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Original Research Article

Waist to Height Ratio a reliable Indicator of Obesity in Igbos of Enugu Metropolis

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Abstract

***Background*:** Obesity could be generalized or truncal/android and most of the pathologies linked to obesity is with the android obesity. There is multiplicity of indices for measuring obesity hence the need for simple but sensitive and accurate index of assessing obesity. ***Objective*:** the aim was to determine the index that is simple, accurate and sensitive in detecting obesity. ***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. Ethical approval and consents were duly and respectively obtained from the Ethics Committee of the Enugu state university of science and technology Enugu. The data obtained were 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 was used to examine correlates. Statistical significance is set at $p < 0.05$ and 95% confidence interval. ***Result*:** A total of 482 participants were recruited; of which, 33.2% and 66.8% were males and females respectively. By BMI, 95(19.7%) were obese; 180(37.3%) were considered obese by WHR; 94(19.5%) were obese by %body fat; while 214(44.4%) were obese by WC and 230(47.7%) were obese by WHtR. ***Conclusion*:** The superiority of WHtR in detecting obesity is clearly demonstrated in this study and this can easily be applied in our clinics.
Keywords: WHtR, obesity, indices, Enugu.

INTRODUCTION

Obesity is a multifactorial pathology that can be related to an altered nutritional behavior or secondary to genetic, hypothalamic, iatrogenic or endocrine diseases [1]. At the base of obesity is adiposopathy (or "sick fat") defined as "pathologic adipose tissue anatomic/functional disturbances promoted by positive caloric balance in genetically and environmentally susceptible individuals that result in adverse endocrine and immune responses that may cause or exacerbate metabolic disease" [1].

The Obesity Medicine Association's definition of obesity is "a chronic, relapsing, multifactorial, neurobehavioral disease, wherein an increase in body fat promotes adipose tissue dysfunction and abnormal fat mass physical forces, resulting in adverse metabolic, biomechanical, and psychosocial health consequences" [2].

There has been increasing trend in global obesity since the 1980s with large regional differences using the traditional BMI [3]. The estimated total numbers of overweight and obese adults in 2005 were 937 million (922–951 million) and 396 million (388–405 million), respectively and by 2030, the respective number of overweight and obese adults was projected to be 1.35 billion and 573 million individuals without adjusting for secular trends [4].

If recent secular trends continue unabated, the absolute numbers were projected to total 2.16 billion overweight and 1.12 billion obese individuals and is estimated that by 2025 some 268 million children aged 5-17 years may be overweight, including 91 million obese, assuming no policy interventions have proven effective at changing current trends [5]. 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 [6].

Some Asian countries use lower values due to the fact that Asian population develops negative health consequences at a lower BMI than Caucasians and redefined obesity; Japan have defined obesity as any BMI greater than 25kg/m^2 while China uses a BMI of greater than 28kg/m^2 [7, 8].

Aside BMI other parameters like Waist Circumference (WC), waist-Hip Ratio, Waist-to-Height Ratio, and Skin Fold measurement are also used to assess obesity. Causes of Obesity at individual level, include a combination of excessive food, energy intake and a lack or diminished physical activity [9, 10]. A limited number of cases are due primarily to genetics, medical reasons, or psychiatric illness. Increasing rates of obesity at a societal level are felt to be due to an easily accessible and palatable diet, increased reliance on automation [11]. Overweight and obesity have been considered a serious health problem worldwide since 1997 [12] 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) [13].

Following the UK, Spain is the second European Union Country with the highest increases in obesity prevalence over the past decade, and is currently responsible for approximately 5.5percent of total mortality due to obesity and 18,000 deaths, annually [14]. The prevalence of obesity is still very low in China, Japan, and many countries in Africa [15]. Nigeria is witnessing both demographic and epidemiologic transitions and these could be some of the possible reasons why the prevalence of non-communicable diseases is increasing [16]. Anibeze *et al.*, [17] demonstrated obesity prevalence 1.65% based on BMI among adolescents of Southeast Nigeria; while Ekezie *et al.*, [18] noticed greater prevalence of both general and abdominal obesities Igbo women of Southeastern Nigeria.

In the advanced western Nations obesity is stigmatized, commoner with people of lower socio-economic status and can lead to detrimental psychological, physical, and societal consequences which may further perpetuate the increasing prevalence of obesity [19]. In the eighteenth century in the western nations, obesity was viewed as a sign of opulence and was then higher with the elites [20]. Obesity increases the risk of many physical and mental conditions, the strength of the link between obesity and specific conditions varies, one of the strongest is the link with type 2 diabetes. Obesity underlies 64% of cases of diabetes in men and 77% of cases in women [21]. Health consequences associated with obesity fall into two broad categories; Those attributable to the mass effect of fat which include (Osteoarthritis, Obstructive sleep apnea, social stigmatization) and those due to the increased number of fat cells (diabetes, cancer, cardiovascular disease, non- alcoholic fatty liver disease) [22].

For instance, in Nigeria, presently about eight million people are suffering from hypertension, four million are diabetic and 100,000 new cases of cancer are diagnosed each year [23].

According to Health Reform Foundation of Nigeria (HERFON), about five million Nigerians may die of non- communicable disease (NCDs) by the year 2015, and diabetes alone is projected to cause about 52% the mortality. Also, the economic cost of obesity related diseases in Nigeria is enormous. In 2005, it was about 400million dollars, and by 2015 it is estimated to rise to eight billion dollars [24].

The study aimed to determine the most sensitive, accurate and reliable index of obesity among Igbos in Enugu Metropolis.

MATERIALS AND METHOD

This was a cross-sectional community-based descriptive survey 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 [25].

The sample size was determined using Fisher's formula;

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

where q=(1−P) [26, 27]

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. Authentication of ethnicity was by patient admittance and name. 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 will be 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.

Different examination rooms were dedicated to males and females respectively and a chaperone provided where necessary. 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, the participants were asked to take off their shoes, (and with heels together, toes apart, ensuring that weight is evenly distributed on both feet) hat or head ties, stand with back to the tape measure, and hold their head in a position where he/she can look straight at a spot head high on the opposite wall. 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 [28].

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) [28].

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) [28].

WAIST CIRCUMFERENCE:

The subject was dressed as for the weight measurement and is standing erect. He/she was asked to roll up the shirt/sweater, to undo the belt and/or open and lower the trouser/skirt waistband, so that the hip area is identified as the measurement reference points. The measure was taken at the midpoint between the lowest rib and the iliac crest. The measuring tape was placed perpendicular to the long axis of the body and horizontal to the floor, with 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 [28].

HIP CIRCUMFERENCE:

Hip circumference was measured at the widest point of the buttocks. Standard tailor measuring tape, maximum length 150 cm was used for hip measurement. The subject stands erect, the weight evenly distributed on both feet. 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. The tape was held a bit tighter but without compressing the buttocks. The zero end of the tape was held under the measurement value recorded to the nearest 0.1cm [28].

WAIST – HIP RATIO

Waist–hip ratio or waist-to-hip ratio (WHR) is the ratio of the circumference of the waist to that of the hip. This was calculated as waist measurement divided by hip measurement ($W \div H$).

WAIST-to-HEIGHT RATIO

Waist-to-height ratio (WHtR) is the ratio of the circumference of the waist to that of the height.

SKINFOLD MEASURE:

To measure the skin thickness a fold of the participant's skin was pinched up (between thumb and Index finger) and lifted up. The skin fold included two thickness; one of skin and one of the subcutaneous fat 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 midway between the acromiale and radiale, approximately the elbow joint. The triceps skinfold (TSF) was measured in midline of the posterior aspect of the arm over the triceps muscles, midway between the lateral projections of acromion process of the scapula and the inferior margin of the ulna olecranon process. The subscapular skin folds (SSF) were taken about 2cm beneath the inferior angle of the scapula. The suprailiac skinfold (SISF) is a diagonal fold; in line with the natural angle of the iliac crest. Once completed the sum of the measurements of the four sites was read from the standard table (Durnin &Womersley table) as % body fat [29].

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 > 0.9 in men and > 0.85 in women; WHtR > 0.5 was used as cut-off point [28].

DATA 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.

RESULT

This is the data presentation, analysis, and interpretation of various parameters measured and has been summarized in the tables and figures below.

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

Table 1: Mean Height of Study Subjects by Sex and Age Range

Age-range	Female Mean±SD	Male Mean±SD	p-value
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
	161.9±7.0	172.3±7.8	0.00

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

Table 2: Mean Weight of Study Subjects by Sex and Age Range

Age-range	Female Mean±SD	Male Mean±SD	p-value
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
	67.0±14.2	73.3±13.5	0.00

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.

Table 3: Mean Waist Circumference of Study Subjects by Sex and Age Range

Age-range	Female Mean±SD	Male Mean±SD	p-value
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
	85.1±12.9	85.7±11.4	0.54

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

Table 4: Mean Hip Circumference of Study Subjects by Sex and Age Range

Age-range	Female Mean±SD	Male Mean±SD	p-value
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
	102.0±11.8	97.6±10.9	0.00

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.

Table 5: Mean Waist-to-Hip ratio of Study Subjects by Sex and Age Range

Age-range	Female Mean±SD	Male Mean±SD	p-value
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
	0.84±0.07	0.87±0.06	0.02

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

Table 6: Mean Waist-to-Height ratio of Study Subjects by Sex and Age Range

Age-range	Female Mean±SD	Male Mean±SD	p-value
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
	0.53±0.08	0.93±0.08	0.00

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.

Table 7: Mean Percentage Body fat of Study Subjects by Sex and Age Range

Age-range	Female Mean±SD	Male Mean±SD	p-value
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
	27.7±7.8	13.2±7.2	0.00

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

Table 8: Mean Body Mass Index of Study Subjects by Sex and Age Range

Age-range	Female Mean±SD	Male Mean±SD	p-value
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
	27.7±7.8	13.2±7.2	0.00

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.

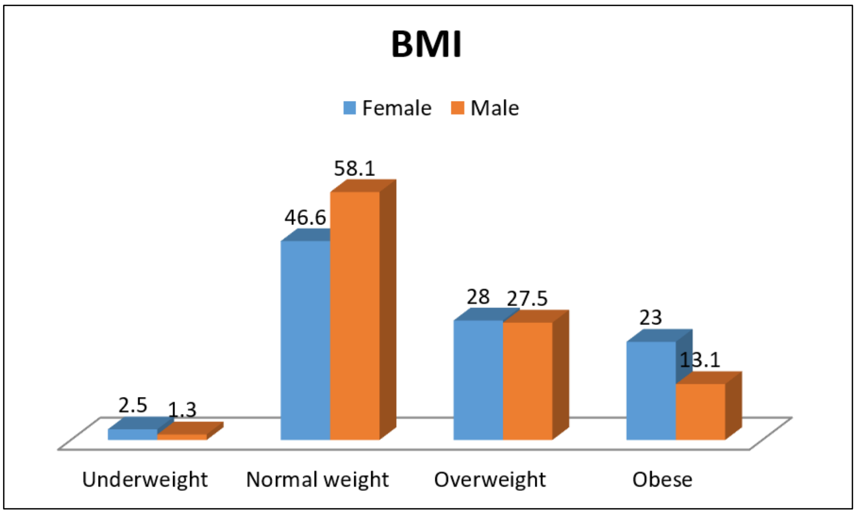

Fig. 1

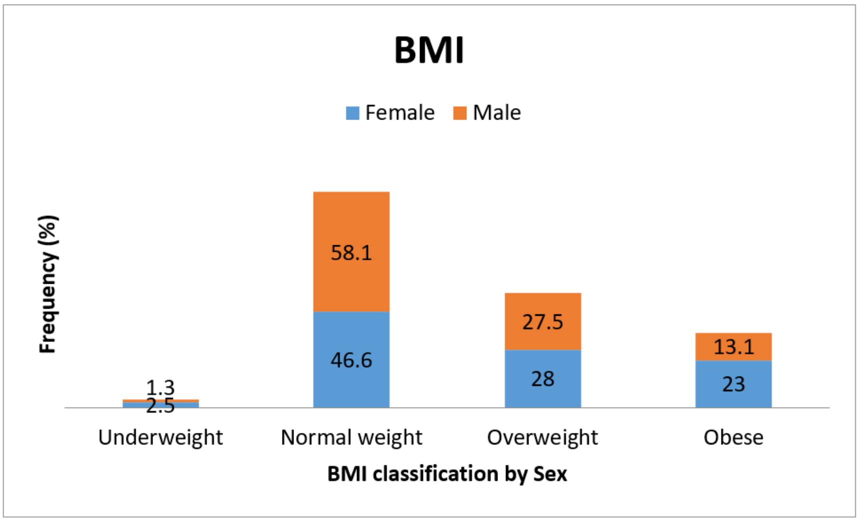

Figure 2: BMI classification by Sex

Figure 2 shows that BMI distribution by Sex, 23% and 13.1% of females and males respectively, were obese. This was significantly (X2=8.885a, $p<0.05$) higher in the females compared to the males.

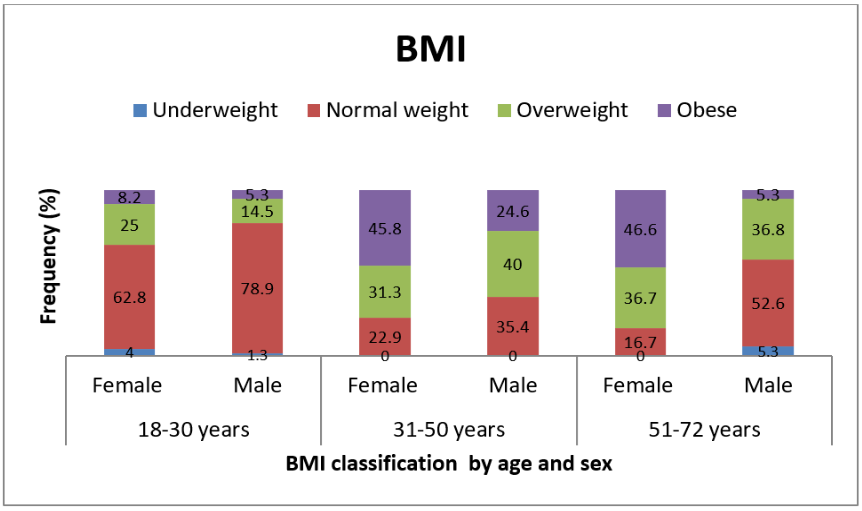

Figure 3: Body Mass Index Classification of Subjects by Sex and Age range

Figure 3 shows that at age 18-30 years, there was no significant (X2=6.778a, p>0.05) difference in the pattern of BMI between males and females.

At age 31-50 years, 45.8% and 24.6 % of females and males respectively, were obese. There was a significant (X2=7.691b, p<0.05) difference in the pattern of BMI.

At age 51-72 years, 46.6% and 5.3 % of females and males respectively, were obese. There was a significant (X2=13.008c, p<0.05) difference in the pattern of BMI.

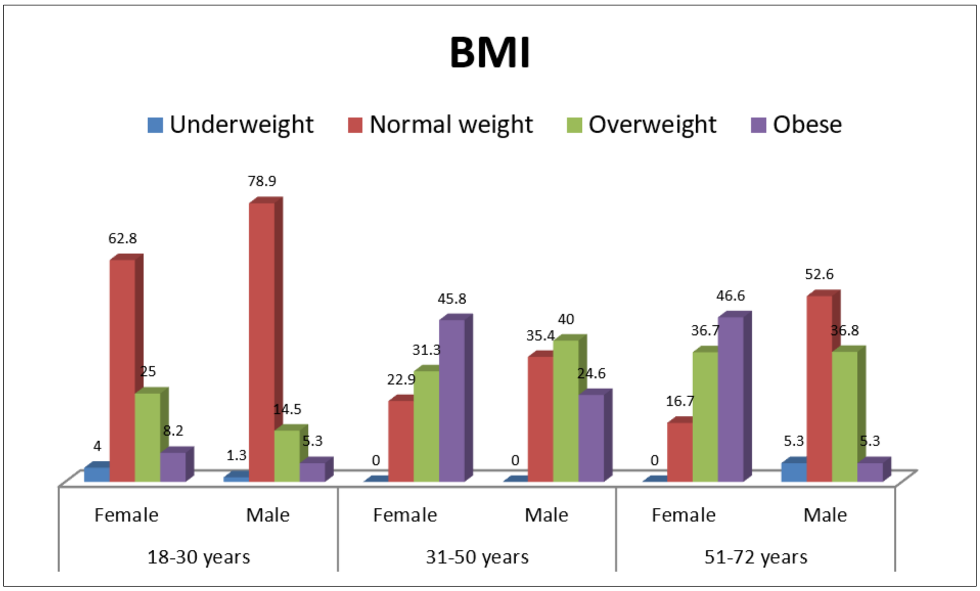

Figure 4: Body Mass Index Classification of Subjects by Sex and Age range

Figure 4 shows that at age 18-30 years, there was no significant (X^2=6.778[a], p>0.05) difference in the pattern of BMI between males and females.

At age 31-50 years, 45.8% and 24.6 % of females and males respectively, were obese. There was a significant (X^2=7.691[b], p<0.05) difference in the pattern of BMI.

At age 51-72 years, 46.6% and 5.3 % of females and males respectively, were obese. There was a significant (X^2=13.008[c], p<0.05) difference in the pattern of BMI.

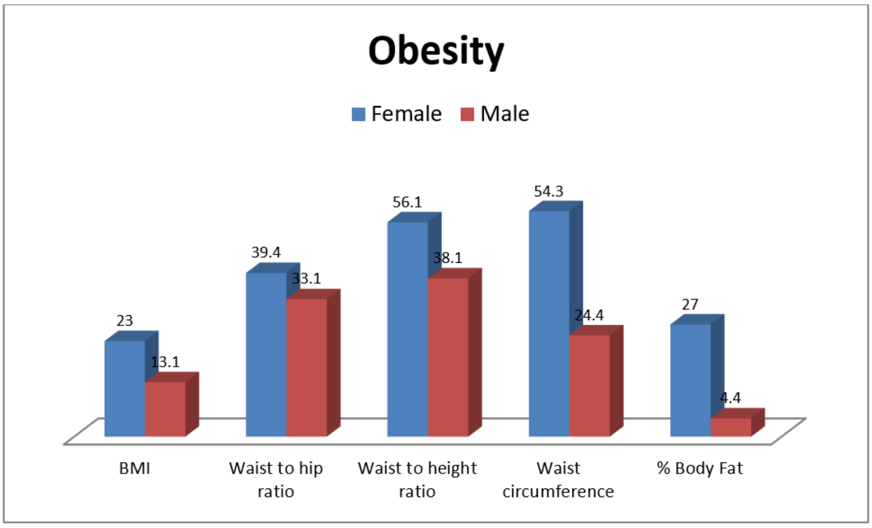

Figure 5: Obesity prevalence by different indices of obesity and gender

Figure 5 shows that using BMI 23% and 13.1% of females and males were obese respectively, there was significant (X^2=8.885[a], 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 (X^2=1.822[a], 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 (X^2=6.827[a], 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 (X^2=38.898[a], 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 (X^2=34.910[a], p<0.05) difference in the prevalence of obesity using Percentage body fat between males and females.

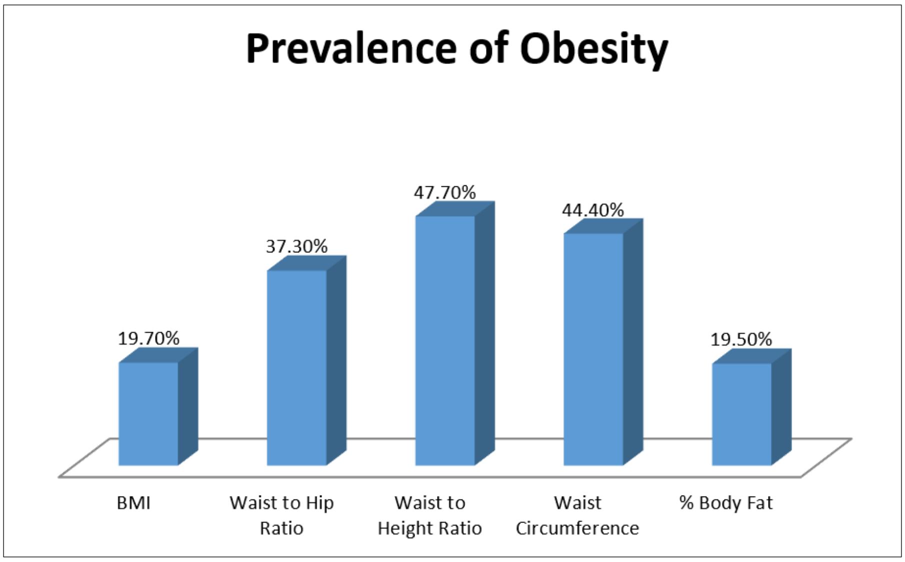

Figure 6: Obesity prevalence by different indices of obesity

Figure 6 shows that WHtR had the highest prevalence followed by WC.

DISCUSSION

This study was undertaken to determine the most sensitive and reliable indices of obesity among Igbos in Enugu Metropolis using various anthropometric parameters. In this study 482 apparently healthy subjects (322 –female 66.8%; 160-male 33.2%) were drawn from age range of 18 to 72 year. The gender bias in favor of females (66.8%) in this particular study may be explained by one of the anthropological characteristics of the traditional Igbo society where health seeking is considered a feminine behavior until an illness becomes severe when it can no longer be ignored.

In this study the prevalence of obesity using the various anthropometric parameters are as follows: %BF=19.5%; BMI=19.7%; WHR=37.3%; WC=44.4% and WHtR=47.7%. The sensitivity of BMI in detecting obesity is slightly superior to that of %BF which is more tedious to calculate compare to the easier BMI. With 47.7% and 44.4% obesity by WHtR and WC respectively, this study shows that WHtR is the most sensitive obesity index among Igbos in Enugu Metropolis followed closely by WC while %BF is the least sensitive and this could explain its relatively poor application in our clinics.

The values by BMI and percentage body fat compare well with the values obtained from the study carried by Amira *et al.*, [30] which is at 22.2% and Okafor *et al.*, [31] at 21.2% prevalence rates and higher than the prevalence of 2.3% reported in a study by Olufemi and Abiodun [32] in Lagos, but lower than the results obtained from a study in America by Ogden *et al.*, [11] which is at 30% .The results from waist circumference which gives the prevalence of obesity at 44.4% differs from the study by Ilo *et al.*, [33] which shows prevalence of 11.6%; and also more than 31.7 % reported among adult patients in rural hospital in Okrika River State, South South Nigeria by Siminnialayi *et al.*, [34], 21.7% reported in Abia State, South East Nigeria by Chukwuonye *et al.*, [35], 33.8% reported in Ogbomosho south West Nigeria by Amole *et al.*, [36] and 32 % reported in Cotonou, Benin Republic by Sodjinou *et al.*, [37]. The highest prevalence by waist height ratio (47.7%) has the advantage of being independent of gender, race, age and is easily calculated.

This high prevalence of android obesity measured by both WHR and WHtR at 37.3% and 47.7%

respectively are lower than that obtained in a study by Ekezie *et al*., [18] which is 66% and 60% for WHR and WHtR respectively.

CONCLUSION

The result of this study has shown that obesity is already a health problem among Igbos in Enugu Metropolis, that %Body fat which is more laborious is less sensitive than BMI in detecting general obesity while WHtR is superior to all the obesity indices used in this work with a staggering obesity ratio of 47.7% against the lowest from %BF which is at 19.5%

Limitations

Study is limited to the population of Igbo ethnic nationality but may unlikely to differ from those of other ethnic groups.

What is known about the study

1. WC, WHR and WHtR are indices of central obesity.
2. Central obesity has a stronger correlation with cardiovascular risks than general obesity measured by BMI.
3. Obesity is associated various malignancies.

What this study adds

1. WHtR is the most sensitive indicator of obesity among the Igbos.
2. %BF is laborious and inefficient in detecting obesity.
3. obesity is on the rise among the Igbos of Nigeria.

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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.
- **Methodology:** Maxwell Ubanagu Odumeh, Chike Ikechukwu Patrick Anibeze, Rosemary Ngozi Njeze, Elizabeth Finbarr-Bello
- **Data acquisition, analysis and interpretation**: Maxwell Ubanagu Odumeh, Nto Johnson Nto, Chike Ikechukwu Patrick Anibeze, Emeka Mgbe.
- **Writing- original draft preparation**: Maxwell Ubanagu Odumeh, 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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