Body Adiposity Phenotypes among Patients with Hypertension, Diabetes Mellitus or their Co-Morbidity in the Metropolis of Kano State, Nigeria

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Abstract
Excessive accumulation of adipose tissue in the body is tightly linked with cardio-metabolic derangements exemplified by hypertension and diabetes. Compartmental adipose tissue aggregation has currently received great attention from investigators. Beyond total absolute fat collection, adiposity phenotypes greatly influence the pattern of cardio-metabolic risk predisposition. This pattern shows wide ethnic and racial variation. The aim of the present study was to determine for Hausa ethnic group in Kano metropolis, the distribution of various adiposity phenotypes among subjects with essential hypertension, type 2 diabetes mellitus or their co-morbidity. The study was a cross sectional study and systematic random sampling technique was used to select 405subjects with a mean age of 53.39 years. Heights, weight, waist circumference (WC), hip circumference, body mass index (BMI), waist-to-hip ratio (WHR), were obtained using standard protocol. Subjects were categorized into hypertensive, diabetics or hypertensive-diabetics based on clinical diagnosis using patient case notes. Data were described using mean and SEM and simple percentages were used to compare the pattern and prevalence of the various adiposity phenotypes among the subgroups. The results showed that truncal adiposity defined by waist-to-hip ratio (WHR) was the commonest adiposity trend in all the subgroups. It was highest in male diabetics (66.7%) and in females, it highest value was also in female diabetic (47.8%). This was followed by truncal adiposity defined by waist circumference (WC). Generalized adiposity defined by body mass index (BMI) showed the least common trend in both sexes and in all disease subgroups.

Key words: Adiposity phenotypes, hypertension, diabetes, hypertension-diabetes co-morbidity, Kano.

INTRODUCTION
The clustering of cardio-metabolic risk factors among subjects with hypertension, diabetes or their co-morbidity has been tightly linked with higher prevalence of excessive adipose tissue accumulation in such individuals (Wajchenberg, 2000; Shao *et al*., 2010; Owolabi *et al*., 2016). This is widely attributed to the role of adipose tissue in insulin resistance (Després and Lemieux, 2006; Després*et al*., 2008) which is the major pathophysiological link between

adiposity and metabolic derangement (Despré*set al.,* 2008). Adiposity, which refers to body fat content may be distributed throughout the body (generalized adiposity) or may be preferentially accumulated in the central region of the body (truncal or central adiposity). While generalized adiposity is measured anthropometrically by the Quetelet index popularly known as body mass index (BMI), central adiposity is measured by tools such as WC, HC and WHR. Although both total (Pischon *et al.,* 2008; MacKay *et al.,* 2009) and compartmental (Adiels *et al.*, 2008; Korenbla t*et al.,* 2008) adipose tissue are implicated, recent and robust evidences point toward the unique role of truncal fat collection as compared to generalized adiposity in many populations of different ethnic and racial lineage(Andreas *et al.*, 2013; Mbanya *et al.,* 2015). This findings form the basis for the current hypothesis that visceral adiposity, a strong correlate of truncal adiposity is the hallmark of metabolic syndrome phenotype (Bays,2011). The wide ethnic and racial variation in the pattern and distribution of the various adiposity indices in different metabolic disease state suggest that ethnicity plays a key role in the interrelationship between adiposity indices and cardio-metabolic diseases. The present study was driven by the hypothesis that adiposity trend differs among hypertensives, diabetics and subjects with their co-morbidity. The aim of this study was therefore to determine for Hausa ethnic group in Kano metropolis, the adiposity pattern in subjects with essential hypertension, type 2 diabetes mellitus and those with hypertension-diabetes co-morbidity. The findings of the study may provide information helpful in categorizing obese individuals based on disease susceptibility to hypertension, diabetes or both hypertension and diabetes.

MATERIALS AND METHODS

Systematic random sampling technique was employed in selecting 405 subjects Hausas of Kano based on a history of at least two parental generation being Hausas from Kano. Participants were recruited from medical outpatient unit of Murtala Muhammad specialist Hospital which is located in the metropolis of Kano city using systematic random sampling technique. Subjects were grouped into 3 categories of hypertensive, diabetic and hypertensive-diabetics based on the clinical diagnosis documented in the patient case notes. The study included only subjects in the age range of 18 years to 65 years. Subjects with pregnancy, abdominal or pelvic space occupying lesions, congenital and/or acquired spinal deformity were however excluded. Ethical approval was obtained from Kano state hospitals management board and written informed consent obtained from the subjects. Height was measured to the nearest 0.1cm as the vertical distance between the standing surface and the vertex of the head while the subject was standing erect in the frank forth plane and without shoes using a stadiometer. The weight was measured in kilograms using a digital weighing scale while the subject is in light clothes. The body mass index was be calculated by dividing the weight in kilograms by the square of the height in meters and the result expressed in kg/m^2. Waist circumference was measured in centimeter with a non- stretchable plastic tape horizontally placed over the unclothed abdomen at the narrowest point between the lowest rib and the iliac crest. The hip circumference was measured while the subject was standing erect with the feet fairly close together; pockets emptied and the tape passed around the point with the maximum circumference over the bottom. WC was divided by the HC to obtain waist-hip ratio (WHR). Data were described using mean and SEM and simple percentages were used to compare the pattern and prevalence of the various adiposity phenotypes among the subgroups.

RESULTS

A total of 405 subjects were studied, 190 males (47%) and 215 females (53%). Table 1 shows descriptive statistics for age, anthropometric indices of central and generalized adiposity of participants.

Table 1: Descriptive statistics for age and athropometric parameters of male participants (n= 190)

Variables	Mean	Range	Minimum	Maximum	SEM
Age (years)	56.89	33.00	36.00	69.00	0.47
Weight (kg)	68.13	59.20	46.60	105.80	0.82
Height (cm)	167.13	47.30	141.80	189.10	0.62
BMI (kg/m^2)	24.41	18.06	17.21	35.27	0.27
WC (cm)	90.60	47.10	65.90	113.00	0.83
W/H ratio	0.99	1.03	0.10	1.13	0.00

BMI: body mass index, WC; waist circumference, WHR waist to hip ratio, SEM; standard error of mean

Table 2 shows descriptive statistics for age, anthropometric indices of central and generalized adiposity of female participants.

Table 2: Descriptive statistics for age and athropometric parameters of female participants (n= 215)

Variables	Mean	Minimum	Maximum	Range	SEM
Age (years)	50.29	36.00	69.00	28.00	0.43
Weight (kg)	70.57	46.60	105.80	71.00	0.98
Height (cm)	159.99	141.80	189.10	42.00	0.52
BMI (kg/m^2)	27.52	17.21	35.27	27.00	0.34
WC (cm)	92.97	65.90	113.00	48.00	0.81
W/H ratio	0.94	0.10	1.13	0.38	0.00

BMI: body mass index, WC; waist circumference, WHR waist to hip ratio, SEM; standard error of mean

Table 3: Distribution of obesity markers using BMI, WC and WHR in the general study population

	Male			Female		
Diseases sub group	BMI	WC	W/R	BMI	WC	W/R
Hypertensive	16%	28%	56%	18.7%	37%	44.3%
Diabetic	0%	33.3%	66.6%	17.9%	34.3%	47.8%
Hypertensive-Diabetic	12%	29.3%	58.6%	15.9%	40.2%	43.9%

BMI: body mass index, WC; waist circumference, WHR; waist to hip ratio.

From Table 4 and Table 5 showing the distribution of adiposity indices (BMI, WC and WHR) among male and female participants, in female hypertensive, the prevalence of generalized obesity using BMI was 18.7% while in male hypertensive it was 16%. The BMI of the female diabetes showed a generalized obesity prevalence of 17.9% while for male diabetics generalized obesity was 0%.Prevalence of generalized obesity in female subject with co-existence of hypertension and diabetes was 15.9% while in co morbid male clients generalized obesity was 12%. For hypertensive male and female clients truncal obesity prevalence was 28% and 37% respectively using waist circumference. In the diabetic clients truncal obesity prevalence using waist circumference was 34.3% and 33.3% in females and males respectively.Truncal obesity prevalence using WC in co morbid females was 40.2% while in co morbid males it was 29.3%. Truncal obesity prevalence by W/H ratio in female with co morbidity was 43.9%. The prevalence of truncal obesity using waist to hip ratio in hypertensive clients was 44.3% in females and 56% in males. Truncal obesity using W/H ratio was 66.6% in diabetic male clients while in diabetic female clients it was 47.8%. For clients with hypertension-diabetes co morbidity, the prevalence of truncal obesity using waist to hip ratio was 58.6% and 43.9% in males and females respectively.

Table 4: Distribution of obesity markers using BMI, WC and WHR in male subjects

Metabolic disorder (n)	BMI	WC	WHR ratio	Total Frequency
Hypertensive (96)	8 (16%)	14 (28%)	28 (56%)	50
Diabetes (22)	None (0%)	4 (33.3%)	8 (66.6%)	12
Hypertensive-diabetes (72)	9 (12%)	22 (29.3%)	44 (58.6%)	75
Total (n) = 190	17	40	80	137

BMI: body mass index, WC; waist circumference, WHR; waist to hip ratio.

Table 5: Distribution of obesity markers using BMI, WC and WHR in female subjects

Metabolic disorder (n)	BMI	WC	WHR	Total Frequency
Hypertensive (137)	41 (18.7%)	81 (37%)	97 (44.3%)	219
Diabetics (36)	12 (17.9%)	23 (34.3%)	32 (47.8%)	67
Hypertensive-diabetic (42)	13 (15.9%)	33 (40.2%)	36 (43.9%)	82
Total (n) = 215	66	137	165	368

BMI: body mass index, WC; waist circumference, WHR; waist to hip ratio.

From Fig. 1 showing the adiposity pattern among the study subjects, truncal obesity measured by waist-to-hip ratio was the commonest form of obesity among hypertensive subjects with frequency of 24.7%, followed by truncal obesity using waist circumference with frequency of 18.8%. Generalized obesity was least common with frequency of 9.6%. Measurement of waist to hip ratio of the diabetic group of clients showed truncal obesity to be the commonest form of obesity with frequency of 7.9%, followed by truncal obesity using waist circumference with frequency of 5.3%. Generalized obesity using BMI showed a frequency of 2.3%. Truncal obesity using waist-to-hip ratio was the most common among subjects with hypertension-diabetes co-morbidity, having a frequency 15.2%, while truncal obesity by waist circumference measurement had a frequency of 10.9% and generalized obesity had 4.3%.

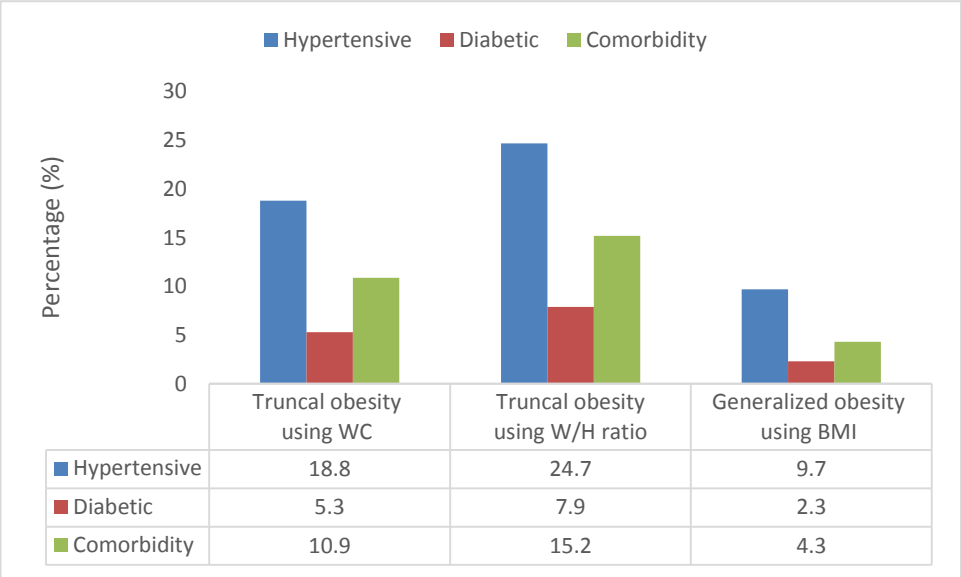

Figure 1: Pattern of obesity among hypertensive, diabetic and hypertension-diabetes co morbidity subjects

DISCUSSION

The values of generalized obesity prevalence in this study are slightly higher than those obtained by Taiwo *et al.*(2015) who conducted a study to determine the prevalence of obesity as well as its predictors in a rural south western Nigeria and estimated obesity prevalence to be 10%. The finding of this study is also higher than a reported prevalence of 2% for obesity in a southern Nigerian community (Oladapo *et al.,* 2010). It is also higher than a reported prevalence of 4.3% from rural northern Nigeria by (Adediran *et al.,* 2012). It is however similar to the findings of (Ahaneku *et al.,* 2011) who reported generalized obesity prevalence of between 11.7% and 13.3% in a rural community in south eastern Nigeria. Even though the result of this study shows obesity rates to be higher than many studies in Nigeria, it is closer to the findings of Kolawole *et al.*(2011) which showed a prevalence of 21% for generalized obesity in a northern Nigerian community, but much lower than reported prevalence from some other parts of the world. For example the obesity levels (BMI>30 kg/m2) range from below 5%collectively in China, Japan, India, Indonesia and certain African nations to over 75% in Samoa and Nauru (WHO, 2012). The wide variation in the global and local prevalence may be explained by genetic, environmental and socio cultural differences. And this may further explain the relative similarity in the obesity prevalence obtained from this study and that of Kolawole *et al.*(2011) conducted in northern Nigeria. However contrary to the findings of some researchers which show a high prevalence of generalized obesity in diabetics (WHO, 1995; Haslam and James, 2005; Victor *et al.,* 2014) its prevalence in male diabetics according to this study is 0%. This may either be due to relatively fewer number of male diabetics (only 22 subjects) recruited for this study or a pointer to the metabolic insignificance of generalized adiposity in the pathogenesis of type 2 diabetes mellitus in the male diabetics of Kano metropolis. Also the close values of the prevalence of generalized obesity using BMI in this study with those obtained from by the same index in many populations including Nigeria (Kolawole *et al.,* 2011) may suggest that BMI alone either plays minimal role in the risk of occurrence of these diseases or at least needs other factors with which it must interplay. However, the observation that among the female diabetics (36 subjects), a generalized obesity prevalence of 17.9% was obtained supports the reason of low sample size proportion for the unusually low prevalence of generalized obesity in male diabetics.

Overall the prevalence rates for Truncal obesity obtained in this study using both indices is higher than obtained from the general populace (community prevalence) according to literature. For example in 2011 an anthropometric study conducted in Kayseri, Turkey revealed the prevalence of truncal obesity to be 29.9% using waist-to-hip ratio as the obesity index and 50.4% using waist circumference (Sahin *et al.*,2011). A cross sectional observational study conducted among Indians to determine the prevalence of obesity by various markers showed a truncal obesity prevalence to be 16.4% using waist circumference (Pengpida and Peltzer, 2014).About 50% of men and 70% of women in the United States now exceed the waist circumference threshold for central obesity (Li *et al.*, 2007). A demographic health survey conducted in South Africa shows that about 10% of its population have isolated central obesity of which 9% were living with a metabolic problem attributable to hyperlipidemia (SADHS, 2003). Prevalence of abdominal obesity in southern Nigerian population was 21.75% by WHR. In men and women, it was 3.2% and 39.2% respectively (Chukuonye *et al.,* 2013). The higher prevalence of truncal obesity indices in this study and in other similar studies (Molarius *et al.,* 1999) may not be unconnected with the close relationship of truncal obesity with the metabolic

diseases (Leopold *et al*., 2007). However worthy of mention is the lower prevalence of these indices in this study group compared to the results obtained from the general population in the United State and some European countries (Li *et al.,* 2007). The explanation for this may not be far from the same genetic, environmental and socio cultural factors that explain the difference in the generalized obesity prevalence between the two environments.

Generally, the commonest form of obesity observed in both sexes and in all the disease groups was truncal obesity using waist to hip ratio followed by truncal obesity using WC and generalized obesity using BMI. Specifically in the hypertensive group of clients, truncal obesity using WHR had a relatively higher frequency of occurrence when compared to the diabetic group of clients, or clients with co morbidity. The pattern distribution of the obesity indices among the male and female subgroups shows that obesity is more common in the females when compared to males using two indices (waist circumference and BMI) out of the three. Only Truncal obesity defined by waist to hip ratio was fairly more common in male subjects (58.4% against 44.8%) This result is in keeping with the findings of some studies (Oladapo *et al.,* 2010; Adediran*et al*., 2012). A similar trend was reported by World Health Organisation in 2000. Also the study of obesity trend in northern Nigeria by Kolawole *et al.,* (2011) had a higher female predilection. In another study on a rural Africa population the prevalence of obesity was ten times higher in women than in men, irrespective of the definition used (Abubakari *et al*., 2008). Apart from genetic and hormonal differences, this can partly be explained by the high number of deliveries, as well as their lower level of physical activity (Sobngwi *et al*., 2002). However a clear difference between the finding of this study and that of similar studies as cited above, is that one of the obesity indices (waist to hip ratio) is fairly more common among the male subjects with hypertension, diabetes or both as opposed to the above studies in which obesity is more common in females using all the indices of obesity. The reason for this may be because in this study the mean age (tables 2 and 3) of the male (56.89years) subjects was higher than the females (50.29years), and truncal obesity has been shown to increase with age (Sudera *et al*., 2015), this may partly explain why truncal obesity by waist to hip ratio is more common in the male subjects of this study.

CONCLUSION

Truncal obesity by waist- to- hip ratio was the most prevalent form in both males and females with hypertension, diabetes or both. It was highest in male diabetics (66.7%) and its highest value in females was also in female diabetic (47.8%). Generalized obesity was the least prevalent across all the subgroups of both sexes and was even 0% in the male diabetics. Using all the indices, obesity was generally more common in the female subjects.

Conflict of Interest: None declared by authors

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