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PREVALENCE AND ASSOCIATED RISK FACTORS OF STROKE IN PATIENTS VISITED FOR COMPUTED TOMOGRAPHY (CT) BRAIN AT PESHAWAR

Original Research

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ABSTRACT

Background: Stroke continues to be a major global health challenge and is a leading cause of mortality and long-term disability, particularly in low- and middle-income countries such as Pakistan. Early recognition of associated risk factors is crucial for improving clinical outcomes and guiding targeted prevention strategies. Neuroimaging, especially computed tomography (CT) of the brain, plays an essential role in the prompt identification and classification of stroke subtypes.

Objective: To determine the prevalence and associated risk factors of stroke among patients who underwent CT brain imaging in public and private hospitals of Peshawar.

Methods: This descriptive cross-sectional study was conducted over six months, from January to June 2025, in radiology departments of tertiary care hospitals across Peshawar. A total of 323 patients aged 30 years and above, who presented with clinical suspicion of stroke, were included through non-probability consecutive sampling. Data were collected using a structured proforma covering demographic, clinical, and lifestyle variables. CT brain scans were interpreted to categorize stroke as ischemic, hemorrhagic, or subarachnoid hemorrhage. Statistical analysis was performed using IBM SPSS version 26. Descriptive statistics summarized demographic characteristics, while chi-square tests evaluated associations between stroke type and risk factors, with a significance threshold of $p < 0.05$.

Results: Out of 323 patients, males constituted 69.7%, and the majority (53.9%) were aged 46–60 years. Hypertension (44.9%) and diabetes mellitus (25.1%) were the most frequent comorbidities, while smoking (46.4%) and physical inactivity (46.4%) were the most common lifestyle risks. Ischemic stroke was detected in 66.3% of patients, followed by hemorrhagic stroke (26.9%) and subarachnoid hemorrhage (6.8%). Significant associations were found between stroke subtype and hypertension ($p = 0.02$), diabetes mellitus ($p = 0.03$), and smoking ($p = 0.04$).

Conclusion: The study demonstrates that stroke in Peshawar is predominantly ischemic and strongly linked with modifiable risk factors such as hypertension, diabetes, smoking, and physical inactivity. Preventive strategies emphasizing early detection, community-based education, and lifestyle modification are vital to reducing stroke incidence and improving outcomes in high-risk populations.

Keywords: Computed Tomography, Diabetes Mellitus, Hypertension, Ischemic Stroke, Pakistan, Prevalence, Risk Factors.

INTRODUCTION

Stroke represents one of the most pressing global health concerns, ranking as the second leading cause of mortality and a predominant cause of long-term neurological disability. It poses a significant public health and socioeconomic challenge, affecting millions of individuals each year and imposing a substantial burden on healthcare systems worldwide. According to the World Health Organization, stroke is defined as the sudden onset of focal or global neurological dysfunction lasting more than 24 hours or resulting in death, with no apparent cause other than vascular origin (1,2). Among the two principal types, ischemic stroke accounts for approximately 80–90% of cases in high-income nations, whereas hemorrhagic stroke occurs more frequently in low- and middle-income countries (3). In Pakistan, the annual incidence of stroke is estimated at about 250 cases per 100,000 individuals, with a notably higher occurrence among younger adults compared to Western populations (4). This epidemiological shift reflects a combination of demographic, genetic, and lifestyle factors unique to the local context. The burden of stroke in such regions is further compounded by limited healthcare infrastructure, lack of public awareness, and delayed hospital presentation. Modifiable and non-modifiable risk factors—including hypertension, diabetes mellitus, dyslipidemia, smoking, obesity, sedentary behavior, and advancing age—have been widely implicated in stroke development (5–7). However, poor control of these risk factors, particularly in resource-constrained environments, continues to elevate disease prevalence and associated complications. Diagnostic advancements, especially neuroimaging modalities such as non-contrast computed tomography (CT) of the brain, have revolutionized early detection and differentiation between ischemic and hemorrhagic subtypes, enabling rapid clinical decision-making and timely intervention (8,9). Despite these advancements, data from Pakistan—particularly from Peshawar—remain scarce, with few studies systematically examining the prevalence and risk profiles of stroke among patients undergoing CT brain evaluation. Given this gap, the present study aims to determine the prevalence of stroke and its associated risk factors among patients presenting for CT brain imaging in Peshawar, thereby contributing locally relevant evidence to guide preventive strategies and optimize clinical management.

METHODS

This descriptive cross-sectional study was conducted in the Radiology Departments of both public and private tertiary care hospitals in Peshawar over a six-month period, from January to June 2025. These hospitals were selected based on the availability of advanced neuroimaging facilities and established stroke units, ensuring representation of both urban and rural populations across the Khyber Pakhtunkhwa province. The study aimed to determine the prevalence and associated risk factors of stroke among patients undergoing non-contrast computed tomography (CT) brain imaging for suspected cerebrovascular events. All patients who presented to the radiology departments with a clinical suspicion of stroke and were referred for non-contrast CT brain during the study period were considered eligible for inclusion. A total of 323 consecutive patients were enrolled using a non-probability consecutive sampling technique. Patients of either sex, aged 30 years or older, were included in the study. Exclusion criteria encompassed individuals with radiological or clinical features that could mimic stroke, such as cerebral venous sinus thrombosis, intracranial neoplasms, abscesses, traumatic brain injury, or subarachnoid hemorrhage secondary to trauma (4,5). Those who had recently undergone neurosurgical interventions or who declined to provide written informed consent were also excluded from participation. Data were collected prospectively using a predesigned structured proforma. Sociodemographic information including age, sex, education level, and area of residence was recorded. Clinical variables such as history of hypertension, diabetes mellitus, dyslipidemia, smoking, previous surgeries, medication use, and level of physical activity were documented. Presenting symptoms including sudden painless weakness, paralysis, or visual disturbances were carefully noted. To ensure data reliability, all information was verified against hospital records and patient files.

All CT examinations were performed on multi-slice scanners using standardized non-contrast brain imaging protocols. Axial sections were acquired from the skull base to the vertex at a slice thickness of 5–10 mm. The radiological diagnosis of stroke was established based on CT findings, with ischemic stroke characterized by hypodense areas conforming to arterial territories and hemorrhagic stroke identified by hyperdense regions corresponding to acute hemorrhage. Subarachnoid hemorrhage was differentiated based on high-attenuation signals within the basal cisterns or cortical sulci. All scans were reviewed and confirmed by qualified radiologists to maintain diagnostic consistency. Data were entered and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were applied to summarize demographic and clinical characteristics. Continuous variables were expressed as mean ± standard deviation (SD), whereas

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categorical data were presented as frequencies and percentages. The Pearson chi-square test was employed to assess associations between stroke subtypes and potential risk factors. A p-value of less than 0.05 was considered statistically significant. Ethical approval for this study was obtained from the institutional ethics committees of the participating hospitals. Written informed consent was obtained from all participants or, where necessary, from their legal guardians. Confidentiality and anonymity of patient data were strictly maintained throughout the research process. All study procedures adhered to the ethical standards of the Declaration of Helsinki for research involving human subjects.

RESULTS

The study analyzed data from 323 patients who underwent non-contrast CT brain scans for suspected stroke. The majority of patients were aged between 46 and 60 years (53.9%), followed by those between 31 and 45 years (30.3%) and 15 to 30 years (15.8%). Males constituted a larger proportion of the study population (69.7%) compared to females (30.3%). In terms of educational attainment, 37.5% of the participants had received higher education, 26.6% had completed secondary education, 25.4% had primary education, and 10.5% were illiterate. Most of the patients were married (81.4%), while 18.6% were unmarried. A family history of relevant medical conditions was reported by 53.3% of patients, whereas 46.7% had no such history. Hypertension emerged as the most prevalent comorbidity, affecting 44.9% of the cohort, followed by diabetes mellitus (25.1%), combined hypertension and diabetes (15.5%), heart disease (8.4%), and hypercholesterolemia (6.2%). Approximately 71.5% of participants were taking medications, and 50.8% had a history of previous surgery. Blood disorders were observed in 19.2% of the patients. Regarding lifestyle factors, 46.4% of participants reported smoking, and 14.9% acknowledged alcohol consumption. Physical inactivity was widespread; 46.4% never engaged in exercise, 22.9% exercised once or twice weekly, 14.9% were active three to five times weekly, and only 15.8% exercised daily. Moreover, 72.4% of participants reported experiencing psychological stress, while 59.4% reported obtaining six to eight hours of sleep nightly. Clinically, 64.1% of patients presented with painless body weakness, 52.6% had visual loss in one or both eyes, and 35.6% experienced paralysis in one or more limbs. Previous CT brain scans for similar conditions had been performed in 27.2% of participants, indicating a recurrent presentation pattern.

A statistically significant association was found between increasing age and the presence of hypertension and diabetes mellitus ($p = 0.04$), as well as between age and the occurrence of painless body weakness and vision loss ($p = 0.00$). Patients aged 46–60 years demonstrated a markedly higher frequency of these conditions compared to younger groups, indicating that stroke-related comorbidities increase with advancing age. Gender-based analysis revealed that males had higher rates of hypertension, diabetes mellitus, heart disease, and smoking compared to females, with these associations being statistically significant ($p = 0.01$ and $p = 0.00$, respectively). However, cholesterol levels were similar across both sexes. Male participants also reported higher physical activity levels, though females were more likely to be completely inactive ($p = 0.01$). Educational status showed a strong relationship with health and lifestyle indicators. Participants with higher education demonstrated lower prevalence of hypertension, diabetes, and smoking, and reported greater engagement in physical activity ($p = 0.00$ and $p = 0.01$). Conversely, lower educational attainment correlated with higher rates of hypertension, diabetes, and sedentary behavior, emphasizing the influence of health literacy and socioeconomic status on stroke risk.

CT imaging findings revealed that out of 323 patients who underwent non-contrast CT brain scans for suspected stroke, 214 cases (66.3%) were diagnosed as ischemic stroke, 87 cases (26.9%) as hemorrhagic stroke, and 22 cases (6.8%) as subarachnoid hemorrhage. Ischemic stroke was predominantly observed among patients aged 46–60 years (73.8%) and was more frequent in males (69.1%) than females (30.9%). Hemorrhagic strokes showed a similar male predominance but tended to occur in slightly younger individuals, particularly within the 31–45 age range. Analysis of risk factors showed a significant association between hypertension and hemorrhagic stroke ($p = 0.02$), indicating that poorly controlled blood pressure substantially contributed to intracerebral hemorrhage. Conversely, diabetes mellitus ($p = 0.03$) and combined hypertension with diabetes ($p = 0.01$) were strongly linked to ischemic stroke patterns. Smoking history was notably more prevalent among ischemic stroke patients (51.4%) than those with hemorrhagic stroke (38.2%), suggesting that chronic vascular endothelial damage may underlie ischemic events. Patients with low physical activity levels, particularly those who never exercised (48.6%), also demonstrated a higher frequency of ischemic stroke. Collectively, these findings indicate that ischemic stroke represents the most common subtype detected on CT brain imaging among patients in Peshawar, particularly affecting older males with comorbid hypertension and diabetes. Hemorrhagic strokes, though less frequent, were more strongly associated with uncontrolled hypertension, while lifestyle factors such as smoking and inactivity further amplified the risk across both stroke subtypes.

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Table 1: Showing Age and Gender of the patients

Age of the patients	Frequency	Percent
15-30 years	51	15.8
31-45 years	98	30.3
46-60 years	174	53.9
Gender		
Male	225	69.7
Female	98	30.3
Total	323	100.0

Table 2: Showing family history, Medical Conditions, Previous Surgery, Blood Disorders, Smoking status, Physical activities, Alcohol consumption, Painless visions, Loss of vision, and Paralysis in one or both limbs of the patient

Family History	**Frequency**	**Percent**
Yes	172	53.3
No	151	46.7
Medical conditions		
Hypertension	145	44.9
Diabetes mellitus	81	25.1
Heart disease	27	8.4
High cholesterol	20	6.2
Both hypertension and diabetes mellitus	50	15.5
Previous Surgery		
Yes	164	50.8
No	159	49.2
Blood Disorders		
Yes	62	19.2
No	261	80.0
Smoking Status		
Yes	150	46.4
No	173	53.6
Physical Activities		
Never	150	46.4
1-2 times a week	74	22.9

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Family History	**Frequency**	**Percent**
3-5 times a week	48	14.9
Daily	51	15.8
Alcohol Consumption		
Yes	48	14.9
No	275	85.1
Painless Weakness		
Yes	207	64.1
No	116	35.9
Loss of vision		
Yes	170	52.6
No	153	47.4
Paralysis in one or both limbs		
Yes	115	35.6
No	208	64.4
Total	323	100.0

Table 3: Showing cross tabulation of age group with condition of the patient, painless weakness on patient body and loss of vision on patient eyes.

Variables	**Age Group**			**P-value**
Condition of Patient	15-30	31-45	46-60	
Hypertension	25	44	76	
Diabetes mellitus	11	24	46	
Heart disease	4	6	17	0.04
High cholesterol	8	7	5	
Both hypertension and diabetes mellitus	3	17	30	
Painless weakness on patient body				0.00
Yes	20	61	126	
No	31	37	48	
Loss of vision on patient eyes				
Yes	10	46	114	0.00
No	41	52	60	

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Table 4: Showing cross tabulation of gender of the patient with condition of the patient, smoking status of the patient and shows level of patient physical activity.

Variable	**Gender of the patient**		
Condition of the patient	Male	Female	P- value
Hypertension	96	49	0.01
Diabetes mellitus	55	26	
Heart disease	21	6	
High cholesterol	10	10	
Both hypertension and diabetes mellitus	43	7	
Smoking status of the patient			0.00
Yes	143	7	
No	82	91	
Level of patient physical activity			0.01
Never	90	60	
1-2 times a week	53	21	
3-5 times a week	38	10	
Daily	44	7	

Table 5: Shows cross tabulation of education of the patient with condition of the patient, smoking status of the patients and level of physical activity of patient

Variable	**Education of the patient**				
Condition of the patient	primary	secondary	Higher	illiterate	P- value
Hypertension	35	34	68	8	0.00
Diabetes mellitus	23	32	22	4	
Heart disease	10	4	10	3	
High cholesterol	5	8	6	1	
Both hypertension and diabetes mellitus	9	8	15	18	
Smoking status of the patient					0.01
Yes	25	36	69	20	
No	57	50	52	14	

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Table 6: Distribution of Stroke Types and Associated Risk Factors Detected by CT Brain Imaging (n = 323)

Variables	Ischemic Stroke n (%)	Hemorrhagic Stroke n (%)	Subarachnoid Hemorrhage n (%)	p-value
Total Patients	214 (66.3)	87 (26.9)	22 (6.8)	—
Gender				
Male	148 (69.1)	64 (73.6)	13 (59.1)	0.18
Female	66 (30.9)	23 (26.4)	9 (40.9)	—
Age Group (years)				
15–30	25 (11.7)	19 (21.8)	7 (31.8)	0.03
31–45	69 (32.2)	24 (27.6)	5 (22.7)	—
46–60	120 (56.1)	44 (50.6)	10 (45.5)	—
Hypertension	108 (50.5)	55 (63.2)	5 (22.7)	0.02*
Diabetes Mellitus	66 (30.8)	12 (13.8)	3 (13.6)	0.03*
Both HTN & DM	38 (17.8)	10 (11.5)	2 (9.1)	0.01*
Smoking History	110 (51.4)	33 (38.2)	7 (31.8)	0.04
Physical Inactivity	104 (48.6)	36 (41.4)	10 (45.5)	0.09

*Significant at $p < 0.05$

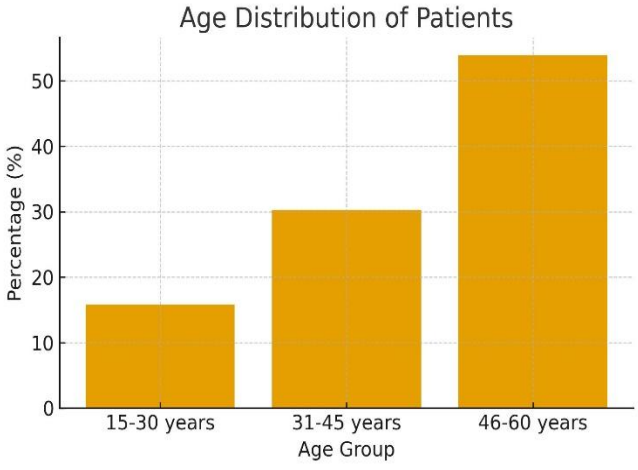

Figure 2 Age Distribution of Patients

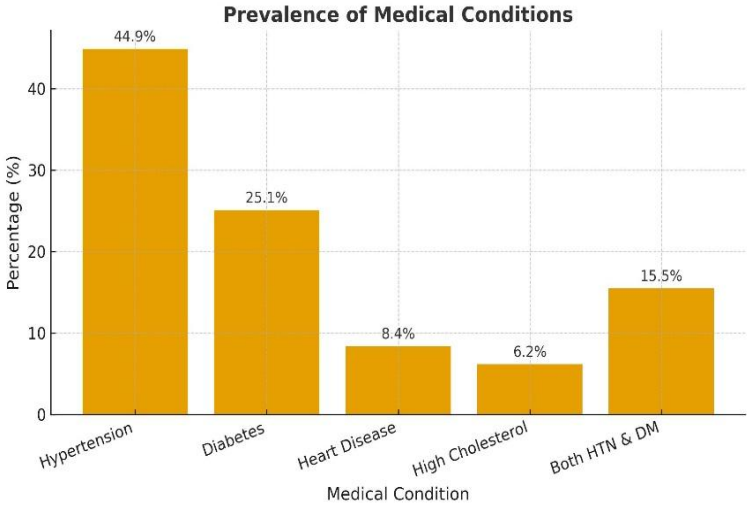

Figure 2 Prevalence of Medical Conditions

DISCUSSION

The present study investigated the prevalence and associated risk factors of stroke among patients undergoing computed tomography (CT) brain imaging in both public and private hospitals in Peshawar District. The findings demonstrated that stroke predominantly affected individuals between 46 and 60 years of age, with males representing nearly two-thirds of the study population. This pattern aligns with global and regional epidemiological evidence indicating a higher incidence of stroke in middle-aged and elderly men, which has been attributed to differential exposure to behavioral and metabolic risk factors such as hypertension, smoking, and diabetes (10–

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15). The predominance of ischemic stroke in older males underscores the influence of cumulative vascular injury and lifestyle-related comorbidities over time. Hypertension emerged as the most prevalent modifiable risk factor, affecting approximately 45% of participants, followed by diabetes mellitus, either alone or in combination with hypertension. These findings are consistent with international and local studies that have consistently identified hypertension as the leading contributor to both ischemic and hemorrhagic strokes (9,10). Elevated blood pressure accelerates vascular wall stress, promoting endothelial dysfunction and microvascular damage that precipitate cerebral infarction or hemorrhage. Diabetes further compounds this risk through chronic hyperglycemia, which induces atherogenesis, platelet aggregation, and reduced fibrinolysis (11). Notably, the coexistence of hypertension and diabetes in nearly one-sixth of the cohort highlights the additive impact of metabolic derangements in precipitating cerebrovascular events. Educational attainment was found to be significantly associated with stroke prevalence. Participants with lower educational levels exhibited a higher frequency of vascular risk factors and poorer health outcomes. Similar patterns have been observed in population-based surveys linking limited health literacy to delayed diagnosis, reduced adherence to treatment, and underutilization of preventive services (12,13). Such disparities illustrate the importance of incorporating educational and socioeconomic determinants into community-based prevention strategies. Improving public awareness regarding the signs of stroke and emphasizing regular health screenings could substantially mitigate these disparities in lower-income and less-educated populations.

Lifestyle behaviors further influenced stroke risk profiles in this cohort. Nearly half of the participants reported smoking, a well-established etiological factor in both ischemic and hemorrhagic stroke through its effects on vascular inflammation, endothelial dysfunction, and atherothrombosis (14). Although alcohol consumption was relatively uncommon, its role in precipitating hypertension and hemorrhagic stroke remains clinically relevant. Physical inactivity, observed in nearly half of the sample, further exacerbated cardiovascular risk through weight gain, insulin resistance, and impaired endothelial function. Additionally, the high prevalence of perceived stress (72.4%) underscores the growing recognition of psychosocial stress as an independent stroke risk factor. Chronic stress contributes to sympathetic overactivity, increased cortisol secretion, and systemic inflammation, all of which predispose individuals to cerebrovascular events (15,16). The symptom distribution in this study—painless weakness, visual loss, and limb paralysis—suggests that the majority of strokes were ischemic in nature, consistent with global estimates indicating that ischemic strokes account for approximately 70–80% of all cerebrovascular accidents (17). The CT imaging findings from this cohort support this distribution, with ischemic stroke comprising the dominant subtype. This pattern corresponds with previous hospital-based data from Pakistan and other South Asian nations, where similar proportions have been observed. Hemorrhagic stroke, though less frequent, was strongly associated with uncontrolled hypertension, reaffirming the pivotal role of blood pressure regulation in stroke prevention. The gender-based disparity observed in this study—where men had higher rates of hypertension, diabetes, and smoking—parallels prior regional investigations that attribute the male predominance in stroke to lifestyle habits and differential healthcare-seeking behavior (18,19). While biological and hormonal factors may provide some protection to premenopausal women, sociocultural constraints and underdiagnosis in female populations remain notable contributors to apparent gender differences in stroke incidence. Moreover, regional analyses have shown that diabetes doubles the risk of ischemic stroke in women, further emphasizing the need for targeted metabolic screening in this demographic (20,21).

The relationship between obesity and stroke, though not directly measured in this dataset, remains crucial for contextual understanding. Prior studies have established that increased body mass index is linked to higher odds of ischemic stroke, particularly when confounders such as hypertension and diabetes are considered (22). These findings collectively reinforce the interdependence of metabolic, behavioral, and environmental risk factors in shaping stroke epidemiology within developing regions. The implications of these findings are multifold. The high prevalence of modifiable risk factors underscores the urgent need for community-level interventions focusing on early diagnosis, continuous management of chronic illnesses, and promotion of healthy behaviors. Healthcare education programs tailored to improve literacy about hypertension and diabetes control are essential. Furthermore, structured workplace wellness initiatives and policies promoting physical activity can serve as cost-effective public health measures to reduce stroke burden in the region. Despite the strengths of a sizable sample and the inclusion of both public and private institutions, this study carries certain limitations. The cross-sectional design restricts causal inference between identified risk factors and stroke occurrence. Additionally, reliance on non-contrast CT alone may have underestimated small or transient ischemic events, as magnetic resonance imaging (MRI) was not incorporated. The use of a non-probability sampling method limits generalizability beyond the study population. Information bias may also have occurred due to reliance on patient self-reporting for behavioral factors such as smoking, alcohol consumption, and physical activity. Nevertheless, this study provides valuable region-specific insight into the risk profile of stroke patients in Peshawar. It highlights a preventable pattern dominated by modifiable cardiovascular and lifestyle-related factors. Future research should incorporate longitudinal follow-up to establish temporal relationships between risk factors and stroke outcomes, integrate MRI and biomarker assessments for enhanced

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diagnostic accuracy, and explore psychosocial determinants more comprehensively. Expanding stroke registries and rehabilitation programs would further aid in improving post-stroke outcomes and informing evidence-based national health strategies.

CONCLUSION

This study concludes that stroke in the Peshawar population is predominantly influenced by a combination of medical and lifestyle factors, with hypertension, diabetes, smoking, stress, and physical inactivity emerging as the most critical contributors. The findings highlight that, middle-aged adults, particularly men, constitute a high-risk group due to poor health awareness, limited preventive practices, and delayed diagnosis. The strong association between modifiable risk factors and stroke-related symptoms underscores the urgent need for comprehensive community-based interventions focused on education, early screening, and lifestyle modification. Strengthening public health initiatives to promote physical activity, control chronic illnesses, reduce tobacco use, and manage stress could significantly lower the local stroke burden. Ultimately, improving health literacy and preventive care accessibility remains essential to reduce morbidity, enhance recovery outcomes, and prevent recurrent cerebrovascular events within this population.

AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Basit	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Alia Wazir	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Salman Khan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muhammad Sohail	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Abdul Salam	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Abdul Wadood*	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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