Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Knowledge Toward Warning Signs of Stroke and Its Associated Factors Among Patients with Heart Disease at Woldia and Dessie Comprehensive Specialized Hospitals North-East, Ethiopia: A Mixed-Method Cross-Sectional Study

Desalegn Askale Andarge
Amhara Regional Health Bureau
Mengistu Abate Belay
Wollo University
Dagnachew Melak
Wollo University
Bemnet Yazew Abegaz
bemnet.yazew@wu.edu.et

Wollo University
Shambel Wodajo
Wollo University
Mulugeta Belayneh Asfaw
Amhara Regional Health Bureau
Ebrahim Abdurehman Geto
Amhara Regional Health Bureau

Article

Keywords: Stroke warning signs, Heart disease, Knowledge, Associated factors, Ethiopia, Mixed-method study

Posted Date: May 26th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8996803/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Stroke is a leading cause of mortality and disability worldwide and the economic costs of treatment and poststroke care are extensive. The inability to identify stroke warning signs accurately is an important cause of delays in seeking medical attention, leading to potential ineligibility for acute intervention, which can lead to secondary complications. Therefore, this study aimed to assess knowledge of warning signs of stroke and its associated factors among patients with heart disease at Woldia and Dessie Comprehensive Specialized Hospitals, Amhara Region, Ethiopia.

Methods

A hospital-based cross-sectional study supplemented with qualitative inquiry was conducted among 414 and 17 adult patients with heart disease for quantitative and qualitative studies, respectively, attending Woldia and Dessie comprehensive Specialized Hospitals from June 20 to July 19, 2025. Study participants were selected via a systematic random sampling technique.

Results

The proportion of patients with knowledge of stroke warning signs among patients with heart disease at Woldia and Dessie Comprehensive Specialized Hospitals was 28.4% [95% CI, (24.00%, 32.79%)]. Urban residency [AOR = 2.1; 95% CI (1.03, 4.39)], the absence of formal education [AOR = 0.3; 95% CI (0.14, 0.97)], and having somebody with stroke [AOR = 2.5; 95% CI (1.12, 5.71)] were significantly associated with having knowledge of stroke warning signs.

Conclusions

This study revealed that the proportion of individuals with knowledge of warning signs of stroke was low among cardiac patients. Therefore, the findings of this study suggest the need for all stakeholders to emphasize stroke education to increase individual’s knowledge of warning signs of stroke.

INTRODUCTION

The neurological condition known as stroke is the leading cause of physical and mental disability and death worldwide. It is characterized by an acute focal injury to the central nervous system caused by a vascular mechanism, such as cerebral infarction intracerebral hemorrhage or subarachnoid hemorrhage (1). It is a leading cause of mortality and disability worldwide and the economic costs of treatment and poststroke care are substantial (2).

Before 2008, the 5 “sudden” of stroke warning signs (sudden weakness of extremities; sudden speech difficulty; sudden visual loss; sudden dizziness; sudden severe headache of unknown cause) were used widely in public education campaigns (3). The World Stroke Association practices warning signs of stroke via the acronym FAST (face, arm, speech, time) message campaign, to explain the signs of stroke and ensure that treatment quickly saves lives and improves recovery (3–5).

The inability to identify stroke warning signs accurately is an important cause of delays in seeking medical attention, leading to potential ineligibility for prompt intervention and increasing the burden of disease in different aspects (6). The control of the main modifiable risk factors for stroke which have risk factors similar to those of coronary heart disease and other vascular diseases includes hypertension, hyperlipidemia, diabetes mellitus and lifestyle risk factors such as a sedentary lifestyle (low physical activity), smoking, unhealthy diet and obesity through effective prevention strategies, which effectively decreases mortality and disability due to stroke, even in low-income countries (3–5).

In addition to warning signs of stroke;, patient arrival by EMS (emergency medical services) also shortens the time to be seen for initial evaluation by an emergency physician, shortens the time to brain imaging, and increases the use of intravenous recombinant tissue-type plasminogen activator (2, 3). The Global Burden of Disease Study (GBD) 2019 reported that stroke is the second-leading cause of death and the third-leading cause of morbidity and disability worldwide (7).

In Ethiopia, cardiovascular diseases, including ischemic heart disease, stroke, and hypertensive heart disease, are the leading causes of premature death and disability (6,458 age-standardized DALYs per 100,000) (8). Even if the age-adjusted mortality rate from cardiovascular diseases is declining, stroke remains the leading cause of death in the setups (9).

Stroke is a major health-related problem that causes death and long term disability worldwide (10). Currently, 75.2% of all stroke deaths and 81.1% of the total DALYs lost due to stroke occur in developing countries (7, 11). The mortality rate from stroke in sub-Saharan Africa (SSA) is five times higher than that in developed countries (5, 7). The prevalence of ischemic and hemorrhagic strokes in Ethiopia is 31.5% and 18.3%, respectively, with 50.2% having an undetermined type of stroke (12).

Stroke has a significant effect on the physical, mental, and social well-being of the individual s (13). It not only affects the individual, but also places a caregiver burden on family members, and the direct cost of stroke management and indirect loss of productivity from both the affected individual and their caregivers are enormous, resulting in a high social burden (14). This invisible epidemic of chronic disease burden is yet another emerging challenge to socioeconomic progress, particularly in developing countries (15). The disease burden caused by high blood pressure, alcohol consumption, smoking and obesity is the leading cause of early death and disability associated with stroke globally (16).

Prevention strategies that focus on modifiable factors such as hypertension, diabetes mellitus, smoking, unhealthy diet, and sedentary physical activity practices can reduce the stroke burden by up to 80% (17).

Prompt identification of stroke symptoms and timely management are important for decreasing both morbidity and mortality (15, 18). Poor awareness of stroke warning signs contributes to pre-hospital delay in seeking medical care, which may adversely affect stroke outcomes. Timely activation of emergency services and eligibility for acute stroke interventions depend largely on adequate recognition of stroke warning signs (23). However, the overall stroke burden, in terms of the absolute number of people affected by, or who remain disabled from, stroke has increased globally, due to poor community knowledge of its warning signs (18). This is supported by the evidence that increased awareness of stroke risk factors leads to improved compliance with stroke prevention practices, while a lack of recognition of stroke warning signs is an important causal factor of delays in hospital reporting of stroke (19). Evidence from studies in developed and developing countries shows that respondents' recognition of any of the established stroke warning signs is generally less than 50% (20–22, 36). In line with these findings, knowledge of stroke risk factors has been shown to vary according to country of residence, age, educational status, and medical history, with women demonstrating greater awareness than men (34).

Even though early identification of stroke warning signs is essential for stroke prevention and early management, as far as the principal investigator literature search there is a single study conducted on knowledge on warning signs of stroke and its associated factors among cardiac patients in our country. Moreover, the study focused only on quantitative data; the study could not exhaustively examine patients' perceptions. Therefore, this study aimed to fill this gap by assessing the knowledge of warning signs of stroke and its associated factors among cardiac patients at DCSH and WCSH via a hospital-based cross-sectional study supplemented with qualitative inquiry.

METHODS AND MATERIALS

Study Period and Setting

The study was conducted from June 20 to July 19, 2025, at two public comprehensive specialized hospitals in Wollo, Amhara Region, Northeast Ethiopia: Dessie Comprehensive Specialized Hospital (DCSH) and Woldia Comprehensive Specialized Hospital (WCSH).

The DCSH, located in Dessie city (South Wollo Zone), was established in 1961 and serves approximately 10 million people from the Amhara, Oromia, Afar, and Tigray regions. The hospital provides services to approximately 100,000 adult patients annually through 18 outpatient departments and has more than 550 inpatient beds.

WCSH, established in 1961 and located in Woldia town, serves over 2.5 million people from Woldia and surrounding areas, including the Tigray and Afar regions.

Study design.

An institution-based cross-sectional study design supplemented with qualitative inquiry was employed. A phenomenological approach was used to study the qualitative component concurrently to explore

additional underlying factors contributing to the knowledge of stroke warning signs.

Source and study population.

The source population was all adult patients with heart disease at Woldia and Dessie Comprehensive Specialized Hospitals, Northeast Ethiopia, 2025.

Study population

Quantitative

The study population included adult patients with heart disease at Woldia and Dessie Comprehensive Specialized Hospitals, Northeast Ethiopia, 2025 during the study period.

Qualitative

All adult patients with heart disease at Woldia and Dessie Comprehensive Specialized Hospitals who were not included in the quantitative study

Eligibility criteria

Inclusion criteria

Quantitative

Adult patients with heart disease above 18 years of age at Woldia and Dessie Comprehensive Specialized Hospitals, Northeast Ethiopia, were included in the study.

Qualitative

Adult cardiac patients above 18 years of age at Woldia and Dessie Comprehensive Specialized Hospitals who did not participate the quantitative study were included in this study.

The exclusion criteria

were patients with heart disease who had already developed stroke before data collection and critically ill patients who could not respond.

Sample size determination and sampling procedure

The sample size was determined via a single population proportion formula by taking the “p” proportion of adequate knowledge of the sign of stroke warning, 42.7%, from a study performed among patients

with heart disease at Tikur Anbessa Specialized Hospital (30), with a confidence level of 95% and a 5% margin of error.

$$n = \frac{(Za/2)^2 * p(1-p)}{d^2}$$

$$n = \frac{(1.96)^2 * 0.427(1-0.427)}{0.05^2}$$

$$n = 376$$

The sample size for the second objective was determined via the double population proportion formula using the software Epi info version 7.2.3.1. However, the sample size calculated for the first objective was greater than that for the second objective which was 376, with a 10% nonresponse rate to increase the power and compensate for the nonresponse rate 376 + 38 = 414 patients with heart disease included in the study.

For the qualitative part, 17 patients with heart disease participated in this study 10 from DCSH and 7 from WCSH. The final sample size for the qualitative study was determined on the basis of information saturation.

A systematic random sampling technique was employed to select the study participants. First, a recent quarterly report was reviewed from the patient registration books in the OPDs of both WCSH and DCSH to estimate the average number of patients with heart disease seen per month. The sample sizes were then distributed to each OPD in proportion to the average number of adult patients with heart disease per month of the OPD. Finally, the participants were selected using a systematic random sampling technique after the initial respondent was identified via a random (lottery) method (Fig. 1).

For the qualitative study

a purposive sampling technique (a criterion selection method) was applied to recruit patients with heart disease who met the eligibility criteria and had not participated in the quantitative study. The participants were selected on the basis of their willingness to participate in the in-depth interview, communication ability (ability to describe their live experiences, beliefs and attitudes on knowledge of stroke warning signs), diagnosis type (known heart disease patients), and age > 18 years among cardiac patients.

Operational definition

Knowledge of stroke warning signs: Knowledge of stroke warning signs refers to the respondent's ability to correctly identify key symptoms that indicate the onset of a stroke. It was measured using five standardized questions that assess recognition of major warning signs, including: sudden numbness or weakness of the face, arm, or leg (especially on one side of the body), sudden trouble with walking, dizziness, or loss of balance, sudden trouble speaking or understanding speech, sudden severe

headache with no known cause and Sudden trouble seeing in one or both eyes. Each correct answer was scored 1, and incorrect or “I don’t know” answers were scored 0.

Adequate knowledge of stroke warning signs

Participants who had responded to the mean value and above to warning sign questions were included (24).

Inadequate knowledge of stroke warning signs

included those participants who had responded below the mean value to warning signs questions (24).

Knowledge of stroke risk factors: Knowledge of stroke risk factors refers to a respondent’s ability to correctly identify key stroke risk factors. It was measured using six standardized questions that assess the recognition of major risk factors, including: hypertension, obesity, excessive alcohol intake, diabetes mellitus, physical inactivity and smoking. Each correct answer was scored 1, and incorrect or “I don’t know” answers were scored 0.

Adequate knowledge of stroke risk factors

Participants who had responded to the mean value and above to stroke risk factor questions were included (24).

Inadequate knowledge of stroke risk factors

Participants who had responded below the mean value to stroke risk factors questions (24).

Physical inactivity

is a term used to identify people who do not perform the recommended 30–60 minutes of aerobic exercise three to four times per week to promote cardiovascular fitness (20).

Body mass index (BMI)

Body mass index (BMI) categories were defined using thresholds previously validated in Ethiopian adult populations (38), which may differ from global cutoffs because of population-specific body composition patterns. Patients with a BMI ≤ 18.3 kg/m2 for males and < 21.9 kg/m2 for females were considered underweight, and the normal range BMI for males was 18.3–21.5 kg/m2, whereas it was 21.9–23.0 kg/m2 for females. The cutoff values for overweight were 21.6–22.2 kg/m2 for males and 23.1–24.5 kg/m2 for females. Patients with a BMI ≥ 22.2 k/m2 for males and > 24.5 kg/m2 for females were classified as obese (38).

Smoker

It refers to those participants who smoke any tobacco products (such as cigarettes, cigars, or rolled tobacco).

A daily smoker

is someone who smokes any tobacco product at least once a day (with the exception that people who smoke every day, but not on days of religious fasting, are still classified as daily smokers) (39).

Occasional smoker

is someone who smokes, but not every day (39).

Non-smoker

are those who, at the time of the survey, does not smoke at all (39).

Alcohol Drinker

This refers to those participants who consumed a drink containing alcohol.

Moderate drinkers

were defined as participants who consumed a standard of two drinks on a single occasion for men, and one drink on a single occasion for women (40).

Heavy drinkers

were defined as participants who consumed a standard of five or more drinks on a single occasion or twenty or more drinks per week for men; and four or more drinks on a single occasion or fifteen or more drinks per week for women (40).

The mean score was used as the cutoff point to categorize participants' knowledge status, a method commonly applied in similar studies to enhance comparability across settings.

Data collection tools and procedures

The data were collected by face-to-face interviewer-administered questionnaire. A standardized questionnaire already used in previous studies to assess knowledge of warning signs was adapted and applied for the study (20, 26, 41). These data include sociodemographic characteristics, stroke risk factors, stroke warning signs and behavioral risk factors. The questionnaires have a list of 6 stroke risk factors, and 5 warning signs for stroke based on faces, arms, legs, and speech, with yes or no answers. For statistical purposes, yes was assigned value of 1, whereas no was assigned a value of 0. The interviews will be conducted by two BSc holder nursing staffs and one MPH supervisor among patients with heart disease during the study period.

For the qualitative study, a semi structured Face-to-face in-depth interview (IDI) questionnaire was prepared. The data were collected using a note-taker and tape-recorded. To achieve saturation an in-depth interview was conducted to gain insight into issues that could not be addressed by the quantitative survey. The interviews were started with several questions prepared to create rapport with the study participants. After a rapport was created, the objective of the study was introduced. The participants were interviewed until the semi-structured questionnaire was completed, and each question was probed. The questions focus on live experiences, beliefs and attitudes related to knowledge of stroke warning signs among cardiac patients. An in-depth interview was conducted for approximately 10 to 30 minutes for each respondent until saturation was reached. Upon completion of each interview and on the basis of the recorded audio a detailed transcription that captures all the discussion was developed. Those texts and the emerging themes identified during the course of the interviews were confirmed. All the interviews were transcribed and prepared for coding and thematic analysis.

Body weight and height were measured using the electronic weighing scale ((Qutyle dental (export) manufacturing, Administration address: DEROTOR house 6 Farncombe road, Bach number: 112, serial number: 3131403061781)) with regular monitoring and adjustment of the beam-balance. The height was recorded in cm (to the nearest mm) and weight in kg (to the nearest 0.1 kg). The participants were wearing light clothing (single and thin), without shoes, standing with their feet together, and heeling against the back board and knees straight. The participant's position was to look straight ahead and not tilt their head up with their eyes at the same level as the ears. Calibration of the instruments was done after each measurement and after moving the instrument from place to place. When calibration was performed, the instrument was first adjusted to zero, then the standard load was placed on load scale and indication was recorded once it is stabilized. Additionally, zero indication was checked after the standard load is removed before measuring of new respondents (42). And BMI was calculated by dividing weight in kilograms by height squared in meters (kg/m2). BMI categories were form using optimal cut-off for obesity and markers of metabolic syndrome for Ethiopian adult's classification system. Patients with BMI ≤ 18.3 kg/m2 for males and < 21.9 kg/m2 for females stated as underweight, the normal range for BMI is 18.3–21.5 kg/m2 for males, while it was 21.9–23.0 kg/m2 for females. The cutoff values for overweight were 21.6–22.2 kg/m2 for males and 23.1–24.5 kg/m2 for females. Patients with BMI ≥ 22.2 k/m2 for males and > 24.5 kg/m2 for females were classified as obese (38).

Data Quality Control

The questionnaire was first written in English. It was then expertly translated into Amharic, the local language of the study area, to ensure uniformity. Those who could understand neither English nor Amharic data provided translations for them.

Training was provided to the data collectors about the objective of the study and the data collection procedures. Any unclear issues that arose during data collection were corrected and communicated immediately under close supervision.

The questionnaire was pretested on 42(5%) patients at Borumeda Hospital and some modifications were made on the basis of the findings. The reliability of the checklist (criteria) used to measure the outcome variable was checked via Cronbach's alpha test (0.76) and the validity of the tool was verified by many experts in the field.

The principal investigator checked the questionnaires on the spot for consistency and completeness. Frequency, percentage and cross-tabulation were performed to detect any missing values of the variables.

The quality of the data in the qualitative study was assured by member checking which involved taking short sums of IDIs back to the study participants and allowing them to confirm that those ideas were their own. The guide was developed in English and translated into Amharic (the local language) for all participants. The interviews were audio-recorded via mobile devices to capture all the information provided by the interviewees.

Data Processing and Analysis

The data were coded, cleaned, and edited. After checking the completeness of the questionnaire where there were no missing values, the data were coded, entered into Epi-Data version 4.6.0.2, and then exported to SPSS version 25 for further analyses. Basic descriptive analyses were performed using measures of central tendency and dispersion for continuous variables. The frequency distribution was computed for categorical variables. Furthermore, to identify statistically associated factors, bivariable logistic regression analysis was performed for each independent variable with the outcome variable separately. Those variables with *P value* less than 0.2 in the bivariable analysis were exported to the final model. Then multivariable logistic regression was performed and variables with *p values* ≤ 0.05 were considered significant and are presented using AOR with 95% CIs. Model fitness was checked via the Hosmer and Leme test (0.98) and omnibus test (0.006). Multicollinearity was checked by variance inflation factors (VIFs) (< 4.72) prior to running the model. Finally, the findings were presented by using texts, tables, and graphs. Qualitative data were analyzed via a thematic analysis approach. Audio recordings were transcribed verbatim and read repeatedly to achieve data familiarization. Initial codes were generated manually on the basis of recurring ideas and patterns, which were then grouped into broader themes. Coding was primarily conducted by the principal investigator, and emerging themes were reviewed with the research team to enhance credibility. Formal intercoder reliability statistics were not calculated. Thematic saturation was reached when no new themes or concepts emerged from subsequent interviews. The quantitative and qualitative findings were triangulated for discussion, conclusion and recommendation.

Ethical Consideration

An ethical clearance letter was obtained from the Ethical Review Committee of Wollo University, College of Medicine and Health Science. An official letter of cooperation was sent to the administrations of the study hospitals. A full explanation of the purpose of the study was given to the authorities of the study

hospitals, and permission was granted. For each eligible study participant, the purpose and benefits of the study, as well as the right to withdraw or stop completing the questionnaire at any time, were clearly described and discussed. To maintain the Confidentiality and privacy of the participants their name and medical record number (MRN) were not recorded on the questionnaire. All information collected from patients was kept strictly confidential. Informed consent was obtained from all individuals enrolled in the study before they were interviewed.

RESULTS

Sociology-demographic characteristics of the study participants

From a total of 414 participants, 405 patients with heart disease were involved in the study with a response rate of 97.82%. The majority (208, 51.4%) were females and the mean (± SD) age of the participants was 44.55 (± 15.52) years (Table 1).

Table 1
Sociodemographic characteristics of patients with heart disease at WCSH and DCSH, Ethiopia, 2025 (n = 405).

Variables		Frequency	Percentage
Sex	Female	208	51.4
	Male	197	48.6
Age (years)	18-34years	87	21.5
	35-44years	91	22.5
	45-54years	77	19.0
	55-64years	69	17.0
	65years and above	81	20.0
	Mean age (± SD)	44.55 (± 15.52) years	
Marital status	Single	123	30.4
	Widowed/ Divorced	85	21
	Separated	28	6.9
	Married	169	41.7
Religion	Other	60	14.8
	Muslim	191	47.2
	Orthodox Christian	154	38.0
Educational status	No formal schooling	103	25.4
	High school and less	145	35.8
	College and above	157	38.8
Monthly income	< 2000ETB	191	47.2
	2000-4000ETB	87	21.5
	≥ 4000ETB	127	31.4
Habitation	Urban	233	57.5
	Rural	172	42.5
BMI	Obese	24	5.9
	Overweight	48	11.9
	Underweight	34	8.4

Variables		Frequency	Percentage
	Normal	299	73.8

Knowledge of stroke risk factors

The risk factor identified by the respondents was excessive alcohol intake (63, 15.6%) followed by hypertension (56, 13.8%), whereas only 27 (6.7%) of the study participants identified smoking as a risk factor for stroke (Table 2).

Table 2
Risk factors for stroke identified by patients with heart disease at WCSH and DCSH, Ethiopia, 2025 (n = 405).

Variables		Frequency	Percentage
Hypertension	Yes	56	13.8
	No/- I do not know	349	86.2
Obesity	Yes	32	7.9
	No/- I do not know	373	92.1
Excessive alcohol intake	Yes	63	15.6
	No/- I do not know	342	84.4
Diabetes mellitus	Yes	43	10.6
	No/- I do not know	362	89.4
Physical inactivity	Yes	44	10.9
	No	361	89.1
Smoking	Yes	27	6.7
	No/- I do not know	378	93.3
Knowledge on stroke risk factor	Adequate knowledge	135	33.3%
	Inadequate knowledge	270	66.7%
	Mean (± SD)	1.59(± 1.05)	

This is supplemented by a 28-year-old in-depth interview with a participant who stated: “I believe that once a person is over the age of 40, excess alcohol drinking, smoking and if you are the type that has high BP and you fall. Immediately after the fall with high BP, it is a stroke I have a friend who had a stroke, he had high BP, he fell, and that was how he developed a stroke.” (P7, Male).

Similarly, a 31-year-old in-depth interview participant stated, “From my knowledge, obesity (when someone is too fat), physical inactivity or a sedentary lifestyle, and especially deep thinking meaning

thinking with tension, being constantly anxious or worrying too much can cause stroke" (P3, female).

Behavioral characteristics of the study participants

Among the respondents, nearly half (198, 48.9%) were alcohol users, 141 (71.2%) of whom had inadequate knowledge of stroke warning signs. More than half of the respondents 220 (54.3%) were coffee consumers (Table 3).

Table 3
Behavioral risk factors among patients with heart disease at WCSH and DCSH, Ethiopia, 2025 (n = 405).

Variables		Frequency (%)	Knowledge on SWS	
			Adequate (%)	Inadequate %)
Smoking	Yes	47 (11.6)	13 (3.2)	34 (8.4)
	No	358 (88.4)	102 (25.2)	256 (63.2)
Frequency of smoking	Daily	36 (8.9)	11 (2.7)	25 (6.2)
	Occasionally	11 (2.7)	2 (0.5)	9 (2.2)
	Non smoker	358 (88.4)	102 (25.2)	256 (63.2)
Alcohol user	Yes	197 (48.9)	50 (14.1)	147 (34.8)
	No	208 (51.1)	65 (14.3)	143 (36.8)
Type of drinker	Heavy drinkers	86 (21.3)	23 (5.7)	63 (15.6)
	Moderate drinkers	111 (27.4)	27 (6.7)	84 (20.7)
	No drinkers	208 (51.3)	65 (16.0)	143 (35.3)
Coffee Consumption	Yes	220 (54.3)	66 (16.3)	154(38.0)
	No	185 (45.7)	49 (12.1)	136 (33.6)
frequency of coffee consumption (n = 220)	Non consumers	184 (83.6)	46 (20.9)	138 (62.7)
	Irregular consumer	45 (20.5)	12 (5.4)	33 (15.0)
	Exactly once a day	79 (35.9)	26 (11.8)	53 (24.1)
	More than once a day	98 (44.5)	31 (14.1)	67 (30.4)
Chewing Khat	Yes	72 (17.8)	19 (4.7)	53 (13.1)
	No	333 (82.2)	96 (23.7)	237 (58.5)
frequency of chewing Khat (n = 72)	Daily	13 (18.1)	5(6.9)	8 (11.1)
	Once during 2 or 3 days	20 (27.8)	6 (8.3)	14 (19.4)
	Once in a week	39 (54.2)	11 (15.3)	28 (38.9)

This is supplemented by a 37-year-old in-depth interview participant who stated “I know that drinking too much alcohol and being physically inactive can lead to stroke. Additionally, old age, such as 50 years and above can lead to stroke” (P9, Male). Another 33-year-old in-depth interview participant stated “Well, as far as I know, excessive alcohol consumption and smoking tobacco can cause stroke” (P1, Female).

Source of information about stroke

Among the total respondents, only 190 (46.9%) had information about stroke. Among these majority, 69 (36.3%) had heard about stroke from health personnel, followed by 47 (24.7%) who had received information from radio or television (Fig. 2).

This was supplemented by a 47-year-old in-depth interviewer who stated “I got the information from health personnel… I had periodic follow-up at the hospital and during that time health providers told me about some information regarding stroke. It was clear and easy to understand (P2, Male).

A 29-year-old in-depth interviewer stated “Of course, I heard some information from media but I know someone with a stroke, he was hypertensive … suddenly he fell down from lunch table that was how he had a stroke. After that, he could not walk well and many activities become difficult for him even eating can become difficult because his hand is now weak” (P8, Female).

Action to be taken by respondents if a stroke occurs

Among the study participants, 166 (41.0%) reported that they would call an ambulance or take the patient to a health institution. This was followed by 90(22.2%) of the study participants who would give the patient a drink or food, 62 (15.3%) who would take the patient to a religious place and the remaining 87 (21.5%) respondents said they would wait until recovery (Fig. 3).

This is supplemented by a 31-year-old in-depth interviewer who stated, “Since I didn’t know what first aid to give to the person at that moment, I would push them to the hospital to get help as quickly as possible” (P5, Male). This was corroborated by Participant 10, who stated, “I would rush the person to the hospital immediately” (P11, Female).

A 52-year-old in-depth interview participant stated “I am not sure that taking the person to the hospital is the first thing I would do. In a way, herbs are an option, because I know someone who was taken immediately to the hospital but died within a day” (P6, Male).

Knowing somebody with a stroke

Among the total study participants, 82(20.2%) responded that they knew somebody who had previously had a stroke before, of whom 40(48.78%) had adequate knowledge (Fig. 4).

This is supplemented by a 49-year-old in-depth interviewer who stated “I have a friend who was just in his living room when strange breeze just blew in, and that was how he had stroke. He was very fine before that day, and after that strange breeze, he had a stroke” (P12, male).

A 29-year-old in-depth interviewer stated “As I said earlier, I know someone with a stroke, he took excessive alcohol and he was hypertensive … suddenly he fell from lunch table, and that was how he had a stroke. After that, he couldn’t walk well, and a lot of activities became difficult for him. Even eating becomes difficult because his hand is now weak” (P8, Female).

Knowledge of stroke warning signs

The proportion of patients with knowledge of stroke warning signs among patients with heart disease at WCSH and DCSH was 28.4% [95% CI, (24.00%, 32.79%)]. The symptom most commonly reported by the participants was sudden severe headache with no known cause, reported by 54(13.3%) participants, followed by sudden unilateral numbness or weakness of the face, arm, or leg, reported by 48 (11.9%) participants. Other symptoms included sudden trouble seeing one or both eyes, 53 (13.1%), sudden trouble speaking or communication problems, 48 (11.9%); and sudden trouble walking or loss of balance, 34(8.4%) (Fig. 5). The stroke warning sign knowledge score ranged from 0 to 5, with a mean (± SD) of 1.59 (± 1.05), indicating generally low recognition of warning signs among participants.

This is supplemented by a 28 year old in-depth interview participant who stated “As I said earlier, … it is a kind of sudden illness that leads to deformity of the hands and legs, whereby the person will not be able to lift either the hand or leg in partial stroke, and for full stroke, the person will not be able to lift both the hand and the leg” (P7, male).

A 28-year-old in-depth interview participant stated “I know it is a loss of brain function caused by interruption of blood supply to the brain. A common word that comes to mind when I hear stroke is paralysis” (P13, male).

Another 33-year-old in-depth interview participant stated “The person will suddenly become dumb. It will be hard for the person to talk; he will just be making signs” (P1, Female).

Factors associated with knowledge of stroke warning signs

In the multivariable binary logistic regression, three of the eight variables were significantly associated with knowledge of stroke warning signs (SWSs) at the 5% level of significance. The significant predictors were: urban residence, no formal education, and having somebody with a history of stroke (Table 4).

Table 4

Bivariable and multi variable binary logistic regression analysis of factors associated with knowledge of stroke warning signs among patients with heart disease at WCSH and DCSH, Ethiopia, 2025 (n = 405).

Variables		Knowledge on SWS		COR (95%CI)	AOR (95%CI)
		Adequate	Inadequate		
Sex	Female	66	142	1.4(4.90,2.17)	1.3(0.67,2.62)
	Male	49	148	1	1
Residence	Urban	82	151	2.2(1.43,3.64)	2.1(1.03,4.39) *
	Rural	33	139	1	1
Educational status	No formal education	15	88	0.3(0.15,0.55)	0.3(0.14,0.97) *
	Elementary	42	103	0.7(0.42,1.13)	0.6(0.30,1.27)
	Secondary and above	58	99	1	1
Monthly income	< 2000ETB	58	133	1.4(0.84,2.35)	1.1(0.52,2.53)
	2000–4000 ETB	27	60	1.4(0.78,2.68)	1.1(0.47,3.02)
	≥ 4000 ETB	30	97	1	1
Ever heard about a stroke	Yes	72	118	2.4(1.56,3.80)	1.1(0.55,2.17)
	No	43	172	1	1
Source of information	Health Personnel	23	46	1	1
	Radio/Television	13	28	0.9(0.40,2.12)	1.1(0.48,2.98)
	Neighbour/Colleague	10	21	0.9(0.38,2.35)	0.9(0.34,2.44)
	Read about Stroke	12	15	1.6(0.64,3.97)	2.1(0.80,5.93)
	Had relative with stroke	13	9	2.8(1.07,7.74)	2.9(0.98,8.94)
know somebody with stroke	Yes	40	42	3.1(1.9,5.21)	2.5(1.12,5.71) *
	No	75	248	1	1
Consumption of alcohol	Yes	50	147	0.7(0.48,1.15)	0.9(0.47,1.76)
	No	65	143	1	1

* *P-value* < 0.05 and 1 indicate the reference category

The qualitative part also supplemented the quantitative part, and the reasons for adequate knowledge of warning signs of a stroke were the urban habitat, education level, and knowledge of somebody with stroke. The majority of the respondents felt that anyone can use the information provided from affected families or relatives and relay it to their household members who live with stroke. This is supported by a 29-year-old in-depth interviewer, who stated that "… for younger people and even everyone, it is very good to obtain the history information from actual patients or relatives because, if you know your family is in this category, you can start to know more and prevent it on time" (P8, Female). Another a 45-year-old in-depth interviewer stated "I have searched and read a lot of information about it after my coworker at work suffered a stroke since last year, he has not returned to work since. If you don't give attention, it will affect everyone around you, directly or indirectly" (P14, Male).

DISCUSSION

This study was conducted to assess knowledge of warning signs of stroke and its associated factors among cardiac patients at Woldia and Dessie Comprehensive Specialized Hospitals. The prevalence of knowledge of warning signs of stroke among patients with heart disease at WCSH and DCSH was 28.4% [95% CI, (24.00, 32.79)].

The qualitative findings also supplemented the quantitative results in that the participants from the in-depth interviews generally had poor knowledge of stroke signs. Most participants could not mention any stroke warning signs and some listed at most two Similarly, the majority of in-depth interview participants had heard of stroke before the study with "health workers" being the most commonly cited source of stroke information. This may be attributed to the fact that most people prefer to obtain medical information from healthcare personnel as they believe that the information given may be more accurate and error-free.

This finding is in line with those of studies conducted in India 25% (25), and in Ghana 26.9% (26), However, the results of this study are higher than those of studies conducted in Bahir Dar (22.7%) (20), Tanzania 17.5% (27), South Gondar Zone 15% (31), and only 1% in Egypt (28). A multicenter cross-sectional study conducted in Morocco similarly reported suboptimal awareness, with 37.3% of participants identifying sudden numbness or weakness of the face, arm, or leg and 34.5% recognizing sudden dizziness, difficulty walking, loss of balance, or coordination problems as warning signs of stroke (29).This discrepancy might be explained by, socioeconomic and cultural differences between the populations. Additionally, methodological variations such as the study period, study design, study population and sample size might be attributed to the discrepancy; for example, the study participants conducted in Bahir Dar and South Gondar Zones included hypertensive patients whereas, in this study the study participants were patients with heart disease.

Moreover, this discrepancy might be explained by variations in ascertainment methods; in our study, participants were considered to have adequate knowledge if they scored at or above the mean on the

warning sign questions. In contrast, in the study performed by Bahir Dar, individuals who identified 5–10 stroke warning signs were categorized as having good knowledge of stroke warning signs (20).

In contrast, these findings were lower than those of studies conducted in China 36.5% (24), Benin 54.9% (21), and Addis Ababa 42.7% (30). This discrepancy might be explained by, differences in access to health information, and socioeconomic and cultural differences between the populations. In addition, variations in methodology such as study period, study design, and sample size might be attributed to these discrepancies.

Moreover, this inconsistency might be due to the difference in study participants, even when similar study designs were used. For example, the study conducted in China included admitted stroke patients, who are more likely to be informed about the disease process, its consequences, and its risk factors. Finally, the gap may be due to differences in study settings and participant residences. In the Addis Ababa study, 67.8% of the participants were urban residents, whereas in the present study only 57.5% were urban residents.

In Ethiopia, rural residents have lower educational levels and poor access to health information that do urban residents, who generally have better health literacy (43). Thus, the lower level of awareness of stroke signs among rural residents could be attributed to their lower education attainment.

In this study, a significant relation was found between knowledge on warning signs of stroke and urban habitat, education level, and knowing someone who is aware of stroke. This study revealed that an urban resident was an independent predictor of knowledge of warning signs of stroke among patients with heart disease. The odds of having adequate knowledge of warning signs of stroke among patients in urban residential areas were 2.1 times more likely than rural area residents. This finding is supported by a study conducted in Addis Ababa among patients with heart disease at Tikur Anbessa Specialized Hospital (30) and at the Felege Hiwot Referral Hospital among hypertensive patients (20).

In Ethiopia, rural residents have lower educational levels and poor access to health information than do urban residents, who have relatively better health literacy (43). Thus, the low level of awareness of stroke among rural residents could be due to their lower education attainment (43).

Additionally, the possible explanation for this association could be that urban residents are exposed to new information; most of them are social media users, and because of the increasing prevalence of chronic disease, they are more interested in learning about risk factors and warning signs of stroke. Urban residents also have better access to health facilities and greater educational opportunities (20).

Additionally, education level was one of the factors associated with adequate knowledge of warning signs of stroke among patients with heart disease. These findings suggest that those without formal education were 70% less likely to have adequate knowledge of warning signs of stroke that those with higher education levels were. This finding is in agreement with those of studies conducted in Korea (32),

Nigeria (21, 35), Addis Ababa among patients with heart disease at Tikur Anbessa Specialized Hospital (30), and Felege Hiwot Referral Hospital among hypertensive patients (20).

The potential rationale is that a low level of education may lead to limited interaction with society and therefore less interest in following medical developments, thereby resulting in a low level of health care knowledge and attitudes toward stroke (44). Furthermore, knowing someone with stroke was identified as a significant predictor of adequate knowledge of stroke warning signs.

Individuals who knew someone with stroke were 2.5 times more likely to have adequate knowledge of stroke warning signs than their counterparts were. This result was consistent with a study performed in Addis Ababa (30, 33, 37). This may be because family members or relatives can use the information provided to stroke patients and may also share it among themselves. Therefore, health care teams should consider the involvement of families or relatives when teaching patients with heart disease about warning signs of stroke (33).

STRENGTH AND LIMITATION

Strengths of the Study

The main strength of the current study is its mixed methods design, which allows to a more in-depth understanding of the factors related to knowledge of stroke warning sign.

Limitations of the Study

- As with any cross-sectional study, a cause-and-effect relationship was not possible to establish for the factors addressed in the study.
- Social desirability biases may have led to underestimation of some lifestyle and behavioral factors, such as smoking and alcohol consumption
- Using a mean-based dichotomization of knowledge scores may result in some loss of information; future studies may consider analyzing knowledge as a continuous variable or applying predefined cut-off points.
- Detailed clinical characteristics such as specific cardiac diagnoses, duration of heart disease, and frequency of follow-up visits were not assessed, which may have influenced patients' exposure to stroke-related health education.
- Awareness of the FAST (Face–Arm–Speech–Time) message was not specifically assessed, as the study focused on individual recognition of stroke warning signs.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion: This study revealed that the proportion of individuals with knowledge of warning signs of stroke was lower among cardiac patients at Woldia and Dessie Comprehensive Specialized Hospitals than among those in most of the literature. The study also revealed significantly associated factors that

contribute to the understanding of warning signs of stroke which include; urban habitat, education level, and knowing somebody with a history of stroke.

Recommendation: On the basis of the findings of this research, the following recommendations are proposed:

Policy makers: Experts should design effective programs to increase patients' understanding of stroke warning signs and their related factors among patients with heart disease in Ethiopia.

Dessie and Woldia comprehensive specialized hospital

In collaboration with city administration health departments and all health facilities around the study area, effective protocols, guidelines, and training manuals should be developed to address regular health education programs concerning stroke warning signs and related factors among patients with heart disease. Monitoring metrics, including periodic assessments of patients' recognition of stroke symptoms during clinic visits, may help evaluate the effectiveness of these interventions over time.

Stroke education may be feasibly integrated into routine cardiac clinic workflows through brief, structured counseling via the Face–Arm–Speech–Time (FAST) message during follow-up visits.

In collaboration with public media and social-media, efforts should be made to raise public awareness about stroke and its related factors regularly. Simple educational materials such as posters and leaflets in local languages could reinforce key warning signs.

Clinicians: Given the low level of stroke awareness, it would be beneficial if they form a group of patients with stroke and heart disease to discuss stroke warning signs and its related factors during their follow-up appointments allowing them to easily share experiences. Integrating brief FAST-based counseling into routine cardiac clinic visits may be a feasible and impactful strategy to improve the early recognition of stroke symptoms.

Researchers: This study was institutionally based, so researchers should conduct further research on stroke risk warning signs and their related factors.

LIST OF ABBREVIATIONS

AOR Adjusted odd ratio

CI Confidence interval

COR Crude odds ratio

DALYs Disability-Adjusted Life Years

DCSH Dessie Comprehensive Specialized Hospital

EMS Emergency medical services

FAST Face, Arm, Speech, and Time

GBD Global Burden of Disease

NCD Non-Communicable Diseases

SPSS Statistical Package for Social Sciences

WCSH Woldia Comprehensive Specialized Hospital

WHO World Health Organization

WSO World Stroke Association

DECLARATIONS

Ethics approval and consent to participate

Ethical approval was obtained from the Ethical Review Committee of Wollo University, College of Health Sciences. An official letter of cooperation was submitted to the administrations of the participating hospitals prior to data collection.

All eligible participants were informed about the purpose and potential benefits of the study, as well as their right to decline participation or withdraw at any time without consequences. Written informed consent was obtained from all participants before enrollment.

To ensure confidentiality and privacy, participants' names and medical record numbers were not recorded on the data collection instruments. All collected information was kept strictly confidential.

All methods were performed in accordance with the relevant guidelines and regulations and adhered to the principles of the Declaration of Helsinki.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

The study was not granted any funding source

Acknowledgment

Not applicable

Author Contributions

All the authors reviewed and put substantial effort into this study. DA: conceptualization and design of the study; DA and DM: data extraction and management; DA, MB, and DM: analysis, interpretation of the findings, and writing the first draft of the research; DA, BY, and SW: writing the final draft of the research; BY, MA, EG: editing and approval of the final research before submission.

REFERENCES

1. Sacco, R. L. et al. 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 (2013).
2. McCoy, C. E., Langdorf, M. I. & Lotfipour, S. American heart Association/American stroke association deletes sections from 2018 stroke guidelines. *Western J. Emerg. Med.* **19** (6), 947 (2018).
3. Jauch, E. C. et al. 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* **44** (3), 870–947 (2013).
4. Fisher, M., Iadecola, C. & Sacco, R. *Introduction to the stroke compendium* p. 437–438 (Lippincott Williams & Wilkins Hagerstown, MD, 2017).
5. Johnson, W., Onuma, O., Owolabi, M. & Sachdev, S. Stroke: a global response is needed. *Bull. World Health Organ.* **94** (9), 634 (2016).
6. Hickey, A., Mellon, L., Williams, D., Shelley, E. & Conroy, R. M. Does stroke health promotion increase awareness of appropriate behavioural response? Impact of the face, arm, speech and time (FAST) campaign on population knowledge of stroke risk factors, warning signs and emergency response. *Eur. stroke J.* **3** (2), 117–125 (2018).
7. Feigin, V. L. et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol.* **20** (10), 795–820 (2021).
8. Shiferaw, F. et al. Non-communicable Diseases in Ethiopia: Disease burden, gaps in health care delivery and strategic directions. *Ethiop. J. Health Dev.* ;**32**(3). (2018).
9. Tolla, M. T. et al. Prevention and treatment of cardiovascular disease in Ethiopia: a cost-effectiveness analysis. *Cost Eff. Resource Allocation*. **14**, 1–14 (2016).

10. Chen, Y. et al. Mortality and recurrent vascular events after first incident stroke: a 9-year community-based study of 0· 5 million Chinese adults. *Lancet Global Health*. **8** (4), e580–e90 (2020).
11. Connor, M. D., Walker, R., Modi, G. & Warlow, C. P. Burden of stroke in black populations in sub-Saharan Africa. *Lancet Neurol.* **6** (3), 269–278 (2007).
12. Baye, M. et al. Stroke characteristics and outcomes of adult patients in Northwest Ethiopia. *Front. Neurol.* **11**, 428 (2020).
13. Zemed, A., Nigussie Chala, K., Azeze Eriku, G. & Yalew Aschalew, A. Health-related quality of life and associated factors among patients with stroke at tertiary level hospitals in Ethiopia. *PloS one*. **16** (3), e0248481 (2021).
14. Arisegi, S. A., Awosan, K. J., Oche, M. O., Sabir, A. A. & Ibrahim, M. T. Knowledge and practices related to stroke prevention among hypertensive and diabetic patients attending Specialist Hospital, Sokoto, Nigeria. *Pan Afr. Med. J.* **29** (1), 1–17 (2018).
15. Dar, N. Z., Khan, S. A., Ahmad, A., Maqsood, S. & Khan, S. A. Awareness of stroke and health-seeking practices among hypertensive patients in a tertiary care hospital: a cross-sectional survey. *Cureus* ;**11**(5). (2019).
16. Benjamin, E. J. et al. Heart disease and stroke statistics—2017 update: a report from the American Heart Association. circulation. ;135(10):e146-e603. (2017).
17. Woldetsadik, F. K., Kassa, T., Bilchut, W. H., Kibret Ak, Guadie, Y. G. & Eriku, G. A. Stroke related knowledge, Prevention practices and Associated factors among hypertensive patients at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, 2021. *Front. Neurol.* **13**, 839879 (2022).
18. Meschia, J. F. et al. Guidelines for the primary prevention of stroke. *Stroke* (2014).
19. Donkor, E. S. Stroke in the 21st century: a snapshot of the burden, epidemiology, and quality of life. *Stroke Res. Treat.* **2018** (1), 3238165 (2018).
20. Abate, A. T., Bayu, N. & Mariam, T. G. Hypertensive Patients' Knowledge of Risk Factors and Warning Signs of Stroke at Felege Hiwot Referral Hospital, Northwest Ethiopia: A Cross-Sectional Study. *Neurol. Res. Int.* **2019** (1), 8570428 (2019).
21. Ehidiamen, O. F. & Ehinwenma, O. J. Awareness of stroke risk factors and warning symptoms amongst hypertensive patients in Benin City. *Ann. Med. Health Sci. Res.* **8** (1), 40–44 (2018).
22. Falavigna, A. et al. Awareness of stroke risk factors and warning signs in southern Brazil. *Arq. Neuropsiquiatr.* **67**, 1076–1081 (2009).
23. Hickey, A., Holly, D., McGee, H., Conroy, R. & Shelley, E. Knowledge of stroke risk factors and warning signs in Ireland: development and application of the Stroke Awareness Questionnaire (SAQ). *Int. J. Stroke*. **7** (4), 298–306 (2012).
24. Liang, J., Luo, C., Ke, S. & Tung, T-H. Stroke related knowledge, prevention practices and associated factors among stroke patients in Taizhou, China. *Prev. Med. Rep.* **35**, 102340 (2023).

25. Mehta, S. et al. Assessing Public Awareness of Stroke: Knowledge of Warning Signs, Risk Factors, and Treatment Responses. *Eur. J. Cardiovasc. Med.* **14**, 7–12 (2024).
26. Attakorah, J., Mensah, K. B., Yamoah, P., Bangalee, V. & Oosthuizen, F. Awareness of stroke, its signs, and risk factors: A cross-sectional population-based survey in Ghana. *Health Sci. Rep.* **7** (6), e2179 (2024).
27. Muhihi, A. J. et al. Public knowledge of risk factors and warning signs for cardiovascular disease among young and middle-aged adults in rural Tanzania. *BMC Public. Health*. **20**, 1–12 (2020).
28. Pallangyo, P. et al. Public knowledge of risk factors and warning signs of heart attack and stroke. *Egypt. J. Neurol. Psychiatry Neurosurg.* **60** (1), 12 (2024).
29. Kharbach, A. et al. Level of knowledge on stroke and associated factors: a cross-sectional study at primary health care centers in Morocco. *Annals Global Health*. **86** (1), 83 (2020).
30. Workina, A., Kebede, S., Fekadu, C. & Wubetie Snr, A. Knowledge of risk factors and warning signs of stroke among patients with heart disease at Tikur Anbessa specialized hospital. *Open. Access. Emerg. Med.* :57–66. (2021).
31. Nigat, A. B. et al. Knowledge on stroke warning signs and associated factors among hypertensive patients, Northwest Ethiopia: an institution-based cross-sectional study. *Vasc. Health Risk Manag.* :721–728. (2021).
32. Kim, E. M., Hwang, S. Y. & Kim, A. L. Knowledge of stroke and heart attack symptoms and risk factors among rural elderly people: a questionnaire survey. *Korean circulation J.* **41** (5), 259–264 (2011).
33. Getu, R. A. et al. Knowledge of stroke risk factors and warning symptoms among adults with type 2 diabetes in Addis Ababa, Ethiopia, 2021: an institution-Based cross-sectional study. *BMC Cardiovasc. Disord.* **23** (1), 21 (2023).
34. Sadighi, A., Groody, A., Wasko, L., Hornak, J. & Zand, R. Recognition of stroke warning signs and risk factors among rural population in Central Pennsylvania. *J. Vasc. Interv. Neurol.* **10** (2), 4 (2018).
35. Margaret Bukola Fatudimu* JO, and Joshua Olumayowa Ojo. Knowledge of Stroke Risk Factors, Warning Signs, Emergency Response, and Prevention among Adults in an Urban Community in Nigeria. *Eur. J. Med. Health Sci.* ;**7**(2). (2025).
36. Chang, T. et al. Knowledge of stroke, its warning symptoms, risk factors and treatment among the general public and general practitioners in a South Asian population. *J. Stroke Cerebrovasc. Dis.* **29** (5), 104760 (2020).
37. Tuli, W., Teshome, E. & Jiru, T. Knowledge of stroke risk factors and prevention among hypertensive patients on follow-up at Addis Ababa University Tertiary Hospital, Addis Ababa, Ethiopia: a cross-sectional study. *BMJ open.* **14** (11), e089159 (2024).
38. Makeda Sinaga1 MW. Tilahun Yemane3, Elsah Tegene4, Tolassa Wakayo1, Tsinuel Girma5, David Lindstrom6 and Tefera Belachew1*. Optimal cut-off for obesity and markers of metabolic syndrome for Ethiopian adults. Sinaga et al Nutrition Journal. 2018Sinaga et al. Nutrition Journal;https://doi.org/10.1186/s12937-018-0416-0

39. WHO. *Guidelines for controlling and monitoring the tobacco epidemic* (World Health Organization, 1998).
40. WHO. The WHO STEPS Surveillance Manual.
41. Malaeb, D. et al. Factors associated with knowledge and awareness of stroke among the Lebanese population: a cross-sectional study. *F1000Research* **11**, 425 (2022).
42. WHO. Section 5: Collecting Step 2 data: Physical Measurements Overview. **26** January (2017).
43. Lemma, B., Negesa, J. M. & Philippa Rasmussen, J. M. L. Hendriks. Patients' knowledge on cardiovascular risk factors and associated lifestyle behaviour in Ethiopia in 2018: A cross-sectional study. *PLOS ONE* ;**15**(6). (2020).
44. Komolafe, M. A., Adebiyi, M. O. B. O. A. M., .Obembe, A. O., Fawale, M. B. & Adebowale, A. A. Stroke risk factors among participants of a world stroke day awareness programin South-Western Nigeria. *Niger. J. Clin. Pract.* **18** (6), 807–809 (2015).

Figures

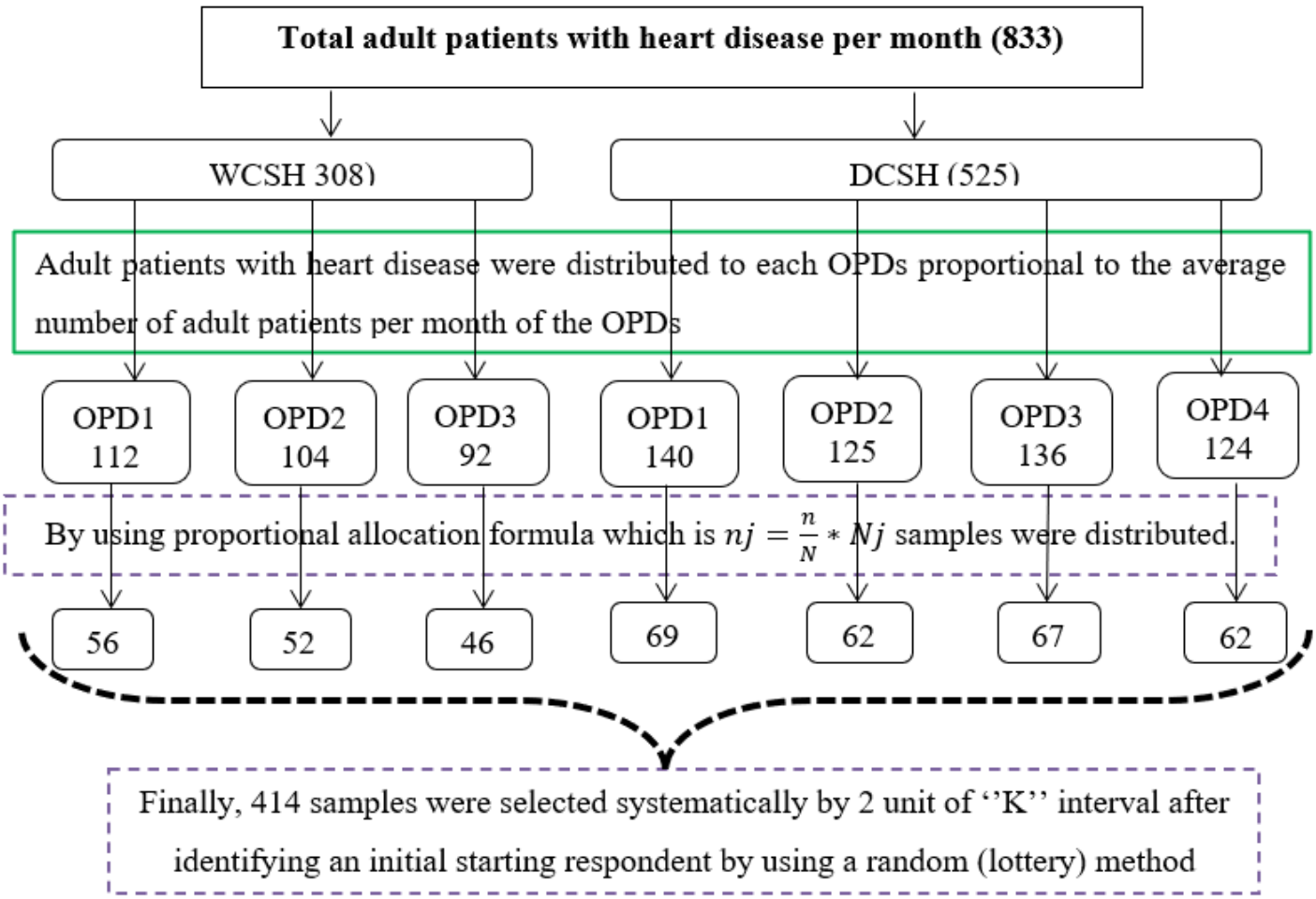


Figure 1

Schematic presentation of the sampling procedure for identifying factors associated with knowledge of warning signs of stroke among patients with heart disease at Woldia and Dessie Comprehensive Specialized Hospitals, 2025.

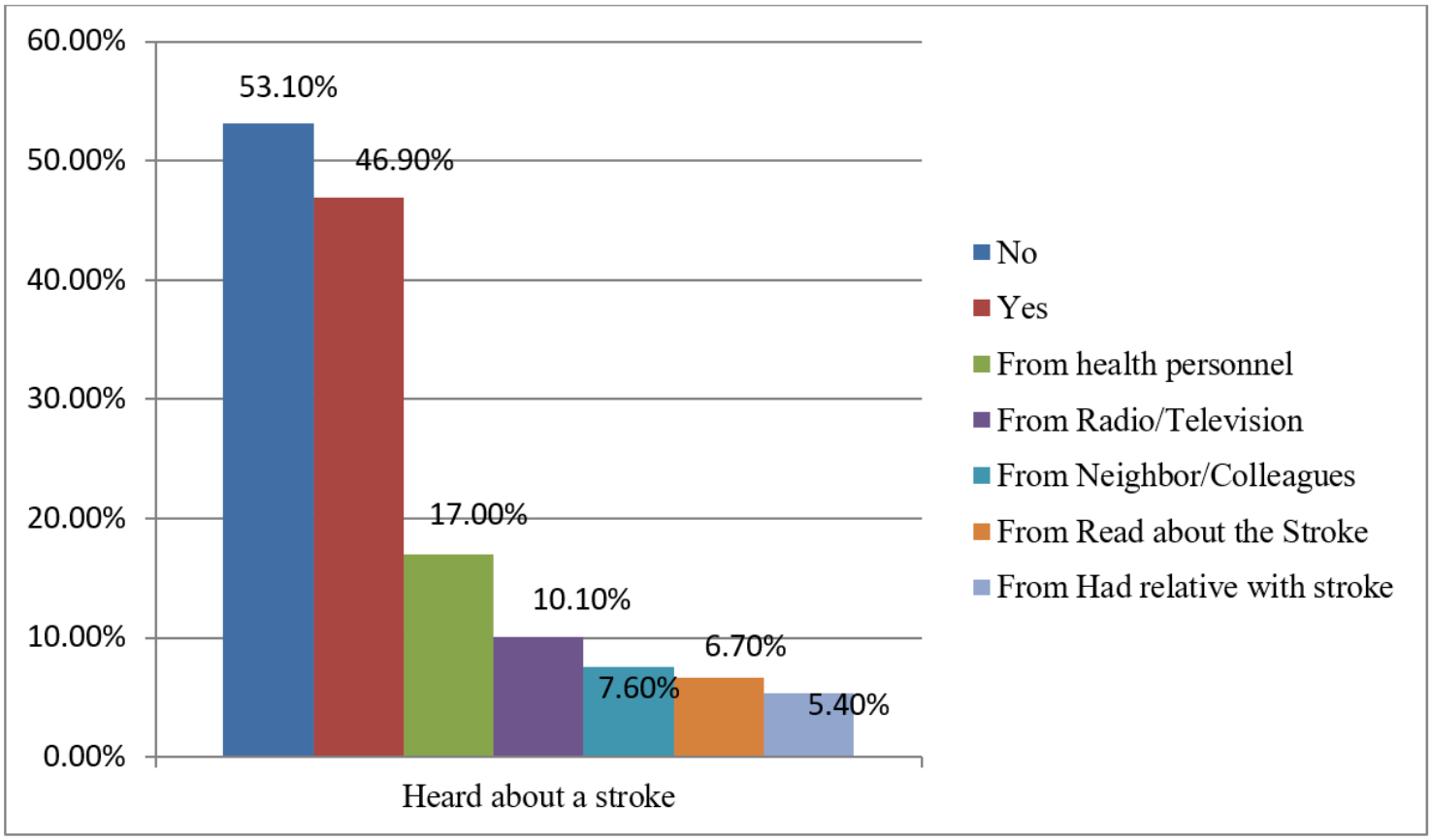


Figure 2

Source of information about stroke among patients with heart disease at WCSH and DCSH, Ethiopia, 2025 (n=405).

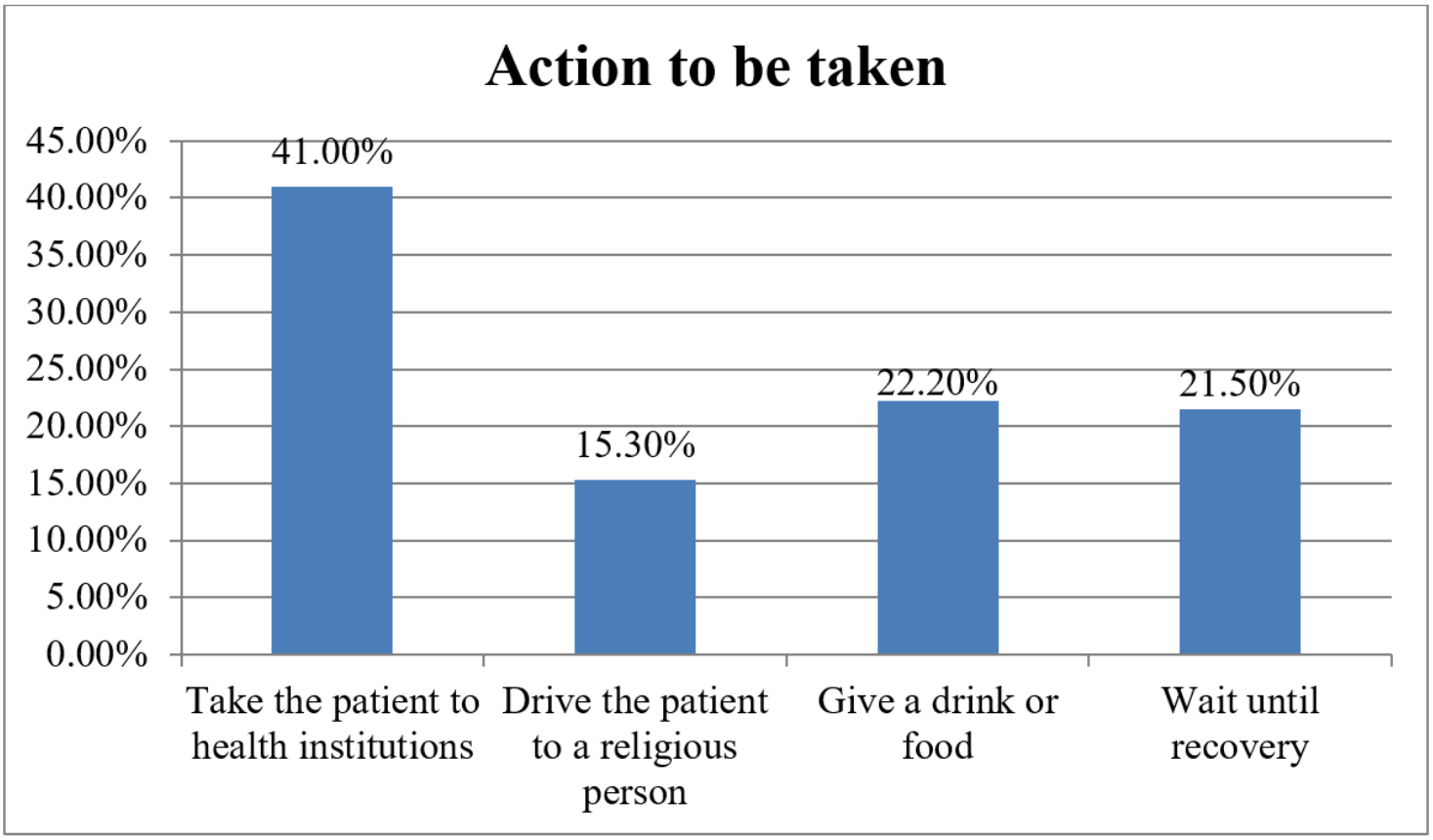


Figure 3

Action to be taken if a stroke occurs among patients with heart disease at WCSH and DCSH, Ethiopia, 2025 (n=405).

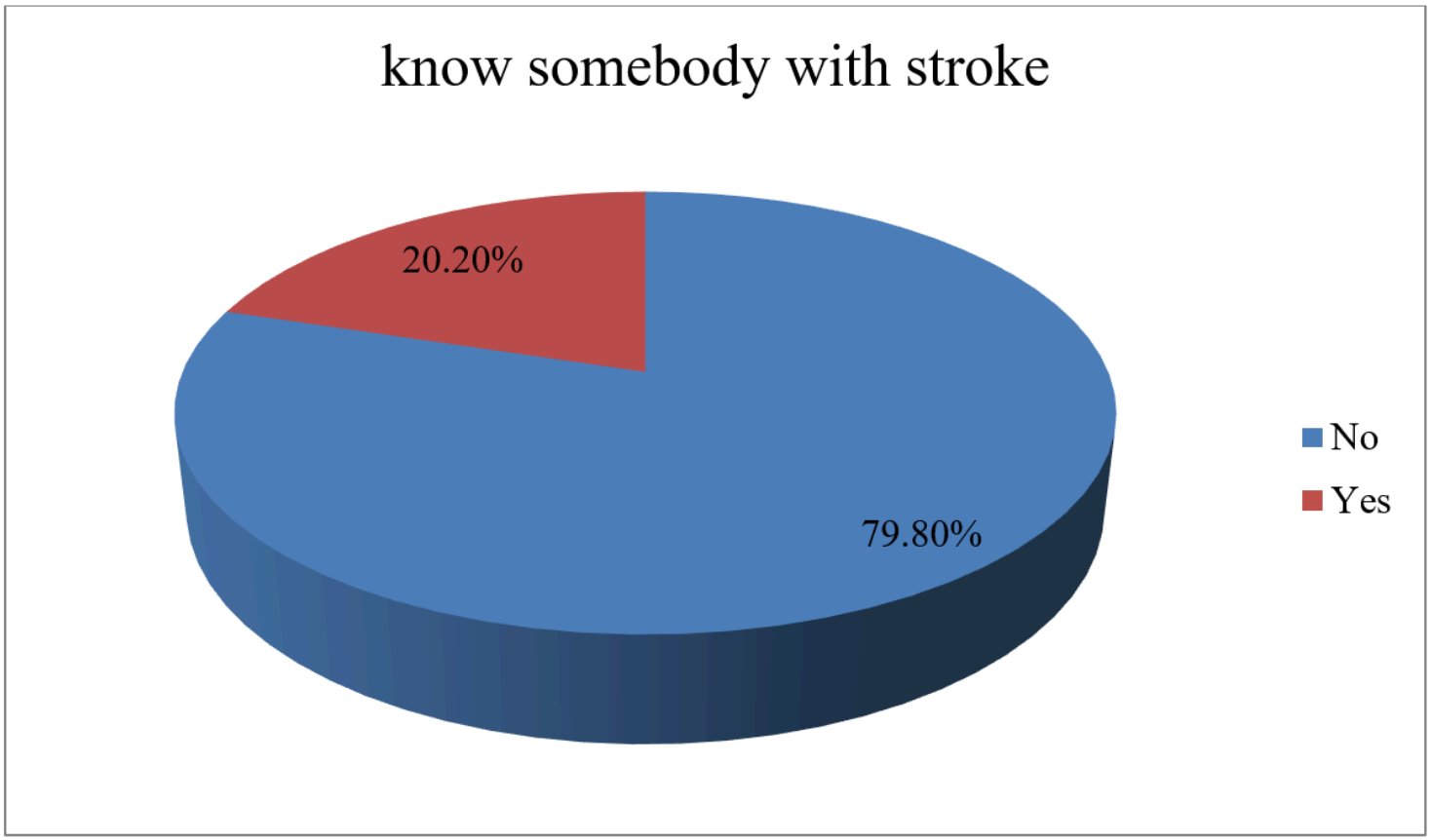


Figure 4

Respondents' familiarity with individuals who had experienced stroke among patients with heart disease at WCSH and DCSH, Ethiopia, 2025 (n=405)

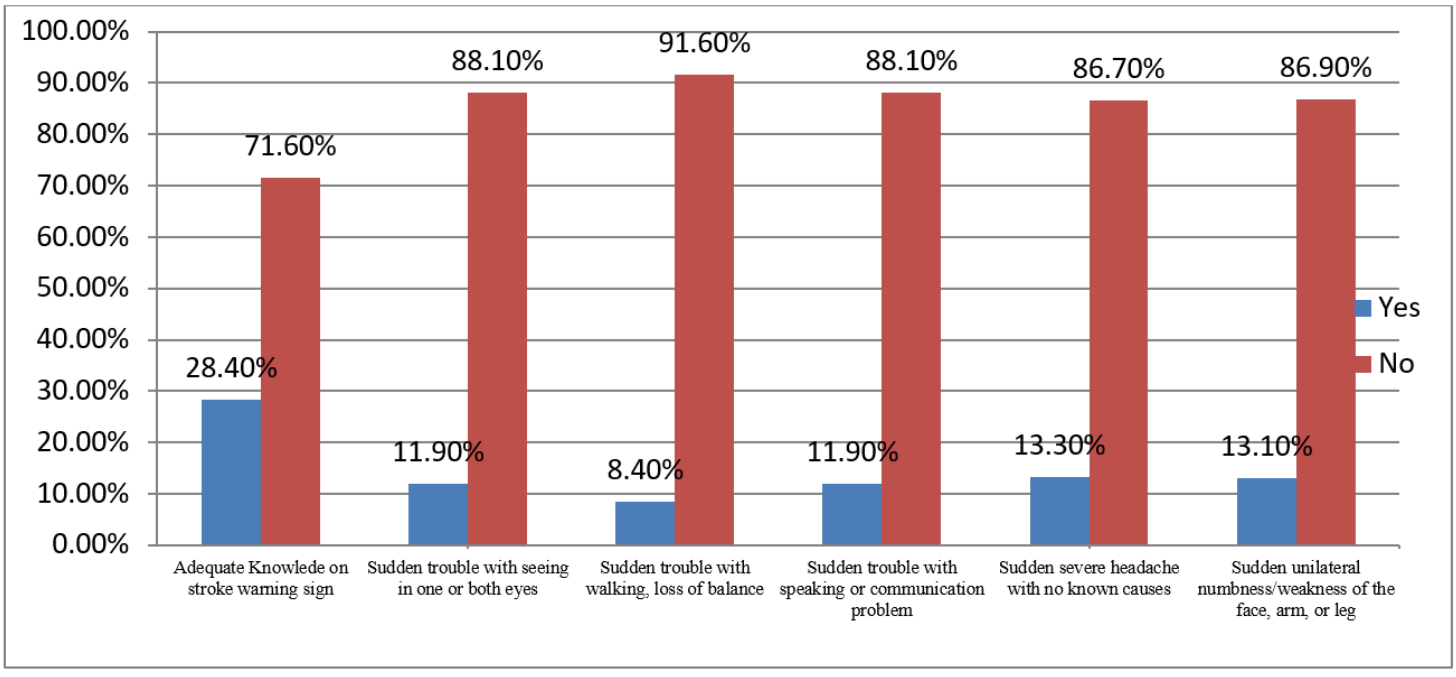


Figure 5

Proportion of knowledge of stroke warnings among patients with heart disease at WCSH and DCSH, Ethiopia, 2025 (n=405).