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Original Article

Pattern of Stroke in Young Adults and Its Association with Cardiac Disorders: Evidence from a Tertiary Care Hospital in Bangladesh

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Abstract

Stroke in young adults has substantial clinical and socioeconomic consequences, particularly in low- and middle-income countries where cardiac disorders may remain undiagnosed until the index cerebrovascular event. The study aimed to determine the pattern of stroke, frequency of selected cardiac disorders, and their association with ischemic and hemorrhagic stroke among young adults in Bangladesh. This hospital-based analytical cross-sectional study was conducted in the Medicine Ward of Jahurul Islam Medical College Hospital, Kishoreganj, from September 2020 to February 2021. A total of 100 consecutive patients aged 18-50 years with radiologically confirmed stroke were enrolled. Socio-demographic characteristics, stroke subtype, electro-cardiographic (ECG) and echocardiographic findings, and cardiac disorders were analyzed. Associations were tested using Chi-square analysis, and logistic regression was used to estimate odds ratios (ORs) with 95% confidence intervals (CIs). The mean age was 42.09 ± 7.14 years; 57% were aged 42-50 years, and 31% were aged 34-41 years. Males constituted 74% of patients, with a male-to-female ratio of 2.85:1. Socioeconomic findings showed that 96% were married, 68% had no formal or below-secondary education, 37% were in other occupations, 22% were business persons, 16% were housewives, 74% earned 20,000 BDT or less per month, and 79% lived in urban areas. Ischemic stroke predominated in 81% of cases. In comparison, hemorrhagic stroke accounted for 19%, giving an ischemic-to-hemorrhagic ratio of approximately 4.3:1. ECG abnormalities were significantly more frequent in ischemic than hemorrhagic stroke (63.0% vs. 26.3%, $p = 0.004$). St-elevation infarction patterns occurred only in ischemic cases (23.5%). Abnormal echocardiographic findings were more common in hemorrhagic stroke (68.4% vs. 43.2%, $p = 0.04$). Coronary artery disease (CAD) was the most frequent (43.0%) cardiac disorder (48.1% vs. 21.1%; $\chi^2 = 4.610$, $p = 0.032$), and Valvular heart disease (VHD) was present in 16.0% overall (19.8% vs. 0.0%; $\chi^2 = 4.468$, $p = 0.035$); both were significantly associated with ischemic stroke. Congenital heart disease (CHD) was present in 19.0% overall and showed the strongest association with hemorrhagic stroke (63.2% vs. 8.6%; $\chi^2 = 29.720$, $p < 0.001$). Logistic regression confirmed CAD (OR = 1.23, 95% CI: 1.01-1.56) and VHD (OR = 1.29, 95% CI: 1.05-1.62) as predictors of ischemic stroke, and CHD (OR = 7.31, 95% CI: 3.12-17.12) as a strong predictor of hemorrhagic stroke. Atrial fibrillation, left ventricular failure, cardiogenic thrombus, and single or multiple cardiac disease patterns did not differ significantly by stroke subtype. Coronary artery disease and valvular heart disease were linked to ischemic stroke, whereas congenital heart disease strongly predicted hemorrhagic stroke among young stroke patients. Routine ECG and echocardiography should be emphasized in young adults presenting with stroke to improve etiological classification, secondary prevention in Bangladesh.

Keywords: *Young stroke, cardiac disorders, coronary artery disease, valvular heart disease, congenital heart disease.*

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INTRODUCTION

Stroke remains one of the leading causes of death and long-term disability worldwide, and its burden is no longer confined to older populations.[1] Young adults account for a smaller proportion of all strokes than elderly patients, but the individual, family, and economic consequences are often disproportionately large because events occur during the most productive years of life.[2,3] For clinical and epidemiological work, young stroke is commonly studied in patients aged up to 45 or 50 years, although definitions vary across cohorts.[2,3,26] This heterogeneity makes local evidence important, particularly in countries where delayed presentation, limited diagnostic access, and competing vascular risks may alter the observed pattern of disease.[26-29]

Ischemic stroke is usually classified according to mechanism, including large-artery atherosclerosis, small-vessel disease, cardioembolism, other determined causes, and undetermined causes.[4,22] In young adults, however, the etiological spectrum is broader than in older patients, and a substantial proportion of cases remain cryptogenic after routine evaluation.[10-13,21] Accurate subtype assignment is clinically important because secondary prevention differs markedly between atherosclerotic disease, cardioembolism, structural cardiac lesions, and non-cardiac mechanisms.[4,16,22] Misclassification may expose patients either to insufficient prevention or to unnecessary treatment risks.[23]

Atrial fibrillation is an established independent risk factor for ischemic stroke, with risk varying by age, associated cardiac disease, and the quality of rhythm detection.[5-9] Beyond atrial fibrillation, CAD, left ventricular dysfunction, intracardiac thrombus, and valvular heart disease can create embolic substrates capable of causing cerebral infarction.[16,17,24,25] Echocardiography, especially when selected appropriately and complemented by electrocardiography, can identify clinically meaningful sources that may otherwise remain occult in younger patients.[18,24,25] These observations support a systematic cardiac assessment when young adults present with radiologically confirmed stroke.[16-18]

Patent foramen ovale and other congenital or residual intracardiac shunts are frequently considered in cryptogenic stroke, especially when conventional vascular risk factors are absent.[19-21] Valvular lesions, including rheumatic mitral valve disease, also remain clinically important in South Asian settings and may predispose to atrial arrhythmia, chamber dilatation, thrombus formation, or embolism.[16,17,30] The relationship between congenital heart disease and hemorrhagic stroke is less straightforward, but altered hemodynamics, vascular abnormalities, secondary hypertension, anticoagulant exposure, and procedure-related factors may contribute in selected patients.[17,19,20]

Bangladesh faces a dual challenge: traditional vascular risks are common, while cardiac diseases may be underdiagnosed before the index stroke.[26-30] Local studies describe hypertension, diabetes, smoking, dyslipidemia, socioeconomic disadvantage, and variable access to preventive care as important contributors to stroke occurrence and outcomes.[27-29] At the same time, the national cardiovascular disease profile continues to include rheumatic and congenital conditions as well as ischemic heart disease, making cardiac evaluation especially relevant for younger patients rather than only for elderly stroke populations.[26,30] Yet relatively few Bangladeshi studies have focused specifically on the cardiac profile of young stroke patients or compared cardiac abnormalities between ischemic and hemorrhagic subtypes.[26,28,30] Evidence from tertiary hospitals can therefore help clinicians decide how strongly to prioritize ECG, echocardiography, and targeted cardiovascular evaluation in this age group.[18,24,25]

Against this background, the present study was undertaken at Jahurul Islam Medical College Hospital to describe the pattern of stroke among adults aged 18-50 years, determine the frequency of selected cardiac disorders, and examine their association with ischemic and hemorrhagic stroke. By evaluating electrocardiographic and echocardiographic findings alongside stroke subtype, the study aims to clarify whether coronary artery disease, valvular heart disease, congenital heart disease, atrial fibrillation, left ventricular failure, or cardiogenic thrombus show distinct relationships with stroke type in young Bangladeshi patients. Such information may strengthen early risk recognition, guide secondary prevention, and support more integrated cardio-neurological care in resource-constrained settings.[16-18,26-30]

MATERIALS AND METHODS

This hospital-based analytical cross-sectional study was conducted in the Medicine Wards of Jahurul Islam Medical College Hospital (JIMCH), Kishoreganj, Bangladesh, over six months from September 2020 to February 2021. The study was designed to assess the pattern of stroke and the association between selected cardiac disorders and stroke subtype among young adults. All consecutive patients aged 18-50 years who were admitted during the study period with clinically suspected stroke were screened. Stroke was confirmed by neuroimaging using non-contrast computed tomography (CT) or magnetic resonance imaging (MRI). Patients with radiologically confirmed ischemic or hemorrhagic stroke who provided informed consent were included. Exclusion Criteria: Patients in deep coma, with intracranial space-occupying lesions, no radiological evidence of stroke, chronic kidney disease, pregnant women, or unwilling to participate were excluded from this Study.

The sample size was calculated using previously reported estimates of ischemic stroke (61%) and hemorrhagic stroke

(39%) among young adults, resulting in a minimum sample size of 100 participants. A purposive consecutive sampling technique was applied until the target sample was achieved. Data were collected using a structured data collection sheet after obtaining written informed consent. Socio-demographic variables included age, sex, marital status, education, occupation, monthly income, and residence. Clinical information included stroke subtype, relevant history, physical examination findings, and the presence of cardiac comorbidities.

Clinical and Cardiac Evaluation: All participants underwent detailed clinical assessment, standard 12-lead ECG, and echocardiography. ECG was performed using a Philips PageWriter TC20 machine. Recorded ECG abnormalities included ST-elevation infarction patterns, old infarct changes with pathological Q waves, ischemic T-wave changes, and atrial fibrillation.

Echocardiographic Assessment: Echocardiography was performed using an Acuson SC2000 PRIME ultrasound cardiology system (Siemens). Transthoracic echocardiography was performed as the primary modality, with other approaches considered when clinically indicated. Documented findings included left ventricular failure, left ventricular thrombus, valvular heart disease, and congenital heart disease such as patent foramen ovale, atrial septal defect, ventricular septal defect, persistent ductus arteriosus, and coarctation of the aorta.

The primary outcome variable was stroke subtype, categorized as ischemic or hemorrhagic based on neuroimaging. The main explanatory variables were cardiac disorders, including CAD, VHD, CHD, atrial fibrillation (AF), left ventricular failure (LVF), and cardiogenic thrombus. ECG and echocardiographic findings were also categorized as normal or abnormal for comparative analysis.

Data were entered and analyzed using IBM Statistical Package for Social Sciences (SPSS) version 23.0. Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. Associations between cardiac disorders and stroke subtype were assessed using Pearson's Chi-square test. Logistic regression was performed to estimate predictors of ischemic and hemorrhagic stroke, and results were presented as ORs with 95% CIs. A p-value <0.05 was considered statistically significant. Ethical approval was obtained from the Ethical Review Committee of JIMCH. Written informed consent was obtained from all participants or their legal representatives when appropriate. Confidentiality was maintained throughout data collection and analysis, participation was voluntary, and participants had the right to withdraw at any stage. As the study was observational, no additional intervention-related risk was imposed.

RESULTS

Table I summarizes the demographic profile of the 100 young stroke patients. The mean age was 42.09 ± 7.14 years. Most patients were in the 42-50-year age group (57%), followed by the 34-41-year group (31%). Men represented 74% of the cohort, giving a male-to-female ratio of 2.85:1.

Table I: Demographic characteristics of the participants

Variables	Category	Frequency (n)	Percentage (%)
Mean Age (±SD)	—	42.09 ± (7.14)	—
Age Group (years)	18-25	3	3%
	26-33	9	9%
	34-41	31	31%
	42-50	57	57%
Sex	Male	74	74%
	Female	26	26%
Male to Female Ratio		2.85:1	

Figure 1 shows the socioeconomic characteristics of the study participants. Most patients were married (96%). Educational attainment was generally low: 35% had no formal education, 33% had education below secondary level, 10% completed secondary school, 16% completed higher secondary education, and 6% were graduates or above. Occupationally, 37% were grouped as others, including day laborers, drivers, or small-scale workers, followed by businesspersons (22%), housewives (16%), non-government employees (12%), government employees (9%), unemployed individuals (2%), and students (2%). Monthly income was below 10,000 BDT in 35% and 10,001-20,000 BDT in 39%, whereas only 6% reported income above 40,000 BDT. Urban residents constituted 79% of the cohort, and 21% were from rural areas.

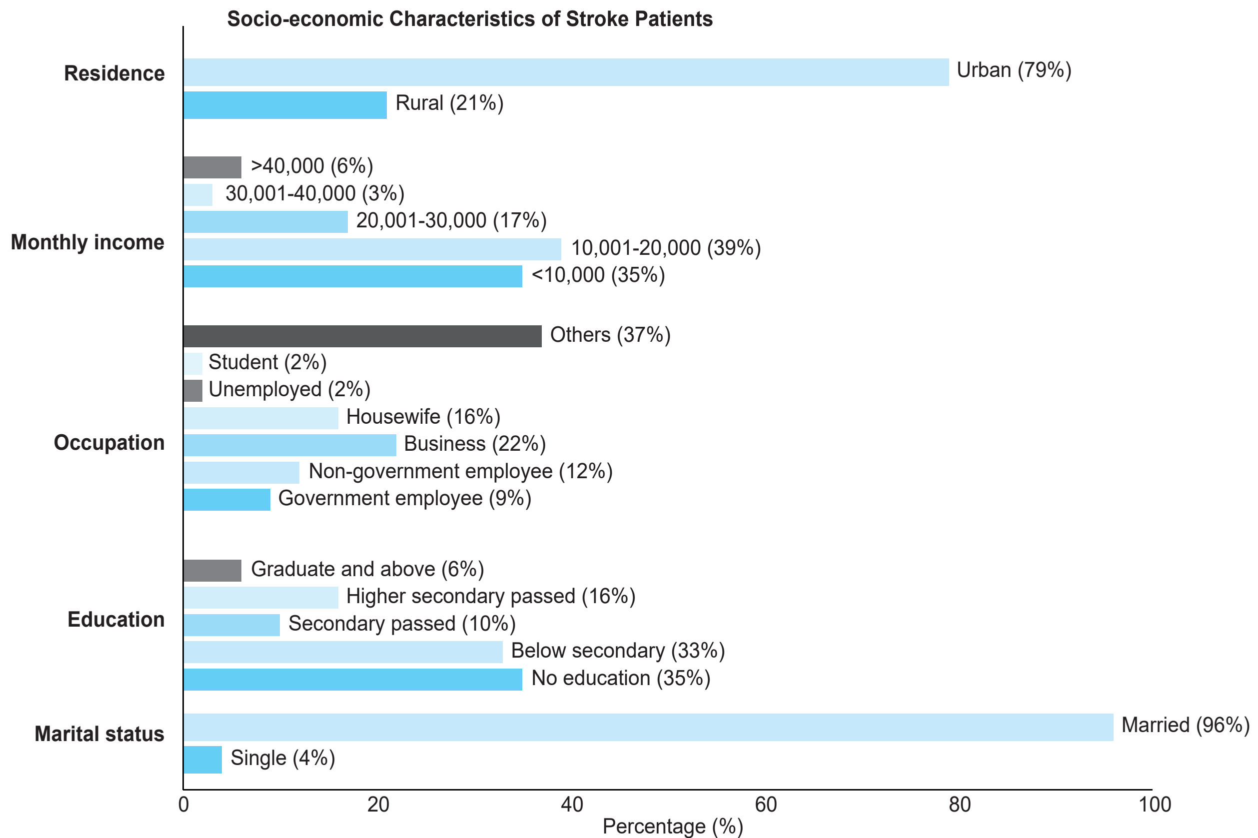


Figure 1: Distribution of socio-economic characteristics of stroke patients

Figure 2 presents the distribution of stroke subtypes. Ischemic stroke was the predominant subtype, affecting 81% of participants, while hemorrhagic stroke accounted for 19%.

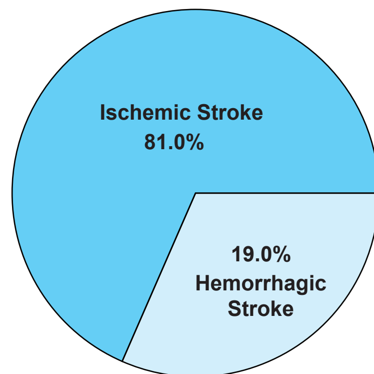


Figure 2: Distribution of stroke types among stroke patients

ECG and Echocardiographic Findings

Table II compares ECG findings by stroke subtype. ECG abnormalities were more frequent among patients with ischemic stroke than among those with hemorrhagic stroke (63.0% vs. 26.3%). ST-elevation infarction patterns were observed only in ischemic stroke cases (23.5%). Old infarct patterns were present in 9.9% of ischemic and 10.5% of hemorrhagic cases, ischemic T-wave changes in 14.8% and 10.5%, respectively, and atrial fibrillation in 14.8% and 5.3%, respectively.

Table II: Proportions of ECG findings in different types of strokes

Findings	Ischemic n (%)	Hemorrhagic n (%)	Total n (%)
ECG findings			
Infarction (ST elevation)	19(23.5%)	0(0.0%)	19(19.0%)
Old infarct (Q waves)	8(9.9%)	2(10.5%)	10(10.0%)
Ischemic changes (T inversion)	12(14.8%)	2(10.5%)	14(14.0%)
Atrial fibrillation	12 (14.8%)	1 (5.3%)	13 (13.0%)

Table III displays the echocardiographic findings according to stroke subtype. LVF was identified in 11.1% of ischemic and 5.3% of hemorrhagic stroke cases, while left ventricular thrombus was found only in ischemic stroke (3.7%). Valvular lesions were confined to ischemic stroke patients, with MS in 16.1%. In contrast, congenital heart disease, particularly VSD, ASD, CoA, and PDA were 31.6%, 15.8%, 10.5%, and 5.3%, respectively.

Table III: Proportions of Echocardiograph findings in different types of strokes

Findings	Ischemic n (%)	Hemorrhagic n (%)	Total n (%)
	Echocardiograph findings		
Incidental/Acute			
Left ventricular failure (LVF)	9 (11.1%)	1 (5.3%)	10 (10.0%)
Left ventricular thrombus	3 (3.7%)	0 (0.0%)	3 (3.0%)
Valvular Heart Disease			
Mitral Stenosis (MS)	13 (16.1%)	0 (0.0%)	13 (13.0%)
MS + Mitral Regurgitation (MR)	2 (2.5%)	0 (0.0%)	2 (2.0%)
MS + Aortic Stenosis (AS)	1 (1.2%)	0 (0.0%)	1 (1.0%)
Congenital Heart Disease			
Persistent Foramen Ovale (PFO)	5 (6.2%)	0 (0.0%)	5 (5.0%)
Atrial Septal Defect (ASD)	2 (2.5%)	3 (15.8%)	5 (5.0%)
Ventricular Septal Defect (VSD)	0 (0.0%)	6 (31.6%)	6 (6.0%)
Persistent Ductus Arteriosus (PDA)	0 (0.0%)	1 (5.3%)	1 (1.0%)
Coarctation of the aorta (CoA)	0 (0.0%)	2 (10.5%)	2 (2.0%)

Prevalence of Cardiac Disorders

Figure 3 summarizes the overall distribution of cardiac disorders among young stroke patients. CAD was 43.0%, followed by CHD (19.0%), VHD (16.0%), AF (13.0%), LVF (10.0%), and cardiogenic thrombus (3.0%).

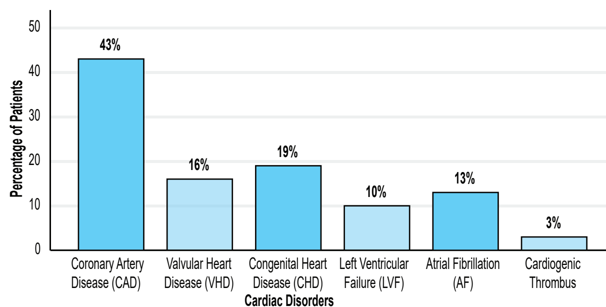


Figure 3: Distribution of cardiac disorders among young stroke patients

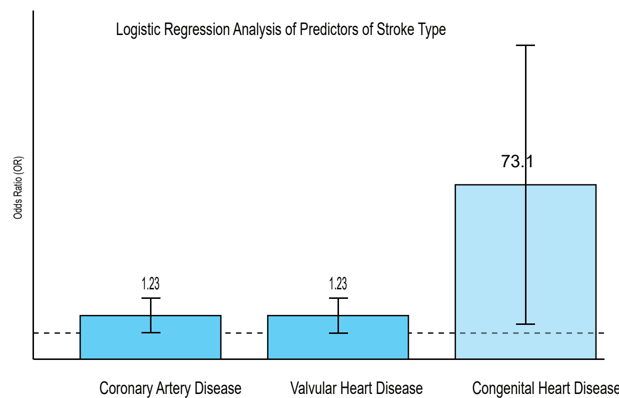
Table IV presents the distribution of cardiac diseases by stroke subtype. CAD was significantly more common in ischemic stroke than in hemorrhagic stroke (48.1% vs. 21.1%, p = 0.032). VHD was observed only among ischemic stroke patients (19.8% vs. 0.0%, p = 0.035). Conversely, CHD was more frequent in hemorrhagic stroke than in ischemic stroke (63.2% vs. 8.6%, $p < 0.001$). AF (14.8% vs. 5.3%), LVF (11.1% vs. 5.3%), and cardiogenic thrombus (3.7% vs. 0.0%) were numerically more frequent in ischemic stroke, although these differences were not statistically significant. A single cardiac disease was present in 43.0% of patients and multiple cardiac diseases in 33.0%, without significant differences between stroke subtypes.

Table IV: Distribution of Cardiac Diseases among Young Stroke Patients (n = 100)

Cardiac Disease	Ischemic Stroke n (%)	Hemorrhagic Stroke n (%)	Total n (%)	χ^2 value	P-value
Name of Cardiac Disease					
Coronary Artery Disease (CAD)	39 (48.1)	4 (21.1)	43 (43.0)	4.610	0.032*
Valvular Heart Disease (VHD)	16 (19.8)	0 (0.0)	16 (16.0)	4.468	0.035*
Congenital Heart Disease (CHD)	7 (8.6)	12 (63.2)	19 (19.0)	29.720	<0.001*
Atrial Fibrillation (AF)	12 (14.8)	1 (5.3)	13 (13.0)	1.241	0.265
Left Ventricular Failure (LVF)	9 (11.1)	1 (5.3)	10 (10.0)	0.585	0.444
Cardiogenic thrombus	3 (3.7)	0 (0.0%)	3 (3.0)	0.725	0.394
Single/ Multiple Cardiac Disease					
Single Disease Present	39 (48.1)	4 (21.1)	43 (43.0%)	0.082	0.774
Multiple Disease Present	29 (35.8)	4 (21.1)	33 (33.0)	1.514	0.218

Multiple response; χ^2 (Chi-square), *Statistically significant at $p < 0.05$*

Figure 4 presents the logistic regression analysis of selected cardiac disorders as predictors of stroke subtype. CHD showed the strongest association with hemorrhagic stroke (OR = 7.31; 95% CI: 3.12-17.12). CAD (OR = 1.23; 95% CI: 1.01-1.56) and VHD (OR = 1.29; 95% CI: 1.05-1.62) were associated with increased odds of ischemic stroke.



Data expressed as Odds Ratio (OR) with 95% Confidence Interval (CI), Statistically significant at p < 0.05.

Figure 4: Logistic regression analysis of selected cardiac disorders predicting stroke type

DISCUSSION

This study provides hospital-based evidence on stroke patterns and cardiac comorbidity among 100 young adults aged 18-50 years in Bangladesh. The mean age was 42.09 ± 7.14 years, with most patients in the 42-50-year group (57%), followed by the 34-41-year group (31%). This indicates clustering of stroke toward the upper range of young adulthood, consistent with previous young-stroke literature.[2,3,26]

Males constituted 74% of participants, with a male-to-female ratio of 2.85:1. This male predominance is comparable with several South Asian and young-adult stroke reports and may reflect greater exposure to behavioral and cardiometabolic risks.[2,3,26-29] The socioeconomic profile also has clinical relevance: 35% had no formal education, 74% earned 20,000 BDT or less per month, and 79% lived in urban areas, suggesting possible gaps in preventive care and cardiac screening. [27-30]

Ischemic stroke was the dominant subtype, affecting 81% of patients, whereas hemorrhagic stroke accounted for 19%. This 4.3:1 ischemic-to-hemorrhagic ratio is consistent with prior young-stroke cohorts in which cerebral infarction is generally more frequent than intracerebral hemorrhage.[4,15,22,26] Clinically, this supports careful evaluation for embolic and atherosclerotic mechanisms because young patients often have a wider etiological spectrum than older patients.[10-13,21]

ECG findings strengthened the evidence for a cardiac contribution. ECG abnormalities were more frequent in ischemic than hemorrhagic stroke (63.0% vs. 26.3%, p = 0.004), and ST-elevation infarction patterns were found only in ischemic cases (23.5%). AF was also more common in ischemic stroke (14.8% vs. 5.3%), although not statistically significant in the cardiac-disease comparison (chi-square = 1.241, p = 0.265). This should be interpreted cautiously because a single ECG recording may miss paroxysmal atrial fibrillation. [5-9]

Echocardiography clarified subtype-specific patterns. Overall, abnormal echocardiographic findings were more common in hemorrhagic than ischemic stroke (68.4% vs. 43.2%, p = 0.04), but the abnormality type differed. Valvular lesions were confined to ischemic stroke, with mitral stenosis in 16.1% of ischemic cases. LVF (11.1% vs. 5.3%) and cardiogenic thrombus (3.7% vs. 0.0%) were also numerically higher in ischemic stroke, supporting a plausible cardioembolic pathway.[16-18,24,25]

CAD was the most frequent cardiac disorder (43.0%). It was significantly associated with ischemic stroke (48.1% vs. 21.1%; chi-square = 4.610, p = 0.032), and regression showed increased odds of ischemic stroke (OR = 1.23; 95% CI: 1.01-1.56). This suggests that coronary disease in young stroke patients may indicate systemic vascular disease and cardiac embolic vulnerability rather than an incidental finding.[16,17,24,25]

VHD was present in 16.0% overall and was significantly associated with ischemic stroke (19.8% vs. 0.0%; chi-square = 4.468, p = 0.035), with higher odds on regression (OR = 1.29; 95% CI: 1.05-1.62). This is clinically important in Bangladesh, where rheumatic and structural valve disease remain relevant. Valvular lesions can promote atrial enlargement, arrhythmia, thrombus formation, and embolization, making detection important for secondary prevention.[16-18,30]

CHD was present in 19.0% overall and showed the strongest relationship with hemorrhagic stroke (63.2% vs. 8.6%; chi-square = 29.720, p < 0.001). Regression identified it as the strongest predictor of hemorrhagic stroke (OR = 7.31; 95% CI: 3.12-17.12). VSD (31.6%), ASD (15.8%), CoA (10.5%), and PDA (5.3%) were concentrated in hemorrhagic cases, whereas PFO appeared only in ischemic cases. These results suggest possible effects

of altered hemodynamics, secondary hypertension, vascular fragility, or treatment-related factors.[19-21]

Not all numerical differences were statistically significant. Left ventricular failure (10.0% overall; chi-square = 0.585, p = 0.444), cardiogenic thrombus (3.0%; chi-square = 0.725, p = 0.394), single cardiac disease (43.0%; p = 0.774), and multiple cardiac diseases (33.0%; p = 0.218) did not differ significantly by stroke subtype. Thus, the main subtype-discriminating variables were coronary artery disease, valvular heart disease, and congenital heart disease. The results support routine ECG and echocardiography in young stroke patients, interpreted alongside clinical history, vascular risk assessment, and neuroimaging.[4,16-18,24,25]

Nevertheless, the data add locally relevant evidence that cardiac disorders are common in young Bangladeshi stroke patients and that statistically significant associations differ by stroke subtype. Larger multicenter prospective studies are needed to validate these findings and define cost-effective cardiac screening pathways.[26-30]

LIMITATIONS OF THE STUDY

This study was conducted in a single tertiary care hospital using a hospital-based cross-sectional design; therefore, the findings may not fully represent young stroke patients in the wider Bangladeshi community or in primary and secondary care settings. The sample size was relatively small, particularly for hemorrhagic stroke (n = 19). A cross-sectional design allowed assessment of associations but not causality or temporal sequence. Cardiac disease evaluation was based mainly on standard ECG and echocardiography. Prolonged rhythm monitoring, transesophageal echocardiography for all patients, and advanced vascular imaging were not routinely available. Long-term outcomes, recurrence, treatment adherence, and post-discharge cardiac follow-up were not assessed.

CONCLUSIONS

This study found that ischemic stroke was the predominant subtype among young adults admitted with stroke, and that cardiac disorders were frequent in this population. CAD and VHD were significantly associated with ischemic stroke, whereas CHD showed a strong association with hemorrhagic stroke and the highest odds in regression analysis. These findings indicate that cardiac evaluation should be an essential component of young-stroke assessment in Bangladesh. Routine ECG and echocardiography may help identify modifiable or treatable cardiac conditions. Future multicenter prospective studies with larger samples, extended rhythm monitoring, advanced cardiac imaging, and follow-up data are needed to confirm these findings.

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