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Impact of Hypertension and Other Comorbidities on Stroke Subtypes among Patients in Anambra State Teaching Hospital Awka, Nigeria

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ABSTRACT

Stroke continues to be a major cause of illness and death. Its occurrence is greatly affected by modifiable risk factors. This study aimed to describe the demographic and clinical characteristics of stroke patients and to explore the relationship between hypertension and stroke subtype. A retrospective cross-sectional analysis of 264 stroke patients was conducted. Continuous variables using means, medians, and interquartile ranges were summarized. Categorical variables were described with frequencies and percentages. The prevalence estimates with 95% confidence intervals (CIs) were calculated. Fisher's Exact Test assessed the simple association between hypertension and stroke subtype (ischemic, haemorrhagic, transient ischemic attack [TIA]). A multinomial logistic regression model, adjusted for age and gender were applied, to estimate adjusted odds ratios (aORs) with 95% CIs, using ischemic stroke as the reference category. The average age was 59.1 years (SD = 16.3), and mean BMI was 29.9 (SD = 6.36), indicating a predominance of overweight and obesity (BMI ≥ 25). Hypertension was the most common comorbidity (91.3%, 95% CI: 87.2–94.4), followed by hyperlipidaemia (97%) and high cholesterol (35%). Type 2 diabetes (11%) and heart disease (26.9%) were less common. Fisher's Exact Test showed no statistically significant association between hypertension status and stroke subtype (p = 0.362). Stroke subtype distribution was as follows: ischemic stroke (58.7%), haemorrhagic stroke (39.0%), and transient ischemic attack (TIA) (2.3%). In logistic regression analysis, hypertension was not significantly related to haemorrhagic stroke (aOR = 1.47, 95% CI: 0.58–3.76) or TIA (aOR = 0.55, 95% CI: 0.06–5.22) compared to ischemic stroke. Stroke patients in this group were mostly older, obese, and had high blood pressure. Although hypertension was quite common, it did not significantly vary by stroke subtype, highlighting its role as a universal risk factor across different types of strokes.

Keywords*:* Ischemic stroke; Haemorrhagic stroke; Hypertension; Risk factors; Multinomial logistic regression; Epidemiology

1. Introduction

Stroke remains a leading cause of death and long-term disability around the world. Its impact is especially severe in low- and middle-income countries, particularly in sub-Saharan Africa (SSA) (Owolabi et al., 2022). A systematic review highlights the rising burden of stroke across Africa, emphasizing the need for localized data (Adeloye et al., 2023). Nigeria, the most populous country in Africa, is at the center of this crisis. It faces a rising incidence of stroke, coupled with high fatality rates and serious social and economic effects (Akinyemi et al., 2022). According to global estimates, stroke remains a leading cause of death and disability worldwide (Benjamin et al., 2023). Stroke occurs when blood flow to the brain is interrupted, resulting in neuronal ischemia. The two main types are ischemic stroke, which happens due to blocked arteries, and haemorrhagic stroke, which occurs from ruptured blood vessels (Feigin et al., 2022). The development of these stroke types is significantly affected by other health conditions. Hypertension is the most crucial risk factor that can be changed in Africa (Ojji et al., 2019). The widespread issue of hypertension in Nigeria, worsened by low awareness and poor management, drives the stroke crisis (Ogah et al., 2022). Recent studies reveal a more complicated risk profile, noting that the growing rate of cardiometabolic diseases is causing strokes to occur at a younger age in Nigeria. This trend requires immediate public health action (Wahab et al., 2023). A study from South-Eastern Nigeria confirmed a high prevalence of metabolic syndrome, which includes hypertension, dyslipidaemia, and obesity, among adults. This highlights the presence of these important risk factors (Ejike et al., 2022). While global guidelines offer some direction, effective stroke treatment needs evidence from local populations. Anambra State in South-Eastern Nigeria has a notably high rate of hypertension (Ulasi et al., 2021). As a key referral center, the Anambra State Teaching Hospital in Awka deals with many stroke cases. However, there is a lack of detailed, up-to-date analysis on how these other health conditions affect stroke type distribution among this specific group of patients. This study aims to find out how common hypertension and other comorbidities are among stroke patients and to evaluate their effect on stroke types at this hospital.

2. Methods

A retrospective cross-sectional study was conducted at Anambra State Teaching Hospital in Awka, Nigeria. The study involved all patients admitted with a confirmed stroke diagnosis between January 2022 and December 2024.

Patient records were identified from the hospital's admission registry. The inclusion criteria were 1) age 18 years or older, and 2) a confirmed stroke diagnosis (ischemic, haemorrhagic, or Transient Ischemic Attack [TIA]) based on clinical assessment and neuroimaging (CT or MRI).

We excluded patients with incomplete medical records or those diagnosed with a TIA without confirmation of a completed stroke. Data were extracted from patient medical records using a standardized data collection form. The information gathered covered various variables, organized for clarity. Sociodemographic characteristics included the patient's age, gender, and marital status. Clinical variables focused on the stroke diagnosed and comorbidities. The primary outcome was the confirmed stroke subtype, classified as ischemic, haemorrhagic, or transient ischemic attack (TIA). Key clinical factors included hypertension status, diabetes, high cholesterol, heart disease, and a history of previous stroke. In addition, data on modifiable lifestyle factors were collected. These included the patient's smoking status (categorized as never, former, or current smoker), level of alcohol intake (none, moderate, or heavy), and regular physical activity level (low, moderate, or high). Finally, anthropometric data, with body mass index (BMI) as the main measure were retrieved. BMI values were used to classify patients into obesity categories: normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥30.0 kg/m²), based on WHO guidelines. (WHO, 2000)

Ethical approval from the Anambra State Ministry of Health were obtained and patient data were anonymized following the principles of the Declaration of Helsinki.

Data were analysed using R statistical software (2025.09.0+387). Descriptive statistics summarized the data. Categorical variables were presented as frequencies and percentages. Continuous variables, like Age, were checked for normality with the Shapiro-Wilk test and described with means and standard deviations if normally distributed or with medians and interquartile ranges if skewed. The analysis aimed to address specific research objectives:

- Demographic and clinical characteristics were described using the appropriate descriptive statistics.
- The prevalence of hypertension among stroke patients was calculated as a proportion with a 95% confidence interval (CI).
- The distribution of comorbidities, such as Diabetes and Heart Disease, was examined by calculating their individual frequencies and percentages within the study population.

The association between hypertension and stroke subtypes was assessed in two steps:

- Fisher's exact test, where cell counts expected were less than 5, evaluated the crude association between hypertension (Yes/No) and stroke subtype (Ischemic/Haemorrhagic/TIA).
- Secondly, a multinomial logistic regression model quantified this association while adjusting for possible confounders such as age, gender, diabetes status, heart disease, smoking status, and alcohol intake. Ischemic stroke was the reference category because it was the most prevalent subtype in the study population, allowing for meaningful comparisons with less common subtypes. The model estimated adjusted odds ratios (aOR) with 95% CIs for the chance of haemorrhagic stroke or TIA compared to ischemic stroke. The initial model adjusted for age and gender.

The combined effects of hypertension and other risk factors were explored by adding more covariates to the multinomial logistic regression model, including Diabetes, Smoking status (never, former, or current smoker), Alcohol Intake (none, moderate, or heavy), and heart disease. Model fit was assessed using the Akaike Information Criterion (AIC) and multicollinearity was examined using Variance Inflation Factors (VIF); variables with VIF > 5 were excluded from the final model.

Other model assumptions include independence of observations, absence of perfect separation, and linearity of log-odds for continuous predictors were also checked to ensure validity. The significance of interaction terms, such as Hypertension*Diabetes, was tested and a two-tailed p-value ≤ 0.05 was considered statistically significant for all analyses.

Binomial Distribution Method

Wilson Score Interval according to Wilson, E. B. (1927)

More accurate for small or extreme proportions.

Formula:

$$CI = \frac{p+\frac{z^2}{2n} \pm Z\sqrt{\frac{p(1-p)}{n}+\frac{Z^2}{4n^2}}}{1+\frac{Z^2}{n}} \quad (1)$$

Where:

- p = prevalence (proportion)
- n = total stroke patients
- Z = 1.96 for 95% CI

Multinomial Logistics Regression by Hosmer et al (2013)

Let Y be the dependent variable with J categories (stroke types: TIA, Ischemic, and Hemorrhagic), where TIA (category 1) is the reference category. The probability of each outcome is given as:

For the reference category (TIA):

$$p(Y=1|X) = \frac{1}{1+\sum_{j=2}^{J} exp\left(\beta_{0j}+\beta_{1j}X_1+\cdots+\beta_{kj}X_k\right)} \quad (2)$$

For other categories (Ischemic and Haemorrhagic):

$$p(Y=j|X) = \frac{exp\left(\beta_{0j}+\beta_{1j}X_1+\cdots+\beta_{kj}X_k\right)}{1+\sum_{m=2}^{J} exp(\beta_{0m}+\beta_{1m}X_1+\cdots+\beta_{km}X_k)}; j=2,\cdots,J \quad (3)$$

where $p(Y=1|X)$ is the probability that the outcome is in the reference category (e.g., TIA) given the predictor values, $p(Y=j|X)$ is the probability that the outcome is in category j given the predictor values, Y is the categorical outcome variable with J possible categories, $X=(X_1,X_2,\cdots,X_k)$ is the set of independent variables, J is the number of outcome categories, k is the number of predictor (independent) variables, β_{0j} is the intercept term for the jth outcome category relative to the reference category, and β_{ij} is the coefficient for X_i for category j relative to the reference category.

The model estimates the log-odds of being in category j relative to the reference category as:

$$\log\left(\frac{p(Y=j)}{p(Y=1)}\right) = \beta_{0j}+\beta_{1j}X_1+\beta_{2j}X_2+\cdots+\beta_{kj}X_k \quad (4)$$

This is done separately for each non-reference category.

3. Results

Demographic and clinical characteristics of patients with stroke (N = 264)

***Table 1**: Demographic and clinical characteristics of patients with stroke (N = 264)*

Characteristic	N = 264[1]	Characteristic	N = 264[1]
Age	59 (16)	Low	10 (3.8%)
BMI	29.9 (6.4)	Normal	162 (61%)
Gender	148 (56%)	**Smoking**	
Hypertension	241 (91%)	Current	18 (6.8%)
Diabetes	29 (11%)	Former	27 (10%)
Cholesterol		Never	219 (83%)
High	92 (35%)		

Characteristic	N = 264[1]
Physical_Activity	Low (sedentary), Moderate (occasional exercise), High (regular exercise ≥3 times/week)
Low	257(97%)
Moderate	6(2.3%)
High	1(0.4%)
Family_History	2 (0.8%)
Previous_Stroke	5 (1.9%)
Heart_Disease	71 (27%)
Alcohol_Intake	None, Moderate (≤2 drinks/day), Heavy (>2 drinks/day).
None	204 (77%)
Moderate	53 (20%)
Heavy	7(2.7%)
Hyperlipidemia	256 (97%)
Stroke_Type	
Hemorrhagic	103 (39%)
Ischemic	155 (59%)
TIA	6 (2.3%)
Obesity	
Normal	67 (25%)
Obese	24 (9.1%)
Overweight	173 (66%)
Marital_Status	
Divorced	1 (0.4%)
Married	203 (77%)
Single	13 (4.9%)
Widowed	47 (18%)

[1] Mean (SD); n (%)

Values are presented as **mean (SD)** for continuous variables and **n (%)** for categorical variables. Abbreviations: BMI = Body Mass Index; IQR = Interquartile Range.

From the above results, the average age of stroke patients was 59.1 years, with a standard deviation of 16.3. The median age was 61 years, and the interquartile range was 29, which indicates that half of the patients were between roughly 46 and 75 years old. This implies that most patients were older adults, which aligns with the known link between aging and stroke risk. The body mass index (BMI) had a mean of 29.9, with a standard deviation of 6.36 and a median of 30.3; the interquartile range was 10.9, placing many patients in the overweight to obese category. This finding points to obesity as a possible contributing factor in this group.

Regarding lifestyle and clinical risk factors, most patients reported no alcohol intake at 77.3%. About 20.1% reported moderate intake, while only 2.7% reported heavy drinking, suggesting that alcohol consumption was not a major risk factor in this dataset. Cholesterol levels were mostly normal at 61.4%, but a significant portion, 34.8%, had high cholesterol, highlighting its role as a vascular risk factor. Diabetes was present in 11% of patients, making it a noteworthy but less common comorbidity. Almost all patients, 99.2%, reported no family history of stroke, indicating that genetic factors were less significant compared to those that can be changed. Other prevalent risk factors included hypertension and high lipid levels, both of which are consistent with known stroke epidemiology. Smoking status varied among those who currently smoke, those who smoked before, and those who never smoked, although most reported never having smoked. Both ischemic and haemorrhagic strokes occurred, but ischemic strokes were more common, which aligns with global trends. Generally, the typical stroke patient in this dataset was an older adult around 60 years old with an overweight or obese BMI. Hypertension, high lipid levels, and elevated cholesterol were the most frequent comorbidities, while diabetes and heavy alcohol intake were less common.

The prevalence of hypertension among stroke patients calculated as a proportion with a 95% confidence interval (CI).

Table 2: *Prevalence of hypertension among stroke patients with 95% confidence interval*

Measure	Value
Number of stroke patients	264
Number with hypertension	241
Prevalence (proportion)	0.913 (91.3%)
95% Confidence Interval (CI)	87.2% – 94.4%
p-value	< 0.001

Values are based on an exact binomial test. Prevalence is expressed as a proportion with corresponding 95% confidence interval (CI). The p-value tests the null hypothesis that the prevalence equals 50%.

Among 264 stroke patients, 241 had hypertension. This results in a prevalence of 91.3% (95% CI: 87.2%–94.4%). This shows that hypertension is very common in this stroke group, affecting more than 9 out of 10 patients. The narrow confidence interval shows accuracy due to the relatively large sample size. The p-value (<0.001) comes from the binomial test against the null hypothesis of 50% prevalence. This confirms that the observed prevalence is much higher than what would happen by chance.

The Distribution of Comorbidities (Diabetes and Heart Disease) among the Stroke Patients

Table 3: *Distribution of comorbidities (Diabetes and Heart Disease) among stroke patients.*

Comorbidity	Status	n	%
Diabetes	No	235	89.0%
Diabetes	Yes	29	11.0%
Heart Disease	No	193	73.1%
Heart Disease	Yes	71	26.9%

Values are presented as absolute frequencies (n) and percentages (%). Percentages were calculated within each comorbidity category based on the total number of patients in the study population (N = 264).

In this study population, 11% of stroke patients had diabetes, while 89% did not. In contrast, 26.9% of patients had heart disease, which affected more than a quarter of the group. These findings indicate that diabetes is a less common comorbidity, while heart disease is a fairly frequent condition among stroke patients. This highlights the importance of considering heart disease in stroke risk assessment and management.

The relationship between hypertension and stroke subtypes assessed in two steps

Table 4: *Distribution of stroke subtype by hypertension status*

Hypertension	Haemorrhagic	Ischemic	TIA	Total
No (n = 23)	7 (30.4%)	15 (65.2%)	1 (4.3%)	23 (100%)
Yes (n = 241)	96 (39.8%)	140 (58.1%)	5 (2.1%)	241 (100%)
Total	103 (39.0%)	155 (58.7%)	6 (2.3%)	264 (100%)

Values represent absolute frequencies of stroke subtypes stratified by hypertension status. Percentages are calculated relative to row or column totals as appropriate.

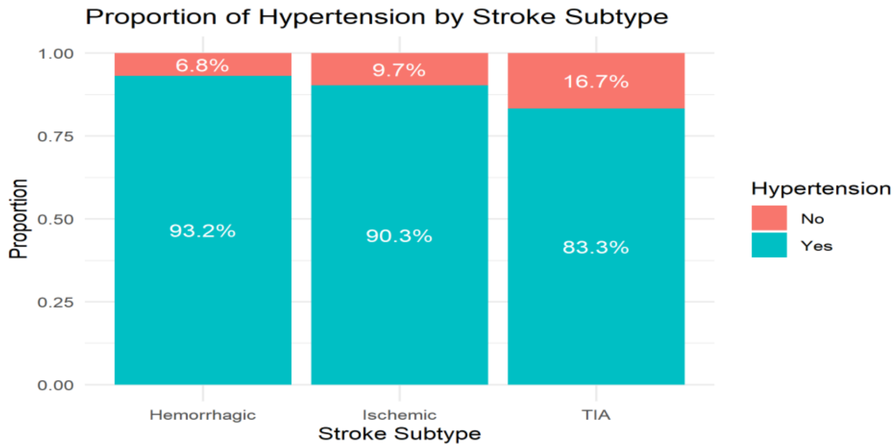

Figure 1*: Distribution of stroke subtype by hypertension status among patients in the study population*

As shown in figure 1, Bars represent the proportion of ischemic, hemorrhagic, and TIA cases stratified by hypertension status. The association between hypertension status and stroke subtype was assessed using Fisher's Exact Test, which was selected due to small expected cell counts in the contingency table. The test showed no significant link between hypertension status and stroke subtype (p = 0.3623). While hypertension was very common among stroke patients overall (91.3%), its distribution was similar across ischemic, haemorrhagic, and TIA cases in this dataset. This suggests that, in this population, hypertension is a common risk factor for all stroke subtypes rather than being closely tied to any specific type.

Multinomial Logistic Regression Model Quantified the Association

Table 5*: Adjusted odds ratios (aOR) with 95% confidence intervals for the association between hypertension and stroke subtype, adjusted for age and gender. Ischemic stroke was the reference category*

Outcome	Variable	aOR	95% CI (Low–High)	p-value
Hemorrhagic vs. Ischemic	Intercept	0.24	0.06 – 0.91	0.036
	Hypertension (Yes)	1.47	0.58 – 3.76	0.419
	Age	1.01	0.99 – 1.03	0.216
	Gender (Yes)	1.15	0.70 – 1.91	0.582
TIA vs. Ischemic	Intercept	1.37	0.04 – 45.0	0.860
	Hypertension (Yes)	0.55	0.06 – 5.22	0.602
	Age	0.94	0.89 – 1.00	0.063
	Gender (Yes)	0.81	0.16 – 4.23	0.805

Values are adjusted odds ratios (aOR) with 95% confidence intervals (CI) and p-values from a multinomial logistic regression model. Ischemic stroke was the reference category. The model was adjusted for hypertension, age, and gender.

Haemorrhagic stroke vs. Ischemic stroke

Patients with hypertension had 1.47 times higher odds of haemorrhagic stroke compared to ischemic stroke, but this link was not statistically significant (aOR = 1.47, 95% CI: 0.58, 3.76, p = 0.419). Age had a small but not significant effect, and gender showed no association.

TIA vs. Ischemic stroke

Hypertension was linked to lower odds of TIA (aOR = 0.55, 95% CI: 0.06, 5.22), but this also was not statistically significant (p = 0.602). Age indicated a trend toward lower odds of TIA as age increased (aOR = 0.94, 95% CI: 0.89, 1.00, p = 0.063), suggesting that younger patients were more likely to experience TIA compared to ischemic stroke. Gender did not show a significant association.

Generally, hypertension was common among stroke subtypes, but after adjusting for age and gender, it did not show a statistically significant association with either haemorrhagic stroke or TIA compared to ischemic stroke in this dataset.

Variance Inflation Factor

Table 6*: Variance Inflation Factor (VIF) for predictors in the Logistic regression model*

Predictor	VIF
Hypertension	1.42
Age	1.11
Gender	1.09
Diabetes	2.03
Heart Disease	2.15
Smoking Status	1.87
Alcohol Intake	1.76

Note: All VIF values < 5, indicating no significant multicollinearity

4. Discussion

This study shows that hypertension is very common among stroke patients in Anambra State. This aligns with findings from Ogah et al. (2022) and Ulasi et al. (2021), who found high rates of hypertension in Nigerian populations. However, hypertension did not significantly relate to stroke subtype. This is similar to what Ojji et al. (2019) found, suggesting that hypertension affects overall stroke risk rather than specific subtypes.

The high occurrence of ischemic stroke (59%) matches global trends (Feigin et al., 2022), while the presence of hyperlipidemia and obesity highlights concerns about metabolic syndrome in Nigeria (Ejike et al., 2022). The lack of a significant link between hypertension and stroke subtype in the regression analysis may indicate the complex nature of stroke development, where overlapping risk factors lessen the impact of each one.

The study has limitations, such as its retrospective design and the limited range of comorbidities examined. Future research should consider renal function, atrial fibrillation, and inflammatory markers to gain a better understanding of stroke outcomes. Moreover, increasing the sample size and including long-term follow-up could shed light on stroke recurrence and recovery.

5. Conclusion

In this study of 264 stroke patients, most were older adults with an average age of about 59 years. Obesity and excess weight were common, as shown by a mean BMI in the obese range, highlighting the metabolic risk faced by this group. Hypertension was the most frequent comorbidity, impacting over 90% of patients, while high cholesterol and hyperlipidaemia were also common. In contrast, diabetes and heart disease were less frequent, although still important. Most patients reported no alcohol consumption, and a family history of stroke was rare. When looking at the risk factor distribution among different stroke types, hypertension was widespread in cases of ischemic, haemorrhagic, and TIA strokes. Fisher's Exact Test did not find a significant link between hypertension and stroke type, suggesting that hypertension is a common risk factor regardless of type. Additionally, multinomial logistic regression adjusted for age and gender showed that hypertension was not significantly linked to an increased chance of haemorrhagic stroke or TIA when compared to ischemic stroke. Older age showed a slight but not significant trend toward haemorrhagic stroke, while younger patients seemed more likely to have TIA, although this was not statistically significant. Gender did not have an effect on stroke type. Generally, these findings indicate that the typical stroke patient in this group is an older adult with obesity and hypertension, often with dyslipidaemia. While hypertension is a strong and common risk factor for stroke in general, it does not seem to separate the different types of strokes in this data. These results highlight the need for strong prevention and management of adjustable vascular risk factors, especially hypertension, obesity, and dyslipidaemia, to lessen the impact of stroke across all types.

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