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# Determinants of Stroke among Adults with Hypertension in Nekemte Public Hospitals, Oromia, Ethiopia: A Case-Control Study

**Samuel Gebeula[1], Lemessa Dube[1], Daniel Geleta[2]* and Teshome Kebeta[1]**

[1]*Department of Epidemiology, Public Health Faculty, Institute of Health, Jimma University, Ethiopia*

[2]*School of Medical Laboratory Sciences, Faculty of Health Sciences, Department of tropical and infectious diseases, Jimma University, Ethiopia*

***Corresponding author:** Daniel Geleta, School of Medical Laboratory Sciences, Faculty of Health Sciences, Jimma, University, Jimma, Oromia, Ethiopia

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**ABSTRACT**

**Background:** Stroke remains a significant contributor to both mortality and disability on a global scale, with a particularly pronounced impact in low- and middle-income countries. The objective of this study was to examine the risk factors linked to stroke among adult hypertensive patients who are being treated at public hospitals located in western Ethiopia.

**Methods:** A case-control study was conducted from September 2021 to April 2022 to investigate the relationship between hypertension and various socio-demographic and clinical factors. Data was collected through patient records and interviews. A total of 50 cases and 150 controls were randomly selected from the group of hypertensive patients. The collected data was carefully verified, coded, and entered Epi data version 3.1. Subsequently, the dataset was analyzed using SPSS version 25. Bivariable and multivariable analyses were conducted, with statistical thresholds of <0.25 and 0.05, respectively, at a 95% confidence interval to assess the significance of the variables.

**Results:** The study included a total of 200 participants, comprising 50 cases and 150 controls. The mean age of cases and controls was 63.7 (SD±15.25) and 52.6 (SD ±12.58) years, respectively. Several significant determinants of stroke were male gender (AOR=3.2, 95% CI: 1.2, 8.7, P=0.02), family history of stroke (AOR=5.6, 95% CI: 2.1, 14.9), loss from hypertensive follow-up (AOR=4.4, 95% CI: 1.5, 12.0), comorbidity (AOR=5.4, 95% CI: 1.6, 18.1), age ≥50 years (AOR=6.2, 95% CI: 2.0, 19.0), high perceived stress (AOR=4.2, 95% CI: 2.6, 7.2), and uncontrolled systolic blood pressure (AOR=4.4, 95% CI: 2.6, 12.0).

**Conclusion:** The study identified multiple interconnected determinants of stroke, emphasizing the importance of implementing strategies like health education, promoting a healthy lifestyle, and regular healthcare.

**Keywords:** Adults; Case-Control; Determinants; Ethiopia; Hypertension; Stroke

**Abbreviations:** AOR: Adjusted Odds Ratio; BMI: Body Mass Index; CI: Confidence Interval; CT-Scan: Computed Tomography; COR: Crude Odd Ratio; WHO: World Health Organization

## Introduction

The World Health Organization (WHO) classifies strokes into ischemic and hemorrhagic main types, with the ischemic type being the most common and both causing cell death due to poor blood flow to the brain [1-4]. Globally, stroke ranks as the second leading cause of death with an estimated 5.5 million deaths [5], 80 million disabilities, and 116 million years of healthy life lost from hypertensive every year [6], adding to the heavy economic, social, and emotional burden worldwide [7]. It puts a burden on every community, reaching nearly 17% of the world population in their lifetime, from which about 85% of all stroke deaths occur in low and middle-income countries [8,9]. Recently, the incidence of stroke is increasing because of a corresponding increase in modifiable (hypertension, particularly atrial

fibrillation; diabetes mellitus; hypercholesterolemia; cigarette smoking; and alcohol abuse) and non-modifiable (age; gender; race, ethnicity, and heredity) risk factors that further contributed to the increase in mortality, morbidity, and disability. In particular, the mortality and morbidity related to stroke are attributed to poor identification and management of modifiable risk factors [6,10-12]. These risk factors are frequently changed because of several underlying risk factors and etiologies. Typically, 85 % of hypertensive adult patients have at least one determinant factor for stroke, with 45 % of people having a combination of two or more risk factors [13-15]. A study conducted in 22 developed countries found that hypertension, current smoking, diabetes, obesity, poor diet, and physical inactivity accounted for more than 80% of the global risk of all types of strokes.

Increased blood pressure is the single most important treatable risk factor for stroke that recently contributes 30% to recurrence of stroke and one out of twenty adult deaths. Regrettably, the overall risk of stroke increases when multiple risk factors are present, requiring regular studies [4,16-18]. Studies have classified stroke determinants as socio-demographic, medical condition, and behavioral-related factors. Of the socio-demographic factors, place of residence, male gender, black ethnic, age 40 & above years, education, occupation, and income were identified to have positive relation with stroke [7,19-26]. Likewise, studies in different areas revealed that medical conditions such as hypertension, diabetes, dyslipidemia, higher glucose level, history of cardiovascular disease, HIV infection, being overweight (higher BMI), and family history of stroke were the most prominent risks for stroke, with uncontrolled hypertension contributing 23% of all risks [19,27-30]. There were also studies that reported behaviors to have an association with stroke. A study conducted in various regions revealed a link between stroke distribution and alcohol consumption, low physical activity, smoking, salt intake, fat intake, stress, non-adherence to antihypertensive drugs, loss to follow-up, and sedentary lifestyle [17,31-35]. In contrast, studies conducted in Indonesia found no link between alcohol consumption, a high salt diet, fatty food consumption, and physical activity and stroke [36] (Figure 1). In Ethiopia, stroke is currently observed to be one of the commonest reasons for admission in many health care setups and is becoming an alarmingly serious public health problem in [11].

However, there were limited studies on stroke with the scare reports showing similar characteristics to predictors of stroke conducted in different areas as indicated in Figure 1 [8,31,37,38]. Consequently, this study aims to establish the determinants of stroke among adult hypertensive patients in eastern Wollega, Ethiopia.

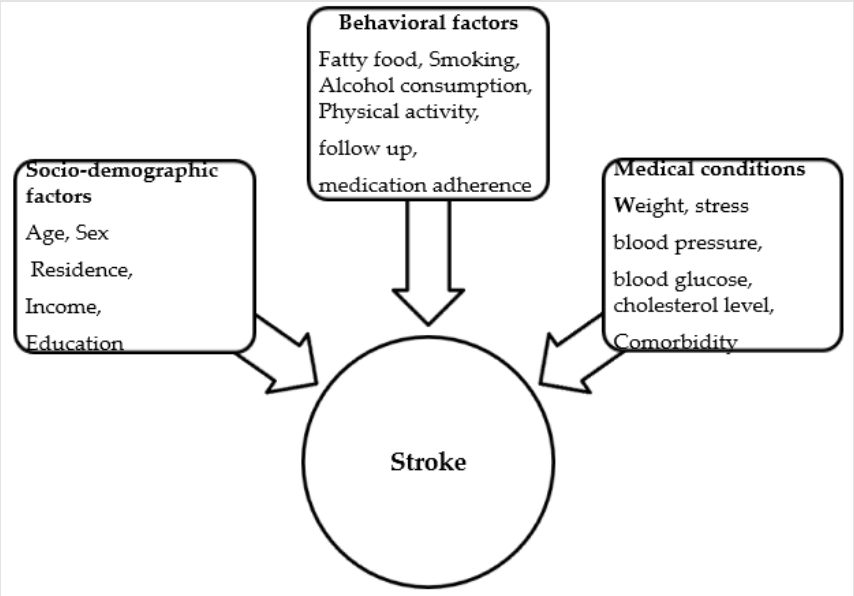


**Figure 1:** Conceptual framework for predictors of variables adopted from study of non-communicable disease risk factors.

## Methodology

### Study Area, Population and Period

A case-control study was conducted among randomly selected adult hypertensive patients in two public hospitals in Nekemte Town, Oromia, Ethiopia, namely Wollega University Referral Hospital and Nekemte Specialized Hospital, from September 1, 2021, E.C to April 30, 2022. Nekemte town is located in the East Wollega zone, Oromia regional state, which is 331 KM away from Addis Ababa, the capital city of Ethiopia. According to the 2007 population and housing census report, the total population size of Nekemte town is estimated to be 100,135. Currently, Nekemte town has one teaching hospital (Wollega University Referral Hospital), one specialized hospital, and two health centers. More than two million people in the area are served by the two hospitals.

### Sample Size Determination and Sampling Procedure

Sample size was calculated using Epi Info version 7 for an unmatched case control study based on the assumption that significant predictors of stroke from the previous case control study by using the 95% confidence level, 80% power, and 1:3 case to control ratio and 56.2% of main exposure variable among controls (uncontrolled SBP) from the previous study to detect an Odd Ratio of 3.19, which, accordingly, yielded a total of 200 (50 cases and 150 controls) samples with an added 10% non-response rate. To saturate the sample size, we proportionally allocated participants based on the caseloads of the two study public hospitals. Accordingly, 21 cases and corresponding 63 controls from Wollega University Referral Hospital and 29 cases and corresponding 87 controls were randomly selected and included in the study. During the selection process, we defined a case as an adult (≥18 years) hypertensive patient with a history of stroke who is under follow-up at a public hospital, while controls were adult (≥18 years) hypertensive patients without clinical evidence of stroke and without a history of stroke who are under follow-up in public hospitals. Case participants were excluded from the study if they have less than three follow-up episodes for hypertension treatment before the first stroke occurrence, and similarly, controls with less than three follow-ups for hypertension treatment before data collection. Cases and controls with incomplete records or incomplete information during the interview and Pregnant mothers were excluded.

### Data Collection and Variable Specification

For data collection, a structured questionnaire with some modifications from the previous study, which contains socio-demographic characteristics, medical information, behavioral risk factors, anti-hypertension medication adherence, stress assessment, physical measurement, and data abstraction, was used. The questionnaire was translated to Afan Oromo by language experts in written form and then back to the English version for analysis. Data collection was conducted by three trained BSc nurses and two physician supervisors. Cases and controls were identified by the physician and allocated to data collectors using the hospital record number as an internal code. Information on socio-demographic data, behavioral risk factors, medical information, anti-hypertension adherence information, and perceived stress assessment was obtained from the patients or close relatives of unconscious and aphasic stroke patients through face-to-face interviews. The history of clinical duration of hypertension, type of stroke, the presence of stroke, physical measurements, and other related data were taken from patient records. Moreover, the completed data format was checked daily for completeness. Finally, the data was checked for completeness, coded, and finally entered Epi Data version 3.1, and exported to SPSS version 25 for further analysis. Before the initiation of the study, ethical clearance was obtained from the JU Review Board and Faculty of Public Health, and finally, informed consent was taken from study facility heads and every individual participant.

### Data Analysis

Frequencies and tables were used to present the frequencies for categorical variables and the mean for continuous variables in both cases and controls. Bivariate logistic regression was done to assess the association between each independent variable and the dependent variable at a p-value of 0.25. Variables with a P-value of below 0.25 were simultaneously subjected to multivariable logistic regression. During the data analysis, the model was assessed for goodness of fit using the Hosmer-Lemeshow test. Finally, variables that demonstrated a p-value of <0.05 in the final model were considered independent determinant factors of stroke among hypertensive patients. For statistical significance, the adjusted odds ratio and P-value 0.05 with 95% CI were used in the interpretation of the results.

## Results

### Socio-Demographic Characteristics Participants

A total of 200 participants (50 cases and 150 controls) participated in the study, making a response rate of 100%. The mean age of cases and controls was 63.74 years (SD±12.59) and 52.64 years (SD±15.25) respectively. Of the study participants, majority of them, 121 (60.5%) were males, out of whom 38 (76%) were cases and 83(41.5%) were controls. The majority of the respondents, 34 (68%) of cases and 80 (53.3%) of controls, were married. Of the subjects, 64% of cases and 66% of controls were married. Fifteen (30%) of the cases and 48 (32% of controls) were self-employed (Table 1).

**Table 1:** Socio-demographic characteristics of study participants.

| Variables | Category | Case(n=50) | | Control(n=150) | |
|---|---|---|---|---|---|
| | | **Frequency** | % | **Frequency** | % |
| Sex | Male | 38 | 76 | 83 | 68.6 |
| | Female | 12 | 24 | 67 | 55.3 |
| Age (in year) | 25-49 | 7 | 14 | 71 | 47.3 |
| | ≥50 | 43 | 86 | 79 | 52.7 |
| Place of residence | Urban | 31 | 62 | 93 | 62 |
| | Rural | 19 | 38 | 57 | 38 |
| Ethnic group | Oromo | 37 | 74 | 107 | 74.3 |
| | Amhara | 4 | 8 | 19 | 12.7 |
| | Gurage | 5 | 10 | 17 | 11.3 |
| | Tigre | 4 | 4 | 7 | 4.7 |
| Marital status | Never married | 5 | 10 | 24 | 16 |
| | Married | 34 | 68 | 80 | 53.3 |
| | Live together | 0 | 0 | 13 | 8.7 |
| | Divorced | 1 | 2 | 13 | 18.7 |
| | Widowed | 10 | 20 | 20 | 13.3 |
| Religion | Protestant | 18 | 36 | 70 | 46.7 |
| | Orthodox | 18 | 36 | 43 | 28.7 |
| | Muslim | 10 | 20 | 25 | 17.5 |
| | Catholic | 3 | 6 | 10 | 6.7 |
| | Traditional | 1 | 2 | 2 | 1.3 |
| Educational level | No education | 12 | 24 | 20 | 15.3 |
| | Primary | 21 | 42 | 29 | 36 |
| | Secondary | 15 | 30 | 50 | 30 |
| | More than secondary | 2 | 4 | 52 | 34.7 |
| Occupation | Farmer | 16 | 32 | 24 | 16 |
| | Housewife | 3 | 6 | 21 | 14 |
| | Government employee | 12 | 24 | 25 | 16 |
| | Non-Government | 4 | 8 | 32 | 21 |
| | Self- employee | 15 | 30 | 48 | 32 |
| Monthly income | 0-4999 ETB | 20 | 40 | 66 | 44 |
| | ≥5000 ETB | 30 | 60 | 84 | 56 |

## Medical Condition of the Participants

Of the total included participants, 16(32%) of cases and 26(17%) of controls were overweight. Of the clinical characteristics, 3(6.6%) of cases and 5 (2.5%) of controls of the participants had a family history of stroke. The mean duration of the diagnosis of hypertension was 9 ± 4.7years for cases and 6±4.5years for controls. The mean systolic blood pressure was 156±22 in the case and 143±16 in the controls. The mean diastolic blood pressure was 100±15 mmHg in the case and 87±12 mmHg in the controls (Table 2).

## Behavioral Factors of the Respondents

From a total of 50 cases and 150 controls, 12(24%) of cases and 27(18%) of controls were currently alcohol consumers. One case (2%) and two (1.3%) of the controls were current smokers. According to this study, 14(28% of the cases and 39(26% of controls) did not adhere to their anti-hypertension medication. Thirty-two (64%) of cases and 41(27.3%) of controls had a history of being lost from hypertensive from follow-up (Table 3).

**Table 2:** Clinical and physical measurements of the study participants.

| Variables | Categories | Case(N=50) | | Control(N=150) | |
|---|---|---|---|---|---|
| | | **Frequency** | % | **Frequency** | % |
| Duration of the diagnose of HPN | <6years | 13 | 26 | 88 | 58.7 |
| | ≥6years | 37 | 74 | 62 | 41 |
| Systolic BP | controlled | 12 | 24 | 102 | 68 |
| | uncontrolled | 38 | 76 | 48 | 32 |
| Diastolic BP | controlled | 13 | 26 | 84 | 56 |
| | uncontrolled | 37 | 74 | 66 | 44 |
| BMI | Underweight | 2 | 4 | 6 | 4 |
| | Normal | 32 | 64 | 118 | 78.7 |
| | Overweight | 16 | 32 | 26 | 17.3 |
| Comorbidity | Yes | 23 | 46 | 43 | 28.7 |
| | No | 27 | 54 | 107 | 71.3 |
| Family history of stroke | Yes | 3 | 6.6 | 4 | 2.5 |
| | No | 47 | 94.6 | 156 | 97.5 |

**Table 3:** Behavioral characteristics of the participants.

| Variables | Categories | Case | | Control | |
|---|---|---|---|---|---|
| | | **Frequency** | % | **Frequency** | % |
| Ever smoking | Yes | 7 | 14 | 5 | 3.3 |
| | No | 43 | 86 | 145 | 96.7 |
| Current Smoking | Yes | 1 | 2 | 2 | 1.3 |
| | No | 49 | 98 | 158 | 99.7 |
| Physical exercise | Yes | 15 | 30 | 59 | 39.3 |
| | No | 35 | 70 | 91 | 60.7 |
| Drug adherence | Yes | 36 | 72 | 111 | 74 |
| | No | 14 | 28 | 39 | 26 |
| Ever drink alcohol | Yes | 29 | 58 | 48 | 32 |
| | No | 21 | 42 | 102 | 68 |
| Currently drink alcohol | Yes | 12 | 24 | 27 | 18 |
| | No | 48 | 76 | 123 | 82 |
| Reduce salt in diet | Yes | 14 | 28 | 102 | 68 |
| | No | 36 | 72 | 48 | 32 |
| Eat fatty diet | Yes | 28 | 56 | 31 | 20.7 |
| | No | 22 | 44 | 119 | 79.3 |
| Lost to follow-up | Yes | 32 | 64 | 41 | 27.3 |
| | No | 18 | 36 | 109 | 72.7 |
| Frequency of follow-up | 1month | 9 | 18 | 32 | 21.3 |
| | 2months | 28 | 56 | 70 | 46.7 |
| | 3months | 13 | 26 | 48 | 32 |

### Determinants of Stroke

Every studied variable was independently entered into bivariate logistic regression and some of them, such as age, sex, lost from hypertensive to follow-up, family history of stroke, comorbidity, ever smoking, current smoking, ever alcohol intake, fatty diet intake, reduced salty diet intake, medication adherence, stress, systolic and diastolic BP, and physical exercise, demonstrated a P-value of <0.25 to show an association with stroke. Consequently, all variables with a P-value of P-value <0.25 in the bivariate analysis were simultaneously entered into the multivariate analysis for backward logistic regression. Of the total of variables entered into the regression model, eight variables have upheld statistical significance at the level of P-value <0.05. Accordingly, male gender (AOR=3.2, 95% CI: 1.2, 8.7, P=0.02), family history of stroke (AOR=5.62, 95% CI: 2.1, 14.9, P=0.00), lost from hypertensive from follow-up (AOR=4.41, 95% CI: 1.53,12, P=0.00), comorbidity of disease (AOR=5.38, 95% CI:1.6,18.1, P-value=0.00), age 50 year and above (AOR=6.24, 95% CI: 2.0, 19.5), P=0.002), high perceived stress (AOR=14.3, 95% CI: 2.6, 77.5), P=0.02), ever smoking (AOR=7.8, (1.4, 42.5), P= 0.01], and uncontrolled systolic blood pressure (AOR=4.4, 95% CI: 2.6,12.0), P=0.004] were found to be independent significant determinants of stroke among hypertensive patients. This result indicates that hypertensive men were 3.2 times more likely to have a stroke than the female gender with a similar case.

Similarly, hypertensive patients who had a family history of stroke were 5.6 times more likely to develop a stroke than those who had no family history of stroke. In the same way, patients who were not adhered to their medication follow-up were 4.4 times more likely to be at high risk of developing stroke when compared with adhered patients. On the other hand, hypertensive patients who had comorbidity were 5.4 times more likely to be at risk for stroke when compared to patients who had no comorbidity. Patients aged 50 and up, on the other hand, were 6.2 times more likely to develop strokes than their counterparts. In addition, patients with high stress levels have a 14.3-times higher risk of developing a stroke. Finally, the result of this study showed that uncontrolled systolic blood pressure is 4.4 times more likely to be at risk for the development of stroke than hypertensive patients with controlled systolic pressure (Table 4).

**Table 4:** Bivariate and multivariate logistic regression result of the study.

| Variables | category | Case(n=50) n (%) | Control(n=150) n (%) | PV, COR (95%CI) | PV, AOR (95%CI) |
|---|---|---|---|---|---|
| Age | 25-49 year | 7 (14) | 71 (47.3) | 1 | 1 |
| | 50 and above | 43(86) | 79 (52.7) | 0.00, 6.5 (2.3,13.0) | 0.00, 6.2 (2.0,19.3) |
| Sex | Female | 12(24) | 67(55.3) | 1 | 1 |
| | Male | 38(76) | 83 (68.6) | 0.00, 5.6 (1.2,5.3) | 0.02, 3.2 (1.2-8.8) |
| Family story of stroke | No | 47(93.4) | 156(97.5) | 1 | 1 |
| | Yes | 3(6.6) | 4(2.5) | 0.00, 5.7(2.9,11.4) | 0.01, 5.6 (2.1, 14.9) |
| Lost to follow up | No | 18(36) | 119(81.7) | 1 | 1 |
| | Yes | 32(64) | 41(27.3) | 0.00, 4.7 (2.4, 9.3) | 0.00, 4.4 (1.5, 12.7) |
| Comorbidity | No | 27(54) | 107(71.3) | 1 | 1 |
| | yes | 23(4) | 43(28.7) | 0.02, 2.1(1.9, 4.1) | 0.00, 5.4 (1.6, 18.1) |
| Perceived stress | Low stress | 3(6) | 43(26.7) | 1 | 1 |
| | Moderate | 20(49) | 67(44.7) | 0.02,.27(1.2, 15.3) | 0.06, 4.6(0.9, 23.0) |
| | High stress | 27(54) | 40(26.7) | 0.00, 9.7(2.7, 34.4) | 0.04, 14.3(2.6, 77.2) |
| Systolic BP | Controlled | 12(24) | 102(68) | 1 | 1 |
| | Uncontrolled | 38(76) | 48(32) | 00, 6.7(3.2, 14.1) | 0.05, 4.4(2.6, 12.2) |
| Ever smoking | No | 43(86) | 145(96.7) | 1 | 1 |
| | Yes | 7(14) | 5(3.3) | 0.01,4.7(1.42, 15.6) | 0.01, 7.8(1.43,42.5) |

## Discussion

The present study used quantitative data analysis collected through a survey from facility-based hypertensive participants to identify the determinants of stroke. Participants of different socio-demographic and other characteristics were assessed for the articulated result. In this study, participants with advanced age (≥50 years), being male gender, family history of stroke, being lost from hypertensive to follow up, stress, having comorbidity, and uncontrolled systolic blood pressure were more likely to have a risk of stroke. According to this study, the odds of developing a stroke in males was 3.2 times more likely than in females, which is consistent with the study conducted

in Northern Manhattan (New York) [39]. The possible explanation might be due to more exposure of males to stroke-related behavioral risks than females. In addition, our study showed that participants with an average age of ≥50 years were 6.2 times more at risk of stroke when compared with their counterparts, which is similar to a study done in Sudan indicating a high risk of stroke in the elderly [20] and also matched with a study conducted in Korea which showed that aging is the main predictor of stroke [21]. This may be due to physiological changes during aging that challenge control of blood pressure. In the present study, participants who had a history of missing follow-up were 4.4 times more likely to be at high risk of developing stroke when compared with those who were adherent to their follow-up. This result is consistent with a study conducted in Mekele Ayder Comprehensive Specialized Hospital which indicated that patients who lost from hypertensive follow-up were 2.5 times more at risk of developing stroke than those who were adherent [31,37].

This might be due to patients who were poor in adherence to follow up and might miss their routine medications and counseling services related to risks of stroke. Similarly, this study result indicated that patients who had a family history of stroke were 5.62 times more at high risk of stroke than their counterparts. This finding is in line with a study conducted in Finland which shows that patients who had a history of stroke in their family were 1.37 times more likely to develop stroke [40]. Studies done in India and China similarly reported that, family history of stroke was the main predictor of stroke [34]. This may be because family members may share genes, behaviors, lifestyles, and environments that can influence their health and risk of stroke. Study participants who had comorbidity were 5.38 times more likely to develop a stroke when compared to participants who had no comorbidity (AOR=5.38, 95%CI: 1.60-18.06). This finding was consistent with a Chinese study that found comorbidity was independently associated with an increased risk of stroke facility [28]. The possible explanation for our result may be due to a synergic effect between increased age and comorbidities on stroke occurrence. Patients with high perceived stress were 14.25 times more likely to be at risk for stroke than low-stress patients. This finding is in line with a study done in Gaza that showed stress is the most independent predictor of stroke among adult hypertensive patients [33]. In addition, this study showed that patients who had uncontrolled systolic blood pressure were 4.4 times more likely at risk of developing stroke than their counterparts.

This result is in line with study conducted in Tanzania [20], Georgia [27], Nigeria [41] and Mekele [31] which were indicating uncontrolled systolic blood pressure was independent predictor of stroke. This may be due to a greater risk of stroke and heart disease related to higher systolic pressures. Finally, our result established that, patients who were former cigarette smokers were 7.79 times more likely at risk of developing stroke when compared to patients who had no history of cigarette smoking This result was supported by studies conducted in China [30], Nigeria and Ghana [41] which was similarly indicated that history of smoking was predictor of stroke. This result, however, is inconsistent with research conducted in India [34].

## Conclusion and Recommendation

Adult hypertensive patients suffered stroke in study area possibly due to their masculinity, advanced age, family history of stroke, poor systolic pressure, smoking, poor follow up of hypertensive appointments, comorbidities and stress. As of this study all factors look the families of interwoven characteristics needing comprehensive approach like regular checkup of blood pressure for males, advancing age and risky people (people in stress situation & people with familial history). Likewise, once the hypertension was diagnosed people would better strictly adhere to follow up, avoid smoking and regularly check for comorbidities.

## Data Availability

The corresponding author can provide the data that were utilized to support the study's conclusions upon request.

## Ethics Approval and Consent to Participate

There was no industry involvement in the study's design, implementation, or data analysis. Jimma University's ethical review board granted ethical approval with Ref.No IHRPGn/296. Every participant provided informed consent for the study.

## Consent for Publication

Not applicable.

## Authors' Contributions

SG, LD, DG and TK were equally participated in designing, data supervision, analysis, interpretation. All of them were also prepared, read and approved the manuscript.

## Declaration of Conflicting Interests

The authors declare that there is no competing interest in writing, or publication of this paper.

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**Daniel Geleta.** Biomed J Sci & Tech Res