



RESEARCH ARTICLE

SERUM GAMMA-GLUTAMYL TRANSFERASE LEVELS IN ACUTE STROKE: A HOSPITAL-BASED CASE-CONTROL STUDY FROM INDIA

¹Dr. Ashwini Upadhyay, ²Dr. Dheeraj Mittal, ³Dr. Rajesh Meena, ⁴Dr. Hemant Mahur, ^{5,*}Dr. Arpit Agarwal and ⁶Dr. Daksh Labana

^{1,5,6}Junior Resident, Department of Medicine, RNT Medical College, Udaipur; ^{2,3}Assistant Professor, Department of Medicine, RNT Medical College, Udaipur; ⁴Senior Professor, Department of Medicine, RNT Medical College, Udaipur

ARTICLE INFO

Article History:

Received 20th July, 2025
Received in revised form
15th August, 2025
Accepted 07th September, 2025
Published online 30th October, 2025

Keywords:

Acute stroke; Biomarker; Gamma-glutamyl transferase; Hypertension; India; Oxidative stress; Smoking; Vascular risk.

*Corresponding author:
Dr. Arpit Agarwal

ABSTRACT

Background & objectives: Gamma-glutamyl transferase (GGT), an enzyme involved in oxidative stress and glutathione metabolism, is increasingly recognized as a cardiovascular risk biomarker. Limited data are available on its association with stroke in the Indian population. This study aimed to evaluate serum GGT levels in acute stroke patients and analyze variations across stroke subtypes and established vascular risk factors. **Methods:** This hospital-based case-control study included 50 consecutive patients aged ≥ 18 years presenting within 24 hours of their first acute stroke and 50 age- and sex-matched healthy controls. Patients with liver/kidney disease, alcohol use, or prior stroke were excluded. Serum GGT was measured enzymatically and compared between groups and across subgroups (smokers vs non-smokers, diabetics vs non-diabetics, hypertensives vs normotensives, haemorrhagic vs non-haemorrhagic strokes). Statistical analysis used unpaired t-test, chi-square test, and Pearson's correlation. **Results:** Mean GGT levels were significantly higher in stroke patients than controls (50.46 ± 23.57 vs 33.52 ± 18.77 U/L; $p = 0.0001$). Elevated GGT correlated significantly with smoking ($p = 0.03$), diabetes mellitus ($p = 0.01$), and hypertension ($p = 0.03$). No significant difference was observed between haemorrhagic and non-haemorrhagic stroke subtypes ($p = 0.6$). Age showed a positive correlation with GGT, while gender did not. **Interpretation & conclusions:** Elevated GGT levels in acute stroke patients support its potential role as a biomarker reflecting oxidative stress and vascular risk. Larger longitudinal studies are warranted to explore its prognostic value in stroke.

Copyright©2025, Ashwini Upadhyay et al. 2025. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Dr. Ashwini Upadhyay, Dr. Dheeraj Mittal, Dr. Rajesh Meena, Dr. Hemant Mahur, Dr. Arpit Agarwal and Dr. Daksh Labana. 2025. "Serum Gamma-Glutamyl Transferase Levels in Acute Stroke: A Hospital-Based Case-Control Study from India." *International Journal of Current Research*, 17, (10), 35106-35108.

INTRODUCTION

A stroke, or cerebrovascular accident (CVA), is the sudden onset of a neurological deficit due to vascular causes. The WHO defines stroke as rapidly developing clinical signs of cerebral dysfunction lasting 24 hours or more or leading to death, with no apparent cause other than vascular origin. Approximately 85–87% of strokes are ischemic, caused by thrombosis or embolism, while the rest are hemorrhagic, including intracerebral and subarachnoid hemorrhages [1]. In India, stroke cases were estimated at 930,985 in 2004, with projections of 1.67 million by 2015 [1,2,3]. In India, stroke prevalence among individuals over 20 years is about 203 per 100,000 [4]. Ischemic strokes, comprising up to 85% of all strokes, are commonly caused by atherosclerosis of large and small arteries, artery-to-artery embolism, or cardiogenic embolism, particularly from atrial fibrillation. Stroke survivors often suffer long-term disability, with many not regaining independence. Major risk factors include hypertension, smoking, diabetes, and hyperlipidemia. Diabetes doubles the risk of ischemic stroke, and hyperglycemia is common during acute events. Gamma-glutamyl transferase (GGT), traditionally used as a marker for alcohol intake and hepatobiliary disorders, is gaining recognition for its role in oxidative stress, inflammation, and atherosclerosis, making it a

potential cardiovascular risk biomarker. Elevated GGT levels have been linked with increased stroke and cardiovascular risk. GGT assists in glutathione metabolism, crucial for antioxidant defense. High GGT levels correlate with age, BMI, smoking, sedentary lifestyle, hypertension, and lipid abnormalities. Interestingly, GGT may also contribute to reactive oxygen species generation in the presence of transition metals. Despite its emerging significance, there is a lack of studies evaluating the relationship between GGT and stroke in the Indian population. Therefore, the present study was undertaken to assess GGT levels in acute stroke patients and explore variations across stroke subtypes.

AIMS AND OBJECTIVES

- To estimate the GGT levels in patient with acute stroke.
- To analyse the GGT levels in haemorrhagic and non haemorrhagic stroke and various risk factors of stroke.

MATERIAL AND METHODS

This hospital-based case-control study was conducted over one year at Maharana Bhopal Hospital, Udaipur, involving patients aged ≥ 18 years presenting within 24 hours of their first acute stroke episode.

Patients with liver or kidney disease, acute infections, neoplasia, alcohol use, prior stroke, certain drug histories, toxemia of pregnancy, or coronary artery disease were excluded. After obtaining consent, eligible stroke patients were clinically examined, and venous blood samples were collected for various investigations including CBC, LFT, RFT, blood sugar, lipid profile, PT-INR, and gamma-glutamyl transferase (GGT), which was measured enzymatically within an hour of collection. GGT levels in stroke patients were compared to age-matched healthy controls, and further analyzed across subgroups such as diabetics vs. non-diabetics, hypertensives vs. non-hypertensives, hemorrhagic vs. non-hemorrhagic stroke, and smokers vs. non-smokers.

DATA ANALYSIS: Statistical analysis was performed using SPSS version 21.0 with unpaired t-test, Pearson’s correlation, and chi-square test, considering a p-value <0.05 as significant.

RESULTS AND OBSERVATIONS

In this study, the majority of patients in both the case group (40%) and control group (50%) were between 61–75 years of age. The mean age was 62.38 ± 13.49 years for the case group and 59.72 ± 12.12 years for the control group, with a p-value of 0.3, indicating no statistically significant difference in age distribution. Gender distribution was also comparable, with males comprising 88% of the case group and 84% of the control group (p = 0.56), showing no significant difference. Among stroke patients, 84% had non-haemorrhagic strokes, and 16% had haemorrhagic strokes (Table 1).

Table 1. Distribution of study population according to type of stroke

Type of Stroke	Case Group	
	No. of Patients	Percentage
Nonhaemorrhagic	42	84
Haemorrhagic	8	16
Total	50	100

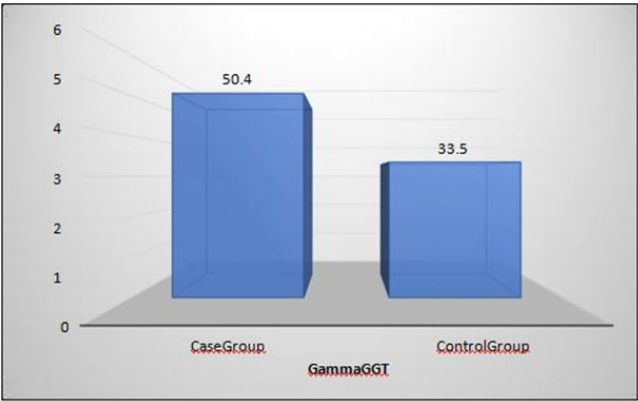


Figure 1. Comparison of Gamma GGT in Stroke patients with controls

The mean Gamma-Glutamyl Transferase (GGT) level was significantly higher in stroke patients (50.46 ± 23.57) compared to controls (33.52 ± 18.77), with a highly significant p-value of 0.0001 (Figure 1). When comparing smokers and non-smokers, GGT levels were significantly elevated in smokers (48.38 ± 23.09) versus non-smokers (41.64 ± 25.65), with a p-value of 0.03 (Figure 2). Diabetic patients showed higher GGT levels (52.72 ± 24.32) compared to non-diabetics (41.4 ± 18.63), with a p-value of 0.01, indicating statistical significance (Figure 2). Similarly, hypertensive patients had significantly higher GGT levels (51.56 ± 26.76) than those without hypertension (45.64 ± 22.32), with a p-value of 0.03 (Figure 2). However, no significant difference in GGT levels was observed between patients with haemorrhagic (52.62 ± 23.61) and non-haemorrhagic strokes (51.95 ± 21.29), with a p-value of 0.6 (Table 2).

Table 2. Comparison of Gamma GGT with Type of stroke

Parameter	Gamma GGT				
Type of Stroke	Nonhaemorrhagic		Haemorrhage		P-Value
	Mean	SD	Mean	SD	
	51.95	21.29	52.62	23.61	0.6

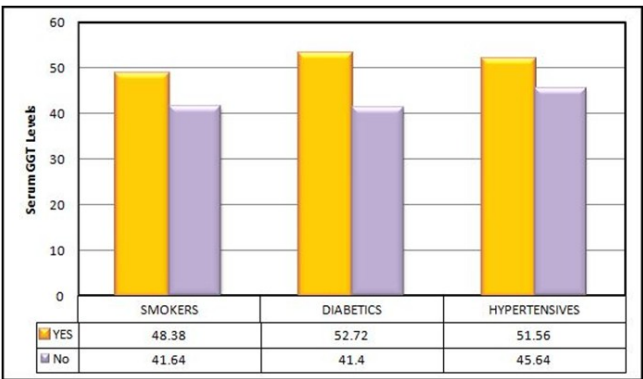


Figure 2. Comparison of Gamma GGT among Smokers, Diabetics and Hypertensives

DISCUSSION

Gamma-glutamyl transferase (GGT) is a key enzyme involved in glutathione metabolism and cellular antioxidant defense. It plays a central role in the uptake of amino acids and peptides, particularly during oxidative stress, when intracellular glutathione levels decline. Increased GGT activity is thought to be a compensatory mechanism to maintain redox balance.^[5] Although the exact link between GGT and stroke is not fully understood, studies suggest that oxidative stress, which lowers glutathione levels, may lead to increased GGT production. Elevated GGT has been independently associated with a higher risk of diabetes, hypertension, and ischemic stroke—even in the absence of liver disease or alcohol use.^[6] This study included 50 acute stroke patients and 50 age-matched controls admitted to Maharana Bhopal Hospital, Udaipur, within 24 hours of stroke onset.

Age and GGT: GGT levels increased with age, being highest in those over 75 years. Our findings are in line with studies by Singh D et al.^[7] and Kumari N et al.^[8], who reported significantly higher GGT levels in older age groups. Similarly, Ismail QM et al.^[9] observed that GGT levels were significantly higher in the 60–80 years group (mean 65.89 U/L) than in younger patients.

Gender: There was no significant difference in GGT levels between males and females, consistent with Gurbuzer et al.^[10]. However, Mijovic et al.^[11] reported higher GGT levels in males, possibly due to a higher prevalence of smoking.

Smoking: In our study, smokers had significantly higher GGT levels (48.38 U/L) compared to non-smokers (41.64 U/L). This is supported by Singh LK et al.^[12], who reported GGT levels of 71.73 U/L in smokers versus 47.75 U/L in non-smokers (p < 0.0001).

Diabetes Mellitus: Diabetics had higher GGT levels (52.72 U/L) than non-diabetics (41.4 U/L) in our study. However, Ismail QM et al.^[9] found the opposite: higher GGT in non-diabetics, with statistically significant differences across 24, 48, and 72-hour readings, challenging conventional expectations^[13].

Hypertension: GGT levels were higher in hypertensive patients (51.56 U/L) compared to non-hypertensives (45.64 U/L), consistent with findings by Yamada Y et al.^[14] and Jousilahti et al.^[15]. However,

Ismail QM et al^[9] reported higher—but statistically non-significant—GGT levels in hypertensive patients.

Type of Stroke: Among stroke cases, 84% had ischemic strokes and 16% had hemorrhagic strokes. Mean GGT levels were nearly identical: 51.95 U/L in ischemic and 52.62 U/L in hemorrhagic stroke (not significant). Singh LK et al^[12] also found slightly higher GGT in hemorrhagic strokes, though the difference was not significant. Singh D et al^[7] and Ismail QM et al^[9] observed minor differences in GGT levels between ischemic and non-ischemic strokes, suggesting limited clinical distinction based on stroke subtype. However, Jousilahti et al^[15] reported increased stroke risk (total and ischemic) with higher GGT levels, particularly in men. In summary, GGT appears to be elevated in stroke patients and may reflect underlying oxidative stress and vascular risk factors, including age, smoking, diabetes, and hypertension. Its utility as a biomarker in cerebrovascular disease warrants further exploration in larger, population-based studies.

CONCLUSION

This study highlights a significant association between elevated serum Gamma-Glutamyl Transferase (GGT) levels and acute stroke, suggesting its potential role as a biomarker of cerebrovascular risk. GGT levels were notably higher in stroke patients compared to healthy controls, and were further elevated among individuals with established risk factors such as smoking, diabetes mellitus, and hypertension. While age showed a clear correlation with increasing GGT levels, gender did not significantly influence its levels. Although no statistically significant difference was observed between GGT levels in ischemic and hemorrhagic stroke subtypes, the overall trend supports a role for GGT in stroke pathophysiology, possibly linked to oxidative stress and metabolic dysfunction. These findings are in agreement with previous national and international studies, emphasizing GGT's emerging value beyond liver dysfunction and alcohol use, particularly in vascular disease contexts. Further large-scale, longitudinal studies are needed to validate GGT as a predictive and prognostic marker in stroke and to better understand its mechanistic role in cerebrovascular events.

REFERENCES

1. Shah B, Mathur P. Workshop Report on Stroke Surveillance in India, Division of noncommunicable Diseases. New Delhi, India: Indian Council of Medical Research: 2006.
2. Govt. of India, Central Bureau of Health Intelligence, National Health Profile 2008. New Delhi: Directorate General of Health Sciences; 2008.p.102.

3. Prasad K, Singhal KK. Stroke in young: An Indian perspective. *Neurol India* 2010;58:343-50
4. Anand K, Chowdhury D, Singh KB, Pandav CS, Kapoor SK. Estimation of mortality and morbidity due to strokes in India. *Neuroepidemiology* 2001;20(3):208-11.
5. J. Yamada H, Tomiyama M, Yambeet al. Elevated serum levels of alanine aminotransferase and gamma-glutamyltransferase are markers of inflammation and oxidative stress independent of the metabolic syndrome, *Atherosclerosis*. 2006;189(1):198–205.
6. E. Ikai, R. Honda, and Y. Yamada, —Serum gamma-glutamyl transpeptidase level and blood pressure in nondrinkers: A possible pathogenetic role of fatty liver in obesity-related hypertension, *Journal of Human Hypertension* 1994;8(2):95–100.
7. Singh D, Agarwal S, Mittal P, Sharma S B. Gamma glutamyl transferase levels in patients with acute stroke: an analytical study. *Asian J Pharm Clin Res* 2023;16(9):62-64.
8. Kumari N et. al. —Study on the Impact of Serum Gamma-Glutamyl Transferase (GGT) level and other Risk factors on Stroke and its Clinical Relevance. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)* 2021;20(10):45-49.
9. Ismail QM, Prasad MK, Marandi S, Guria RT, Dungdung A. Serum gamma-glutamyl transferase level as a risk factor in acute stroke. *J Family Med Prim Care* 2023;12:3172-10.
10. Gurbuzer N. Serum gamma-glutamyl transferase levels in hypertensive patients and its association with other risk factors. *Int J Hypertens* 2016;:8319569.
11. Mijovic V. Gender differences in serum gamma-glutamyltransferase activity. *Clin Chem* 2005;51:2046-7.
12. Singh LK, Pradhan S, Dash L, Pradhan J, Raul U, Meher RK. Serum gamma glutamyl transferase level in acute stroke. *Int J Res Med Sci* 2019;7:2950-5
13. Dutta S, Roy M, Pramanik A B, Das S. Study of association between serum gamma glutamyl transferase and acute ischemic non-embolic stroke. *Journal of Cardiovascular Disease Research* (2023);14(11):452- 463.
14. Yamada Y, Ishizaki M, Kido T, Honda R, Tsuritani I, Ikai E, et al. Alcohol, high blood pressure, and serum gamma-glutamyl transpeptidase level. *Hypertension* 1991;18:819-26.
15. Jousilahti P, Rastenyte D, Tuomilehto J. Serum gamma glutamyl transferase, self-reported alcohol drinking, and the risk of stroke. *Stroke*. 2000;31:1851-5.
