The effect of calf and thigh circumferences in determining brain lesion characteristics in patients with acute stroke: A hospital-based study

Musa Ado Bashir, Anas Ibrahim Yahaya, Mukhtar Muhammad

Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Bayero University Kano, Nigeria

Abstract

The role of stroke risk factors in stroke patterning and differentiation is poorly investigated, especially for measures of body composition. This study aimed to investigate the effect of skinfold thickness, waist and limb circumference measurements in patterning and differentiation of stroke in hospitalized patients. Prospective study of acute stroke patients hospitalized in Aminu Kano Teaching Hospital in Nigeria was conducted in 16 months. Biceps brachii, triceps brachii, suprailiac and subscapular skinfold thickness measurements were taken using Skyndex Research Caliper. Upper arm, waist, thigh, and calf circumferences were taken, using an inelastic measuring tape according to the same standards. The data was analyzed using descriptive statistics, unpaired sample t-test, and Binary logistic regression using SPSS IBM version 20. The results shown that the studied anthropometric parameters, do not only predispose to stroke but tend to determine the specific stroke pathologic type. Thigh circumference predisposes more, and calf circumference predisposes less to ischemic stroke subtype. This means that these studied anthropometric parameters can predict stroke subtype and serve as predisposing factors conclusively.

Introduction

Stroke is a neurological dysfunction resulting from a localized cerebral infarction (Ischemic stroke), or from localized collection of blood in the brain tissue/ventricular system that is not caused by trauma with a rapidly developing clinical signs (Hemorrhagic stroke).[1] Low socioeconomic status is one of the major stroke risk factors because SES strongly associates with modifiable risk factors and stroke burden.[2] In the under-developed countries, one will expect higher incidence and prevalence of stroke, but ironically, there has been a relatively low incidence and prevalence of it in the sub Saharan Africa. However, it is still a major public health problem, with higher mortality than in the developed countries and occurrence at younger age.[3]

The interaction between stroke and its risk factors is not limited to the mere fact of the latter predisposing to the former. For example, risk factors also play a role in stroke differentiation and patterning *i.e.* stroke risk factors do not necessarily predispose to different stroke subtypes in equal measure.[4] As an example, different serum lipids are associated with different stroke subtypes.[5] Similarly, different demographic populations and subpopulations may be more predisposed to one type of stroke due to variations in the genetic makeup[6] or sex. For example, lacunar infarcts were found to be more common in males whereas posterior circulation infarcts are more frequent in females.

Among well known risk factors for stroke are body size and composition, especially the total and percentage body fat mass.[7] The gold standards for measuring body composition are Dual Energy Xray Absorptiometry (DXA), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI).[8]

The goal standards for assessing body composition are however complex and costly. Therefore they serve as validating instruments for cheaper and simpler surrogates of body composition, which include Bioelectric Impedance Analysis (BIA) and anthropometry.[9] Anthropometry is a branch of anthropology, which deals with measurements of different parts of human body. It provides the single most portable, universally applicable, inexpensive, and non-invasive technique for assessing the size, proportions and composition of the human body.[10]

Risk factors for stroke in general have been well-studied,[6] but the relationship of cerebrovascular risk factors to clinical classifications of stroke, however, has poorly been investigated.[11] The role of risk factors in patterning stroke has significant implications as stroke subtypes had different short- and long-term functional outcomes, mortality, and recurrence rates.[12] In addition to patterning of stroke, risk factors play a role in determining functional outcome and mortality. For example, Megherbi *et al.* had shown that stroke in diabetics had a poorer prognosis than in non-diabetics.[13]

Just like other risk factors, anthropometric parameters' interaction with stroke goes beyond mere predisposition. Anthropometric parameters are also known to affect stroke patterning and outcome. For example, a high waist to hip ratio leads more to ischemic than hemorrhagic stroke. It is shown that general and abdominal adiposity increases the risk of total stroke and ischemic stroke but not hemorrhagic stroke.[4] For the influence of anthropometric parameters on stroke outcome, it would be enough to cite the so-called obesity paradox whereby obesity is associated with decreased mortality after both stroke and heart failure.[14]

This research studies the independent role of thigh and calf circumference measures in determining brain lesion characteristics in stroke.

Correspondence: Musa Ado Bashir, Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Bayero University Kano, Nigeria.
Tel.: +2347036878467
E-mail: musabashir34@gmail.com

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Materials and Methods

This was cross sectional, prospective correlational study and was conducted in Aminu Kano Teaching Hospital between July 2016 to November 2017. Subjects were all stroke patients admitted to the neurology unit of the medical ward of Aminu Kano Teaching Hospital. Ethical clearance was sought and gotten from the ethical commitee of Aminu Kano Teaching Hospital and informed consent from the patients and/or their relatives

All measurements were taken according to International Standards for Anthropometric Assessment (ISAK, 2001), and were taken on the right side of the body. Skinfold measurements were taken in millimeters using Skyndex Reserarch Caliper (Figure 1). A non-elastic tape measure was used in measuring girths (to the nearest 0.1 centimeters).

Skinfold measurements were taken at four anatomical sites-biceps, triceps, subscapular, supra-iliac region. The thickness of the double layer of skin and subcutaneous tissue were recorded directly from caliper dial and recorded to the nearest 0.1 millimeters (mm) within 2-5 seconds after applying the full force of caliper.

The landmark for the measurement of the waist circumference was the midpoint between the lowest ribs and the iliac crest.[15-17]

The girth of the thigh was taken 1 cm below the level of the gluteal fold,[18] perpendicular to the long axis of the thigh. Calf circumference was measured at the point of greatest circumference.[19] Arm circumference was recorded at midpoint between the tip of acromion and the olecranon process of the ulna.[20]

Information regarding the type (ischemic or hemorrhagic) and site (right or left hemispheric, cortical or subcortical) of the infarct was accessed from the hospital radiologist' report. A specially designed form was used to record the patients' name, hospital number, age, sex, and educational level as well as smoking, dietary and drinking habits. Information on hypertension, diabetes and dyslipidemias was gotten from the patients' clinical records.

The data was summarized using frequencies and percentages for qualitative variables and means and standard deviations for quantitative variables. Differences in anthropometric parameters between sexes, age groups and stroke subtype groups were subjected to unpaired sample t-test.

Infarcts were divided into dichotomous groups, *i.e.* ischemic and hemorrhagic, right and left and cortical and subcortical. Binary logistic regression models were then developed with the infarct type as the dependent variable and the anthropometric parameters and other variates as independent variables.

SPSS 20 was used for the analyses. Confidence interval was set at 95% and level of significance at $p<0.05$.

Results

The intra-observer variability was assessed using Pearson correlation between two readings taken by the researcher on the same day. The Pearson Correlation Coefficient was in the range 78-96%. The interobserver variability was also assessed by correlating measurements made by the researcher and a clinician and ranged from 75-99%.

Three hundred and seven (307) patients had their measurements and other data analyzed. The Mean age was 57 years with a minimum of 38 years and the maximum of 90 years. Sixty two percent (62%) of the patients were males and 38% were females. About 70% of the patients had a form of formal education with about 30% having only Quranic education. 85% of the patients had ischemic stroke with 15% having hemorrhagic stroke. The proportions for left- and right-sided strokes were 54% and 46% respectively. 72% had cortical lesions with 28% having lesion below the cortex. The proportion of patients with hypertension, diabetes and dyslipidemia were 72%, 49.8% and 78% respectively. 65.5% reported smoking cigarettes and only about 4% reported ingesting alcohol. The prevalence of abdominal adiposity for women and men were 30% and 31% respectively (Table 1).

Patients with ischemic stroke had mean arm circumference (1.2cm) significantly higher than in those with hemorrhagic stroke ($t_{=2.274}$ df=305, P=0.024). They also had mean thigh circumference (1.3cm) significantly higher than in those with hemorrhagic stroke ($t_{=1.994,}$ df=305, P=0.047). No significant difference was found in the means of all other anthropometrics measured between ischemic and hemorrhagic stroke groups (Table 2).

Figure 1. Skyndex reserach caliper.

Table 1. Characteristics of the patients.

Variable	Groups	Frequency	Percentage
Education	Primary or Secondary	111	36.2
	Quranic Education	94	30.6
	Tertiary Education	102	33.2
Stroke Type	Hemorrhagic Stroke	46	15.0
	Ischemic Stroke	261	85.0
Stroke Side	Left-sided Lesion	167	54.4
	Right-sided Lesion	140	45.6
Stroke Level	Lesion Below the Cortex	87	28.3
	Cortical Lesion	220	71.7
Hypertension	No	86	28.0
	Yes	221	72.0
Diabetes	No	154	50.2
	Yes	153	49.8
Dyslipidemia	No	67	21.8
	Yes	240	78.2
Smoking	No	201	65.5
	Yes	106	34.5
Alcohol	No	296	96.4
	Yes	11	3.6
Abdominal	non-obese female	27	8.8
	obese female	91	29.6
Adiposity	non-obese male	94	30.6
	obese male	95	30.9

A logistic regression model was fitted with stroke subtype as the dependent variable and anthropometric parameters and other cardiovascular risk factors as independent variables. This model has significantly lower -2 Log likelihood than the null model without coefficients (X^2=50.071 df=6 p value<0.001) and explains 26% of the variation in the odds of the dependent variable (Nagelkerke R Square=0.264). Hosmer and Lemeshow Test revealed the model is a good fit for the data (X^2=8.507 df=8 p value=0.386). Table 3 shows the model coefficients and their significance. A 1-Standard Deviation increase in thigh circumference increases the odds of having ischemic stroke by about 120% (X^2=0.142, df=1, p value=0.029). A 1-Standard Deviation increase on calf circumference on the other hand decreases the odds of having ischemic stroke by 85% (X^2=-0.167, df=1, p value=0.041). Non-hypertensives are about 3 times more likely than hypertensives to have ischemic stroke. Diabetics are about 4 times more likely than non-diabetics to have ischemic stroke (X^2=1.307, df=1, p value=0.001). Dyslipidemic patients are 3 times more likely than non-dyslipidemic patients to have ischemic stroke (X^2=1.229, df=1, p value=0.001). Non-smokers are about 3 times more likely than smokers to have ischemic stroke (X^2=1.056,df=1, p value=0.003).

Discussion

The mean age of the respondents in this study (57 years) was similar to what was found in the neurology outpatients attending two other hospitals in Kano, Murtala Muhammad Specialist Hospital and Muhammad Abdullahi Wase Specialist Hospital.[21] The sex proportion of the subjects was similar to the proportion of males and females in a study conducted in stroke patients in Aminu Kano Teaching Hospital.[22]

The preponderance of ischemic stroke is higher than what was found in the same hospital but in young adults with stroke. However, similar high proportion of ischemic stroke was found in a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee.[23]

The prevalence of hypertension, smoking and alcohol intake were similar to what were obtained by Owolabi and Ibrahim in Kano[22] but the prevalence of diabetes and dyslipidemia were found to be much higher. This can be explained by the fact that Owolabi and Ibrahim focused on a younger age population of stroke patients. The prevalence of abdominal adiposity for women and men in this study (30% and 31% respectively) is similar to was found in two population based studies in Ogbomoso, south-west Nigeria[24] and Okrika, Rivers State south-south Nigeria.[25] But it is higher in another population-based study Abia State south-east Nigeria[26] and a hospital based study in the same region.[27]

Patients with ischemic stroke had mean arm circumference 1.2cm significantly higher than in those with hemorrhagic stroke. However, this relationship disappears in the logistic regression equation as the effects of other variates were controlled. This suggests the arm circumference effect in determining stroke type is not independent; it is probably through its relationship with diabetes. Ischemic stroke patients also had mean thigh circumference 1.3cm signif-

Table 2. Comparison of anthropometrics between ischemic and hemorrhagic stroke types.

Parameter	Stroke type	N	Mean (cm)	Mean difference (cm)	T	P
Triceps skinfold	Ischemic Hemorrhagic	261 46	11.126 10.872	0.2543	0.431	0.666
Biceps skinfold	Ischemic Hemorrhagic	261 46	8.115 8.126	-0.0111	-0.023	0.981
Subscapular skinfold	Ischemic Stroke Hemorrhagic	261 46	16.068 15.389	0.6791	0.736	0.462
Suprailiac skinfold	Ischemic Hemorrhagic stroke	261 46	13.517 12.826	0.6908	1.238	0.220
Arm circumference	Ischemic Stroke Hemorrhagic stroke	261 46	28.744 27.496	1.2488	2.274	0.024**
Waist circumference	Ischemic Stroke Hemorrhagic stroke	261 46	100.811 98.687	2.1242	1.005	0.315
Thigh circumference	Ischemic Stroke Hemorrhagic stroke	261 46	51.850 50.539	1.3111	1.994	0.047**
Calf circumference	Ischemic Stroke Hemorrhagic stroke	261 46	30.970 30.835	0.1349	0.260	0.795

**. Correlation is significant at <0.05 level (2-tailed).

Table 3. Significance of the variables in the model for predicting the odds of ischemic stroke subtype.

Variable	B	Wald	Df	Sig.	Exp(B)
TC	0.142	4.796	1	0.029	1.152
CC	-0.167	4.156	1	0.041	0.846
Non-hypertensives	1.076	4.199	1	0.040	2.934
Non-diabetics	-1.307	10.805	1	0.001	0.271
Non-dyslipidemic	-1.229	11.033	1	0.001	0.293
Non-smokers	1.056	8.661	1	0.003	2.876
Constant	0.010	0.000	1	0.997	1.010

TC = Thigh circumference, CC = Calf circumference, Correlation significant at p value <0.05.

icantly higher than in those with hemorrhagic stroke. This relationship persists even after controlling for diabetes, smoking and hypertension in the logistic regression model. A 1-Standard Deviation increase in thigh circumference increases the odds of having ischemic stroke by about 120%. This is through the role of thigh circumference as a measure of adiposity, a well-known risk factor for ischemic stroke.[28] A 1-Standard Deviation increase on calf circumference on the other hand decreases the odds of having ischemic stroke by 85%. This is probably through the role of calf circumference in reducing the frequency of carotid plaques as demonstrated.[29] It has been suggested that this might be due to the anti-atherogenic effect of peripheral fat.[30]

Conclusions

This study has been able to determine that anthropometrics, like other stroke risk factors, do not only predispose to stroke but tend to determine the specific stroke pathologic type. Thigh circumference predisposes more, and calf circumference predisposes less to ischemic than hemorrhagic stroke subtype.

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