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Original Research Article

Correlation of Indices of Obesity with Hypertension among Igbos in Enugu Metropolis

Maxwell Ubanagu Odumeh[1,2*], Chike I. P. Anibeze[1], Emmanuel Anayochukwu Esom[3], Rosemary Ngozi Njeze[2], Nto Johnson Nto[3], Elizabeth Finbarrs-Bello[4], Emeka Mgbe[2], Nneka Iloanusi[2]

[1]Department of Anatomy, Faculty of Basic Medical Science, College of Medicine, Enugu State University of Science and Technology, Enugu, Nigeria
[2]Department of Radiation Medicine, Faculty of Medical Sciences, College of Medicine, University of Nigeria Enugu Campus, Enugu, Nigeria
[3]Department of Anatomy, Faculty of Basic Medical Science, College of Medicine, University of Nigeria Enugu Campus, Enugu, Nigeria
[4]Department of Anatomy, Faculty of Basic Medical Science, College of Medicine, King David Umahi University of Medical Sciences, Uburu

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***Corresponding author:** Dr. Maxwell Ubanagu Odumeh
Department of Anatomy, Faculty of Basic Medical Science, College of Medicine, Enugu State University of Science and Technology, Enugu, Nigeria

Abstract

Background: Relationship between obesity and hypertension is well established and hypertension shows positive relationship with all obesity indices. ***Objective***: To determine the obesity indicator with the greatest sensitivity in predicting hypertension. ***Method***: A cross-sectional community-based descriptive survey was carried out in Enugu Metropolis. Multistage sampling procedures were used to select participants using the World Health Organization STEPS instrument. Height, weight, waist circumference; hip circumference and blood pressure were measured and recorded. ***Results***: A total of 482 participants were recruited; of which 160 (33.2%) and 322 (66.8%) were males and females respectively. 89 (18.5%) participants have high systolic blood pressure, 117(24.3%) have high diastolic blood pressure, while the overall hypertension prevalence is seen in 123 participants (25.5%). The blood pressure was noticed to increase as obesity increases regardless of the index of obesity used and that at WHR≥1 all the 15 participants (M:8, F:7m) that crossed that threshold were hypertensive regardless of age and sex demonstrating the sensitivity of WHR in predicting hypertension and associated cardiometabolic risks. ***Conclusion***: obesity and hypertension are interrelated and common in our environment, all the indices of obesity show positive correlation with hypertension but WHR offers a simple index that can be used to detect occult hypertension in our clinics due its 100% correlation at the WHR threshold of ≥1.

Keywords: Obesity, hypertension, indices, Igbos.

INTRODUCTION

Overweight and obesity occur when excess fat accumulation (regionally, globally, or both) increases risk to health. It is the point at which health risk is increased that is most important because body weights and fat distributions lead to expression of co-morbid diseases at different thresholds depending on the population [1, 2]. People are generally considered obese when their body mass index is over 30kg/m^2 with the range 25-30kg/m^2 defined as overweight [3].

Some Asian countries use lower values due to the fact that Asian population develops negative health consequences at a lower BMI than Caucasians. Obesity has been redefined in some Asian countries; in Japan BMI greater than 25kg/m^2 is considered obese while in China BMI greater than 28kg/m^2 defines obesity [4]. Other anthropometric parameters viz: waist circumference, waist-hip ratio, waist-height ratio and skin fold measurements in addition to BMI are also used in assessing obesity.

Overweight and obesity have been considered a serious health problem worldwide since 1997 [3], and are linked to more deaths worldwide than underweight. For example, 65% of the world's population live in countries where overweight and obesity kill more people than underweight (this includes the high income and most middle-income countries) [5]. In Europe, overweight affects 30% to 80% of European adults [6], while in Brazil and Columbia, the figure of overweight is about 40% - comparable with a number of European countries and in all regions, obesity appears to escalate as income increases [7].

Africans seem to be more susceptible to elevated blood pressure and excessive adiposity than their Europeans and Asians counterparts and easily reflect these indexes by often being more severely affected [8], this situation has been seen to be getting worse and this study more pertinent with the results showed that increased blood pressure with age is accelerated in black Africans adopting western lifestyle and is more rapid in American of African origin than those of European origin.

Amira *et al*., [9], found strong correlation between obesity and hypertension in a study of urban population Lagos southwest Nigeria while Gezawa *et al*., [10], in a study in Maiduguri also found strong link between obesity and hypertension which is more in the female gender and in ages >40years. Obesity and weight gain have been reported to be the most significant determinants of hypertension. In the Framingham study, a 10% rise in body weight is associated with a 7mmHg rise in systolic blood pressure (SBP).

The National Health and Nutrition Examination survey reported linear association between increase in Body Mass Index (BMI) and systolic, diastolic and pulse pressure in the American population and it is reported that an increase of BMI of 1.75 kg/m2 in men and 1.25 kg/m2 in women will cause 1 mm Hg rise in systolic blood pressure.

Obese people are more prone to hypertension and hypertensive patients also appear prone to weight gain. Framingham and Tecumseh [11], revealed that future weight gain is significantly higher in hypertensive than in normotensive subjects, which thus suggests that even hypertensive patients with normal weight are at increased risk of developing obesity. A potential hypothesis to explain this reverse relationship is that the enhanced sympathetic activation observed in hypertensive subjects, might lead to development of insulin resistance and subsequent obesity later in life.

Hypertension is defined as blood pressure ≥ 140/90mmHg [12], It is a disease that has placed high financial burden on patients, families as well as Nigeria Health care system. It has been consistent with the global projections of burden of diseases from 1990 -2020 [12].

The recognized global risk factors for hypertension include family history of hypertension, alcohol intake, salt intake, tobacco smoking, physical inactivity, hyperlipidemia, advancing age and obesity [12, 13]. The association between hypertension and obesity has been demonstrated by large population-based studies [14, 15], and it has been reported amongst African –Americans, Chinese and African studies. [14-17]. Tesfaye *et al*., [18], described a J- shaped relationship between BMI and blood pressures. In addition, some researchers have described a minimum threshold required for Body mass index (BMI) to be positively associated with blood pressure [19]. Africans seem to be more susceptible to elevated blood pressure and excessive adiposity than their Europeans and Asians counterparts and easily reflect these indexes by often being more severely affected [8]. This situation has been seen to be getting worse and this study more pertinent with the results showed that increased blood pressure with age is accelerated in black Africans adopting western lifestyle and is more rapid in American of African origin than those of European origin. Edward *et al*., [20], suggests that both genetic and environmental factors play roles in hypertension, 90% of which is classified as idiopathic.

The exact explanation of the relationship between obesity and hypertension is still unclear as no biological model of this association has been established however, a number of metabolic consequences of obesity have been proposed as the blood pressure elevating mechanisms. These include fluid and salt retention, Insulin resistance, and production of angiotensinogen by adipose tissue [21]. The relationship between blood pressure and body mass index has been further substantiated by the effect of weight reduction on blood pressure [21- 24].

Akinkugbe generally regarded as the father and doyen of hypertension research in Nigeria [25- 29], documented that systolic blood pressure increases with age in both sexes but less so with diastolic blood pressure and that there is no significant difference between blood pressure in rural and urban women while it is higher in urban men compare to rural men; he also noticed that there is little correlation between blood pressure and weight and with height beyond the age of 40years.

Anyanwu *et al*., [30], found high rate of correlation between hypertension and obesity in both rural and urban areas among the Igbos in south east Nigeria using anthropometric parameters; while Okamkpa *et al*., [31], in a study of adults of Igbo origin in Enugu southeastern Nigeria also found positive correlation of obesity indices with hypertension and a slightly higher hypertension burden in the females compare to the males (M=24.4%; F=28%).

The study aimed to determine the correlation of obesity indices with hypertension among Igbos resident in Enugu Metropolis and showed the most sensitive obesity indicator in predicting hypertension.

MATERIALS AND METHOD

A cross-sectional community-based descriptive survey was carried out in Enugu Metropolis. Enugu is the former capital of the defunct Eastern region which presently comprises of the five states of the southeast Nigeria and the current capital of Enugu state. People from all Igbo-speaking states are adequately represented. Its population according to 2006 population census is 722,664 [32].

The sample size was determined using Fisher's formula

$$n = \frac{Z^2 Pq}{d^2}$$

Where q = (1−P) [33]

The calculated sample size was 400, however, 482 participants were recruited to make up for cases of attrition. A stratified random sampling technique was used in the selection of this cross-sectional study. 482 apparently healthy subjects with no physical deformity were selected in this study. The cohort consisted of 160 males and 322 females with age range 18-72 years from different parts of Enugu Metropolis. Ethical approval was obtained from the Ethical Committee of Enugu state university teaching hospital, in accordance with the declaration of Helsinki. The nature of the study was explained to the participants before obtaining a verbal informed consent and only those who volunteered took part in the study and data collected during the study was kept confidential.

Participants were of Igbo ethnic nationality and resident of Enugu Metropolis for at least one year. The age range under study was between 18-72 years. Physically challenged persons, pregnant women, known diabetics, those with clinical evidence of ascites or abdominal mass and those outside the age range were excluded from the study.

The data for the study was collected from all parts of Enugu metropolis. Enugu is a cosmopolitan city with good representation of Igbos from all Igbo-speaking states. A brief medical assessment was carried out on each participant followed by anthropometric measurements and blood pressure check. The main findings were filled into the study questionnaire. Clinical data collection (by interviewer administered questionnaire) and measurements was carried out as provided in the WHO STEPS instrument on surveillance of behavioral risk factors (version 2). All the measurements were conducted in strict privacy where the participants were neither heard nor seen by other people.

Oral Informed consent was also obtained from the participants before their inclusion into the study using consent form. In this case, the nature of the study was explained to the participants in the language they understood. Anthropometric measurements were collected directly and with the help of trained research nurses and students.

Anthropometric Measurements

Height

Participant height was measured with a rigid tape stadiometer (SECA: Model 213 Hamburg Germany) in accordance to the World Health Organization (WHO) multinational monitoring of trends and determinants in cardiovascular disease criteria. To measure height, shoes and headgears were removed with participant standing back to the tape measure. A flat rule was placed on the participant's head, so that their hair (if present) was pressed flat. Height was measured to the nearest centimeter, at the level where the flat rule touches the rigid rule [34].

Weight

Weight was estimated to the nearest 0.1kg using a Hanson bathroom scale which is placed on a hard, even surface and adjusted to zero mark after each measurement. Participants are weighed wearing minimal clothes and no footwear. The weights were recorded to the nearest 0.1kilogram (kg) [34].

Body Mass Index (BMI)

The BMI also known as "Quetelet's index" is an index that uses the variables weight and height to measure body fat and protein stores. It is calculated as the rapport of weight in kilogram by square of height in meters (m^2). BMI (kg/m^2) = weight (kg)/height (m^2)

Waist Circumference

Subject was lightly dressed without accessories to identify the measurement reference points. Measure was taken at the midpoint between the lowest rib and the iliac crest with just sufficient tension to avoid slipping off but without compressing the skin. The measurement is made at the end of a normal expiration to the nearest 0.1cm [34].

Hip Circumference

Hip circumference was measured at the widest point of the buttocks using standard tailor measuring tape with a maximum length 150 cm. The subject stands erect, the tape was placed at the maximum extension of the buttocks, (usually at the level of the greater trochanter) horizontal to the floor, with sufficient tension to avoid slipping off but without compressing the buttocks and value recorded to the nearest 0.1cm [34].

WAIST – HIP RATIO

This was calculated as waist circumference divided by hip circumference ($W \div H$).

WAIST-to-HEIGHT RATIO

This was calculated by waist circumference divided by the height (W÷Ht)

Skinfold Measure

The skin fold included two thickness; one of skin and one of the subcutaneous fats pinched up between the thumb and index finger but no muscle or fascia in place, the contact surface of the caliper was at a 90^0 angle to the skinfold approximately 1cm below the fingers. A digital skinfold caliper was used to read the measurement to the nearest 0.1mm. This study used the sum of the triceps, biceps, subscapula and supriailiac skinfolds to produce an estimate of body fat for females and males. Biceps skinfold (BSF) was measured in the midline at the anterior aspect of the arm over the biceps muscle. The triceps skinfold (TSF) was measured in midline of the posterior aspect of the arm over the triceps muscles, midway between the acromion and the inferior margin of the olecranon. The subscapular skin fold (SSF) was taken about 2cm beneath the inferior angle of the scapula. The suprailiac skinfold (SISF) is a diagonal fold immediately above the iliac crest. Once completed the sum of the measurements of the four sites was read from the standard Durnin &Womersley table as % body fat [35].

Blood Pressure Measure

The blood pressure was measured using auscultatory method with standard mercury in glass Accuson sphygmomanometer. Prior to the measurement, the patient was seated and rested for 5 minutes in sitting position on a chair that supported the back comfortably. The left arm muscles were relaxed and the forearm supported with the cubital fossa at the heart level. A cuff of suitable size was applied evenly to the exposed arm. The cuff was rapidly inflated until the manometer reading was about 30 mmHg above the level at which the pulse disappeared and then slowly deflated. During this time, the Korotkoff sounds was monitored using a Litman stethoscope placed over the brachial artery. The systolic blood pressure was noted at the pressure at which the first heart sounds was heard (Korotkoff phase I). Diastolic blood pressure was taken as the pressure at the point when the heart sounds disappear [26].

Measurement Cut-Off Points

Based on WHO definition for cardiovascular disease risk, the following were accepted as cut-off points for obesity, BMI > 30 Kg/m²; WC > 94cm for men and 80cm women; %body fat ≥ 25% for men and ≥ 32% for women; WHR > 1.0 in men and ≥0.85 in women; WHtR > 0.5 was used as cut-off point for both genders. Following WHO standard for definition of elevated blood pressure, the following were accepted as elevated BP, systolic blood pressure (SBP) ≥ 140mmHg and/or diastolic blood pressure (DBP) ≥ 90mmHg [34].

Statistical Analysis

The data obtained was coded and analyzed into frequencies, percentages and mean using the Statistical Package for Social Sciences (SPSS), version 17. Chi-square (x) test was used to compare categorical variables for associations while multi-nominal logistic regression shall be used to examine correlates. Statistical significance is set at $p< 0.05$ and 95% confidence interval.

RESULTS

A total of 482 subjects participated in the study, this comprises 322 females (66.8%) and 160 male (33.2%)

Table 1: Shows the mean value of measured anthropometric indices by age and sex.

INDICES	AGE-RANGE	FEMALE	MALE	P-VALUE
HEIGHT	18-30 years	162.7±7.3	174.8±6.1	0.00
	31-50 years	161.5±5.8	171.7±7.9	0.00
	51-72 years	158.0±7.5	164.3±8.0	0.01
WEIGHT	18-30 years	61.8±10.7	71.3±8.9	0.00
	31-50 years	75.5±14.8	79.1±13.8	0.13
	51-72 years	73.7±16.1	61.4±18.1	0.02
WAIST CIRCUMFERENCE	18-30 years	78.7±8.9	79.4±7.2	0.53
	31-50 years	94.3±11.6	92.9±11.7	0.44
	51-72 years	96.8±12.9	86.9±9.7	0.01
HIP CIRCUMFERENCE	18-30 years	97.9±10.8	94.5±12.2	0.02
	31-50 years	108.9±10.5	102.3±7.9	0.00
	51-72 years	106.8±10.3	93.9±8.3	0.00
WAIST-TO-HIP RATIO	18-30 years	0.80±0.05	0.83±0.04	0.00
	31-50 years	0.87±0.07	0.91±0.06	0.00
	51-72 years	0.91±0.07	0.92±0.05	0.47
WAIST-TO-HEIGHT RATIO	18-30 years	0.49±0.06	0.46±0.04	0.00
	31-50 years	0.59±0.07	0.54±0.07	0.00
	51-72 years	0.61±0.07	0.53±0.05	0.00

INDICES	AGE-RANGE	FEMALE	MALE	P-VALUE
PERCENTAGE BODY FAT	18-30 years	24.0±5.8	8.7±4.6	0.00
	31-50 years	32.7±6.7	18.2±6.6	0.00
	51-72 years	36.2±6.8	14.9±5.4	0.00
BMI	18-30 years	23.3±3.9	23.6±3.0	0.57
	31-50 years	29.0±5.2	27.1±4.6	0.02
	51-72 years	29.4±5.1	23.8±3.8	0.00

The mean height of the male subjects was significantly ($p<0.05$, ANOVA) higher compared to the females.

The mean weight of the male subjects was significantly ($p<0.05$, ANOVA) higher compared to the females at 18-30years and was significantly ($p<0.05$, ANOVA) higher in the females compared to the males at age 51-72 years.

The mean waist circumference of the female subjects was significantly ($p<0.05$, ANOVA) higher compared to the males at age 51-72 years.

The mean hip circumference of the female subjects was significantly ($p<0.05$, ANOVA) higher compared to the males at age in all the age groups.

The mean waist-to-hip ratio of the male subjects was significantly ($p<0.05$, ANOVA) higher compared to the females at age 18-30 and 31-50 years

The mean waist-to-height ratio of the female subjects was significantly ($p<0.05$, ANOVA) higher compared to the males in all the age groups.

The mean percentage body fat of the female subjects was significantly ($p<0.05$, ANOVA) higher compared to the males in all the age groups.

The mean body mass index of the female subjects was significantly ($p<0.05$, ANOVA) higher compared to the males at 31-50 and 51-72 age groups.

Table 2: Shows Overall Hypertension

BP	Frequency	Percent
Hypertensive	123	25.5
Normotensive	359	74.5
Total	482	100

Table 2 shows combined systolic and diastolic blood pressure and reveals that 25.5% of the participants were hypertensive.

Table 3: displays the summary of gender WHR ≥ 1.0 cross tabulation.

Gender	Frequency	Number of Hypertensives	% of Hypertensives
Male	8	8	100
Female	7	7	100
Total	15	15	100

Table 3 reveals the summary of gender WHR ≥ 1.0 cross tabulation. 15 participants (8 males and 7 females) with WHR ≥ 1.0 were hypertensive

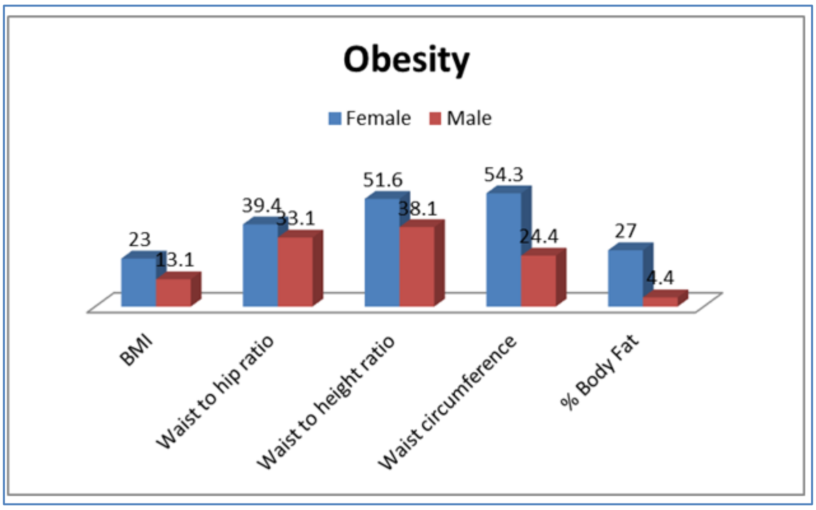

Figure 1: Shows obesity prevalence of the participants using the various obesity indices

It shows that using BMI 23% and 13.1% of females and males were obese respectively, there was significant (X2=8.885a, p<0.05) difference in the prevalence of obesity using BMI between males and females.

Using Waist to Hip Ratio 39.4% and 33.1% of females and males were obese respectively, there was no significant (X2=1.822a, p>0.05) difference in the prevalence of obesity using Waist to Hip Ratio between males and females.

Using Waist to Height Ratio 56.1% and 38.1% of females and males were obese respectively, there was significant (X2=6.827a, p<0.05) difference in the prevalence of obesity using Waist to Height Ratio between males and females.

Using Waist circumference 54.3% and 24.4% of females and males were obese respectively, there was significant (X2=38.898a, p<0.05) difference in the prevalence of obesity using Waist circumference between males and females.

Using Percentage body fat 27% and 4.4% of females and males were obese respectively, there was significant (X2=34.910a, p<0.05) difference in the prevalence of obesity using Percentage body fat between males and females.

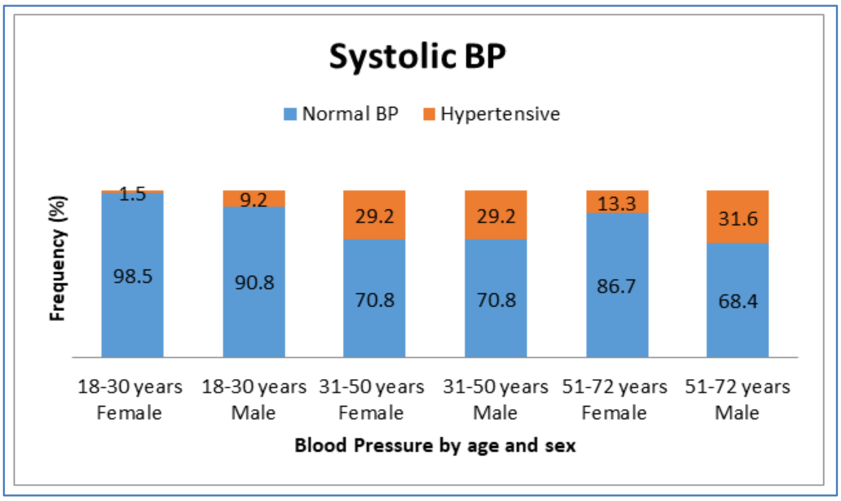

Figure 2: Shows systolic blood pressure of the participants by gender and age group

At age 18-30 years 1.5% and 9.2% of females and males respectively, had systolic high blood pressure. This was significantly (X2=9.121a, p<0.05) higher in the males compared to females. At age 31-50 years both females and males had 29.2% systolic high blood pressure (X2=0.000c, p>0.05)

At age 51-72 years 13.3% and 31.6% of females and males respectively, had systolic high blood pressure. This was significantly (X2=15.581d, p<0.05) higher in the males compared to females.

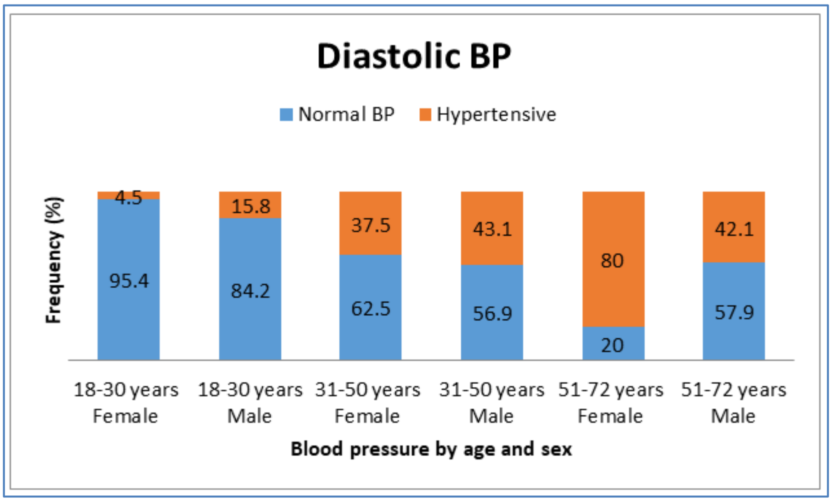

Figure 3: Shows Diastolic Blood pressure of Subjects by Sex and Age range

At age 18-30 years, 4.5% and 15.8% of females and males respectively, had diastolic high blood pressure. This was significantly (X2=9.638a, p<0.05) higher in the males compared to females.

At age 31-50 years 37.5% and 43.1% of females and males respectively, had diastolic high blood pressure (X2=0.503c, p>0.05)

At age 51-72 years 80% and 42.1% of females and males respectively, had diastolic high blood pressure. This was significantly (X2=7.581d, p<0.05) higher in the females compared to males.

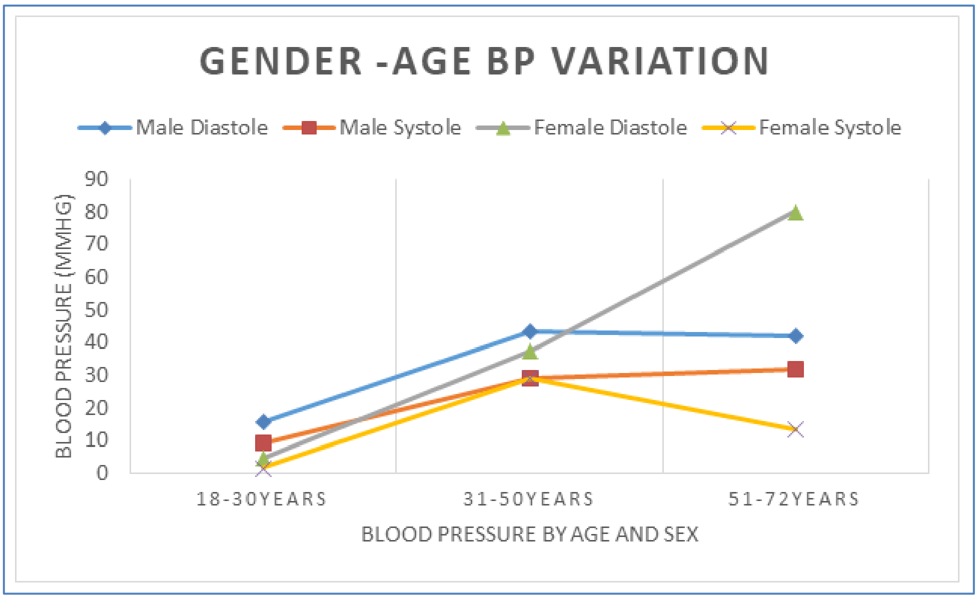

Figure 4: Shows combined isolated diastolic and systolic blood pressure by sex

At 18 -30 years and 31-50 years males have higher diastolic blood pressure compared the females. At 51-72years the diastolic blood pressure in the female spikes higher than that of the males. Systolic blood pressure in the males at age 18-30 years was higher compare to the females. At age 31-50 the systolic blood pressure in the male and female subjects was comparable. At age 51-72 years the systolic blood pressure was higher in the males compared to the females.

Table 4: Summary of the correlation of indices of obesity with hypertension

BMI Group	WC	SBP	DBP	WHR	1% Body Fat	WHtR
Class I	101±7.1	127.9±31.6	86.6±11.2	0.9±0.007	33.5±7.7	0.6187±00.4
Class II	116±6.8	135.5±40.5	92.5±13.3	0.9±00.8	37.5±7.8	0.692±0.05
Class III	116.0±8.5	140±28.3	95.0±21.2	0.9±0.04	39.4±2.9	0.7123±0.04
NW	77.5±6.2	116.7±17.8	80.0±41.1	0.8±0.05	17.9±8.4	0.4664±0.04
OW	90.7±7.6	126.5±19.1	82.8±11.2	0.9±0.07	26.9±7.8	0.5515±0.05
UW	69.7±4.0	111.7±9.4	72.5±4.5	0.8±0.04	14.2±4.7	0.3949±0.16

This table shows positive linear correlation between blood pressure and all the indices of obesity (p<0.05)

DISCUSSION

In this study we compare the association between obesity indices and hypertension using 482 apparently healthy adults (Female=322; Male=160). The gender bias in favor of females in this particular study may be explained by one of the anthropological characteristics of the traditional Igbo society where health seeking by men who are expected to face life with stoicism is considered effeminate. The anthropometric parameters show some significant differences between male and female participants; male participants were taller in all the age ranges; heavier in the young and middle age groups but the female participants were heavier in the elderly group and this could be explained by the earlier onset of age- related sarcopenia in males with consequent loss of muscle mass. Among the indices of obesity, only Waist-Hip Ratio showed significantly higher mean values among the male participants while the rest show greater mean value in the female participants. In our previous study we have reported obesity prevalence ranges from 19.7% to 47.7% [36]. The overall hypertension in this study was 25.5% with isolated systolic and diastolic hypertension in 18.5% (SBP) and 24.3% (DBP) of participants; this lower than the hypertension prevalence obtained by Ofoegbu *et al.*, [37], which is at 47.7%.

Hypertension is slightly more prevalent in males in both systolic and diastolic hypertension with prevalence of 20% and 30% against 17.7% and 21.4% for females; this result is comparable to the one obtained by Okamkpa *et al.*, [31], in a study of adult Igbo population in Southeastern Nigeria which gives hypertension prevalence rate at 24.4% and 28% for males and females respectively.

The overall prevalence of hypertension in the study is 25.5% and it was also observed that the prevalence increases with obesity and age; at age 18-30 there is insignificant difference in systolic blood pressure between the genders being greater in males than females; at the age 31-50 which roughly corresponds to the early middle age the systolic blood pressure between the genders equalizes while at the age 52-72 which in the female is the postmenopausal age, systolic blood pressure of the male becomes greater than those of the female in the elderly but the diastolic blood pressure in the female becomes significantly greater in the postmenopausal age, this might be explained by loss of the vasodilatory effect of estrogen and progesterone also by the loss of anti-inflammatory and cholesterol lowering effects of estrogen in the postmenopausal ages. This association was significant ($P = 0.03$). The odd for developing high blood pressure in the presence of obesity was 1.5 (95% CI: 1.1-2.1).

This study has demonstrated that abdominal obesity is no longer the disease of affluent countries alone and has corroborated the reports that abdominal obesity exist in Nigeria in various proportion and that hypertension is strongly associated ($p<0.05$) with abdominal obesity ranging from 37.3-47.7%. This finding is in consonance with the reports of the co-occurrence of hypertension among abdominally obese patients in Okirika, South-South Nigeria, Ogbomoso, South-West Nigeria, United States of America and Jamaica [38- 41].

It was also discovered in this study that all the participants with WHR≥ 1.0 were hypertensive regardless of gender meaning that WHR is an excellent predictor of cardiovascular risk of obesity (hypertension) at and beyond the critical cut off point of 1.0)

LIMITATIONS

Study is limited to the population of Igbo ethnic nationality but the result may not likely differ from those of other ethnic groups

CONCLUSION

The result of this study has shown that obesity is strongly associated with hypertension; it also demonstrated a peculiar relationship between WHR and hypertension in which all participants with WHR≥1.0 were found to be hypertensive making WHR an extremely sensitive predictor of hypertension which can be applied in our clinics.

What Is Known About the Study

- Obesity is a cardiovascular risk factor
- Hypertension correlates positively with Obesity Indices

What This Study Adds

- At the critical WHR cut-off of ≥1, there is 100% correlation with hypertension.
- WHR is superior to other indices of obesity in assessing cardiovascular risks.
- Blood pressure is more in young males than females, at par in both sexes by middle age and greater in the female gender in the elderly.

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COMPETING INTERESTS: The authors declare no competing interests.

AUTHOR'S CONTRIBUTIONS

Conceptualization and design: Maxwell Ubanagu Odumeh, Chike Ikechukwu Patrick Anibeze, Rosemary Ngozi Njeze, Emmanuel Anayochukwu Esom

Methodology: Maxwell Ubanagu Odumeh, Chike Ikechukwu Patrick Anibeze, Rosemary Ngozi Njeze, Elizabeth Finbarr-Bello, Emmanuel Anayochukwu Esom

Data acquisition, analysis and interpretation: Maxwell Ubanagu Odumeh, Nto Johnson Nto, Chike Ikechukwu Patrick Anibeze, Emeka Mgbe.

Writing- original draft preparation: Maxwell Ubanagu Odumeh, Emmanuel Anayochukwu Esom, Emeka Mgbe, Elizabeth Finbarr-Bello, Nneka Iloanusi, Nto Johnson Nto

Writing – Review and Editing: Maxwell Ubanagu Odumeh, Nneka Iloanusi, Elizabeth Finbarr-Bello, Emeka Mgbe, Nto Johnson Nto.

The final version was read and approved by all authors.

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