International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Association of Serum Gamma-Glutamyl Transferase with Ischemic Heart Disease in Patients with Metabolic Syndrome: A Cross-Sectional Study

Dr Akshatha A[1], Dr M E Mohan[2], Dr Harshith C S[3]

[1]PG Student (3rd Year), Department of General Medicine, BGS Global Institute of Medical Sciences, Bangalore
[2]Professor, Dean cum Principal, Department of General Medicine, BGS Global Institute of Medical Sciences, Bangalore
[3]Associate Professor, Department of General Medicine, BGS Global Institute of Medical Sciences, Bangalore

Corresponding Author:

Dr Akshatha A
PG Student (3rd Year), Department of General Medicine, BGS Global Institute of Medical Sciences, Bangalore;
Email ID:
akshathaanil09@gmail.com

Received: 21-04-2026
Accepted: 01-05-2026
Available online: 22-05-2026

ABSTRACT

Background: Gamma-glutamyl transferase (GGT), traditionally regarded as a marker of hepatobiliary dysfunction and alcohol consumption, is increasingly recognized as a biomarker of oxidative stress and cardiometabolic risk. Its association with ischemic heart disease (IHD), particularly in patients with metabolic syndrome (MetS), has gained significant clinical relevance.
Objective: To determine the association between serum gamma-glutamyl transferase levels and ischemic heart disease in patients with metabolic syndrome.
Materials and Methods: This hospital-based cross-sectional study was conducted among 150 patients diagnosed with metabolic syndrome according to NCEP ATP III criteria. Serum GGT levels were measured and patients were evaluated for ischemic heart disease using clinical and electrocardiographic criteria. Statistical analysis was performed using SPSS version 20. Independent t-test and Pearson correlation were applied, with $p < 0.05$ considered statistically significant.
Results: The mean serum GGT level among study participants was 92.7 ± 52.5 U/L. Ischemic heart disease was present in 42 (28%) patients. Patients with IHD had significantly higher mean serum GGT levels (118.9 ± 58.6 U/L) compared to those without IHD (82.4 ± 44.1 U/L) ($p = 0.001$). Serum GGT demonstrated significant positive correlations with fasting blood sugar, waist circumference, triglycerides, body mass index, and systolic blood pressure.
Conclusion: Elevated serum GGT levels are significantly associated with ischemic heart disease in patients with metabolic syndrome and may serve as a simple, inexpensive biomarker for cardiovascular risk stratification.

Keywords: *Gamma-glutamyl transferase; ischemic heart disease; metabolic syndrome; oxidative stress; cardiovascular risk.*

INTRODUCTION

Metabolic syndrome (MetS) is a constellation of interrelated metabolic abnormalities including central obesity, insulin resistance, hypertension, hyperglycemia, and dyslipidemia that significantly increase the risk of cardiovascular disease and type 2 diabetes mellitus (1-3). Cardiovascular diseases, especially ischemic heart disease (IHD), remain the leading cause of morbidity and mortality worldwide, accounting for nearly one-third of all global deaths (4).

Gamma-glutamyl transferase (GGT) is a membrane-bound enzyme involved in extracellular glutathione metabolism and antioxidant defense (5). Traditionally regarded as a marker of hepatobiliary dysfunction and alcohol intake, recent evidence suggests that GGT also reflects oxidative stress and systemic inflammation (6). Oxidative stress plays a major role in endothelial dysfunction, lipid oxidation, plaque formation, and progression of atherosclerosis.

Several epidemiological studies have demonstrated a positive association between elevated GGT levels and vascular events independent of alcohol intake (7). GGT levels have also been shown to correlate with components of metabolic syndrome such as obesity, insulin resistance, hypertriglyceridemia, and hypertension (8). Furthermore, GGT activity has been demonstrated within atherosclerotic plaques, suggesting a direct role in atherogenesis (9). Large cohort studies have

identified elevated serum GGT as an independent predictor of cardiovascular mortality and coronary artery disease (10,11). Increasing cardiovascular burden due to diabetes and metabolic syndrome has further amplified interest in identifying novel biomarkers for early risk stratification (12). Inflammatory mediators such as C-reactive protein and cytokines are also known to correlate with elevated GGT levels (13).

Studies have additionally shown associations between GGT and incident diabetes mellitus, suggesting that GGT reflects broader metabolic dysfunction rather than isolated hepatic pathology (14). A recent meta-analysis demonstrated a strong dose-response relationship between serum GGT and metabolic syndrome risk (15). Indian studies evaluating this association remain limited, although Singh et al. demonstrated a positive correlation between GGT levels and severity of coronary artery disease among Indian patients (16). Rantala et al. first proposed that GGT may be considered a biochemical component of metabolic syndrome itself (17). Koenig and Seneff later emphasized the role of GGT as a marker of cellular antioxidant inadequacy and chronic disease risk (18). Additional cross-sectional studies have reinforced the diagnostic utility of GGT in metabolic syndrome and cardiovascular risk assessment (19,20). Population-based studies from China and Africa have shown significant associations between GGT and cardiovascular risk factors including insulin resistance, obesity, and hypertension (21-23). Endothelial dysfunction and vascular inflammation, central to the pathogenesis of IHD, are strongly associated with metabolic syndrome and oxidative stress (24). Meta-analyses have consistently demonstrated increased cardiovascular events and mortality among individuals with metabolic syndrome (25).

The American Heart Association and National Heart, Lung, and Blood Institute have emphasized the importance of early identification of high-risk metabolic syndrome patients using accessible biomarkers (26). Since obesity and metabolic syndrome substantially increase future cardiovascular risk (27), identifying inexpensive and readily available markers such as serum GGT may aid in early detection of ischemic heart disease. Therefore, the present study was undertaken to determine the association between serum gamma-glutamyl transferase levels and ischemic heart disease in patients with metabolic syndrome.

OBJECTIVE

To determine the association of serum Gamma-Glutamyl Transferase levels in patients with ischemic heart disease among individuals with metabolic syndrome.

MATERIALS AND METHODS

This hospital-based cross-sectional study was conducted in the Department of General Medicine, BGS Global Institute of Medical Sciences and Hospital, Bangalore, over a period of 18 months from April 2024 to September 2025. A total of 150 patients diagnosed with metabolic syndrome according to NCEP ATP III criteria were included in the study.

Inclusion Criteria: Patients aged ≥18 years diagnosed with metabolic syndrome according to NCEP ATP III criteria.

Exclusion Criteria: Chronic liver disease; Alcohol consumption; Chronic kidney disease; Malignancy; Hypothyroidism; Hepatotoxic drug use

Data collection: Detailed clinical history and examination were performed in all patients. Anthropometric measurements including body mass index (BMI) and waist circumference were recorded. Blood pressure was measured using standard methods. Laboratory investigations included fasting blood sugar, lipid profile, and serum gamma-glutamyl transferase levels. Serum GGT was estimated using automated biochemical analysis. Patients were evaluated for ischemic heart disease based on clinical symptoms, electrocardiographic findings, and previous documented evidence of coronary artery disease.

RESULTS

Data were analyzed using SPSS version 20. Continuous variables were expressed as mean ± standard deviation. Independent Student's t-test was used for comparison between groups. Pearson's correlation analysis was performed to assess the relationship between serum GGT and metabolic parameters. A p-value <0.05 was considered statistically significant. Patients with ischemic heart disease had significantly higher serum GGT levels compared to those without ischemic heart disease ($P=0.001$), as shown in the Table 3 below. Serum GGT showed significant positive correlations with metabolic syndrome components and cardiovascular risk factors ($P<0.001$), as shown in the Table 4 below.

Table 1: Baseline Characteristics of Study Participants

Variable	Value
Mean age (years)	54.6 ± 9.8
Male (%)	61.3
Female (%)	38.7

Table 2: Serum GGT Distribution

Parameter	Value

Mean GGT (U/L)	92.7 ± 52.5
Range	28–286

Table 3: Association of Serum GGT with Ischemic Heart Disease

IHD Status	Number (n)	Mean GGT (U/L)	SD	p-value*
Present	42	118.9	58.6	0.001
Absent	108	82.4	44.1	

*Student's t-test applied.

Table 4: Correlation of Serum GGT with Metabolic Parameters

Parameter	r-value	p-value*
BMI	0.34	<0.001
Waist circumference	0.41	<0.001
Fasting blood sugar	0.46	<0.001
Triglycerides	0.38	<0.001
Systolic blood pressure	0.29	<0.001

*Pearson's correlation test

DISCUSSION

The present study demonstrated a statistically significant association between elevated serum gamma-glutamyl transferase (GGT) levels and ischemic heart disease among patients with metabolic syndrome. Patients with IHD had significantly higher mean serum GGT levels compared to those without IHD, suggesting that GGT may serve as a useful biomarker for cardiovascular risk assessment.

The observed findings are consistent with earlier epidemiological studies demonstrating a relationship between elevated GGT levels and cardiovascular morbidity and mortality (10,11). Ruttmann et al. reported that elevated GGT independently predicts cardiovascular mortality in a large Austrian cohort (10). Similarly, findings from the Framingham Heart Study established GGT as a predictor of cardiovascular disease independent of traditional risk factors (11). Oxidative stress appears to be the principal mechanism underlying this association. GGT participates in glutathione metabolism and may contribute to reactive oxygen species generation under pathological conditions (5,6). Oxidative stress promotes endothelial dysfunction, lipid oxidation, vascular inflammation, and plaque instability, all of which contribute to ischemic heart disease. Paolicchi et al. demonstrated the presence of active GGT within atherosclerotic plaques, suggesting a direct role in LDL oxidation and atherogenesis (9). Furthermore, inflammatory pathways appear closely linked to elevated GGT levels, as inflammatory mediators such as CRP and IL-6 are commonly elevated in individuals with high serum GGT levels (13).

Our study also demonstrated significant positive correlations between GGT and fasting blood sugar, triglycerides, BMI, waist circumference, and systolic blood pressure. These findings are comparable to studies by Kang et al. and Fraser et al., who reported strong associations between GGT and various components of metabolic syndrome (8,14). Rantala et al. previously demonstrated that GGT levels progressively increase with accumulation of metabolic syndrome components, supporting the concept that GGT reflects overall metabolic burden (17). Similar findings were reported in systematic reviews and meta-analyses evaluating the relationship between GGT and metabolic syndrome risk (15).

Koenig and Seneff proposed that elevated GGT may represent cellular antioxidant inadequacy and chronic oxidative stress, thereby linking metabolic dysfunction with cardiovascular disease progression (18). Kasapoglu et al. additionally suggested that serum GGT could be incorporated into routine metabolic syndrome evaluation due to its diagnostic value (19). Studies from Asian populations have further validated these findings. Tao et al. demonstrated a strong association between elevated GGT and metabolic syndrome in a Chinese adult population (20). Li et al. reported that elevated GGT levels were independently associated with multiple cardiovascular risk factors in a nationwide Chinese study (21). Matsha et al. similarly observed significant associations between GGT, insulin resistance, and cardiometabolic risk in African populations (22).

The association between GGT and hypertension observed in the present study is supported by Zhu et al., who demonstrated a significant relationship between elevated GGT and prehypertension (23). Since hypertension is a major contributor to endothelial dysfunction and atherosclerosis, this may partly explain the increased prevalence of ischemic heart disease among individuals with elevated GGT. Endothelial dysfunction plays a central role in the pathogenesis of atherosclerosis and ischemic heart disease. Esposito et al. demonstrated that metabolic syndrome is strongly associated with endothelial dysfunction and vascular inflammation (24). Moreover, Gami et al. confirmed through meta-analysis that metabolic syndrome significantly increases cardiovascular events and mortality (25). The findings of the present study therefore reinforce the importance of identifying simple biomarkers that can predict cardiovascular risk in metabolic syndrome patients. Current guidelines by the American Heart Association emphasize early recognition and aggressive management of metabolic syndrome components to reduce cardiovascular complications (26).

Since obesity and insulin resistance are closely associated with future cardiovascular risk (27), elevated GGT may represent an early biochemical indicator of adverse cardiometabolic status. The major strengths of the present study include adequate sample size, standardized biochemical evaluation, and focused assessment of metabolic syndrome patients. However, certain limitations must be acknowledged. The cross-sectional design precludes causal inference, and residual confounding factors such as dietary habits, physical activity, and subclinical liver disease may have influenced serum GGT levels. Future longitudinal studies are needed to determine whether serum GGT can independently predict future cardiovascular events and whether incorporation of GGT into cardiovascular risk prediction models improves clinical outcomes.

CONCLUSION

Serum gamma-glutamyl transferase levels are significantly elevated in patients with ischemic heart disease among individuals with metabolic syndrome. Elevated GGT reflects increased oxidative stress and metabolic burden and may serve as a useful biomarker for cardiovascular risk stratification. Due to its low cost and widespread availability, serum GGT may be considered an adjunctive marker for early cardiovascular risk assessment in metabolic syndrome patients.

ACKNOWLEDGEMENT

The authors acknowledge the support of the Department of General Medicine staff and the institute BGS Global Institute of Medical Sciences, Bangalore. The authors also wish to thank Dr. Shailendra Vashistha (Assistant Professor, Transplant Immunology – HLA Lab, Dept of IHTM, GMC, Kota) and the VAssist Research team (www.thevassist.com) for their contribution in manuscript editing and submission process.

Conflict of Interest: None.

Source of Funding: Nil.

REFERENCES

1. Alberti KGMM, Zimmet P, Shaw J, Grundy SM, Cleeman JI, Donato KA, et al. The metabolic syndrome—a new worldwide definition. Lancet. 2005;366(9491):1059-62.
2. Suman, Shubhendu Kumar; Sinha, Manish Kumar; Sirvi, Gautam Chand; Purohit, Kunal; Singh, Uday Narayan. Impact of Diabetes Mellitus (DM) and Metabolic Syndrome (MS) on Acute Liver Disease (ALD) and Chronic Liver Disease (CLD). European Journal of Cardiovascular Medicine. 2023;13(3):965-70.
3. Suman, Shubhendu Kumar; Kumar, Anil; Ghanchi, Chhagan Lal; Ola, Saroj; Singh, Uday Narayan. A Comparative Study of Acute-On-Chronic Liver Failure (ACLF) Patients with Respect to Diabetes Mellitus and Metabolic Syndrome. European Journal of Cardiovascular Medicine. 2023;13(3):1007-12.
4. World Health Organization. Cardiovascular diseases (CVDs) fact sheet. Geneva: WHO; 2021.
5. Whitfield JB. Gamma glutamyl transferase. Crit Rev Clin Lab Sci. 2001;38(4):263-55.
6. Lee DH, Blomhoff R, Jacobs DR Jr. Is serum gamma glutamyltransferase a marker of oxidative stress? Free Radic Res. 2004;38(6):535-9.
7. Fraser A, Harris R, Sattar N, Ebrahim S, Davey Smith G, Lawlor DA. Gamma-glutamyltransferase is associated with incident vascular events independently of alcohol intake analysis of the British Women's Heart and Health Study and Meta-analysis. Arterioscler Thromb Vasc Biol. 2007;27(12):2729-35.
8. Kang YH, Min HK, Son SM, Kim IJ, Kim YK. The association of serum gamma glutamyltransferase with components of the metabolic syndrome in the Korean adults. Diabetes Res Clin Pract. 2007;77(2):306-13.
9. Paolicchi A, Minotti G, Tonarelli P, Tongiani R, De Cesare D, Mezzetti A, et al. Gamma-glutamyl transpeptidase-dependent iron reduction and LDL oxidation—a potential mechanism in atherosclerosis. Arterioscler Thromb Vasc Biol. 2004;24(2):360-6.
10. Ruttmann E, Brant LJ, Concin H, Diem G, Rapp K, Ulmer H, et al. Gamma-glutamyltransferase as a risk factor for cardiovascular disease mortality: an epidemiological investigation in a cohort of 163944 Austrian adults. Circulation. 2005;112(14):2130-7.
11. Lee DS, Evans JC, Robins SJ, Wilson PW, Albano I, Fox CS, et al. Gamma glutamyl transferase and metabolic syndrome, cardiovascular disease, and mortality risk: the Framingham Heart Study. Arterioscler Thromb Vasc Biol. 2007;27(1):127-33.
12. Fox CS, Coady S, Sorlie PD, Levy D, Meigs JB, D'Agostino RB Sr, et al. Increasing cardiovascular disease burden due to diabetes mellitus: the Framingham Heart Study. Circulation. 2007;115(12):1544-50.
13. Pepys MB, Hirschfield GM. C-reactive protein: a critical update. J Clin Invest. 2003;111(12):1805-12.
14. Fraser A, Harris R, Sattar N, Ebrahim S, Smith GD, Lawlor DA. Alanine aminotransferase, gamma-glutamyltransferase, and incident diabetes: the British Women's Heart and Health Study and meta-analysis. Diabetes Care. 2009;32(4):741-50.
15. Kunutsor SK, Apekey TA, Seddoh D. Gamma glutamyltransferase and metabolic syndrome risk: a systematic review and dose-response meta-analysis. Int J Clin Pract. 2015;69(1):136-44.
16. Singh KK, Kapoor A, Khanna R, Sahu A, Kapoor V, Kumar S, et al. Serum Gamma Glutamyltransferase (GGT) in coronary artery disease: Exploring the Asian Indian Connection. Ann Card Anaesth. 2022;25(4):408-13.

17. Rantala AO, Lilja M, Kauma H, Savolainen MJ, Reunanen A, Kesäniemi YA. Gamma-glutamyl transpeptidase and the metabolic syndrome. J Intern Med. 2000;248(3):230-8.
18. Koenig G, Seneff S. Gamma-Glutamyltransferase: A predictive biomarker of cellular antioxidant inadequacy and disease risk. Dis Markers. 2015;2015:818570.
19. Kasapoglu B, Turkay C, Bayram Y, Koca C. Role of GGT in diagnosis of metabolic syndrome: a clinic-based cross-sectional survey. Indian J Med Res. 2010;132:56-61.
20. Tao L, Li X, Zhu H, Gao Y, Luo Y, Wang W, et al. Association between gamma-glutamyl transferase and metabolic syndrome: a cross-sectional study of an adult population in Beijing. Int J Environ Res Public Health. 2013;10(11):5523-40.
21. Li DD, Xu T, Cheng XQ, Wu W, Ye YC, Guo XZ, et al. Serum gamma-glutamyltransferase levels are associated with cardiovascular risk factors in China: a nationwide population-based study. Sci Rep. 2018;8(1):16533.
22. Matsha TE, Macharia M, Yako YY, Erasmus RT, Hassan MS, Kengne AP. Gamma-glutamyltransferase, insulin resistance and cardiometabolic risk profile in a middle-aged African population. Eur J Prev Cardiol. 2014;21(12):1541-8.
23. Zhu Y, Gong Y, Zhu R, Liu XK, Sun YT, Wang Y, et al. Relationship between serum gamma-glutamyltransferase levels and prehypertension in Chinese adults: the cardiometabolic risk in Chinese study. J Clin Hypertens (Greenwich). 2014;16(10):760-5.
24. Esposito K, Marfella R, Ciotola M, Di Palo C, Giugliano F, Giugliano G, et al. Effect of a Mediterranean-style diet on endothelial dysfunction and markers of vascular inflammation in the metabolic syndrome: a randomized trial. JAMA. 2004;292(12):1440-6.
25. Gami AS, Witt BJ, Howard DE, Erwin PJ, Gami LA, Somers VK, et al. Metabolic syndrome and risk of incident cardiovascular events and death: a systematic review and meta-analysis of longitudinal studies. J Am Coll Cardiol. 2007;49(4):403-14.
26. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. Circulation. 2005;112(17):2735-52.
27. Meigs JB, Wilson PWF, Fox CS, Vasan RS, Nathan DM, Sullivan LM, et al. Body mass index, metabolic syndrome, and risk of type 2 diabetes or cardiovascular disease. J Clin Endocrinol Metab. 2006;91(8):2906-12.