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ORIGINAL ARTICLE

Prevalence of Prediabetes among Subjects with First Ever Acute Stroke

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ABSTRACT

Background: *Stroke and diabetes are major global health concerns, with prediabetes representing an intermediate metabolic state that significantly increases the risk of diabetes and recurrent stroke. Therefore, the present study was conducted to determine the prevalence of prediabetes among patients with first-ever acute stroke.* ***Aim of the study:*** *To determine the prevalence of prediabetes among patients with first-ever acute stroke.* ***Methods & Materials:*** *This cross-sectional study at the Department of Medicine, Sher-E-Bangla Medical College Hospital, Barisal, Bangladesh (March–September 2015), enrolled 100 patients aged ≥40 years with first-ever acute stroke and no prior diabetes. Glycometabolic status was assessed using FPG, 2-h postload glucose, and HbA1c, with data collected via structured forms and stroke confirmed by CT scan. Analyses were done in SPSS with ethical approval and informed consent.* ***Results:*** *Among 100 stroke patients (mean age 57 years, 78% male), ischemic stroke was most common (68%), with hemiplegia as the leading presentation. Hypertension (68%) and smoking (42%) were major risk factors. Glycometabolic tests revealed 18–26% diabetes and 24–34% prediabetes, with combined testing identifying 18% prediabetes and 12% diabetes (p = 0.130).* ***Conclusion:*** *Prediabetes is common among first-ever acute stroke patients, especially in males and the elderly, emphasizing the need for comprehensive post-stroke glycometabolic screening using multiple diagnostic tests.*

Keywords: *Prevalence, Prediabetes, Stroke.*

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INTRODUCTION

Stroke and diabetes are major global health concerns, affecting populations in both developed and developing countries. The prevalence of metabolic syndrome is projected to nearly double over the next two decades[1,2]. Cerebrovascular disease or stroke appears to increase progressively across the spectrum of insulin resistance, from impaired fasting glucose (IFG) to impaired glucose tolerance (IGT) to diabetes, suggesting that hyperglycemia may be continuously associated with stroke. Prediabetes, defined as FPG between 5.6 and 6.9 mmol/L or 2-h postload glucose (2-h PPG) between 7.8 and 11.0 mmol/L among participants without a history of diabetes[1], represents an intermediate metabolic state between normal glucose metabolism and diabetes, conferring a significantly increased risk of developing diabetes.

A common mechanism linking components of the insulin resistance syndrome is cellular and molecular defects promoting atherogenesis and inflammation, which contribute to vascular risk factors and ultimately increase the likelihood of stroke, coronary artery disease, or peripheral vascular disease[2]. Individuals with prediabetes also exhibit dyslipidemia, including small dense LDL particles, hypertriglyceridemia, and reduced HDL cholesterol, further

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accelerating atherogenesis. Prediabetes is highly prevalent in non-diabetic patients with transient ischemic attack (TIA) or ischemic stroke and nearly doubles their risk of recurrent stroke[3].

Pathophysiologically, isolated IFG and isolated IGT differ in insulin resistance and secretory defects: IFG is associated with hepatic insulin resistance and early-phase insulin secretion defects, while IGT shows more severe muscle insulin resistance and late-phase secretory defects. Patients with combined IFG/IGT manifest both hepatic and muscle insulin resistance along with impairments in first- and second-phase insulin secretion, resembling type 2 diabetes[4-6]. The American Diabetes Association (ADA) has recently recommended HbA1c as an additional diagnostic tool for prediabetes[7].

Given the high prevalence of abnormal glycometabolism diagnosed by OGTT among Chinese patients with acute stroke[8,9], and the association of both diabetes and high-normal glycemia with stroke risk[10], efficient screening tools for glycometabolic abnormalities in acute ischemic stroke patients are urgently needed. Although OGTT remains a standard method, it is inconvenient, time-consuming, and requires fasting[11]. HbA1c offers a simpler, non-fasting alternative endorsed by the ADA, with levels of 5.7–6.4% recommended for identifying prediabetes due to the high risk of progression to diabetes[10,12,13].

Fasting plasma glucose (FPG) is another practical option, notable for its low cost and simplicity, though it is sensitive to short-term glucose fluctuations[11]. OGTT, performed after overnight fasting with a 75 g oral glucose load, remains a reliable method for diagnosing DM and prediabetes when combined with FPG measurement[8,14,15]. Despite global studies comparing OGTT and HbA1c for detecting glycometabolic abnormalities, results remain inconsistent, and few studies have specifically focused on patients with first-ever acute ischemic stroke[16]. Therefore, the present study was conducted to determine the prevalence of prediabetes among patients with first-ever acute stroke.

Objective

- To determine the prevalence of prediabetes among patients with first-ever acute stroke.

Methods & Materials

This cross-sectional observational study was conducted in the Department of Medicine, Sher-E-Bangla Medical College Hospital, Barisal, Bangladesh, between 30th March 2015 and 29th September 2015. A total of 100 patients with first-ever acute stroke, aged ≥40 years and without a prior history of diabetes mellitus, were enrolled in the study. Patients were selected consecutively based on predefined inclusion and exclusion criteria to assess the prevalence of prediabetes among acute stroke patients.

Inclusion Criteria:

- Adults aged ≥40 years.
- Both male and female patients.
- Patients with first-ever acute stroke.

Exclusion Criteria:

- Known diabetic patients.
- Patients currently on anti-diabetic medications.

Glycometabolic status was classified according to American Diabetes Association criteria into prediabetes, diabetes, and normoglycemia based on FPG, 2-hour postload glucose (2-h PPG), and HbA1c levels. Eligible patients were informed about the study objectives and procedures, and written consent was obtained. Data on socio-demographics, clinical features, and glycometabolic status were collected using a pre-structured Case Record Form, with stroke diagnosis and type confirmed by CT scan. Blood samples were drawn after overnight fasting for FPG measurement, followed by 75 g oral glucose administration and measurement of 2-h PPG; HbA1c was also assessed. Primary outcome variables included age, sex, occupation, residence, stroke type, clinical manifestations, glycometabolic status, and prevalence of prediabetes. Data were checked for consistency, entered into SPSS version 6, and analyzed descriptively with frequencies and percentages; graphs and charts were prepared using MS Excel, and a p-value <0.05 was considered significant. The questionnaire was pretested and finalized to ensure clarity, and data collection followed standard procedures with continuous verification for completeness and accuracy. The study protocol was approved by the Ethical Committee of SBMCH, and confidentiality of all information was maintained. The overall study procedure involved pretesting and finalizing the questionnaire, consecutive sampling, informed consent, detailed history and physical examination, laboratory investigations (FPG, 2-h PPG, HbA1c), and data entry and analysis.

RESULTS

Table – I: Socio-Demographic Characteristics of the Study Population (*n*=100)

Variable		Number of Patients	Percentage (%)
Age (years)	41–50	26	26.0
	51–60	38	38.0
	61–70	28	28.0
	>70	8	8.0
Sex	Male	78	78.0
	Female	22	22.0
Occupation	Service holder	14	14.0
	Business	26	26.0

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	Daily worker	10	10.0
	Housewife	16	16.0
	Garments worker	6	6.0
	Unemployed	12	12.0
	Retired	16	16.0
Residence	Urban	66	66.0
	Rural	34	34.0

In this table, the mean age of patients was 57.08 ± 6.78 years, with the highest proportion belonging to the 51–60 years age group (38%), followed by 61–70 years (28%). Males constituted the majority (78%) with a male-to-female ratio of 3.6:1. Most male patients were in the 51–60 years age group (38.46%), while more than half of the female patients (54.54%) were between 61–70 years. Regarding occupation, businessmen (26%) and housewives (16%) were most common, followed by service holders (14%). Notably, the majority of female patients were housewives. Two-thirds of the participants (66%) resided in urban areas, while 34% were from rural settings.

Table – II: Pre-existing Risk Factors and Co-morbid Conditions among the Study Population (*n*=100)

Risk Factors	Number of Patients	Percentage (%)
Hypertension	68	68.0
Smoking	42	42.0
Family history of premature CAD/CVD	30	30.0
Heart diseases	16	16.0
Hyperlipidaemia	10	10.0
Obesity	24	24.0
Heavy alcohol intake	4	4.0

The study revealed several predisposing factors associated with acute stroke. Hypertension was the most common risk factor, present in 68% of patients, followed by smoking (42%), family history of CAD/CVD (30%), and obesity (24%). Other less frequent conditions included heart diseases (16%), hyperlipidaemia (10%), and heavy alcohol intake (4%).

Table – III: Distribution of Stroke Types among the Study Population (*n*=100)

Stroke Type	Number of Patients	Percentage (%)
Ischemic stroke	68	68.0
Hemorrhagic stroke	32	32.0

Among the study subjects, ischemic stroke was more common, accounting for 68% of cases, while hemorrhagic stroke was observed in 32%.

Table – IV: Clinical Presentations of Stroke Patients (*n*=100)

Clinical Presentation	Ischemic Stroke (n=68)	Hemorrhagic Stroke (n=32)
Hemiplegia	63	26.0
Impaired consciousness	18	30.0
Dysarthria	0	14.0
Dysphasia	32	17.0
Dysphagia	11	8.0
Headache	35	18.0
Vomiting	15	19.0
Sphincter problem	7	19.0
Facial nerve palsy	6	24.0
Hiccup	12	11.0
Neck rigidity	0	5.0
Convulsion	3	8.0

Hemiplegia was the most frequent presentation, occurring in 92.6% of ischemic and 81.3% of hemorrhagic stroke cases. Impaired consciousness was more common in hemorrhagic stroke (93.8%), while dysphasia was frequently observed in ischemic stroke (47%). Other notable features included headache, vomiting, sphincter disturbances, facial nerve palsy, and convulsions.

Table – V: Diagnosis of Patients According to Status of IFG Finding (*n*=100)

FPG Category (mmol/L)	Number of Patients	Percentage (%)
Prediabetes (5.6–6.9)	24	24.0
Diabetes (≥7.0)	18	18.0
Normoglycemia (<5.6)	58	58.0

Fasting plasma glucose identified 18 DM and 24 prediabetes cases. Among the three tests, IFG had the lowest detection rate for DM (18%) and for prediabetes (24%), respectively.

Table – VI: Diagnosis of Patients According to Status of IGT Finding (*n*=100)

2-h PPG Status	Number of Patients	Percentage (%)
Prediabetes (7.8–11.0 mmol/L)	30	30.0
Diabetes (≥11.1 mmol/L)	26	26.0
Normoglycemia (<7.8 mmol/L)	44	44.0

The OGTT identified 26 patients with diabetes (26%) and 30 patients with prediabetes (30%). OGTT detected more patients with diabetes compared to FPG and HbA1c (26% vs.

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18% and 24%, respectively), demonstrating its higher sensitivity for diagnosing glycometabolic abnormalities.

Table – VII: Status of HbA1c Among Study Subjects (*n*=100)

HbA1c Status	Number of Patients	Percentage (%)
Prediabetes	34	34.0
Diabetes	24	24.0
Normoglycemia	42	42.0

HbA1c assessment identified 24 patients with diabetes (24%) and 34 patients with prediabetes (34%). Notably, HbA1c detected a higher proportion of prediabetes cases compared to OGTT and FPG (34% vs. 30% and 24%, respectively).

Table – VIII: Combination of Glycometabolic Status Categorized by HbA1c, IFG, and IGT (*n*=100)

Glycometabolic Status	Number of Patients	p-value
Prediabetes	18	0.130
Diabetes	12	
Normoglycemia	70	

When combining all three tests (HbA1c, FPG, and OGTT), 18% of patients were classified as prediabetes and 12% as diabetes. The concordant detection among the tests indicates agreement in glycometabolic categorization. The p-value (0.130) shows that the differences were not statistically significant at $p < 0.05$.

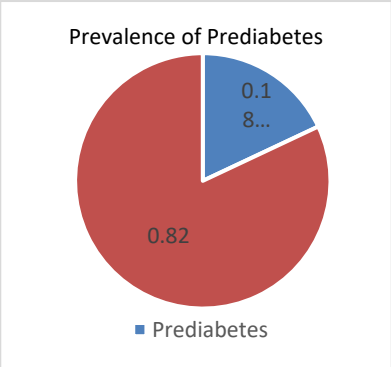

Figure – 1: Prevalence of Prediabetes Among First-Ever Stroke Patients (*n*=100)

Among patients with first-ever stroke, 18% were identified as prediabetes.

DISCUSSION

In the present study, the majority of patients (38%) were in the 51–60 years age group, with a mean age of 57.08 ± 6.78 years. Among males, the highest proportion (38.46%) also fell within this age range, followed by 30.76% in the 41–50 years group. In contrast, over half of the female patients (54.54%) belonged to the 61–70 years group. These findings are consistent with other reports, including those by Hasan et al.[17] and Hasan et al.[18], as well as by Wu et al.[8], who observed a mean age of 62.4 years and male predominance of 63.3%.

Out of 100 patients, 78% were male and 22% were female, giving a male-to-female ratio of 3.6:1. This male preponderance is comparable to other Bangladeshi studies, including those by Hasan et al.[17]. In the current cohort, most patients were from urban backgrounds and of lower socioeconomic status. Businessmen constituted the largest occupational group (26%), followed by housewives (16%) and service holders (14%). Notably, the majority of female patients were housewives.

Hemiplegia was the most frequent presenting symptom, occurring in 92.64% of ischemic stroke and 81.25% of hemorrhagic stroke cases. Other common manifestations included impaired consciousness, sphincter disturbances, and dysphasia, depending on stroke subtype. Neuroimaging with CT was performed in all cases, confirming ischemic stroke in 68% and hemorrhagic stroke in 32% of patients. Hasan et al.[18] also reported similar findings, with 74% ischemic and 26% hemorrhagic cases in his study.

Several vascular risk factors were identified among the stroke patients. Hypertension was the most prevalent, seen in 68% of cases, followed by smoking (42%) and a positive family history of CVD/CAD (30%). These findings are in line with previous studies. Wu et al.[8] reported hypertension in over 50% of cases and current smoking in 33%, while Hasan et al.[18] observed hypertension in 72% of stroke patients. Collectively, these studies strongly support the established association between stroke and hypertension.

With regard to glycometabolic abnormalities, our findings revealed that diabetes and prediabetes were not uniformly identified across the three diagnostic methods (HbA1c, FPG, and OGTT). The degree of overlap between these tests was limited, with each identifying different proportions of patients. FPG detected 18 diabetes and 24 prediabetes cases, while OGTT identified 26 diabetes and 30 prediabetes cases. HbA1c, on the other hand, diagnosed 24 diabetes and 34 prediabetes cases. Notably, OGTT demonstrated the highest yield for diagnosing diabetes (26%), whereas HbA1c was more effective in identifying prediabetes (34%). The detection rate of diabetes by HbA1c was higher than that of FPG but lower than OGTT, consistent with findings from Wu et al.[8]. HbA1c was confirmed to be a feasible tool for diagnosing diabetes, although its concordance with OGTT and FPG was only moderate.

Our finding that HbA1c identified more prediabetes than FPG or OGTT is consistent with Hjellestad et al.[19] and Wu et al.[8], but differs from results by Lorenzo et al. and the National Health and Nutrition Examination Survey [20]. Lorenzo et al.[21] highlighted the low sensitivity of HbA1c (5.7–6.4%) in detecting prediabetes, as many individuals with IFG or IGT may have HbA1c below this range. They emphasized the influence of age, race, and obesity on HbA1c values, cautioning against its use as the sole screening tool. The discrepancy between our results and theirs may be explained by

differences in study populations, as both our patients and those in Hjellestad et al.'s[19] research were more representative of individuals with chronic glycemic overload than general epidemiological samples. HbA1c remains useful for indicating chronic hyperglycemia.

In the present study, the prevalence of prediabetes in first-ever stroke patients was 18% at a tertiary care hospital in Bangladesh. This aligns with the REGARDS study, which reported diabetes in 23.6%, prediabetes in 15.6%, and normoglycemia in 60.8% of participants[22]. Stroke symptoms were most common among those with diabetes (22.7%), followed by prediabetes (15.6%) and normoglycemia (14.9%). U.S. population data also show IFG prevalence of ~26% and IGT prevalence of ~15%, both increasing with age[23]. These findings collectively support our results and highlight the strong association between impaired glucose regulation and stroke risk.

Limitations of the study

This study was not without limitations. The limitations were as follows:

- First, this study was cross-sectional and descriptive, which allowed assessment of the prevalence of prediabetes among stroke patients but not causal relationships. Additionally, we did not include a control group; incorporating one would have enabled evaluation of risk factors for prediabetes and their associations. Therefore, future studies should consider a prospective cohort design with both case and control groups.
- Second, it was a single-center study, including only patients admitted to Sher-E-Bangla Medical College Hospital. As a result, the findings may not be generalizable to the broader population of the country. Larger-scale studies are needed to reach more definitive conclusions.
- Third, the sample was selected using a purposive sampling method, which could introduce personal bias.

Conclusion

This study demonstrated that acute stroke has a strong but often silent association with metabolic disease. The prevalence of prediabetes among patients with first-ever acute stroke was 18%. An important implication of these findings is that individuals with acute stroke should be made aware of their increased risk of developing future diabetes. Several diagnostic methods exist for identifying (pre)diabetes, including fasting plasma glucose, 2-hour postload glucose, and glycosylated hemoglobin (HbA1c) levels. Since the concordance between these tests is not complete, they are considered complementary. Screening for prediabetes after stroke using fasting plasma glucose alone is insufficient; therefore, 2-hour postload glucose and/or HbA1c levels should also be assessed. Our findings further revealed that prediabetes prevalence was higher among male and elderly patients in a tertiary hospital setting in Bangladesh.

Additionally, the study observed that OGTT and HbA1c identified different subsets of patients with diabetes or prediabetes. The overlap between HbA1c and FPG, HbA1c and 2-h PPG, or all three tests was low. Notably, combining FPG, 2-h PPG, and HbA1c reduced the detection rate of prediabetes or diabetes compared with using each test individually.

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