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# BURDEN OF VASCULAR NEUROLOGICAL DISORDERS: A CROSS-SECTIONAL MULTICENTER STUDY

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## ABSTRACT

### Background and Objective

Stroke remains a leading cause of morbidity and mortality worldwide, with a particularly high burden in low- and middle-income countries (LMICs) such as Pakistan. Despite its growing prevalence, limited nationwide data exist on vascular diseases, their risk factors, and disability outcomes. The objective of this study was to identify the frequency and age-stratified type of vascular disease incidence among in-patient hospital admissions.

### Methods

A retrospective observational study was conducted across 39 neurology centers in Pakistan, spanning both public and private sectors from August 2017 to December 2019. Data on demographics, comorbidities, and stroke type were systematically collected from hospital records. The severity of disability was assessed using the Modified Rankin Scale (mRS). Statistical analyses were performed using SPSS.

### Results

Among 5,735 patients, stroke was the most prevalent vascular disease (78.6%), with ischemic stroke comprising 60.9% of cases. Stroke was more common among males (65.8%) and individuals with primary education (45.2%). Hypertension (62.2%) and diabetes (26%) were the most frequent comorbidities. Analysis of disability status revealed that 34.3% of stroke patients suffered from moderate to severe disability (mRS 3-5).

### Conclusion

This study highlights the substantial burden of stroke and vascular diseases in Pakistan, emphasizing the urgent need for preventive strategies, improved stroke care, and a nationwide registry to guide healthcare policies and interventions.

### Keywords

Vascular diseases, Stroke, Moya-moya, Aneurysm,

## INTRODUCTION

Stroke is the second most common cause of death in non-communicable diseases worldwide and the third cause of disability across the world, it is estimated that by 2050, deaths from stroke will rise by 50% with disability-adjusted life years also increasing by 45 million people globally.[1]

Previously considered a disease of old age, it is now alarmingly affecting the younger population. Analyzing the evaluation of stroke occurrences over decades has highlighted it to be now a common disease in lower-middle-income countries.[2,3] The greatest burden of age-standardized ischemic stroke is highest in sub-Saharan and Southeast Asia.[2] As per the Global Burden Diseases (GBD) Data of 2025, despite advancements in treatment and relatively increasing awareness, there has been a substantial rise in stroke by 70% in its incidence with a higher contribution from Lower Middle-Income Country (LMIC), contributing 89.4% to Disability-Adjusted Life Years (DALYs).[4]

In Pakistan, classified as a Low and Middle-Income Country (LMIC), where 64% of the population is comprised of youth, the looming risk of increasing stroke occurrences is a significant concern.[5] This can be attributed to the lack of data availability from developing countries, decreased awareness among the population about the primary and secondary prevention of stroke, traditional acquisition of dietary and lifestyle risk factors, and inaccessibility/scarcity

of comprehensive stroke care centers.[6] Exact stroke incidence is still deficient in Pakistan due to the infrastructure of healthcare of Pakistan. To date, there is a deficiency in epidemiological studies that accurately depict the incidence of strokes in Pakistan. Published articles predominantly focus on single-center or multicenter studies, leaving a gap in comprehensive nationwide data on stroke occurrences.

This study will aid in emphasizing the importance of raising awareness among both medical and non-medical personnel. Additionally, addressing this gap can improve the management of stroke patients in specialized stroke centers and facilitate the development of more effective health policies. The overall aim of the study is to generate knowledge on the burden of neurovascular diseases encountered among in-patient admissions in a tertiary care setup. The objective of this study was to identify the frequency and age-stratified type of vascular disease incidence among in-patient hospital admissions.

## METHODS

This retrospective observational study was conducted at 39 neurology centers across Pakistan, including both private and public sector institutions from urban and rural areas. Ethical approval and exemption were obtained from the local Ethics Review Committee and the National Bioethics Committee (NBC), with the exemption applicable across all participating centers. The study period spanned from August 2017 to December 2019.

The 39 centers were recruited through voluntary participation in response to a national call shared via professional neurology networks. No centers were excluded initially based on location; however, data from centers that submitted incomplete or inconsistent datasets were excluded during the data cleaning phase. Ultimately, only those centers that provided complete datasets were included in the final analysis.

To ensure standardization, all neurologists involved in the study used the World Health Organization (WHO) standardized classification for stroke diagnosis. A structured survey form was developed to collect demographic and clinical data, including age, education status, comorbidities, and stroke type. This form was initially piloted at Aga Khan University (AKU) to assess feasibility in collecting relevant data. Following this pilot phase, the finalized tool was shared with all participating centers.

Data collection was conducted retrospectively at each center by the attending neurologist and no direct patient interaction occurred.

Patients eligible for inclusion were aged 18 years or older and had a diagnosis of a neurological disease of vascular etiology confirmed through clinical evaluation and radiological imaging by a trained, practicing neurologist. Patients with non-vascular neurological diseases such as neurodegenerative disorders, primary brain tumors, epilepsy, and traumatic brain injuries were excluded. Additionally, patients with incomplete medical records were excluded from the analysis. Patients with a Modified Rankin Scale (mRS) score of 6 were excluded, as the study did not analyze mortality-related outcomes.

Functional disability was assessed using the Modified Rankin Scale, a six-point measure ranging from 0 (no symptoms) to 5 (severe disability requiring constant care). This score was recorded in the patient's file by the treating neurologist at the time of discharge or last clinical follow-up. The authors did not retrospectively calculate or infer mRS scores; only patients with documented mRS scores in their charts were included in the study.

To maintain confidentiality, each patient was assigned a unique code during data abstraction. The data collected were entered into a secure Microsoft Excel spreadsheet, accessible only to the principal investigator. The cleaned and anonymized dataset was then shared with the study statistician exclusively for analysis.

Continuous variables were reported as means ± standard deviation and percentage for categorical variables. The number (%) of demographic as well as clinical factors was assessed and divided by patient gender. Continuous variables with normal distribution were analyzed using an independent samples t-test, while those with categorical variables were analyzed using a Chi-square test. The analysis was performed using SPSS (Statistical Package of Social Sciences) version 19. All p-values were based on two-sided tests and significance was set at a p-value $<0.05$.

## RESULTS

In the study cohort, 5,735 patients visited during the study period. The median age of the participants was 57.1 years with a predominance of males (65.8%) compared to females (34.2%). Within the study population, stroke prevalence was highest among individuals with primary education as their highest qualification (n=2,604; 45.2%), followed by those with secondary education (n=453; 7.9%). In contrast, the lowest incidence was observed among individuals with professional qualifications, such as

PhDs and medical doctors. Hypertension (n=3,580; 62.2%) and diabetes (n=1,495; 26%) were the most prevalent comorbid conditions linked to stroke. Additionally, depression was identified as another risk factor in 127 patients (2.2%) (Table 1).

| **Table 1: Descriptive Characteristics of Study Population** | | | |
|---|---|---|---|
| **S.No** | **Characteristics** | | **n (%)** |
| 1 | Age, in years | | 57.1 ± 14.0 |
| | Age, median (IQR) | | 58(48-67) |
| 2 | Gender | Male | 3790(65.8) |
| | | Female | 1968(34.2) |
| 3 | Education | | |
| | Unknown | | 1863 (32.4) |
| | Illiterate | | 1286(22.3) |
| | Under Matric | | 1318(22.9) |
| | Inter | | 453(7.9) |
| | Graduate | | 538(9.3) |
| | Masters | | 203(3.5) |
| | PhD | | 3(0.1) |
| | Doctor | | 16(0.3) |
| | Others | | 78(1.4) |
| 4 | Co-Morbid | | |
| | Hypertension | | 3580(62.2) |
| | Diabetes | | 1495(26) |
| | Dyslipidemia | | 9661(16.8) |
| | Coronary Artery Disease | | 421(7.3) |
| | Tobacco use | | 449(7.8) |
| | Depression | | 127(2.2) |

Among vascular diseases, strokes were the frequent etiology accounting for the majority (n=4,509; 78.6%). Among these, ischemic strokes were the most prevalent, affecting 3,494 patients (60.9%), followed by hemorrhagic strokes (n=646; 11.3%). Other vascular diseases, including Moyamoya disease, saccular aneurysms, and arteriovenous (AV) malformations, were identified in smaller proportions, as illustrated in Figure 1.

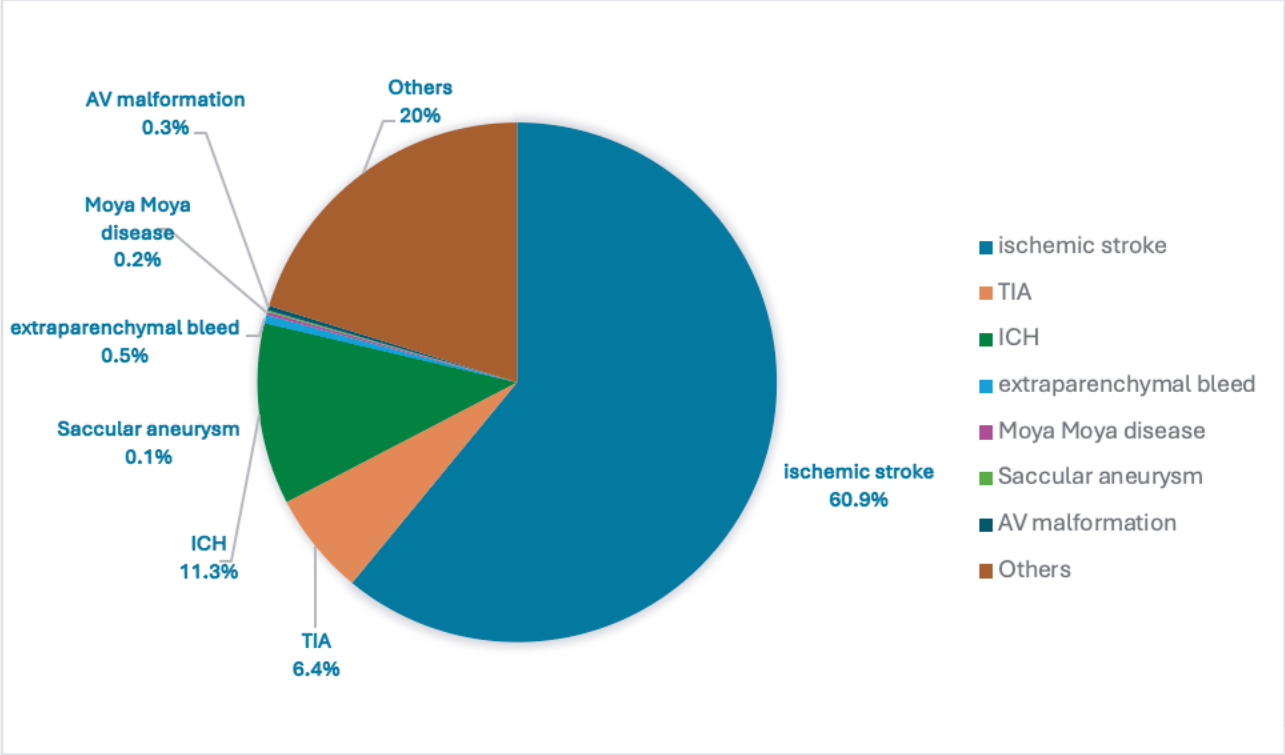


**Figure 1:** Frequency of neurovascular disorders

When analyzed by gender, vascular diseases showed near-equal distribution among males and females, except for Moyamoya disease (0.1% in males vs. 0.5% in females) and saccular aneurysms (0.1% in males vs. 0.3% in females), where the prevalence was slightly higher in females. However, the difference was not statistically significant.

Age group analysis revealed that ischemic strokes were more common in individuals aged >60 years (n=1,462; 62.3%). In contrast, transient ischemic attacks (TIAs) and hemorrhagic strokes were more frequently observed in patients younger than 40 years. Notably, conditions such as Moyamoya disease and saccular aneurysms were predominantly seen in patients under 40 years of age (Table 2).

**Table 2: Distribution of vascular diseases stratified with age**

| S. No | Vascular Diseases | ≤40 (750) | 41-60 (2647) | >60 (2361) | p-value |
|---|---|---|---|---|---|
| 1 | Ischemic stroke | 400 (53.5) | 1632 (61.8) | 1462 (62.3) | <0.001 |
| 2 | Transient ischemic attack | 61 (8.2) | 166 (6.3) | 142 (6.1) | |
| 3 | Hemorrhagic stroke | 107 (14.3) | 333 (12.6) | 206 (8.8) | |
| 4 | Extra-parenchymal bleed | 6 (0.8) | 15 (0.6) | 7 (0.3) | |
| 5 | Moya-Moya disease | 11 (1.5) | 1 (0.0) | 1 (0.0) | |
| 6 | Saccular aneurysm | 50 (0.7) | 3 (0.1) | 0 | |
| 7 | Arteriovenous malformation | 11 (1.5) | 6 (0.2) | 3 (0.1) | |
| 8 | Other | 147 (19.7) | 484 (18.3) | 526 (22.4) | |

Analysis based on disability as defined as a score on a modified Rankin Scale (mRS) is shown in Table 3.

| Table 3: Disability Prevalence as defined by modified Rankin | mRS | n (%) |
|---|---|---|
| Normal | 0 | 1107(19.2) |
| Minor symptoms without disability, able to perform prior activities | 1 | 1922(33.4) |
| Slightly disabled but can walk and do self-care without assistance | 2 | 740(12.9) |
| Moderately disabled, needing some help but can walk unaided | 3 | 561(9.7) |
| Moderate to severe disability, unable to walk, needing some help in ADL | 4 | 1073(18.6) |
| Severely disabled, bedridden, requiring constant care | 5 | 347(6.0) |
| Patient not present reports only/ Not applicable | - | 8(0.1) |

## DISCUSSION

This retrospective cross-sectional study therefore highlights stroke having a higher prevalence among vascular diseases with modifiable risk factors to be majorly responsible for its occurrence. This also highlighted the educational status to be associated with the occurrence of stroke as the cohort with the higher educational background to be least affected. The true incidence and prevalence of stroke and other vascular diseases in Pakistan remain largely unknown due to a lack of comprehensive epidemiological studies and inadequate healthcare infrastructure. While many patients suffer from these illnesses, limited access to healthcare and underreporting obscure the true magnitude of the problem. Observational studies have identified vascular diseases as the leading cause of neurological disability, with males above the age of 46 being more commonly affected.[7] Our findings align with these observations, demonstrating a higher prevalence of stroke and vascular diseases in males, similar to results from previous single-center studies where vascular diseases ranked as the second most common neurological disorders.[8]

Regional studies further highlight the prevalence of vascular diseases in specific areas. For instance, research conducted in Khyber Pakhtunkhwa (KP) reported a 1.2% incidence of stroke, with a female predominance and higher prevalence in rural areas and individuals with only primary education.[9] Another study in the same region reported a 4.8% stroke incidence with gender parity and a higher prevalence of strokes in younger individuals.[10] These findings contrast with our study highlighting male predominance. It also resonates with the significant burden of vascular diseases in Pakistan, particularly ischemic strokes. The findings of our study corroborated with the Brazilian database showing higher stroke prevalence in individuals without proper formal education.[11]

Urban-based studies, such as one conducted in metropolitan slums, revealed that 21.8% of the population had experienced a transient ischemic attack (TIA) or prior stroke. However, such interview-based research raises concerns about underdiagnosis and the exclusion of populations without healthcare access, thereby diluting the true picture of the vascular disease burden.[12]

The younger age of vascular disease sufferers is particularly alarming, indicating a growing healthcare burden that threatens to transform an independent, working-age population into one that is dependent and disabled. Hypertension and diabetes are the most prevalent non-communicable diseases contributing to vascular diseases across Pakistan, as observed in population-based surveys.[7-9,13] Our study similarly identifies these conditions as major risk factors. This underscores the urgent need for primary prevention strategies to mitigate the rising healthcare burden associated with vascular diseases, particularly in younger populations. A recent study further highlighted that the prevalence of stroke risk factors in Pakistan is comparable to other South Asian countries, reinforcing the need for targeted interventions.[14]

The prevalence of other vascular diseases, such as Moyamoya disease and arteriovenous (AV) malformations, remains underreported due to similar gaps in awareness and healthcare access. Limited studies suggest that Moyamoya disease predominantly affects the pediatric population, with an average age of presentation of 16.5 years and a female predominance.[15] Our findings similarly

indicate a higher prevalence of Moyamoya disease among females, even in adults. Subarachnoid hemorrhage (extra-parenchymal hemorrhage) is another vascular condition observed more frequently in individuals aged 20-40 years, without significant gender predilection.[16] AV malformations, though rare, contribute to the vascular disease burden, with a prevalence of 0.01% to 0.5% and equal distribution among genders.[17]

Disability scores in strokes have been 3.7 times higher in low-income countries when compared with higher income.4 A local study highlighted stroke as the leading cause of disability among all neurological disorders.[7]

The rising prevalence of vascular diseases in Pakistan is exacerbated by lifestyle changes and an increasing incidence of non-communicable diseases. This growing burden affects all socioeconomic strata and poses a significant threat to the future of healthcare in the country. As a lower-middle-income nation, Pakistan faces unique challenges in addressing the rising toll of neurological disabilities associated with vascular diseases.

## CONCLUSION

Our study is the first to stratify vascular disease etiologies by age in Pakistan, offering a foundational understanding of the burden and distribution of these conditions. The findings underscore the need for a nationwide registry to accurately quantify the prevalence of vascular diseases and inform healthcare policies aimed at targeting specific risk factors.

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All the authors have approved the final version to be published and agree to be accountable for all aspects of the work.