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ORIGINAL ARTICLE

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Cerebrovascular Accidents in Sana'a City, Yemen: Clinico-Epidemiologic and Neuroimaging Findings

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ABSTRACT

Background: Cerebrovascular accidents (CVA) are acute neurologic injuries that represent a common cause of disability and mortality worldwide, with ischemic and hemorrhagic strokes being the most common forms. In Yemen, there has been limited research on CVA. Therefore, this study aimed to determine the clinical presentation, risk factors and different types of CVA based on head computed tomography (CT) scans among patients admitted to tertiary care hospitals in Sana'a.

Methods: A descriptive cross-sectional study was conducted among 201 patients with CVA who underwent head CT scans at four tertiary hospitals in Sana'a from October 2023 to February 2024. Data about sociodemographic characteristics, clinical presentation and potential risk factors for CVA were collected using a questionnaire. Descriptive statistics were then used to summarize and present the data.

Results: Most patients with CVA admitted to tertiary care hospitals were males (63.7%) and over 40 years old (81%), with a mean age of 56 ± 17 years. More than half of the patients were rural residents (56.7%), illiterate (57.2%), and unemployed (55.2%). Based on CT scan findings, 68.7% (138/201) of patients with CVA had ischemic strokes and 15.4% (31/201) had hemorrhagic strokes. However, the pattern of CVA was undetermined in 15.9% (32/201) of patients. Dysarthria (49.3%) was the most frequent presentation among patients with CVA, followed by left-sided hemiplegia (39.8%), headache (32.8%), right-sided hemiplegia (30.8%), and choking (30.3%). In contrast, fatigue and loss of vision were the least frequent presentations (0.5% each), followed by asphyxia (2.5%), diplopia (3%), chest pain (4.5%), and coma (5.5%). Other manifestations ranged from 7% for memory loss to 28.9% for decreased consciousness. Khat chewing was the most frequent potential risk factor among 64.2% of stroke patients, followed by HTN (46.8%), smoking (39.8%), DM (33.3%), and past history of stroke (23.4%). However, dyslipidemia (8.4%) and family history of stroke (15.9%) were the least frequent potential risk factors among stroke patients.

Conclusion: Approximately two-thirds of patients admitted with CVA to tertiary care hospitals in Sana'a experience ischemic strokes in alignment with the global trends in CVA epidemiology. Clinical presentations in CVA patients vary, with dysarthria and hemiplegia being the most predominant. The high frequency of khat chewing and smoking as potential risk factors emphasizes the necessity of public health interventions to reduce these habits. Likewise, hypertension and diabetes mellitus are common potential risk factors that call for improving healthcare services to control these chronic diseases and lower the risk of CVA.

Keywords: Cerebrovascular accident ▪ Clinical presentation ▪ Potential risk factor ▪ Yemen

1. Introduction

A cerebrovascular accident (CVA) is the sudden onset of a neurological deficit due to a localized vascular etiology,[1] with over a third of stroke-related deaths occurring in developing countries.[2] It is a widespread neurological disorder that counts as the second most common cause of mortality worldwide, leading to 6.2 million deaths in 2015, with an increase of 830,000 since 2000.[1] It is estimated that 15 million people get a stroke annually worldwide, with low- and middle-income nations accounting for four out of five strokes.[3] Over 795,000 people in the United States experience a stroke each year, with approximately 610,000 of cases being new strokes.[4] The two most basic types of stroke are ischemic and hemorrhagic, with different proportions across populations; however, ischemic stroke accounts for the majority of about 80% of strokes.[5]

Emboli from the heart or proximal arterial sources or thrombosis of the cerebral arteries can cause focal ischemia or infarction. If blood supply to the ischemic brain tissue is restored before a substantial infarction occurs, the patient only experiences a transient ischemic attack (TIA).[1] TIA is a temporary focal neurological impairment caused by brain or retinal ischemia without signs of an infarction that typically

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resolves within 24 hours. However, a cerebral ischemic stroke involves an acute focal neurological impairment due to a focal infarction at one or more brain or retinal sites, as confirmed by neuroimaging or symptoms lasting longer than 24 hours. Acute focal neurological disruption due to bleeding within the brain's ventricular system or parenchyma is known as an intracerebral hemorrhage.[6]

In developed countries, the incidence of age-standardized strokes has significantly decreased over the past few decades due to effective initiatives for avoiding cerebrovascular risk factors and efficient health care. In contrast, low- and middle-income countries (LMICs) have reported higher rates of stroke incidence.[7] Age, sex and race are examples of nonmodifiable risk factors for stroke, whereas common modifiable risk factors include diet, physical inactivity, and smoking. Hypertension (HTN) has been identified as the most common risk factor for stroke in Arab nations,[2] and lowering blood pressure is crucial to reduce the risk of having future strokes.[6] In addition, diabetes mellitus (DM) increases the risk of stroke and could contribute to a poorer prognosis. A meta-analysis of 39 studies found that around one-third of all strokes occurred in people with DM, with ischemic strokes being more common than hemorrhagic strokes.[8] Inflammatory conditions, infections, pollutants and cardiac atrial abnormalities unrelated to atrial fibrillation are among the most recently identified risk factors and triggers for stroke. Stroke can be a major sign of rare, inherited illnesses due to single-gene abnormalities. Recent studies indicate that genetic variants can affect the risk of stroke due to other common causes. These genetic factors can be modified more than previously thought, especially those that interact with the environment.[5] The clinical presentation of an ischemic stroke depends on the arterial territory involved and the size of the lesion, which play a critical role in the management of stroke.

The incidence, risk factors and mortality rates of stroke vary across different countries. A meta-analysis from 32 cohorts across 29 countries focusing on patients with ischemic stroke found that HTN and DM were the most common risk factors among Asian and Black patients.[9] High-income countries showed higher rates of large vessel atherosclerosis. In contrast, LMICs showed more undetermined stroke cases. Furthermore, patients in LMICs experienced a higher three-month mortality rate despite having fewer vascular risk factors.[9] In Egypt, the lifetime stroke incidence among individuals aged 20 years and older was 8.5 per 1000,[10] with ischemic strokes (7.2 per 1000) being higher than hemorrhagic strokes (1.1 per 1000). The incidence increased with age and was higher in males. HTN was the most common risk factor among Egyptian stroke patients, followed by DM and hyperlipidemia.[10] In Ethiopia, 48.3% of stroke cases were hemorrhagic, while 51.7% were ischemic.[11] HTN was the most common risk factor for stroke, followed by family history, alcohol consumption, heart failure, and smoking.[11] In Bangladesh, 39% of stroke cases were hemorrhagic and 56% were ischemic, with HTN being the most common risk factor, followed by smoking, dyslipidemia, and DM.[12]

In Yemen, limited research has been conducted on CVA. Therefore, this study aimed to determine the clinical presentation, risk factors and different types of CVA based on head computed tomography (CT) scans among patients admitted to tertiary care hospitals in Sana'a.

2. Methods

2.1. Study design, population and setting

A descriptive cross-sectional study was carried out among patients with CVA admitted to the medical

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wards, intensive care units and emergency departments of four tertiary hospitals in Sana'a from October 2023 to February 2024. The study hospitals included two public hospitals (Al-Jomhouri Teaching Hospital and Al-Thawra Modern General Hospital) and two private hospitals (University of Science and Technology Hospital and Azal Hospital). All hospitalized patients who had neurological presentations and underwent head CT scans were included in the study, provided they or their legal representatives consented to participation. Patients who refused to participate or did not have a head CT scan were excluded.

2.2. Data collection

Data were collected using a three-part questionnaire through face-to-face interviews with patients or their relatives. The first part covered sociodemographic characteristics. The second part focused on the clinical presentation, and the fourth part was used to record the findings of CT scans. The third part assessed certain risk factors, including khat chewing, smoking, family and personal history of CVA, HTN, DM, and dyslipidemia.

2.3. Data analysis

Data were descriptively analyzed with IBM SPSS Statistics, version 22 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as the mean and standard deviation (SD), while categorical variables were presented as frequencies and percentages.

3. Results

3.1. Sociodemographic characteristics of patients with CVA

Table 1 shows that most patients with CVA admitted to tertiary care hospitals were males (63.7%) and over 40 years old (81%), with a mean age of 56 ± 17 years. More than half of the patients were rural residents (56.7%), illiterate (57.2%), and unemployed (55.2%).

Table 1: Sociodemographic characteristics of patients with CVA admitted to tertiary care hospitals in Sana'a City, Yemen (2023)*

Characteristics	*n* (%)
Sex	
Male	128 (**63.7**)
Female	73 (**36.3**)
Age (years)	
<20	84 (**36.3**)
20–40	30 (**15.0**)
>40	163 (**81.0**)
Residence	
Urban	87 (**43.3**)
Rural	114 (**56.7**)
Literacy status	
Illiterate	115 (**57.2**)
Literate	86 (**42.8**)
Employment status	
Employed	90 (**44.8**)
Unemployed	111 (55.2)

* The total number of patients included in the study was 201. SD, standard deviation.

3.2. Patterns of CVA among patients based on CT neuroimaging

Based on CT scan findings, 68.7% (138/201) of patients with CVA had ischemic strokes and 15.4% (31/201) had hemorrhagic strokes. However, the pattern of CVA was undetermined in 15.9% (32/201) of patients.

3.3. Clinical presentation of patients with CVA

Table 2 shows that dysarthria (49.3%) was the most frequent presentation among patients with CVA admitted, followed by left-sided hemiplegia (39.8%), headache (32.8%), right-sided hemiplegia (30.8%), and choking (30.3%). In contrast, fatigue and loss of vision were the least frequent presentations (0.5% each), followed by asphyxia (2.5%), diplopia (3%), chest pain (4.5%), and coma (5.5%). Other manifestations ranged from 7% for memory loss to 28.9% for decreased consciousness.

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Table 2: Clinical presentation of patients with CVA admitted to tertiary hospitals in Sana'a City, Yemen (2023)*

Clinical features	n (%)
Dysarthria	99(**49.3**)
Left-sided hemiplegia	80(**39.8**)
Headache	66(**32.8**)
Right-sided hemiplegia	62(**30.8**)
Choking	61(**30.3**)
Decreased consciousness	58(**28.9**)
Nausea and/or vomiting	56(**27.9**)
Facial palsy	53(**26.4**)
Dizziness	45(**22.4**)
Swallowing difficulty	40(**19.9**)
Blurred vision	29(**14.4**)
Urinary incontinence	26(**12.9**)
Altered sensation	25(**12.4**)
Gait abnormality	24(**11.9**)
Aphasia	23(**11.4**)
Convulsion	19(**9.5**)
Loss of memory	19(**9.5**)
Paralysis	14(**7.0**)
Coma	11(**5.5**)
Chest pain	9(**4.5**)
Diplopia	6(**3.0**)
Asphyxia	5(**2.5**)
Loss of vision	1(**0.5**)
Fatigue	1(**0.5**)

* The total number of patients was 201.

3.4. Frequency distribution of potential risk factors among patients with CVA

Table 3 shows that khat chewing was the most frequent potential risk factor among 64.2% of stroke patients, followed by HTN (46.8%), smoking (39.8%), DM (33.3%), and past history of stroke (23.4%). However, dyslipidemia (8.4%) and family history of stroke (15.9%) were the least frequent potential risk factors among stroke patients.

Table 3: Frequency distribution of potential risk factors for CVA among patients admitted to tertiary hospitals in Sana'a City, Yemen (2023)*

Potential risk factor	n (%)
Khat chewing	129 (**64.2**)
HTN	94 (**46.8**)
Smoking	76 (**39.8**)
DM	67 (**33.3**)
Past history of stroke	47 (**23.4**)
Family history of stroke	32 (**15.9**)
Dyslipidemia	17 (**8.4**)

* The total number of patients was 201; HTN, hypertension; DM, diabetes mellitus.

4. Discussion

Understanding the risk factors and patterns of CVA is crucial for effective management and prevention. In this study, 68.7% of patients admitted to tertiary care hospitals had ischemic strokes. Similarly, ischemic strokes were the most clinical pattern reported in 72% of patients hospitalized over four years (1999–2003) in Sana'a City, while hemorrhagic strokes were observed in 25% of cases.[13] It also aligns with the most recently reported rates in two hospitals in Sana'a (73.3% for ischemic and 19.9% for hemorrhagic strokes).[14] Consistent patterns were also reported among stroke patients in Hadhramout (70–82.9% for ischemic and 17.1–30% for hemorrhagic strokes),[15–17] Dhamar (76.9% for ischemic and 23.1% for hemorrhagic strokes),[18] and Shabwah (76.6% for ischemic and 23.4% for hemorrhagic).[19] In addition, this finding is similar to that reported among hospitalized Indian patients, where ischemic strokes represented 80%.[20] A similar pattern was found among patients in Qatar, where 80.4% had ischemic stroke and 19.6% had hemorrhagic stroke.[21] However, it contrasts with that reported for patients hospitalized with stroke in Mukalla City, where 83% of strokes were hemorrhagic.[16] It is noteworthy that a systematic review analyzing 64 published articles on stroke in the Middle East from 1980 to 2015 found that ischemic stroke is the most common type in the region.[22] The pattern of stroke in the present study is also consistent with patterns reported elsewhere in the world.[23–27]

The mean age of patients with CVA in the present study was 56 years. Similarly, a previous study in Sana'a found that the mean age of stroke patients was 59.6 years. However, higher mean ages of patients with stroke had been reported from other Yemeni governorates, ranging from 65 to 69 years in Hadhramout, Shabwah and Dhamar.[16–19] In the present study, over 80% of CVA occurred in patients

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older than 40 years. A previous study in Sana'a showed that more than half of strokes were observed in the middle age group of 15–44 years.[13] The finding of the present study is consistent with that reported in Mukalla, where the majority of cases (97%) affected patients older than 40 years.[15] The elderly remain the primary population that requires special attention to lower the burden of stroke.

In the present study, CVA affected males more than females (63.7% *vs.* 36.3%). This finding is consistent with a predominance of stroke among males compared to females in a previous study in Sana'a.[13] Higher proportions of males affected by stroke were also reported among hospitalized patients in other Yemeni governorates, including Dhamar (63.7%),[18] Shabwah (74.2%),[19] and Hadhramout (77%).[17] The reason for the male predominance is unclear, though it may be partially attributed to the high prevalence of HTN, DM, smoking and khat chewing among male patients. Men may also have better healthcare-seeking behavior, making them more likely to seek medical care and present to hospitals. A systematic review of studies on stroke in the Middle East shows a notable male-to-female ratio among stroke patients.[22] In contrast, female predominance for stroke was found in Ethiopia (57.4%).[28]

Regarding the clinical manifestations among patients with CVA in the present study, dysarthria was the most predominant feature in approximately one-half of patients, followed by left-sided hemiplegia, headache, right-sided hemiplegia, choking, and decreased consciousness in more or less than one-third of cases. Dysarthria serves as a key indicator of neurological impairment, which may require post-stroke management and rehabilitation.[29] In alignment with the findings of the present study, dysarthria was reported among 45.7% of patients admitted with stroke to tertiary hospitals in Sana'a.[14] Speech disorder was also reported among 40.3% of patients with stroke in Shabwah, second to hemiplegia (82.1%).[19] Likewise, motor dysphasia that affects speech was observed in about one-third of patients with stroke in Mukalla.[16]

Hemiplegia is a main cause of disability in stroke sufferers, hence early physiotherapy and mobility therapies are rather important for improving rehabilitation.[30] The high proportion of patients with left-sided hemiplegia indicates right hemisphere involvement, which is a classic feature of stroke originating from contralateral brain damage.[31] This study revealed only slight variations in the proportions of both left-sided and right-sided hemiplegia (39.8% *vs.* 30.8%), suggesting a somewhat equal distribution of hemispheric lesions in this study population. In contrast, a higher proportion of stroke patients (87%) presented with hemiplegia in Sana'a.[14] In a pattern consistent with the present study, left-sided and right-sided hemiplegia (55.7% and 44.3%, respectively) was reported among stroke patients in Mukalla.[16]

Headache, which was reported by approximately one-third of patients in the present study, is a non-specific symptom that can be associated with many neurological disorders, including stroke.[32] Therefore, the high frequency of headache in this study emphasizes the importance of thorough assessment of this condition to distinguish between primary and secondary causes because its sudden and explosive onset can be a symptom of life-threatening conditions such as subarachnoid hemorrhage.[33] In line with the finding of the present study, headache was reported among 42.7% of stroke patients in Shabwah.[19]

Choking (30.3%) and swallowing difficulty (19.9%) were also significant presentations among patients in the present study, often linked to dysphagia, a common complication of stroke.[34] This finding high-

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lights the high occurrence of dysphagia in patients with CVA, which emphasizes the need for early swallowing assessments and interventions to reduce complications and increase patient safety. On the other hand, decreased consciousness was observed in approximately 29% of patients with CVA in the present study; however, only 5.5% were comatose. These findings are consistent with the spectrum of altered consciousness often observed in stroke patients, which can range from mild confusion to deep coma, based on brain damage degree and location. Impaired consciousness is usually linked to large infarcts, hemorrhagic strokes or brainstem involvement and is a predictor of poor prognosis.[35] In Mukalla, 22.1% of patients with stroke were found to have confused consensualness, while 15.9% were comatose.[16] The higher frequency of coma in the latter study suggests potential differences in stroke severity or healthcare access, warranting further investigation.

Khat chewing is a deeply ingrained cultural practice in Yemen with substantial health implications. In this study, the majority of stroke patients were khat chewers (64.2%), a proportion higher than the 43.4% reported among stroke patients in Sana'a in a four-year study conducted from 1999 to 2003.[13] However, regional variations exist, with a higher proportion of khat chewers (74.8%) observed among stroke patients in Dhamar,[18] while a lower proportion (39.5%) was reported in Shabwah.[19] These differences may reflect variations in cultural habits and the geographic distribution of khat cultivation. While this study did not establish a statistical association between khat chewing and stroke because of the absence of a comparison group of non-stroke patients, it underscores the need for analytical studies to investigate the role of khat chewing as a risk factor for stroke.

The proportion of hypertensive patients with stroke in the present study was 46.8%, which is higher than that previously reported among stroke patients in Sana'a (28.9%).[13] In contrast, it is slightly lower than that reported among stroke patients in Dhamar (54.5-57.1%),[18, 36] Hadramout (55.3–81%),[15–17] and Shabwah (71%).[17] On the other hand, diabetic patients accounted for one-third of stroke patients in the present study, which is higher than that reported previously in Sana'a (6.5%)[13] and recently reported in Dhamar (11%).[18] However, it is lower than the proportion of DM among stroke patients in Hadhramout (38–58%)[15–17] and Shabwah (48%).[19] Notably, a systematic review of stroke studies in the Middle East highlights HTN as the most common risk factor, affecting 24.9–80% of stroke patients in the region.[22] These disparities may be attributed to a lack of individual awareness regarding the importance of glycemic control and/or insufficient access to specialized healthcare providers. While HTN continues to be the leading risk factor for stroke, DM also significantly contributes to stroke etiology, especially in regions where awareness of glycemic control is limited and access to specialized healthcare services is inadequate. Therefore, there is a need for targeted public health interventions and enhancing healthcare delivery systems to effectively reduce the burden of stroke linked to DM in these populations.

Smoking is a well-established risk factor for acute stroke, as it contributes to the development of atherosclerosis, HTN, and other cardiovascular conditions that increase stroke risk.[36] In this context, 39.8% of stroke patients in the present study were smokers, a proportion that aligns closely with findings from Shabwah (37.3%)[19] and Hadramout (40%).[17] In contrast, the frequency of smoking was 47.3% among stroke patients in Dhamar and 18.2% in Mukalla.[15, 18] The high number of smokers among stroke patients in this study highlights the im-

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portance of taking action to reduce tobacco use through targeted interventions and programs. It is noteworthy that there are great variations in the proportion of smokers among stroke patients in the Middle East, ranging from 1.6% to 47.3%.[22]

In this study, 23.4% of stroke patients reported a personal history of stroke, while 15.9% had a family history of stroke. These findings align with but also show some variation from other studies conducted across the country. For instance, a history of previous strokes was reported among 17.3% of cases in Sana'a, 15.4% in Dhamar, and 8.5–30% in Hadhramout.[13, 15–18] On the other hand, the proportion of stroke patients with a family history of stroke was 5.4% in a previous study in Sana'a, 5.5% in Dhamar, 12–31% in Hadhramout, and 18.1% in Shabwah.[13, 15–19] These differences may stem from a combination of genetic, environmental, and healthcare-associated factors. Therefore, it is essential that people who have experienced a stroke before take steps to prevent future strokes, including managing predisposing conditions like HTN and DM. In addition, people with a family history of stroke should get screened early and make changes to their lifestyle habits.

Dyslipidemia is increasingly recognized as a significant risk factor for stroke, particularly ischemic stroke.[37] However, dyslipidemia was identified in 8.5% of cases in this study, which aligns closely with that reported for stroke patients in Mukalla (8.7%) and hyperlipidemia observed among stroke patients in Sana'a.[13, 16] However, higher dyslipidemia proportions were observed among stroke patients in Shabwah (21.8%) and Hadramout (39%).[17, 19] Although dyslipidemia was not predominant among stroke patients in the present study, it requires attention as part of comprehensive stroke prevention strategies through adjustments of lifestyle, dietary habits and medications.

This study is limited by being descriptive, and several potential risk factors and co-morbidities might not be studied. However, it provides valuable insights into the clinico-epidemiologic and neuroimaging findings in patients presented with CVA. Moreover, due to the cross-sectional nature of this study, the patients were not followed for the outcomes, and hence, the mortality rates could not be determined. Therefore, longitudinal studies are essential for understanding the long-term outcomes, progression, and impact of interventions in patients with CVA.

5. Conclusion

Approximately two-thirds of patients admitted with CVA to tertiary care hospitals in Sana'a experience ischemic strokes based on neuroimaging using CT scans, while the other third of cases can have hemorrhagic strokes or other attacks. This pattern of CVA aligns with the global trends in CVA epidemiology. Clinical presentations of CVA show slight variations from those reported elsewhere, with dysarthria and hemiplegia being the most predominant. The high frequency of khat chewing and smoking as potential risk factors emphasizes the necessity of public health interventions to reduce these habits. Likewise, HTN and DM are common potential risk factors that call for improving healthcare services to control these chronic diseases and lower the risk of CVA.

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Ethical approval and consent

The study was approved by the Research Ethics Committee of the University of Science and Technology, Sana'a (Ethical clearance No.: 1445/0015/UREC/UST).

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Permission was also obtained from the administrations of the study hospitals. Written informed consent was obtained from the patients or their close relatives. The privacy of the patients and the confidentially of their data were strictly maintained throughout the study.

Conflict of Interest

The authors declare no conflict of interest associated with this article.

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