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Population-based stroke risk profile from a West-African community

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A R T I C L E I N F O

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A B S T R A C T

Objectives: To determine the stroke risk profile of dwellers of Nnewi community in Nigeria.
Methods: This was a cross-sectional survey involving consecutively recruited community-dwelling adults without a previous history of stroke. The Modified Framingham Stroke Risk Score (MFSRS) was used to evaluate the stroke risk profile of the participants. Data was analysed using descriptive and inferential statistics at an alpha level of 0.05.
Result: 310 individuals (mean age = 37.21 ± 15.84 years; 68.7% females) participated in this study. The mean MFSRS (6.79 ± 5.21) of the participants was minimal with 16% having a moderate-to-high risk. Dyslipidaemia (100.0%), meat (88.1%) and sugar (70.6%) consumption, hypertension (37.7%), physical inactivity (43.2%), and psychological stress (41.3%) were the most prevalent risk factors in the population. Participants' MFSRS significantly and positively correlated with their body mass index (BMI), waist circumference (WC), and waist-hip ratio (WHR) and significantly differed across their gender, educational, and occupational categories ($p < 0.05$).
Conclusion: According to MFSRS, the risk of stroke among the sampled community was minimal and was significantly influenced by their BMI, WC, WHR, gender, education, and occupation. However, results revealed that stroke risk might be higher in the population than was depicted by the MFSRS. Enlightenment on the risk of stroke is needed in the community.

1. Introduction

Stroke is a global leading cause of morbidity and mortality that imposes a great burden on the sufferers, families, communities, healthcare facilities, and nations [1,2]. Among 240 causes of death globally, stroke is the second leading cause of death, accounting for over 11% of deaths in 2019, with scientific projections predicting a significant increase in this percentage in the next few years [3,4]. It is expected that within the next twenty years, the percentage of the world population over the age of forty-five will more than triple (especially in developing countries), thus incredibly increasing the likelihood of stroke events and deaths [5]. Sub-Saharan Africa presently bears the highest burden (in terms of incidence, prevalence, and case fatality) of stroke worldwide [6,7]. Currently, Africa has up to 2–3 fold greater rates of stroke incidence and higher stroke prevalence than Western Europe and the USA, a far cry from the medieval period when stroke was rare and communicable diseases were the main causes of death in Africa [8]. However, these percentages do not tell the full story. This is because as for every clinical case of stroke reported in Africa, there are about four covert or 'silent' cases of stroke left unreported [8]. The increase in stroke burden in Africa has been attributed to the increasing trends in the prevalence of modifiable risk factors in this region, thus highlighting the importance of having in-depth knowledge about these risk factors [9].

Stroke is a multifactorial disease regulated by both modifiable (including hypertension, smoking, dyslipidemia, hyperlipidemia, poor diet, abdominal obesity, diabetes, physical inactivity, atrial fibrillation, and high salt intake) and non-modifiable (such as age, sex, race, geographic locations, and heredity) risk factors [10]. An increase in the prevalence of these risk factors has been proven to correlate with an increase in the prevalence and burden of stroke [9]. Hence, stroke risk

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profile assessment has become very vital in stroke prevention. Primary prevention of stroke which is usually targeted at the risks in the general population reportedly has the potential of reducing stroke by up to 80% [11] thus highlighting the importance of assessing these risks in the population. Despite this enormous potential, there is a paucity of population-based studies on stroke risk profiling from West Africa thereby making individuals and policymakers largely unaware of stroke risk scores in their environments, thus hampering prevention efforts.

Population-based studies on stroke risk profiles from Africa are rather rare thereby making the primary prevention of stroke in this region difficult [6]. The majority of studies on the risks of stroke from this region were among stroke patients which could only be useful in secondary stroke prevention [7,12,13]. Apart from Walker et al. [14] and Owolabi et al. [6], the authors are not aware of any other community-based studies on the risk factors of stroke from sub-Haran Africa. These two studies employed case-control methods that highlighted the risks of stroke in the studied population but did not provide avenues for easy comparison between the populations and other regions of the world. For ease of assessment and comparison across regions, a handful of stroke risk assessment algorithms have been developed [15,16]. Among these algorithms, the Modified Framingham Stroke Risk Score (MFSRS) is still the most popular, utilized, and well-accepted stroke risk prediction score, thereby making it a suitable candidate for international comparison [17,18]. It factors in only six risk factors (age, gender, diabetic status, high-density lipoprotein-cholesterol, total cholesterol, systolic blood pressure, and smoking status) that have been repeatedly reported to predict stroke [19–21]. This community-based study was designed to assess stroke risk factors in a community in Nigeria, the most populous black nation.

2. Materials and method

2.1. Design, setting, and sampling

This study was a cross-sectional survey involving consecutively recruited adult residents (18 years and above) of Nnewi, a Local Government Area in Anambra State, Southeast Nigeria. Nnewi is located on latitude 6.0105° North and longitude 6.9103° East, with an elevation of approximately 82 m and a time-zone of UTC + 1. It is noted for its commercial activities ranging from auto parts manufacturing, automobile assembling, and industrial services with an estimated population of 1.2 million people [22,23]. Nnewi is a metropolitan, semi-urban, commercial, and agricultural community comprising four quarters: Otolo, Uruagu, Umudim, and Nnewichi. Otolo and Umudim quarters were randomly selected using the Fisch Bowl technique. Mbanagu and Okpuno-egbu communities were selected using the Fisch Bowl technique from the 17 and 13 communities of Otolo and Umudim respectively. An advertisement for the study was made in each community through the community, church, and market leaders. Before the commencement of data collection, the study protocol was approved by the Ethical Review Committee of the Faculty of Health Sciences and Technology, Nnamdi Azikiwe University Nnewi, Anambra State, Nigeria. Prospective participants were asked to converge at community town halls, church premises, or markets where those who met the inclusion criteria were consecutively recruited. Verbal or written informed consent (depending on the participant's preference) was obtained from each participant after the purpose and procedure for the study had been thoroughly explained to them. The participants who met the inclusion criteria (of being well-oriented in time, place, and person, and having no communication impairments or history of stroke or transient ischemic attack) were then consecutively recruited into the study. A sample size of 310 had a 95% power to detect a moderate change of 0.25 at an alpha of 0.05. The sample size was calculated using the G*Power 3.10.0 software [24]. Data was collected from January to June 2022. All data collected from the participants were treated with utmost confidentiality, and the participants were duly informed of this before commencement. This manuscript was written in conformity with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) reporting guidelines [25].

2.2. Research instrument

i. Modified Framingham Stroke Risk Score (MFSRS)

This was used to determine the level of stroke risk among participants in this present study. It is a tool used to predict the 10-year probability of stroke in subjects using a delicate combination of several risk factors to generate a mathematical risk score that quantifies the probability of stroke in such patients. It utilizes the Cox proportional hazards regression model which provides a simple formula for estimating the probabilities of stroke for specified levels of risk factors and also allows for computation of stroke probabilities for variable lengths of time [26]. The MFSRS was adapted in 2017 by a team led by Carole Dufouil as an updated version of the original FSRS to improve the accuracy of stroke prediction [18]. The MFSRS contains six items in total which include age, gender, diabetic status, high-density lipoprotein-cholesterol, total cholesterol, systolic blood pressure, and smoking status. The risk score for each participant is calculated from the information on the six aforementioned factors using the MFSRS sheet values. The risk levels are categorised as low (score of <10%), intermediate (score of 10–19%), and high (score of ≥20%). The MFSRS has been validated in 3 external cohorts and was deemed a better predictor of current stroke risks than the old FSRS in all the three samples [18].

ii. ***Narrow-Care mercury-column sphygmomanometer:*** This was used to determine the blood pressure of the participants in this study in mmHg.

iii. ***Hana-model weighing balance:*** For measuring the weight of the participants. It is a 120 kg weight-capped model graded in 1 kg subunits, made in China, and suitable for household uses and research purposes.

iv ***Height meter (Locally constructed):*** This was used to determine the height of the participants in this study in meters.

v. ***2 ml syringe:*** This was used to draw 2 ml blood from the participants in this study.

vi ***Plain tubes:*** This was used to store the blood drawn from participants in this study.

vii ***Roll of cotton wool:*** This was used to clean and pad the site of the body of the participants where blood was drawn.

viii ***Methylated spirit:*** This was used to clean the site of the body of the participants where blood was drawn.

ix ***Randox cholesterol procedure:*** This was used to determine the total cholesterol level of the participants in this study in mmol/l.

x ***Randox HDL procedure:*** This was used to determine the HDL cholesterol levels of the participants in this study in mmol/l.

2.3. Data collection

Potential participants were first screened for previous histories of stroke using the Questionnaire for Verifying Stroke-Freestatus (QVSFS), an 8-item questionnaire that identifies those who have a history of stroke by asking questions about the most frequent symptoms of stroke and transient ischemic attack. Individuals with no prior history of stroke were then accepted for this study. Participants' age, sex, occupation, and level of education were recorded.

Systolic Blood Pressure: This was evaluated using a mercury-column sphygmomanometer. The participant was placed in a comfortable chair with a backrest and allowed a variable rest period. The blood pressure was taken by supporting the left arm at the level of the chest and duly using a Narrow-Care Mercurial Sphygmomanometer (by applying the cuffs just above the cubital fossa and inflating to at least 160 mmHg) to take two blood pressure readings and noting the systolic blood pressure, the eventual systolic blood pressure being the average of the two values. Hypertension was defined using a cut-off of ≥140/90 mmHg or having a history of hypertension or use of antihypertensive drugs.

High-density lipoprotein and total cholesterol were collected simultaneously and analysed with the aid of a laboratory (biomedical) scientist. The samples were collected early in the morning, and participants were instructed not to eat before the test. A tourniquet was tied at the upper parts of the arm so that blood could flow into the veins in the arm. An antiseptic was then used to clean the cubital fossa before collecting blood from the cubital vein using a syringe. The collected blood was placed in test tubes which were then properly stored and immediately transported to the lab for lipid profiling. A tuft of cotton wool was placed over the punctured area before untying the tourniquet to prevent bleeding. The blood was then centrifuged in the laboratory to separate the serum which was used to determine the levels of total cholesterol and high-density lipoprotein cholesterol in mmol/dL. Dyslipidaemia was defined as having fasting total cholesterol levels of ≥5.2 mmol/l, low-density lipoprotein of ≥3.4 mmol/l, high-density lipoprotein of ≤1.03 mmol/l or triglycerides of ≥1.7 mmol/l.

Diabetic status: This is defined as a history of diabetes or diabetic drugs, or having a fasting blood glucose level of ≥7.0 mmol/l.

Smoking status: Individuals were graded as non-smokers and smokers (individuals who smoked any tobacco in the past 12 months) or former smokers (stopped for >12 months).

Weight: This was measured using a Hana Model Weighing Scale with the pointer initially set at 0 kg. Each participant mounted the scale barefooted with as minimal clothing as possible without disrespecting their privacy and dignity. The participant was instructed to look forward and the value was read off by the assessor while avoiding error due to parallax.

Height: This was measured to the nearest centimetre. Each participant's weight and height were used in calculating his/her body mass index. Obesity was defined as having a body mass index of ≥30 kg/m^2.

Waist and hip circumferences were both assessed using an inelastic tape measure. The waist circumference was assessed by wrapping the tape measure around the waist in the area immediately inferior to the umbilicus. The hip circumference was assessed by wrapping the tape rule around the participant's hip at the level of the greater trochanter of the femur. The waist and hip circumferences were used to calculate the waist-hip ratio. Obesity was defined as having a waist-hip ratio of ≥0.90 and ≥ 0.85 for men and women respectively.

Other factors not accounted for in the MFSRS were assessed using the guidelines outlined by Akpa et al. [15]:

Family history of cardiovascular diseases: This involved a family history of cardiovascular diseases such as stroke, atrial fibrillation, etc.

History of cardiovascular diseases: This involved a history of cardiovascular diseases such as heart failure.

Obesity: This was described as having a waist-hip ratio of 0.90 for men and 0.85 for women or a body mass index ≥30 kg/m^2.

Physical activity: Physically individuals involved in moderate exercise (walking, or cycling) or strenuous exercise (jogging, football, and vigorous swimming) for ≥4 h per week.

Dietary history: The frequencies of consumption of green leafy vegetables, meat, fish, nuts, sugar, and other local staple food items and sprinkling salt on food at the table were classified as daily, weekly, at least once.

Psychological stress: This was defined as elevated levels of stress due to work, school, and/or family issues.

Traumatic life events: This was defined as abnormal and traumatic life events that could have caused psychological stress within the previous month.

Depression: In most cases, it was defined as an aggravated level of mental depreciation, while in other cases it was simply defined as excessive mental constraint.

2.4. Data analysis

Obtained data was analysed using Statistical Package for the Social Sciences (SPSS) version 20.0. Descriptive statistics of frequency, percentages, charts, mean and standard deviation were used to summarize participants' socio-demographic and risk profiles. Spearman rank-order correlation was used to determine the correlation between stroke risk scores and each of the participants' body mass index, waist-hip ratio, and hip and waist circumferences. The Kruskal-Wallis test was used to analyse for significant differences in stroke risk scores across different categories of participants' occupational and educational statuses. The alpha level was set at 0.05.

3. Results

3.1. Socio-demographic and anthropometric profiles of participants

A total of 310 adults (68.7% females) with a mean age of 37.21 ± 15.84 years participated in this study. The majority of the participants were young adults (51.3%), were into trading/business (53.2%), and attained at least a secondary level of education (84.1%). The mean body mass index and the waist-hip ratio of the participants were 24.93 ± 5.01 kg/m^2 (normal) and 0.88 ± 0.07 respectively (Table 1).

3.2. Stroke risk profiles of the participants

The mean stroke risk profile score (6.79 ± 5.21) of the participants fell within the range for low risk (Table 2). The mean age (37.21 ± 15.84 years) of the participants was in the range of middle age group. Participants' mean systolic and diastolic blood pressure were within the normal ranges whereas their mean total cholesterol (10.53 ± 2.18 mmol/l), high-density lipoprotein (1.60 ± 0.38) and triglycerides (10.534 ± 2.182 mmol/l) were high (Table 2).

Generally, 16% of the participants had moderate or high stroke risk scores (Fig. 1). Among the six factors accounted for in the MFSR, dyslipidaemia from triglycerides (100.0%) was the most prevalent risk factor. This was followed by hypertension (37.7%), smoking (8.7%), age of ≥65 (7.1%), diabetes, and dyslipidaemia from high-density lipoprotein. Among other factors not accounted for in the MFSR, meat consumption (88.1%) followed by consumption of processed sugar (70.6%), physical inactivity (43.2%), psychological stress (41.3%), obesity (37.10%) and failure to consume vegetables (23.9%) were the most

Table 1
Socio-demographic and anthropometric profiles of the participants.

Variable	Class	Frequency(Percentage)	Mean ± SD
Sex	Male	97(31.3)	–
	Female	213(68.7)	–
Age (years)	18–34	159(51.3)	–
	35–54	104(33.5)	–
	55–64	25(8.1)	–
	≥65	22(7.1)	–
Occupation	Unemployed	21(6.8)	–
	Civil/private sector	23(7.4)	
	Trading/business	165(53.2)	–
	Artisan	21(6.8)	–
	Student	68(21.9)	
	Others	12(3.9)	–
Education	None	4(1.3)	–
	Primary	45(14.6)	–
	Secondary	226(73.1)	–
	Tertiary	34(11.0)	–
BMI (kg/m^2)	–	–	24.93 ± 5.01
WC (cm)	–	–	85.05 ± 12.35
HC (cm)	–	–	97.34 ± 13.08
Waist-hip ratio	–	–	0.88 ± 0.07

Key
SD=Standard deviation.
BMI=Body mass index.
HC = Hip circumference.
WC = Waist circumference.

Table 2
Mean values of stroke risk and other related factors among the participants.

Variable Deviation	Mean	Standard
Stroke Risk (%)	6.79	5.21
Age (years)	37.21	15.84
Systolic Blood Pressure (mmHg)	124.92	13.58
Diastolic Blood Pressure (mmHg)	79.25	10.89
Total Cholesterol (mmol/l)	10.53	2.18
High Density Lipoprotein (mmol/l)	1.60	0.38
Triglyceride (mmol/l)	10.53	2.18

prevalent risk factors. Others were family history of cardiovascular disease (20.6%), highly stressful life events (20.6%), sprinkling raw salt on served food (20.3%), and depression (15.8%) (Table 3).

3.3. Correlation between stroke risk score and selected variables

There was a significant positive correlation between participants' stroke risk score and each of their body mass index (rho = 0.227, $p < 0.01$), waist circumference (rho = 0.376, $p < 0.01$), hip circumference (rho = 0.313, $p < 0.01$), and waist-hip ratio (rho = 0.151, $p < 0.01$) showing that stroke risk score significantly increased with increase in each variable. Each variable predicted between 2% and 14% of the variances in the stroke risk score (Table 4).

3.4. Differences in stroke risk across different categories of participants' occupation and educational attainment

Male participants significantly had higher stroke risk scores than their female counterparts (u = 8404.0, $p < 0.01$). There was a significant influence of occupation of the participants on their stroke risk score with unemployed or retired participants and homemakers (housewives) having the highest scores while students had the lowest scores (k = 66.94, $p < 0.01$). Also, participants' educational status had a significant influence on their risk score with those without formal education and those with tertiary education having the highest and the lowest scores respectively (Table 5).

4. Discussion

This study was aimed at determining the stroke risk profile of adults in Nnewi, a community in the Southeast geopolitical zone of Nigeria

Table 3
Distribution of participants across other different risk factors.

Risk	Category (f (%))	
	No	Yes
MFSRS risks factors		
Dyslipidemia (triglyceride)	0(0.0)	310(100.0)
Hypertension	193(62.3)	117(37.7)
Smoking status	283 (91.3)	27 (8.7)
Older adults (≥65 years)	288(92.9)	22(7.1)
Diabetes status	301 (97.1)	9 (2.9)
Dyslipidemia (HDL)	289(93.2)	21(6.8)
Other risk factors		
Meat Consumption	37(11.9)	273(88.1)
Sugar Consumption	91(29.4)	219(70.6)
Physical inactivity	176(56.8)	134(43.2)
Psychological Stress	182(58.7)	128(41.3)
Obesity	195(62.90)	115(37.10)
Vegetable Consumption	74(23.9)	236(76.1)
Family History of Cardiovascular Disease	246(79.4)	64(20.6)
Life Events	246(79.4)	64(20.6)
Extra Salt Intake	247(79.7)	63(20.3)
Depression	261(84.2)	49(15.8)
History of Cardiovascular Disease	283(91.3)	27(8.7)

Table 4
Spearman rank order correlation showing the correlation between risk of stroke and some participant-related variables.

Variable	rho	P	CD
Body Mass Index (kg/m2)	0.23	<0.01*	0.05
Waist Circumference (cm)	0.376	<0.01*	0.14
Hip Circumference (cm)	0.313	<0.01*	0.10
Waist to Hip Ratio	0.151	<0.01*	0.02

KEY;
CD- Coefficient of Determination.
* = significant at $P < 0.05$.

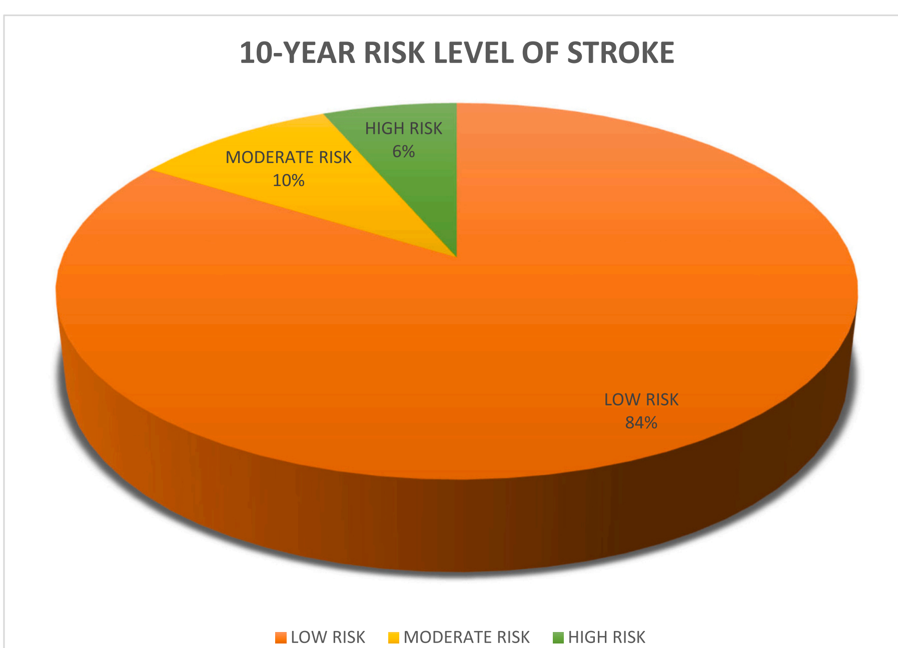

Fig. 1. 10-year risk levels of stroke among the participants.

Table 5
Kruskal-Wallis test showing the differences in stroke risk across different categories of participants' sex, occupation status, and educational attainment.

Variable	Category	Mean rank	U/K	P
Sex	Male	175.36	8404.00	<0.01*
	Female	146.46		
Occupation	Unemployed/Retired/ Housewife	231.52	66.94	<0.01*
	Civil Servant/Private enterprise	162.7		
	Trading/Business	162.57		
	Artisan	177.48		
	Student	89.56		
Education	None	258.38	50.36	<0.01*
	Primary	227.91		
	Secondary	134.60		
	Tertiary	181.97		

* = significant at $p < 0.05$.

using the Modified Framingham Stroke Risk Score (MFSRS). The use of the MFSRS in this study was predicated on the fact that it is the most well-known, and well-accepted gold standard for predicting stroke risk [27,28]. Though the MFSRS has been reported not to factor in some modifiable risk factors indigenous to Africans [28], its wide utility and international appeal, which could engender easy international comparison, was the main reason it was chosen in this study. However, to give a more encompassing view, other established risk factors not considered in the MFSRS were also surveyed in this study.

Sixteen percent of the participants in this study had moderate to high risk of stroke according to the MFSRS. This is lower than what was reported in previous studies from Iran (27%; [29]) and Sweden (20.5%; [30]) that utilized the MFSRS. Coming from a region that has been severally reported to have the highest incidence, prevalence, and fatality from stroke globally [6], the present results seem to be at variance with expectations. The MFSRS was developed using data from high-income nations and had been reported to not factor in the peculiarities of Africans [28]. It may therefore be safe to assume that the MFSRS underestimates the risk of stroke in Africa. This assumption may be buttressed by the fact that out of the seventeen stroke risk factors considered in this study, four out of the six risk factors considered in the MFSRS had the least prevalence (6.8%–8.7%).

All the participants in the present study had dyslipidemia which is much higher than the reported mean African and global prevalence [31,32]. However, Newton [33] reported African prevalence figures of 2% to 96% with the upper limit being similar to the present result. The high variability in the prevalence rates of dyslipidemia across different populations may be attributable to differences in different populations' genetic make-ups, diets, lifestyles, and comorbidities, which have all been reported to influence the development of dyslipidemia [32]. The high dyslipidemia prevalence in the present population is a cause for alarm considering its associated high morbidity and mortality [34]. The prevalence of diabetes, hypertension, and smoking and the proportions of older adults and male participants in this study were similar to other local reports [35–37] but were all significantly below the global prevalence rates and proportions [5,38–40]. The fact that these five factors were utilized in the calculation of the MFSRS stroke risk score could explain the lower risk score obtained from this study when compared with results from other regions. This may have wrongly underestimated the risk of stroke in this population as was suggested by the high prevalence of other stroke risk factors not accounted for in MFSRS among the participants. For instance, the prevalence of physical inactivity and obesity in this report were all well above the global prevalence [41,42].

Present results revealed that male participants had a higher stroke risk score than their female counterparts. There have been contradicting reports in the literature on which gender has the higher prevalence of stroke [19,43]. In this study, there was a significant influence of occupation of the participants on their stroke risk score with unemployed or retired participants and homemakers (housewives) having the highest scores while students had the lowest scores. The fact that students were likely to be younger and more knowledgeable about stroke risk factors than other groups might have helped to reduce their risks of stroke. This opinion may be supported by the significantly reduced risk of stroke among participants with higher educational attainment in the present report. The ability of education to reduce stroke risk has been previously reported [44]. Most Nigerian unemployed, retired, and homemaking individuals are usually known to suffer substantial hardships [45], which could have discouraged positive lifestyles that would have reduced their risk of stroke. Employment status has also been reported as an independent factor associated with the risk of stroke [46]. Each of the body mass index, waist circumference, and waist-hip ratio of the participants had a positive relationship with their stroke risk scores similar to previous reports [8,47]. This is not surprising as all the three variables are markers of obesity which has been proven to predispose to stroke [48].

The present study has some limitations. Even though the study was population-based, it was restricted to a single community. A larger sample size recruited from different locations and communities would have given more power to the study. Hence, the present result may need to be interpreted with caution.

5. Conclusion

Stroke risk among adult dwellers of Nnewi community of Anambra State, Nigeria was minimal according to the ratings on the MFSRS. However, the high prevalence of other stroke risk factors not accounted for in the MFSRS suggests a higher prevalence of stroke risk factors than portrayed by the MFSRS. Dyslipidaemia, meat and sugar consumption, hypertension, physical inactivity, and psychological stress were the most prevalent risk factors for stroke in the population. Higher body mass index, waist circumference, and waist-hip ratio, male gender, being unemployed/retired, and having less education attainment connoted higher risk of stroke among the participants. This has suggested the need for stakeholders (government, non-governmental organisations, health professionals, and so on) to institute strategies to increase public education on the risk of stroke to reduce the risk and burden of stroke. These interventions need to focus more on vulnerable groups including male, obese, unemployed/retired, and less educated individuals.

CRediT authorship contribution statement

Ifeoma Uchenna Onwuakagba: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. **Emmanuel Chiebuka Okoye:** Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation. **Favour Chidera Kanu:** Resources, Methodology, Data curation. **Chukwuemeka Michael Kalu:** Resources, Investigation, Data curation. **Daniel Chidubem Akaeme:** Resources, Project administration, Data curation. **Ogochukwu Charity Obaji:** Validation, Investigation, Data curation. **Christopher Olusanjo Akosile:** Supervision, Methodology, Investigation, Conceptualization.

Declaration of Competing Interest

None.

References

[1] W.L. Teh, E. Abdin, J.A. Vaingankar, E. Seow, V. Sagayadevan, S. Shafie, S. Shahwan, Y. Zhang, S.A. Chong, L.L. Ng, M. Subramaniam, Prevalence of stroke, risk factors, disability and care needs in older adults in Singapore: results from the WiSE study, BMJ Open 8 (3) (2018), e020285, https://doi.org/10.1136/bmjopen-2017-020285.

[2] E.S. Donkor, Stroke in the 21st century: a snapshot of the burden, epidemiology, and quality of life, Stroke Res. Treatment 2018 (2018) 3238165, 10.1155%2F2018%2F3238165.
[3] A. Avan, H. Digaleh, M. Di Napoli, S. Stranges, R. Behrouz, G. Shojaeianbabaei, A. Amiri, R. Tabrizi, N. Mokhber, J.D. Spence, M.R. Azarpazhooh, Socioeconomic status and stroke incidence, prevalence, mortality, and worldwide burden: an ecological analysis from the global burden of disease study 2017, BMC Med. 17 (1) (2019) 1–30, https://doi.org/10.1186/s12916-019-1397-3.
[4] World Health Organization, Global Stroke Fact Sheet 2019, Available at, https://www.world-stroke.org/assets/downloads/WSO_Fact-sheet_15.01.2020.pdf, 2019. Accessed on April 25 2023.
[5] World Health Organization, Ageing and Health, Available at, https://www.who.int/news-room/fact-sheets/detail/ageing-and-health, 2022. Accessed on April 25 2023.
[6] M.O. Owolabi, F. Sarfo, R. Akinyemi, M. Gebregziabher, O. Akpa, A. Akpalu, K. Wahab, R. Obiako, L. Owolabi, B. Ovbiagele, M.O. Owolabi, Dominant modifiable risk factors for stroke in Ghana and Nigeria (SIREN): a case-control study, Lancet Glob. Health 6 (4) (2018) e436–e446, https://doi.org/10.1016/s2214-109x(18)30002-0.
[7] F.S. Sarfo, B. Ovbiagele, M. Gebregziabher, K. Wahab, R. Akinyemi, A. Akpalu, O. Akpa, R. Obiako, L. Owolabi, C. Jenkins, M. Owolabi, Stroke among young west Africans: evidence from the SIREN (stroke investigative research and educational network) large multisite case–control study, Stroke 49 (5) (2018) 1116–1122, https://doi.org/10.1161/strokeaha.118.020783.
[8] R.O. Akinyemi, B. Ovbiagele, O.A. Adeniji, F.S. Sarfo, F. Abd-Allah, T. Adoukonou, O.S. Ogah, P. Naidoo, A. Damasceno, R.W. Walker, A. Ogunniyi, Stroke in Africa: profile, progress, prospects and priorities, Nat. Rev. Neurol. 17 (10) (2021) 634–656, https://doi.org/10.1038/s41582-021-00542-4.
[9] T. Yahya, M.H. Jilani, S.U. Khan, R. Mszar, S.Z. Hassan, M.J. Blaha, R. Blankstein, S.S. Virani, M.C. Johansen, F. Vahidy, M. Cainzos-Achirica, Stroke in young adults: current trends, opportunities for prevention and pathways forward, Am. J. Preven. Cardiol. 3 (2020), 100085, 10.1016%2Fj.ajpc.2020.100085.
[10] Q. Cui, N.A. Naikoo, Modifiable and non-modifiable risk factors in ischemic stroke: a meta-analysis, Afr. Health Sci. 19 (2) (2019) 2121–2129, 10.4314%2Fahs.v19i2.36.
[11] R.C. Li, W.D. Xu, Y.L. Lei, T. Bao, H.W. Yang, W.X. Huang, H.R. Tang, The risk of stroke and associated risk factors in a health examination population: a cross-sectional study, Medicine 98 (40) (2019), e17218, https://doi.org/10.1097/md.0000000000017218.
[12] N.H. Alkali, S.A. Bwala, A.O. Akano, O. Osi-Ogbu, P. Alabi, O.A. Ayeni, Stroke risk factors, subtypes, and 30-day case fatality in Abuja, Nigeria, Nigerian Med. J. 54 (2) (2013) 129, 10.4103%2F0300-1652.110051.
[13] S.A. Gebremariam, H.S. Yang, Types, risk profiles, and outcomes of stroke patients in a tertiary teaching hospital in northern Ethiopia, ENeurologicalSci 3 (2016) 41–47, https://doi.org/10.1016/j.ensci.2016.02.010.
[14] R.W. Walker, A. Jusabani, E. Aris, W.K. Gray, N. Unwin, M. Swai, G. Alberti, F. Mugusi, Stroke risk factors in an incident population in urban and rural Tanzania: a prospective, community-based, case-control study, Lancet Glob. Health 1 (5) (2013) e282–e288, 10.1016%2FS2214-109X(13)70068-8.
[15] O. Akpa, F.S. Sarfo, M. Owolabi, A. Akpalu, K. Wahab, R. Obiako, M. Komolafe, L. Owolabi, G.O. Osaigbovo, G. Ogbole, H.K. Tiwari, A novel Afrocentric stroke risk assessment score: models from the Siren study, J. Stroke Cerebrovasc. Dis. 30 (10) (2021), 106003, https://doi.org/10.1016/j.jstrokecerebrovasdis.2021.106003.
[16] P. Parmar, R. Krishnamurthi, M.A. Ikram, A. Hofman, S.S. Mirza, Y. Varakin, M. Kravchenko, M. Piradov, A.G. Thrift, B. Norrving, W. Wang, The stroke RiskometerTM app: validation of a data collection tool and stroke risk predictor, Int. J. Stroke 10 (2) (2015) 231–244, https://doi.org/10.1111/ijs.12411.
[17] D. Bos, M.A. Ikram, M.J. Leening, M.K. Ikram, The revised Framingham stroke risk profile in a primary prevention population: the Rotterdam study, Circulation 135 (22) (2017) 2207–2209, https://doi.org/10.1161/circulationaha.117.028429.
[18] C. Dufouil, A. Beiser, L.A. McLure, P.A. Wolf, C. Tzourio, V.J. Howard, A. J. Westwood, J.J. Himali, L. Sullivan, H.J. Aparicio, M. Kelly-Hayes, Revised Framingham stroke risk profile to reflect temporal trends, Circulation 135 (12) (2017) 1145–1159, https://doi.org/10.1161/circulationaha.115.021275.
[19] A. Akpalu, M. Gebregziabher, B. Ovbiagele, F. Sarfo, H. Iheonye, R. Akinyemi, O. Akpa, H.K. Tiwari, D. Arnett, K. Wahab, D. Lackland, Differential impact of risk factors on stroke occurrence among men versus women in West Africa: the SIREN study, Stroke 50 (4) (2019) 820–827, 10.1161%2FSTROKEAHA.118.022786.
[20] L. Jahangiry, M.A. Farhangi, F. Rezaei, Framingham risk score for estimation of 10-years of cardiovascular diseases risk in patients with metabolic syndrome, J. Health Popul. Nutr. 36 (2017) 1–6, https://doi.org/10.1186/s41043-017-0114-0.
[21] H. Lou, Z. Dong, P. Zhang, X. Shao, T. Li, C. Zhao, X. Zhang, P. Lou, Interaction of diabetes and smoking on stroke: a population-based cross-sectional survey in China, BMJ Open 8 (4) (2018), e017706, 10.1136%2Fbmjopen-2017-017706.
[22] Latitude and Longitude Finder, Nnewi, Anambra, Nigeria, Available at, https://www.latlong.net/place/nnewi-anambra-nigeria-24864.html, 2023. Accessed on April 25, 2023.
[23] World Population Review, Nnewi Population 2023, Available at, https://worldpopulationreview.com/world-cities/nnewi-population, 2023. Accessed on 18 January 2023. Accessed on April 25 2023.
[24] F. Faul, E. Erdfelder, A.G. Lang, A. Buchner, G* power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences, Behav. Res. Methods 39 (2) (2007) 175–191, https://doi.org/10.3758/bf03193146.
[25] Vandenbroucke, J.P., Elm, E.V., Altman, D.G., Gøtzsche, P.C., Mulrow, C.D., Pocock, S.J., Poole, C., Schlesselman, J.J., Egger, M. and Strobe Initiative, 2007. Strengthening the reporting of observational studies in epidemiology (STROBE): explanation and elaboration. Ann. Intern. Med., 147(8), pp.W-163. doi:https://doi.org/10.1016/j.ijsu.2014.07.014. Vandenbroucke.
[26] P.A. Wolf, R.B. D'Agostino, A.J. Belanger, W.B. Kamel, Probability of stroke: a risk profile from the Framingham study, Stroke 22 (3) (1991) 312–317, https://doi.org/10.1161/01.str.22.3.312.
[27] J. Hippisley-Cox, C. Coupland, P. Brindle, Derivation and validation of QStroke score for predicting risk of ischaemic stroke in primary care and comparison with other risk scores: a prospective open cohort study, BMJ 346 (2013), https://doi.org/10.1136/bmj.f2573.
[28] L.A. McClure, D.O. Kleindorfer, B.M. Kissela, M. Cushman, E.Z. Soliman, G. Howard, Assessing the performance of the Framingham stroke risk score in the reasons for geographic and racial differences in stroke cohort, Stroke 45 (6) (2014) 1716–1720, https://doi.org/10.1161/strokeaha.114.004915.
[29] P.S. Bavarsad, S. Kheiri, A. Ahmadi, Estimation of the 10-year risk of cardiovascular diseases using the SCORE, WHO/ISH and Framingham models in the Shahrekord cohort study in Southwestern Iran, J. Tehran Univ. Heart Center 15 (3) (2020) 105, https://doi.org/10.18502/jthc.v15i3.4219.
[30] M. Taloyan, et al., Comparison of Framingham 10-year cardiovascular event risks in native and Foerign-born primary healthcare populations in Sweden, BMC Public Health 23 (1) (2020) 543, https://doi.org/10.1186/s12889-023-15449-6.
[31] J.J. Noubiap, E.V. Balti, J.J. Bigna, J.B. Echouffo-Tcheugui, A.P. Kengne, Dyslipidaemia in Africa—comment on a recent systematic review–Authors' reply, Lancet Glob. Health 7 (3) (2019) e308–e309, https://doi.org/10.1016/s2214-109x(18)30517-5.
[32] A. Pirillo, M. Casula, E. Olmastroni, G.D. Norata, A.L. Catapano, Global epidemiology of dyslipidaemias, Nat. Rev. Cardiol. 18 (10) (2021) 689–700, https://doi.org/10.1038/s41569-021-00541-4.
[33] R. Newton, Dyslipidaemia in Africa—comment on a recent systematic review, Lancet Glob. Health 7 (3) (2019), e307, https://doi.org/10.1016/s2214-109x(18)30517-5.
[34] L. Xing, L. Jing, Y. Tian, H. Yan, B. Zhang, Q. Sun, D. Dai, L. Shi, D. Liu, Z. Yang, S. Liu, Epidemiology of dyslipidemia and associated cardiovascular risk factors in Northeast China: a cross-sectional study, Nutr. Metab. Cardiovasc. Dis. 30 (12) (2020) 2262–2270, https://doi.org/10.1016/j.numecd.2020.07.032.
[35] D. Adeloye, A. Auta, A. Fawibe, M. Gadanya, N. Ezeigwe, R.G. Mpazanje, M. T. Dewan, C. Omoyele, W. Alemu, M.O. Harhay, I.F. Adewole, Current prevalence pattern of tobacco smoking in Nigeria: a systematic review and meta-analysis, BMC Public Health 19 (2019) 1–14, https://doi.org/10.1186/s12889-019-8010-8.
[36] T. Dahiru, A.A. Aliyu, A.U. Shehu, A review of population-based studies on diabetes mellitus in Nigeria, Sub-Saharan African J. Med. 3 (2) (2016) 59. https://www.ssajm.org/text.asp?2016/3/2/59/184351.
[37] National Population Commission, N, Final results of 2006 Census, *Official Gazette of 2nd February*, 2009, p. *2009*. https://gazettes.africa/gazettes/ng-government-gazette-dated-2009-02-02-no-2. Accessed on April 25, 2023.
[38] M. Mobasseri, M. Shirmohammadi, T. Amiri, N. Vahed, H.H. Fard, M. Ghojazadeh, Prevalence and incidence of type 1 diabetes in the world: a systematic review and meta-analysis, Health Promot. Perspect. 10 (2) (2020) 98, 10.34172%2Fhpp.2020.18.
[39] K.T. Mills, A. Stefanescu, J. He, The global epidemiology of hypertension, Nat. Rev. Nephrol. 16 (4) (2020) 223–237, https://doi.org/10.1038/s41581-019-0244-2.
[40] M.B. Reitsma, P.J. Kendrick, E. Ababneh, C. Abbafati, M. Abbasi-Kangevari, A. Abdoli, A. Abedi, E.S. Abhilash, D.B. Abila, V. Aboyans, N.M. Abu-Rmeileh, Spatial, temporal, and demographic patterns in prevalence of smoking tobacco use and attributable disease burden in 204 countries and territories, 1990–2019: a systematic analysis from the Global Burden of Disease Study 2019, Lancet 397 (10292) (2021) 2337–2360, https://doi.org/10.1016/s2468-2667(21)00102-x.
[41] World Health Organisation, Global Status Report on Physical Activity 2022, Available at, https://www.who.int/teams/health-promotion/physical-activity/global-status-report-on-physical-activity-2022, 2022. Accessed on April 25 2023.
[42] Statista, Prevalence of Obesity among Adults in Selected Countries as of 2021, or Latest Year Available, by Gender, Available at, https://www.statista.com/statistics/236823/prevalence-of-obesity-among-adults-by-country/?kw=&crmtag=adwords&gclid=EAIaIQobChMI_M-w54nM_gIVyBoGAB3vIgXoEAAYASAAEgKhbPD_BwE, 2021. Accessed on April 25, 2023.
[43] Yang Yang, G. Jin, Y. Yang, L. Chen, Z. Jiang, L. Xie, L. Liu, D. Zeng, Q. Zhan, Z. Zhong, The prevalence of stroke and related factors among residents aged greater than or equal to 40 yeears in Chongqing, SouthWest China, J. Public Health 29 (2020) 1423–1432, https://doi.org/10.1007/s10389-019-01149-2.
[44] W. Xiuyun, W. Qian, X. Minjun, L. Weidong, L. Lizhen, Education and stroke: evidence from epidemiology and Mendelian randomization study, Sci. Rep. 10 (1) (2020) 1–11, https://doi.org/10.1038/s41598-020-78248-8.
[45] C.C. Igbokwe, V.J. Ejeh, O.S. Agbaje, P.I.C. Umoke, C.N. Iweama, E.L. Ozoemena, Prevalence of loneliness and association with depressive and anxiety symptoms among retirees in Northcentral Nigeria: a cross-sectional study, BMC Geriatr. 20 (2020) 1–10, https://doi.org/10.1186/s12877-020-01561-4.
[46] J.M. Ramírez-Moreno, R. Alonso-González, D.P. Pacheco, M.V. Millán-Nuñez, A. Roa-Montero, A.B. Constantino-Silva, J.J. Aguirre-Sánchez, Effect of socioeconomic level on knowledge of stroke in the general population: a social inequality gradient, Neurología (English Edition) 31 (1) (2016) 24–32, https://doi.org/10.1016/j.nrl.2014.06.004.
[47] P. Zhang, X. Sun, H. Jin, F.L. Zhang, Z.N. Guo, Y. Yang, Comparison of the four anthropometric indexes and their association with stroke: a population-based cross-sectional study in Jilin Province, China, Front. Neurol. 10 (2019) 1304, https://doi.org/10.3389/fneur.2019.01304.
[48] X. Su, K. Li, L. Yang, Y. Yang, Y. Gao, Y. Gao, J. Guo, J. Lin, K. Chen, J. Han, L. Liu, Associations between abdominal obesity and the risk of stroke in Chinese older

patients with obstructive sleep apnea: is there an obesity paradox? Front. Aging Neurosci. 14 (2022), 957396, 10.3389%2Ffnagi.2022.957396.