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GLYCOSYLATED HEMOGLOBIN (HBA1C) LEVELS IN DIABETES MELLITUS PATIENTS PRESENTING WITH CEREBROVASCULAR ACCIDENT AT A TERTIARY CARE CENTER

Srikanth Vadlamudi
https://orcid.org/0009-0009-1891-9756
Department of General Medicine, Apollo Institute of Medical sciences and Research Chittoor, Andhra Pradesh, India

N Uday Kumar
https://orcid.org/0000-0002-7207-3458
Department of General Surgery, Apollo Institute of Medical sciences and Research Chittoor, Andhra Pradesh, India

Loya Geeta Anusha
https://orcid.org/0000-0002-6684-8050
Department of Ophthalmology, Apollo Institute of Medical sciences and Research Chittoor, Andhra Pradesh, India

ABSTRACT

Background: Diabetes mellitus significantly increases the risk of cerebrovascular accidents (CVAs), including ischemic and hemorrhagic strokes. Glycosylated hemoglobin (HbA1c) serves as a crucial marker for long-term glycemic control and may influence stroke outcomes. This study explores the relationship between HbA1c levels and the type and severity of CVAs in diabetic patients.

Aim: To determine HbA1c levels in relation to cerebrovascular accidents (ischemic/hemorrhagic) and assess stroke severity based on HbA1c levels using the National Institutes of Health Stroke Scale (NIHSS).

Material and Methods: A cross-sectional study was conducted at AIMSR & Government District Hospital, Chittoor, from October 2022 to September 2023. A total of 100 diabetic patients diagnosed with CVA via CT/MRI were included. Demographic data, HbA1c levels, fasting and postprandial blood glucose, lipid profiles, and stroke severity (NIHSS) were analyzed using SPSS version 21. Statistical associations were evaluated using the Chi-square and Mann-Whitney U tests, with a significance threshold of $p<0.05$.

Results: The mean age of participants was 63.29 ± 11.09 years, with 59% males. Ischemic stroke was predominant (83%), while 17% had hemorrhagic strokes. The mean HbA1c was significantly higher in ischemic stroke patients (8.63% ± 2.09) than in hemorrhagic stroke patients (8.29% ± 2.07) ($p=0.020$). Stroke severity correlated with HbA1c levels, with severe strokes exhibiting the highest HbA1c values (9.43% ± 1.86).

Conclusion: Higher HbA1c levels are associated with increased stroke severity, emphasizing the need for stringent glycemic control in diabetes management to mitigate cerebrovascular risks.

Keywords: Diabetes mellitus, Ischaemic stroke, HbA1c, Glycemic control, NIHSS.

Corresponding author: *Loya Geeta Anusha, Assistant professor, Department of Ophthalmology, Apollo institute of medical sciences and research Chittoor, Andhra Pradesh, India*
Phone no: 8897043737
Email id: geetaanushaloya@gmail.com

INTRODUCTION

In 2010, there were an estimated 285 million diabetics globally; by 2030, that figure is expected to rise to 439 million [1]. This worldwide rise in adult diabetes cases comprises a 69% rise in emerging nations and a similar 20% increase in developed nations [2]. The sharp increase in diabetes prevalence may probably be attributed to the increase of obesity prevalence. At least one in five persons are thought to have the metabolic syndrome, that upsurges the hazard of type II diabetes and cardiovascular disease [3]. If diabetes is not well managed, it may result in a number of grave consequences.

These consist of stroke, heart disease, retinopathy, limb amputation, and chronic renal disease. Type I, or insulin-dependent diabetes, and type II, or insulin-insensitive diabetes, are the two types of the disease. Most instances of diabetes (about 90%) are of type II diabetes, which is much more prevalent [4]. Although they show distinct patterns, both forms of diabetes are related to higher risks of CVD. For instance, PAD and CAD are more common in people with type I diabetes. Conversely, obesity, PAD, large-artery atherosclerosis, and stroke are more common in those with type II diabetes [5].

Diabetes is a known risk factor for stroke, including hemorrhagic and ischemic stroke, according to epidemiologic research [6-9]. The adjusted hazard ratios were 2.27 (1.95–2.65) for ischaemic stroke, 1.56 (1.19–2.05) for haemorrhagic stroke, and 1.84 (1.59–2.13) for unclassified stroke among those with diabetes, according to data from the Emerging Risk Factors Collaboration [9]. Twenty to forty percent of patients presenting with hyperglycemia upon hospital admission, and up to half with acute stroke had previously unidentified impairments in glucose tolerance [10].

Despite advancements in diabetes care and stroke management, there remains a gap in understanding the specific relationship between HbA1c levels and cerebrovascular accidents in diabetic patients. Investigating this connotation can deliver valued insights into risk stratification, preventive measures, and tailored management approaches for diabetic individuals at risk of stroke.

This study's findings are expected to contribute significantly to the existing knowledge base, informing evidence-based practices in diabetes management and stroke prevention. Ultimately, a well considerate of the relationship between HbA1c levels and cerebrovascular accidents can lead to improved clinical decision-making, optimized patient care, and enhanced outcomes for diabetic patients at risk of stroke.

OBJECTIVES

The objectives of the study were to determine HbA1C levels in relation to cerebrovascular accidents and its types (Ischaemic/haemorrhagic) and to assess the severity of stroke with HbA1C levels (as per NIHSS score).

Material and Methods:

Study Design and setting: This was a cross sectional study conducted in AIMSR& Government District Hospital, Chittoor for 1 year from October 2022 to September 2023.

Sample size:100

Sample size n= $Z^2_{1-\alpha/2}(1-P)/E^2P$

Confidence level is 95% and with specified relative precision 0.10

The sample size estimated is around 100 patients presenting with CVA and Diabetes.

The assumed true rate is 80%

Sampling Technique: Consecutive patients admitted with CVA and with history of known diabetes were considered as the sample.

Study Population: Diabetes mellitus subjects with cerebrovascular stroke

Inclusion Criteria:

(1) All cerebrovascular patients admitted within 72 hours after onset of stroke.

(2) Cerebrovascular accidents confirmed by CT or MRI brain.

(3) Age >12 years

Exclusion Criteria:

(1) Age less than 12 years.

(2) Transient Ischaemic attack.

(3) Stroke mimicker's unusual manifestations of non-vascular conditions that may resemble acute stroke syndrome.

(4) Negative CT scan of brain both on admission and after 72 hours.

(5) Patients with old history of cerebrovascular accidents.

Data collection. CT brain or MRI brain scans was done to diagnose cerebrovascular accidents. Blood

glucose levels (FBG, PPBG, RBS), HbA1c, Urine routine and urine samples for ketone bodies, lipid profile tests etc was done to comprehensively evaluate the diabetic patients with cerebrovascular accidents.

Statistical analysis. SPSS version 21 was used to analyse the data once it was entered into Microsoft Excel. For categorical variables, mean/SD was utilised, while for continuous variables, frequency/ percentages were employed. Using the Chi Square test and Mann Whitney U test, the variables were shown to be associated, and a p-value of less than 0.05 was deemed significant

RESULTS

Mean age of the study participants is 63.29 ± 11.09 years. The age range of the participants spans from a minimum of 35 years to a maximum of 85 years. The study consists of 59% males and 41% females. All participants have diabetes (100%), and 49% have hypertension. (Table 1). The mean FBS is 129.46 mg/dL ± 14.86 mg/dL, ranging from 101 mg/dL to 170 mg/dL. The mean postprandial blood glucose (PPBG) level is 196.85 ± 20.94 mg/dL, with values ranging from 156 mg/dL to 260 mg/dL and Mean HbA1c level is 8.90 ± 2.03%, ranging from 5.4% to 14.8% (Table 2). The mean National Institutes of Health Stroke Scale (NIHSS) score is 20.21, with a standard deviation of 6.42, ranging from 8 to 35. Stroke severity is categorized as moderate (22%), moderate to severe (35%), and severe (43%) (Fig 1).

The mean triglyceride level is 178.63 mg/dL (SD 92.41, range 68-429 mg/dL), mean HDL is 38.49 mg/dL (SD 9.30, range 24-67 mg/dL), mean LDL is 111.05 mg/dL (SD 53.02, range 27-300 mg/dL), and mean total cholesterol is 180.29 mg/dL (SD 56.71, range 68-360 mg/dL) (Table 2).

Table 1: Profile of the study participants

No	Variable	Frequency	Percentage
1	**Gender**		
	Male	59	59
	Female	41	41
2	Diabetes	100	100
3	Hypertension	49	49

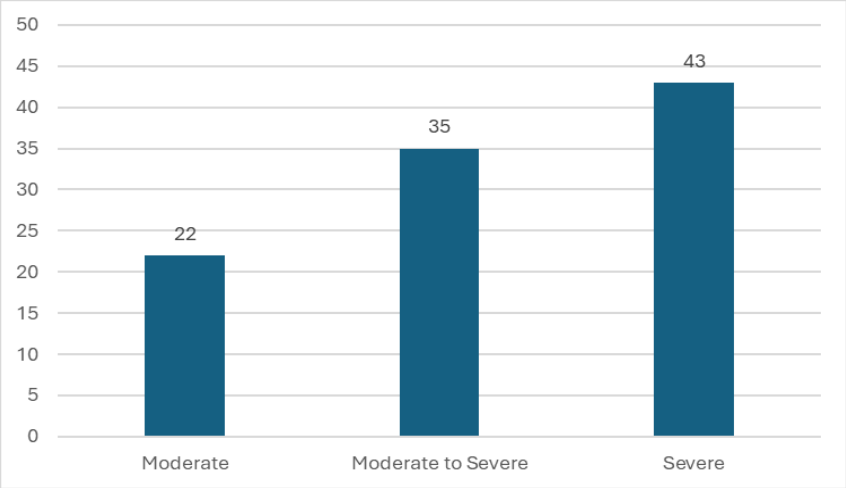

Figure 1: Stroke severity

All participants (100%) had no detectable urine ketones. The mean hemoglobin level is 11.73 g/dL with a standard deviation of 1.99 g/dL, ranging from 8.7 g/dL to 16.2 g/dL (Table 2). Among the participants, 17% had haemorrhagic strokes, while 83% had ischemic strokes (Fig 2).

Participants with haemorrhagic strokes had a mean fasting blood glucose of 135 mg/dL (SD 13.75) and PPBG of 202.71 mg/dL (SD 14.42). Those with ischemic strokes had a mean fasting blood glucose of 128.33 mg/dL (SD 14.90) and PPBG of 195.67 mg/dL (SD 21.89). The mean HbA1c for haemorrhagic stroke patients is 8.29% (SD 2.07) and for ischemic stroke patients is 8.63% (SD 2.09), with a p-value of 0.020. (Table 3).

Moderate stroke patients had a mean FBG of 126.73 mg/dL (SD 19.07) and PPBG of 191.73 mg/dL (SD 20.47). Moderate to severe stroke patients had a mean FBG of 128.69 mg/dL (SD 12.12) and PPBG of 197.40 mg/dL (SD 24.56). Severe stroke patients had a mean FBG of 131.43 mg/dL (SD 14.54) and PPBG of 198.98 mg/dL (SD 17.87). Patients with moderate strokes had a mean HbA1c of 8.29% (SD 2.07), moderate to severe strokes had a mean HbA1c of 8.63% (SD 2.09), and severe strokes had a mean HbA1c of 9.43% (SD 1.86) (Table 4).

Table 2: Blood Investigation findings in the study participants

No	Variable	Mean	SD	Minimum	Maximum
1	Fasting Blood glucose (mg/dl)	129.46	14.86	101	170
2	PPBG (mg/dl)	196.85	20.94	156	260
3	HbA1c (%)	8.90	2.03	5.4	14.8
4	Triglycerides (mg/dl)	178.63	92.41	68	429
5	High Density Lipoprotein (mg/dl)	38.49	9.30	24	67
6	Low Density Lipoprotein (mg/dl)	111.05	53.02	27	300
7	Total Cholesterol (mg/dl)	180.29	56.71	68	360
8	Haemoglobin (g/dl)	11.73	1.99	8.7	16.2

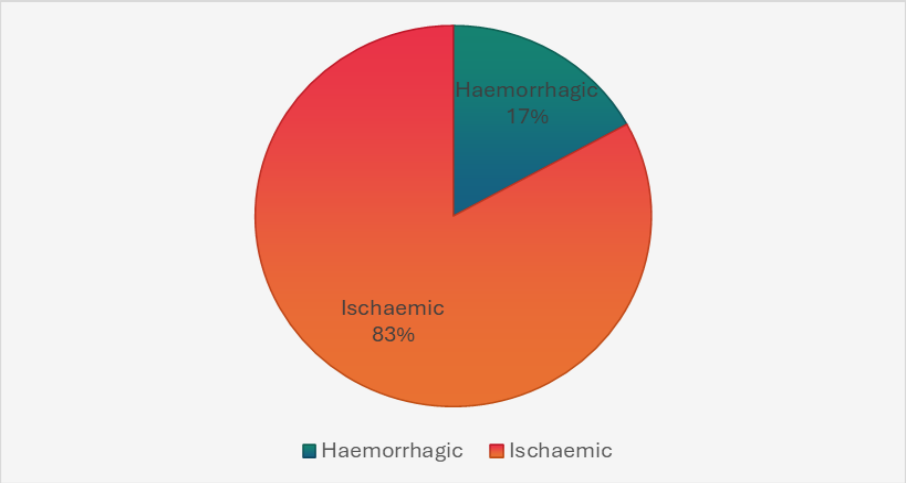

Figure 2: Type of stroke

Table 3: Association between type of stroke and glucose level

Type of stroke	Haemorrhagic		Ischaemic		P value
	Mean	SD	Mean	SD	
FBS (mg/dl)	135	13.75	128.33	14.90	0.272
PPBS (mg/dl)	202.71	14.42	195.67	21.89	0.100
HbA1c (%)	8.29	2.07	8.63	2.09	0.020

Note: P value < 0.05 is significant

Table 4: Association between severity of stroke and glucose level

Type of stroke	Moderate		Moderate - severe		Severe		P value
	Mean	SD	Mean	SD	Mean	SD	
FBS (mg/dl)	126.73	19.07	128.69	12.12	131.43	14.54	0.561
PPBS (mg/dl)	191.73	20.47	197.4	24.56	198.98	17.87	0.234
HbA1c (%)	8.29	2.07	8.63	2.09	9.43	1.86	0.029

Note:P value < 0.05 is significant

DISCUSSION

The present study was done with the objective to determine HbA1C levels in relation to cerebrovascular accidents and its types (Ischaemic/haemorrhagic) and to assess the severity of stroke with HbA1C levels (as per NIHSS score).

Stroke severity is categorized as moderate (22%), moderate to severe (35%), and severe (43%). The mean NIHSS score is 20.21± 6.42, ranging from 8 to 35. Sunanda T et al. [11] has shown that the mean NIHSS score was 6.47 with 53.3%, 45% and 1.7% had mild, moderate and severe stroke. In research by Kamel R et al. [12], it was shown that the mean NIHSS score was 22.07. 10%, 45% and 45% had mild, moderate and severe stroke according to NIHSS.

Among the participants, 17% had haemorrhagic strokes, while 83% had ischemic strokes. Shen Y et al. [13] has shown that 11.3% and 88.7% had ischaemic and haemorrhagic stroke respectively. In a study done by Zhuo Y et al. [14] , it was shown that 70.3% and 27.9% had ischaemic and haemorrhagic stroke respectively. The prevalence of ischaemic stroke is 10 times more common than the haemorrhagic stroke. This is due to the widespread incidence of risk factors such as atherosclerosis, hypertension, and diabetes, which lead to the blockage of blood flow to the brain.

The mean age is 63.29 ± 11.09 years. The age range of the participants spans from a minimum of 35 years to a maximum of 85 years. In a study done by Robson R et al. [15], it was shown that the mean age of the study participants was 72.3 years. Similarly in a study done by Wang H et al. [16], it was shown that the mean age of the study participants was 63.8 years. Kamel RA et al. [12] has shown that average age of the study participants was 70.4 years. Sunanda T et al. [11] has shown that the mean age of the study participants was 56.78 years.

The study consists of 59% males and 41% females. In a study done by Sunanda T et al. [11], it was the shown that majority of the study participants was 72.3%. Kamel R et al. [12] has shown that majority of the study participants with acute stroke and diabetes was males (55%). Wang H et al. [16] has shown that 64% of the patients were males. Jeong J et al. [17] showed that 59.02% were males. Nomani AZ et al. [18] has shown that majority was males (57.08%).

49% had hypertension. In a study done by Wang H et al. [16] it was shown that 77% of patients had hypertension. Pathak A et al. [19] has shown that 65% had hypertension. In a study done by Lin Q et al. [20] it was shown that 77% of the stroke patients had hypertension. Wijono AD et al [21]. has shown that 50.8% of the stroke patients had hypertension.

The mean triglyceride level is 178.63 mg/dL (SD 92.41, range 68-429 mg/dL), mean HDL is 38.49 mg/dL (SD 9.30, range 24-67 mg/dL), mean LDL is 111.05 mg/dL (SD 53.02, range 27-300 mg/dL), and mean total cholesterol is 180.29 mg/dL (SD 56.71, range 68-360 mg/dL).

In a study done by Sunanda T et al. [11], it was shown that the mean triglyceride, HDL, LDL and total cholesterol was 181.50, 45.35, 113.08 and 207.63 respectively. Similar findings were in a study done by Kamel R et al. [12], It has shown that the mean triglyceride, HDL, LDL and total cholesterol was 181.50, 45.3, 113.8 and 207.6 respectively. Nomani AZ et al. [18] has shown that the mean triglyceride, HDL, LDL and total cholesterol was 221, 43, 96.4 and 178.5 respectively.

The mean FBS is 129.46 ± 14.86 mg/dL, ranging from 101 mg/dL to 170 mg/dL. The mean postprandial blood sugar (PPBG) level is 196.85 ± 20.94 mg/dL, with values ranging from 156 mg/dL to 260 mg/dL. Participants with haemorrhagic strokes had a mean fasting blood glucose of 135 mg/dL (SD 13.75) and PPBG of 202.71 mg/dL (SD 14.42). Those with ischemic strokes had a mean fasting blood glucose of 128.33 mg/dL (SD 14.90) and PPBG of 195.67 mg/dL (SD 21.89).

Moderate stroke patients had a mean FBG of 126.73 mg/dL (SD 19.07) and PPBG of 191.73 mg/dL (SD 20.47). Moderate to severe stroke patients had a mean FBS of 128.69 mg/dL (SD 12.12) and PPBG of 197.40 mg/dL (SD 24.56). Severe stroke patients had a mean FBG of 131.43 mg/dL (SD 14.54) and PPBS of 198.98 mg/dL (SD 17.87). In a study done by Sunanda T et al. [11] it was shown that the mean FBG was 179.9. Nomani AZ et al [18] has shown that the mean FBG was 112.43.

The mean HbA1c level is 8.90% with a standard deviation of 2.03%, ranging from 5.4% to 14.8%. The mean HbA1c for haemorrhagic stroke patients is 8.29% (SD 2.07) and for ischemic stroke patients is 8.63% (SD 2.09), with a p-value of 0.020.

Patients with moderate strokes had average HbA1c of 8.29% (SD 2.07), moderate to severe strokes had average HbA1c of 8.63% (SD 2.09), and severe strokes had an average glycosylated Hb of 9.43% (SD 1.86). The p-value of 0.029 suggests that poorer long-term glucose control is linked with more severe strokes.

Glycosylated hemoglobin (HbA1c) is a crucial marker for long-term glucose control and has significant prognostic value in stroke outcomes. Studies indicate that elevated HbA1c is associated with higher stroke severity, worse functional recovery, increased mortality, and prolonged hospital stays.Sunanda T et al. [11]and Wang H et al. [16] found that patients with HbA1c >7 had more severe strokes and worse neurological outcomes. Wu S et al. [22] observed that higher baseline

HbA1c levels were linked to increased one-year all-cause mortality, with the highest risk seen at HbA1c ≥7.2%. Mitsios JP et al. [23] reported that diabetes-range HbA1c (≥6.5%) was associated with a higher risk of first-ever ischemic stroke. Jeong J et al. [17] and Lew J et al. [24] found that elevated HbA1c levels correlated with poor functional outcomes, particularly in younger patients and those with small vessel occlusion.

Meta-analysis by Bao Y et al. [25] confirmed that increased HbA1c is associated with worse stroke outcomes, including a higher risk of symptomatic intracranial hemorrhage. Studies by Kezerle L et al. [26] and Dong N et al. [27] linked elevated HbA1c with a greater risk of stroke recurrence, all-cause mortality, and reduced functional independence.

Overall, research consistently highlights the negative impact of poor glycemic control on stroke prognosis, emphasizing the importance of HbA1c monitoring in stroke patients to improve outcomes and reduce complications.

CONCLUSION

This study underscores the critical role of glycemic control in managing cerebrovascular accidents among diabetic patients. The data reveals a significant association between higher HbA1c levels and increased stroke severity, suggesting that better long-term glucose management could potentially mitigate the impact of strokes. These findings emphasize the need for healthcare providers to prioritize optimal glycemic control in diabetic patients to improve their cerebrovascular health outcomes.

PROSPECTS FOR FUTURE RESEARCH

Longitudinal studies would be particularly valuable in establishing a causal relationship between glycemic control and stroke severity. Furthermore, exploring the impact of various diabetes management strategies, such as lifestyle modifications and medication adjustments, on stroke incidence and outcomes in diabetic patients would provide deeper insights into effective interventions.

AUTHOR CONTRIBUTIONS

1. Srikanth Vadlamudi (Computeration, methodology and review of literature)
2. N Uday Kumar (Manuscript writing, editing and drafting)
3. Loya Geeta Anusha (Statistics analysis and references arrangement)

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ARTIFICIAL INTELLIGENCE DISCLOSURE

Artificial Intelligence (AI) was used only for grammar corrections.

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INFORMATION ABOUT THE AUTHORS

Srikanth Vadlamudi – Assistant Professor, Department of General Medicine, Apollo Institute of Medical sciences and Research, Chittoor, Andhra Pradesh, India, 517127

N Uday Kumar – Assistant Professor , Department of General Surgery, Apollo Institute of Medical sciences and Research, Chittoor, Andhra Pradesh, India, 517127

Loya Geeta Anusha – Assistant Professor , Department of Ophthalmology, Apollo Institute of Medical sciences and Research, Chittoor, Andhra Pradesh, India, 517127