Correlates of obesity indices and systemic arterial hypertension in adult Nigerians: a community based study

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Abstract

Background: The aim of the study was to determine the correlation between indices of obesity and systemic arterial hypertension in adult Nigerians.

Methods: This cross-sectional descriptive survey and was carried out in Abia state, southeast Nigeria. Two thousand nine hundred and ninety nine (2,999) subjects, aged ≥18years were selected by a multi-stage sampling technique from six Local Government Areas of Abia state, south east Nigeria. The World Health Organization Stepwise Approach to Surveillance of chronic disease risk factors was used. Body mass index, anthropometric measurements, and other relevant data were collected.

Results: Two thousand eight hundred and seven subjects (2,807) gave all the relevant data required. The prevalence of hypertension by three obesity indices, body mass index (BMI), waist circumference (WC), and waist to hip ratio (WHR) was 16.7%, 27.2%, 42.3% respectively. The correlation coefficient (r) of the obesity indices with systolic BP for BMI was 0.141 and 0.110, for WC was 0.182 and 0.198, and for WHR was 0.130 and 0.167, in males and females respectively. The r coefficient of the obesity indices with diastolic BP for BMI was 0.205 and 0.171, for WC was 0.182 and 0.217, and for WHR was 123 and 0.118 in males and females respectively. The odds ratio of obesity indices with BP for BMI was 1.54, and 1.06, for WC was 1.72 and 2.13 and for WHR was 1.48 and 1.47 for males and females respectively. The OR of obesity indices with diastolic BP for BMI was 1.41 and 1.40, for WC was 1.14 and 1.40, and for WHR was 1.28, and 1.20 in males and females respectively.

Conclusion: There exit a weak relationship between the indices of obesity and BP.

Keywords: Body Mass Index, Waist Circumference, Waist to Hip Ratio, Hypertension

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Introduction

Hypertension is the most common non-communicable disease in sub-Saharan Africa, with increased morbidity and mortality from associated damage of target organs (heart failure, stroke, chronic kidney disease and ischemic heart disease)[1]. The prevalence of hypertension in Nigeria has been reported to range from 8% to 46.4% (7.9% to 50.2% in males and 3.5% to 68.8% females)[2]. The high prevalence of hypertension in Nigeria can be viewed as a public health problem with the excess accruing burden of morbidity and mortality that arises from complications of hypertension. Obesity is a major risk factor for hypertension and other non communicable diseases. Obesity is defined as Body Mass Index (BMI) of 30kg/m^2 or more[3]. In 1997 the World Health Organization (WHO) Expert Consultation on obesity recognized the importance of abdominal fat mass as an index of obesity. It highlighted the need for other indicators to complement the measurement of BMI, to identify individuals at increased risk of obesity related morbidity due to accumulation of abdominal fat[4]. The Consultation suggested WHR as an acceptable measure of body fat distribution, in addition to BMI[4]. The 2002 WHO Expert Consultation on Obesity in addition highlighted the need for WC inclusion in monitoring obesity related risk, and also on studying it association with BMI[4]. There is still divided opinion regarding which obesity index that can best correlate with blood pressure to determine cardiovascular risk[5-7].

The need to have a good grasps of the correlation between the different anthropometric measures of obesity and hypertension in sub-Saharan African countries cannot be overemphasized. Although numerous studies have determined the prevalence of obesity in urban and rural communities in Nigeria using different obesity indices[8-10], however, there is dearth of cross sectional population based studies on the relationships between different indices of obesity and

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hypertension in Nigeria and other sub-Saharan African Countries. [11-12] This finding prompted us to undertake this study

Material and Methods
This was a cross sectional study carried out in randomly selected urban and rural communities in Abia state south East Nigeria, one of the 36 states in Nigeria. The study was a part of a state wide survey of non-communicable diseases and cardiovascular risk factors in Abia state, Nigeria. Abia state is divided into three senatorial zones, namely Abia North, Abia Central and Abia South. There are 17 local government areas (LGAs) in the state.

The study population comprised of adults; 18 years old and above, who were residing in the state. Individuals on transit or on temporary visits were excluded from the study. Pregnant women, women in puerperium (up to 6 weeks post delivery), subjects with increased abdominal girth from organic causes were excluded from the study.

The subjects were recruited by a three-stage random sampling method. The first stage of the sampling was simple random selection of six LGAs (one urban and one rural each) from the three senatorial zones. The second stage involved a simple random selection of four national census enumeration areas from each selected LGAs. The third stage was the random selection of two eligible respondents of both sexes from every household within the selected enumeration areas.

Data was collected from the respondents with a pretested and validated modified version of WHO STEP wise questionnaire[13], administered by trained research assistants. We adopted the WHO STEPS guideline (http://www.who.int/chp/steps/resources/ sampling/ en/) to calculate the appropriate and minimum sample size and the STEPS method to select a representative sample for the state. The level of confidence and the corresponding margin of error (MOE) used for the sample size calculation for the survey were 95% and 0.05 respectively. As there was no previous data on baseline levels of the indicators for the state, an estimated prevalence of 50% was used in order to ensure the most conservative sample size (n_1). Using the values obtained and the population estimate for each 10-year age group by sex cluster for the population of the state (based on the 2006 population census), the estimated sample size was computed for each age and sex strata (n_2). The total sample size was then adjusted for design effect (n_3) and for expected non-response rate (n_4 or final sample size). The design effect of 1 was chosen (for random sampling) while the expected response rate was 80%.

Step 1: $n_1 \geq Z^2 p(1-p)/e^2$
Where: $n \geq$ sample size
$z \geq$ level of confidence (1.96 or 95%)
$p \geq$ baseline level of indicators (0.5 or 50%)
$e \geq$ margin of error
Step 2: $n_2 \geq n_{1/}(1+[n_{1/}\text{population}])$
Step 3: $n_3 \geq n_2$ * design effect
Step 4: $n_4 \geq$ n3/response rate.

Hence, the minimum calculated sample size for this study, making allowance for design effect, age-sex estimates as well as non-response rate was 2,880. However, of 2,999 subjects that were interviewed, 2,807 subjects with complete demographic and clinical data were included for analysis in this study.

Ethical approval for the survey was obtained from the Abia State Ministry of Health Ethics Review Committee. Participation in the survey was voluntary and written consent was obtained from participants prior to enrollment after due explanation of the purpose, objectives, benefits and risks of the survey

Anthropometry and blood pressure measurements:
The subjects had their blood pressure, height and weight measured. Height was measured to the nearest 0.5 cm without shoes using a stadiometer (RGZ-160 by Pyrochy Medical England). Each participant was made to stand in the erect position with heels, buttocks and shoulders resting lightly against the backing board. Weight was measured after removal of shoes and when wearing light clothing only, using a weighing scale, and was recorded to the nearest 0.1 kg.

Both systolic and diastolic blood pressures were measured thrice in a sitting position using Omron M2 Upper Arm Blood Pressure Monitor (Omron Healthcare Co. Ltd., Kyoto, 615-0084 Japan). Appropriate cuff size was used, and the blood pressure was measured after a 5 minutes rest. Three blood pressure readings were taken at an interval of 2 minutes. Thereafter the second and third readings (systolic or diastolic) were averaged.

Definition of terms
Hypertension
Subjects having systolic blood pressure 140 mmHg and above or diastolic blood pressure 90 mmHg and above or who had normal blood pressure but were pharmacologically being treated for hypertension were categorized as hypertensive [14, 15.]

Body mass index (BMI) classification
BMI was measured with the WHO classification[3] as follows: underweight BMI below 18.5 kg/m^2, normal weight 18.5–24.9 kg/m^2, and overweight BMI 25–29.9 kg/m^2. BMI of 30–34.9 kg/m^2 defines class I obesity, BMI of 35–39.9 kg/m^2 class II obesity, and BMI of 40 kg/m^2 and above defines class III obesity.

Waist circumference (WC)
WC was measured using a non stretchable fiber measuring tape. The participants were asked to stand erect in a relaxed position with both feet together on a flat surface, and the arms by the sides; one layer of clothing was allowed. It was measured to the nearest 0.5 cm at the

high point of the iliac crest at minimal respiration[9]. Two measurements to the nearest 0.5 cm were recorded, and in situations where the variation between the measurements was greater than 1 cm, a third measurement was taken. The average of the two closest measurements was calculated [16].

Hip circumference

The measurement was made at the maximum circumference over the buttocks with the arms relaxed at the sides [14]. Two measurements to the nearest 0.5 cm were recorded, and in situations where the variation between the measurements was greater than 1 cm, a third measurement was taken. The mean of the two closest measurements was calculated [16].

Abdominal obesity

WC

Males and females with a waist circumference of 94–101.9 cm and of 80–87.9 cm respectively, were classified as overweight. Males and females with a waist circumference ≥ 102.0 cm and ≥ 88.0 cm respectively were classified as obese [7]

WHR

Males and females with a WHR 0.90–0.99 and 0.80–0.84 respectively, were classified as overweight. Males and females with a WHR ≥ 1.00 and ≥ 0.85 respectively were classified as obese [16,17].

Statistical analysis

Data obtained were entered using EpiData Software Version 3.1 (EpiData Association Odense, Denmark), while analysis was carried out using SPSS Version 17.0 (SPSS Inc, Chicago Illinois, USA). Proportion of obesity among the study population and those with hypertension was estimated using BMI, WC and WHR. Correlation between BMI, WC and WHR and systolic and diastolic blood pressure was measured using Pearson correlation coefficient (r) and p-value of 0.01 was assumed to be statistically significant. Binary logistic regression was used to estimate association between obesity and hypertension.

Results

Relevant data was collected from 2,807 subjects out of 2999 subjects that took part in the study. The number of males was 1,378 (49.09%), and the number of female participants was 1,429 (50.90%). The mean age of the men was 41 ± 18 years, while the mean age of the women was 42 ± 18 years, p < 0.0001. The 2,807 (100%) subjects had complete documentation for WC. The number of participants, that had their data for BMI and WHR documented was 2551 (90%) and 2750 (97%) respectively.

Table 1 shows prevalence of obesity by BMI, WC and WHR. Using BMI as indices of obesity 28.1%, of the subjects was overweight and 12.4% was obese. Using WC and WHR as indices of obesity the prevalence of overweight and obesity were 17.3%, and 21.4% for WC, and 27.6% and 41.4% respectively for WHR. In males the prevalence of obesity using BMI, WC, and WHR as measures of obesity was 7.9%, 3.1%, 4.4% respectively. In females the prevalence of obesity using BMI, WC, and WHR as a measure of obesity was 16.5%, 39.1%, and 77.2% respectively.

Table 1: Prevalence of obesity by BMI, WC and WHR

	Body Mass Index			Waist Circumference			WHR		
Obesity category	Male	Female	Total	Male	Female	Total	Male	Female	Total
Normal	775 (63.5)	744(55.9)	1519(59.5)	1226(88.9)	492 (34.5)	1718(61.2)	746 (55.2)	107 (7.6)	853 (31.1)
Overweight	349 (28.6)	367 (27.6)	716 (28.1)	110(8.0)	377(26.4)	487 (17.3)	546 (40.4)	212 (15.2)	758 (27.6)
Obese	96 (7.9)	220 (16.5)	316 (12.4)	43 (3.1)	559(39.1)	602 (21.4)	59 (4.4)	1080 (77.2)	1139 (41.4)
Total	1220	1331	2551	1379	1428	2807	1351	1399	2750

Table 2: Indices of obesity and prevalence of hypertension

	Hypertension		
Obesity category	BMI	WC	WHR
Normal	522 (52.2)	627 (55.6)	320 (28.9)
Overweight	311 (31.1)	194 (17.2)	318 (28.6)
Obese	167 (16.7)	307 (27.2)	468 (42.3)
Total	1000	1128	1106

Table 2 shows the prevalence of hypertension by obesity category. The prevalence of hypertension using BMI, WC, and WHR as indices of obesity was 16.7%, 27.2%, 42.3% respectively. Table 3 shows the prevalence of hypertension by gender and weight category. The prevalence of hypertension in males using BMI, WC, and WHR as measures of obesity in males was 12.0%, 5.4%, and 5.1% respectively. In females it was 21.5%, 49.9% and 81.0% respectively.

Table 3: Prevalence of Hypertension by Gender and Obesity category

	Men			Women		
Obesity category	BMI	WC	WHR	BMI	WC	WHR
Normal	280 (55.1)	482 (83.8)	279 (49.5)	242 (49.2)	145 (26.2)	41 (7.6)
Overweight	167 (32.9)	62 (10.8)	256 (45.4)	144 (29.3)	132 (23.9)	62 (11.4)
Obese	61 (12.0)	31 (5.4)	29 (5.1)	106 (21.5)	276 (49.9)	439 (81.0)
Total	508	575	564	492	553	542

The correlation coefficient (r) of BMI with systolic BP was 0.141 and 0.110 in males and females respectively. The r with systolic BP was 0.182 and 0.198 for WC, and 0.130 and 0.167 for WHR in males and females respectively. The r of BMI with diastolic BP was 0.205 and 0.171 in males and females respectively. The r with diastolic was 0.182 and 0.217 for WC and 0.123 and 0.118 for WHR in males and females respectively.

Table 4: Odds Ratio of Hypertension by the three measures of obesity

	Hypertension					
Obesity category	Men		Women		All	
	OR	95%CI	OR	95%CI	OR	95%CI
BMI	0.704	0.572 - 0.867	0.845	0.703 - 1.015	0.728	0.636 - 0.833
WC	0.648	0.464 - 0.905	0.709	0.596 - 0.845	0.831	0.722 - 0.956
WHR	0.717	0.578 - 0.890	0.957	0.770 - 1.188	1.041	0.920 - 1,178

Table 4 shows the association of BP with obesity. Among men WC, BMI and WHR had strong association with BP, while WC had a strong association in women.

Discussion

Obesity has already become one of the most pressing health problems, more so in developing countries of the world where there is evidence of rapidly increasing prevalence of obesity.[18-19.] In Nigeria and other sub-Saharan countries there is high prevalence of obesity[8-9]. Obesity is usually defined using BMI because of the robust nature of the measurement of weight and height. Overweight is usually defined as BMI greater than 25kg/m^2, while obesity is usually defined as BMI of 30kg/m^2. These definitions are as a result of the relationship between BMI with morbidity and mortality outcomes[17]. The general assumption is that individuals that are obese using the BMI definition do have excess body fat mass; however this is not always the case. The reason for this is that usually BMI does not distinguish between weight associated with increased fat mass and that associated with increased muscle mass. It is also a known fact that the body fat mass increases with age in both men and women up to the 60-65 years, and body fat is lower in men than in women of equivalent BMI[16].

The presence of excess fat in the abdomen out of proportion to total body fat is an independent predictor of risk factors and morbidity. WC is positively correlated with abdominal fat content. It provides a clinically acceptable measurement for assessing a patient's abdominal fat content before and during weight loss treatment[20]. Weighted evidence indicates that WC coupled with BMI predicts health risk better than BMI alone[21]. Waist circumference is particularly useful for individuals with a BMI of 25-34.9. For individuals with a BMI > than 35, WC adds little predictive power on the disease risk classification of BMI.[20]. The limitations of WC as a measure of obesity includes the facts that there are no universally acceptable cut-off criteria for defining abdominal obesity, given the existence of different criteria (including the International Diabetes Foundation,[22] and the Adult Treatment Panel III,[23] which are the more prominent criteria).

WHR is believed to be a reliable measure of risk, and is usually associated with increased visceral fat area after adjustment for BMI and age. This contributes to the risk of developing non communicable diseases like hypertension and type 2 diabetes mellitus[7]. However, WC alone may provide a more practical correlation between fat distribution and associated diseases[16].

We studied the correlations between each of three anthropometric measures of obesity (BMI, WC, and WHR), and hypertension in Abia State, south east Nigeria. The result showed BMI, WC, and WHR had a linear relationship with BP. The odd ratio of hypertension with each of the indices of obesity also showed a positive relationship between obesity and hypertension (systolic and diastolic).

In Nigeria, the result of a population based study by Sonya et al[11] on the relationship of BMI and WHR to blood pressure of individuals at Ibadan South West, Oyo state, Nigeria showed that an increase in BMI above 25kg/m^2 and WHR greater than 0.9 correlates with hypertension in both male and female participants. BMI and WHR had a linear relationship with blood pressure. However, in another population based study, Okafor et al[12] compared the performance of WC and WHR in predicting the presence of hypertension and generalized obesity in an apparently healthy population at Enugu, Enugu state, south east Nigeria. They found that WC performed better than WHR in predicting the presence of hypertension and generalized obesity

Studies have shown that the prevalence of overweight and obesity is increasing in the country due to poor nutritional habits including the increased consumption of more energy-dense, nutrient-poor foods with high levels of sugar and saturated fats, combined with reduced physical activity[24]. The results of this present survey further highlight the implications of the increased obesity prevalence observed with regards to prevalence of hypertension. In addition, it indicates that all the three indices of obesity have a linear relationship with both diastolic and systolic hypertension. However, BMI and

WC performed better in predicting hypertension than WHR. This is similar to the observation made by Okafor et al in their survey also carried out in south east Nigeria that showed that WC is better predictor of hypertension compared to WHR.

Limitations

The presence of different landmarks for the measurement of WC and WHR, and the adoption of particular landmarks for measurement of these in this study may pose some limitation in comparing the study with some other studies that used different landmarks. In addition values used for overweight in WC and WHR vary from that used in some other studies, and this may also pose some limitations.

Conclusion

The study showed that the three measures of obesity have a weak relationship with BP. This lends credence to the fact that other factors apart from obesity also play major roles in the development of hypertension.

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Disclosure

The authors report no conflicts of interest in this work.

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