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Original Article

Determining the Relationship between the Severity of Carotid Stenosis and High-Risk Factors

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ABSTRACT

Background: *Stroke, predominantly ischemic, remains a major global health concern, often resulting from carotid artery stenosis (CAS). CAS severity increases with age and high-risk factors like hypertension, diabetes, and smoking. This study explores the relationship between CAS severity and these risk factors among elderly patients in a resource-limited setting.* ***Methods & Materials:*** *This cross-sectional study was conducted over six months (September 2012–February 2013) at BSMMU, Dhaka. One hundred patients aged >55 years with one or more high-risk factors were enrolled through convenient sampling. Carotid Doppler ultrasonography assessed stenosis severity. Data were analyzed using SPSS, with significance set at $p < 0.05$.* ***Result:*** *In this study of 100 elderly high-risk individuals, the mean age was 65.63 ± 8.13 years, with most patients aged between 51 and 70 years. Males comprised 64% of the population. A large proportion were sedentary (89%), occasional exercisers (96%), and smokers (63%). Common comorbidities included hypertension (64%), dyslipidemia (58%), ischemic heart disease (42%), and transient ischemic attack (39%). Family history revealed hypertension in 59% and diabetes in 36%. Carotid Doppler findings showed 73% had stenosis, mostly mild (60%). Statistically significant associations with carotid stenosis were found for hypertension (p=0.04), dyslipidemia (p=0.04), IHD (p=0.01), and TIA (p=0.03), while the association with IFG/IGT/DM was not significant (p=0.08).* ***Conclusion:*** *A significant proportion of high-risk elderly patients had carotid artery stenosis, with hypertension, dyslipidemia, IHD, and TIA showing strong associations. These findings underscore the importance of targeted screening using Doppler ultrasonography to facilitate early detection and prevention of stroke in resource-limited settings.*

Keywords: *Stenosis, Ultrasonography, Hypertension, Dyslipidemia, Stroke*

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INTRODUCTION

Stroke is a leading cause of morbidity and mortality worldwide, with ischemic stroke constituting approximately 87% of all stroke cases [1]. One of the primary etiologies of ischemic stroke is carotid artery stenosis (CAS), a condition resulting from atherosclerotic narrowing of the carotid arteries that increases with age and cardiovascular comorbidities [2]. CAS contributes significantly to the risk of transient ischemic attacks (TIA) and stroke, particularly in elderly individuals who possess multiple high-risk factors such as hypertension, diabetes mellitus, dyslipidemia, smoking, obesity, and ischemic heart disease (IHD) [3]. These risk factors synergistically promote endothelial dysfunction and accelerate plaque formation, heightening the severity of arterial stenosis and the probability of cerebrovascular events. The global burden of stroke disproportionately affects low- and middle-income countries, where over 80% of stroke-related deaths occur, including in countries like Bangladesh [4]. Despite this high burden, the prevalence and severity of CAS in these populations remain under-studied, and there is a lack of structured screening programs for early detection. This gap in local data limits the capacity of clinicians to implement evidence-based preventive measures. In developed countries, the prevalence of asymptomatic moderate-to-severe CAS in people aged 65 and older ranges from 2% to 8%, with a higher prevalence observed among men and individuals with cardiovascular risk factors [5]. The use of color Doppler ultrasonography has emerged as a frontline diagnostic tool for evaluating carotid artery disease. It is a non-invasive, cost-effective, and widely accessible method, especially suited for

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resource-limited settings. Doppler imaging provides detailed information about both anatomical and hemodynamic aspects of the carotid arteries, including plaque characterization and peak systolic velocities, which are critical in grading the severity of stenosis. Compared to other imaging modalities like CT angiography (CTA) and magnetic resonance angiography (MRA), Doppler ultrasound is free of radiation and contrast exposure and is generally preferred for initial screening [6]. However, the diagnostic accuracy of Doppler studies is highly dependent on the operator's expertise and equipment quality [7]. In Bangladesh, there is a critical need for data that links the severity of carotid artery stenosis to major cardiovascular risk factors. Such information can inform national screening policies, improve early detection, and facilitate timely interventions. This study, therefore, aims to determine the relationship between the severity of CAS and high-risk factors in elderly patients. It also seeks to describe the demographic and clinical characteristics of these patients to support future risk stratification and prevention strategies. The findings of this research could serve as a foundation for promoting Doppler ultrasonography as a primary screening modality for high-risk elderly populations in similar low-resource settings.

METHODS & MATERIALS

This was a cross-sectional study conducted over a six-month period from September 2012 to February 2013 in the Departments of Medicine, Vascular Surgery, and Neuro medicine, and the Institute of Nuclear Medicine and Ultrasound at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh. A total of 100 patients aged over 55 years, presenting with one or more high-risk factors such as hypertension, diabetes mellitus, dyslipidemia, or a family history of stroke, were enrolled using a convenient sampling method. Patients with carotid aneurysms, congenital vascular anomalies, or those who did not provide informed consent were excluded. Detailed clinical histories were obtained either from patients or their attendants. Thorough physical examinations were conducted, and relevant investigations were reviewed and documented. Carotid Doppler ultrasonography was performed to assess the presence and degree of carotid artery stenosis, which was categorized as normal, mild, moderate, or severe based on established criteria, including peak systolic velocity and color flow imaging. All data were recorded using a structured protocol and analyzed with SPSS software. Continuous variables were expressed as mean ± standard deviation, and categorical data were expressed as percentages. Chi-square tests were used to determine associations between high-risk factors and severity of stenosis, with a p-value <0.05 considered statistically significant. Ethical clearance was obtained, and all participants provided written informed consent. Confidentiality was maintained throughout the study, and participation was voluntary.

Inclusion criteria

- Age >55 years with one or more following risk factors like hypertension, diabetes mellitus, dyslipidemia, and family history of stroke.
- Both gender

Exclusion criteria:

- Patients / legal guardians who would not give consent
- Age < 55 years

RESULTS

Table I shows the age distribution of the study population. The Mean age was 65.63 (±8.13), the minimum age was 55, and the maximum was 90. The age group 51-60 was 40%, 61-70 was 38%, 71-80 was 18%, and> 80 was 04%.

Table – I: Age group distribution of the study population (*n*=100)

Age group	Frequency	Percent
51-60 years	40	40.0
61-70 years	38	38.0
71-80 years	18	18.0
>80 years	04	04.0
Total	100	100.0
Mean ±SD	65.63(±8.13)	Range 55-90

Figure 1 shows the gender distribution of the study participants. Out of 100 patients, 64% were male and 36% were female, resulting in a male-to-female ratio of approximately 1.8:1. This indicates a higher proportion of male patients among the high-risk elderly population included in the study.

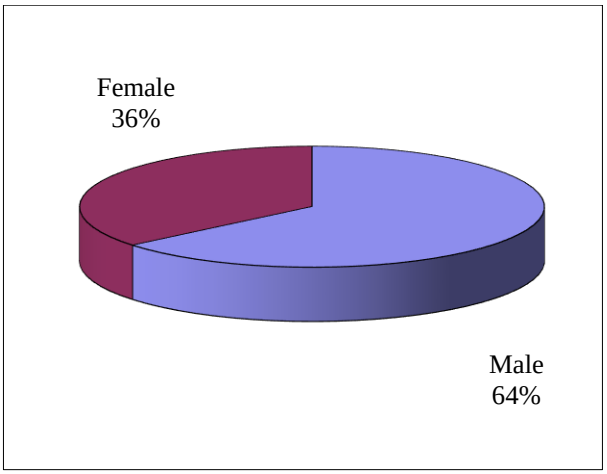

Figure – 1: Gender distribution of the study population

Table II shows personal history majority (89%) were sedentary people and 11% were active. The majority (96%) of patients occasionally exercises, 85% were a balanced diet, 63% were smokers, 64% had a history of hypertension, 37% had a history of IFG/IGT/DM, 58% had dyslipidemia, 42% had IHD and 39% had a history of TIA.

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Table – II: Personal history of the study population (*n*=100)

Physical activity	Frequency	Percentage
Active	11	11.0
Sedentary people	89	89.0
Exercise		
Regular	04	04.0
Occasional	96	96.0
Dietary		
Balanced diet	85	85.0
Overeating	15	15.0
Smoking status		
Smoker	63	63.0
Nonsmoker	37	37.0
HTN	64	64%
H/O IFG/IGT/DM	37	37
Dyslipemia	58	58
IHD	42	42
TIA	39	39

Table III shows the family history of the study population, The Majority (59%) of patients had hypertension, 36% had Diabetes mellitus and 05% had stroke.

Table – III: Family history of the study population (*n*=100)

Family history	Frequency	Percentage
DM	36	36
HTN	59	59
Stroke	05	05
Total	100	100

Table IV presents the degree of carotid artery stenosis observed in the study population. Among 100 patients, 73% had varying degrees of stenosis, while 27% had normal findings on Doppler ultrasound. Of those with stenosis, 60% had mild stenosis, 7% had moderate stenosis, and 6% had severe stenosis.

Table – IV: Degree of stenosis of the study population (*n*=100)

Outcome	Frequency	Percent
Normal	27	27
Degree of stenosis	73	73
Mild	60	60
Moderate	7	7
Severe	6	6
Total	100	100

Table V illustrates the association between carotid stenosis and major cardiovascular risk factors. The presence of hypertension (69.86%), dyslipidemia (47.95%), ischemic heart disease (49.32%), and transient ischemic attack (45.21%) was significantly higher in patients with carotid stenosis compared to those without. These associations were statistically significant, with p-values of <0.05. Although IFG/IGT/DM was more common in the non-stenosis group (51.85%), the difference was not statistically significant (p = 0.08).

Table – V: Association between risk factors with Carotid stenosis (*n*=100)

Risk factors	Carotid stenosis		Total	P value
	Present (n=73)	Absent (n=27)		
HTN	51(69.86)	13(48.15)	64	0.04
IFG/IGT/DM	24(32.88)	14(51.85)	38	0.08
Dyslipidemia	35(47.95)	07(25.93)	42	0.04
IHD	36(49.32)	06(22.22)	42	0.01
TIA	33(45.21)	06(22.22)	39	0.03

DISCUSSION

This cross-sectional study was conducted among inpatients and outpatients in the Department of Medicine, Department of Vascular Surgery, Department of Neuromedicine, and the Institute of Nuclear Medicine and Ultrasound at Bangabandhu Sheikh Mujib Medical University (BSMMU), with a sample size of 100 cases. The study aimed to determine the degree of stenosis and facilitate early detection of high-risk groups who are likely to develop stroke in the future. The mean age was 65.63 ± 8.13 years, with a minimum age of 55 years and a maximum age of 90 years. The age distribution was as follows: 40% were aged 51–60 years, 38% were 61–70 years, 18% were 71–80 years, and 4% were over 80 years. Males comprised 64% and females 36% of the study population, resulting in a male-to-female ratio of 1.8:1. A similar study by Esquetini-Vernon et al. 2025 found 123 male (69.1%) and 55 female (30.9%) patients, with a male-to-female ratio of approximately 2.2:1. The mean age of the study population was 71.5 ± 9.6 years [8]. Another study by Taheri et al. showed that among 352 patients, 144 (41%) were female and 208 (59%) were male. The mean ± SD age of patients was 67.5 ± 8.6 years (range: 29–84 years); 14 (4%) were <50 years, 188 (53.4%) were between 50 and 70 years, and 131 (37.2%) were >70 years [9]. These findings are similar to those in our study. Chowdhury et al.[42] reported that among their patients, 12 were aged 41–50, 16 were 51–60, 10 were 61–70, and the rest were >70 years. The maximum number of patients (40%) were in the 51–60 age group. The minimum age was 45 and the maximum was 80 years, with a mean of 62 ± 10.32 years. There were 36 male and 4 female patients [10]. Regarding socioeconomic status, the majority (52%) of the study population belonged to the middle class, followed by 40% in

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the higher class and 8% in the lower socioeconomic class. In this study, 76% of the participants were obese, while 24% were not. Regarding personal history, the majority (89%) led sedentary lifestyles, while only 11% were physically active. Most patients (96%) exercised occasionally, 85% followed a balanced diet, and 63% were smokers. Additionally, 64% had a history of hypertension, 37% had a history of IFG/IGT/DM, 58% had dyslipidemia, 42% had ischemic heart disease (IHD), and 39% had a history of transient ischemic attack (TIA). Chowdhury et al. found that 52.5% (n=21) of their patients had a history of TIA [10]. Smoking is widely recognized as one of the major risk factors for ischemic stroke in Western countries and is associated with the progression of carotid plaques. Smoking is linked to increased fibrinogen levels, elevated packed cell volume, decreased macrophage activity, and changes in lipid biochemistry. It also increases arterial wall stiffness and alters blood flow patterns. In Shaikh's study, smoking was present in 43.59% of cases. In terms of family history, 59% of the study population had a family history of hypertension, 36% had a family history of diabetes mellitus, and 5% had a family history of stroke. Regarding the degree of stenosis, out of 100 patients, 27% had normal carotid findings while 73% showed carotid stenosis. Among them, 60% had mild stenosis, 7% had moderate stenosis, and 6% had severe stenosis. Bari et al. observed carotid atherosclerosis (i.e., intimal thickening with or without plaque) in 68% of cases [11]. The frequency of Carotid Artery Stenosis (CAS) in our study was 39%. A recent study by Ranjan et al. (2022) from Bangladesh reported a CAS prevalence of 13.5% among patients undergoing coronary artery bypass graft (CABG) surgery [12]. In comparison, a large population-based study by Fu et al. (2024) in China observed a standardized CAS prevalence of 0.56% in adults aged 40 years and above [13]. Additionally, a global systematic review by Feigin et al. (2014) estimated the prevalence of carotid stenosis to be approximately 1.5% among individuals aged 30–79 years [14]. These differences highlight the variability of CAS prevalence across populations and the influence of study design and diagnostic criteria. In our study, there was a statistically significant association between carotid stenosis and hypertension (69.86%), dyslipidemia (47.95%), ischemic heart disease (IHD) (49.32%), and transient ischemic attack (TIA) (45.21%) ($p<0.05$). These findings align with previous research, which has identified hypertension and dyslipidemia as significant risk factors for carotid artery stenosis [15]. Furthermore, the presence of carotid atherosclerosis in 30% of patients without coronary artery disease (CAD) in our study is comparable to findings by Crouse et al, who observed it in 50% of cases [16]. A strong correlation between the extent of coronary artery disease (CAD) and progression of carotid atherosclerosis was also found by Shaikh et al. observed that hypertension was the most common risk factor, present in 76.92% of cases, either alone or in combination [17]. Diabetes is associated with an increased risk of traditional coronary heart disease (CHD) risk factors, including hypertension, dyslipidemia, obesity, and hyperinsulinemia. Other metabolic disturbances unique to diabetes—such as increased levels of circulating glucose, advanced glycation end-products, and oxidation of lipoproteins—might also elevate the risk and rate of atherosclerosis [18]. Interestingly, in our study, diabetes was found to be less common among patients with carotid stenosis compared to those without. Higher LDL cholesterol levels are associated with an increased incidence of carotid atherosclerotic disease, while high HDL levels appear to be protective. In the Shaikh study, hyperlipidemia in ischemic stroke patients with carotid artery stenosis was found in 25.64% of cases [17].

Limitation of the Study:

This study was conducted at a single hospital with a small sample size and short duration, limiting its generalizability to the entire country.

CONCLUSION

Carotid artery stenosis is highly prevalent among high-risk elderly patients, with significant associations with hypertension, dyslipidemia, IHD, and TIA. Early detection using Doppler ultrasonography can aid in timely intervention and reduce stroke risk in resource-limited settings like Bangladesh.

RECOMMENDATION

Routine Doppler screening should be implemented for high-risk elderly patients, alongside lifestyle interventions and integrated cardiovascular risk management to prevent stroke and related complications.

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