

Time to Death and its Predictors among Stroke Patients with Hypertension at Comprehensive Specialized Public Hospitals

Yihenew Sewale Bizu

yihenewsewale123@gmail.com

Debre Markos University

Kassahun Dires Ayenew

Asrat Woldeyes Health Science Campus, Debre Berhan University

Article

Keywords: Stroke, Hypertensive, Predictors, Ethiopia

Posted Date: October 18th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10216632/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 death, with hypertension significantly increasing mortality risk. However, studies on time to death and its predictors among hypertensive stroke patients are scarce in Ethiopia. This study aimed to assess the time to death and its predictors among h stroke patients with hypertension admitted at public hospitals in the Amhara region, 2023.

Methods: A retrospective cohort study was conducted among stroke patients with hypertension admitted to selected public hospitals in the Amhara region, Ethiopia. Data were collected using a structured checklist, entered into EPI Data 4.2, and analyzed with STATA 16. The proportional hazards assumption was checked, and model fitness was assessed using Cox–Snell residuals ($p > 0.05$). Variables with $p < 0.25$ in bi-variable analysis were included in the multivariable Cox regression to control for confounders, and predictors of time to death were identified in the final model using adjusted hazard ratios (AHR) with $p < 0.05$.

Result: The study included 737 participants, 307 (45.7%) of them died, with an overall median time to death of 40 days (IQR: 39, 57), and 400 (54.3%) were censored. Most of 309 (91.7%) death were greater than aged 65 years old and 246 (73%) were males with proportion of 333(98.8%) death in hemorrhagic stroke. Age group > 65 years [AHR=3.2(95%CI,1.28-8.06)], elevated blood pressure [ARH=5.75(95%CI,2.23,14.79)],Cardiovascular disease [AHR= 0.08 (95%CI:0.01- 0.43)],consumed alcohol [AHR=12.9 (95% CI: 2.57- 65.51)] , complication at admission [AHR= 8.2 (95% CI: 4.19-16.37)], unconscious (GCS<8) [AHR:=3.30 (95% CI: 1.46-7.47)] and drowsy (GCS 9-12) at the time of admission [AHR:2.30 (95% CI:1.06-4.99)] were statistically significant predictors of death patients stroke with hypertension.

Conclusion and recommendation: A study reported a median recovery time of 40 days for stroke patient with hypertensive, with a recovery rate of 10 per 1,000 person-days. Age, blood pressure, presence of cardiovascular disease, alcohol use, Glasgow Coma Scale score, and associated complications were significant associated predictors of death.

Introduction

Background

Stroke is defined as "rapidly developing clinical signs of focal or global disturbance of cerebral function with symptoms lasting 24 hours or longer that lead to death (1). It is a major cause of disability and mortality worldwide (2). According to the Global Burden of Disease (GBD) 2019 report, approximately 90% of stroke risk is attributable to high blood pressure, obesity, diabetes, hyperlipidemia, and renal dysfunction, whereas the remaining 10% is associated with family history, smoking, physical inactivity, alcohol consumption, and unhealthy dietary habits (3, 4).

Global stroke organization states that an individual's suffering from stroke frequently experiences unilateral motor or sensory deficits, speech disturbances, altered mentation, headaches, and/or vertigo(5). Stroke causes 11.8% of global deaths, ranking second after ischemic heart disease and leading to major disability. World Stroke Organization estimates that one in four people over 25 years will experience a stroke in their lifetime. Each year, over 16% of strokes occur in aged 15–49, and more than 62% affect individuals under 70 years. Women account for 53% of cases, and men 47%. Stroke causes about 6.5 million deaths annually, with 34% occurring in people younger than 70 years (6). The global stroke burden is increasing due to low awareness of risks and warning signs, with deaths projected to rise 17% in the next decade. In Ethiopia, WHO (2014) reported stroke caused 4.71% of deaths and was the leading cause of disability (6,458 DALYs per 100,000)(7). A Norwegian study reported 78.6% ischemic strokes, 13.3% hemorrhagic, and 8.1% unspecified (8, 9). In Thailand, systemic arterial hypertension was identified as a major risk factor for stroke and coronary heart(10).

Most stroke patients recover within six months, with the greatest improvement observed after one year. In Ethiopia, 39,409 stroke-related deaths were recorded in 2004, and hospital mortality ranges from 11% to 38%, with a pooled in-hospital mortality of 18% (11). By 2030, stroke cases are projected to exceed 23 million globally, causing 7.8 million deaths (12).

Studies in Ethiopia indicate that ischemic stroke is the most common type, with over three-fourths of patients presenting with comorbid conditions, primarily hypertension, and the majority reporting left-sided body weakness during hospital admission(13, 14). Hypertension (75.9%) was identified as the most frequent risk factor, followed by family history of stroke (33.6%), alcohol use (22.4%), smoking (17.2%), and heart failure (17.2%)(15). The strategies for stroke prevention in Ethiopia have included blood pressure control campaigns, tobacco regulation, reduced salt intake, and the promotion of physical activity(16). Despite the increasing public health burden of stroke in the country, studies specifically addressing stroke patients with hypertension remain limited. Therefore, this study aimed to assess the time to death and its predictors among stroke patients with hypertension in the Amhara National Regional State, Ethiopia.

Methods

Study design, study area and period

An institutional retrospective cohort study was conducted from January 1, 2018, to December 30, 2023, in eight specialized comprehensive hospitals in Ethiopia of University of Gondar, Felege Hiwot, Tibebe Gion, Debre Markos, Debre Berhan, Dessie, Debre Tabor, and Woldia. These hospitals serve over 15 million people according to 2017 census.

Source population

All patients diagnosed with stroke either clinically or via brain imaging who were admitted to the comprehensive specialized public hospitals in the Amhara national regional state of Ethiopia.

Study population

All patients diagnosed stroke secondary to hypertension clinically or by using brain imaging instrument, and admitted to public hospitals of Amhara national regional state from January 2018 to December 2023.

Inclusion and Exclusion criteria

Inclusion criteria

- Patients must have a documented diagnosis of stroke, either ischemic or hemorrhagic, based on clinical evaluation and/or neuroimaging (CT or MRI).
- Both known hypertensive patients with a previous diagnosis or on antihypertensive medication, and newly diagnosed hypertensive patients identified during admission are included.
- Patients admitted to the selected comprehensive specialized public hospitals in the Amhara region during the study period (January 1, 2018 – December 30, 2023).
- Patients must have complete medical records including blood pressure measurements, stroke diagnosis, and relevant clinical information.

Exclusion criteria

- Patients with missing or incomplete information on stroke diagnosis, blood pressure measurements.
- Non-Hypertensive Stroke Patients
- Patients diagnosed only with TIA or other transient neurological events, not confirmed stroke.
- Patients referred from other hospitals without sufficient diagnostic or treatment records.
- Patients outside the age range defined in the study

Sample size determination

The sample size was determined by using STATA software version 16.0 with using the Hazard ratio (HR) of a co-variable and log-rank test, Schoenfeld method by assumption of $H_0: S_1(t)=S_2(t)$, two-sided significance level ($\alpha = 5\%$), $Z_{\alpha/2} = Z$ value at 95% confidence interval = 1.96, power 80% = 0.842, IR = incidence rate (4 per 100 person) from previous research in Ethiopia (4) , π = proportion allocated to each groups (for equal allocation $\pi_1 * \pi_2 = 1$) and $Pr(E)$ = probability of event for each variable (**Table-1**).

$$E = \frac{(Z\alpha/2 + Z\beta)^2}{\Pi_1 \Pi_2 (\ln HR)^2} \text{ and } Pr(E) = 1 - \frac{\exp S1(t) + \exp S1(t) * HR}{2}$$

The total sample size is calculated by; - $n = \frac{E}{Pr(E)}$

Table 1
-The sample size determination of time to death and its predictors among stroke patients with hypertension among Comprehensive Specialized hospitals Amhara National Regional State, Ethiopia, 2023.

Variable	AHR	Probability of event	Sample size	Reference
GCS during admission	4.8	0.108	124	(4)
Increased ICP	2.3	0.064	737	(4)
Pneumonia complication	3.51	0.055	378	(17)

Sampling technique

The registration books of each hospital were used as the sampling frame. A simple random sampling technique was applied to select the medical record numbers of patients admitted between January 2018 and December 2023. The selected record numbers were then used to retrieve and extract relevant clinical and demographic information from patient medical folders.

Sampling procedure

From eight public hospitals in the region, three were selected using a simple random (lottery) sampling method: Debre Markos Comprehensive Specialized Hospital, Debre Berhan Comprehensive Specialized Hospital, and Dessie Comprehensive Specialized Hospital. Data covering a five-year period (January 2018 to December 2023) were extracted from the selected hospitals. The sample size for each hospital was allocated proportionally based on the yearly average number of patients, and a systematic random sampling technique was applied using a calculated sampling interval $K = N/n = 1260/737 \approx 2$ (**Table.2**) (**Figure.1**).

Table 2
Proportion of patient distribution of hospitals, 2023.

s/no	Name of hospitals	Yearly average
1	Debre Berhan Comprehensive Hospital	80*5 = 400
2	Dessie Hospital	88*5 = 440
3	Debre Markos Comprehensive Hospital	44*5 = 420

Variables in the study

Dependent variable

- Time to death among stroke patients with hypertension

Independent variables

Independent variables in this study included sociodemographic factors (age, sex, residence), antecedent risk factors (hypertension, diabetes mellitus, cardiac illness, atrial fibrillation, previous history of stroke), behavioral factors (history of smoking and alcohol use), acute stroke information (method of diagnosis, blood pressure at admission, stroke complications, type of treatment received, treatment outcome at discharge), and neurological factors (stroke subtype, clinical presentation at admission, GCS score at admission, and increased intracranial pressure).

Operational definition

Stroke

a confirmed diagnosis of stroke that have a documented evidence of a cerebrovascular event, either ischemic or hemorrhagic, based on clinical assessment and neuroimaging.

Hypertensive stroke patients are individuals who have experienced a cerebrovascular event (stroke) and have a history of high blood pressure (hypertension). Hypertension is defined as having a systolic blood pressure (SBP) ≥ 140 mm Hg and/or a diastolic blood pressure (DBP) ≥ 90 mm Hg, or currently being on antihypertensive medication(18).

Censored

Those subjects who were discharged against medical advice, discharged with medical advice with improvement or significant neurologic deficit, death other than stroke (accident or any cause not related to stroke), referred to other health facilities or alive until the end of the study whichever occurred first were considered as censored.

Death (Event)

Stroke patients who were died in the hospital after admission and the cause of death secondary to hypertension.

Cardiac illness

a patient who have at least one of the following of disease ischemic heart diseases, rheumatic heart disease, hypertensive heart disease, and valvular heart disease.

Entry date

The date of admission taken from the patient medical record.

Glasgow coma scale (GSC) is categorized as poor GCS (≤ 8) of severe brain injury (unconscious), moderate GCS (9–12) of moderate brain injury (drowsy), and Good GCS (13–15) of mild brain injury (alert)(19).

Time to death is the median time from first day of admission to the occurrence of death within the admission period.

Time of onset of stroke is the time in hours when the patient or observer first became aware of stroke symptoms.

Incomplete medical record

chart with one of the following predictor missed to tell the patient whole story and lacks clarity specificity or incompleteness.

Cardiac illness refers to any clinically diagnosed disease of the heart or its associated blood vessels, including coronary artery disease, heart failure, arrhythmias, valvular heart disease, and congenital heart defects. Patients were considered to have cardiac illness if they had a documented diagnosis in medical records or were receiving treatment for any of these conditions(18).

Complications in stroke patients with hypertension are defined as any new or worsening medical conditions occurring during or after a stroke, directly related to hypertension like intracerebral hemorrhage, hypertensive Crisis, malignant hypertension, organ dysfunction and cognitive decline which is confirmed and documented(20).

Cardiovascular disease (CVD) in stroke patients with hypertension defined as any clinically diagnosed condition affecting the heart or blood vessels, occurring before, during, or after a stroke, and associated with elevated blood pressure that were documented(20).

Data collection

Data was collected using a data abstraction checklist. The checklist was developed from reviewing different literatures (21). The checklist was prepared in English with components of socio-demographic characteristics, behavioral factors, antecedent factors, acute stroke symptoms, and neurological factor. The sources of data were patient medical chart with clinical records including imaging results and any relevant investigations were using during the data abstraction.

Data quality control

A pre-test was conducted at Shegaw Motta General Hospital with 37 participants (5% of the sample). Based on the pre-test feedback, necessary revisions were made before the main data collection. Data collectors and supervisors received training on the questionnaire, data collection procedures, ethical considerations, and the study's objectives. The principal investigator and supervisors conducted daily on-

site supervision throughout the data collection period, and the completeness and accuracy of all collected information were checked at the end of each day.

Data processing and analysis

Data were entered into EpiData version 4.2 checked for completeness and consistency, and exported to STATA version 16 for analysis. Continuous variables were summarized using means and standard deviations, while categorical variables were summarized using frequencies and percentages. Survival analysis was performed using Kaplan–Meier estimates to describe the probability of survival over time, and the log-rank test was used to compare survival curves between groups. The proportional hazards (PH) assumption was checked using global goodness-of-fit tests and assessment of time-dependent covariates. Model fitness was checked using Cox–Snell residuals with a cut-off of $p > 0.05$. In bivariate (unadjusted) Cox regression, variables with $p \leq 0.25$ were included in the multivariable model to control for potential confounders. Predictors of time to death were identified in the final multivariable Cox proportional hazards model using adjusted hazard ratios (AHR) with 95% confidence intervals, and statistical significance were considered a $p < 0.05$.

Results

Socio-demographic characteristics

The study included 737 participants with the mean age of participants were 64.3 ± 8.5 years, or the median age was 67 years (range: 45–90 years). Among participants, more than half 490 (66.48%) were men. and two-third of, 482 (65.48%) were over 65 years old, which accounted for 91.7% of stroke deaths (Table.3).

Table 3
Socio-demographic characteristics of stroke patients with hypertension admitted to selected comprehensive specialized public hospitals, 2023

Variables	Category	Censored		Death	
		Number	(%)	Number	Percentage (%)
Age	1. < 50 years	73	18.3%	8	2.4%
	2. 50–65 years	154	38.5%	20	5.9%
	3. > 65 years	173	43.3%	309	91.7%
Sex	Male	244	61.0%	246	73.0%
	Female	156	39.0%	91	27.0%
Marital status	Married	399	99.8%	336	99.7%
	Widowed	1	0.3%	1	0.3%

Antecedent Risk factors

Among the participants, 240 (32.56%) had diabetes mellitus, and 238 (32.3%) had heart diseases (**Table.4**).

Table 4
Predictors of stroke patients with hypertension admitted to public hospitals, Ethiopia, 2023

Variables	Category	Death (%)		Censored (%)	
Diabetes mellitus	Yes	79	23.6%	161	40.5%
	No	256	76.4%	237	59.5%
Cardiac illness	Yes	80	23.9%	158	39.7%
	No	255	76.1%	240	60.3%
Atrial fibrillation	Yes	1	0.3%	81	20.4%
	No	334	99.7%	317	79.6%
Previous history of stroke	Recurrent	1	0.3%	1	0.3%
	New	334	99.7%	397	99.7%

Behavioral factors

Among stroke patients with hypertensive admitted to the hospitals, 164 (22.4%) had a history of smoking, and 82 (11.2%) reported alcohol use.

Neurological factors

Among the study patients, 651 (88.3%) had hemorrhagic stroke, and 322 (43.7%) presented with poor consciousness (GCS < 8). Among stroke patients with hypertension at admission, 84 (11.4%) had altered mental status, 166 (22.5%) had hemiplegia, and more than half (55.4%) had aphasia (**Figure.2**).

Survival status of stroke patients with hypertension

The overall median time of hospital stay was 40 (IQR: 39, 57) days with a minimum and maximum follow-up time of 2 and 131 days respectively. The overall mortality of hypertensive stroke patients was 45.7% with the total follow-up time is 11,613 person-years, a death rate of 10 per 1000 person/day of observation (95% CI: 0.83, 1.19). The total follow-up time for those deaths and censored during follow-up is 5034 and 6579 respectively.

Kaplan-Meier survival stroke secondary to hypertension

The overall median time of death was 40 (IQR: 39, 57) days. During the first day of hospital stay, 89.50% of survival probability was observed with (95% CI: 84.04, 93.17). At half of the study follow up day, the probability of death was also found to be 61.88% with (95%CI: 54.38, 68.51). The overall study follow-up

of the survival probability to death was also found to be 6.72% with (95%CI: 0.86, 21.61) (**Table.3**) (**Figure. 3**).

Survival function and comparison of survivorship functions for different categorical variables

The Kaplan–Meier survival curve was used to estimate and compare survival functions across categories, where a curve lying above another indicates better survival. Equality of survival curves was tested using the Cochran–Mantel–Haenszel log-rank test, which showed a statistically significant difference in the distribution of survival times among categorical variables (**Table.4**). In this study, patients with BP > 160/100 mmHg had a lower survival probability, with a median survival of 74 days (95% CI: 11–84), compared to those with BP < 160/90–100 mmHg. At the end of follow-up, the probability of death was 4.42% in the BP > 160/100 mmHg group and 71.7% in the BP < 160/90–100 mmHg group, a difference that was statistically significant ($p < 0.001$) (**Figure. 4**).

This study revealed that patients who had complications had a lower survival probability with a median of 82 days (95% CI: 19, 94) as compared to without complications. At the end of follow-up, the death probability of hemorrhagic stroke and ischemic stroke was found to be 5.05% and 72.79% respectively. The difference was statistically significant with a p-value of 0.0000 (**Table. 4**) (**Figure. 5**).

This study revealed that patients who had cardiovascular disease had a lower survival probability with a median of 104 (95% CI: 84, 122) days as compared to patients without cardiovascular disease. At the end of follow-up up the death probability of those who had cardiovascular disease and those without cardiovascular disease was found to be 29.39% and 5.10% respectively. The difference was statistically significant with a p-value of 0.0691 (**Figure. 6**).

Predictors of stroke patients with hypertension

The Cox proportional hazards regression model was used to analyze the relationship between variables and time to death. Bivariate analysis identified variables associated with mortality among stroke patients with hypertensive, including age, cardiovascular disease, alcohol use, type of stroke, blood pressure, clinical presentation, complications, and Glasgow Coma Scale, with a p-value ≤ 0.25 . All covariates with $p \leq 0.25$ in the bivariate analysis were entered into the multivariate model.

Multivariable Cox regression identified several independent predictors of mortality among hypertensive stroke patients. Age group > 65 years [AHR = 3.2(95%CI,1.28–8.06)], elevated blood pressure[ARH = 5.75(95%CI,2.23–14.79)],Cardiovascular disease [AHR:0.08 (95%CI:0.01–0.43)],consumed alcohol [AHR: 12.9 (95% CI: 2.57–65.51)], complication at admission [AHR: 8.2 (95% CI: 4.19–16.37)], unconscious (GCS < 8) [AHR: 3.30 (95% CI: 1.46–7.47)] and drowsy (GCS 9–12) at the time of admission [AHR:2.30 (95% CI:1.06–4.99)] were statistically significant predictors of death patients stroke with hypertension.

Participants aged ≥ 65 years had a 3.2-fold higher risk of faster death compared to age < 65 years [AHR = 3.2(95%CI, 1.28–8.06)]. Participants with stage II or higher hypertension were 5.7 times more likely to die earlier than patients with stage I hypertension [ARH = 5.75(95%CI, 2.23–14.79)]. Participants with cardiovascular disease at admission experienced shorter survival compared to those without [AHR: 0.08 (95% CI: 0.01–0.43)]. Participants who were drinkers had a 12.9-fold higher risk of faster death [AHR: 12.9 (95% CI: 2.57–65.51)]. Patients presenting with complications had an 8.2-fold higher risk of death compared to patients without complications [AHR: 8.29 (95% CI: 4.19–16.37)].

Finally, participants with unconscious (GCS < 8) and those drowsy (GCS 9–12) were 3.30 and 2.30 times more likely to die earlier than alert patients (GCS > 13), respectively [AHR: 3.30 (95% CI: 1.46–7.47)] and [AHR = 2.30 (95% CI: 1.06–4.99)] (**Table. 5**).

Table 5
Results of the bi-variable and multivariable Cox regression analysis among participants at public hospitals, 2023.

Variable	Category	Status		CHR(95%CI)	AHR(95%CI)
		Death	Follow-up time		
Age	1. <50 years	8(2.4%)	1281	1	1
	2. 50–65 years	20(5.9%)	2661	0.35(0.59,0.89)*	2.51(0.70,5.72)
	3. >65 years	309(91.7)	7671	7.7(3.84,15.67)***	3.2(1.28, 8.06)*
Blood pressure	Stage I 140–160/90	9(2.67%)	3853	1	1
	Stage II and above HTN	328(97.3%)	7760	13.04(6.72,25.30)**	5.75(2.23,14.79***
Cardiovascular disease	Yes	80(23.9%)	4133	1.52(1.18,1.96)***	0.08(0.01,0.43)**
	No	255(76.1)	7480	1	1
Alcohol users	Yes	78(23.15%)	1185	0.37(0.28,0.47)***	12.9(2.57,65.51)**
	No	259(76.8%)	10428	1	1
Type of stroke	Ischemic	4(1.19%)	1282	1	1
	Hemorrhagic	333(98.8%)	10331	10.92(4.07, 29.29)	5.71(0.83 ,38.90)
Clinical presentation	Speech disturbances	173(51.3%)	7048	6.93(2.85, 16.88)	0.37(0.06, 2.18)
	Hemiplegia	159(47.1%)	2393	16.45(6.75, 40.09)*	0.46(0.07,2.77)
	Abnormal body movement	10(12.8%)	890	5.76(3.05,9.54)	0.93(0.56,1.27)
	Altered mental status	5(1.48%)	1282	1	1
GCS	Alert	7(2.08%)	1324	1	1
	Drowsy	239(70.9%)	5085	3.71(1.73, 7.95)***	2.30(1.06, 4.99)*
	Unconscious	91(27.00%)	5204	1.61(0.46,5.68)	3.30(1.46, 7.47)*
Complication	Yes	327(97.0%)	9093	9.55(5.09,17.93)***	8.2(4.19,16.37)***
	No	10(2.97%)	2520	1	1

Test of proportional hazard assumption

The goodness-of-fit of the Cox proportional hazards model was assessed both statistically and graphically using the Cox-Snell residuals plot. The Schoenfeld residuals test was applied to evaluate the proportional hazards assumption for each covariate and globally. While the P-value for individual covariates was < 0.05, the global test P-value was 0.1703, indicating that the overall model satisfied the proportional hazards assumption. Graphically, the Cox-Snell residuals closely followed a 45° line relative to the baseline hazard, confirming that the model was well-fitted (**Table.6**) & (**Figure.7**).

Table 6
Schoenfeld residual test for proportional assumption of each covariant and overall Cox proportional hazard model.

Covariates	Rho	Chi²	p-value
Age	0.04904	0.90	0.3439
Sex	0.00253	0.00	0.9625
Marital status	0.02192	0.16	0.6866
Diabetes mellitus	0.00684	0.03	0.8658
Cardiovascular disease	0.03001	0.67	0.4116
Arterial fibrillation	0.00067	0.00	0.9609
Previous history of stroke	0.00323	0.01	0.9333
Smoking	0.00399	0.11	0.7396
Alcohol	0.00578	0.20	0.6542
Type of stroke	0.07096	2.62	0.1052
Glasgow comma scale	0.04355	0.57	0.4510
Blood pressure	0.09496	3.30	0.0694
Complication	0.00982	0.06	0.8137
Global test	17.67	13	0.1703

Discussion

The overall median time to death in this study was 40 days (IQR: 39–57), which was longer than the 7.8 days reported in a previous study conducted in Ethiopia. The discrepancy may reflect differences in study population characteristics, inclusion criteria, healthcare facilities, treatment availability, and the timing of patient presentation after stroke onset. However, the median time to death observed in this study was lower than that reported from Saint Paul's Hospital Millennium Medical College and Ayder Comprehensive Specialized Hospital, where the median survival times were 41 and 48 days, respectively(22, 23). The observed differences may be explained by several factors, including differences in study period, analytical approaches, study areas, study designs, and source populations. The previous studies used logistic

regression models, which estimate the association between predictors and mortality outcomes but do not account for censored observations or time-to-event information. In contrast, the current study applied survival analysis methods, which consider the timing of death and censoring during follow-up. Additionally, variations in patient characteristics, stroke severity, availability of specialized stroke care, clinical management practices, and healthcare access across study settings may have contributed to the observed differences in survival estimates.

In this study, the incidence rate of mortality among hypertensive stroke patients was 10 deaths per 1,000 person-days of observation, with an overall mortality of 45.7% and a cumulative survival probability of 6.72%. Survival probabilities declined from 89.5% on the first day to 61.9% mid-hospitalization, reaching 6.72% by the end of follow-up. These findings are consistent with a study at Debre Markos Comprehensive Specialized Hospital, Ethiopia, where in-hospital mortality among stroke patients was 29 per 1,000 person-days in the first week, decreasing to 11 per 1,000 in the second week, 8 per 1,000 in the third week, and 13.6 per 1,000 by the end of follow-up (24).

The study reported a notably high proportion of hemorrhagic stroke (88.3%), which is substantially higher than findings from other studies. In Ethiopia, previous studies reported hemorrhagic stroke at 46.4% and ischemic stroke at 51.4% (25). In Sub-Saharan Africa, hemorrhagic stroke ranges from 29% to 57% (26), while studies from China reported proportions of 81.9%, 65.1%, and 57.5% (27). The possible reason could be explained by differences in study setting, diagnostic capacity, patient characteristics, and limited access to advanced imaging that may have led to underdiagnosed of ischemic stroke.

Participants who were age ≥ 65 years were a significant effect on death of stroke patient with hypertension. This findings is consistent with a study in Saudi Arabia(28),and Ethiopia (29). The possible reason might be mediated by age-related changes in hormones that affects stroke Pathophysiology(30) and educed functional capacity of critical brain support cells(31).

Participants who had cardiovascular disease and a complication at admission, which had a significant effect on the death of a stroke patient with hypertension. These findings are supported by a study conducted in Ethiopia (4, 32, 33). A possible reason is that underlying cardiovascular conditions, such as heart failure or arrhythmias, can exacerbate cerebral ischemia, compromise hemodynamic stability, and increase the likelihood of secondary complications that worsening stroke outcomes

Participants who had an unconscious (GCS < 8) or drowsy (GCS 9–12) state during admission had a faster death time compared to those who were alert (GCS > 13). A decreased level of GCS has a strong association with stroke patients' mortality, with an adjusted hazard ratio. These finding are supported by a study conducted in Ethiopia(34), Uganda (35), Nigeria(36). A possible reason that might be a lower GCS reflects more severe neurological impairment, often indicating extensive brain injury or increased intracranial pressure, which compromises vital brain functions. Patients with low GCS are also at higher risk of complications such as aspiration pneumonia, respiratory failure, and secondary brain injury, all of which contribute to increased mortality.

A patient who had a blood pressure > 160/110mmHg had a faster death time as compared to a lower blood pressure. The possible reason might be a high blood pressure can damage the tiny blood vessels deep within the brain by causing them to narrow and stiffen. This process may also promote the build-up of fatty deposits in the vessel walls, which can ultimately lead to rupture and bleeding in the brain.

Patients who were drinking alcohol were significantly associated with stroke and death in patients with hypertension. The possible explanation could be alcohol consumption can raise blood pressure and worsen hypertension, increasing the strain on blood vessels. Chronic drinking may also contribute to clot formation, irregular heart rhythms, and weakening of the vessel walls, all of which elevate the risk of stroke and death in patients with hypertension.

Strength and limitations of the study

This study provides important evidence on time to death and predictors of mortality among stroke patients with hypertension, a population for which evidence remains limited in Ethiopia. The multicentre design involving public hospitals in the Amhara National Regional State enhances the generalizability of the findings. The application of survival analysis methods, including Kaplan–Meier estimation and Cox proportional hazards regression, enabled evaluation of mortality patterns over time and identification of independent predictors of death. Furthermore, the inclusion of relevant clinical and sociodemographic factors and the use of appropriate statistical methods strengthen the validity of the findings. The results provide valuable evidence for clinicians, policymakers, and health program planners to improve stroke management and develop targeted mortality reduction strategies. However, the study has some limitations. The retrospective nature of the study resulted in incomplete documentation of some clinical variables. Important prognostic factors, including hematoma volume, bleeding location (hemispheric versus brainstem), midline shift (components of the ICH score), and neurological status at admission measured by the National Institutes of Health Stroke Scale (NIHSS), were not included due to limited data availability. The absence of these variables may have affected the ability to fully assess factors associated with mortality among stroke patients with hypertension.

Conclusion

The median time to death among stroke patients with hypertensive was 40 days, with a recovery rate of 10 per 1,000 person-days. Age > 65 years, high blood pressure, cardiovascular disease, alcohol use, decreased consciousness, and complications were significant predictors of mortality. To reduce mortality, it is essential to strengthen acute stroke care systems, maintain continuous blood pressure control, and expand rehabilitation services. Future studies using multicentre designs with larger cohorts, advanced imaging, and detailed clinical assessments, including bleeding volume, anatomical location, midline shift (ICH score), and initial neurological status (NIHSS score) are recommended to validate these findings and inform evidence-based interventions.

Declarations

Acknowledgments

We would like to acknowledge administrative officials to allow us to conduct this project on their customers. We extend our special thanks to all data collectors and respondents.

Data availability Statement

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request."

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of Debre Markos University. The study was conducted in accordance with the principles of the Declaration of Helsinki. Since this study involved the retrospective review of secondary data, a formal support letter was issued to the hospital, and permission was obtained to access the relevant patient records. The requirement for individual informed consent was waived by the IRB due to the retrospective nature of the study and the use of existing data. To ensure confidentiality, all patient records were coded, and data were accessed only by authorized personnel directly involved in the study and responsible for the relevant clinical area.

Authors' contribution

YSB: Conception of a research protocol, literature review, study design, data analysis, interpretation, and drafting of the manuscript. YSB and KDA were done the data analysis, interpretation, and manuscript review and draft the manuscript. All authors have read and approved the manuscript.

Clinical trial number

Not applicable

Consent for publication

Not applicable

Competing interests

The author has declared that they have no competing interests.

Funding

No funding

References

1. Coupland, A. P., Thapar, A., Qureshi, M. I., Jenkins, H. & Davies, A. H. The definition of stroke. *J. R. Soc. Med.* **110** (1), 9–12 (2017).

2. Owolabi, M. O. et al. The state of stroke services across the globe: Report of World Stroke Organization–World Health Organization surveys. *Int. J. Stroke*. **16** (8), 889–901 (2021).
3. Benjamin, E. J. et al. Heart disease and stroke statistics—2019 update: a report from the American Heart Association. *Circulation* **139** (10), e56–e528 (2019).
4. Betelhem, T. Time to Death and Its Predictors Among Stroke Patients Admitted to Felege Hiwot Comprehensive Specialized Hospital, Northwest Ethiopia, Retrospective Cohort Study, January/2019–November/2020 2021.
5. Lindsay, P., Furie, K. L., Davis, S. M., Donnan, G. A. & Norrving, B. World Stroke Organization global stroke services guidelines and action plan. *Int. J. Stroke*. **9** (SA100), 4–13 (2014).
6. Feigin, V. L. et al. World Stroke Organization (WSO): global stroke fact sheet 2022. *Int. J. Stroke*. **17** (1), 18–29 (2022).
7. 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. medicine: OAEM*. **13**, 57–66 (2021).
8. Skyrud, K. D., Vikum, E., Hansen, T. M., Kristoffersen, D. T. & Helgeland, J. Hospital variation in 30-day mortality for patients with stroke; the impact of individual and municipal socio-demographic status. *J. Am. Heart Association*. **8** (14), e010148 (2019).
9. Sagui, E. et al. Ischemic and hemorrhagic strokes in Dakar, Senegal: a hospital-based study. *Stroke* **36** (9), 1844–1847 (2005).
10. Chantkran, W., Chaisakul, J., Rangsin, R., Mungthin, M. & Sakboonyarat, B. Prevalence of and factors associated with stroke in hypertensive patients in Thailand from 2014 to 2018: a nationwide cross-sectional study. *Sci. Rep.* **11** (1), 17614 (2021).
11. Alene, M., Assemie, M. A., Yismaw, L. & Ketema, D. B. Magnitude of risk factors and in-hospital mortality of stroke in Ethiopia: a systematic review and meta-analysis. *BMC Neurol.* **20** (1), 1–10 (2020).
12. Admas, M., Teshome, M., Petrucka, P., Telayneh, A. T. & Alamirew, N. M. In-hospital mortality and its predictors among adult stroke patients admitted in Debre Markos Comprehensive Specialized Hospital, Northwest Ethiopia. *SAGE Open. Med.* **10**, 20503121221122465 (2022).
13. Fekadu, G., Adola, B., Mosisa, G., Shibiru, T. & Chelkeba, L. Clinical characteristics and treatment outcomes among stroke patients hospitalized to Nekemte referral hospital, western Ethiopia. *J. Clin. Neurosci.* **71**, 170–176 (2020).
14. Deresse, B. & Shaweno, D. Epidemiology and in-hospital outcome of stroke in South Ethiopia. *J. Neurol. Sci.* **355** (1–2), 138–142 (2015).
15. Fekadu, G., Chelkeba, L. & Kebede, A. Risk factors, clinical presentations and predictors of stroke among adult patients admitted to stroke unit of Jimma university medical center, south west Ethiopia: prospective observational study. *BMC Neurol.* **19** (1), 187 (2019).
16. Mulugeta, H. et al. Magnitude, risk factors and outcomes of stroke at Debre Markos Referral Hospital, Northwest Ethiopia: a retrospective observational study. *Egypt. J. Neurol. Psychiatry Neurosurg.* **56**,

- 1–9 (2020).
17. Zewdie, A. et al. Prospective assessment of patients with stroke in Tikur Anbessa specialised hospital, Addis Ababa, Ethiopia. *Afr. J. Emerg. Med.* **8** (1), 21–24 (2018).
 18. Association, A. H. Heart Disease and Stroke Statistics. *Am. Heart Association.* **147**, e93–e621 (2023).
 19. Nik, A. et al. The efficacy of glasgow coma scale (GCS) score and acute physiology and chronic health evaluation (APACHE) II for predicting hospital mortality of ICU patients with acute traumatic brain injury. *Bull. Emerg. Trauma.* **6** (2), 141 (2018).
 20. 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).
 21. Brott, T. et al. Measurements of acute cerebral infarction: a clinical examination scale. *Stroke* **20** (7), 864–870 (1989).
 22. Hagos Gufue, Z. et al. Survival of stroke patients according to hypertension status in Northern Ethiopia: seven years retrospective cohort study. *Vasc. Health Risk Manag.* :389–401. (2020).
 23. Walelgn, N., Abyu, G. Y., Seyoum, Y., Habtegiorgis, S. D. & Birhanu, M. Y. The survival status and predictors of mortality among stroke patients at North West Ethiopia. *Risk Manage. Healthc. Policy* :2983–2994. (2021).
 24. Admas, M., Teshome, M., Petrucka, P., Telayneh, A. T. & Alamirew, N. M. In-hospital mortality and its predictors among adult stroke patients admitted in Debre Markos Comprehensive Specialized Hospital, Northwest Ethiopia. *SAGE open. Med.* **10**, 20503121221122465 (2022).
 25. Abate, T. W., Zeleke, B., Genanew, A. & Abate, B. W. The burden of stroke and modifiable risk factors in Ethiopia: A systemic review and meta-analysis. *PloS one.* **16** (11), e0259244 (2021).
 26. Olajide, T. et al. Stroke neurobiobanking and genomic research in Africa: a narrative review. *Egypt. J. Neurol. Psychiatry Neurosurg.* **61** (1), 14 (2025).
 27. Fan, X. et al. Factors influencing short-term and long-term survival rates in stroke patients receiving enteral nutrition: a machine learning approach using MIMIC-IV database. *BMC Neurol.* **25** (1), 190 (2025).
 28. Alhazzani, A. A. & Mahfouz, A. A. In Hospital Stroke Mortality: Rates and Determinants in Southwestern Saudi Arabia. ;15(5). (2018).
 29. Erkabu, S. G., Agedie, Y., Mihretu, D. D., Semere, A. & Alemu, Y. M. Ischemic and hemorrhagic stroke in Bahir Dar, Ethiopia: a retrospective hospital-based study. *J. Stroke Cerebrovasc. Dis.* **27** (6), 1533–1538 (2018).
 30. Roy-O'Reilly, M. & McCullough, L. D. Age and sex are critical factors in ischemic stroke pathology. *Endocrinology* **159** (8), 3120–3131 (2018).
 31. Sohrabji, F., Bake, S. & Lewis, D. K. Age-related changes in brain support cells: Implications for stroke severity. *Neurochem. Int.* **63** (4), 291–301 (2013).
 32. Labodi, L. D., Kadri, C., Valentin, Y. N., Christian, N. & Jean, K. B. Intra-hospital mortality of stroke and its predictive factors in a reference hospital in Ouagadougou, Burkina Faso. *Brain* **1** (3), 1–6 (2017).

33. Gedefa, B., Menna, T., Berhe, T. & Abera, H. Assessment of risk factors and treatment outcome of stroke admissions at St. Paul's teaching hospital, addis ababa, Ethiopia. *J. Neurol. Neurophysiol.* **8** (3), 1–6 (2017).
34. Weldegebreal, S. et al. *Management Outcome, Mortality and Factors Associated with Mortality Amongst Hospitalized Patients with Stroke* (A Cross Sectional Study, 2020).
35. Nakibuuka, J. et al. Early mortality and functional outcome after acute stroke in Uganda: prospective study with 30 day follow-up. *SpringerPlus* **4** (1), 1–10 (2015).
36. Ekeh, B., Ogunniyi, A., Isamade, E. & Ekrikpo, U. Stroke mortality and its predictors in a Nigerian teaching hospital. *Afr. Health Sci.* **15** (1), 74–80 (2015).

Figures

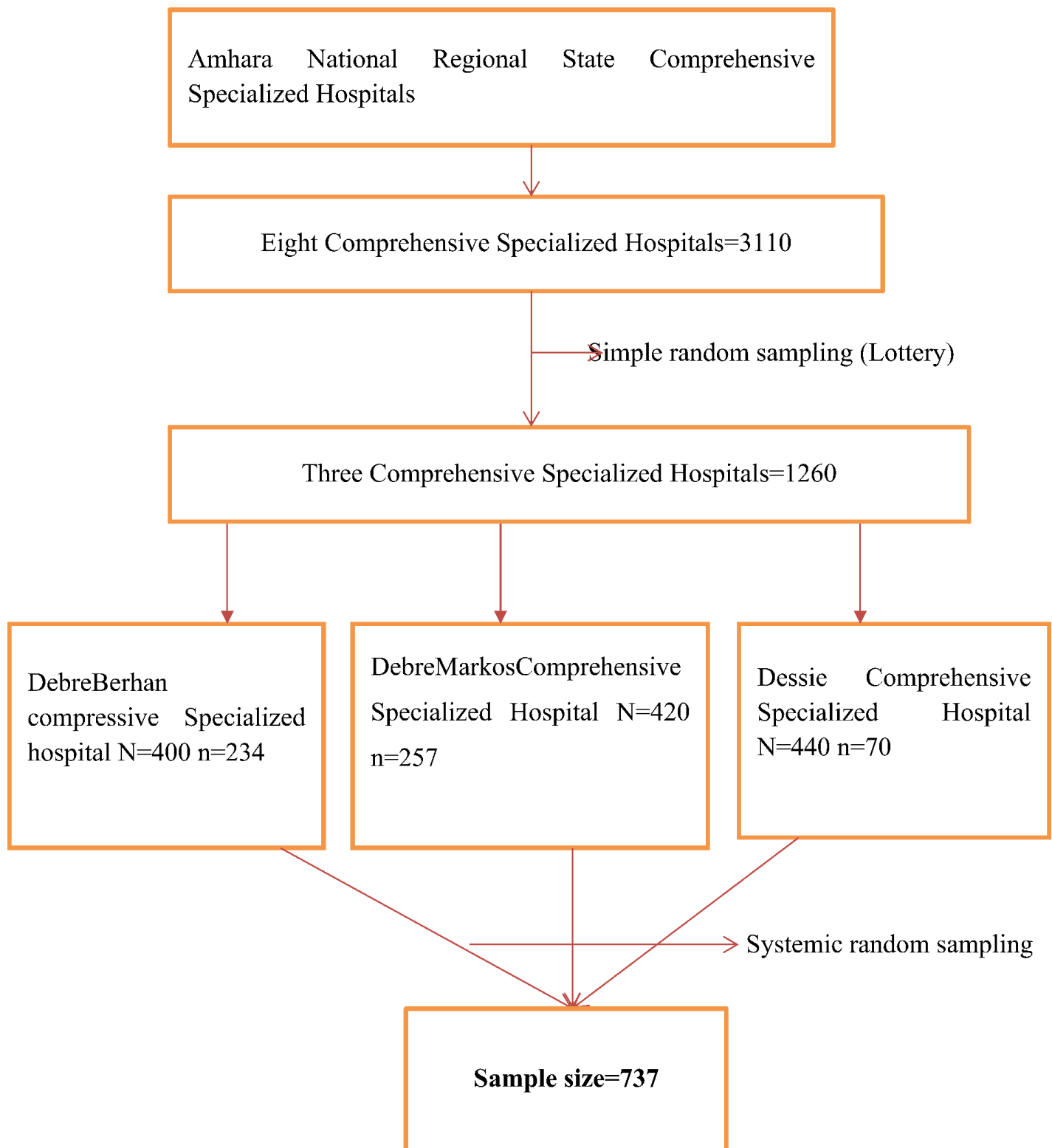


Figure 1

Schematic representation of sampling procedure of stroke patient with hypertensive at Comprehensive Specialized Public Hospitals, 2023.

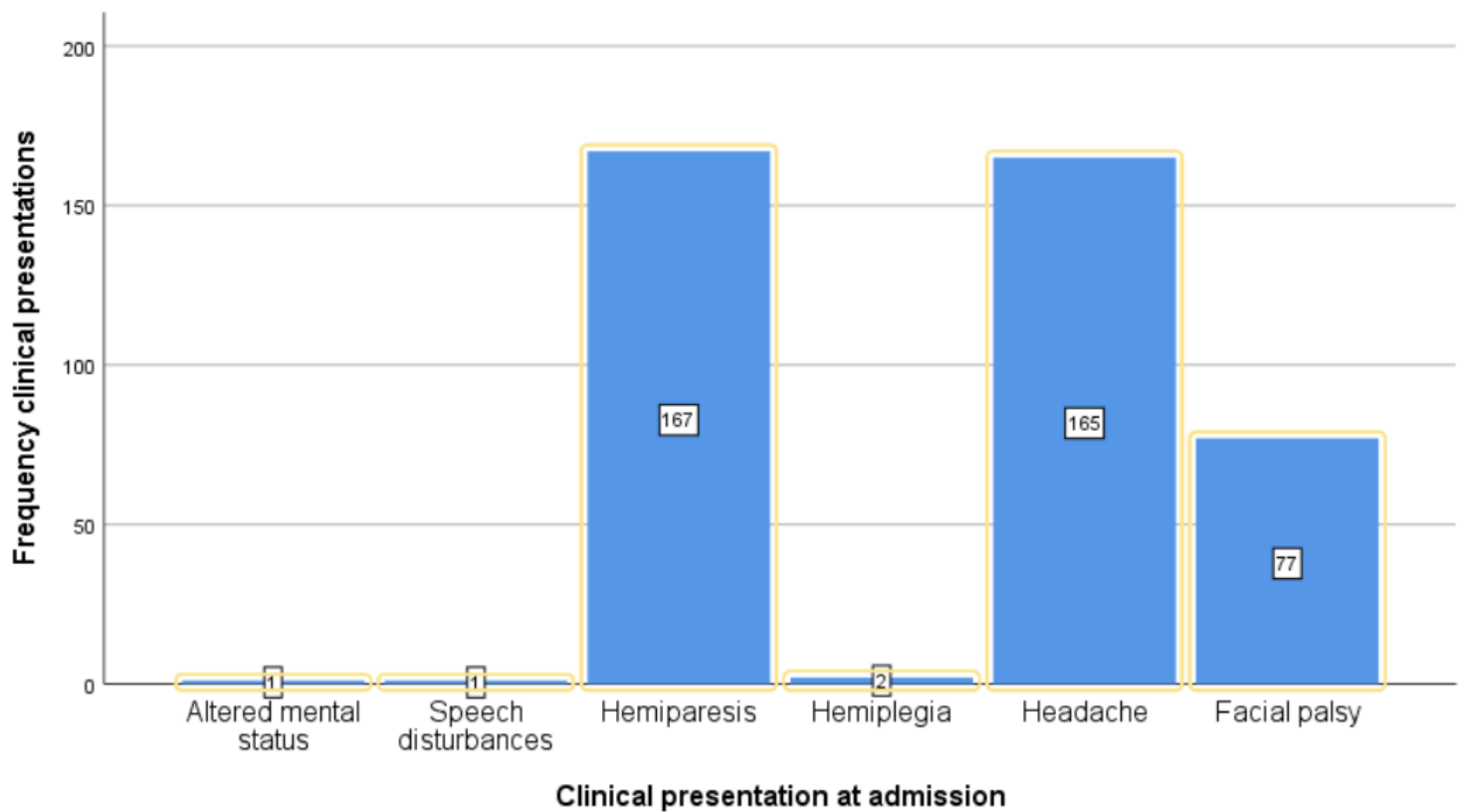


Figure 2

Clinical presentation among participants during five-year follow-up in at selected hospitals, Ethiopia from January 1, 2018 to December 30, 2023

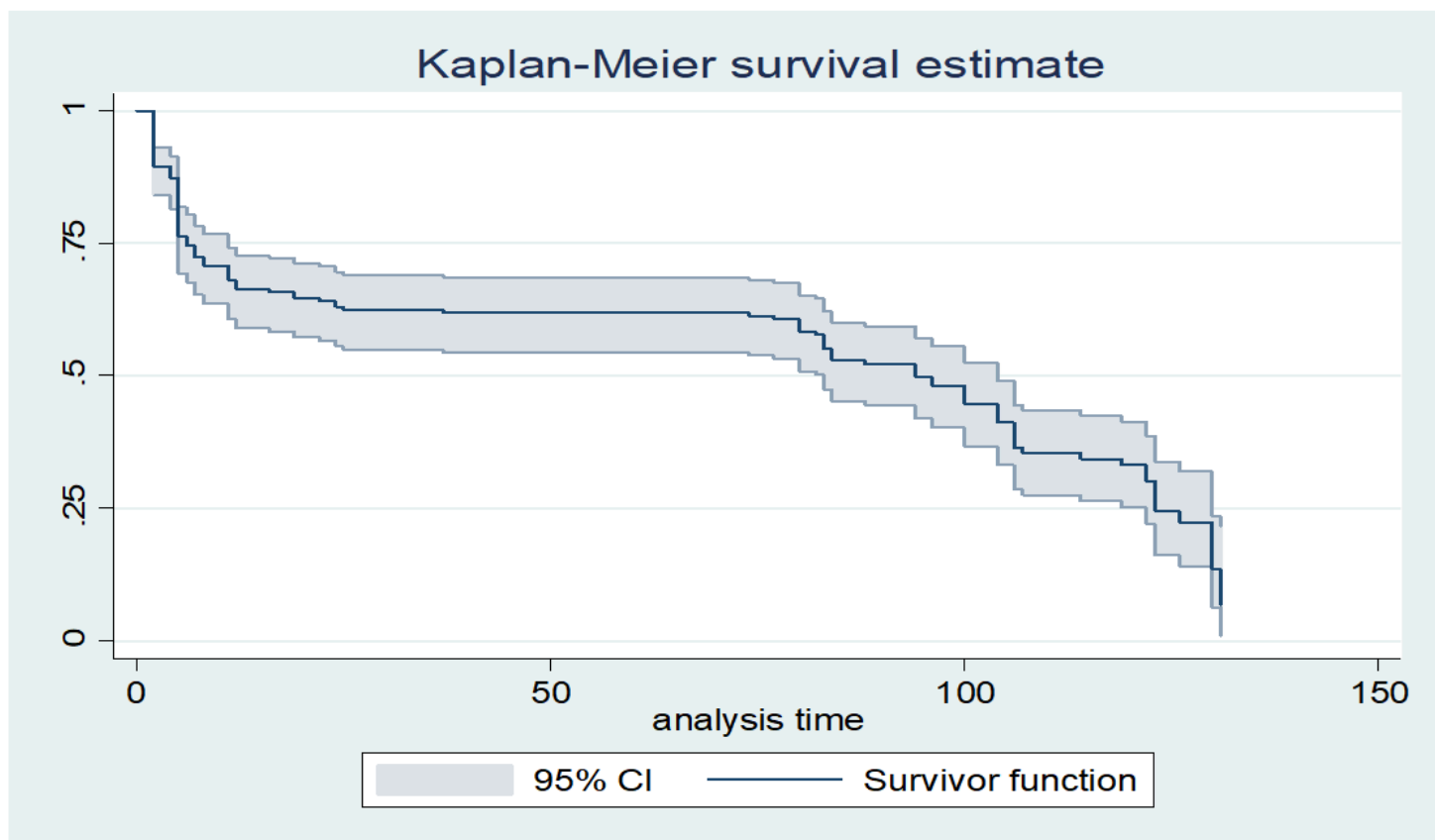


Figure 3

Overall Kaplan-Meier estimates of study participant admitted at selected public hospitals of Amhara National regional state, Ethiopia, from January 1, 2018 to December 30, 2023.

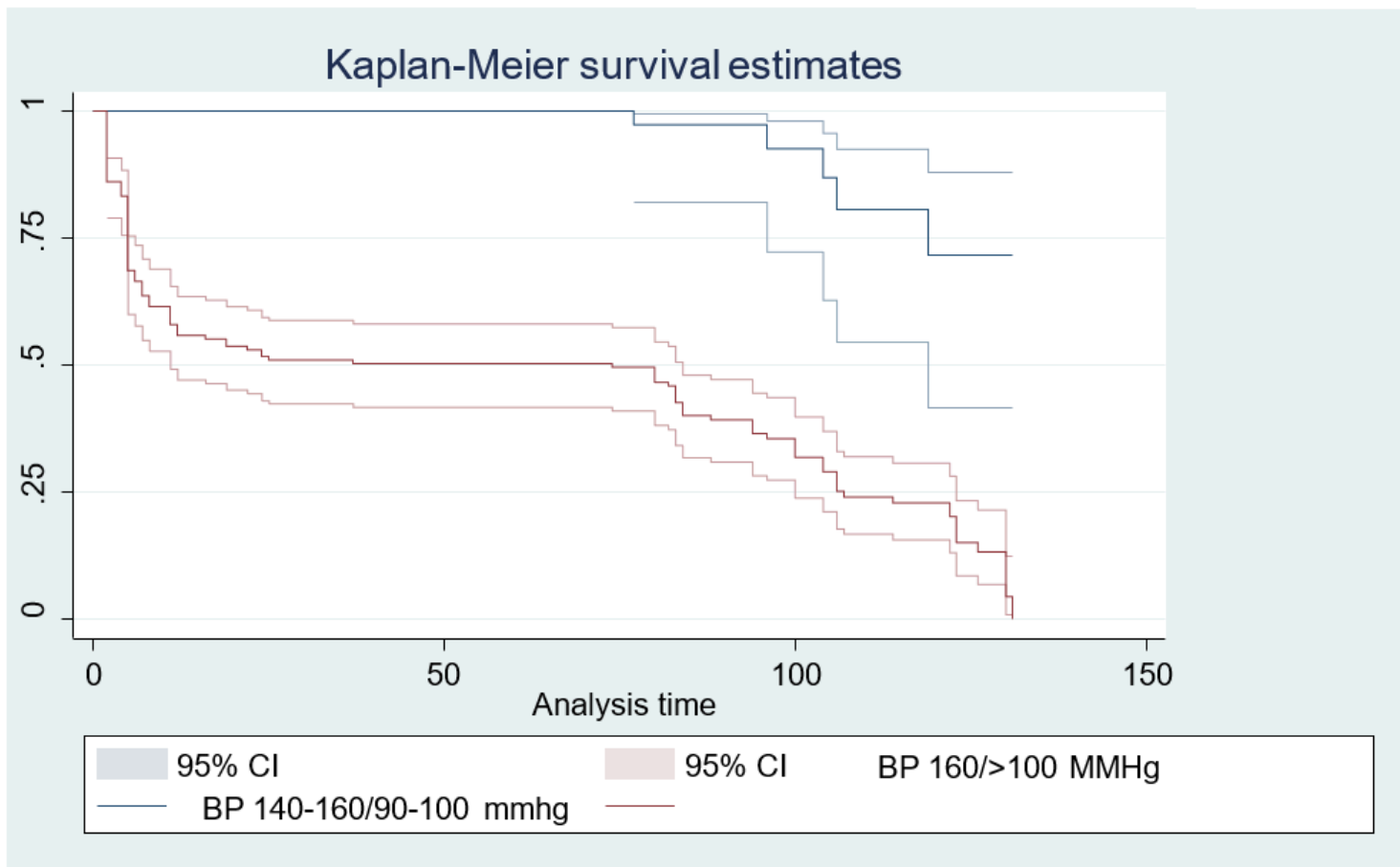


Figure 4

The Kaplan-Meier survival curve compares the survival time of category of vital signs (BP) participants admitted at selected public hospitals, 2023.

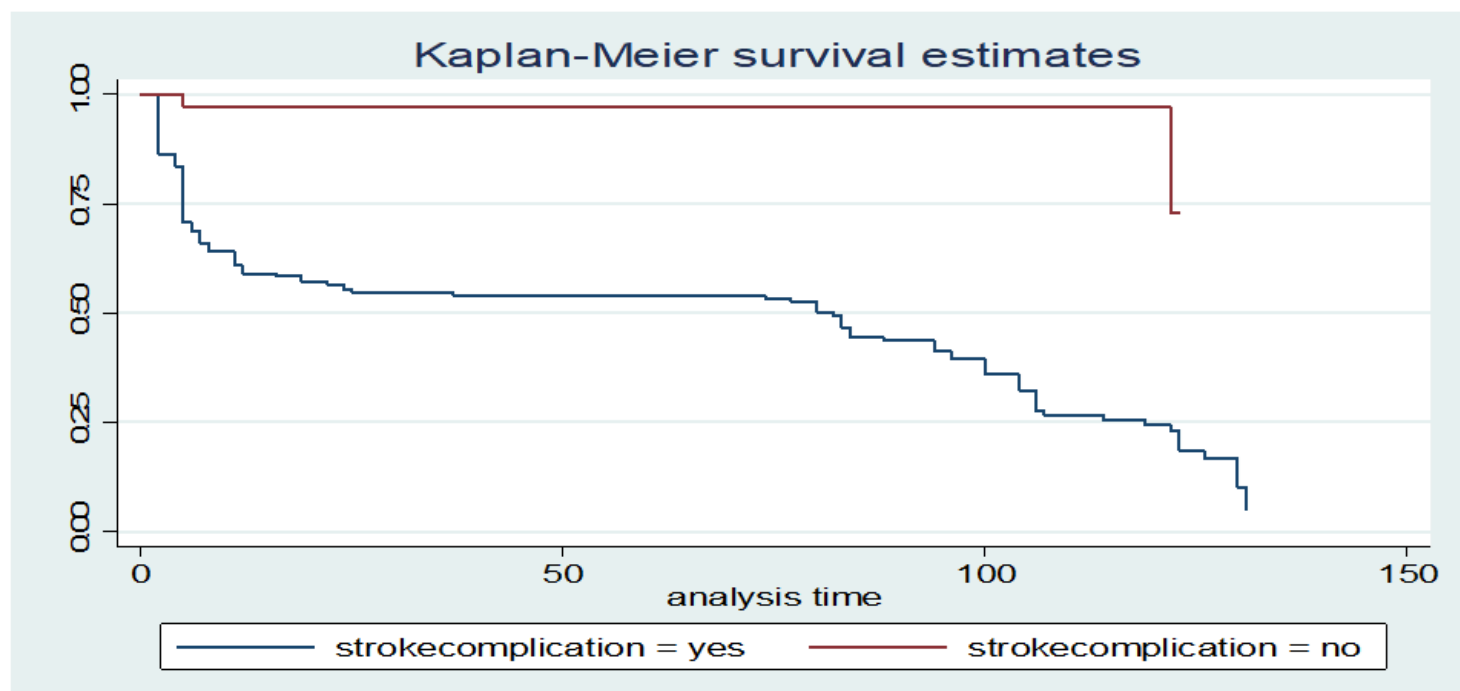


Figure 5

The Kaplan-Meier survival curves compares the survival time of category of stroke complication among participants admitted at selected public hospitals, 2023.

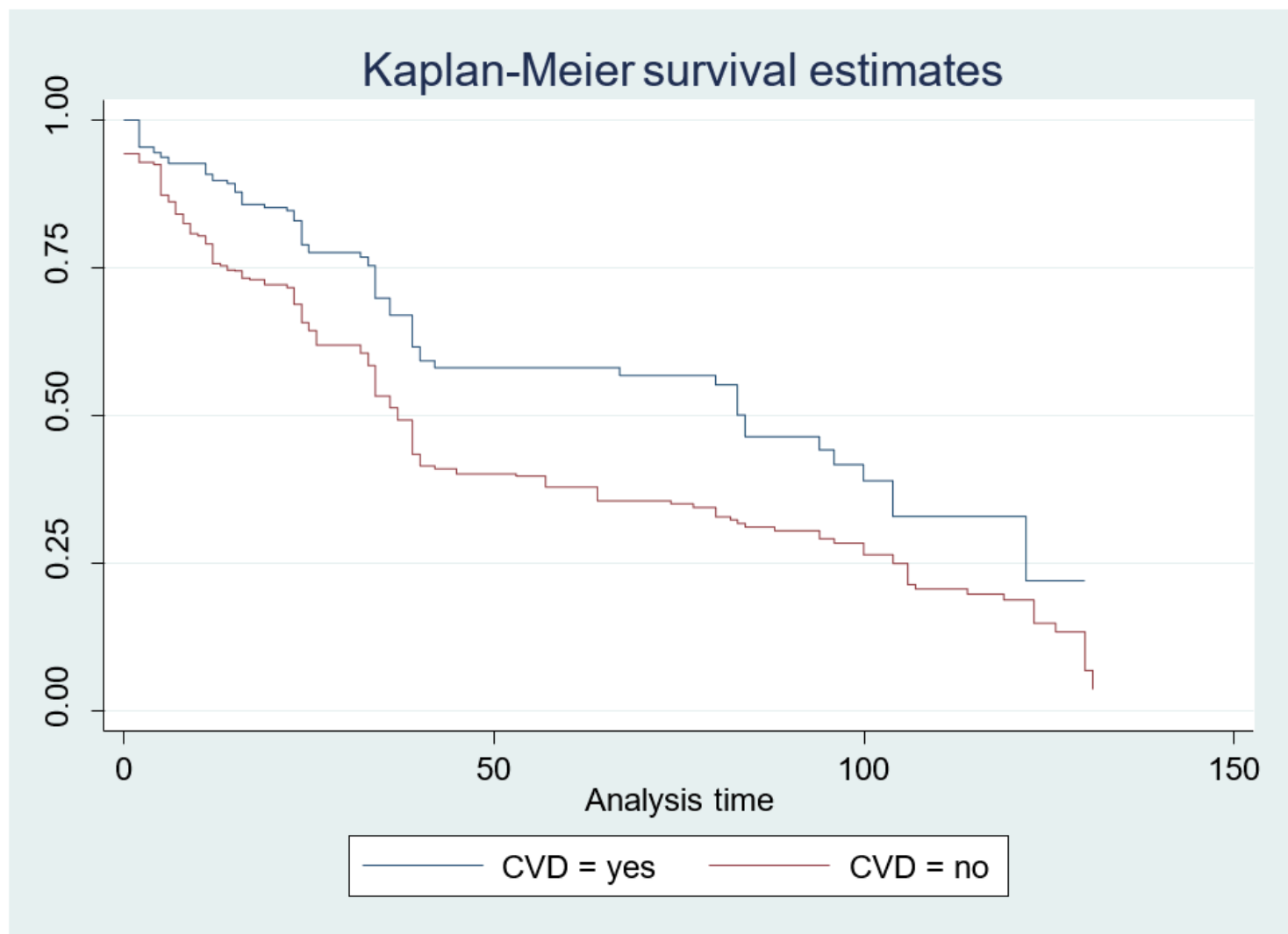


Figure 6

The Kaplan-Meier survival curve compares the survival time of category of cardiovascular disease among participants admitted at selected public hospitals , Ethiopia 2023.

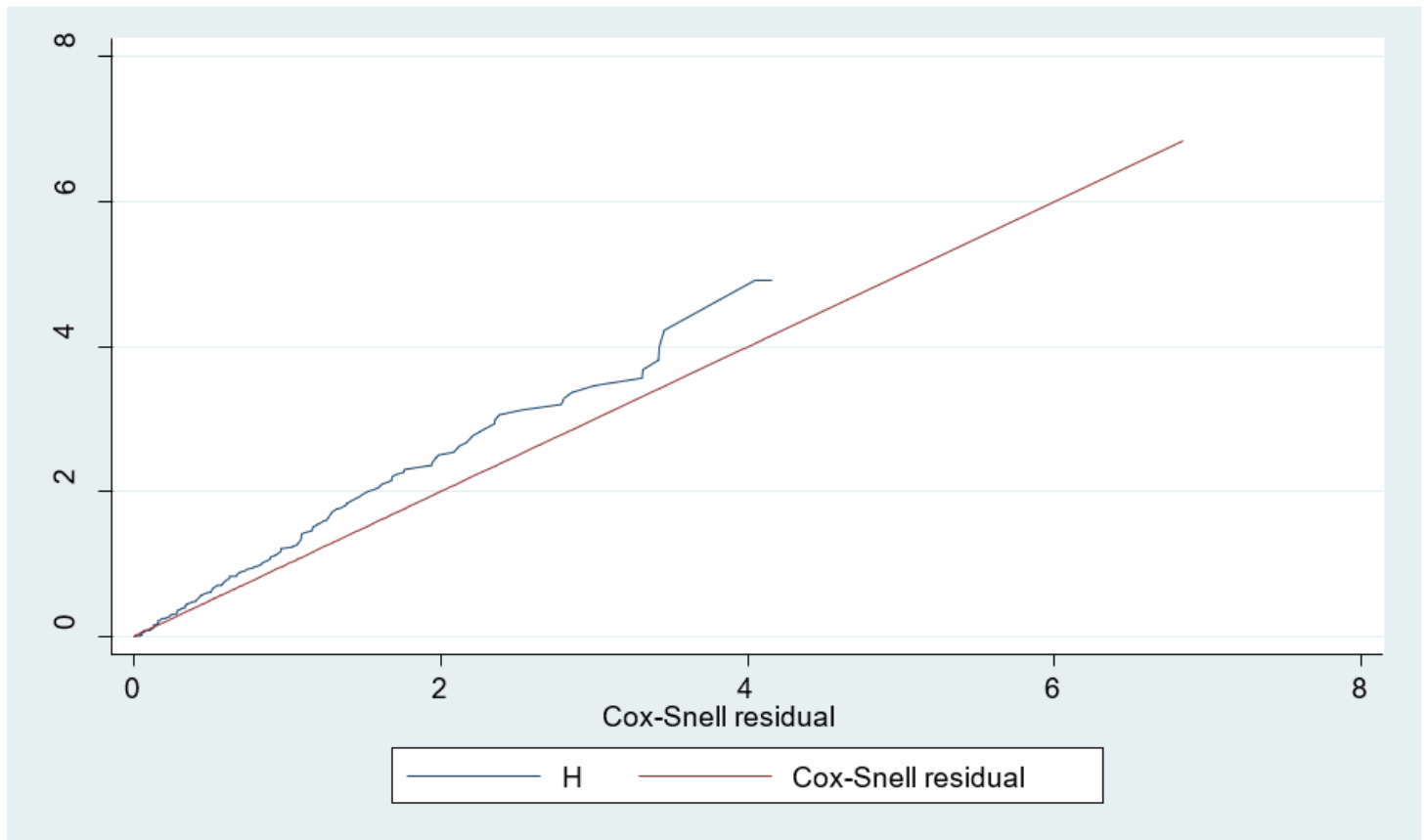


Figure 7

Cox Snell residual test for proportional assumption of each covariant and overall Cox proportional hazard model