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ASSESSMENT OF MEASURES OF ADIPOSITY THAT CORRELATE WITH BLOOD PRESSURE AMONG HYPERTENSIVE AFRICANS

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ABSTRACT

Background: **Studies differ on which anthropometric measure of adiposity shows good correlation with cardiovascular diseases. In this study, we evaluated the effects of common epidemiological measures of adiposity as a correlate of elevated blood pressure in an African population.**

Methodology: **The study was carried out between June 2009 and December 2011 at the medical out-patient department of a tertiary healthcare center in Nigeria. Correlation analysis was used to assess the relationship between blood pressure and body mass index (BMI), waist to height ratio (WHtR), and waist circumference (WC).**

Results: **A total of 1,416 Hypertensives comprising 1090 (77%) adult females recruited over two and half years. Women were significantly older (49.2±8.1 vs. 48.0±10.0 years, p=0.039) and shorter (1.6±6.3 vs 1.7±6.8 meters, p<0.0001) when compared with men. Blood pressure parameters were comparable between women and men. Approximately 1 out of 5 participants had good blood pressure control with no gender difference. Anthropometric measurements showed that 446(32%) were overweight, 404(29%) obese and 40(3%) were morbidly obese. Compared with their male counterparts, females were significantly more likely to be obese (P<0.0001). Similarly, 51.6% of the subjects had abdominal obesity, with female preponderance (P<0.0001). Likewise, a greater proportion of women had substantially higher measured waist circumference risk. Compared with other measures of adiposity, body mass index correlated best with diastolic blood pressure in both gender (P< 0.05).**

Conclusion: **This study adds to the evidence that obesity is a major cardiovascular risk factor. BMI, as a measure of adiposity, was found to correlate best with blood pressure. These findings support other observations in other populations that BMI rather than waist to height ratio (WHtR), and waist circumference (WC) is a better correlate of hypertension.**

INTRODUCTION

The rising trend of increasing adiposity has been a great challenge globally. It has also been increasingly observed that the burden of obesity among Africans is on the increase which is attributable to the epidemiologic transition. In addition, increased adiposity plays major role in all-cause mortality.[1] There are abundant evidences that increased adiposity/differential fat distributions are associated with disorders like hypertension, diabetes, and cardiovascular disease.[2,3]

Body Mass Index (BMI), particularly from about 22kg/m^2, although more marked at overweight and obesity level, is associated with the development of hypertension and diabetes mellitus which are major independent risk factors for cardiovascular morbidity and mortality.[4,5]

BMI, waist-to-hip ratio (WHpR), waist circumference (WC), and waist -to-height ratio (WHtR) are the commonly used epidemiology measures of adiposity.[6,7] Other standard direct measurements of viscera and abdominal fat using imaging techniques are not readily available in developing countries and more so, may not be cost effective for large epidemiology studies. BMI is a simple and widely used clinical measure but it is widely believed not to be an optimal indicator of health risk.[8] Furthermore, its correlation with adiposity is not consistent across ethnic and racial populations. Comparing BMI with dual energy xray absorptiometry (DXA), an example of direct measurement of total body fat, the variance for adiposity measurement is very small suggesting reliability of BMI as measure of body fat distributions.[9] BMI is more related to body size estimate while WHpR is relevant in differential assessment of fat distribution. Interestingly, WC, WHpR, and WHtR have possibly more predictive power for body adiposity than BMI.[2,10] Waist circumference is an effective and arguably the best inexpensive epidemiologic marker for visceral obesity.[11,12] It is also an early predictor of cardiovascular risk development but metabolic risks differed between people of similar WC with different heights.[13] Measurement of WC is a practical method which has been shown to be a better predictor of intra-abdominal adipose tissue than BMI and thus provides a measure of fat distribution that cannot be obtained by measuring BMI.[14] However, this may not adequately explain the aetiology of hypertension among the obese/overweight.

From the foregoing, despite the availability of several studies that investigated the relationship between measures of adiposity and blood pressure, there is no consensus on which anthropometric measure of adiposity correlate best with blood pressure. Some recent large epidemiological studies may have demonstrated the superiority of WC by showing positive correlations with elevated blood pressure in certain populations.[15,16] There is wide variation in the strength of BMI and BP relationship among different population.[17] Furthermore it appears that WHtR is better in measuring obesity but it is yet to be determined whether it correlates better than WC with hypertension among Nigeria population.[18] In this cross-sectional survey, we assessed which of the measures of adiposity correlates best with blood pressure among Nigerian hypertensives and which can serve as a marker for early identification of individuals at risk and targeted for prevention.

METHODS

Subjects

One thousand four hundred and sixteen (1,416) hypertensive patients comprising 1090 (77%) adult female patients were recruited over two and half years (between June 2009 and December 2011). They were enrolled at the medical outpatient department of a tertiary healthcare center in Nigeria.

Inclusion and exclusion criteria

Adult participants aged 18years and above of both genders that were hypertensive were enrolled into the study. Those that declined participation in the study were excluded.

Measurement of variables

Blood pressure was measured using a standard Omron (HEM711DLX) blood pressure apparatus on the left arm placed at heart level after 5-minute rest and using a cuff of appropriate size with the subject in the sitting position and legs uncrossed. Three BP measurements were obtained with a minimum interval of one minute and average of the last two measurements was used in the present analysis.

Anthropometric measurements including height, weight, waist and arm circumferences were obtained. Height was measured without shoes to the nearest centimeter using a ruler attached to the wall, while weight was measured to the nearest 0.1 kg on an electronic scale with the subject wearing light outdoor clothing and no shoes. Waist circumference was measured at the narrowest part of the participant's torso (or the minimum circumference between the rib cage and the iliac crest) using an anthropometric measuring tape. The measurement was taken at the end of expiration. Average of three measured waist circumference, recorded to the nearest tenth of a centimeter was obtained for analysis.

Hypertension was defined as a systolic blood pressure (SBP) $\geq$ 140mmHg and/or diastolic blood pressure (DBP) $\geq$ 90mmHg or being on pharmacological treatment for hypertension. Obesity was classified based on BMI in kg/m^2 as normal (18.5- <25), overweight (25 - <30), obesity (30 - <35) and severe obesity ($\geq$35). Abdominal obesity was defined as waist circumference of greater or equal to 102cm in men and greater or equal to 88cm in women. Participants were further categorized as normal risk (men<94cm; women<80 cm), increased risk (men 94-102cm; women80–88 cm), or substantially increased risk (men>102cm; women>88 cm) on the basis of the World Health Organization's standards for increased health risk associated with waist circumference for both gender.

Data Management: Data were analyzed using the Statistical Package for the Social Sciences (SPSS) for Windows version 22.0 (IBM, Armonk, NY). Estimates were expressed as either mean values ($\pm$standard deviation) for continuous variables or proportions (percentage) for categorical variables. Comparison for statistical significance was by Student's t-Test for continuous variables or chi-square for categorical variables. Pearson's Correlation (or Spearman's correlation when data is non-parametric) analysis method was used to assess relationship between blood pressure and BMI, WHtR, and WC. The level of significance was set at P $\leq$ .05.

Ethical Considerations

The ethical approval was by the Institutional Review Board of our Institution and informed consent were obtained from all participants. Ethical approval was obtained before the commencement of the study.

RESULTS

A total of 1,416 hypertensives comprising of 23% adult men were enrolled into the study. Baseline characteristics of study participants are presented in Table 1. Women were on the average significantly older (49.2±8.1 vs. 48.0±10.0 years, p=0.039) and shorter (1.6±6.3 vs. 1.7±6.8 meters, p<0.0001) than men. Blood pressure parameters were comparable between the women and men. Less than 20% of the participants had good blood pressure control with no gender difference. Anthropometric measurements showed that 446(32%) were overweight, 404(29%) obese and 40(3%) had morbid obesity. Compared with their male counterparts, females were significantly more obese (P<0.0001). Similarly, 51.6% of the subjects had abdominal obesity, with female preponderance (P<0.0001). Furthermore, greater proportion of women had substantially increased waist circumference risk. Table 2 showed the correlation of measures of adiposity with blood pressure of the participants. Waist circumference and waist to height ratio did not correlate

Table 1: Basic characteristics of the population

Variable	Total (n=1416)	Female (n=1090)	Male(n=326)	p- value
Age(yrs)	48.9±8.57	49.2± 8.09	48.0± 10.0	0.039*
Weight(kg)	71.6± 15.9	71.6± 16.4	72.2± 13.8	0.588
Height(m)	1.61± 0.08	1.59±0.0 6	1.68± 0.06	0.0001*
SBP (mmHg)	160.0± 26.5	160.0± 26.5	160.3± 26.2	0.829
DBP (mmHg)	100.5± 14.8	100.6± 14.3	100.3± 16.2	0.0746
Body mass index(kg/m2)	27.7± 6.0	28.3± 6.30	25.42± 4.4	0.0001*
Waist Circumference(cm)	92.3± 12.2	93.3± 12.5	88.9± 10.5	0.0001*
BMI Groups (%)				<0.001*
Normal	505(36.2)	341(31.8)	164(50.8)	
Overweight	446(32.0)	336(31.3)	110(34.1)	
Obese	404(29.0)	357(33.3)	47(14.6)	
Severe Obesity	40(2.9)	38(3.5)	2(0.6)	
Waist-to-height ratio	0.57(0.08)	0.59(0.08)	0.53(0.06)	<0.0001
Waist Circumference risk (%)				<0.0001*
Normal	368(26.0)	145(13.3)	223(68.4)	
Increased	272(19.2)	206(18.9)	66(20.2)	
Substantially increased	776(54.8)	739(67.8)	37(11.3)	
Controlled blood pressure	205(16.5)	153(15.9)	52(18.6)	0.314

**Statistically significant; SBP: systolic blood pressure; DBP: diastolic blood pressure*

Table 2: Correlations of blood pressure with measures of adiposity

	Males		Females	
	Systolic BP	Diastolic BP	Systolic BP	Diastolic BP
Waist Circumference	0.019	0.053	-0.059	-0.014
Waist Height Ratio	0.049	0.065.	0.041	0.023
Body Mass Index	0.088	0.111*	-0.003	0.061*

***= $p < 0.01$; * $p < 0.05$*

with blood pressure, while BMI correlated positively with diastolic blood pressure in both men and women ($P < 0.05$).

DISCUSSION

This study demonstrates a significant burden of adiposity, which was predominant among women, and concurrent poor blood pressure control among the study population. Body mass index compared with other measures of adiposity, correlated best with diastolic blood pressure in both gender.

The findings of female obesity preponderance in our study is similar to that in the study by Ejim *et al*[19] who found hypertensive women in the eastern Nigeria community to be more obese, shorter and older than their male counterparts. Furthermore, high propensity of obesity among women had been reported in our previous studies.[20,21] Gender-specific approach to control of obesity may therefore be necessary.

Studies on the best anthropometric measures of adiposity that correlates with hypertension have been inconclusive. In a study of 4,557 Japanese subjects, waist circumference in men and BMI in women had the strongest associations with blood pressure whereas that of waist-to-height ratio with BP and the prevalence of hypertension were a little weaker than those of waist circumference for both men and women.[22] Similarly in a multi-racial study population of 8,014 individuals mean SBP and mean DBP increased along with increasing BMI quintiles.[23] While these studies showed clear relationship between BMI and both SBP and DBP, our findings though similar only showed correlation between diastolic blood pressure and BMI in both gender. Also Cappuccio *et al* in a study of African population from various environments demonstrated a strong relationship between blood pressure and BMI, and this relationship declines as the body size increases.[17] The seeming discordance may not be unconnected with our smaller sample size, environmental, and ethnically varied sample population. Geographical and ethnical variation have been reported to affect the relationship between BMI and blood pressure.[24] However contrary to above findings, studies by P Okosun *et al*[14] and Warren *et al*[16] found that increased waist circumference was associated with higher risk of hypertension and diabetes which was independent of BMI.

Although, not explored in the current study, resting energy expenditure (REE), had been demonstrated to explain the effect of BMI on blood pressure.[25] It was shown that the relationship between adiposity and blood pressure is confounded by joint association with REE. Adjusting for REE makes relationship between body fat store and blood pressure of no effect. Likewise, previous evidence in support of WC had explained that waist circumference is an aggregate measurement of the actual amount of total and abdominal fat accumulation and is a crucial correlate of the complexities observed among obese and overweight patients. However, recent hypothesis is pointing to the role of overall increase body size rather than regional assessment of body fat distribution.

Worrisome is the high rate of obesity among the studied population especially female participants. Obesity has been shown to promote dysfunctional adipose tissue in ectopic locations which in turn influences the overall total body metabolism with secretions that have auto, para, and endocrine effects.[26] This assumes greater importance in light of increasing prevalence of obesity among women in urban African settings.[27,28] Our obese hypertensive group in the current study may be more at risk of metabolic derangement which may lead to untoward major cardiovascular events in them.

Although, this study was not designed to assess drug adherence, the high proportion of obesity and poor blood pressure control in the study population is worrisome. Less than a fifth of the study population had controlled blood pressure. Uncontrolled Blood Pressure increases the risk of end-organ damage in hypertensive patients.[29] Controlled BP with anti-hypertensive agents has been shown to decrease all-cause mortality and coronary artery diseases.[30,31] The current finding is similar to those reported in the United States that found only 12% of treated patients had controlled BP despite awareness and insured health care.[32] This is contrary to a study among health workers where two thirds of treated hypertensive patients had controlled blood pressure.[33] The reasons may be that the group with controlled blood pressure had better attitude towards prevention of hypertension and greater access to drugs since health workers are presumed to be knowledgeable of complication of poor blood pressure control hence better compliance with anti-hypertensive medications.

Limitation of Study

A limitation of our study is in its cross-sectional design and the fact that the study population was hospital-based and thus our findings may not be generalizable to the general population. Furthermore, due to the type of study design, the causality effect of increased Body Mass Index on blood pressure could not be established. However, our findings equating those reported in community studies make this study relevant and gives credence for a call for proper education on lifestyle modification especially reduction in body weight. finally, BMI does not distinguish between individuals with different types of fat distribution. Therefore, further prospective research would be needed to explore the best anthropometric measure of other cardio-vascular co-morbidities among Nigerians.

CONCLUSION

In conclusion, this study shows that obesity is a major cardiovascular risk factor among the study population. Diastolic blood pressure correlated most with BMI. Significant reduction in diastolic blood pressure may be possible if overall body size is reduced in the studied population. Intervention programs targeted at the overall body size rather than differential body fat distribution reduction through lifestyle modification, including exercise and diet, may have significant public health significance in reducing the incidence of hypertension among the population.

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