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Association Between Anthropometric Measures of Adiposity and Cardiovascular Risk Factors in Hospitalized Stroke Patients

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Abstract
Clustering of cardiovascular risks was known to occur around measures of central adiposity such as waist circumference whereas measures of peripheral adiposity such as calf circumference were known to be anti-athrogenic. The aim of this study is to determine the relationship between anthropometric measures of adiposity and cardiovascular risk factors in hospitalized patients with acute stroke. This is a cross-sectional correlational study of acute stroke patients hospitalized in Aminu Kano Teaching Hospital Kano, Nigeria. Biceps, triceps, suprailiac and subscapular skinfold thickness measurements were taken, to the nearest 0.1mm, using Skyndex Research Caliper according toInternational Standards for Anthropometric Assessment. Inelastic tape was used to measure waist Circumference (WC), thigh circumference (TC), calf circumference (CC) and arm circumference (AC)using same standards. The data were summarized using frequencies and percentages for qualitative variables, and means and standard deviations for quantitative variables. Differences in anthropometric parameters between sexes, cardiovascular risk and stroke subtype groups were subjected to unpaired t-test; all using SPSS version 20.0, p value of less than 0.05 was considered significant. This study found that subcutaneous, central and peripheral adiposity measures correlate positively with diabetes and dyslipidemia, whereas subcutaneous measures of adiposity correlate negatively with hypertension.

Keywords: Adiposity measures, Diabetes, Dyslipidemia Hypertension, Stroke

INTRODUCTION
The most prominent causes of death are vascular in nature, and stroke is currently the second leading cause of death worldwide with the ischemic heart disease and stroke together accounting for about 15.2 million deaths in 2015 (Feigin *et al*., 2017).

Waist Circumference is a measure of visceral fat deposit (Goh *et al.,* 2014). The National Cholesterol Education Programme Adult Treatment Panel III (NCEP ATP III 2001) regards WC>88cm as central obesity for females and >102cm for males. A population-based study in south west Nigeria established WC as a good predictor of cardiovascular risk factors such as hypertension and diabetes (Taiwo *et al.,* 2015**).** In another population-based study, visceral adipose tissue was negatively associated with peripheral insulin sensitivity (Francesca *et al.*,2012)

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In contrast to this clustering of measures of central adiposity with cardiovascular risk factors, Tanko *et al (*2003) established anti-atherogenic effect of peripheral fat. Peripheral adiposity measures, such as calf circumference, were found to be inversely related with the occurrence of carotid plaques suggesting anti-atherogenic effect of large calf circumference (Ste´phanie *et al.,* 2008).

This study aims to investigate the association association between anthropometric measures of adiposity and cardiovascular risk factors in stroke patients.

ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the ethical commitee of Aminu Kano Teaching Hospital (Certificate Number: NHREC/21/08/2008/AKTH/EC/1690) and informed consent from the patients and/or their relatives

METHODOLOGY

The study was cross-sectional prospective correlational study conducted in Aminu Kano Teaching Hospital which is a tertiary health center in Kano State, Nigeria. The study subjects were 307 patients admitted to the neurology unit of the medical ward of Aminu Kano Teaching Hospital during the course of the study (July 2016 to November 2017).
Patients admitted with acute stroke and whose relatives gave informed consentwere included in the study, while those with restroke or massive peripheral edema were excluded.

Skinfold measurements were taken in millimeters using Skyndex Research Caliper (Caldwell, Justiss and Company, inc. Fayetteville, Arkansas USA), a digital caliper which gives similar values to Harpenden caliper when used to measure skinfold thickness in the range 4 to 45mm (Schmidt and Carter, 1990).Skinfoldmeasurements were taken at four anatomical sites-biceps, triceps, sub-scapular, 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 *(*Norton *et al.*,2001*)*.

A non-elastic tape measure (MEDLINE, 1-800-Medline, USA) was used in measuring girths (to the nearest 0.1 centimeters).The landmark for the measurement of the waist circumference was the midpoint between the lowest ribs and the iliac crest as recommended by WHO (WHO,2000). Measurement was made at the end of expiration with the patient's hands by the sides and feet together. This was modified for those who cannot stand as the measurement was then taken with patient in supine position.

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

Data were summarized using frequencies, percentages, means and standard deviations. Differences in anthropometric parameters between sexes and cardiovascular risk groups were subjected to unpaired t-test. IBM SPSS version 20.0 was used for the analyses. P value of less than 0.05.was considered significant. The Pearson's correlation for intra-observer and inter-observer measurements were in the range 78-96% and 78-92% respectively.

RESULTS

Three hundred and seven (307) patients had their measurements and other data analyzed. Mean age was 57 (±10.7)years. The minimum age of the patients was 38 years and the maximum was 90 years. Sixty two percent (62%) of the patients were males and 38% were females. Table 1 shows the characteristics of the study subjects. Majority (85%) of the patients had ischemic stroke with 15% having hemorrhagic stroke. The proportion of patients with hypertension, diabetes and dyslipidemia were 72%, 49.8% and 78% respectively. Majority (65.5%) reported smoking cigarettes and only about 4% reported ingesting alcohol. The total prevalence of abdominal adiposity among the subjects was 60.6%; the prevalence for women and men were 77.1% and 51.9% respectively.

Table 1: Characteristics of the Subjects

Variable	Group	Frequency (%)
Stroke type	Ischemic	46 (15.0)
	Hemorrhagic	261 (85.0)
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)
Abdominal adiposity	Non-obese female	27 (22.9)
	Obese female	91 (77.1)
	Non-obese male	94 (48.1)
	Obese male	95 (51.9)
	Total non-obese	121 (39.4)
	Total obese	186 (60.6)

Table 2 shows comparison of anthropometrics across gender and cardiovascular risk groups. Mean biceps skinfold thickness is significantly higher by 7mm in females. The mean thigh circumference in males was 1.2cm significantly higher and mean calf circumference 8mm significantly higher in males. No significant difference was found between the two sexes in other anthropometrics measured.

Non-hypertensives have a mean biceps and suprailiac skinfold thickness significantly higher than those with hypertension. Non-hypertensives also have mean waist circumference 3cm significantly higher than those with hypertension. There was no significant difference in other anthropometrics between those with and without hypertension.

Table 2 Comparison of Anthropometrics across Gender and Cardiovascular Risk Groups

Parameter	HTN vs Non-HTN		DM vs Non-DM		DL vs Non-DL		Male vs Female	
	T	*P* value	T	*P* value	T	*P* value	t	*P* value
TSF	-1.398	0.163	3.423	<0.001**	1.092	0.276	-0.408	0.683
BSF	-2.072	0.039**	3.598	<0.001**	1.525	0.128	-2.013	0.045**
SSF	-0.988	0.325	3.033	<0.003**	0.928	0.354	-0.048	0.962
SIS	-2.138	0.033**	4.117	<0.001**	1.72	0.087	-1.713	0.088
AC	-0.572	0.568	3.426	<0.001**	1.936	0.054	0.351	0.726
WC	-2.309	0.022**	4.586	<0.001**	2.686	0.008	176.32	0.3091
TC	-0.91	0.364	4.077	<0.001**	1.504	0.133	2.516	0.012**
CC	-0.714	0.476	4.214	<0.001**	0.638	0.524	2.039	0.042**

TSF = triceps skinfold thickness, BSF = biceps skinfold thickness, SSF = subscapular skinfold thickness, SIS = suprailiac skinfold thickness, AC = arm circumference, WC = waist circumference, TC = thigh circumference, CC = calf circumference, vs = versus, t = test value

**p vaues significant at <0.05

From the result of the present study it was found that diabetic patients had significantly higher mean in all the anthropometrics measured.

Dyslipidemic patients had mean waist circumference about 5cm significantly higher than non-dyslipidemic patients. No significant difference was found between means of all other anthropometrics measured.

Table 3 shows association between abdominal obesity and other cardiovascular risk factors. Abdominal obesity was found to be significantly associated with diagnosis of diabetes. Female centrally obese patients are more than four times more likely than non-obese females to be diabetic (OR=4.4, X^2 =1.885 p=0.001). Male patients with central obesity are twice as likely as non-obese males to be diabetic (OR=2.0, X^2 =1.885, p=0.001). No significant association was found between abdominal obesity and diagnosis of hypertension and dyslipidemia.

Table 3 Association of Abdominal obesity with other Cardiovascular Risk Factors

Clinical Risk Factor	Abdominal Adiposity	NO n(%)	YESn(%)	X^2	*P*-value
Diabetes	non-obese female	22(78)	6(21)	1.885	0.001
	obese female	41(46)	49(54)		
	non-obese male	54(57)	41(43)		
	obese male	37(39)	57(61)		
Dyslipidemia	non-obese female	8(29)	20(71)	1.994	0.584
	obese female	16(18)	74(82)		
	non-obese male	23(24)	72(76)		
	obese male	20(21)	74(79)		
Hypertension	non-obese female	5(18)	23(82)	6.212	0.102
	obese female	26(29)	64(71)		
	non-obese male	21(22)	74(78)		
	obese male	34(36)	60(64)		

DISCUSSION

The mean age of the respondents in this study (57 ±10.7 years) is 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 (Bashir *et al*., 2017). The sex proportion of the subjects is similar to the proportion of males and females in a study conducted in stroke patients in Aminu Kano Teaching Hospital (Owolabi, 2010).

The mean waist circumference in this study is comparable to what was found in hospital based studies of stroke patients in India (Hingorani *et al*., 2017), Maiduguri, Nigeria (Onabajo *et al*., 2017) and Kano, Nigeria (Fatai *et al*., 2011). The similarity in the findings in Maiduguri and Kano, both in Nigeria, might be due to racial similarity between the two populations. However, the mean waist circumference in this study is higher than what Choo *et al* (2009) found in a hospital based study in Malaysia. This may be due racial differences in anthropometric measurements.

The proportion of male and female patients with abnormal waist circumference in this study is significantly higher than what Onabajo *et al* (2017) found in a hospital based study in Maiduguri. The high prevalence of abnormal waist circumference is explained by the high prevalence of ischeamic stroke subtype in this study, as the two were found to be strongly associated with each other (Anxin *et al.,* 2012).

The high preponderance of ischemic stroke in this study is similar to the higher proportion of ischemic stroke found in a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee (Lloyd-Jones *et al.,* 2009). However, such a preponderance of ischaemic stroke is lower than what was found in hospital based studies in rural southwestern Nigeria (Desalu *et al*., 2011), Rivers State Nigeria (Onwuchewa *et al*., 2009), Aminu Kano Teaching Hospital, Kano Nigeria (Owolabi *et al*., 2010) and Ogun State Nigeria (Ogun *et al.,* 2005). The lower proportion of ischaemic stroke and higher proportion of hemorrhagic stroke in these other studies might be related to higher prevalence of hypertension in their subjects. Hypertension had long been associated with higher proportion of hemorrhagic stroke type in Africans and persons of African descent (Klaus *et al*., 2009). However, other explanations of the disparity between prevalence of stroke subtypes in this study and what others reported lie in methodology. Ogun *et al (*2005) relied on clinical assessment to identify stroke subtypes whereas this study relied on radiologist report of brain computed tomography. Owolabi and Ibrahim (2010) studied stroke in a much younger population in whom non-ischaemic strokes are known to be higher.

The diabetic patients had significantly higher mean in all the anthropometrics measured. This is probably because the anthropometrics are measures of adiposity, known to be higher in diabetics than in non-diabetics (Pandurang *et al.,* 2015).

Dyslipidemic patients have significantly higher mean waist circumference than non-dyslipidemic patients. This may be due to the well-known association between abdominal adiposity, which waist circumference measures, and cardiometabolic abnormalities (Iloh *et al.,* 2012). However, when waist circumference was categorized as obese and non-obese according to NCEP ATP III for males and females, this relationship disappears in this study. The males were found to have higher peripheral body fat as measured by thigh and calf circumferences than females. This is in contradiction to the well-known tendency for males to have higher peripheral body fat as demonstrated by Rattarasarn *et al* (2004). The reason for this may be due to the fact that healthy women with higher peripheral body fat are less likely to have stroke and are thus under-represented in this study of hospitalized stroke patients.

Non-hypertensive stroke patients were found to have higher adiposity as measured by biceps and suprascapular skinfold thickness as well as waist circumference. The negative correlation between diagnosis of hypertension and waist circumference disappears when the latter is expressed as a categorical variable of normal and abnormal according to NCEP ATP III criteria. This means stroke patient with higher subcutaneous fat are less likely to be hypertensive.

CONCLUSION

In this study, female stroke patients were found to have lower values of measures of peripheral adiposity probably because females with healthier fat phenotype are less likely to have stroke and are thus under-represented in the study. Stroke patients with dyslipidemia and diabetes were found to have higher values of measures of adiposity. Stroke patients without hypertension were found to have higher values of measures of subcutaneous adiposity than hypertensive stroke patients.

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