Journal of Arabian Peninsula Centre for Medical and Applied Researches
Volume (1), Issue (3), year/2025
p: 76-101

ISSN/E: 2959-829X || ISSN/P: 2059-8303

مجلة مركز جزيرة العرب للبحوث الطبية والتطبيقية
المجلد (1)، العدد (3)، العام 2025م
ص: 76-101
الاستلام: 2025/8/25|| القبول: 2025/12/28||
النشر: 2025/12/31

Risk Factors Affecting Stroke Patients Attending Teaching Hospitals in Amran City, Yemen August–October 2024[1] [2]

عوامل الخطر المؤثرة على مرضى السكتة الدماغية المترددين على المستشفيات التعليمية في مدينة عمران، اليمن خلال الفترة من أغسطس إلى أكتوبر/ 2024 [3]

Prepared by the Researchers/ إعداد الباحثين

رعد السيد / Raad Al-Sayed / raadmohammed193@gmail.com / 0009-0008-1374-497X / +967-771456271

عبد الخالق أبودباة / Abdulkhaliq Abodabah / alymns982@gmail.com / +967-775027199

عزيز أبوسط -967+ / Aziz Abusut / Azizabusut@gmail.com / 776644619

محمد الذيب / Mohammed Al-Theeb / altheebm78@gmail.com / 0009-0001-6149-3342 / +967-776046011

عائشة العموش / Aisha Al-Amoush / Shaifnageeb@gmail.com

أسامة مداغش / Osamah Madaghesh / os.modaghesh@gmail.com / +967-771781500

سليم الضلعي / Saleem Al-Dhela'i / akremh2222@gmail.com / +967-770439027

نجم الطير / Najum Al-Tair / altairnajm1440@gmail.com / +967-774446036

حذيفة المعمري / Huthaifa Al-Mamari / asadrruur4@gmail.com / 0009-0003-4566-7626 / +967-771349253 /

شرف الدين قيران / Sharaf Al-Din Qairan / sharafal.deengairan97@gmail.com / +967-775550970

خليل حنيش / Khalil Hunaish / khlylhnysh@gmail.com / +967-771246314

عمر مناع / Omar Manna'a / mrmna4924@gmail.com / +967-771456243

رحمة المأخذي / Rahma Al-Makhathi / ibbbrrr2@gmail.com

مطيع زناف / Mutea Zanaf / aboahmedalamalsy@gmail.com / +967-772905199

عبد الله السبّاك / Abdullah Alsbbak / ahmedhammdan102@gmail.com / +967-777837998 / 0009-0001-8953-6412

حنان المأخذي / Hanan Al-Makhathi / wwwhananali@gmail.com

المستخلص: تمثل السكتة الدماغية في اليمن تحديًا صحيًا بارزًا، حيث تتجاوز نسب الإصابة المعدلات العالمية، مما يستدعي تحسين الرعاية الصحية وتعزيز استراتيجيات الوقاية والعلاج؛ **هدف البحث** إلى استقصاء عوامل الخطر المرتبطة بمرضى السكتة الدماغية الذين حضروا المستشفيات التعليمية في مدينة عمران خلال أغسطس-

Abstract: Stroke represents a major public health challenge in Yemen, with incidence rates exceeding global averages, which necessitates improving healthcare services and strengthening prevention and treatment strategies. This study aimed to investigate the risk factors associated with stroke patients who attended teaching hospitals in Amran City during the period August–October 2024. A descriptive cross-

[1]- This research originates from a graduation project submitted to the Faculty of Medicine and Health Sciences, University of Amran, as a partial requirement for obtaining a Bachelor's degree in Medicine. Supervised by Lecturer Zumuruda Haroon (Neuroscience) and Associate Professor Munira Shahir (Community Medicine), University of Amran, during the academic year 2024–2025.

[2]- **APA7 Citation:** Al-Mamari, H., Al-Sayed, R., Gairan, S. A., Abodabah, A., Honish, K., Abusut, A., Manna'a, O., Al-Theeb, M., Al-Makhathi, R., Al-Amoush, A., Zanaf, M., Madaghesh, O., Alsbbak, A., Al-Dheleai, S., Al-Makhathi, H., & Al-Tair, N. (2025). Risk factors affecting stroke patients attending teaching hospitals in Amran City, Yemen, August–October 2024. ***Journal of the Arabian Peninsula Center for Medical and Applied Research, 1***(3), 76–101. https://doi.org/10.56793/pcra23134

3-**توثيق الاقتباس (APA7)**: المعمري، ح.، السيد، ر.، قيران، ش. أ.، أبودباة، ع.، حنيش، خ.، أبوست، ع.، مناع، ع.، الذيب، م.، المأخذي، ر.، العموش، ع.، زناف، م.، مداغش، أ.، السبّاك، ع.، لضلعي، س.، المأخذي، ح.، والطير، ن. (2025). عوامل الخطر المؤثرة على مرضى السكتة الدماغية المرتادين للمستشفيات التعليمية في مدينة عمران، اليمن، أغسطس–أكتوبر 2024. ***مجلة مركز الجزيرة العربية للبحوث الطبية والتطبيقية، 1*** (3)، 76–110. https://doi.org/10.56793/pcra23134

أكتوبر 2024. واعتمدت الدراسة المنهج الوصفي القطعي باستخدام استبانة شملت جميع المرضى (161) في مستشفى الشهيد الصماد والمستشفى الوطني الاستشاري. وبينت **النتائج** أن السكتة الإقفارية كانت الأكثر شيوعًا (68.3%) مقارنة بالنزفية (31.7%). برزت عوامل الخطر: ارتفاع ضغط الدم (62.1%)، مضغ القات (66.5%)، السكري (32.9%)، التدخين (42.2%)، قلة النشاط البدني (48.4%)، إضافة إلى السمنة (16.8%) والتاريخ العائلي (28%). شكّل الذكور (63.4%) الغالبية، وغالبهم من الريف (80.7%) وكبار السن (>60 عامًا، 70.8%). وُجد ارتباط معنوي بين أمراض القلب والسكتة الإقفارية (p = 0.004). بلغت ذروة النزفية بين 1 ظهرًا و7 مساءً (35.4%) وخلاصة **الاستنتاجات** تؤكد ارتباط السكتة الدماغية بعوامل خطر رئيسية أبرزها ارتفاع الضغط، القات، والسكري، مع أثر للعمر والتوزيع الجغرافي، بناء على النتائج أوصت الدراسة بإنشاء مراكز متخصصة، تعزيز الوعي الوقائي، تدريب الكوادر، وتحسين إمكانيات المستشفيات الريفية، مع الدعوة لدراسات أوسع حول العوامل البيئية والغذائية وكفاءة التدخلات العلاجية.

الكلمات المفتاحية: السكتة الدماغية، مستشفيات عمران، عوامل الخطر، الرعاية الصحية.

sectional design was employed using a structured questionnaire that included all stroke patients (n = 161) admitted to Al-Shaheed Al-Samad Hospital and the National Consultative Hospital. The results showed that ischemic stroke was more prevalent (68.3%) than hemorrhagic stroke (31.7%). The most prominent risk factors were hypertension (62.1%), khat chewing (66.5%), diabetes mellitus (32.9%), smoking (42.2%), physical inactivity (48.4%), obesity (16.8%), and positive family history (28%). Males constituted the majority of patients (63.4%), most of whom resided in rural areas (80.7%) and were older adults (>60 years, 70.8%). A statistically significant association was found between heart disease and ischemic stroke (p = 0.004), and the peak occurrence of hemorrhagic stroke was observed between 1:00 p.m. and 7:00 p.m. (35.4%). In conclusion, stroke was strongly associated with key risk factors, particularly hypertension, khat chewing, and diabetes mellitus, with notable effects of age and geographic distribution. Accordingly, the study recommends establishing specialized stroke centers, enhancing preventive awareness, training healthcare personnel, improving the capacities of rural hospitals, and conducting further large-scale studies to explore environmental and dietary factors and evaluate the effectiveness of therapeutic interventions.

Keywords: Stroke, Amran Hospitals, Risk Factors, Healthcare.

1-LIST OF ABBREVIATIONS

Abbreviation	Full Name	Abbreviation	Full Name
AHA	American Heart Association	ASA	American Stroke Association
TPA	Tissue Plasminogen Activator	BMI	Body Mass Index
UFH	Unfractionated Heparin	LMWH	Low Molecular Weight Heparin
CBC	Complete Blood Count	WHO	World Health Organization
TIA	Transient Ischemic Attack	CT SCAN	Computed Tomography Scan
CVA	Cerebral Vascular Accident	VTE	Venous Thromboembolism
DM	Diabetes Mellitus	TOAST	Trial of Org 10172 in Acute Stroke Treatment
HLP	Hyperlipidemia	HTN	Hypertension
DVT	Deep Vein Thrombosis	ICH	Intracerebral Hemorrhage
ICVA	Ischemic Cerebral Vascular Accident	CVT	Cerebral Venous Thrombosis
ISCVT	International Study on Cerebral Vein and Dural Sinus Thrombosis	MRA	Magnetic Resonance Angiography
MRI	Magnetic Resonance Imaging	BP	Blood Pressure
RFS	Risk Factors	COVID-19	Coronavirus Disease 2019
SAH	Subarachnoid Hemorrhage	SPSS	Statistical Package for the Social Sciences
AOR	Adjusted Odds Ratio	—	—

1-Introduction.

1-1-Background:

Stroke is a leading cause of death and disability worldwide, occurring when blood flow to part of the brain is interrupted, causing tissue damage. Globally, ischemic strokes constitute approximately 87% of all stroke cases, whereas hemorrhagic strokes account for 13%. Hemorrhagic strokes are further categorized into intracerebral hemorrhage (ICH) and

subarachnoid hemorrhage (SAH). Studies indicate a higher incidence of hemorrhagic strokes in low- and middle-income countries like Yemen, due to factors like uncontrolled hypertension and limited healthcare access. [1-2]

In Yemen, there have been no comprehensive, population-based studies conducted to assess stroke-related mortality, which limits understanding of the true burden of the disease in the country. Despite this lack of local data, statistics from the World Health Organization (WHO) indicate that stroke is a significant public health issue in Yemen. In 2020, the country ranked 32nd globally in terms of deaths caused by stroke, with an age-adjusted mortality rate of 127.49 per 100,000 people. [3] This high ranking reflects the urgent need for effective strategies to prevent and manage stroke. Improving stroke care requires accurate and up-to-date information on the patterns and causes of the disease, including its risk factors, common clinical features, treatment approaches, and patient outcomes. However, such essential data remain scarce in the Yemeni context. There is limited research available on how stroke presents in patients, what factors increase the risk, and what predicts patient survival or death. Only a small number of studies have attempted to address parts of these issues.[4–8] In response to this gap, the current study was designed to investigate stroke in a more comprehensive manner. Specifically, it aims to describe the major risk factors to patients that income to teaching hospitals in Amran Governorate, Yemen.

Stroke remains a significant public health burden in Yemen, yet comprehensive data on its epidemiology, risk factors, and outcomes remain scarce.

Two recent studies in Shabwah and Hadhramout Governorates provide critical insights into stroke profiles in these regions. In Shabwah (2023), a retrospective analysis of 124 stroke patients revealed a male predominance (74.2%), a mean age of 65 years, and hypertension as the leading risk factor (71%).

Ischemic stroke constituted 76.6% of cases, with in-hospital mortality at 21.8%, independently linked to diabetes mellitus (DM) and coma. Similarly, a 2022 study in Hadhramout (n=100) reported comparable demographics (77% male, mean age 65 years) and hypertension prevalence (81%), with ischemic stroke accounting for 70% of cases. However, in-hospital mortality was higher (29%), associated with hemorrhagic stroke and hypertension. Both studies underscore the urgency of addressing vascular risk factors particularly hypertension and DM and improving acute stroke care to reduce mortality. These findings highlight regional variations in stroke outcomes and emphasize the need for context-specific preventive and therapeutic strategies in Yemen's resource-limited settings. [1] [9]

Stroke is globally recognized as the second leading cause of death and a major contributor to long-term disability. A multicenter case-control study conducted in the Aseer region of southwest Saudi Arabia aimed to identify modifiable risk factors associated with first-time stroke. The study included 1, 249 first-time stroke patients and an equal number of age-, sex-, and residence-matched controls. The results showed that hypertension was present in 57.7% of stroke cases compared to 31.8% of controls, diabetes mellitus in 49.4% of cases vs. 25.9% of controls, obesity in 42.0% vs. 30.8%, and high cholesterol in 29.4% vs. 12.1%. On the other hand, regular physical activity was reported by 29.9% of controls compared to only 13.1% of stroke patients. These findings highlight the importance of addressing modifiable risk factors such as hypertension, diabetes, obesity, and high cholesterol, while also promoting physical activity as a protective measure against stroke.[11]

Researchers have identified several contributing factors that may worsen the stroke burden in specific areas, particularly in Amran City. These challenges are largely attributed to the limitations of the local healthcare system, including inadequate medical infrastructure, a shortage of qualified healthcare professionals, and limited access to essential diagnostic and treatment resources.

Such constraints make it more difficult to manage and prevent stroke cases effectively. Therefore, it becomes crucial to investigate the specific risk factors affecting stroke patients in this region to gain a better understanding of the situation.

Educational hospitals in Amran City play a vital role in this process, as they not only provide healthcare services but also act as key centers for clinical research and data collection. By analyzing patient data from these hospitals, researchers can identify the most common and influential risk factors among the local population. This information is essential for developing targeted prevention and treatment strategies that are adapted to the local context, ultimately aiming to reduce the incidence of stroke and enhance the quality of care provided to patients.

1.2. Problem Statement

Stroke is one of the major public health challenges in Yemen, with studies showing a higher incidence than the global average. This highlights the urgent need to improve healthcare services for stroke patients and to develop effective strategies for prevention, early diagnosis, and treatment. Tackling these issues is key to reducing stroke-related deaths and disabilities and improving public health in Yemen.

Despite global advancement in stroke prevention and management, stroke remains a significant public health concern in Yemen. A study by Sallam investigated the clinical profile and risk factors associated with stroke among Yemeni patients in a retrospective hospital-based study conducted at Kuwait Teaching Hospital in Sana'a over a four-year period (1999–2003). The study included patients diagnosed with stroke based on clinical evaluation and CT imaging. The findings revealed a mean patient age of 59.6 years, with males representing 62.6% of cases. Ischemic stroke was the predominant type (72%), followed by hemorrhagic stroke (25%), while 2.5% were undetermined. Interestingly, 51.7% of strokes occurred in the middle-aged group (15–44 years), which is younger than typically reported in other countries. Hypertension was the most common associated condition (68.3%), especially in hemorrhagic cases (82.6%), followed by cardiac diseases (42.4%) and diabetes mellitus (24.4%). Other notable risk factors included smoking (42%), hyperlipidemia (13.9%), and Khat chewing (43.4%), with the latter potentially linked to elevated blood pressure. [5]

The overall case fatality rate was 24.2%, higher in hemorrhagic strokes (28.8%) than ischemic ones (19.7%). The study highlights the need for further research into the potential impact of Khat chewing on stroke risk. [4]

To reduce stroke mortality rates, improving stroke care is crucial. This requires reliable data on stroke epidemiology, risk factors, treatments, and outcomes. However, there is a notable scarcity of data regarding the clinical manifestations of stroke, its risk factors, and outcomes, as well as predictions of stroke mortality rates in Yemen. Only a limited number of studies have addressed some of these aspects. [4-7]

1.3. Justification of the Study:

Stroke is considered one of the leading causes of death and long-term disability worldwide, with its impact being more profound in developing countries due to limited health awareness and inadequate preventive and rehabilitative services. In Yemen, most previous studies on stroke have focused on specific governorates such as Sana'a and Hadramout, with no recent, documented research conducted in Amran Governorate, particularly in teaching hospitals that receive large numbers of patients. Furthermore, many of these studies have not adequately explored the relationship between common risk factors, such as hypertension, diabetes, heart disease, and lifestyle-related habits like smoking and khat chewing and the occurrence of stroke, leaving these factors under-researched within the Yemeni context. During our clinical rounds in teaching hospitals over the past two years, we observed a noticeable increase in stroke cases. Therefore, this study seeks to address the existing research gap by analyzing the risk factors associated with stroke among patients in Amran City, with the aim of contributing to the development of targeted preventive programs and improving health strategies in similar settings.

1.4. Questions

Based on the above, the research problem is defined by the main question: **"What are the factors affecting stroke patients attending teaching hospitals in Amran city, Yemen?"**

The main question branches into the following sub-questions:

1. What is the most common type of stroke among stroke patients attending hospitals in Amran city?
2. What are the main risk factors associated with the development of stroke?
3. What is the relationship between (diabetes, hypertension, smoking, obesity, physical activity) and the type of stroke?
4. What is the most common temporal pattern for the onset of ischemic and hemorrhagic stroke?

1.5. Hypothesis:

To obtain accurate answers to the research questions, the researchers formulated a set of hypotheses:

1. There are risk factors that lead to delays in seeking treatment among stroke patients in Amran, Yemen. These risk factors differ between stroke patients who delay seeking treatment and those who seek treatment immediately.
2. Effective interventions can be developed to increase the speed of treatment-seeking among stroke patients in Amran, Yemen.
3. There is an association between age, gender, and the occurrence of stroke among patients. Unhealthy habits and behaviors, such as smoking and lack of physical exercise, increase the risk of stroke.
4. Family history and an unhealthy diet negatively impact access to healthcare, exacerbating the effects of stroke. Additionally, the inability to access healthcare increases the likelihood of recurrent strokes.

1-6-Objectives

1.6.1. General Objective:

To identify the risk factors affecting stroke patients attending teaching hospitals in Amran city, Yemen, from August to October 2024.

1.6.2. Specific Objectives:

1. Explore the factors affecting stroke patients attending teaching hospitals in Amran city, Yemen.
2. Determine the type of stroke among stroke patients attending hospitals in Amran city.
3. Identify the most influential risk factors in the occurrence of stroke.
4. Determine the relationship between (diabetes, hypertension, smoking, obesity, physical activity) and the type of stroke.
5. Determine the most common temporal pattern for the onset of ischemic and hemorrhagic stroke.

1.7 Importance of the Study:

The importance of the study lies in being one of the few studies targeting the topic in Yemen, and it is expected to benefit as follows:

1.7.1. Scientific Importance:

- Bridging the knowledge gap related to stroke-specific factors in the Yemeni context, providing local data that supports modern scientific literature.
- The study offers a precise analysis of the relationship between chronic diseases and stroke, aiding in the development of predictive models and improving treatment and prevention plans.

1.7.2. Practical Importance:

- Guiding health awareness campaigns on modifiable risk factors such as smoking, obesity, and physical inactivity.
- Improving treatment protocols in teaching hospitals by focusing on the most dangerous factors among Yemeni patients.
- Enabling physicians to develop follow-up and treatment plans targeting the most at-risk groups based on the extracted data.
- Providing policymakers with accurate data on risk factors, helping in formulating effective health policies to combat stroke.
- Improving patients' quality of life by identifying temporal patterns of stroke onset, enhancing emergency response, and reducing long-term complications.

1.8. Study Limitations:

- **Subject Limitations:** Focus on stroke-related risk factors such as diabetes, hypertension, smoking, obesity, and physical activity, in addition to stroke type and temporal patterns.
- **Human Limitations:** Stroke patients attending teaching hospitals.
- **Geographical Limitations:** Limited to the two teaching hospitals (Martyr Al-Sammad and National Consultant hospitals) in Amran city, Yemen.
- **Temporal Limitations:** Covers the period from August to October 2024.

1.9. Study Terminology:

- **Ischemic Stroke:** Defined by Brown (2024) [16] as "a reduction in blood flow to a part of the brain due to arterial blockage."
- **Hemorrhagic Stroke:** Defined by Brown (2024) [16] as "internal bleeding resulting from the rupture of blood vessels, leading to brain damage, a medical emergency requiring immediate treatment to reduce damage and complications."
- **Stroke**: Defined as: "a sudden brain dysfunction due to cerebrovascular disease. Stroke is the third most common cause of disability worldwide after ischemic heart disease and congenital disorders." [17] It is also defined as: "the sudden onset of a neurological deficit attributable to a focal vascular cause, and cerebrovascular diseases include some of the most common and devastating disorders: ischemic stroke and hemorrhagic stroke." [18]
- **Stroke:** Also defined as "a cerebrovascular accident; however, it is essential to note that stroke is not an incidental event. The more accurate and meaningful term to describe it is 'brain attack, ' which carries similar significance to 'heart attack. [19]
- The affected brain initially appears pale, and within hours to days, the gray matter becomes congested with dilated and engorged blood vessels and small hemorrhages. When emboli blocking a major vessel dissolve or disperse within minutes to days, reperfusion of the affected area can cause hemorrhagic infarction and may exacerbate edema formation due to disruption of the blood-brain barrier. [20]
- The vast majority of ischemic strokes result from a reduction in arterial blood supply, which carries sugar and oxygen to brain tissues. Another cause of stroke that is difficult to classify is stroke caused by the blockage of veins that drain blood from the brain. Venous obstruction leads to fluid accumulation, causing brain edema, and may also result in brain ischemia and hemorrhage. [20]
- Stroke resulting from the blockage of a cerebral artery. [21] In a minority of cases, stroke is hemorrhagic and results from the rupture of blood vessels.
- In both ischemic and hemorrhagic stroke, inflammation is a critical factor in disease progression, and clinical studies have identified inflammation as a promising therapeutic target. [22]

- **Operationally,** for the purposes of study, stroke is defined as "a disease affecting the arteries in the brain, occurring due to a sudden disruption in the blood supply to the brain, often caused by a blockage or sudden rupture of a brain artery. It is considered one of the most important neurological diseases, affecting anyone but more common in the elderly."

2- Literature Review

2-1-Theoretical Framework

2-1-1- Etiology of Stroke:

Ischemic Stroke [23–24]: The TOAST classification identifies five main subtypes: large artery atherosclerosis, cardio embolism (e.g., atrial fibrillation), small vessel occlusion, other specific causes (e.g., infections, coagulation disorders), and undetermined causes.

Hemorrhagic Stroke [25–26]: Intracerebral Hemorrhage (ICH): Caused mainly by hypertension-related arterial rupture, forming hematomas that may extend into ventricles.

- *Subarachnoid Hemorrhage (SAH):* Often from ruptured aneurysms with sudden "thunderclap" headache, reported in 25% of cases.

Venous Stroke [27]: Cerebral venous thrombosis (CVT) is associated with hypercoagulable states (pregnancy, oral contraceptives). The ISCVT study found 34% of patients had inherited/acquired thrombophilia (e.g., protein C/S or antithrombin deficiency, factor V Leiden, prothrombin mutation, hyperhomocysteinemia).

2.1.2 Risk Factors of Stroke

Non-Modifiable [28–31]: *Age:* Risk doubles every decade after 55.

1. *Sex:* Higher risk in older men and postmenopausal women.
2. *Race:* African Caribbeans have double the risk; South Asians and Pacific Islanders face metabolic risks; East Asians show higher intracranial stenosis and ICH.
3. *Genetics:* Rare disorders and specific polymorphisms linked to large and small vessel disease.

Modifiable [32–43]:

A. Hypertension: Most significant modifiable factor.
B. Diabetes: Doubles risk; accounts for 20% of diabetes-related deaths.
C. Heart disease: AF contributes to 20–25% of strokes in those >80; anticoagulants reduce risk.
D. Lifestyle factors: Smoking doubles risk; cessation normalizes risk in 2–4 years. Hyperlipidemia raises ischemic stroke risk but may reduce ICH. Heavy alcohol, illicit drugs, obesity, and inactivity worsen outcomes.
E. Other conditions: Infections (e.g., COVID-19), thyroid dysfunction, blood disorders (sickle cell, antiphospholipid syndrome), and oral contraceptives increase risk.
F. Psychosocial factors: Chronic stress and armed conflicts elevate risk through vascular and systemic effects. In Amran, hypertension and smoking are particularly critical, warranting targeted prevention programs.

2.1.3 Pathophysiology of Stroke

- **Ischemic Stroke [44–47]:** Arises from reduced blood flow due to thrombosis, embolism, vasospasm, or atherosclerosis. *Virchow's Triad* (endothelial injury, hypercoagulability, stasis) is central. Ischemia depletes ATP, disrupts ion balance, and promotes excitotoxicity via glutamate release, while inflammation worsens neuronal injury.

- **Hemorrhagic Stroke [48]:** Caused by vascular rupture from hypertension, cerebral amyloid angiopathy, or vascular malformations (e.g., AVMs, trauma, tumors).
- **Venous Stroke [49]:** Thrombosis in cerebral veins increases venous pressure, reducing perfusion and causing ischemic injury, cytotoxic and vasogenic edema, and potential hemorrhage. Blockage of venous sinuses impairs CSF absorption, further elevating intracranial pressure

2.1.4 Clinical Diagnosis of Stroke

2.1.4.1 Importance of Early Diagnosis:

Timely diagnosis is critical, especially in ischemic strokes where thrombolysis significantly improves outcomes. The American Heart Association highlights the "golden hour" for intervention [50].

2.1.4.2 Symptoms and Signs by Lesion

A. **Anterior Choroidal Artery:** Contralateral motor/sensory deficits, visual field loss.

B. **Middle Cerebral Artery (most common):** Face/arm weakness > leg; hemispatial neglect; aphasia in dominant hemisphere; ipsilateral eye deviation.

C. **Posterior Cerebral Artery:** Thalamic infarct causes contralateral hemianesthesia/ataxia; occipital infarct produces homonymous hemianopia.

D. **Subarachnoid Hemorrhage (SAH):** Sudden "thunderclap" headache, neck stiffness, LOC, nausea/vomiting, photophobia, seizures [51].

E. **Cerebral Vein Thrombosis:** Headache, focal deficits, seizures, altered consciousness, raised intracranial pressure, ocular signs [49].

2.1.5 Imaging and Laboratory Tests:

Table (1) Imaging, Laboratory Tests, and Stroke Complications

Section	Details	References
2.1.5.1 Imaging	- **CT: Rapid and effective in excluding hemorrhage.** - **NCCT: First-line for hemorrhage.** - **CTA: Detects clots/occlusions.** - **CTP: Measures cerebral perfusion.** - **MRI: More sensitive for ischemic changes.** - **MRA: Vascular occlusion.** - **MRV and Doppler ultrasound for venous assessment.**	**[52]–[57]**
2.1.5.2 Laboratory Tests	**Include CBC, coagulation profile, LFTs, CRP, and lipid profile.**	**[58]**
2.1.5.3 Complications of Stroke	- **Neurological: Hemiplegia, aphasia, memory loss, cognitive decline, dysphagia, depression.** - **Pulmonary: Aspiration pneumonia, respiratory failure.** - **VTE: DVT and pulmonary embolism.** - **Infections: Pneumonia and urinary tract infections.** - **Musculoskeletal/Functional: Spasticity, contractures, falls.**	**[59]–[63]**

This table (1) demonstrates that comprehensive stroke diagnosis requires both advanced imaging modalities and laboratory investigations to determine type and severity. The wide range of complications—neurological, pulmonary, vascular,

infectious, and functional—illustrates the disease's serious burden. It highlights the necessity of multidisciplinary care and early rehabilitation to improve patient outcomes and quality of life.

2.1.6 Stroke Management:

Management aims to minimize brain damage, prevent complications, and reduce recurrence. In TIA, focus is stroke prevention [64].

2.1.6.1 Reperfusion Therapies:

- **Thrombolysis:** IV tenecteplase (0.25 mg/kg, max 25 mg) up to 4.5h; if unavailable, alteplase (0.9 mg/kg, max 90 mg) [65–67]. Thrombolysis may be considered in severe CVT refractory to anticoagulation but carries bleeding risks [68].
- **Endovascular Therapy:** Mechanical thrombectomy to remove arterial clots.

2.1.6.2 Antithrombotic Therapy:

- **Acute Ischemic Stroke:** Aspirin within 24–48h after excluding hemorrhage improves outcomes [65–67]. Anticoagulants are reserved for cardioembolic sources (e.g., AF).
- **CVT:** Heparin (UFH/LMWH) followed by oral anticoagulants; indefinite therapy for high-risk patients. Thrombolysis/thrombectomy only in specialized centers [68].

2.1.6.3 Blood Pressure Control:

- **ICH:** Lower systolic BP to 130–140 mmHg within 1h [70–72].
- **Ischemic Stroke:** BP reduction if ≥220/100 or for thrombolysis candidates (<185/110) [64]. Trials suggest optimal systolic BP 135–150 mmHg [73]

Table (2) Clinical Diagnosis, Investigations, Complications, and Management of Stroke

Aspect	Details	References
Clinical Diagnosis	Early identification critical; symptoms depend on lesion (MCA, PCA, ACA, SAH, CVT); "golden hour" for intervention	[50–51, 49]
Imaging	NCCT, CTA, CTP, MRI, MRA, MRV, Doppler	[52–57]
Laboratory Tests	CBC, coagulation profile, LFTs, CRP, lipid profile	[58]
Complications	Neurological: hemiplegia, cognitive/psychological disorders; Pulmonary: aspiration pneumonia; VTE: DVT/PE; Infections: UTI/pneumonia; Musculoskeletal: spasticity, contractures, falls	[59–63]
Reperfusion Therapy	Thrombolysis (tenecteplase, alteplase), mechanical thrombectomy for eligible patients	[65–68]
Antithrombotic Therapy	Antiplatelets for ischemic stroke; anticoagulation for CVT or cardioembolic sources	[65–68]
Blood Pressure Control	ICH: target 130–140 mmHg; Ischemic stroke: lower if ≥220/100 or thrombolysis candidates	[64, 70–73]

The findings summarized in table (2) reflect a comprehensive approach to stroke management, emphasizing timely diagnosis, appropriate imaging, and targeted laboratory evaluations. Complications across neurological, pulmonary, vascular, infectious, and musculoskeletal systems necessitate a multidisciplinary care model. Reperfusion and antithrombotic therapies are guided by stroke type, timing, and patient-specific contraindications, highlighting the importance of evidence-based protocols. Blood pressure management remains a cornerstone, particularly in acute ICH and ischemic stroke undergoing reperfusion. These strategies collectively aim to reduce mortality, improve functional outcomes, and prevent recurrence. The integration of early detection, precise intervention, and continuous monitoring underscores the critical role of healthcare systems in stroke care. Researchers advocate for ongoing evaluation of these protocols to optimize patient outcomes.

2.2. Previous Studies.

2.2.1 Studies Conducted in the Republic of Yemen:

- **Al-Mahfadhi (2023)** conducted a study on 774 stroke cases in Mukalla, Yemen, with a mean age of 69±13.3 years and a male predominance (55.8%). Ischemic strokes represented 82.9% of cases, while 17.1% were hemorrhagic. Hypertension (57.2%), diabetes mellitus (44.8%), and smoking (20.9%) were leading risk factors. Notably, 70.8% of patients had two or more risk factors, and 4.7% had none. Sudden onset was reported in 90.6% of patients, with 38.6% presenting with disturbed consciousness [74].
- **Hezam & Khan (2023)** carried out a retrospective cross-sectional study in Shabwah Governorate between July 2022 and June 2023, involving 124 stroke patients (mean age: 64.98 ± 16.22 years; males: 74.2%). Hypertension was the most frequent risk factor (71%). Ischemic stroke accounted for 76.6%, followed by intracerebral hemorrhage (20.2%) and subarachnoid hemorrhage (3.2%). The in-hospital mortality rate was 21.8%. Independent predictors of mortality included hypertension and other modifiable factors [9].
- **Salah & Aljarmouz (2019)** investigated stroke prevalence among 1,482 patients admitted to Al-Wahdah Teaching Hospital, Dhamar University, in 2016. Stroke prevalence was 6.1%, with ischemic stroke at 76.9% and hemorrhagic stroke at 23.1%. Risk factors included hypertension (57.1%), smoking (47.3%), khat chewing (74.7%), and previous stroke history (15.8%). Hemorrhagic strokes showed higher mortality rates [76].

2.2.2 Arab and Foreign Studies:

- **Alhazzani et al. (2023)** conducted a multicenter case-control study in Saudi Arabia, including 1,249 stroke patients and 1,249 matched controls. Hypertension (57.7%), diabetes mellitus (49.4%), obesity (42.0%), &hypercholesterolemia (29.4%) were significantly more common among stroke patients, while physical activity appeared protective (aOR = 0.12) [77].
- **Nour et al. (2022)** carried out a multicenter study in Djibouti on 70 patients (mean age 59.6 years; male ratio 2.5). Hypertension (73%), khat chewing (64%), and tobacco use (50%) were the most prevalent risk factors. Ischemic stroke accounted for 61.5% of cases. The study highlighted the early onset of stroke among khat and tobacco users [79].
- **Farhoudi et al. (2017)** analyzed 5,355 stroke cases in northwest Iran (mean age 67.5 years). Ischemic stroke predominated (76.5%), followed by intracerebral hemorrhage (14.3%) and subarachnoid hemorrhage (9.2%). Hypertension (68.8%) and diabetes (23.9%) were the most common risk factors, with smoking at 12.6% [80].
- **Schneider et al. (2017)** studied 741 first-time and 96 recurrent stroke patients in Estonia (ages 18–54). Hypertension (53%), dyslipidemia (46%), and smoking (35%) were major risk factors. Atrial fibrillation was the main cause of cardioembolic strokes (48%). Large-artery atherosclerosis was more frequent in recurrent strokes (24%) than first-time strokes (14.3%) [81].
- **Khedr et al. (2013)** conducted an epidemiological study in Assiut, Egypt, involving 6,498 participants. The crude prevalence of stroke was 963 per 100,000, with ischemic stroke being predominant. Hypertension (66%) and diabetes mellitus (38.6%) were leading risk factors. Stroke prevalence was equal in urban and rural areas but higher among illiterate individuals [78].

2-2-3-Critical Commentary:

- The reviewed studies converge on the predominance of **ischemic strokes** over hemorrhagic ones, with **hypertension** emerging consistently as the most significant modifiable risk factor across Yemeni, Arab, and international contexts. However, differences are notable: in Yemen and Djibouti, **khat chewing and tobacco use** appear as region-specific contributors, unlike in Saudi Arabia and Iran, where obesity and hyperlipidemia dominate. Mortality rates also vary, with

Shabwah (Yemen) reporting higher in-hospital mortality (21.8%) compared to international cohorts. Moreover, younger patients were more represented in Estonia, where lifestyle factors and atrial fibrillation played stronger roles.

- What distinguishes the **current study** is its novelty as the **first investigation in Amran Governorate**, addressing a geographic gap in Yemeni stroke research. It integrates both clinical and epidemiological data during a defined period (August–October 2024), offering local insights into risk factor distribution. The study's added value lies in contextualizing global knowledge within Yemen's unique sociocultural and health system challenges, thereby guiding **targeted prevention and intervention strategies** in underserved regions

3-Methodology.

Table (3) Methodology Overview of the Study on Stroke Risk Factors in Amran, Yemen

No	Component	Description
3/1	Study Design	Descriptive analytic cross-sectional study to identify prevalence and distribution of stroke risk factors.
3/2	Study Setting	Martyr Al-Sammad Teaching Hospital and National Consultant Hospital, Amran City, Yemen.
3/3	Study Duration	August – October 2024 (3 months).
3/4	Study Population	All adult patients (≥18 years) diagnosed with acute stroke (ischemic or hemorrhagic) presenting to the participating hospitals during the study period.
3/5	Inclusion Criteria	- Confirmed acute stroke via clinical evaluation and neuroimaging (CT/MRI). - Admission to emergency or neurology departments. - Complete documented medical history regarding key risk factors (HTN, DM, atrial fibrillation, smoking, obesity, family history of stroke).
3/6	Exclusion Criteria	- Incomplete medical records. /- Transient ischemic attacks (TIA) or non-stroke neurological conditions (tumors, traumatic brain injury). - Transfers from other facilities without complete data.
3/7	Sampling & Sample Size	Purposive sampling including all cooperative patients meeting inclusion criteria. Total sample: 161 patients.
3/8	Data Collection Procedures	Structured, face-to-face interviews conducted by trained medical students. Clinical evaluation performed; final diagnosis confirmed by senior neurologist.
3/9	Data Collection Tool	Structured questionnaire covering: - Socio-demographic data (age, gender, residence, education) - Lifestyle habits (khat chewing, smoking, physical activity, BMI) - Medical history (HTN, DM, hyperlipidemia, heart disease, prior stroke, family history) - Clinical characteristics (stroke type, symptom onset, neurological presentation)
3/10	Data Analysis	SPSS v26: Descriptive statistics (frequencies, percentages, means). Chi-square test for associations between risk factors and stroke type. Significance: $p < 0.05$; highly significant: $p < 0.001$.
3/11	Ethical Considerations	Approval from Amran University Ethics Committee; official hospital permissions obtained; informed consent from participants; confidentiality maintained; voluntary participation ensured.

The table presents a comprehensive and structured methodology that aligns with international standards for clinical cross-sectional studies. Strengths include the clear definition of inclusion/exclusion criteria, integration of both clinical and lifestyle risk factors, and rigorous ethical safeguards. The use of purposive sampling allows inclusion of all eligible patients, ensuring that the findings accurately reflect the local population in Amran City. Data collection through structured interviews complemented by clinical verification enhances validity and minimizes information bias. The analysis plan is appropriate for identifying associations between risk factors and stroke characteristics. Overall, this methodology addresses previous gaps in

regional research, providing a reliable and replicable framework for stroke risk assessment in Yemen and contributing valuable local epidemiological data.

4-The Results

The sample involved 161 patients of Stroke who visited Martyr Al-Sammad and National Consultant hospitals in Amran city, during study period.

Table (4) Sociodemographic Characteristics of Stroke Patients in Amran City (n=161) Percentage (%)

Variables	Category	(n)	(%)	Variables	Category	(n)	(%)
Age Group	20–40 years	7	4.3	Type of Stroke	Ischemic	110	68.3
	41–60 years	40	28.8		Hemorrhagic	51	31.7
	>60 years	114	70.8		Total	161	%100
Sex	Male	102	63.4	Educational Level	Illiterate	108	67.1
	Female	59	36.6		Read & Write	42	26.1
Residence	Rural	130	80.7		Primary + Secondary	9	5.6
	Urban	31	19.3		University+	2	1.2

This integrated table provides a comprehensive overview of the sociodemographic, lifestyle, and clinical characteristics of stroke patients in Amran City, revealing clear and clinically significant patterns. The data highlights that the typical stroke patient in this cohort is a rural-dwelling male, over 60 years of age, with low educational attainment, with illiteracy being a prominent feature (67.1%). This demographic profile is a critical finding, as it suggests a vulnerable population that may face significant barriers to stroke awareness, prevention, and timely access to medical care.

Distribution according to Socio-demographic Characteristics

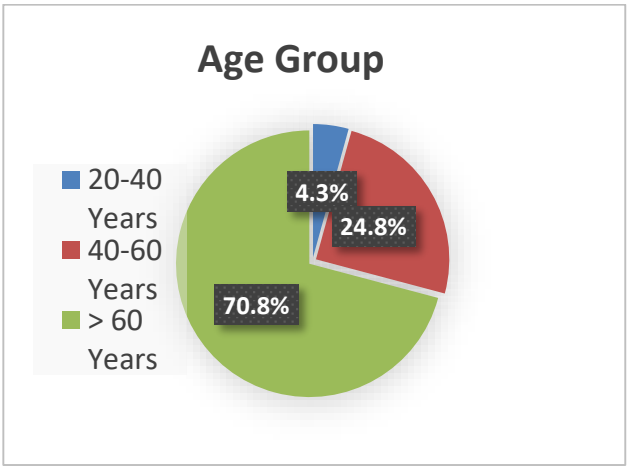
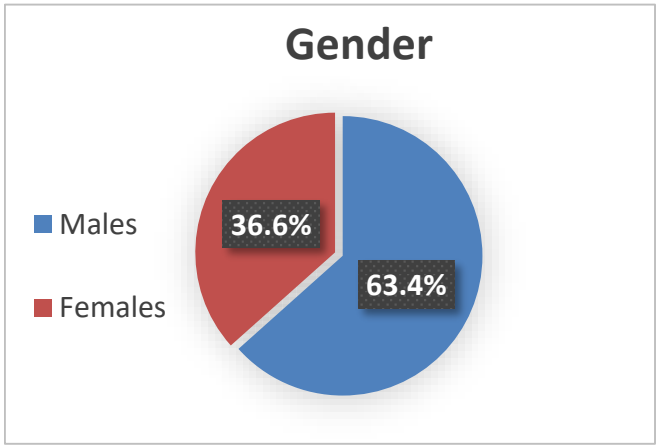


Figure 0.1: distribution of participants according to age group



presents the participants' response based on the sex and it is revealed that 102

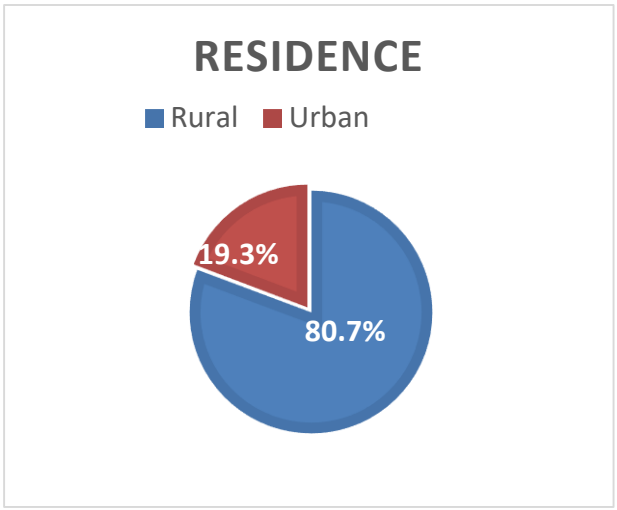


Figure 0.2: distribution of participants according to resident

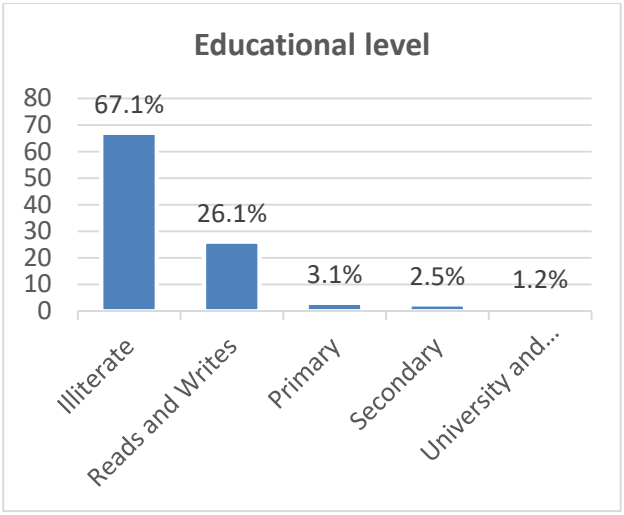


Figure 0.3: distribution of participants according to educational leve

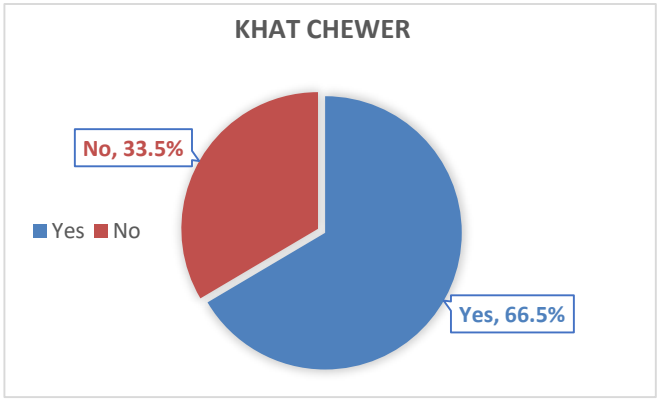


Figure 0.4: distribution of participants according to khat chewer

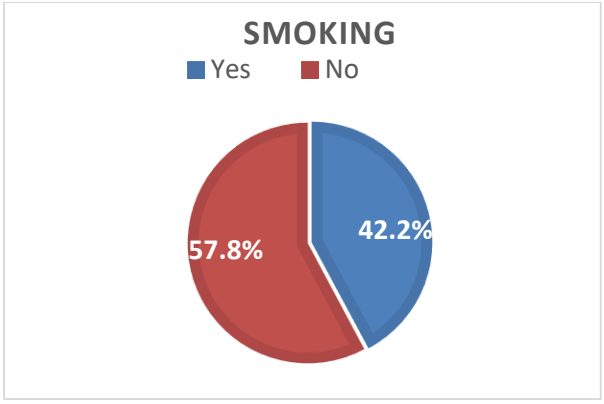


Figure 0.5: distribution of participants according to smoking

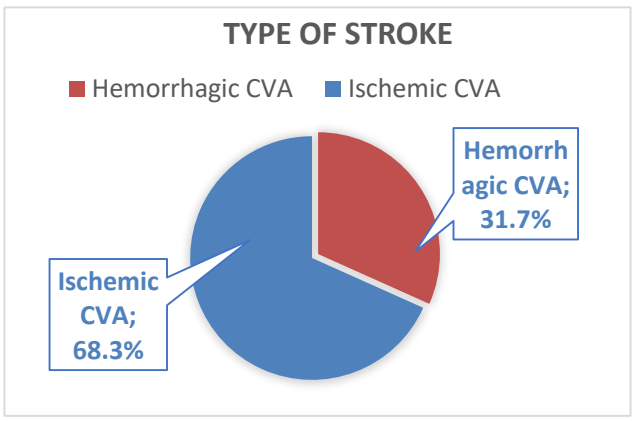


Figure 0.6: distribution of participants according to type of stroke

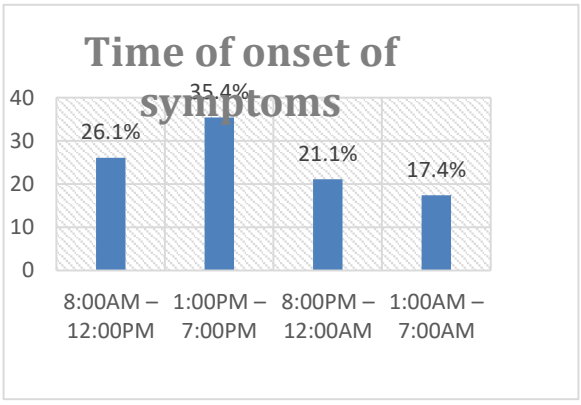


Figure 0.7: distribution of participants according to time of onst of symptoms

Furthermore, the data on lifestyle habits indicates a high prevalence of khat chewing (66.5%) and smoking (42.2%) among the patients. These are well-established risk factors for stroke, and their high frequency underscores their potential role in the local epidemiology of the disease. The clinical characteristics show that ischemic stroke is the predominant type (68.3%) and

that the highest frequency of symptom onset occurs during the afternoon and early evening (1:00 pm to 7:00 pm, 35.4%). This pattern could be linked to daily activities and lifestyle habits, such as the timing of khat chewing sessions.

Overall, this table presents a cohesive and holistic view of the patient population. The findings underscore the need for targeted public health interventions that address key risk factors (age, sex, and lifestyle habits) while also focusing on accessible educational programs for rural, low-literacy communities to improve early recognition of stroke symptoms and prompt presentation to healthcare facilities.

4-4-Factors that may participate (Hypertension& Diabetes Mellitus& Hyperlipidemia) in the stroke:

To examine the extent to which hypertension and diabetes& Hyperlipidemia; mellitus contribute to stroke, the results were as follows:

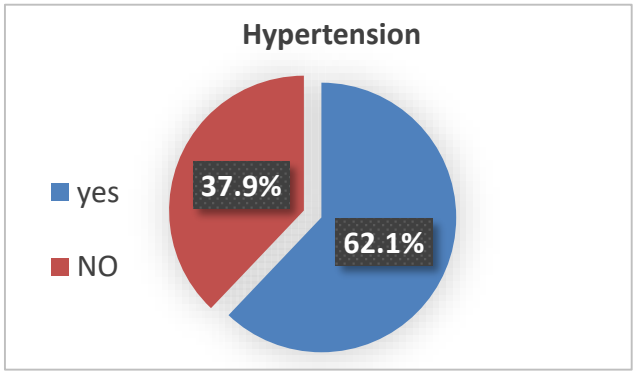


Figure 0.8: distribution of participants according to HTN

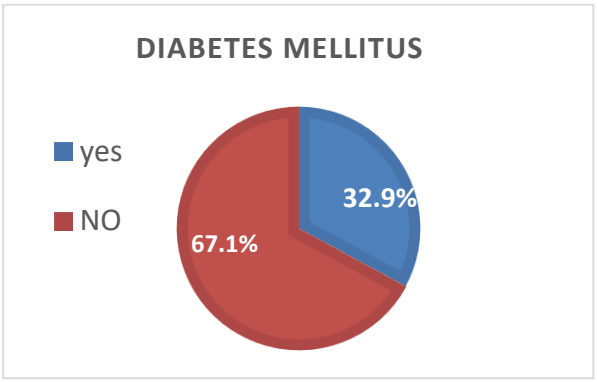


Figure 0.9: distribution of participants according to DM

It is evident from the figures (4.9, 4.10, 4.11) that hypertension, diabetes mellitus, and hyperlipidemia are all significant risk factors among the study participants. Figure 4.9 indicates that hypertension was the most prevalent factor, affecting a staggering 62.1% of patients. Additionally, Figure 4.10 shows that diabetes mellitus was present in 32.9% of the participants. Furthermore, Figure 4.11 reveals that 23.6% of patients had hyperlipidemia. These findings underscore the critical role of these conditions as primary risk factors for stroke in this population and highlight the urgent need for targeted interventions. Therefore, it is recommended that patients with a history of these conditions receive education on the importance of treatment adherence and healthy lifestyle choices. Hospitals should also establish dedicated stroke prevention programs with regular screening and comprehensive care, while relevant authorities are encouraged to launch public health campaigns to raise awareness about the link between these chronic diseases and stroke, ensuring essential medical resources are accessible to all citizens, especially in underserved areas.

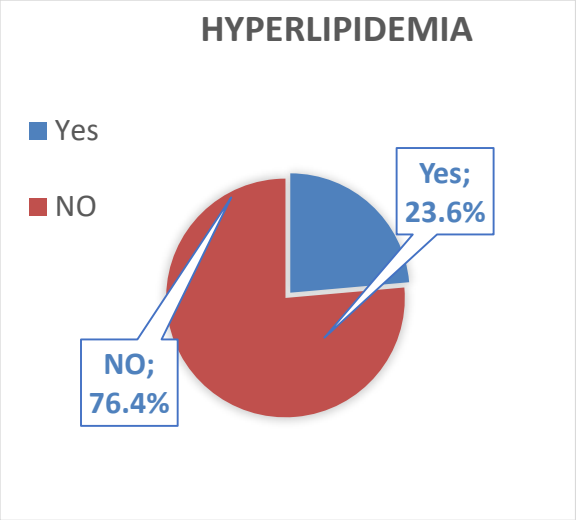


Figure 0.10: distribution of participants according to hyperlipidemia

4-5-History of (Heart Disease, Previous Stroke, Family history of stroke) and Their Association with Stroke:

To ascertain the extent of the influence of historical factors and their association with stroke, the researchers posed three questions, and the participants' responses are shown in the following three figures.

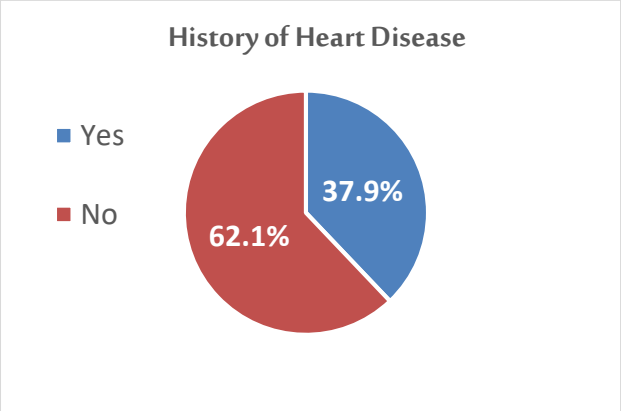


Figure 0.11: distribution of participants according to history of heart diseases

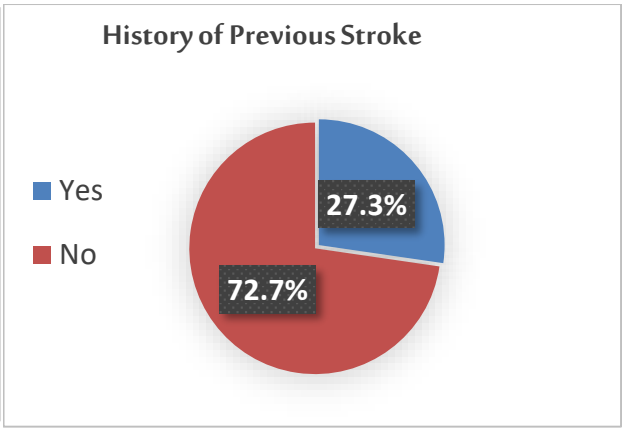


Figure 0.12: distribution of participants according to history of previous stroke

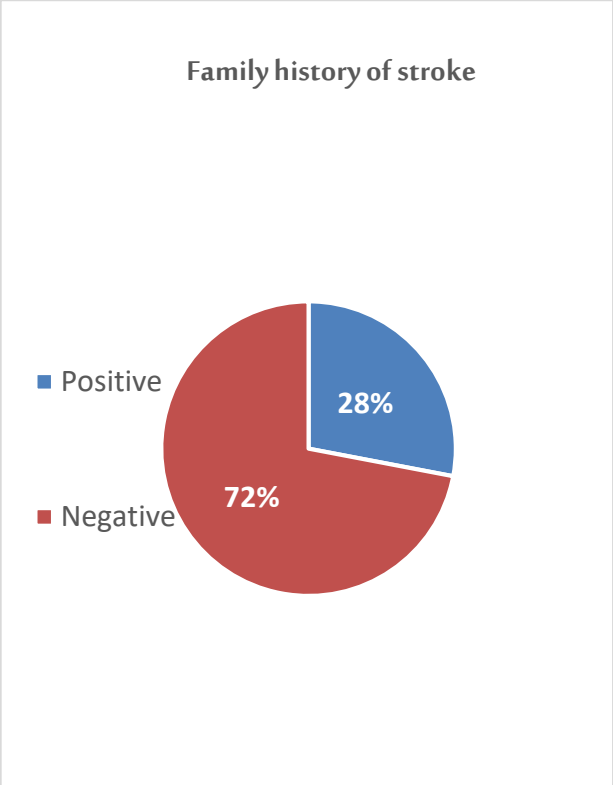


Figure 0.13: distribution of participants according to family history of stroke

The results revealed significant clinical implications: Figure 4.12 shows that 37.9% of participants have a history of heart disease, which is a strong indicator of underlying etiological factors such as atrial fibrillation or coronary artery disease, both of which are potential sources of blood clots that can travel to the brain. Furthermore, Figure 4.13 indicates that 27.3% of patients had a positive history of a previous stroke, confirming that a prior stroke is one of the strongest predictors of recurrence and necessitates a special focus on secondary prevention programs. Similarly, Figure 4.14 illustrates that 28% of the participants reported a positive family history of the disease, suggesting a potential genetic predisposition to stroke or its primary risk factors like hypertension and diabetes. Accordingly, these findings emphasize the critical need to include a comprehensive assessment of the patient's medical history as an essential part of clinical procedures. The researchers therefore recommend that routine clinical practice in hospitals should incorporate a detailed examination of patients' medical histories, with particular attention to those with a history of heart disease, previous stroke, or a positive family history. Health institutions should also launch specialized awareness programs targeting these groups to educate them on the importance of regular medical follow-up and adherence to treatment plans to reduce the likelihood of future events. Furthermore, relevant authorities should support future research that delves deeper into genetic factors to develop more precise preventive strategies.

4.6. Association between (age group, gender, residence) and type of stroke

To investigate the association between age group, gender, residence, and the type of stroke, the researchers conducted a comprehensive statistical analysis. The findings are presented in Table 5.

Table (5) Association between (age group, gender, residence) and type of stroke

Associated factors	Type of stroke		Total	Chi-square	P- value
	Ischemic CVA	Hemorrhagic CVA			

		N	%	N	%	N	%		
Age group	20-40 Yr	2	1.2%	5	3.1%	7	4.3%	11.058a	0.004
	40-60 Yr	22	13.7%	18	11.2%	40	24.8%		
	> 60 Yr	86	53.4%	28	17.4%	114	70.8%		
Total		110	68.3%	51	31.7%	161	100.0%		
gender	Male	65	40.4%	37	23.0%	102	63.4%	2.718a	0.099
	Female	45	28.0%	14	8.7%	59	36.6%		
	Total	110	68.3%	51	31.7%	161	100.0%		
Residence	Urban	15	9.3%	16	9.9%	31	19.3%	7.050a	0.008
	Rural	95	59.0%	35	21.7%	130	80.7%		
	Total	110	68.3%	51	31.6%	161	100.0%		

The Table (5) shows that An analysis of the data reveals that there is a statistically significant association between both age group (p=0.004) and residence (p=0.008) with the type of stroke. It is evident that the majority of participants were over 60 years of age (70.8%), with a notable prevalence of ischemic strokes (53.4% of the total sample) within this demographic. This finding aligns with the well-established understanding that advancing age is a critical and independent risk factor for stroke, particularly the ischemic subtype. Furthermore, the data indicates that a substantial number of patients (80.7%) were residents of rural areas, with 59.0% of all ischemic strokes recorded in this group. This may reflect limited access to advanced healthcare services, lack of awareness, and inadequate management of chronic conditions in these regions. In contrast, no statistically significant association was found between gender and the type of stroke (p=0.099).

Based on these findings, it is clear that a multi-tiered approach is required to mitigate the burden of stroke in the studied population. Patients and their families must be empowered through education to better manage chronic risk factors like hypertension and diabetes, adhere to treatment plans, and recognize the early signs of a stroke. Healthcare professionals and hospitals must prioritize the implementation of dedicated stroke prevention programs and improve screening for high-risk individuals, especially the elderly and those from rural areas. Local communities should engage in public health initiatives to foster a greater understanding of stroke risk and the importance of seeking timely medical care. Finally, the government and the Ministry of Public Health and Population must lead policy-level changes, including the allocation of resources to enhance healthcare infrastructure in rural areas, the launch of nationwide public awareness campaigns, and the development of national guidelines for comprehensive stroke care and secondary prevention.

4-7- Association between (smoking, khat, onset of symptoms) and type of stroke

To investigate the relationship between behavioral patterns (smoking, khat chewing) and the time of symptom onset with stroke type, the researchers conducted a comprehensive statistical analysis. The findings are presented in Table 8.

Table (8) Association between (smoking, khat, onset of symptoms) and type of stroke

Associated factors		Type of stroke				Total		Chi- square	P- value
		Ischemic CVA		Hemorrhagic CVA					
		N	%	N	%	N	%		
Smoking	Yes	43	26.7%	25	15.5%	68	42.2%	1.408a	0.235
	No	67	41.6%	26	16.1%	93	57.8%		
	Total	110	68.3%	51	31.6%	161	100.0%		
Khat chewer	Yes	70	43.5%	37	23.0%	107	66.5%	1.242a	0.265
	No	40	24.8%	14	8.7%	54	33.5%		
	Total	110	68.3%	51	31.7%	161	100.0%		

Time of onset of symptoms	8:00AM–	29	18.0%	13	8.1%	42	26.1%	8.982a	0.03
	1:00PM–	41	25.5%	17	10.6%	58	36.0%		
	8:00PM–	17	10.6%	17	10.6%	34	21.1%		
	1:00AM–	23	14.3%	4	2.5%	27	16.8%		
	Total	110	68.4%	51	31.8%	161	100.0%		

The data analysis in Table 8 indicates that neither smoking (P=0.235) nor khat chewing (P=0.265) showed a statistically significant association with the type of stroke. Nevertheless, the high proportion of participants who were smokers (42.2%) and khat chewers (66.5%) warrants attention, as these behaviors are well-established long-term risk factors for stroke. In contrast, a statistically significant association was found between the time of symptom onset and the type of stroke (P=0.03). It was observed that over a quarter of cases (25.5%) experienced symptom onset during the afternoon (1:00 PM - 7:00 PM), while a considerable proportion also occurred during the morning (8:00 AM - 12:00 PM; 18.0%). The researchers believe this temporal pattern necessitates further investigation to understand the physiological mechanisms that may be linked to an increased incidence of stroke at specific times of the day, such as fluctuations in blood pressure or stress hormone levels.

4.8. Association Between Risk Factors (Hypertension, Diabetes Mellitus, and Hyperlipidemia) and Stroke Type

To assess the relationship between common risk factors (hypertension, diabetes mellitus, and hyperlipidemia) and stroke type, the researchers conducted a comprehensive statistical analysis using the Chi-square test, as shown in Table 9..

Table (9) Association between Risk Factors (HTN, DM, hyperlipidemia) and type of stroke

Associated factors		Type of stroke				Total		Chi-square	P-value
		Ischemic CVA		Hemorrhagic CVA					
		N	%	N	%	N	%		
HTN	Yes	67	41.6%	33	20.5%	100	62.1%	.213a	0.644
	No	43	26.7%	18	11.2%	61	37.9%		
	Total	110	68.3%	51	31.7%	161	100.0%		
DM	Yes	34	21.1%	19	11.8%	53	32.9%	.635a	0.425
	No	76	47.2%	32	19.9%	108	67.1%		
	Total	110	68.3%	51	31.7%	161	100.0%		
Hyperlipidemia	Yes	22	13.7%	16	9.9%	38	23.6%	2.499a	0.114
	No	88	54.7%	35	21.7%	123	76.4%		
	Total	110	68.3%	51	31.7%	161	100.0%		

An analysis of the data revealed no statistically significant association between hypertension (HTN) (P=0.644), diabetes mellitus (DM) (P=0.425), or hyperlipidemia (P=0.114) and the specific type of stroke (ischemic or hemorrhagic). Nevertheless, it is critical to note that a high percentage of the participants with a stroke did have these conditions: 62.1% had hypertension, 32.9% had diabetes, and 23.6% had hyperlipidemia. These findings, while lacking a statistically significant link to stroke subtype, underscore the fundamental role of these conditions as primary and general risk factors for developing a stroke in the first place, regardless of its type.

In light of these results, the researchers emphasize the ongoing need for primary prevention through the effective management of these chronic diseases. It is recommended that public health programs be established to focus on early screening for these conditions and provide health education on the importance of controlling them, thereby directly contributing to a reduction in the overall incidence of stroke within the community.

4-9-The Association between Medical History (Heart Disease, Previous Stroke, Family History) and Stroke Type

To assess the relationship between participants' medical history and stroke type, the researchers conducted a statistical analysis using the Chi-square test. The findings are presented in Table 10.

Table (10) Association between history of (heart disease, previous stroke, family history of stroke) and type of stroke

Associated factors		Type of stroke				Total		Chi-square	P- value
		Ischemic CVA		Hemorrhagic CVA					
		N	%	N	%	N	%		
History of heart disease	Yes	50	31.1%	11	6.8%	61	37.9%	8.448a	0.004
	No	60	37.3%	40	24.8%	100	62.1%		
	Total	110	68.3%	51	31.7%	161	100.0%		
History of previous stroke	Yes	31	19.3%	13	8.1%	44	27.3%	.127a	0.721
	No	79	49.1%	38	23.6%	117	72.7%		
	Total	110	68.3%	51	31.7%	161	100.0%		
Family history of stroke	Positive	30	18.6%	15	9.3%	45	28.0%	.079a	0.778
	Negative	80	49.7%	36	22.4%	116	72.0%		
	Total	110	68.3%	51	31.7%	161	100.0%		

An analysis of the data in Table 10 reveals a statistically significant association between a history of heart disease and the type of stroke (P=0.004). The results show that 31.1% of participants with a history of heart disease suffered an ischemic stroke, compared to only 6.8% who had a hemorrhagic stroke. This finding confirms that heart diseases, particularly those related to clot formation, significantly increase the likelihood of an ischemic stroke.

In contrast, the analysis showed no statistically significant association between a history of previous stroke (P=0.721) and family history of stroke (P=0.778) and stroke type. Nevertheless, the researchers emphasize that a lack of statistical significance in this context does not diminish the importance of these factors as overall, crucial risk factors for developing a stroke in the first place.

Given these findings, the researchers recommend that high priority be given to patients with a history of heart disease in stroke screening and prevention programs. They also underscore the importance of guiding patients with a history of a previous stroke or a family history of stroke toward regular medical follow-up, given the known role of these factors in increasing the probability of stroke.

4.10. The Association between Lifestyle Variables (Body Mass Index and Physical Exercise) and Stroke Types

To assess the relationship between lifestyle variables and stroke type, the researchers conducted a statistical analysis using the Chi-square test. The findings are presented in Table 11.

Table (11) Association between Lifestyle Variables (Body Mass Index and Physical Exercise) and Stroke Types

Associated factors		Type of str Oke				Total		Chi-square	P- value
		Ischemic CVA		Hemorrhagic CVA					
		N	%	N	%	N	%		
Weight (BMI)	underweight= < 18.5	5	3.1%	0	0.0%	5	3.1%	3.117a	0.374
	normal BMI = 18.5- 25	43	26.7%	23	14.3%	66	41.0%		
	overweight = 25-30	42	26.1%	21	13.0%	63	39.1%		
	obesity = > 30	20	12.4%	7	4.3%	27	16.8%		
	Total	110	68.3%	51	31.6%	161	100.0%		
	Yes	55	34.2%	23	14.3%	78	48.5%		

physical exercise	No	36	22.4%	13	8.1%	49	30.4%	3.204a	0.202
	Rarely	19	11.8%	15	9.3%	34	21.1%		
Total		110	68.4%	51	31.7%	161	100.0%		

An analysis of the data in Table 11 indicates that neither Body Mass Index (BMI) (P=0.374) nor physical exercise (P=0.202) showed any statistically significant association with the type of stroke. Nevertheless, it's important to note that a large percentage of participants had a normal BMI or were overweight (41.0% and 39.1%, respectively). As for physical activity, a majority of participants (48.5%) do engage in some form of exercise, which may suggest a decent level of awareness about the importance of physical activity in the community, even though this did not translate into a direct statistical relationship with stroke type.

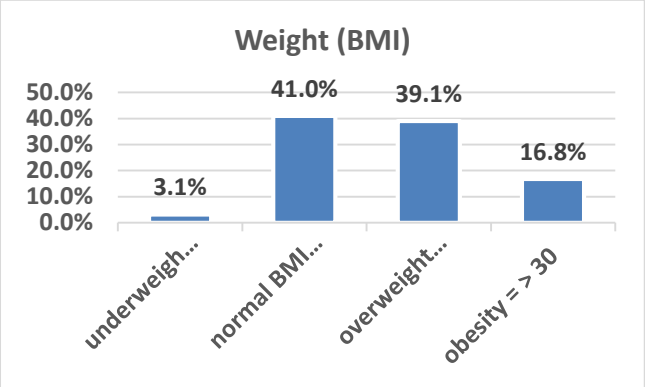


Figure 0.14: distribution of participants according to Weight (BMI)

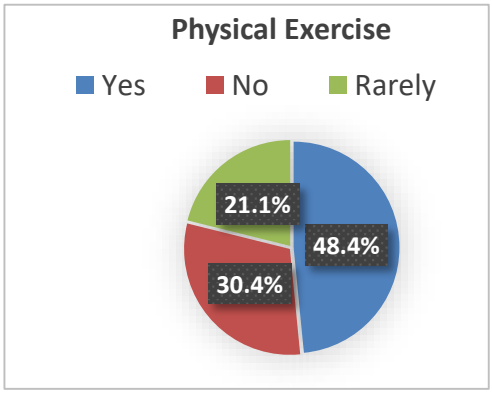


Figure 0.15: distribution of participants according to doing physical exercise

The researchers believe that the lack of statistical significance in this analysis doesn't diminish the overall importance of these factors as general risk factors for stroke. Global research confirms that obesity and a lack of physical activity are key contributors to vascular diseases. Therefore, the researchers recommend focusing on awareness programs that target all community members to promote maintaining a healthy weight and engaging in regular physical activity as an effective preventive strategy to reduce stroke incidence rates.

5-Discussion

This study, conducted in Amran Governorate's teaching hospitals, provides a crucial understanding of stroke epidemiology in a resource-limited setting. The findings align with a substantial body of international and regional literature, while also highlighting unique local factors.

5-1-Stroke Subtype and Demographics:

The study found that ischemic stroke was the predominant subtype (68.3%), while hemorrhagic stroke accounted for 31.7%. This mirrors findings from numerous studies in Yemen and other countries, including Sallam et al. (2009) [12], Al-Mahfadhi et al. (2023) [74], and Hezam and Khan (2023) [9], where ischemic stroke rates ranged from 72% to 82.9%. This pattern is also consistent with studies from Saudi Arabia [77], Egypt [78], Djibouti [79], and Iran [80], confirming the global and regional dominance of ischemic over hemorrhagic stroke.

The study's finding that the majority of patients were older than 60 years (70.8%) is consistent with global trends, reaffirming advanced age as a primary non-modifiable risk factor. This is supported by studies from Yemen (Al-Mahfadhi et al., 2023 [74]; Hezam and Khan, 2023 [9]) and Iran (Farhoudi et al., 2017 [80]), which reported mean ages ranging from 64.98 to 69

years. However, some studies, such as Sallam et al. (2009) [12] in Yemen and Nour et al. (2022) [79] in Djibouti, found a slightly younger mean age, suggesting regional variations possibly due to demographic and lifestyle differences.

The observed male predominance (63.4%) aligns with most regional studies. This trend was also reported by Sallam et al. (2009) [12] (62.6% male), Al-Mahfadhi et al. (2023) [74] (55.8% male), and Hezam and Khan (2023) [9] (74.2% male), and is a pattern seen in other countries like Djibouti [79] and Egypt [78]. This highlights potential sociocultural, behavioral, and biological factors that may contribute to a higher stroke risk among males.

5-2-Lifestyle and Behavioral Risk Factors:

The study found that a high proportion of stroke patients were khat chewers (66.5%), a figure higher than in some previous studies (Sallam et al., 2009 [12] at 43.4%), but similar to others (Salah and Aljarmouz, 2019 [76] at 74.73% and Nour et al., 2022 [79] at 64%). This suggests that khat chewing is a significant, region-specific, and potentially modifiable risk factor, likely linked to its effects on blood pressure and vascular health.

The prevalence of smoking among stroke patients (42.2%) is consistent with findings from other studies in Yemen (Sallam et al., 2009 [12] at 42%; Salah and Aljarmouz, 2019 [76] at 47.3%). While this prevalence is higher than in some studies (Al-Mahfadhi et al., 2023 [74] at 20.9%; Farhoudi et al., 2017 [80] at 12.6%), it aligns with others, such as Nour et al. (2022) [79] in Djibouti (50%). These variations may be a result of differing regional smoking habits, public health campaigns, or the combined effect of cultural practices like khat chewing. And This study, conducted in teaching hospitals in Amran Governorate, provides vital insights into stroke epidemiology in a resource-limited, conflict-affected setting. The findings largely align with global and regional literature while also revealing unique local patterns.

5-3-Prevalent Modifiable Risk Factors: A Comparative Analysis

In this study, **hypertension** was the most prevalent modifiable risk factor (62.1%), a finding consistent with other Yemeni studies (Hezam & Khan, 2023 [9]; Al-Mahfadhi et al., 2023 [74]) and regional data from Djibouti (Nour et al., 2022 [79]) and Egypt (Khedr et al., 2013 [78]). While our prevalence was slightly lower than some reports (Sallam et al., 2009 [12]), hypertension remains a dominant contributor to the stroke burden.

The prevalence of **diabetes mellitus** (32.9%) among our stroke patients was notably higher than some regional studies (Sallam et al., 2009 [12]; Farhoudi et al., 2017 [80]) but aligns with findings from Saudi Arabia (Alhazzani et al., 2023 [77]) and Egypt (Khedr et al., 2013 [78]). This underscores its growing importance as a significant modifiable risk factor in our population.

A striking finding was the high prevalence of **cardiac disease** (62.1%) with a significant association with ischemic stroke (p=0.004). This rate substantially exceeds those reported in other regional studies (Al-Mahfadhi et al., 2023 [74]; Farhoudi et al., 2017 [80]), suggesting a unique epidemiological pattern in this population. The researchers attribute this to potential gaps in primary cardiac care infrastructure and the high prevalence of shared risk factors like khat chewing and smoking.

5-4-Unique Local Patterns and Sociodemographic Influences:

This study identified a significant rural predominance, with **80.7%** of stroke patients residing in rural areas. This disparity reflects documented urban-rural differences in healthcare access, health awareness, and the burden of modifiable risk factors across the region (Khedr et al., 2013 [78]; Nour et al., 2022 [79]).

While obesity (16.8%), previous stroke history (27.3%), and family history of stroke (28%) were also notable, their prevalence differed from some regional patterns. The high rate of **recurrent stroke** (27.3%) compared to other Yemeni cohorts (Al-Mahfadhi et al., 2023 [74]; Salah and Aljarmouz, 2019 [76]) suggests a critical gap in secondary prevention efforts. Similarly,

the higher rate of **familial predisposition** (28%) compared to other studies (Al-Mahfadhi et al., 2023 [74]) suggests potential shared genetic or environmental influences.

Finally, the prevalence of **smoking** (42.2%) and **khat chewing** (66.5%) in our cohort is consistent with regional data, reaffirming their roles as major behavioral risk factors. These findings collectively emphasize the need for targeted, localized interventions that address a complex interplay of systemic, behavioral, and demographic factors, particularly in rural communities.

6-Conclusion and Recommendations

6-1- Key Conclusions from the Study

Based on the findings of the current study and in comparison with previous research, the following are the primary conclusions:

A. Dominance of Ischemic Stroke: The study confirms that ischemic stroke is the predominant subtype (68.3%), consistent with global and regional patterns, including those from Yemen, Saudi Arabia, and Egypt.[78 ,76 ,74]

B. Stroke as an Age-Related Burden: The overwhelming majority of cases (70.8%) were among adults over 60, affirming that advanced age is a primary, non-modifiable risk factor for stroke in the region.[80 ,74]

C. High Prevalence of Traditional Risk Factors: Well-established factors like hypertension (62.1%), diabetes mellitus (32.9%), and smoking (42.2%) are highly prevalent among patients, highlighting their fundamental role in stroke etiology.[78 ,75]

D. Significance of a Local Behavioral Factor: The high prevalence of khat chewing (66.5%) underscores its importance as a region-specific modifiable risk factor that must be addressed in local prevention strategies.[79 ,76]

E. Association Between Heart Disease and Ischemic Stroke: A significant association was found between a history of heart disease and ischemic stroke (p=0.004), suggesting a critical need for enhanced primary cardiac care as a stroke prevention measure.[74]

F. Disparity in Rural-Urban Prevalence: The study's finding that the vast majority of patients (80.7%) reside in rural areas points to significant disparities in healthcare access and awareness between rural and urban populations.[79 ,78]

G. Nuanced Statistical Findings: While some factors like smoking, khat chewing, and hypertension did not show a statistically significant association with stroke subtype, their widespread prevalence confirms their role as overall general risk factors for stroke incidence.

H. Unique Temporal Pattern of Onset: The study observed a peak in hemorrhagic stroke cases during the afternoon (1:00 PM–7:00 PM), a finding that may be linked to local routines and physiological factors and warrants further investigation.

I. Gaps in Secondary Prevention: The high rate of previous stroke history (27.3%) and family history (28%) suggests a critical gap in secondary prevention and an underlying genetic or environmental predisposition within the population [74].

6-2-Recommendations

1. Based on the study's findings and comparisons with previous research, the researchers recommend the following interventions to reduce the burden of stroke in the community:
2. Enhance Community Health Awareness: Launch intensive awareness campaigns targeting rural residents, smokers, and khat chewers, focusing on the importance of controlling major risk factors such as hypertension and diabetes.
3. Improve Healthcare Infrastructure: Establish specialized stroke centers in key hospitals, provide clot-dissolving medications (tPA), and train medical staff on their proper use.

4. Develop Primary and Secondary Prevention Programs: The Ministry of Health should establish national programs for regular early screening for heart disease, hypertension, and diabetes, providing comprehensive treatment plans that focus on patient lifestyle changes.
5. Target Health Interventions to High-Risk Groups: Prevention programs should prioritize the elderly (over 60) and rural residents, along with improving primary healthcare services in these areas.
6. Provide Behavioral Support Services: Free programs are recommended to help smokers and khat chewers quit these habits, highlighting their health risks and direct link to vascular diseases.
7. Develop Health Policies: Relevant authorities should review and update national healthcare policies to include plans for managing strokes and to ensure the availability of medications and equipment in all hospitals.

6.3 Suggestions for Future Research

1) Study the Relationship Between Stroke Timing and Physiological Factors: A detailed analytical study is suggested to identify the physiological and behavioral factors that increase the likelihood of stroke at specific times of the day, such as changes in blood pressure, stress hormone levels, or the effect of daily routines.
2) Analyze the Impact of Genetic Factors on Stroke: A genetic study is recommended to examine the relationship between a family history of stroke and genetic predisposition in the Yemeni community, which would help develop targeted and effective preventive strategies.
3) Assess the Effect of Khat on Stroke Types: A comparative study is proposed to determine whether khat chewing has a preferential effect on a specific stroke type, while considering other associated risk factors

References

- [1]Feigin, V. L., Forouzanfar, M. H., Krishnamurthi, R., Mensah, G. A., Connor, M., Bennett, D. A., Moran, A. E., Sacco, R. L., Anderson, L., Truelsen, T., O'Donnell, M., et al., (2014). *Global and regional burden of stroke during 1990–2010: Findings from the Global Burden of Disease Study 2010.* ***The Lancet***, ***383***(9913), 245–254. https://doi.org/10.1016/S0140-6736(13)61953-4
- [2]Tsao, C. W., Aday, A. W., Almarzooq, Z. I., Anderson, C. A. M., Arora, P., Avery, C. L., Baker-Smith, C. M., Beaton, A. Z., Boehme, A. K., Buxton, A. E., et al., (2023). Heart disease and stroke statistics—2023 update: A report from the American Heart Association. Circulation, 147(8), e93–e621. https://doi.org/10.1161/CIR.0000000000001123
- [3]World Health Rankings. (2020). Yemen: Stroke. Available from: https://www.worldlifeexpectancy.com/yemen-stroke
- [4]Sallam, A.-R., Al Aghbari, K., & Awn, H. (2010). The Clinical Profile of Stroke: A Yemeni Experience. Jordan Medical Journal, 43(2), 115–121. https://www.cabdirect.org/cabdirect/abstract/20093235494
- [5]Bamekhlah, R. M., Bin-Nabhan, A. S., & Musaia, N. S. (2023). Risk factors and clinical presentation of stroke in Mukalla, Hadhramout, Republic of Yemen. Alandalus Journal for Applied Sciences, 6(1), 40–57. https://andalusuniv.net/journ/index.php/AJAS/article/view/672
- [6]Bamekhlah, R. M., Bamekhlah, M. R., Al-Ghazali, H. S., & Bahishwan, A. A. (2019). *Comparative study between haemorrhagic and ischaemic strokes in Hadramout: A hospital-based study.* ***Hamdan Medical Journal***, ***12***(1), 29–33. https://doi.org/10.4103/HMJ.HMJ_62_18
- [7]Salah, M. Q., Aljarmouzi, H. M., Al-Makdad, A. M., Al-Dholae, M. H., & Al-Khawlani, A. M. (2019). Prevalence and pattern of stroke among patients attending a teaching hospital in Dhamar governorate, Yemen. ***Annals of Medicine & Health,*** ***1***(1), 1–4. https://journal.tu.edu.ye/index.php/amh/article/view/1372/1110
- [8]Basamed, J. M. (2025). Risk factors and outcomes of stroke in a tertiary hospital in Hadhramout Governorate, Yemen. ***Yemen Journal of Medicine,*** ***1***(2), 69–73. https://doi.org/10.32677/yjm.v1i2.3552

- [9] Hezam, H. S., & Khan, F. Y. (2023). Clinical presentation, risk factors, and outcomes of stroke in Shabwah Governorate, Yemen. ***Yemen Journal of Medicine, 2***(3), 151–156. https://doi.org/10.32677/yjm.v2i3.4361
- [11] Alhazzani, A. A., Mahfouz, A. A., Abolyazid, A. Y., & Awadalla, N. J. (2021). *Risk factors of the first-time stroke in the southwest of Saudi Arabia: A case–control study*. ***Brain Sciences***, ***11***(2), 222. https://doi.org/10.3390/brainsci11020222
- [16] Brown, R.D., Mayo Clinic. (2024, December 13). Stroke: Care and treatment. Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/stroke/diagnosis-treatment/drc-20350119
- [17] Penman, I. D., Ralston, S. H., Strachan, M. W. J., & Hobson, R. (2022). Davidson's principles and practice of medicine (E-book). Elsevier Health Sciences. https://books.google.com/books/about/Davidson_s_Principles_and_Practice_of_Me.html?id=vhl2EAAAQBAJ
- [18] Loscalzo, J., Fauci, A. S., Kasper, D. L., Hauser, S. L., Longo, D. L., & Jameson, J. L. (Eds.). (2022). Harrison's principles of internal medicine (21st ed.). McGraw Hill Education. https://accessmedicine.mhmedical.com
- [19] Sacco, R. L., Kasner, S. E., Broderick, J. P., Caplan, L. R., Connors, J. J., Culebras, A., Elkind, M. S. V., George, M. G., Hamdan, A. D., Higashida, R. T., Hoh, B. L., et al., (2013). An updated definition of stroke for the 21st century: A statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke, 44(7), 2064–2089. https://doi.org/10.1161/STR.0b013e318296aeca.
- [20] Coutinho, J. M. (2015). Cerebral venous thrombosis. Journal of Thrombosis and Haemostasis, 13(Suppl. 1), S238–S244. https://doi.org/10.1111/jth.12945
- [21] GBD 2016 Stroke Collaborators. (2019). Global, regional, and national burden of stroke, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. The Lancet Neurology, 18(5), 439–458. https://doi.org/10.1016/S1474-4422(19)30034-1
- [22] Iadecola, C., Buckwalter, M. S., & Anrather, J. (2020). Immune responses to stroke: Mechanisms, modulation, and therapeutic potential. Journal of Clinical Investigation, 130(6), 2777–2788. https://doi.org/10.1172/JCI135530
- [23] Chugh, C. (2019). Acute ischemic stroke: Management approach. Indian Journal of Critical Care Medicine, 23(Suppl 2), S140–S146. https://doi.org/10.5005/jp-journals-10071-23192
- [24] Feske, S. K. (2021). Ischemic stroke. The American Journal of Medicine, 134(12), 1457–1464. https://doi.org/10.1016/j.amjmed.2021.07.027
- [25] Kremer, P. H., Jolink, W. M., Kappelle, L. J., Algra, A., & Klijn, C. J. M. (2015). Risk factors for lobar and non-lobar intracerebral hemorrhage in patients with vascular disease. PLOS ONE, 10(11), e0142338. https://doi.org/10.1371/journal.pone.0142338
- [26] Martin, C. O., & Rymer, M. M. (2011). Hemorrhagic stroke: Aneurysmal subarachnoid hemorrhage. Missouri Medicine, 108(2), 124–127. https://pmc.ncbi.nlm.nih.gov/articles/PMC6189155/pdf/ms108_p0124.pdf
- [27] Leite, J., Ribeiro, A., Gonçalves, D., Sargento-Freitas, J., Trindade, L., & Duque, V. (2019). Cerebral venous thrombosis as rare presentation of herpes simplex virus encephalitis. Case Reports in Infectious Diseases, 2019, 7835420. https://doi.org/10.1155/2019/7835420
- [28] Turner, M., Woo, D., Wong, N., Virani, S., Turan, T., Sotoodehnia, N., Sorlie, P., Soliman, E., Paynter, N., Nichol, G., Mussolino, M., Mozaffarian, D., et al., (2012). Heart disease and stroke statistics—2012 update: A report from the American Heart Association. Circulation, 125(1), e2–e220. https://doi.org/10.1161/CIR.0b013e31823ac046
- [29] Kapral, M. K., Fang, J., Hill, M. D., Silver, F., Richards, J., Jaigobin, C., Cheung, A. M., & Investigators of the Registry of the Canadian Stroke Network. (2005). Sex differences in stroke care and outcomes: Results from the Registry of the Canadian Stroke Network. Stroke, 36(4), 809–814. https://doi.org/10.1161/01.STR.0000157662.09551.e5
- [30] Kleindorfer, D., Broderick, J., Khoury, J., Flaherty, M., Woo, D., Alwell, K., Moomaw, C. J., Schneider, A., Miller, R., Shukla, R., & Kissela, B. (2006). The unchanging incidence and case-fatality of stroke in the 1990s. Stroke, 37(10), 2473–2478. https://doi.org/10.1161/01.STR.0000242766.65550.92

- [31] Touzé, E., & Rothwell, P. M. (2008). Sex differences in heritability of ischemic stroke. Stroke, 39(1), 16–23. https://doi.org/10.1161/STROKEAHA.107.484618
- [32] Vermeer, S. E., Sandee, W., Algra, A., Koudstaal, P. J., Kappelle, L. J., & Dippel, D. W. J. (2006). Impaired glucose tolerance increases stroke risk in nondiabetic patients with transient ischemic attack or minor ischemic stroke. Stroke, 37(6), 1413–1417. https://doi.org/10.1161/01.STR.0000221766.73692.0b
- [33] Wolf, P. A., Abbott, R. D., & Kannel, W. B. (1991). Atrial fibrillation as an independent risk factor for stroke: The Framingham Study. Stroke, 22(8), 983–988. https://doi.org/10.1161/01.str.22.8.983
- [34] Song, Y.-M., & Cho, H.-J. (2008). Risk of stroke and myocardial infarction after reduction or cessation of cigarette smoking. Stroke, 39(9), 2432–2438. https://doi.org/10.1161/STROKEAHA.107.512632
- [35] Denti, L., Cecchetti, A., Annoni, V., Merli, M. F., Ablondi, F., & Valenti, G. (2003). The role of lipid profile in determining the risk of ischemic stroke in the elderly: A case–control study. Archives of Gerontology and Geriatrics, 37(1), 51–62. https://doi.org/10.1016/S0167-4943(03)00020-7
- [36] Esse, K., Fossati-Bellani, M., Traylor, A., & Martin-Schild, S. (2011). Epidemic of illicit drug use, mechanisms of action/addiction and stroke as a health hazard. Brain and Behavior, 1(1), 44–54. https://doi.org/10.1002/brb3.7
- [38] O'Donnell, M. J., Chin, S. L., Rangarajan, S., Xavier, D., Liu, L., Zhang, H., Rao-Melacini, P., Zhang, X., Pais, P., Agapay, S., Lopez-Jaramillo, P., Damasceno, A., Langhorne, P., McQueen, M. J., et al., (2016). Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): A case-control study. The Lancet, 388(10046), 761–775. https://doi.org/10.1016/S0140-6736(16)30506-2
- [39] Chaker, L., Baumgartner, C., Ikram, M. A., et al. (2014). Subclinical thyroid dysfunction and the risk of stroke: A systematic review and meta-analysis. European Journal of Epidemiology, 29(9), 791–800. https://doi.org/10.1007/s10654-014-9946-8
- [40] Ostendorf, A. P., Roach, E. S., & Adams, R. J. (2017). Stroke and sickle cell disease. In L. R. Caplan, J. Biller, M. C. Leary, E. H. Lo, A. J. Thomas, M. Yenari, & J. H. Zhang (Eds.), Primer on cerebrovascular diseases (2nd ed., pp. 603–608). Academic Press. https://doi.org/10.1016/B978-0-12-803058-5.00118-1
- [41] Nguyen, A. T., Curtis, K. M., Tepper, N. K., et al. (2024). U.S. medical eligibility criteria for contraceptive use, 2024. MMWR Recommendations and Reports, 73(RR-4), 1–126. http://dx.doi.org/10.15585/mmwr.rr7304a1
- [42] Kushner, A., West, W. P., Khan, S. M. Z., et al. (2024). Virchow triad. In StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. Updated 2024 Jun 7. Available from: https://www.ncbi.nlm.nih.gov/books/NBK539697/
- [43] Reddin, C., Murphy, R., Hankey, G. J., et al. (2022). Association of psychosocial stress with risk of acute stroke. JAMA Network Open, 5(12), e2244836. https://doi.org/10.1001/jamanetworkopen.2022.44836
- [44] Strilciuc, S., Grad, D. A., Radu, C., Chira, D., Stan, A., Ungureanu, M., Gheorghe, A., & Muresanu, F. D. (2021). The economic burden of stroke: A systematic review of cost of illness studies. Journal of Medicine and Life, 14(5), 606–619. https://doi.org/10.25122/jml-2021-0361
- [45] Bogavac, I., Jeličić, L., Marisavljević, M., Bošković Matić, T., & Subotić, M. (2024). Arterial presumed perinatal ischemic stroke: A mini review and case report of cognitive and speech-language profiles in a 5-year-old girl. Children, 11(1), 33. https://doi.org/10.3390/children11010033
- [46] Doyle, K. P., Simon, R. P., & Stenzel-Poore, M. P. (2008). Mechanisms of ischemic brain damage. Neuropharmacology, 55(3), 310–318. https://doi.org/10.1016/j.neuropharm.2008.01.005
- [47] Macrez, R., Ali, C., Toutirais, O., Le Mauff, B., Defer, G., Dirnagl, U., & Vivien, D. (2011). Stroke and the immune system: From pathophysiology to new therapeutic strategies. The Lancet Neurology, 10(5), 471–480. https://doi.org/10.1016/S1474-4422(11)70066-7

- [48] Montaño, A., Hanley, D. F., & Hemphill, J. C. 3rd. (2021). Hemorrhagic stroke. In Handbook of Clinical Neurology (Vol. 176, pp. 229–248). Elsevier. https://doi.org/10.1016/B978-0-444-64034-5.00019-5
- [49] Singh, J., Munakomi, S., & Baruffi, S. (2025). Cerebral venous sinus thrombosis. In StatPearls. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK459315/
- [50] Powers, W. J., Rabinstein, A. A., Ackerson, T., Adeoye, O. M., Bambakidis, N. C., Becker, K., Biller, J., Brown, M., Demaerschalk, B. M., Hoh, B., Jauch, E. C., Kidwell, C. S., et al., (2018). 2018 guidelines for the early management of patients with acute ischemic stroke: A guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke, 49(3), e46–e110. https://doi.org/10.1161/STR.0000000000000158
- [51] Hafez, D. A., Elkhodairy, K. A., Teleb, M., & Elzoghby, A. O. (2020). Nanomedicine-based approaches for improved delivery of phyto-therapeutics for cancer therapy. Expert Opinion on Drug Delivery, 17(3), 279–285. https://doi.org/10.1080/17425247.2020.1716334
- [52] Wardlaw, J. M., Seymour, J., Cairns, J., Keir, S., Lewis, S., & Sandercock, P. (2004). Immediate computed tomography scanning of acute stroke is cost-effective and improves quality of life. *Stroke, 35*(11), 2477–2483. https://doi.org/10.1161/01.STR.0000143453.78005.44
- [53] Saur, D., Kucinski, T., Grzyska, U., Eckert, B., Eggers, C., Niesen, W., Schoder, V., Zeumer, H., Weiller, C., & Röther, J. (2003). Sensitivity and interrater agreement of CT and diffusion-weighted MR imaging in hyperacute stroke. *AJNR American Journal of Neuroradiology, 24*(5), 878–885. https://pubmed.ncbi.nlm.nih.gov/12748088/
- [54] Sun, B., & Wang, Z. (2023). A Short Review on Advances in Early Diagnosis and Treatment of Ischemic Stroke: Advancements in Diagnosis and Treatments of Ischemic Stroke. *Galen Medical Journal, 12*, e2993. https://doi.org/10.31661/gmj.v12i.2993
- [55] Jin Cho, S., Chai Jung, S., Hyun Suh, C., Won Kim, K., Woo, D. C., Yong Oh, W., Gu Lee, J., & Jun Kim, B. (2019). Neuroimaging in acute ischemic stroke: Role and recent advances. Journal of the Korean Society of Radiology, 80(6), 1075-1090. https://doi.org/10.3348/jksr.2019.80.6.1075
- [56] Ferro, J. M., Massaro, A. R., & Mas, J. L. (2010). Aetiological diagnosis of ischaemic stroke in young adults. The Lancet Neurology, 9(11), 1085–1096. https://doi.org/10.1016/S1474-4422(10)70251-9
- [57] Abedi, V., Khan, A., Chaudhary, D., et al. (2020). Using artificial intelligence for improving stroke diagnosis in emergency departments: A practical framework. Therapeutic Advances in Neurological Disorders, 13, 1–13. https://doi.org/10.1177/1756286420938962
- [58]Shafaat, O., & Sotoudeh, H. (2025). Stroke imaging. In StatPearls. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK546635/
- [59] Doria, J. W., & Forgacs, P. B. (2019). Incidence, implications, and management of seizures following ischemic and hemorrhagic stroke. *Current Neurology and Neuroscience Reports, 19*(7), 37. https://doi.org/10.1007/s11910-019-0957-4
- [60] Bendix Labeit, L., Michou, E., Hamdy, S., Trapl-Grundschober, M., Suntrup-Krueger, S., Muhle, P., Bath, P. M., & Dziewas, R. (2023). The assessment of dysphagia after stroke: State of the art and future directions. The Lancet Neurology, 22(9), 858–870. https://doi.org/10.1016/S1474-4422(23)00153-9
- [61] Bembenek, J. P., & Członkowska, A. (2013). Venous thromboembolism prophylactic methods in acute stroke patients – Current state of knowledge. Neurologia i Neurochirurgia Polska, 47(6), 564–571. https://doi.org/10.5114/ninp.2013.39074
- [62] Miller, E. C., & Elkind, M. S. (2016). Infection and stroke: An update on recent progress. Current Neurology and Neuroscience Reports, 16(1), 2. https://doi.org/10.1007/s11910-015-0602-9
- [63] Kuo, C.-L., & Hu, G.-C. (2018). Post-stroke spasticity: A review of epidemiology, pathophysiology, and treatments. International Journal of Gerontology, 12(4), 280–284. https://doi.org/10.1016/j.ijge.2018.05.005

- [64] Penman, I. D., Ralston, S. H., Strachan, M. W. J., & Hobson, R. (2022). Davidson's principles and practice of medicine (24th ed.). Elsevier Health Sciences. https://books.google.com/books?id=vhl2EAAAQBAJ
- [60] Palaiodimou, L., Sarraj, A., Safouris, A., et al. (2023). Endovascular treatment for large-core ischaemic stroke: A meta-analysis of randomised controlled clinical trials. Journal of Neurology, Neurosurgery & Psychiatry, 94, 781–785. https://doi.org/10.1136/jnnp-2023-331513
- [66] Jadhav, A. P., Molyneaux, B. J., Hill, M. D., & Jovin, T. G. (2018). Care of the post-thrombectomy patient. Stroke, 49(11), 2801–2807. https://doi.org/10.1161/STROKEAHA.118.021640
- [67] Sandercock, P. A. G., Counsell, C., Tseng, M. C., & Cecconi, E. (2014). Oral antiplatelet therapy for acute ischaemic stroke. Cochrane Database of Systematic Reviews, 2014(3), CD000029. https://doi.org/10.1002/14651858.CD000029.pub3
- [68] Ulivi, L., Squitieri, M., Cohen, H., Cowley, P., & Werring, D. J. (2020). Cerebral venous thrombosis: A practical guide. Practical Neurology, 20(5), 356–367. https://doi.org/10.1136/practneurol-2019-002415
- [69] Greco, A., Occhipinti, G., Giacoppo, D., Agnello, F., Laudani, C., Spagnolo, M., Mauro, M. S., Rochira, C., Finocchiaro, S., Mazzone, P. M., Faro, D. C., Landolina, D., Ammirabile, N., Imbesi, A., Raffo, C., & Capodanno, D. (2023). Antithrombotic therapy for primary and secondary prevention of ischemic stroke: JACC state-of-the-art review. Journal of the American College of Cardiology, 82(15), 1538–1557. https://doi.org/10.1016/j.jacc.2023.07.025
- [70] Yu, K., Sun, Y., Guo, K., Wang, X., Li, Y., Chen, J., & Zhang, H. (2023). Early blood pressure management in hemorrhagic stroke: A meta-analysis. Journal of Neurology, 270, 3369–3376. https://doi.org/10.1007/s00415-023-11654-w
- [71] Mullen, M. T., & Anderson, C. S. (2022). Review of long-term blood pressure control after intracerebral hemorrhage: Challenges and opportunities. Stroke, 53(7), 2142–2151. https://doi.org/10.1161/STROKEAHA.121.036885
- [72] Shi, A. C., Taylor, T., Huang, C.-C., Singhal, A. B., Goldstein, J. N., Bevers, M. B., & Hou, P. C. (2025). Early intensive blood pressure reduction after intracerebral hemorrhage is associated with worse functional outcome: The risk of overshooting blood pressure goals. Annals of Emergency Medicine. https://doi.org/10.1016/j.annemergmed.2025.10.009
- [73] Yang, Q., Zheng, R., Wang, S., Zhu, J., Li, M., Wang, T., Zhao, Z., Xu, M., Lu, J., Chen, Y., Ning, G., Wang, W., Bi, Y., & Xu, Y. (2023). Systolic blood pressure control targets to prevent major cardiovascular events and death in patients with type 2 diabetes: A systematic review and network meta-analysis. Hypertension, 80(8), 1640–1653. https://doi.org/10.1161/HYPERTENSIONAHA.123.20954
- [74] Lui, F., Khan Suheb, M. Z., & Patti, L. (2025). Ischemic stroke. In StatPearls. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK499997/
- [78] Błaż, M., & Sarzyńska-Długosz, I. (2023). Family history of stroke – A useful clue for the primary care physician and stroke neurologist: A narrative review. Postępy Psychiatrii i Neurologii, 32(1), 31–39. https://doi.org/10.5114/ppn.2023.126482
- [79] Khedr, E. M., Elfetoh, N. A., Al Attar, G., Ahmed, M. A., Ali, A. M., Hamdy, A., Kandil, M. R., & Farweez, H. (2013). Epidemiological study and risk factors of stroke in Assiut Governorate, Egypt: A community-based study. Neuroepidemiology, 40(4), 288–294. https://doi.org/10.1159/000346270
- [80] Nour, M. A. H., Mrabet, S., Maidal, M. A., Gharbi, A., Abida, Y., Souissi, A., Gargouri, A., Kacem, I., Nasri, A., & Gouider, R. (2022). *Stroke in Djibouti*. **African Journal of Emergency Medicine, 12**(2), 141–147. https://doi.org/10.1016/j.afjem.2022.03.002
- [81] Farhoudi, M., Mehrvar, K., Sadeghi-Bazargani, H., Hashemilar, M., Seyedi-Vafaee, M., Sadeghi-Hokmabad, E., Rikhtegar, R., Saber-Maroof, B., Abutalebi, M., Rezaei, M., Vaferi, S., Aghili, A., & Ebrahimi, O. (2017). *Stroke subtypes, risk factors and mortality rate in northwest of Iran*. **Iranian Journal of Neurology, 16**(3), 112–117. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5673982/
- [82] Schneider, S., Kornejeva, A., Vibo, R., & Kõrv, J. (2017). *Risk factors and etiology of young ischemic stroke patients in Estonia*. **Stroke Research and Treatment, 2017**, Article 8075697. https://doi.org/10.1155/2017/8075697