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RESEARCH ARTICLE

ANTHROPOMETRIC INDICES OF OBESITY AND HYPERTENSION AMONG ADULTS IN A PRIMARY CARE SETTING OF AN URBAN TERTIARY HOSPITAL IN NORTHCENTRAL NIGERIA

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ABSTRACT

Obesity has been linked as an independent risk factor for cardiovascular disease including hypertension. Varying patterns of this relationship exists across race, ethnic group and geographical location. Body mass index (BMI), waist circumference (WC) and waist hip ratio (WHR) are simple methods of assessing obesity. This study aimed to assess obesity using BMI, WC and WHR, and to examine the respective relationships with hypertension. In a hospital-based cross-sectional descriptive study, 556 adult out-patients were recruited and relevant data was collected from them. Data was analysed using Epi info 7 statistical software package. Confidence interval of 95% and significance level of <0.05 was applied. According to BMI cut-offs, 60% of the subjects were overweight and obese; by WC cut-offs, 65.5% of the subjects were in the increased risk and high risk category; and abnormal WHR was found in 57.4% of the subjects. Fifty-three percent of the total population were hypertensive. Subjects with abnormal BMI, WC and WHR made up 76%, 81% and 72% of the hypertensive population respectively. There was significant correlation between anthropometric indices (BMI, WC and WHR) and hypertension (p=<0.05). All three methods were useful in assessing obesity and correlating obesity with hypertension.

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INTRODUCTION

Obesity and hypertension are important challenges facing the public health sector in both developed and developing countries. Obesity arises from an abnormal accumulation of body fat due to an energy imbalance between calories consumed and calories expended and it is a major risk factor for metabolic and cardiovascular disease. The prevalence of obesity is increasing worldwide and it has been identified as a major risk factor contributing to the overall burden of disease worldwide (CDC, 2013; Halsam *et al*., 2005; Ladabaum *et al*., 2014; Ng *et al*., 2014). Obesity was once reckoned to be a problem restricted to high-income countries, but due to globalisation with its accompanying pattern of changing lifestyle, it is now on the increase in low- and middle-income countries (Popkin *et al*., 2012; Ellulu *et al*., 2014; Popkin, 2001; Abubakari *et al*., 2008), and Nigeria has not been left out (Akinwale *et al*., 2013; Puepet *et al*., 2002). This trend of emerging obesity in poorer countries is seen more in urban dwellers and rates have reportedly doubled. (Finucane *et al*., 2011; Prentice, 2005)

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Hypertension is defined as a systolic blood pressure (SBP) of 140mm Hg or more, or a diastolic blood pressure (DBP) of 90mm Hg or more, or taking antihypertensive medication (Roger *et al*., 2012). Hypertension is primary when it results from environmental or genetic causes and secondary when it has aetiologies such as renal, vascular or endocrine. Obesity has been identified as one of the most notable risk factors for the development of hypertension (Narkiewicz, 2006)

Several practical techniques exist to assess obesity in clinical practice and research. Anthropometric methods including body mass index (BMI), Waist Circumference (WC) and waist-hip ratio (WHR) are some of the common primary methods used to determine obesity and are based on standard criteria defined by the World Health Organization (WHO, 1995; WHO, 2008). BMI values are the same for both sexes while WC and WHR values are gender dependent. While BMI reflects general obesity, WC and WHR reflect central or abdominal obesity. The diagnosis of obesity is influenced by the method and level of cut offs used in its determination. Variations in obesity profile have also been noted across age, race, ethnic groups and geographical regions (Huang *et al*., 1994; Bell *et al*., 2002; Tuan *et al*., 2009; Wang *et al*., 2014). Over time, and across different regions of the world, a number of researchers have examined the association between obesity and hypertension, and found the association to be strong, though there have been varied conclusions as to which methods of assessing obesity show a stronger association (Wang *et al*., 2014; Guagnano *et al*., 2001; Doll *et al*., 2002; Sonmez *et al*., 2003; Tesfaye *et al*., 2007; Phulpoto, 2013). Studies in various regions of Nigeria have also shown that obesity indices are strongly associated with hypertension (Adedoyin *et al*., 2008; Sanya *et al*., 2009; Sharaye *et al*., 2014; Gezawa *et al*., 2014). Data generated from such studies are important in comparing geographical variations that may exist within the country. So far, none has been reported from north central Nigeria. This study aimed to assess the obesity profile defined by BMI, WC and WHR, and also to examine the association between obesity and hypertension in adult patients in an urbanized setting of a developing country. A possible solution to the varied obesity profiles as seen with BMI, WC and WHR, may be to factor in age, sex and geographical location in the determination of cut off points for all obesity indices.

MATERIALS AND METHODS

The study was carried out in Jos, the Plateau State capital located in north central Nigeria. It was a hospital based cross-sectional descriptive study carried out from February to June 2015. Ethical clearance was obtained from the Ethical Review Committee of Jos University Teaching Hospital and written informed consent was obtained from each participant. Confidentiality and anonymity of patients' information was ensured.

Enrolment of subjects

The study was made up of a total of 556 consecutive adult patients presenting to the general out-patient clinic of Jos University Teaching Hospital, aged 18years and above, who had at least one previous documented consultation with a physician and consented to participate in the study.

Exclusion Criteria

Patients who were very ill, pregnant, had as cites, gross physical deformity or had a known secondary cause of hypertension were excluded from the study.

Data Collection

Data was collected by qualified family physicians trained in the research protocol. A pretested structured questionnaire was used to obtain socio demographic information including a medical diagnosis of hypertension. Patients were documented to be hypertensive if they were currently taking antihypertensive medication, or if they persistently had a systolic blood pressure $\geq$ 140mmHg and a diastolic blood pressure $\geq$90 mmHg (Roger *et al*., 2012). Blood pressure was measured in mmHg using an Accoson brand of mercury sphygmomanometer with an appropriate sized cuff, after the patient had rested for 5 minutes. Each patient was seated comfortably with their back supported and feet placed firmly on the ground. The right arm was placed on the table with the cubital fossa at the level of the heart and the palm facing upwards. A Littman stethoscope was used to listen for the Korotkoff phase 1 and phase 5 sounds signifying the systolic and diastolic blood pressures respectively. Three readings were taken at intervals of 5 minutes with the mean of the second and third readings recorded as the blood pressure reading. Anthropometric measurements were done according to standard technique as follows (WHO, 1995; WHO, 2008): Height was measured in metres (m) to the nearest 0.1cm using a stadiometer (Seca, Germany) with the patient wearing light clothing and no shoes; standing upright with feet together and back to the instrument; looking straight ahead; arms by the sides; back of feet, calves, bottom, upper back and back of the head all in the same plain directly under the dropdown measuring device at the top of clients head.

Weight was measured in kilograms (kg) to the nearest 0.1kg using a weighing scale (Seca, Germany). The patient wore light clothing with empty pockets and no shoes. The scale reading was confirmed to be on or adjusted to the zero mark before each patient mounted. Patients were asked to stand still and look straight ahead for each reading. BMI was calculated as weight in kilograms divided by height in meters squared. BMI was categorized as follows (WHO, 1995): Underweight =<18.5kg/m2; Normal= 18.5-24.9kg/m2; Overweight =25-29.9kg/ m2; Obese =>30kg/m2. Overweight and obese were categorized as abnormal values and grouped as obese. Waist circumference was measured in cm to the nearest 0.1cm using a stretch resistant flexible anthropometric measuring tape. At the end of normal expiration with the patient relaxed, arms to the sides and the feet together, the tape was placed over unclothed abdomen approximately at a level midpoint between the lower margin of lowest rib and the top of the iliac crest with the measuring tape snug but not tight and parallel to the ground.

Waist circumference was grouped into 3 categories as follows (WHO 2008): low risk = (<80cm, female and <94cm, male); increased risk or action level 1= ($\geq$ 80 - 87.9cm, female and $\geq$94 – 101.9cm, male); and high risk or action level 2= ($\geq$88cm, female and $\geq$102cm male). The mean of two measurements was taken as the final reading. After using gender specific cut-offs, all the patients were grouped into the three were categories. Increased risk (action level 1) and high risk (action level 2) were considered abnormal and grouped as obese. Hip circumference was measured in cm to the nearest 0.1cm with the tape parallel to the ground, at the level of the widest portion of the buttocks while patient stood with arms to the sides and feet close together. The mean of two measurements was taken as the final reading. WHR was calculated as waist circumference in cm divided by hip circumference in cm. A value of >0.85 in females and > 0.9 in males (WHO, 2008) was considered abnormal and grouped as obese.

Statistical Analysis

Data was analysed using Epi Info version 7 statistical software package (CDC, Atlanta, GA). Variables were expressed as means $\pm$ standard deviations (SD) or as frequencies and percentages. Differences in mean proportions between males and females were compared using unpaired Student's t-test.

Table 1. Baseline socio demographic characteristics of subjects (n=556)

Variables	Frequency n=556	Percentage (%)
Age group		
18-29	106	19.1
30-39	131	23.6
40-49	119	20.0
50-59	116	20.9
≥60	92	16.5
Sex		
Female	407	73.2
Male	149	26.8
Religion		
Christianity	237	42.6
Islam	319	57.4
Marital status		
Never married	83	15.0
Married	367	66.0
Separated	4	0.7
Divorced	8	1.4
Widowed	94	16.9
Educational status		
No education	183	32.9
Primary	116	20.9
Secondary	110	19.8
Tertiary	147	26.4
Domicile		
Urban	487	87.6
Rural	69	12.4
Hypertension		
Yes	296	53.2
No	260	46.8

Table 2. Clinical characteristics of subjects expressed as mean ±standard deviation (SD)

Variables	Male n=149		Female n=407		P-value
	Mean	SD	Mean	SD	
Age(years)	43.4	±16.2	43.7	±14.9	0.8374
Weight(kg)	69.0	±14.4	71.2	±17.0	0.1604
Height(m)	1.67	±0.1	1.57	±0.1	0.0001*
Body mass index(kg/m^2)	24.7	±4.8	28.8	±6.8	0.0001*
Waist circumference(cm)	87.6	±12.9	92.7	±14.9	0.0002*
Hip circumference(cm)	97.4	±10.9	106.7	±12.9	0.0001*
Waist-hip ratio	0.90	±0.08	0.87	±0.09	0.0004*
Systolic blood pressure(mmHg)	125.8	±20.1	125.2	±20.5	0.7588
Diastolic blood pressure(mmHg)	81.6	±12.5	80.8	±11.7	0.4836

*statistically significant

Table 3. Prevalence of obesity (weighted percentage) defined by BMI, WC and WHR (n=556)

Obesity category	BMI Cut off = 25kg/m^2			WC Cut off by gender = 80cm female/94cm male			WHR Cut off by gender= 0.85 female/0.90 male		
	Female n=407	Male n=149	Total n=556	Female n=407	Male n=149	Total n=556	Female n=407	Male n=149	Total n=556
Normal (<cut-off)	32.7	60.0	39.9	21.4	70.5	34.5	41.8	45.0	42.6
Abnormal (≥cut-off)	67.3	40.0	60.1	78.6	29.5	65.5	58.2	55.0	57.4
Total %	100	100	100	100	100	100	100	100	100

Table 4. Gender distribution of hypertensive status in relation to anthropometric indices

Variables	Number of subjects n=556 Frequency (%)	Non-hypertensive n=260		Hypertensive n=296	
		Female n=176 Frequency (%)	Male n=84 Frequency (%)	Female n=231 Frequency (%)	Male n=65 Frequency (%)
BMI (kg/m^2)					
<18.5	24 (4.3)	14(7.9)	5(6.0)	3 (1.3)	2 (3.1)
18.5 - 24.9	198 (35.6)	75(42.6)	57(67.8)	41 (17.7)	25 (38.4)
25 - 29.9	156 (28.1)	48(27.3)	14(16.7)	70 (30.0)	24 (37.0)
≥30	178 (32.0)	39(22.2)	8(9.5)	117 (51.0)	14 (21.5)
WC (cm)**	192 (34.5)	67(38.1)	71(84.5)	20 (8.7)	34 (52.3)
<80 or <94	88 (15.9)	32(18.2)	5(6.0)	31 (13.4)	20 (30.7)
80–87.9 or 94–101.9					
≥88 or102	276 (49.6)	77(43.7)	8(9.5)	180 (77.9)	11 (17.0)
WHR**					
<0.85 or <0.9	237 (42.6)	100(56.8)	54(64.3)	70 (30.3)	13 (20)
≥0.85 or ≥0.9	319 (57.4)	76(43.2)	30(35.7)	161 (69.6)	52 (80)

**paired values represent cut-off values in females and males respectively for same category.

Logistic regression analysis model was used to determine associations between age, obesity indices and hypertension. Confidence interval of 95% and significance level of $\leq$0.05 was applied.

RESULTS

Socio demographic Characteristics

Out of 566 subjects, 407 (73.2 %) were females and 149(26.7%) were males with a predominance of females. The maximum number of subjects was in the age group of 30 – 39years (23.6%) while the minimum number of subjects was in the age group of 18 – 29 years (19.1%). The mean age of the study population was 43.6 $\pm$15.2 years (male 43.4$\pm$ 16.2 years and female 43.7 $\pm$ 14.9 years). Majority of the subjects were married (65%) and resided in urban settings (87.5%). Sixty-seven of the subjects had some level of formal education ranging from primary to tertiary level while the other 33% had no formal education. See Table 1.

Clinical Measurements and Obesity Assessment

Measurements expressed as means $\pm$ SD showed that men were significantly taller and had significantly higher WHR than women, while women had significantly higher WC, HC and BMI. There was no statistically significant difference in systolic and diastolic blood pressure values between males and females. See Table 2. According to BMI cut-offs, 67.3% of the female population and 60% of the male population were obese and they made up 60.1% of the total population. Based on WC cut-offs, 78.6% of the female population and 29.5% of the male population were obese, and they made up 65.5% of the total subjects. Abnormal WHR was seen in 58.2% of the female subjects and 82% of the male subjects, and they made up 57.4% of the total population. See Table 3.

Abnormal Anthropometric Measurements and Hypertension

Fifty-three percent of the study population were hypertensive, and of these 78% were female while 22% were males. Among the hypertensive subjects, the distribution of males and females that had abnormal BMI, WC and WHR classification cut-offs,(hypertensive and obese subjects) was as follows: BMI - 51% females/21.5% males were obese and 30% females/ 37% males were overweight; WC-13.4% females/30.7% males were in increased risk group (action level 1) and 77.9% females/17% males were in high risk group (action level 2); WHR- 69.6% females/80% males had abnormal ratios. See Table 4.

Correlation of BMI, WC and WHR with Hypertension

There was statistically significant correlation between obesity indices- BMI, WC, WHR and hypertension. As values for BMI, WC and WHR increased, there was increased likelihood of being hypertensive as shown by the logistic regression model in Table 5. Among subjects with BMI in the range of overweight and obese, the likelihood of hypertension was approximately 3 times and 5times respectively (Odds ratio= 3.2244; P-value =0.0000 and Odds ratio=5.9278; P-value = 0.0000 respectively). Subjects with waist circumference in increased risk group and high risk group were approximately 3 times and 5 times respectively more likely to have hypertension (Odds ratio=3.5225; P-value = 0.0000 and Odds ratio = 5.7425; P-value = 0.0000). Similarly, subjects with abnormal WHR were approximately 3 times more likely to have hypertension (Odds ratio = 3.6730; P-value = 0.0000).

Table 5. Logistic regression analysis model of obesity correlates of hypertension

Variable	Odds ratio	95% Confidence interval	P-value
BMI			
<25 kg/m^2	Reference	-	-
overweight	3.2244	2.1037 – 4.9422	0.0000*
obese	5.9278	3.8308 – 9.1727	0.0000*
WC			
Low risk	Reference	-	-
Increased risk	3.5225	2.0788 - 5.9688	0.0000*
High risk	5.7425	3.8289 - 8.6124	0.0000*
WHR			
Normal	Reference	-	
Abnormal	3.6730	2.5768 – 5.2355	0.0000*

DISCUSSION

The obesity profile (defined by BMI, WC, WHR) and hypertensive status of 556 adult patients of the outpatient clinic were assessed for obesity in order to demonstrate in our own setting, the pattern of the long recognized relationship between obesity and hypertension. The rates of obesity as determined by abnormal values for BMI, WC and WHR were 60%, 65.5% and 57.4% respectively. Though the obesity rates defined by the three methods vary three-fold, each of them showed that more than half of the study population was affected implying a high rate of obesity in the population. A contributing factor to this high rate of obesity may be because a majority of the population were urban dwellers and therefore exposed to the factors of urbanization that influence obesity (Popkin *et al.*, 2012; Ellulu *et al.*, 2014; Popkin, 2001).

Another reason for the high rate of obesity could be because the study was a hospital based study using patients as study subjects. These patients may have been experiencing other obesity related problems that prompted them to be at the hospital in the first place, considering that obesity has been identified as a major risk factor contributing to the overall burden of disease worldwide (Haslam *et al.*, 2005). Furthermore, in this study, the increased risk groups for BMI and WC (i.e. overweight and action level 1 respectively) were included in the analysis as obese category.

The highest rate was observed with the WC method while the lowest rate was observed with the WHR method. Difference in rates of obesity using these three methods have been reported consistently by many researchers and many have explained that the reason for this difference is because BMI measures general obesity while WC and WHR measure central obesity, and on this basis concluded that WC was a better method (Sonmez *et al.*, 2003; Phulpoto, 2013; Romero-Corral *et al.*, 2008). The finding in this study of highest obesity prevalence with WC method seems to be in line with reports that have identified WC as a more effective method. However, in this study, WHR method which is also a measure of central obesity showed lower rates of obesity than BMI, thereby downplaying the role of central obesity as a factor in method efficiency. One study in Hong Kong found that there was an overlap between BMI and WC; and that WC and WHR were preferable for use in women while BMI and WC were more effective when used in men (Ho *et al*., 2001). The gender distribution of obese patients in this study did not seem to follow this pattern as the lowest percentage of obese females was diagnosed with WHR while the lowest percentage of males was diagnosed with WC. The prevalence of obesity seen in this study is much higher than in most other studies referred to in this text, including studies in other parts of Nigeria, and the possible reasons for this high prevalence have been put forward.

The reasons for the lower obesity rates in some of the studies may be because the study protocol did not include increased risk groups among the obese, and because the studies were community-based with larger sample sizes. In spite of the varying rates of obesity recorded by the three methods, results of our study confirmed the association between obesity and hypertension in all three methods, each of them showing a statistically significant association with hypertension as shown in Table V. This is similar to work reported by other researchers in Australia and Switzerland (Doll *et al*., 2002; Dalton *et al*., 2003). Other research workers in Turkey, Italy and Pakistan separately reporting their own findings of similar studies concluded from their results that WC rather than BMI had a strong association with hypertension and other cardiovascular diseases (Guagnano *et al*., 2001; Sonmez *et al*., 2003; Phulpoto2013).

One study reported that there seemed to be no significant relationship between BMI and hypertension (Guagnano *et al*., 2001). In variance with this, more recent studies in Africa and Asia have demonstrated that BMI is closely associated with hypertension and general obesity, and probably even stronger than the association with central obesity especially in countries at different stages of socioeconomic and epidemiologic transition and in older age groups (Wang *et al*., 2014; Doll *et al*., 2002; Tesfaye *et al*., 2007). Also the relationship between BMI, WC and blood pressure has been reported to be consistent across developed and developing countries (Doll *et al*., 2002). A possible explanation as to why the validity of BMI as a reliable method for assessing obesity, and its strong association with hypertension and other cardiovascular diseases may be an issue of controversy could be related to the level of BMI cut offs. Unlike WC and WHR, the standard BMI values are the same for both sexes and across ethnic groups. Studies have shown ethnic differences in the optimal BMI cut offs and in the BMI hypertension association (Bell *et al*., 2002; Tuan *et al*., 2009).

The correlation between BMI and cardiovascular diseases including hypertension has been shown to be stronger when age adjustment was factored in, and the relationship between obesity and hypertension has been shown to differ according to age, gender, race and geographical location (Dalton *et al*., 2003; Wakabayashi, 2012). Some of the authors have suggested a need for country-, sex-, and age- specific BMI cut offs to improve the reliability of BMI measurements. Our study has shown that obesity is significantly correlated with hypertension. Obesity is a modifiable risk factor which can be tackled by lifestyle modification. Knowing the effect of obesity on hypertension is important as it relates to prevention and control strategies through lifestyle modification. The results are however limited by the fact that it was a cross sectional study, so the associations observed between obesity and hypertension cannot be used to determine cause. A study of this nature conducted in a community setting and with a larger sample size would have given a better picture of what obtains in the larger society.

Conclusion

BMI, WC and WHR are all useful methods to determine obesity. Though there was variation in the obesity profile portrayed by each method, all three methods seem to overlap to some extent, and they were useful in correlating obesity and hypertension. Further studies are needed to further evaluate the value of each of these methods with a view to determining what categories of patients each method may best be suited for as well identifying any possible need to adjust cut off levels in certain populations.

The authors declare no conflict of interest.

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