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# Knowledge of Risk Factors and Warning Signs of Stroke among Hypertensive Patients at Jakaya Kikwete Cardiac Institute, Tanzania: A Cross-Sectional Study

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**Abstract**

***Background***

In Tanzania, approximately two-thirds of patients who die from stroke have a history of hypertension. Awareness of stroke risk factors and the ability to recognize its warning signs are critical, particularly among high-risk populations such as individuals with hypertension. However, there is limited evidence in Tanzania regarding the level of knowledge among hypertensive patients about these risk factors and early warning signs of stroke.

***Broad objective***

Assessment of knowledge of risk factors and warning signs of stroke among hypertensive patients at the Jakaya Kikwete Cardiac Institute in Tanzania.

***Methods***

A descriptive cross-sectional survey was conducted between February and March 2022 among patients with hypertension attending clinic at the Jakaya Kikwete Cardiac Institute. A systematic sampling technique was used to recruit 280 study participants. Quantitative data were collected using an interviewer-administered questionnaire. Descriptive statistics and logistic regression analyses were performed using SPSS version 25.

***Results***

A total of 280 participants were included in this study. Among the study participants, only less than half of them had adequate knowledge of the risk factors (46.5%) and only half (40.6%) of them had adequate knowledge of warning signs of stroke. Urban residence (AOR 4.63; 95%CI 1.65-12.98) and tertiary education level (AOR 12.73; 95%CI 5.31-30.59) were associated with higher odds of having adequate knowledge of stroke risk factors. Tertiary education level (AOR 10.98; 95%CI 4.96-26.22) and previously seeing someone with a stroke (AOR 11.31; 95%CI 4.99-25.61) were associated with higher odds of having adequate knowledge of stroke warning signs.

***Conclusion and recommendations***

This study revealed that the majority of participants had inadequate knowledge of stroke risk factors and warning signs. Significant predictors of knowledge included education level, place of residence, and prior exposure to stroke. Therefore, targeted educational programs aimed at increasing stroke awareness among individuals with hypertension should be implemented, with particular emphasis on rural areas. Healthcare providers should ensure that hypertensive patients receive adequate and personalized information regarding their stroke risk and early warning signs.

***Keywords:*** *Hypertension, Knowledge, Risk factors, Stroke, Warning signs.*

**Introduction**

Stroke is a life-threatening emergency disorder and a leading cause of morbidity, mortality, disability, and increased economic cost of treatment worldwide. Globally, over 13.7 million new stroke cases occur annually and it is estimated that 1 in 4 people over age 25 will suffer a stroke in their lifetime (1). The prevalence of stroke increases rapidly worldwide and it is expected that by the 2030s it could be the most prevalent cardiovascular disorder if no appropriate preventive measures are taken into consideration. Initially, most stroke cases were occurring in developed countries but recent years' studies show that the burden of stroke is now high and increasing in low- and middle-income countries (LMICs). Around three-fourths of stroke cases and more than three-fourths of both stroke-related deaths and disability-adjusted life years (DALYs) have been recorded in LMICs with the burden increasing among young ages (2). In Tanzania, stroke admissions in 2017 were reported to be 202.2 cases per 100,000 population, a 70-fold increase from 2.9 admissions per 100,000 in 1974 (3).

Knowledge of stroke is a key primary preventive measure to deal with stroke worldwide. To be most effective, adequate knowledge of stroke risk factors and warning signs is needed for the population both at high and low risk for stroke (4). Inadequate knowledge of risk factors and warning signs of stroke has been identified as the significant contributors to the increasing prevalence of stroke and delay in seeking healthcare services resulting in a potential increase in morbidity, mortality, and disability from stroke (4).

Stroke is linked with both modified and non-modified risk factors. The modified risk factors are approximated to contribute to more than 90% of the stroke burden. The major identified modified risk factors for stroke include hypertension, smoking, unhealthy diet, physical inactivity, and obesity (5). According to the Global Burden of Disease, Injuries, and Risk factors, a 2016 report showed that globally, hypertension is the largest single risk for stroke contributing to about 57.3% of all stroke cases. Among the identified risk factors, people with hypertension were found to be four times more likely to have a stroke than normotensive people (5). In Tanzania, about two-thirds of patients who died from stroke had hypertension (6). To reduce the prevalence of stroke, a great focus needs to be on primary prevention. Studies have shown that it is possible to reduce the incidence of stroke by about 90% if modified risk factors would be eliminated (7).

Inadequate knowledge of warning signs of stroke moreover has been identified as another potential factor leading to an increasing burden of stroke worldwide, specifically in LMICs (8). The effective management of stroke is a time-dependent process that requires early identification of stroke warning signs, timely healthcare-seeking, and prompt management. To

be more efficient and effective, a stroke case needs to be managed as an emergency within 4 hours of its initiation (1) (9). Furthermore, inadequate knowledge of accurate identification of warning signs of stroke is an important factor for delaying seeking healthcare services that result in the potential increase in morbidity, mortality, and disability from stroke. According to World Stroke Organization, early recognition of the signs of stroke, treating stroke cases as a medical emergency, admission to a specialized stroke unit, and access to the best professional care can substantially improve outcomes and decrease mortality and disabilities from a stroke (1). A study done in Tanzania revealed that over 80% of stroke cases died within 7 years post-stroke diagnosis, with severe disability obtained as a significant predictor of death and least functional loss as a significant predictor for long-term survival (10).

Different studies have been done to determine knowledge of stroke risk factors, health-seeking behavior, and symptoms worldwide. In Ethiopia, the study obtained that, study participants had inadequate knowledge whereby only 45.81% of participants had adequate knowledge of stroke risk factors (11). In Tanzania, a community-based study obtained that the knowledge of stroke symptoms and perception of self-risk for stroke were poor in which only 27.4% of the participants knew a convectional stroke symptom and only 7.6% of the participants had a good perception of self-risk (12). Adequate knowledge of stroke risk factors and warning signs among individuals at high risk for stroke such as those with hypertension is thus an important means of reducing the burden of stroke worldwide. However, it is not accurately known to what extent there are knowledge gaps of stroke risk factors and warning signs among the population at high risk for stroke specifically hypertensive patients, as there are limited published data on the assessment of knowledge of stroke risk factors and warning signs among the high-stroke risk population groups in Sub-Saharan Africa, specifically in Tanzania. Therefore, this study aimed to assess the knowledge on risk factors and warning signs of stroke among hypertensive patients at Jakaya Kikwete Cardiac Institute in Dar es Salaam, Tanzania.

## Methods

### *Study design and setting*

This study employed a descriptive cross-sectional design using a quantitative approach from February to March 2022 to determine the knowledge of risk factors and warning signs of stroke among hypertensive patients. This approach used was objective and it helped in collecting original data from the study participants. The study was conducted at Jakaya Kikwete Cardiac Institute (JKCI) in Dar es Salaam, Tanzania, which is a public National Specialized and University Teaching Hospital offering cardiovascular care, training, and research services. JKCI serves patients from across all regions of the United Republic of Tanzania who are

referred from regional referrals and designated hospitals for cardiovascular interventions. The average number of attending patients for cardiovascular care is approximately 700 (out-patients) and 100 (in-patients) per day.

***Study population and eligibility criteria***

The participants of this study were all hypertensive patients who were attending outpatient clinics at Jakaya Kikwete Cardiac Institute from February to March 2022. All hypertensive patients who were aged 18 years and above, able to communicate, and willing to participate after informed consent were eligible to participate in this study. The patients who were critically ill, mentally unfit, and had a previous history of having a stroke were excluded from this study.

***Sample size***

The sample size was calculated by using a single proportion formula: [$n = Z^2P\ (100\text{-}P)/d^2$], where n = sample size, Z = Level of confidence (1.96), P = expected prevalence (18.3%), d = Margin of error (5%). The expected prevalence used (18.3%) was from a previous related study conducted in Ethiopia (13). Therefore, n = [$(1.96)^2$ x 0.183(1-0.183)/ $(0.05)^2$] = 230. By adding 20% of n for possible non-respondents, final n = 230 + (20/100 x 230) = 280. Therefore, 280 hypertensive patients were enrolled in this study from February to March 2022.

***Sampling procedure***

A systematic sampling technique was used to obtain the sample for this study whereby all consenting hypertensive patients attending the outpatient clinics at the Jakaya Kikwete Cardiac Institute who met the eligibility inclusion criteria were systematically recruited based on the sitting arrangement at the waiting area. The first participant of the day was selected randomly from the first seat, and the consecutive participants were selected after every third participant until the end of that day. If the participant selected did not meet the inclusion criteria, the next participant was selected without replacement.

***Data collection***

Data was collected from the study participants using an interviewer-administered questionnaire with closed-ended questions from February to March 2022. A questionnaire used in previous related studies was adapted and applied for data collection (11,13,14). The questionnaire was adapted in English language, then translated into Swahili, a national language, and commonly spoken for easy understandability by the study participants. The same Swahili version questionnaire was translated back into the English version to ensure

consistency of the questions. Investigators who are fluent in both languages did the translation. Data collection was done with assistance from three BSc. Nursing fourth-year students with close supervision from the principal investigators. The questionnaire was pretested to 10% of the sample size. This was done for checking if the developed data collection tool was able to collect valid information. The participants in the pilot study were excluded from the actual study. After the pre-testing of the tool, unclear questions were modified and others were removed. A reliability test was performed by calculating the reliability coefficient (Cronbach's alpha), and its value was 0.866. The questionnaire consisted of 21 items divided into three parts: Part A, socio-demographic characteristics; part B, knowledge of risk factors of stroke; and part C, knowledge of warning signs of stroke. The knowledge questions consisted of a list of items whereby each participant was asked to identify all the risk factor(s) and/or warning sign(s) of stroke they knew.

***Data management and analysis***

Data collected was checked for completeness and coded using Microsoft excel. The coded data were then exported to Statistical Package for Social Sciences (SPSS) database program version 25 for analysis. The data cleaning procedure was performed to identify missing items in the data set. Descriptive statistics using frequencies and percentages were computed to summarize the characteristics of the study participants. Inferential statistical analysis using binary logistic regression was conducted to determine the factors associated with the knowledge of risk factors and warning signs of stroke. The variables that showed an association ($p<0.25$) in binary logistic regression were further analyzed by multivariable logistic regression. In the multivariable logistic regression, the variable associations that had a p-value < 0.05 at a 95% confidence interval were considered statistically significant. The participants' knowledge of risk factors and warning signs of stroke was categorized into two (Adequate and inadequate knowledge). Scoring for knowledge was based on the number of correct responses identified. A respondent who was able to identify correctly more than three ($\geq$ 3) risk factors of stroke out of six and more than three ($\geq$ 3) warning signs of stroke out of six was considered to have adequate knowledge of stroke risk factors and stroke warning signs respectively (11,15).

***Ethical considerations***

Ethical clearance was sought by the Muhimbili University of Health and Allied Sciences Research and Publication Committee (Ref. No.DA.25/111/01B/119). Permission to conduct this study was granted by the Jakaya Kikwete Cardiac Institute administration. Verbal or

written informed consent was obtained prior the interview after each participant was given clear information about the importance of the study and ensuring the confidentiality of the given information. The study participants were allowed to decide to drop out from the study at any time with no effect on the relationship with the data collectors, health providers, and the treatment pattern.

## Results

### *Socio-demographic characteristics of the participants*

This study enrolled 280 participants, of them 275 participants responded completely giving a response rate of 98.2%. The mean age of the participants was 55.7 (*SD*=14.4) with the ages ranging from 22 to 89. About half (48.7%) of the participants were in the 46-65 years age stratum. Majority (61.1%) of the participants were female, giving about a 2:1 female-to-male ratio. Around two-thirds (68.0%) of the participants were married. Regarding residence, the majority (84.7%) of the participants were residing in urban areas. Around one-third (34.5%) of the participants were merchants. Concerning educational status, 70.9% of the participants had a secondary education level and below. Almost 40% of the participants' primary source of health information was radio and television. The majority of the participants, 68.4% reported having ever seen someone with a stroke (**Error! Reference source not found.**).

**Table 1: Socio-demographic characteristics of the study participants (N=275)**

| Socio-demographic characteristics | Frequency (n) | Percent (%) |
|---|---|---|
| Age group (years) | | |
| 18-45 | 67 | 24.4 |
| 46-65 | 134 | 48.7 |
| 66 and above | 74 | 26.9 |
| Sex | | |
| Male | 107 | 38.9 |
| Female | 168 | 61.1 |
| Marital status | | |
| Single | 23 | 8.4 |
| Married | 187 | 68.0 |
| Divorced | 9 | 3.3 |
| Widowed | 56 | 20.4 |
| Residence area | | |
| Rural | 42 | 15.3 |

| | | |
|---|---|---|
| Urban | 233 | 84.7 |
| Occupation | | |
| Government worker | 37 | 13.5 |
| Merchant | 95 | 34.5 |
| Peasant/farmer | 32 | 11.6 |
| Housewife | 24 | 8.7 |
| Retired | 59 | 21.5 |
| Labor worker | 15 | 5.5 |
| Student | 3 | 1.1 |
| Others | 10 | 3.6 |
| Education level | | |
| ≤Secondary education | 195 | 70.9 |
| ≥College/vocational training | 80 | 29.1 |
| Primary source of health information | | |
| Radio/television | 109 | 39.6 |
| Social media | 26 | 9.5 |
| Health professional | 84 | 30.5 |
| Relative/friend | 49 | 17.8 |
| Teacher | 2 | 0.7 |
| Others | 5 | 1.8 |
| Ever seen someone with a stroke | | |
| Yes | 188 | 68.4 |
| No | 87 | 31.6 |

***Knowledge of risk factors of stroke***

The most identified risk factors of stroke were hypertension (184; 66.9%) followed by physical inactivity (171; 62.2%). Cigarette smoking was the least identified risk factor for stroke (113; 41.1%) (**Error! Reference source not found.**). Out of all participants, 24 (8.7%) of them did not know any risk factor of stroke; and only 45 (16.4%) participants identified all the six risk factors of stroke (**Error! Reference source not found.**). Overall, only less than half (46.5%) of the study participants had adequate knowledge of the risk factors for stroke (Figure).

**Table 2: Risk factors of stroke identified by the study participants (N = 275)**

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| Hypertension | | |
| Yes | 184 | 66.9 |
| No | 24 | 8.7 |
| I don't know | 67 | 24.4 |
| Obesity | | |
| Yes | 156 | 56.7 |
| No | 44 | 16.0 |
| I don't know | 75 | 27.3 |
| Excessive alcohol intake | | |
| Yes | 138 | 50.2 |
| No | 44 | 16.0 |
| I don't know | 93 | 33.8 |
| Diabetes mellitus | | |
| Yes | 156 | 56.7 |
| No | 25 | 9.1 |
| I don't know | 94 | 34.2 |
| Physical inactivity | | |
| Yes | 171 | 62.2 |
| No | 40 | 14.5 |
| I don't know | 64 | 23.3 |
| Cigarette smoking | | |
| Yes | 113 | 41.1 |
| No | 54 | 19.6 |
| I don't know | 108 | 39.3 |

***Knowledge of warning signs of stroke***

Of all the listed warning signs of stroke, sudden unilateral numbness/weakness of the face, arm, or leg was the most identified by the participants (188; 68.4%) followed by sudden trouble with walking, and/or loss of balance (167; 60.7%). Sudden unexplained dizziness (110; 40.0%); and sudden severe headache with no known causes (111; 40.4%) were the least identified warning signs of stroke (**Error! Reference source not found.**). Among all the participants, 30(10.9%) did not know any of warning sign of stroke, and only 24(8.7%) participants were able to identify six warning signs of stroke (**Error! Reference source not**

**found.**). Overall, less than half (40.6%) of the participants had adequate knowledge of the warning signs of stroke (Figure).

**Table 3: Warning signs of stroke identified by the study participants (N = 275)**

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| Sudden unilateral numbness / Weakness of the face, arm, or leg | | |
| Yes | 188 | 68.4 |
| No | 14 | 5.1 |
| I don't know | 73 | 26.5 |
| Sudden trouble with walking, loss of balance | | |
| Yes | 167 | 60.7 |
| No | 33 | 12.0 |
| I don't know | 75 | 27.3 |
| Sudden trouble with speaking or communication problem | | |
| Yes | 163 | 59.3 |
| No | 34 | 12.4 |
| I don't know | 78 | 28.4 |
| Sudden severe headache with no known causes | | |
| Yes | 111 | 40.4 |
| No | 51 | 18.5 |
| I don't know | 41.1 | |
| Sudden trouble with seeing in one or both eyes | | |
| Yes | 136 | 49.5 |
| No | 48 | 17.5 |
| I don't know | 91 | 33.1 |
| Sudden unexplained dizziness | | |
| Yes | 110 | 40.0 |
| No | 62 | 22.5 |
| I don't know | 103 | 37.5 |

**Table 4: Number of risk factors and warning signs of stroke identified by the study participants (N=275)**

| Number identified | Risk factors of stroke, n (%) | Warning signs of stroke, n (%) |
|---|---|---|
| None | 24(8.7) | 30(10.9) |
| One | 16(5.8) | 20(7.3) |
| Two | 30(10.9) | 33(12.0) |
| Three | 54(19.6) | 72(26.2) |
| Four | 52(18.9) | 51(18.5) |
| Five | 54(19.6) | 45(16.4) |
| Six | 45(16.4) | 24(8.7) |

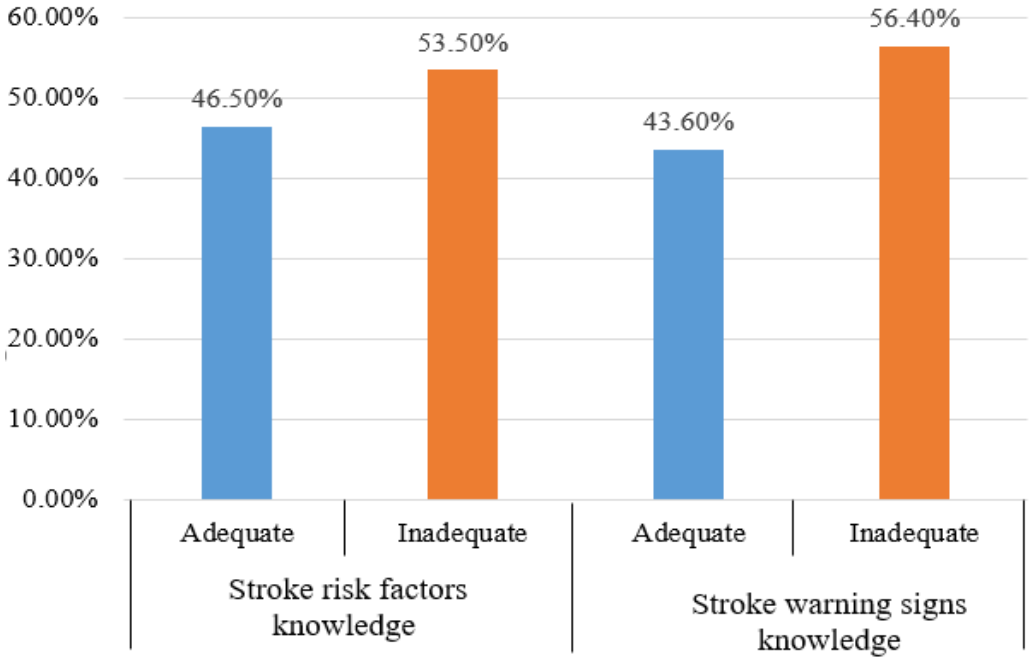


**Figure 1. Participants' knowledge of risk factors and warning signs of stroke (N=275)**

***Factors associated with knowledge of risk factors and warning signs of stroke***

Binary and multivariable logistic regression analyses were conducted to determine the factors associated with knowledge of risk factors and warning signs of stroke. In the binary logistic regression, the candidate independent variables for multivariable analysis identified were sex, marital status, residence area, occupation, education status, and previous history of seeing someone with a stroke.

In multivariable logistic regression by adjusting potential confounders, the factors that were found to be significantly associated with knowledge of risk factors for stroke were residence and educational status (p-value <0.05). The urban residing participants were 4.63 times (AOR 4.63; 95%CI 1.65-12.98, p=0.006) more likely to have adequate knowledge of risk factors for stroke than rural residing participants. The participants with college or vocational training education level and high were 12.73 times (AOR 12.73; 95%CI 5.31-30.59, p<0.001) more likely to have adequate knowledge of risk factors for stroke than participants with secondary school education level and below. Concerning the knowledge on warning signs of stroke, the significant factors associated were sex, education status, and the previous history of seeing someone with stroke (p<0.05). Male participants were less likely (AOR 0.34; 95%CI 0.16-0.73, p=0.006) to have adequate knowledge of warning signs of stroke than female participants. Furthermore, participants who had college or vocational training education level and high were 10.98 times (AOR 10.98; 95%CI 4.96-26.22, p<0.001) more likely to have adequate

knowledge of warning signs of stroke than participants who had secondary school education level and low. Having a previous history of seeing someone with a stroke was significantly associated with higher odds of having adequate knowledge of warning signs of stroke (AOR 11.31; 95%CI, P<0.001) than the absence of the previous history of seeing someone with a stroke (**Error! Reference source not found.**).

**Table 5: Multivariable logistic regression of factors associated with knowledge of risk factors and warning signs of stroke (N=275)**

| Variables | Knowledge of risk factors | | Knowledge of warning signs | |
|---|---|---|---|---|
| | p-value | AOR (95%CI) | p-value | AOR (95%CI) |
| Sex | | | | |
| Male | 0.498 | 0.78(0.38-1.59) | 0.006* | 0.34(0.16-0.73) |
| Female | | Ref | | Ref |
| Marital status | | | | |
| Single | 0.123 | 3.1(0.74-13.08) | 0.970 | 0.97(0.23-4.16) |
| Married | 0.160 | 1.80(0.79-4.09) | 0.173 | 1.82(0.77-4.30) |
| Divorced | 0.124 | 0.13(0.01-1.74) | 0.293 | 0.32(0.04-2.68) |
| Widowed | | Ref | | Ref |
| Residence | | | | |
| Urban | 0.004* | 4.63(1.65-12.98) | 0.516 | 1.37(0.53-3.54) |
| Rural | | Ref | | Ref |
| Education level | | | | |
| College/vocation training and above | 0.000* | 12.73(5.31-30.59) | 0.000* | 10.98(4.59-26.22) |
| Secondary and below | | Ref | | Ref |
| Ever seen someone with a stroke | | | | |
| Yes | 0.078 | 1.79(0.93-3.43) | 0.000* | 11.31(4.99-25.61) |
| No | | Ref | | Ref |

*Note: *p-value <0.05 in multivariable logistic regression (statistical significant);*
*CI, Confidence Interval; AOR, Adjusted odds ratio; Ref, reference category.*

## Discussion

This study aimed to determine the knowledge of risk factors and warning signs of stroke among hypertensive patients at the Jakaya Kikwete Cardiac Institute. The mean age of participants was 55.7±14.4 years and the ages ranged from 22 to 89 years, with the majority

(48.7%) of them being in the 46-65 age interval. This is particularly resembling the study done in Uganda where the median age was 45 with the age range from 18-91 (16). The minimum age of early 20s may be due to the recently reported increase of hypertension incidence among the young population, and the majority of participants being older adults might be explained by the increased risk of hypertension with age (17). Around two-thirds of the participants in this study had ever seen someone with a stroke which shows similarity with the study done in Egypt where nearly two-thirds (63.2%) of the participant had a history of seeing someone with a stroke. This may be due to the high prevalence of stroke in African communities (18).

This study obtained that only less than half (46.5%) of participants had adequate knowledge of risk factors for stroke. This finding is relatively similar to the findings of the studies done in Ethiopia (11) and the Democratic Republic of Congo (19) which showed that the participants with adequate knowledge of risk factors for stroke were less than half (45.8%) and slightly more than one-third (38.6) respectively. This might be due to similarity in the study design, data collection tools, and the nature of the living condition of the study participants as all studies were conducted in SSA. Besides, the study conducted in Spain shows that participants had poor knowledge of stroke risk factors (20). This might be because of failing to recall information accurately as the study participants were hospitalized stroke patients. This study finding shows incongruent with the finding of the study conducted in Saudi Arabia which shows that 60% of the study participants had good knowledge of stroke risk factors (21). This might be because of the differences in social demographic characteristics of the study participants as the majority of them had a college degree and were employed.

The presented study findings furthermore are in contrast with that obtained from the study conducted in Nigeria which showed that 86.6% of the participants had good knowledge of stroke risk factors (22). In the United States, the study showed that the majority (71.8%) of study participants had good knowledge of stroke risk factors (23). This may be due to the existence of effective education programs and campaigns to raise awareness and prevention of stroke in developed countries. In this study, 8.7% of the study participants did not know any risk factor for stroke; and only 16.4% of the respondents identified all the listed risk factors for stroke. This is similar to the finding of the study conducted in Ethiopia that shows that 15.4% of the participants did not know any risk factor of stroke and only 15.9% of them identified all mentioned stroke risk factors (11). The percentage (20.2%) of the participants who did not know any risk factor for stroke in a study conducted in Iran was slightly higher compared to this study (24). This may be due to the overall low of knowledge of stroke in LMICs countries (8).

The presented study obtained an overall inadequate knowledge of warning signs among the study participants whereby only less than half (40.6%) of them had adequate knowledge. A community-based study in Northern Tanzania also revealed poor knowledge as only 27.4% of the participants knew at least a convection symptom of a stroke (12). This indicates an urgent need to have stroke educational and prevention programs to raise awareness. Similar findings to the presented study were obtained in North India where almost half of the study participants were not aware of the warning signs of stroke (25). Besides, the study conducted in Ethiopia obtained that only less than half (42.7%) of the participants had adequate knowledge of warning signs of stroke (11). Furthermore, a study by Osama et al. in Egypt obtained that 68.2% of the participants had poor knowledge of warning signs of stroke (26). This could be the reason for the delay in seeking medical attention and ultimately increase the occurrence of severe complications following a stroke. In contrast, this study's finding differs from the finding of the study done in Nigeria that shows more than three-fourths (87%) of participants had adequate knowledge of stroke signs and symptoms (22). Furthermore, the studies conducted in the United Kingdom and the United States found that the overall knowledge of stroke warning signs among the study participants was good that is 60.2% (27) and 85.3% (23), respectively. The good implementation of stroke prevention strategies in developed countries could be the justification behind the contrast. Among the participants in this study, 10.9% of them did not know any warning signs of stroke. This is congruent with that obtained in Ethiopia, 20.3% (11) but quite lower than that obtained in Iran, 71.2% (24).

In multivariate analysis, the factors that were found to have a significant association with the knowledge of risk factors of stroke were residence area and education status. Living in urban areas was associated with 4.63 times the odds of having adequate knowledge of risk factors for stroke than living in rural areas. Having a college/vocational training education level and higher was associated with higher odds of having adequate knowledge of risk factors and warning signs of stroke than having a secondary school education level and lower. This finding is also similar to that of the study done in Nigeria where education level was found to be significantly associated with knowledge of risk factors (AOR = 4.24, 95% CI = 1.68-10.67, p = 0.002) and warning signs (AOR 3.99; 95%CI 1.58-10.13, p=0.004) of stroke (28). A study by Abate et al. also obtained that urban residence and having the ability to read and write were significantly associated with good knowledge for stroke (13). Besides, a study in the Democratic Republic of Congo obtained that, university education level was significantly associated with good knowledge of stroke risk factors (19). This could be due to the increase in the chance of accessing accurate information with an increase in the education level and ease of obtaining information from different sources in urban areas. Male patients were less

likely (AOR 0.34; 95%CI 0.16-0.73, p=0.006) to have adequate knowledge of warning signs of stroke than female patients. This might be because of good health-seeking behaviour including health information seeking among women (29,30). However, the study in Nigeria showed results contrary to this study, whereby male sex was found to be a significant predictor of good knowledge of stroke warning signs (OR 3.28, 95% CI 1.31 to 8.19, p=0.01) (14). People who had previous exposure to stroke have some memory of the clinical presentation of stroke. As this study also revealed that, a previous history of seeing someone with a stroke was associated with higher odds of adequate knowledge of warning signs of stroke. A study conducted in Morocco similarly reported that the absence of a history of stroke among the respondents, family, or relatives was significantly associated with a low level of knowledge of stroke (31).

**Study limitations**

This study was a single institution-based study; this may limit the generalization of the findings to other settings. The use of cross-sectional and closed-ended questions might limit the participants' responses regarding their knowledge of risk factors and warning signs of stroke.

**Conclusion and recommendations**

This study found that knowledge of stroke risk factors and warning signs among patients with hypertension was generally inadequate and was significantly associated with place of residence (urban vs. rural), level of education, and previous exposure to stroke. These findings underscore the need to plan and implement targeted stroke awareness and prevention campaigns, with particular focus on rural communities. Additionally, healthcare providers managing hypertensive patients should ensure they are adequately informed about stroke, including their individual risk and early warning signs. We recommend further research to explore barriers to knowledge transfer and to identify effective strategies for addressing this knowledge gap.

**Abbreviations**

| | |
|---|---|
| JKCI | Jakaya Kikwete Cardiac Institute |
| LMICs | Low- and Middle-Income Countries |
| SSA | Sub-Saharan Africa |
| SPSS | Statistical Package for Social Sciences |
| WHO | World Health Organization |

**Declarations**

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**Competing interests**

The authors declare that they have no competing interests.

**Authors' contributions**

RAG designed the study, conceptualized, collected, analyzed the data, and drafted and revised the manuscript. EZC designed the study, conceptualized, collected, analyzed the data, and drafted and revised the manuscript. EAM designed the study, collected, analyzed the data, and drafted and revised the manuscript. All authors read and approved the final manuscript.

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