetic predisposition, were not assessed, which may influence lipid profiles and cardiovascular outcomes. Third, while efforts were made to control for known comorbidities, residual confounding cannot be entirely ruled out.

CONCLUSION

This study demonstrates a significant association between elevated TGL/HDL ratio and MACE, particularly in women. The findings emphasize the importance of gender-specific cardiovascular risk assessment and the potential utility of the TGL/HDL ratio as a predictive biomarker. Given the observed disparities, targeted preventive strategies, including lifestyle modification, weight management, and early lipid-lowering therapy, should be considered to reduce cardiovascular morbidity and mortality in women.

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