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Chewing Khat (*Catha edulis*) is a Risk Factor for Stroke: A Prospective Study

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Objective: The plant known as *Catha edulis*, commonly referred to as Khat, holds significant cultural significance within the populations of East Africa and Southwestern Arabia. The objective of this study is to ascertain and assess the association between the act of chewing khat and the incidence of acute stroke.

Materials and Methods: The present study was carried out in a prospective observational manner at the Mogadishu-Somalia Turkish Training and Research Hospital. Data were gathered over a period of three years, from January 2021 to December 2023. The study encompassed all stroke patients who presented at the hospital's emergency department who had the habit of khat consumption and did not have previous risk factors of stroke. The study included a sample size of 52 patients.

Results: The study involved 52 male patients who were diagnosed with acute stroke. Among the participants, 75% (n = 39) were aged between 18 and 39 years, while 25% (n = 13) were aged between 40 and 64 years. The findings indicate that hemorrhagic stroke was the prevailing stroke type, accounting for 88.5% (n = 46) of cases, while ischemic stroke accounted for only 11.5% (n = 6). All 52 participants in the study reported using khat. In addition to the act of chewing khat, it was found that 70% (n = 36) of the participants had been using khat for a period exceeding 5 years; none of the participants exhibited any additional risk factors for stroke.

Conclusion: The findings of our study indicate that *Catha edulis*, commonly known as khat, is a significant risk factor and potential causative agent for stroke. Khat consumption has been identified as a contributing factor to the incidence of cerebrovascular diseases.

Keywords: khat, stroke, *Catha edulis*, hemorrhagic, chewing

Introduction

Catha edulis, commonly known as the khat plant, is a member of the Celastraceae family and is extensively grown in certain regions of East Africa and the Arabian Peninsula.[1] The nomenclature of the plant varies depending on the geographical location where it is cultivated. In Ethiopia, it is commonly known as chat, while in Yemen, it referred to as qat. Similarly, in Kenya, it is called mirra, and in Somalia, it is known as qaad or jaad. Nevertheless, in scholarly circles, the most prevalent term used to denote this plant is Khat.[2] The principal psychoactive constituents present in khat are cathine, cathinone, and other compounds that exhibit structural similarity to amphetamines.[3] While the degree of psychological dependence induced by khat is not as profound as that of alcohol or tobacco, it can still result in significant consequences for an individual's well-being and economic stability. Khat is a potent stimulant that elicits a degree of psychological dependence ranging from mild to moderated.[4] The historical application of khat in medicinal contexts can be traced back to the era of Alexander the Great, who employed it as a treatment for and unspecified "epidemic sickness" among his troops.[5] According to the World Health Organization (WHO), khat has been categorized as a controlled substance, and its misuse has been cautioned against due to the potential for a diverse range of negative health consequences.[6] Overall, there is a paucity of information regarding individuals who engage in khat consumption within Somalia. This study presents the correlation between khat consumption and cerebrovascular diseases. The act of consuming khat leaves for social and psychological purpose has been a longstanding tradition in nations where khat cultivation is prevalent. The objective of this study is to ascertain and assess the association between the act of chewing

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khat and the occurrence of acute stroke. According to reports, each 100 g of fresh leaves of khat contains 36–114 mg of cathinone, 83–120 mg of cathine, and 8–47 mg of norephedrine on average. As the most prevalent alkaloid in fresh *Catha edulis*, cathinone is responsible for the stimulant properties. To fully explore the toxicological consequences of cathinone, numerous in vitro and pre-clinical investigations were conducted. Some drawbacks for those who chew khat include excessive talkativeness, hyperactivity, sleeplessness, and irritation. While its primary metabolite norephedrine induces coronary vasoconstriction similar to that of cathinone, cathinone itself causes negative inotropy, negative chronotropy, and coronary vasoconstriction in isolated hearts.[7]

Materials and Methods

Study population and design: The present study aims to examine the potential association between khat (*Catha Edulis*) consumption and stroke among patients seeking emergency medical care at the Mogadishu Somali-Turkey Recep Tayyip Erdogan Training and Research Hospital. Prospective data collection through observation was conducted to inquire about patients' khat usage and duration of use. Data were collected for a period of three years, from January 2021 to December 2023, following the receipt of ethical approval. The diagnosis of stroke was made through the utilization of clinical presentation with mRS (modified Ranked Scale) and confirmation through computed tomography (CT) scans and magnetic resonance imaging (MRI). All the participants of the study were done a full stroke work-up including CT angiogram and MR angiography to look vascular etiology, and none of them was found pathology. The demographic factors, the vital signs including blood pressure and heart rate, were also recorded for the patients. The study inquired about the duration of khat usage, history of khat chewing or other chronic illness, and prior khat use among stroke patients.

Patient selection: This study included stroke patients who have consumed khat and do not exhibit any additional risk factors for stroke, such as hypertension, diabetes, or hyperlipidemia, upon arrival at the hospital's emergency department. The study comprised a sample size of 52 patients. Patients presenting with stroke who exhibited an additional risk factor for stroke were excluded from the study. The study also added a control group of 26 participants who did not use khat. The demographic data, the type of stroke, the location of the stroke, and mRS for the first evaluation and after 3 months were analyzed.

Statistical analysis: The data from this study were analyzed using the statistical package for social sciences (SPSS) version 26.0. Descriptive statistics were obtained to summarize the results of the data; categorical variables were analyzed as counts and percentages with a statistically significant difference of (P 0.001). A chi-square test for independence was utilized to assess the associations among the categorical variables. In order to examine the factors that contribute to the development of stroke, a statistical measure with linear correlation was used to measure the significance. Odd ratios and 95% confidence intervals were calculated for potential predictors of stroke outcome using mRS.

Ethical consideration: The research was granted approval by the Institutional Ethical Board of the Recep Tayyip Erdogan Training and Research Hospital located in Mogadishu, Somalia, under the reference number MSTH/9394. The study participants' identities were not collected, thus ensuring the anonymity of the data obtained. Voluntary participation was strictly adhered to in the research. The study participants provided written consent prior to their involvement in the research. The present investigation was conducted in accordance with the principles outlined in the Helsinki Declaration.

Results

The study comprised a sample size of 52 individuals who had recently experienced acute stroke and had a history of khat consumption but lacked any other stroke risk factors, all of whom were of the male gender, resulting in a 100% male representation. Out of the total number of participants, 39 individuals, constituting 75% of the sample, were aged between 18 and 39 years (Table 1), whereas 13 participants, accounting for 25% of the sample, were aged between 40 and 64 years. The findings indicate that hemorrhagic strokes were the predominant type, constituting 88.5% (n = 46) of the total cases, while ischemic strokes accounted for a mere 11.5% (n = 6) of the cases (Figure 1). All fifty-two participants in the research study utilized khat. Furthermore, it was observed that a majority of the participants, specifically 36 individuals (constituting 70% of the sample), engaged in the habit of chewing khat for a period exceeding

Table 1 Sociodemographic Factors: Age and Gender of the Participants

Variable	N (%)	X^2 *(p-value)*
Age		
18–39 years	39 (75)	36.674 (0.001)
40–64 years	13 (25)	
≥65 years	0 (0)	
Sex		
Male	52 (100)	9.104 (0.003)
Female	0 (0)	

Notes: This table presents the sex and age of the participants in the study, which indicates that all participants were male, and the majority of the age group was young, between 18 and 39 years. P-value <0.05 is significant.
Abbreviations: AOR, Adjusted Odd Ratio; CI, Confidence Interval=95%.

five years. The remaining sixteen participants (30% of the sample) reported using khat for a duration ranging from one to five years. None of the patients in this study exhibited any additional risk factors for stroke during the presentation and after doing stroke workup.

The rate of ischemic stroke was only 6 patients (11.5%), and four of them had basal ganglia infarct, while the other two patients had lacunar infarct. In contrast, the basal ganglia hemorrhage 30 (65.2%) was the most frequently occurring hemorrhagic strokes, while 8 (17.4%) of the patients had thalamic hemorrhage. The rate of lobular, cerebellar, and subarachnoid hemorrhage was 3 (6.5%), 3 (6.5%), and 2 (4.4%), respectively (Figure 2). No intraventricular or brain stem hemorrhage was seen.

According to the outcome of the patients by using mRS (modified Ranked Scale) indicated the prognostic function outcome of the participants during the first evaluation in the emergency department and follow-up after three months using mRS (modified Ranked Scale) (Figure 3). Thirty-two patients came for the first evaluation with mRS of Grade (2–3), but after 3 months, they improved to Grade (0–1). Fourteen of the participant evaluated with mRS of Grade 3+ for

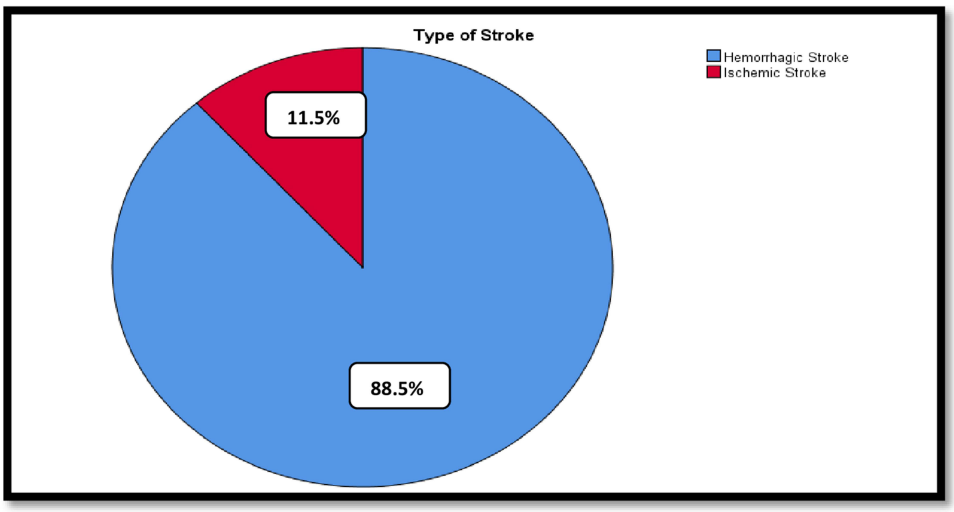

Figure 1 This figure indicates the percentage of hemorrhagic and ischemic stroke among the participants and shows that most of them had hemorrhagic stroke.

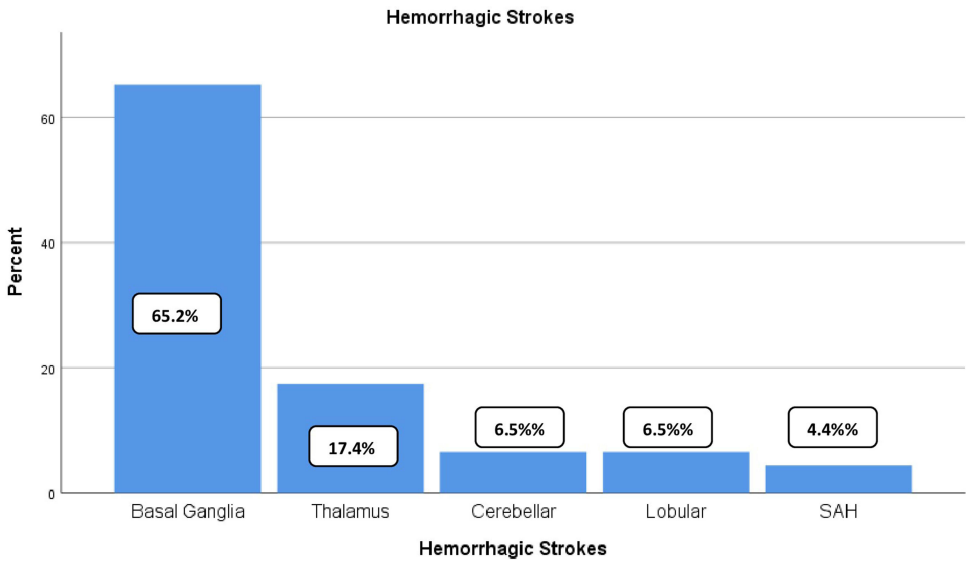

Figure 2 This figure explains the percentage of hemorrhagic stroke according the locations of the participants. SAH: subarachnoid hemorrhage, IVH: intraventricular hemorrhage.

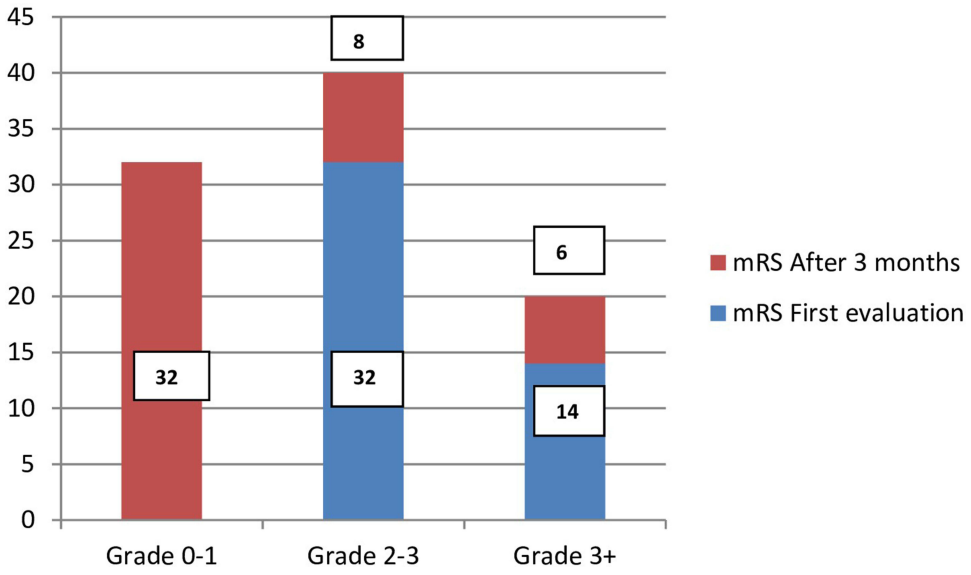

Figure 3 This figure displays functional outcome according mRS (modified Ranked Scale) for the participants. 32 patients came for the first evaluation with mRS of Grade (2–3), but after 3 months, they improved to Grade (0–1).14 of the participant evaluated with mRS of Grade 3+ for first examination, and 8 of them improved to grade (2–3) after 3 months of follow up. No change was seen in a 6 patients for mRS after three months of follow up and six of the participant died within the first week after admission.

first examination, and 8 of them improved to grade (2–3) after 3 months of follow-up. No change was seen in a 6 patients for mRS after three months of follow-up, and six of the participant died within the first week after admission. The study also added a control group of 26 participants who did not use khat; none of them developed a stroke.

The study revealed that a significant proportion of the participants were young, aged below 40 years old, and had experienced hemorrhagic strokes. Additionally, the majority of the participants had a history of khat use for a period exceeding five years without any other identifiable risk factors for stroke. The majority of the participants, specifically 75%, were classified as young.

Discussion

The act of regularly chewing khat has been observed to be linked with an increase in diastolic blood pressure among adult individuals in Ethiopia, as reported in a study.[8] The findings indicate a notable correlation between this condition and an increased likelihood of cardiogenic shock, stroke, and mortality among patients. Anecdotal evidence is purportedly hazardous. Subsequent to that, there have been over 302 scholarly publications by N.N. Al-Hebshi and N. Skauge regarding the potential health implications of khat consumption.[9] According to Halbach's research, khat consumption has been linked to various adverse health effects such as stomatitis, esophagitis, gastritis, constipation, malnutrition, liver cirrhosis, anorexia, sleeplessness, spermatorrhoea, and impotence, infertility, and other health problems.[10]

To date, no prior research has been conducted to evaluate the potential causality and correlation between khat consumption and stroke. The available literature solely comprises case reports.[11] The present study aims to elucidate the potential association between khat consumption and the incidence of stroke, given the increasing prevalence of khat chewing both in Africa and globally.[12]

The plant known as *Catha edulis*, commonly referred to as khat, has a significant cultural history in East African and Southwestern Arabian societies, where it is consumed by individuals who engage in prolonged chewing of the raw leaves. The process enables the absorption of cathinone and cathine, which are amphetamine-like compounds, through the mucosal membrane. Cathinone is present in fresh leaves, while cathine is found in non-fresh leaves.[13]

According to a cross-sectional study conducted in Ethiopia, individuals who chewed khat exhibited a comparatively lower average body weight in comparison to those who did not chew khat.[14] According to a study, individuals with Type-2 diabetes who chew khat had a higher average body weight compared to those who do not chew khat.[15]

The act of chewing khat has been a prevalent and socially sanctioned custom predominantly observed among males. However, due to cultural norms, women are comparatively less inclined to engage in this practice. The phenomenon of gender being considered a risk factor for khat chewing may be attributed to the cultural prohibition that restricts women from participating in certain social activities, as noted by Bebrie et al.[16] Kassim, Rogers, and Leach conducted a study.

All the participants of the study were done a full stroke work-up including CT angiogram and MR angiography to look vascular etiology, and none of them was found pathology.

In a study that was published in 2007 about the consumption of khat and other drugs, observed behaviors linked with problematic khat consumption indicated that a significant proportion of the participants are likely to exhibit severe addiction. Spherically, the definition of excessive use employed in that study – involving an average consumption of more than two bundles of khat per day within a week – was reported by 18% of the sample. Additionally, 43% of the participants reported experiencing more than one sleepless night in the past week due to khat consumption, while 15% reported consuming khat alone.[17] Cathinone is by far the most active component of khat, being primarily responsible for its stimulating and psychotropic properties. This β-keto analog of amphetamine has sympathomimetic/cardiovascular effects (eg, increased blood pressure, contractile force, and heart rate), hyperthermia and mydriasis, and amphetamine-like CNS stimulant effects by stimulating CNS dopamine release.[18] According to a study conducted in Ethiopia on 60 people with an average chewing frequency of 1.7 times per week, 200 g of fresh "Beleche" khat had a substantial effect on respiratory and cardiac performance.[19] A study done in Kenya shows the lifetime prevalence of khat was 44.6%; in Somalia, there is no extreme prevalence of khat in the community.[20]

The study also added a control group of 26 participants who did not use khat; none of them developed a stroke. Khat chewers had a significantly higher risk factor to develop stroke compared to non-khat chewers due to its most active compound, cathinone, which increases the blood pressure, and heavy consumption increases the rate of CVD. Chewing khat is associated with increased both systolic and diastolic blood pressure, especially for heavy khat chewers; it also affects the heart rate, causing tachycardia; and sustained use of khat attributes to cerebrovascular diseases.

The limitations of our study are as follows: first, the sample size, which is too small; second, the amount of khat chewing, which is difficult to accurately infer from the participants. Also, most of the khat chewers are male, which is why all our participants are male; females do not use khat due to cultural and religious reasons and the largest age group of khat chewers is male. The autoimmune and coagulation panel was not performed due to a lack of availability in the hospital and throughout the country.

Conclusion

Khat chewers had a significantly higher risk factor to develop stroke compared to non-khat chewers due to its most active compound, cathinone, which increases the blood pressure and causes vasoconstriction of cerebral vasculature cause stroke, and heavy consumption increases the rate of CVD. Thus, we recommend that health professionals be aware that khat can be a risk factor independently for stroke and advise the community to take care of the consumption of this plant.

Data Sharing Statement

The datasets used or analyzed in the study are available from the corresponding author on reasonable request.

Ethical Approval and Consent

Ethical Approval and Consent: The study was approved by the institutional review board of Mogadishu-Somalia Turkey Hospital (MSTH) Ref No: MSTH/9394. The study corresponds to the ethical standards outlined in the Declaration of Helsinki, and the database method was handled in conformity with privacy legislation and the study participants provided written consent prior to their involvement in the research.

Consent for Publication

Written informed consent was obtained from the patients for participation and publication of this study, and the proof is available for the corresponding author on request.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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