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Prevalence of recurrent stroke and factors influencing recurrence and mortality in Bangladesh

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ABSTRACT
Background: *Stroke remains a leading cause of death and disability globally, with recurrent events contributing disproportionately to morbidity and mortality. In Bangladesh, limited data exist on the prevalence, risk factors, and outcomes of recurrent stroke, hindering effective secondary prevention strategies.*
Aim of the study: *To determine the prevalence of recurrent stroke and identify demographic, clinical, and vascular risk factors associated with stroke recurrence and mortality in a hospital-based Bangladeshi population.*
Methods: *A hospital-based observational study was conducted at the Department of Medicine, Jashore Medical College, Jashore, Bangladesh. Patients were categorized as recurrent stroke (n = 84) or first-ever stroke (n = 216). Sociodemographic data, lifestyle factors, comorbidities, stroke characteristics, and functional outcomes were collected. Stroke severity was assessed using the NIHSS, and functional outcome with the modified Rankin Scale (mRS). Multivariate logistic regression identified independent predictors of stroke recurrence, and Cox proportional hazards models evaluated mortality outcomes.*
Result: *Recurrent stroke accounted for 28% of the study population. Patients with recurrent stroke were older (mean age 67.1 ± 9.8 vs 61.8 ± 11.4 years, $p < 0.001$) and more likely to have rural residence, lower educational status, hypertension, diabetes mellitus, atrial fibrillation, ischemic heart disease, chronic kidney disease, prior TIA, and medication non-adherence. Multivariate analysis revealed that age ≥65 years (adjusted OR 1.94, $p = 0.043$), diabetes mellitus (adjusted OR 1.96, $p = 0.036$), atrial fibrillation (adjusted OR 2.84, $p = 0.020$), previous TIA (adjusted OR 5.77, $p < 0.001$), and medication non-adherence (adjusted OR 3.48, $p < 0.001$) were independent predictors of recurrent stroke. Mortality at 1 year was significantly higher in recurrent stroke patients compared to first-ever stroke (45.2% vs 19.4%, HR 2.74, $p < 0.001$).*
Conclusion: *Recurrent stroke is highly prevalent in the Bangladeshi hospital-based population and is associated with advanced age, diabetes mellitus, atrial fibrillation, previous TIA, and poor medication adherence. Recurrence substantially increases short- and long-term mortality, highlighting the urgent need for targeted secondary prevention strategies and patient education to improve outcomes.*
Keywords: *Recurrent stroke, stroke recurrence, mortality, risk factors, Bangladesh, secondary prevention*

I. INTRODUCTION

Stroke is a major global health problem and one of the leading causes of death and long-term disability worldwide. There are almost 12 million new strokes each year, contributing significantly to mortality and disability-adjusted life years (DALYs) [1]. It occurs when there is a sudden disruption or interruption of blood flow to the brain, which can be either ischemic, caused by a blockage in a blood vessel, or hemorrhagic, resulting from bleeding within the brain. This abrupt disturbance leads to damage of neurons and other brain cells, ultimately causing significant functional impairments [2]. Low- and middle-income countries (LMICs), including Bangladesh, bear a disproportionately high burden of stroke, accounting for nearly 85% of global stroke mortality [3]. This high burden is driven by the increasing prevalence of non-communicable disease risk factors such as hypertension, diabetes mellitus, dyslipidemia, smoking, and sedentary lifestyles, along with demographic shifts such as population aging and urbanization [4]. A recurrent stroke is defined as a new cerebrovascular event occurring after recovery from an initial stroke, typically after 28 days [5]. Recurrent strokes are clinically significant because they are associated with greater neurological deficits, poorer functional outcomes, longer

hospitalization, higher healthcare costs, and increased mortality compared to first-ever strokes [6]. In Bangladesh, the prevalence of recurrent stroke is not well-documented, but the combination of high prevalence of risk factors, inadequate secondary prevention, and limited rehabilitation services likely contributes to elevated recurrence rates [7]. Several modifiable and non-modifiable risk factors have been identified as key contributors to stroke recurrence. Non-modifiable factors include advanced age, male sex, and genetic predisposition, while modifiable factors include uncontrolled hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, ischemic heart disease, smoking, obesity, and physical inactivity [8]. Among these, hypertension is consistently reported as the single most important predictor of stroke recurrence, often followed by diabetes mellitus and dyslipidemia [9,10]. Additionally, cardioembolic strokes, particularly those associated with atrial fibrillation, have a higher tendency to recur if appropriate anticoagulation therapy is not maintained [11]. In Bangladesh, several health system and socio-demographic factors compound the risk of stroke recurrence. Limited access to specialized stroke care, lack of structured rehabilitation programs, irregular follow-up, low medication adherence, and poor patient awareness about secondary prevention are major challenges. Rural populations, in particular, are disproportionately affected due to geographic and economic barriers. These factors not only increase the likelihood of recurrence but also contribute to higher post-stroke mortality and poorer quality of life among survivors [12]. Understanding the prevalence of recurrent stroke and the factors associated with recurrence and mortality is essential to inform targeted interventions and optimize stroke management in Bangladesh. This study aims to determine the prevalence of recurrent stroke and to identify clinical, demographic, and lifestyle factors influencing stroke recurrence and associated mortality among Bangladeshi patients.

II. METHODOLOGY & MATERIALS

This hospital-based, observational study was conducted at the Department of Medicine, Jashore Medical College, Jashore, Bangladesh, between January 2024 and December 2024. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants or their legally authorized representatives, in accordance with the Declaration of Helsinki. A total of 300 adult patients (≥18 years) admitted with a confirmed diagnosis of stroke were enrolled and categorized into two groups:

- **Recurrent Stroke Group (n = 84):** Patients who experienced a new cerebrovascular event at least 28 days after a previous stroke.
- **First-ever Stroke Group (n = 216):** Patients experiencing their first stroke event, confirmed by clinical presentation and imaging.

Inclusion Criteria

Patients were included if they met the following criteria:

- Age ≥18 years.
- Confirmed stroke diagnosis via CT or MRI.
- Admission to the hospital during the study period.
- Provision of informed consent by the patient or a legally authorized representative.

Exclusion Criteria

Patients were excluded if they had:

- Transient ischemic attack (TIA) without imaging-confirmed infarction or hemorrhage.
- Stroke secondary to trauma, infection, or malignancy.
- Incomplete medical records or missing critical clinical information.
- Refusal to provide informed consent.

Data Collection

Data were collected using a structured case record form encompassing sociodemographic variables (age, gender, residence, education), lifestyle factors (smoking, alcohol use), and clinical characteristics (body mass index, comorbidities). Vascular risk factors such as hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, ischemic heart disease, chronic kidney disease, and prior transient ischemic attack (TIA) were documented based on medical history, clinical examination, and relevant laboratory tests. Medication adherence was assessed through patient interviews and review of prescription records. Stroke characteristics were documented, including subtype (ischemic or hemorrhagic), territory of involvement (anterior or posterior circulation), and stroke severity at admission, measured using the National Institutes of Health Stroke Scale (NIHSS) [13]. Functional outcomes were evaluated at discharge using the modified Rankin Scale (mRS), and in-hospital complications, length of hospital stay, and mortality outcomes were recorded. Mortality was assessed during hospitalization and at 30 days, 90 days, 6 months, and 1 year post-stroke through hospital records and follow-up via telephone or outpatient visits.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range, IQR) depending on distribution, and categorical variables as counts and percentages. Between-group comparisons were conducted using Student's t-test or Mann–Whitney U test for continuous variables and chi-square or Fisher's exact test for categorical variables. Crude odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for risk factors associated with stroke recurrence. Variables with $p < 0.10$ in univariate analysis were included in a multivariate logistic regression model to identify independent predictors. Mortality outcomes were assessed using Cox proportional hazards models, reporting hazard ratios (HRs) with 95% CIs. Statistical significance was set at $p < 0.05$ (two-sided). All analyses were performed using statistical software SPSS version 26.0.

III. RESULT

Table 1 presented that the mean age of all participants was 63.4 ± 11.2 years. Patients with recurrent stroke were significantly older (67.1 ± 9.8 years) than those experiencing a first-ever stroke (61.8 ± 11.4 years; $p<0.001$). A higher proportion of recurrent strokes occurred among individuals aged ≥65 years (61.9% vs. 37.0%, $p<0.001$). Males predominated in both groups (69.1% vs. 60.2%), although the difference was not statistically significant ($p=0.16$). Urban residents were more represented in the first-ever stroke group (45.4% vs. 30.9%, $p=0.028$). Illiteracy was more frequent among patients with recurrent stroke (54.8% vs. 35.2%, $p=0.004$). Additionally, current smoking ($p=0.007$), alcohol consumption ($p=0.048$), and a family history of stroke ($p=0.007$) were significantly higher among patients with recurrent stroke. Hypertension (p=0.002), diabetes (p=0.005), atrial fibrillation (p=0.008), ischemic heart disease (p=0.006), chronic kidney disease (p=0.015), prior TIA (p<0.001), and medication non-adherence (p<0.001) were significantly higher in the recurrent stroke group. The strongest crude associations were observed for previous TIA (OR = 7.99; 95% CI: 3.95–16.1) and medication non-adherence (OR = 3.22; 95% CI: 1.86–5.60) (Table 2). Ischemic stroke was the predominant subtype in both groups, with no significant difference ($p=0.64$). Recurrent stroke patients had significantly higher NIHSS scores on admission (11.4 ± 5.1 vs. 8.2 ± 4.4; $p<0.001$), a greater proportion of poor functional outcomes (mRS ≥3: 69.1% vs. 38.9%; $p<0.001$), and higher rates of in-hospital complications (40.5% vs. 20.8%; $p=0.001$). The median hospital stay was longer for recurrent strokes (9 [7–13] vs. 7 [5–10] days; $p=0.003$) (Table 3). Table 4 showed significant independent predictors of stroke recurrence, including age ≥65 years (AOR = 1.94; 95% CI: 1.02–3.69; p=0.043), diabetes (AOR = 1.96; 95% CI: 1.04–3.68; p=0.036), atrial fibrillation (AOR = 2.84; 95% CI: 1.18–6.85; p=0.020), previous TIA (AOR = 5.77; 95% CI: 2.59–12.8; p<0.001), and medication non-adherence (AOR = 3.48; 95% CI: 1.79–6.76; p<0.001). Recurrent stroke patients experienced significantly higher mortality across all follow-up periods: in-hospital (19.1% vs. 8.3%; $p=0.010$), 30-day (26.2% vs. 11.6%; $p=0.001$), 90-day (33.3% vs. 13.9%; $p<0.001$), 6-month (38.1% vs. 16.2%; $p<0.001$), and 1-year (45.2% vs. 19.4%; $p<0.001$). The hazard ratios ranged between 2.36 and 2.88 (Table 5).

Table 1: Baseline demographic and clinical characteristics of the study population (N = 300)

Variable	Total (n=300)	Recurrent Stroke (n=84)	First-ever Stroke (n=216)	p-value
Age (years)				
<65 years	168 (56.00)	32 (38.10)	136 (62.96)	<0.001*
≥65 years	132 (44.00)	52 (61.90)	80 (37.04)	
Mean ± SD	63.4 ± 11.2	67.1 ± 9.8	61.8 ± 11.4	
Gender				
Male	188 (62.67)	58 (69.05)	130 (60.19)	0.16
Female	112 (37.33)	26 (30.95)	86 (39.81)	
BMI (kg/m²)				
Mean ± SD	25.1 ± 3.3	25.6 ± 3.4	24.9 ± 3.2	0.24
Residence				
Urban	124 (41.33)	26 (30.95)	98 (45.37)	0.028*
Rural	176 (58.67)	58 (69.05)	118 (54.63)	
Education				
Illiterate	122 (40.67)	46 (54.76)	76 (35.19)	0.004*
Primary–Secondary	118 (39.33)	30 (35.71)	88 (40.74)	
Higher education	60 (20.00)	8 (9.52)	52 (24.07)	
Current smoker	98 (32.67)	38 (45.24)	60 (27.78)	0.007*
Alcohol consumption	18 (6.00)	9 (10.71)	9 (4.17)	0.048*
Family history of stroke	68 (22.67)	28 (33.33)	40 (18.52)	0.007*

Table 2: Vascular risk factors and comorbidities associated with stroke recurrence

Variable	Recurrent Stroke (n=84)	First-ever Stroke (n=216)	Crude OR (95% CI)	p-value
Hypertension	71 (84.52)	146 (67.59)	2.70 (1.43–5.08)	0.002*
Diabetes mellitus	46 (54.76)	78 (36.11)	2.14 (1.25–3.67)	0.005*
Dyslipidemia	44 (52.38)	90 (41.67)	1.55 (0.92–2.60)	0.10
Atrial fibrillation	16 (19.05)	17 (7.87)	2.77 (1.29–5.95)	0.008*
Ischemic heart disease	27 (32.14)	36 (16.67)	2.34 (1.27–4.30)	0.006*
Chronic kidney disease	20 (23.81)	26 (12.04)	2.27 (1.17–4.41)	0.015*
Previous transient ischemic attack (TIA)	30 (35.71)	14 (6.48)	7.99 (3.95–16.1)	<0.001*
Non-adherence to medication	38 (45.24)	44 (20.37)	3.22 (1.86–5.60)	<0.001*

Table 3: Stroke characteristics and functional outcomes

Variable	Recurrent Stroke (n=84)	First-ever Stroke (n=216)	p-value
Stroke subtype			
Ischemic	74 (88.10)	186 (86.11)	0.64
Hemorrhagic	10 (11.90)	30 (13.89)	
Territory of involvement			
Anterior circulation	56 (66.67)	128 (59.26)	0.24
Posterior circulation	28 (33.33)	88 (40.74)	
NIHSS score on admission (mean ± SD)	11.4 ± 5.1	8.2 ± 4.4	<0.001*
mRS ≥3 at discharge, n (%)	58 (69.05)	84 (38.89)	<0.001*
In-hospital complications, n (%)	34 (40.48)	45 (20.83)	0.001*
Length of hospital stay, days (median [IQR])	9 [7–13]	7 [5–10]	0.003*

Table 4: Multivariate logistic regression analysis of independent predictors of stroke recurrence

Predictor Variable	Adjusted OR (95% CI)	p-value
Age ≥65 years	1.94 (1.02–3.69)	0.043*
Hypertension	1.81 (0.90–3.64)	0.09
Diabetes mellitus	1.96 (1.04–3.68)	0.036*
Atrial fibrillation	2.84 (1.18–6.85)	0.020*
Previous TIA	5.77 (2.59–12.8)	<0.001*
Medication non-adherence	3.48 (1.79–6.76)	<0.001*
Chronic kidney disease	1.98 (0.90–4.35)	0.09

Table 5: Mortality outcomes in relation to stroke recurrence

Outcome	Recurrent Stroke (n=84)	First-ever Stroke (n=216)	Crude HR (95% CI)	p-value
In-hospital mortality	16 (19.05)	18 (8.33)	2.36 (1.23–4.53)	0.010*
30-day mortality	22 (26.19)	25 (11.57)	2.67 (1.50–4.74)	0.001*
90-day mortality	28 (33.33)	30 (13.89)	2.88 (1.69–4.92)	<0.001*
6-month mortality	32 (38.10)	35 (16.20)	2.87 (1.73–4.74)	<0.001*
1-year mortality	38 (45.24)	42 (19.44)	2.74 (1.71–4.39)	<0.001*

IV. DISCUSSION

Stroke remains a leading cause of morbidity and mortality worldwide, posing a substantial burden on healthcare systems, particularly in low- and middle-income countries like Bangladesh [14]. Despite advances in acute stroke management and secondary prevention strategies, recurrent stroke continues to represent a major clinical challenge, often associated with increased severity, disability, and mortality [15]. Understanding the epidemiology, risk factors, and outcomes of recurrent stroke is critical for designing effective preventive interventions and improving patient prognosis [16]. In the present study, 28% of patients experienced recurrent stroke, which is consistent with findings from previous studies in similar populations [17]. Age emerged as a significant determinant, with individuals aged ≥65 years exhibiting a higher likelihood of recurrence (61.9% vs. 37.0%, p<0.001). Multivariate analysis confirmed age ≥65 years as an independent predictor (adjusted OR 1.94, 95% CI 1.02–3.69, p=0.043). These findings are consistent with previous research, including a large multiethnic Asian cohort, where older age was associated with increased recurrence and mortality risk (HR 1.21, 95% CI 1.12–1.30) [18]. Similarly, studies from rural China and Lebanon reported that age ≥65 years significantly elevated recurrence risk and predicted 1-year mortality [17, 19]. In our study, gender distribution was not significantly associated with stroke recurrence, with males comprising 69.0% of recurrent cases versus 60.2% of first-ever strokes (p = 0.16). This finding aligns with evidence from multiple population-based studies [20]. Both the POINT trial and the UCC-SMART study reported no significant differences in recurrence between men and women after multivariable adjustment, suggesting that sex alone is not an independent predictor of recurrent stroke. Similarly, a U.S. population-based analysis found that although women had worse unadjusted outcomes, adjustment for

clinical and demographic factors eliminated sex-based disparities in recurrence [21]. However, some studies have noted modest sex-related differences; the Swedish Riksstroke registry observed a slightly higher recurrence risk in men (HR 1.09; 95% CI 1.045–1.138), whereas the BASIC project in South Texas reported early higher recurrence in women that attenuated over time [22]. Socioeconomic and lifestyle factors demonstrated significant associations with stroke recurrence. Patients residing in rural areas exhibited higher recurrence rates compared to urban counterparts (69.0% vs. 54.6%, p = 0.028), and lower educational attainment was more frequent among recurrent cases (54.8% illiterate vs. 35.2% in first-ever stroke, p = 0.004). These observations align with a nationwide Swedish study, which reported that higher education reduced the risk of recurrent stroke (HR ~0.90, 95% CI 0.86–0.94) [23], and with population-based data from rural China showing increased recurrence among individuals with low educational levels [24]. Similarly, US studies indicate that residence in socioeconomically disadvantaged or rural areas is linked to higher recurrence and adverse outcomes [25]. Furthermore, modifiable behaviors—including smoking (45.2% vs. 27.8%, p = 0.007) and alcohol use (10.7% vs. 4.2%, p = 0.048)—were more prevalent in recurrent cases, consistent with findings from the Nanjing Stroke Registry and Korean cohorts study [26-28]. Vascular risk factors and comorbidities critically influenced stroke recurrence. Multivariate analysis revealed diabetes (OR 1.96), atrial fibrillation (OR 2.84), prior TIA (OR 5.77), and medication non-adherence (OR 3.48) as independent predictors. These findings align with prior research highlighting the impact of metabolic and cardiovascular comorbidities on recurrent stroke risk. A large-scale review identified high initial stroke severity, atrial fibrillation, diabetes mellitus, and prior transient ischemic attacks as significant predictors of recurrence [29]. Similarly, a meta-analysis confirmed that preexisting cardiac conditions and vascular risk factors, including ischemic heart disease and diabetes, substantially elevate recurrence risk [30]. Additionally, suboptimal adherence to prescribed medications and secondary prevention measures has emerged as a critical, modifiable determinant of stroke recurrence [31]. Patients with recurrent strokes exhibited greater severity, with higher admission NIHSS scores (11.4 vs. 8.2), increased disability at discharge (mRS ≥3, 69.1% vs. 38.9%), and more in-hospital complications (40.5% vs. 20.8%). A Norwegian study demonstrated that recurrent ischemic stroke markedly elevated all-cause mortality (HR 2.55) and was associated with advanced age, hypertension, and a history of prior stroke [32]. Likewise, data from the China National Stroke Registry highlighted in-hospital complications as significant predictors of stroke recurrence [33]. In the present study, recurrent stroke was associated with substantially higher mortality at all assessed time points, with 1-year mortality reaching 45.2% compared to 19.4% among first-ever stroke patients (HR 2.74, p<0.001). Crude hazard ratios consistently indicated a 2- to 3-fold elevated risk of death in individuals experiencing stroke recurrence, underscoring its role as a strong prognostic indicator. Supporting this, a prospective studies reported that recurrent ischemic stroke more than doubled all-cause mortality risk (HR 2.55, 95% CI 2.04–3.18) [32], while a 30-day survivor cohort observed 1-year mortality of 57% versus 29% in first-ever strokes [34]. Evidence from systematic reviews and large registries in low- and middle-income settings further confirms recurrence as an independent predictor of post-stroke mortality [6, 15, 35].

Limitations of the study: This study was conducted at a single tertiary care center, potentially limiting generalizability to the broader Bangladeshi population. Its observational design precludes causal inference between identified risk factors and stroke recurrence. Some data, including medication adherence and lifestyle factors, relied on patient self-reporting, introducing potential recall bias. Additionally, long-term follow-up beyond one year was not available, restricting assessment of late recurrence and mortality outcomes.

V. CONCLUSION AND RECOMMENDATIONS

Recurrent stroke affects nearly one-third of hospitalized stroke patients in Bangladesh and is associated with advanced age, diabetes mellitus, atrial fibrillation, prior TIA, and medication non-adherence. These factors independently increase the risk of recurrence and contribute to substantially higher short- and long-term mortality compared to first-ever stroke. Early identification of high-risk patients, strict control of vascular comorbidities, and adherence to secondary prevention strategies are critical to reducing recurrence and improving outcomes. Tailored interventions and patient education remain essential for mitigating the substantial clinical and public health burden of recurrent stroke in Bangladesh.

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