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Obesity Determined by Different Measures and its Impact on the Health-Related Quality of Life of Young-Adult Nigerians

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ABSTRACT

The prevalence of overweight/obesity is rising in developing countries yet their effects on the Quality Of Life (QOL) of Nigerians have not been assessed. This study therefore investigated the prevalence of obesity determined by different tools and their effects on the QOL of young Nigerians. Internationally accepted protocols were employed for the anthropometric diagnosis of obesity while the percentage body fat was estimated using a bioelectrical impedance analysis device. The QOL of the subjects were assessed by subjective self-report. Appropriate statistical analyses were performed on the data generated. A total of 2000 young-adult Nigerians (50% females) were studied. The results show that a total of 17, 3.9, 0.4, 11.9 and 18% of the population were overweight/obese, when BMI, WC, WHpR, WHtR and percentage body fat, respectively, were used as diagnostic criteria. There was a clear female preponderance of obesity in the population. As much as 12.4% of the population were completely dissatisfied with their QOL and the QOL of the subjects was negatively affected by overweight/obesity irrespective of the diagnostic used. The QOL was worse in subjects with visceral obesity and very high percentage body fat compared to those with generalized obesity. Only the anthropometric measures of obesity were positively correlated with QOL in this population. The prevalence of overweight/obesity in this population is lower than previous reports from similar populations in Nigeria but not reports from outside Nigeria. The impact of obesity on QOL appears to be driven by the functional impairment and physical discomfort that arise from it.

Key words: Obesity, overweight, prevalence, quality of life, young-adults

INTRODUCTION

Overweight/obesity, i.e., a Body Mass Index (BMI) $\geq 25 \text{ kg m}^{-2}$ is currently a global public health problem. It is linked to chronic diseases such as heart disease, type II diabetes, hypertension and prostatic diseases (Ejike and Ezeanyika, 2008; Bastien *et al.*, 2014). Popkin *et al.* (2012) estimated from trend analysis that there are already more than 2 billion obese individuals globally and the prevalence is rising steeply in developing countries. The World Health Organisation (WHO) estimated that the prevalence of overweight and obesity among those aged 15 years and above living in sub-Saharan Africa in 2010 exceeded 60% and 70% for men and women, respectively. The same survey reported that the prevalence of overweight/obesity in Nigeria was 29 and 45.1% in men and women respectively (Ono *et al.*, 2012). A recent study in young adult Nigerians reported

a prevalence of 28.4 and 20.7% for overweight/obesity, using the BIA and BMI methods, respectively (Ejike and Ijeh, 2012). There is therefore unequivocal evidence that obesity is currently a public health challenge, even in Nigeria.

The BMI is the most widely used index for the diagnosis of obesity, especially in epidemiological research. Its strengths include its simplicity, wide acceptability and no requirement for elaborate equipment. It is however limited in utility when quantifying body composition as it does not distinguish between the lean muscle and fat mass and does not account for important contributors to weight such as bone density and blood volume (Bogin and Varela-Silva, 2012). As a result, very often otherwise healthy adults with more lean muscle mass are erroneously classified as either obese or overweight. Consequently, other anthropometric indices, namely Waist Circumference (WC), waist-to-hip ratio (WHpR) and waist-to-height ratio (WHtR) are used as surrogates for visceral adiposity and reportedly predict obesity-related health risks better than BMI (Snijder *et al.*, 2006). Though technologies such as underwater weighing, dual-energy X-ray absorptiometry (DXA), etc., define adiposity better than the anthropometric indices in current use, they are not widely used in epidemiological studies due to cost and complexity of operation constraints (Mei *et al.*, 2002). A non-invasive multi frequency Bioelectrical Impedance Analysis (BIA) device for the direct estimation of visceral fat area has been shown to be useful in assessing fat mass in healthy adults (Malavolti *et al.*, 2003) even in Nigeria (Ejike and Ijeh, 2012).

Given that obesity affects negatively the individual's self-esteem, self-image and ultimately Quality Of Life (QOL) (Soltoft *et al.*, 2009; Dey *et al.*, 2013) and the reported variations in the prevalence of obesity determined by different tools (Ejike and Ijeh, 2012), this study sought to determine how much the QOL of young Nigerians was affected by obesity and the impact of the different diagnostic tools on the QOL of the population. Put differently, three questions were asked: (1) What is the prevalence of obesity in this population and how does it vary by the diagnostic tools used, (2) What is the effect of obesity on the QOL of the population and (3) Does the QOL of the population vary significantly if the measure of obesity varies? The answers are hoped to contribute to the knowledge gaps existing in this direction and would help public health research and policy formulation.

MATERIALS AND METHODS

Subjects: Students of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria (mean age, 21.7±2.6 years) were randomly recruited for this study. The purpose and rationale of the study was explained to them and those who gave an informed consent were recruited if they met the other inclusion criteria. Exclusion criteria included apparent ill-health, use of weight-loss medication, current cigarette smoking, drinking of alcoholic beverages in excess of four 600 mL bottles a week, history or present 'Substance' abuse and pregnancy (in females). These conditions were assessed by self-report. A total of 2000 students (50% females) who met the inclusion criteria were ultimately recruited. No honoraria were paid to participants. They were nonetheless offered some health education based on their nutritional status as determined in the study.

Methods: Self-reported age at last birthday for each subject was recorded. The heights of the subjects were measured using an improvised stadiometer with the subject standing on bare feet to the nearest 0.1 cm. The subject's weights were measured using a BIA machine (Omron BF-400, Omron Healthcare Europe BV, Hoofddorp, The Netherlands) with the subject dressed in light clothing, without shoes/sandals to the nearest 0.1 kg. The Waist Circumference (WC) of each participant, as well as the Hip Circumference (HC) was measured using a non-elastic measuring tape to the nearest 0.1 cm. Waist circumference was measured midway between the lowest rib and

the superior border of the iliac crest with the subject breathing minimally. The HC was measured at the widest circumference over the buttocks. From the data obtained from the height and weight measurements, the BMI for each subject was calculated as:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

From the data obtained from the waist, hip and height measurements, WHpR was calculated as WC/HC while WHtR was calculated as WC/Height.

Body fat percentage was measured with the BIA device mentioned above, following the manufacturer's instructions. The device sends an extremely weak electrical current of 50 kHz and less than 500 μA through the subject's body. It then combines the electrical resistance with the distance of electricity conducted and the pre-entered particulars of the subject (age, sex, weight and height) to give the body fat percentage using an in-built formula which the manufacturer did not disclose.

The QOL of the subjects were accessed by a single question: If you were to spend the rest of your life with your weight status just the way it is now, how would you feel about that? The responses ranged from 0-6 denoting delighted to terrible.

Definitions: Overweight and obesity were defined by multiple definitions depending on the diagnostic tool employed, viz: (1) $\text{BMI} \geq 25$ but < 30 (overweight) and $\text{BMI} \geq 30$ (obese) (WHO, 1998), (2) $\text{WC} \geq 80$ for women and ≥ 94 for men (Grundy *et al.*, 2005), (3) $\text{WHpR} \geq 1$ (WHO, 2000), (4) $\text{WHtR} \geq 0.5$ (Ashwell and Hsieh, 2005) and (5) percentage body fat $\geq 32.0\%$ (overweight) and $\geq 37.1\%$ (obese) in black females and $\geq 21.7\%$ (overweight) and $\geq 28.3\%$ (obese) in black males (Zhu *et al.*, 2003). Based on the QOL scores of the subject, they were described as being satisfied (0-2), mixed, i.e., satisfied/dissatisfied (3) and dissatisfied (4-6).

Statistical analyses: The data generated were subjected to descriptive statistics. Continuous data are reported as means \pm standard deviations while categorical data are presented as percentages. Differences between means were separated by One Way ANOVA for continuous variables and the chi-square test for categorical variables. The correlations between the QOL of the subjects and the measures of obesity were assessed using the pearson's product moment correlation coefficients. The significant threshold was fixed at $p < 0.05$ for all analyses. Data analyses were done using IBM-SPSS version 20.0 (IBM Corp. Atlanta, GA).

RESULTS

The mean age of the participants was 21.7 ± 2.6 years. The males were however, significantly older than the females (22.2 ± 3.0 years vs 21.2 ± 2.2 years, $p < 0.001$). Similarly, the males were significantly ($p < 0.001$) taller and heavier than the females. In the same vein, the males had significantly ($p < 0.001$) higher WHpR compared to the females. Conversely, the females had significantly ($p < 0.001$) higher HC, WHtR and percentage fat mass% relative to the males. The BMI, WC and QOL scores of the males and females were statistically similar ($p > 0.001$) (Table 1).

Using BMI as a diagnostic criterion, a total of 17% of the population (13% for males and 20.9% for females) were overweight/obese while 4.1% (1.8% for males and 6.4% for females) were underweight (Fig. 1). Visceral obesity (as diagnosed by WC) was found in 3.9% of the population

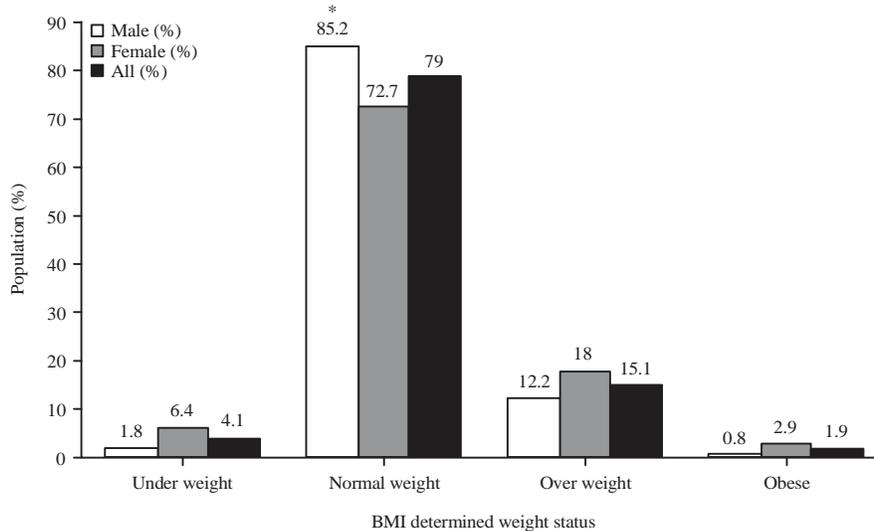


Fig. 1: Weight status of the population determined by BMI, *Significant difference (Chi-squared test) between the sexes

Table 1: Relevant characteristics of the studied population

Parameters	Male	Female	P	All
Age (years)	22.20±3.0	21.20±2.2	<0.001	21.70±2.6
Height (cm)	174.20±6.4	162.70±5.9	<0.001	168.50±8.4
Weight (kg)	68.30±8.5	60.00±9.4	<0.001	22.50±2.4
BMI (kg m ⁻²)	22.50±2.4	22.70±3.4	0.177	22.60±2.9
WC (cm)	76.10±6.1	75.50±7.9	0.052	75.80±7.1
HC (cm)	91.40±7.6	93.40±8.3	<0.001	92.40±8.0
WHpR	0.83±0.05	0.81±0.06	<0.001	0.82±0.06
WHtR	0.44±0.04	0.46±0.05	<0.001	0.45±0.05
FM (%)	12.80±4.3	29.53±7.05	<0.001	21.20±10.2
QOL	2.00±1.4	2.00±1.4	0.614	2.00±1.4

BMI: Body mass index, QOL: Quality of life, FM: Fat mass, HC: Hip circumference, WC: Waist circumference, WhpR: Waist-to-hip ratio, WhtR: Waist to height ratio

(0.2% for males and 7.5% for females). Based on WHpR, only 0.4% of the population (0.2% for males and 0.6% for females) were obese. However, data for WHtR show that 11.9% of the population (5.6% for males and 23.3% for females) were obese (Fig. 2). The BIA determined percentage body fat shows on the one hand, that 18% of the population (6.7 for males and 29.3% for females) had high/very high body fat, corresponding to overweight/obese. On the other hand, 10.1% of the population had low body fat akin to underweight (Fig. 3).

As much as 28.1% of the population were not entirely satisfied with their QOL and the proportion did not vary significantly by sex. However, only 12.4% of the population were completely dissatisfied with their QOL (Fig. 4). Of all those who were satisfied with their QOL, 2.7, 83.4, 12.7 and 1.2% were underweight, normal weight, overweight and obese respectively, based on BMI standards. On the other hand, of the subjects who were dissatisfied with their QOL, 10.0, 63.1, 22.1 and 4.4% were underweight, normal weight, overweight and obese respectively. Among obese and thin subjects, significantly more subjects were dissatisfied with their QOL whereas among normal weight subjects, the reverse was the case (Table 2).

When overweight/obesity is defined using WC, WHpR and WHtR, it was found that irrespective of which of the three diagnostics was used, significantly more overweight/obese subjects were

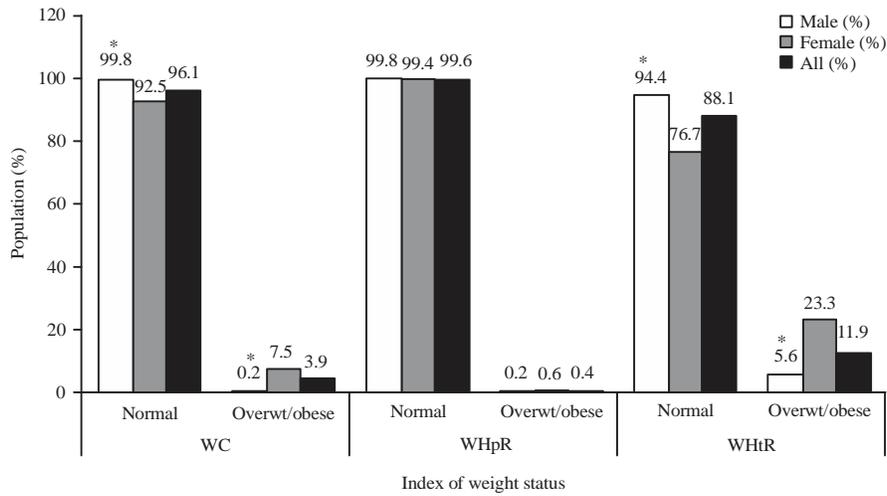


Fig. 2: Weight status of the population determined by relevant anthropometric indices, *Significant difference (Chi-square test) between the sexes

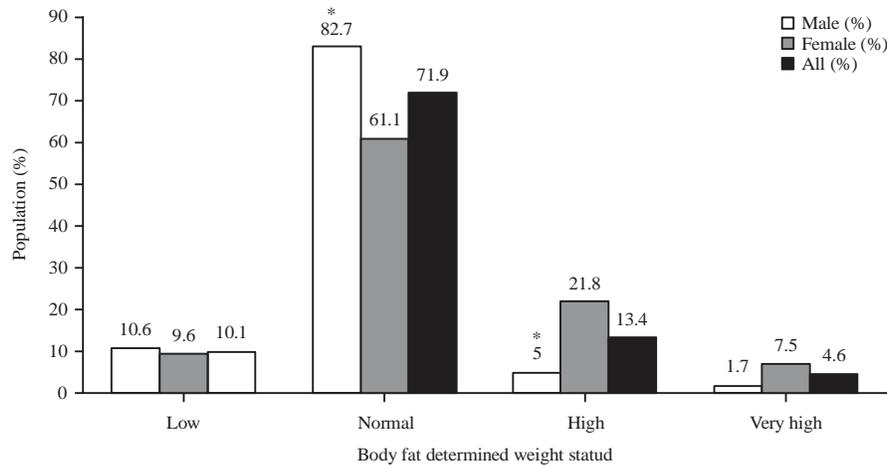


Fig. 3: Weight status of the population determined by body fat percentage, *Significant difference (Chi-square test) between the sexes

Table 2: Proportion of the population (stratified by BMI determined weight status) with the three QOL statuses

QOL	Weight status (BMI)			
	Under weight (%)	Normal weight (%)	Overweight (%)	Obese (%)
Male				
Satisfied	1.1	87.1	11.2	0.6
Mixed	3.1	78.1	17.5	1.3
Dissatisfied	3.9	83.5	11.0	1.6
Female				
Satisfied	4.3	79.8	14.2	1.8
Mixed	8.4*	63.6*	23.4	4.5
Dissatisfied	16.4*	41.8*	33.6*	7.4
All				
Satisfied	2.7	83.4	12.7	1.2
Mixed	5.7	71.0	20.4	2.9
Dissatisfied	10.0	63.1	22.1	4.4

*Significant differences between the sexes but within each QOL classification and along each column, QOL: Quality of life, BMI: Body mass index

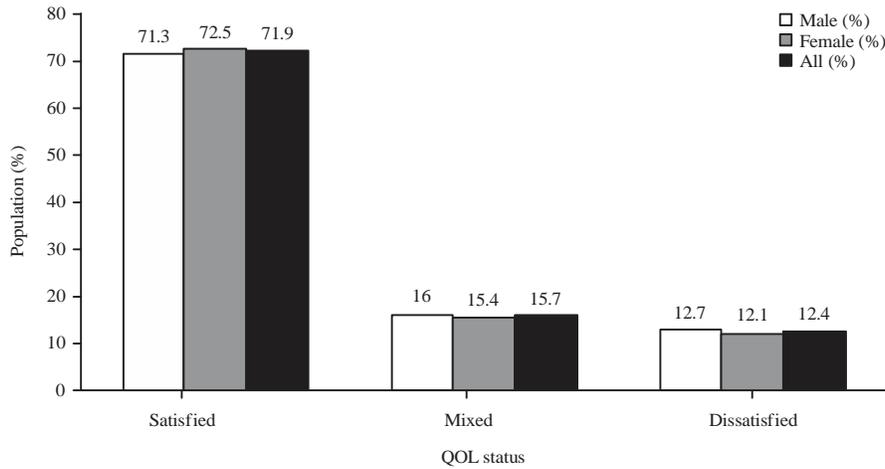


Fig. 4: Self-reported quality of life of the subjects

Table 3: Proportion of the population (stratified by varying anthropometric indices) with the three QOL statuses

Parameters	QOL for normal weight (%)			QOL for overweight/obese (%)		
	Satisfied (%)	Mixed (%)	Dissatisfied (%)	Satisfied (%)	Mixed (%)	Dissatisfied (%)
WC						
Male	99.9	100.0	99.2	0.1	0.0	0.8
Female	94.5*	91.6*	81.8*	5.5*	8.4*	19.2*
All	97.1	95.9	90.7	2.9	4.1	9.3
WhpR						
Male	99.9	100.0	99.2	0.1	0.0	0.8
Female	99.4	100.0	98.3	0.6	0.0	1.7
All	99.7	100.0	98.8	0.3	0.0	1.2
WhtR						
Male	95.4	92.5	91.3	4.6	7.5	9.7
Female	80.4*	72.7*	59.5*	19.6*	27.3*	40.5*
All	87.8	82.8	75.8	12.2	17.2	24.2

*Significant differences between the sexes, for each anthropometric indicator of weight status, along each column, QOL: Quality of life, WC: Waist circumference, WHpR: Waist-to-hip ratio, WhtR: Waist-to-height ratio

Table 4: Proportion of the population (stratified by body fat percentage determined weight status) with the three QOL statuses

QOL	Weight status (FM%)			
	Low (%)	Normal (%)	High (%)	Very high (%)
Male				
Satisfied	9.5	84.2	4.6	1.7
Mixed	13.8	76.9	7.5	1.9
Dissatisfied	12.6	81.9	3.9	1.6
Female				
Satisfied	7.7	65.9*	20.8*	5.5
Mixed	11.7	53.9*	23.4*	11.0*
Dissatisfied	18.2	41.3*	25.6*	14.9*
All				
Satisfied	8.6	75.0	12.8	3.6
Mixed	12.7	65.6	15.3	6.4
Dissatisfied	15.3	62.1	14.5	8.1

*Significant differences between the sexes but within each QOL classification and along each column, QOL: Quality of life, FM: Fat mass

dissatisfied with their QOL compared to those who were satisfied with their QOL. Interestingly, all those who reported having mixed QOL had normal weight by WHpR standards (Table 3). From Table 4, it is seen that the proportion of the population that were dissatisfied with their QOL was

Table 5: Correlations between QOL scores and the measures of obesity in the studied population

QOL	BMI	WC	WHpR	WHtR	FM (%)
Male (P)	0.010 (0.758)	-0.050 (0.118)	+0.058 (0.068)	-0.003 (0.915)	-0.037 (0.247)
Female (P)	+0.129 (<0.001)	+0.154 (<0.001)	+0.121 (<0.001)	+0.145 (<0.001)	+0.024 (0.453)
All (P)	+0.077 (<0.01)	+0.064 (<0.01)	+0.092 (<0.001)	+0.074 (<0.01)	-0.009 (0.687)

QOL: Quality of life, BMI: Body mass index, WC: Waist circumference, WHpR: Waist-to-hip ratio, WHtR: Waist-to-height ratio, FM: Fat mass ratio

exponentially higher among those who had low, high and very high percentage body fat content, compared to their counterparts with normal percentage body fat.

Irrespective of sex, QOL scores were significantly and positively correlated with all the measures of obesity ($r = +0.064 - +0.154$, $p < 0.01$) except percentage fat mass. These significant correlations were however driven by the strength of the correlations in the females as the correlation between QOL and any given measure of obesity in the males was not significant (Table 5).

DISCUSSION

Obesity is characterized by excess adiposity which is often seen in increased body weight. Though scientists agree that adiposity, not simply body weight is the real predictor of adverse health risks and outcomes, the measurement of adiposity remains challenging (Bogin and Varela-Silva, 2012). The finding of BMI-metabolic risk sub-phenotypes has however warranted a rethink of how far the BMI can be used in (at least) individuals. Interestingly, the prevalence of “Metabolically Obese Normal Weight” (MONW) and/or “Metabolically Healthy Obese” (MHO) phenotypes in Nigeria, is high (Ejike *et al.*, 2009; Ijeh *et al.*, 2010). For this and other reasons, other measures of obesity such as WC (Grundy *et al.*, 2005), WHpR (WHO, 2000) and WHtR (Ashwell and Hsieh, 2005) which define visceral fat distribution (apparently better than BMI) have been suggested to be better predictors of cardio-metabolic health (Huxley *et al.*, 2010). As is in all diagnostics, these indices and the references suggested for body fat percentage (Zhu *et al.*, 2003) are not without limitations and criticisms.

Using BMI as a reference diagnostic, the 17% prevalence of overweight/obesity in this population (13% for males and 20.9% for females) is lower than previous reports from Nigeria. An earlier study in young-adult Nigerians found overweight/obesity in 20.7% of the population (Ejike and Ijeh, 2012). An earlier study of undergraduates in a different Nigerian university had reported a prevalence of 27.3% for overweight/obesity (Oghagbon *et al.*, 2009). One must keep in mind however that a 2010 WHO report indicates that 29 and 45.1% of adult male and female Nigerians respectively were overweight/obese (Ono *et al.*, 2012). Mogre *et al.* (2014) reported that the prevalence of general overweight/obesity among University students in Tamale, Ghana was found to be 12.2%. A study of medical students in Delhi, India gave a prevalence of 16.4% for overweight/obesity (Chhabra *et al.*, 2006), while 10.4% of university students in Malaysia were found to be overweight (Hazizi *et al.*, 2012).

Clearly the prevalence of overweight/obesity in this population is lower than previous reports from Nigeria but higher than results from similar populations in West Africa and Asia. Obesity in the studied age-bracket is however expectedly lower than in older populations because obesity is known to increase with age (Flegal *et al.*, 2007). Young people are also known to be more conscious of their body shape, such that ‘Weight-watching’ is more common among them. This coupled with the rigours of undergraduate work and the often widespread poverty appears to be responsible (at least in part) for the low prevalence of obesity in this population. Though 4.1% (1.8% for males

and 6.4% for females) were underweight and apparently have mild nutrient deficiency, the WHO expert committee notes that there is little experimental support for the use of 18.5 as cut off for underweight (WHO., 1995). The maintenance of the recommended threshold for a healthy body habitus is very important especially for people who would soon be engaged in procreation and should therefore be encouraged.

We found variations in prevalence of overweight/obesity when the different anthropometric indices were applied in diagnosis. This is in consonance with the report of Ejike and Ijeh (2012) who earlier reported a similar phenomenon in Nigerian young-adults. Using WC, WHpR, WHtR and BMI, obesity was found in 3.9% of the population (0.2% for males and 7.5% for females), 0.4% of the population (0.2% for males and 0.6% for females), 11.9% of the population (5.6% for males and 23.3% for females) and 1.9% of the population (0.8% for males and 2.9% for females), respectively as against 4.6% of the population (1.7% for males and 7.5% for females) diagnosed to be obese by BIA standard. Using BIA as a reference standard, WHtR misdiagnosed obesity the most, followed by WHpR, BMI and WC. The WC was comparable to BIA especially in the female population but diagnosed fewer males as obese. The BMI under diagnosed obesity in both males and females. The discrepancy observed, especially with reference to BMI poses a lot of challenges for population and individual health as it could result in missed intervention opportunities that otherwise could have been useful in reducing the negative consequences associated with excess adiposity. Though Ejike and Ijeh (2012) had reported that BMI had the least discrepancy when compared to BIA data, their conclusion may have been borne out their lumping of overweight and obese data together in making the comparison as against our comparing data for only obese subjects. In fact, a re-analysis of the present data with pooled data on overweight and obese subjects corroborates the report by Ejike and Ijeh (2012). Kennedy *et al.* (2009) had earlier reported that BMI had the poorest ability to predict true adiposity. The WC therefore, may be a reliable anthropometric indicator of adiposity in this population and its use should be encouraged.

Though anthropometry is accepted universally in the diagnosis of overweight/obesity, there are still concerns about its ability to define adiposity status accurately (Prentice and Jebb, 2001). This and other studies have shown that a significant proportion of subjects with a BMI $<30 \text{ kg m}^{-2}$ were actually obese when classified by BIA derived percentage fat mass (Frankenfield *et al.*, 2001). The BMI is no doubt an important tool used by clinicians and epidemiologists and has become the most commonly used measure of weight status due to its simplicity of calculation when collecting data for large population surveys (Shah and Braverman, 2012). The BMI's inability to identify differences in body composition and body fat distribution remain its greatest challenge (Bogin and Varela-Silva, 2012). The WC though proposed to be better than BMI in measuring obesity, because it captures abdominal obesity does not reflect fat mass that may be distributed in non-abdominal tissues-a major demerit of the tool (Lean *et al.*, 1995). The WHtR has been shown to be a good predictor of adiposity-related disorders such as the metabolic syndrome (Shao *et al.*, 2010). It is nonetheless limited because "The WC measurement assesses only visceral adiposity such that dividing it by the subject's height wrongly distributes the fatness localized around the abdomen to the entire body" (Ejike and Ijeh, 2012). The discordance between WHtR and percentage body fat in the diagnosis of obesity in this population is therefore understandable. The WHpR has a couple of advantages over BMI, WC and WHtR as a measure of adiposity. This is owing to the distinct physiologic characteristics of fat depots in different parts of the body. It has been shown that visceral fat has a lower threshold for lipolysis relative to subcutaneous fat. Free fatty acids released by lipolysis result in a wide array of metabolic consequences especially as they have direct access

to the liver (Snijder *et al.*, 2006). Bioactive peptides and compounds with local and systemic adverse effects are also synthesized in visceral adipose tissues in rates that are proportional to the quantity of visceral fat present (Qatanani and Lazar, 2007). Sub-cutaneous fat on the other hand appears to act as a sink for free-fatty acids (Snijder *et al.*, 2006), such that in older subjects, higher subcutaneous fat is known to be associated with metabolic benefits (Gavi *et al.*, 2007). The fact that the body fat content of the entire body is not just localized around the waist and hip attenuates the benefits of the WHpR and may explain the discrepancy observed between percentage body fat and WHpR in this study. The high degree of discordance between obesity diagnosed by BIA and that determined by the studied anthropometric variables may account (at least in part) for the BMI-metabolic risk sub-phenotype observed in populations in Nigeria (Ejike *et al.*, 2009; Ijeh *et al.*, 2010).

As much as 28.1% of the population were not entirely satisfied with their QOL and the proportion did not vary significantly by sex. Interestingly, among obese and thin subjects, significantly more subjects were dissatisfied with their QOL whereas among normal weight subjects, the reverse was the case. This is not surprising because obesity is known to affect QOL adversely (Soltoft *et al.*, 2009; Mannucci *et al.*, 2010; Dey *et al.*, 2013). The negative effect obesity has on QOL is thought to be driven by the presence of concurrent somatic diseases and psychopathological disturbances in morbidly obese patients, relative to those lesser degrees of obesity (Mannucci *et al.*, 2010). In fact, it has been reported that the sex difference found in the impact of obesity on QOL may be due to the higher incidence of psychopathology among women (Sullivan *et al.*, 1993). It is therefore possible that because of the young age of the studied population, somatic and psychopathological diseases may be minimal (though not assessed in this study) thereby abrogating the sex differences reported in other studies.

Using WC, WHpR and WHtR as diagnostics for obesity, it was found that irrespective of which of the three diagnostics was used significantly more overweight/obese subjects were dissatisfied with their QOL compared to those who were satisfied with their QOL. Furthermore, a greater proportion of the subjects with visceral obesity and very high percentage body fat (compared to generalized obesity) were dissatisfied with their QOL. This is indicative that QOL in this population may have affected more by body shape dissatisfaction and not somatic diseases. Not surprisingly, only the anthropometric measures of obesity and not the BIA determined percentage body fat which is a more precise measure of adiposity which is implicated in somatic diseases (Ejike and Ijeh, 2012) were positively correlated with QOL. Mannucci *et al.* (2010) had argued that a higher BMI affected largely the physical, rather than the psychosocial, components of QOL. Implicit in that is that the functional impairment and physical discomfort that arise due to overweight and obesity are the major factors driving their negative effect on QOL. Addressing this weight driven challenges may therefore improve the QOL of the subjects.

This study may be limited by its small sample size and the fact that we studied a convenient sample that may not represent the same age bracket in the general population. The sample size may not therefore permit robust and unequivocal statistical inferences to be drawn from the data. However, in the light of the daunting cultural and financial challenges that this type of epidemiological study often faces, the sample size should be acceptable. The differences in the prevalence of obesity determined by the different tools should be interpreted with caution especially as there is, as yet no consensus on the notion that percentage body fat is an improved phenotypic indicator of morbidity and mortality over BMI, WC etc. Furthermore, in morbidly obese individuals, an increased amount of body water and extracellular water often leads to an under-estimation of

body fat percentage using the BIA technique. This may however not have affected our data since the prevalence of obesity in this population was low and we did not have morbidly obese subjects. Finally, a single question was used to assess the QOL of the subjects instead of more sophisticated instruments such as the SF-36, the impact of weight on QOL questionnaire, the obesity-related psychosocial scale, etc. This was however warranted by the lack of validation of these scales in our climate and the need to keep the assessment simple and straightforward. The strengths of this study are in its novelty and originality as it is the first to assess the impact of obesity determined by different methods on the QOL of young-adult Nigerians.

CONCLUSION

In conclusion, this study investigated the prevalence of obesity determined by different tools and their effects on the QOL of young Nigerians. The results show that: (1) Using BMI, WC, WHpR, WHtR and body fat percentage as a diagnostic criteria, a total of 17, 3.9, 0.4, 11.9 and 18% of the population respectively were overweight/obese, (2) as much as 12.4% of the population were completely dissatisfied with their QOL and the QOL of the subjects was negatively affected by overweight/obesity irrespective of the diagnostics used, (3) QOL was worse in subjects with visceral obesity and very high body fat percentage compared to those with generalized obesity.

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REFERENCES

- Ashwell, M. and S.D. Hsieh, 2005. Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. *Int. J. Food Sci. Nutr.*, 56: 303-307.
- Bastien, M., P. Poirier, I. Lemieux and J.P. Despres, 2014. Overview of epidemiology and contribution of obesity to cardiovascular disease. *Prog. Cardiovascular Dis.*, 56: 369-381.
- Bogin, B. and M.I. Varela-Silva, 2012. The body mass index: The good, the bad and the horrid. *Bull. Suisse Soc. Anthropol.*, 18: 5-11.
- Chhabra, P., V.L. Grover, K. Aggarwal and A.T. Kannan, 2006. Nutritional status and blood pressure of medical students in Delhi. *Indian J. Community Med.*, 31: 248-251.
- Dey, M., G. Gmel and M. Mohler-Kuo, 2013. Body mass index and health-related quality of life among young Swiss men. *BMC Public Health*, Vol. 13. 10.1186/1471-2458-13-1028
- Ejike, C.E.C.C. and I.I. Ijeh, 2012. Obesity in young-adult Nigerians: Variations in prevalence determined by anthropometry and bioelectrical impedance analysis and the development of % body fat prediction equations. *Int. Arch. Med.*, Vol. 5 10.1186/1755-7682-5-22
- Ejike, C.E.C.C. and L.U.S. Ezeanyika, 2008. Metabolic syndrome in sub-Saharan Africa: Smaller twin of a region's prostatic diseases? *Int. Urol. Nephrol.*, 40: 909-920.
- Ejike, C.E.C.C., C.E. Ugwu and L.U.S. Ezeanyika, 2009. Nutritional status, prevalence of some metabolic risk factors for cardiovascular disease and BMI-metabolic-risk sub-phenotypes in an adult Nigerian population. *Biokemistri*, 21: 17-24.
- Flegal, K.M., B.I. Graubard, D.F. Williamson and M.H. Gail, 2007. Cause-specific excess deaths associated with underweight, overweight and obesity. *J. Am. Med. Assoc.*, 298: 2028-2037.
- Frankenfield, D.C., W.A. Rowe, R.N. Cooney, J.S. Smith and D. Becker, 2001. Limits of body mass index to detect obesity and predict body composition. *Nutrition*, 17: 26-30.

- Gavi, S., J.J. Feiner, M.M. Melendez, D.C. Mynarcik, M.C. Gelato and M.A. McNurlan, 2007. Limb fat to trunk fat ratio in elderly persons is a strong determinant of insulin resistance and adiponectin levels. *J. Gerontol. A Biol. Sci. Med. Sci.*, 62: 997-1001.
- Grundty, S.M., J.I. Cleeman, S.R. Daniels, K.A. Donato and R.H. Eckel *et al.*, 2005. Diagnosis and management of the metabolic syndrome: An American Heart Association/National Heart, Lung and Blood Institute Scientific statement. *Circulation*, 112: 2735-2752.
- Hazizi, A.S., B.M. Hamdi, Y.M. Leong and T. Izumi, 2012. Assessment of physical activity among undergraduate students in a local university using a pedometer. *Health Environ. J.*, 3: 54-66.
- Huxley, R., S. Mendis, E. Zheleznyakov, S. Reddy and J. Chan, 2010. Body mass index, waist circumference and waist:hip ratio as predictors of cardiovascular risk-a review of the literature. *Eur. J. Clin. Nutr.*, 64: 16-22.
- Ijeh, I.I., U. Okorie and C.E.C.C. Ejike, 2010. Obesity, metabolic syndrome and BMI-metabolic-risk sub-phenotypes: A study of an adult Nigerian population. *J. Med. Med. Sci.*, 1: 254-260.
- Kennedy, A.P., J.L. Shea and G. Sun, 2009. Comparison of the classification of obesity by BMI vs. dual-energy X-ray absorptiometry in the Newfoundland population. *Obesity*, 17: 2094-2099.
- Lean, M.E.J., T.S. Han and C.E. Morrison, 1995. Waist circumference as a measure for indicating need for weight management. *Br. Med. J.*, 311: 158-161.
- Malavolti, M., C. Mussi, M. Poli, A.L. Fantuzzi, G. Salvioli, N. Battistini and G. Bedogni, 2003. Cross-calibration of eight-polar bioelectrical impedance analysis versus dual-energy X-ray absorptiometry for the assessment of total and appendicular body composition in healthy subjects aged 21-82 years. *Ann. Hum. Biol.*, 30: 380-391.
- Mannucci, E., M.L. Petroni, N. Villanova, C.M. Rotella, G. Apolone, G. Marchesini and QUOVADIS Study Group, 2010. Clinical and psychological correlates of health-related quality of life in obese patients. *Health Qual. Life Outcomes*, 10.1186/1477-7525-8-90
- Mei, Z., L.M. Grummer-Strawn, A. Pietrobelli, A. Goulding, M.I. Goran and W.H. Dietz, 2002. Validity of body mass index compared with other body-composition screening indexes for the assessment of body fatness in children and adolescents. *Am. J. Clin. Nutr.*, 75: 978-985.
- Mogre, V., R. Nyaba and S. Aleyira, 2014. Lifestyle risk factors of general and abdominal obesity in students of the school of medicine and health science of the university of development studies, Tamale, Ghana. *ISRN Obesity*, 10.1155/2014/508382
- Oghagbon, K., V. Odili, E. Nwangwa and K. Pender, 2009. Body mass index and blood pressure pattern of students in a Nigerian university. *Int. J. Health Res.*, 2: 177-182.
- Ono, T., R. Guthold and K. Strong, 2012. WHO Global comparable estimates: Global Infobase data for saving lives 2005. <https://apps.who.int/infobase/>.
- Popkin, B.M., L.S. Adair and S.W. Ng, 2012. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr. Rev.*, 70: 3-21.
- Prentice, A.M. and S.A. Jebb, 2001. Beyond body mass index. *Obes. Rev.*, 2: 141-147.
- Qatanani, M. and M.A. Lazar, 2007. Mechanisms of obesity-associated insulin resistance: many choices on the menu. *Genes Dev.*, 21: 1443-1455.
- Shah, N.R. and E.R. Braverman, 2012. Measuring adiposity in patients: The utility of body mass index (BMI), percent body fat and leptin. *PLoS One*. 10.1371/journal.pone.0033308
- Shao, J., L. Yu, X. Shen, D. Li and K. Wang, 2010. Waist-to-height ratio, an optimal predictor for obesity and metabolic syndrome in Chinese adults. *J. Nutr. Health Aging*, 14: 782-785.
- Snijder, M.B., R.M. van Dam, M. Visser and J.C. Seidell, 2006. What aspects of body fat are particularly hazardous and how do we measure them? *Int. J. Epidemiol.*, 35: 83-92.

- Soltoft, F., M. Hammer and N. Kragh, 2009. The association of body mass index and health-related quality of life in the general population: data from the 2003 Health Survey of England. *Qual. Life Res.*, 18: 1293-1299.
- Sullivan, M., J. Karlsson, L. Sjostrom, L. Backman and C. Bengtsson *et al.*, 1993. Swedish Obese Subjects (SOS)-an intervention study of obesity. Baseline evaluation of health and psychosocial functioning in the first 1743 subjects examined. *Int. J. Obes. Relat. Metab. Disord.*, 179: 503-512.
- WHO., 1995. Chapter 8: Thin adults. Physical Status: The Use and Interpretation of Anthropometry. World Health Organization, Geneva, Switzerland.
- WHO., 1998. Obesity: Preventing and Managing the Global Epidemic. World Health Organization, Geneva.
- WHO., 2000. Obesity: Preventing and managing the global epidemic. WHO Technical Report Series No. 894. World Health Organization, Geneva.
- Zhu, S., Z. Wang, W. Shen, S.B. Heymsfield and S. Heshka, 2003. Percentage body fat ranges associated with metabolic syndrome risk: results based on the third National Health and Nutrition Examination Survey (1988-1994). *Am. J. Clin. Nutr.*, 78: 228-235.