Evaluating the Body Mass Index and Waist – Hip ratio in a University Community in Delta State, Nigeria

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Abstract

Background: Anthropometric measurements are important non-invasive tools for assessing body composition, size, general health, nutritional status and health risks. This study assessed Body Mass Index (BMI) and the Waist-Hip Ratio (WHR) as a means to determining disease predisposition among the individuals studied.

Method: A cross-sectional study was conducted among 212 participants at a tertiary institution in Delta State, Nigeria. A convenience sampling technique was applied to recruit the participants. Demographic information and anthropometric measurements were done. Data was analyzed using SPSS version 26.0 and results presented in percentages.

Result: The mean age of the participants was 23.7 ± 8.4 years. Majority [60.4%] of the participants had normal BMI. All the male participants [14.2%] had WHR ≤ 0.9 while 11% of the females had WHR > 0.85. There was a significant positive relationship between systolic blood pressure and BMI (r= 0.315, P< 0.05) while diastolic blood pressure also had a positive relationship with BMI but not significant (r= 0.133, P>0.05). Additionally, BMI had a significant positive effect on systolic blood pressure (β= 0.901; t= 3.364; p=0.001) and a non-significant positive effect on diastolic blood pressure (β= 0.356; t= 1.618; p = 0.109} while WHR had a non-significant, negative effect on both systolic (β= -5.360; t= -0312; *p* =0.756) and diastolic (β= -19.421; t= 14.113; *p* =0.172).

Conclusion: Both BMI and WHR are useful indicators of wellness. However, body mass index seems to be a better predictor of systolic blood pressure.

Keywords: Anthropometric, BMI, WHR, Blood Pressure, diastolic, systolic, Delta State

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Introduction

Body mass index [BMI] is a simple inexpensive, readily available screening tool used to classify individuals into three major categories based on the relationship between the weight and height of the individuals. It is calculated as (weight in *kg*)/ (height in m^2). This index classifies individuals into one of three categories: "underweight," "overweight," or "obese. Obesity and overweight are of foremost importance. BMI is an indicator for overweight and obesity when used for screening, and surveillance purposes. These are risk factors for cardiovascular heart diseases, hypertension and metabolic disorders such as diabetes mellitus and hypercholesteremia[1]. In addition, BMI is also used to predict an individual's health and nutritional status as well as the risk of developing a particular disease in the future [1,2,3].

The use of BMI alone in assessing obesity or health is highly controversial as BMI does not take into cognizance the body fat distribution, muscle mass and bone density. Hence combining this measurement with other forms of body measurements such as Waist-Hip Ratio [WHR] assures better prediction of health risk. WHR on the other hand takes into account the central body fat, visceral fat, mid-body fat, waist fat that are risk factors for life threatening and chronic diseases[1.] It measures how much fat is stored in the waist, hips, and buttocks. Khan et al., in a recent study, reported that WHR may be more useful than BMI in determining health risks and medical interventions[4].

Waist-to-hip ratio is easier, more accessible, and cheaper means of assessing body fat. It can be used for screening purposes. WHR calculation measures the ratio of the waist circumference to the hip circumference. Regional adiposity has been found to be associated with health risk. Moosaje et al. found that women with apple -shaped body [abdominal fat] have a higher risk of heart disease, type 2 diabetes, and premature death than women who carry more of their weight in their hips and thighs (a pear-shaped body) [5]. Not only is WHR useful in predicting health risk, it has also been used to classify individuals into low, moderate or high health risk (Table 1). This ratio is different for both genders.

Table 1: Waist-to-hip ratio chart as classified by WHO based on the risk of being affected by weight related health conditions

Health risk	Women	Men
Low	0.80 or lower	0.95 or lower
Moderate	0.81-0.85	0.96-1.0
High	0.86 or higher	1.0 or higher

A high WHR in both gender increases the individual's risk of getting diseases that are associated with overweight and obesity including cardiovascular diseases and diabetes. It has been reported that WHR is negatively related to the level of estradiol in females and positively related to testosterone level in males. This explains why

WHR is lower in women[6,7]. WHR is an independent predictor for the following diseases in women: cancers (endometrial, ovarian and breast), gall bladder disease, cardiovascular diseases, coronary lesions, hypertension, adult-onset diabetes, hyper lipidaemia, and premature death[8]. However, lowering WHR has been found to be beneficial in lowering the risks of developing chronic kidney disease in people with non-alcoholic fatty liver disease[9]. WHR is an indicator of a woman's fecundity. Hence, its significance among women. Despite been widely used, WHR, it has its own limitations especially in individuals who are short statured (< 5 feet tall) and individuals who have a BMI ≥ 35.

Obesity is one of the leading causes of death worldwide. According to World health organization 2.8 million people die from obesity or overweight and its related disease every year globally[10]. In addition, 30% of death in the world will be initiated by lifestyle diseases by 2030 which can be halted by identifying and addressing the associated risk factors[10] . Thus, obesity being a risk factor for most of the life-threatening chronic and noncommunicable diseases when identified early and corrected, through lifestyle/ behavioural changes, can help to reduce the incidence and mortalities associated with such diseases[10].

Table 1 shows BMI classification, values and its risk of morbidity /mortality individuals as classified by WHO.

Table 1. BMI classification of adult weight based on (*BMI = weight in kg/height in meters*^{2}).

Classification	BMI (kg/m^2)	Risk of co-morbidities
Underweight	<18.5	Low (but risk of other clinical problems increased)
Underweight (Severe thinness)	< 16.0	
Underweight (Moderate thinness)	16.0–16.9	
Underweight (Mild thinness)	17.0–18.4	
Normal weight	18.5–24.9	Average
Overweight	25.0–29.9	Mildly increased
Obese	≥30	
Obese I	30.0–34.9	Moderate
Obese II	35.0–39.9	Severe
Obese III	≥40	Very severe

Source: *Safaei et al., 2021*

Individuals can be classified as having low, moderate or high health risk of being affected by weight-related health conditions based on their WHR. A healthy WHR for

women should ≤ 0.85 while for men, it should be ≤ 0.90[11].

This study evaluated the BMI and WHR of participants in a Nigerian University with the aim of identifying those at future risk of health challenges and proffering solutions.
The objectives of the study were

1. To assess the participants' body mass index
2. To assess the participants' waist-to-hip ratio
3. To determine if there is a relationship between the participants' body mass index and their blood pressure
4. To determine the extent to which BMI and WHR can predict the blood pressure

Methodology

This was a cross-sectional study. The population were participants that attended a free health program organized by the Western Delta University in Delta State, Nigeria targeting staff and students of the institution. The university is one of the higher institutions located at Oghara -Ethiope West local government area of Delta State. Those who were pregnant, mentally ill, and children were excluded from the study. Anthropometric measurements were taken from the participants who gave verbal consent. The measurements included height, weight, waist circumference, hip circumference and blood pressure of each participant. The weight (kilograms) was measured using in a digital weighing scale, height (meters) with a stadiometer, waist circumference (WC), and hip circumference (HC) in centimeters using a measuring tape rule. The WC was measured in standing position at full expiration using the umbilicus as the reference point. Care was taken not to pull the tape measure too tight. The HC was taken the widest part of the buttocks. The Body mass index was then calculated from the measurement obtained from the weight and height while the waist-hip ratio (WHR) was calculated from the waist and hip circumference. Blood pressure was measured using an automated mercury-free sphygmomanometer. All the measurements taken were recorded in a proforma.

Sample size

The sample size was calculated using Lesile Kish formula

$n = (Z\alpha + Z\beta)^2 \times (p \times q)/d^2$

n = Sample size

Zα = Normal standard deviant at 95% confidence level (1.96)

Zβ = Power at 80% (0.84)

p = Proportion of BMI and WHR

q = (1 – p)

d = Precision level (0.1)

Calculated sample size was 196. After applying the 10% attrition rate, the final sample size was 216.

Data Analysis

The data collected was transferred to Statistical Package for the Social Sciences (SPSS) version 29.0 (IBM Corp., Armonk, NY), which was used for data analysis. Continuous variables were described as mean and standard deviation, frequency distribution and percentages. Pearson correlation was used to check for relationships and multiple

regression analysis was also done. P-value was considered significant at $P < 0.05$.

Results

There were two hundred and sixteen (216) participants in this study, however the response rate was 212 (98.1%) . The mean age was 23.7 ±8.4 years. Majority, one hundred and twenty-six (59.4%) were between the ages of 15-20 years. Forty-four (20.8%) were between the ages of 21-30years, twenty-eight (13.2%) were between the ages of 31-40years while only a few (14; 6.6%] were within the ages of 41 years and above.

Forty-two (19.8%) were staff of the university while majority of the participants were students (170, 80.2%). Majority were Urhobo by tribe. All the participants were Christians.

Table 3: Sociodemographic characteristics/Age distribution of Participants

Group	Frequency	Percent
Age		
15-20years	126	59.4
21-30years	44	20.8
31-40years	28	13.2
41years and above	14	6.6
Total	212	100
Geder		
Males	30	14.2
Females	182	85.8
Occupation		
Students	170	80.2
Staff	42	10.8
Religion		
Christian	212	100
Islam	-	-
Tribe		
Urhobo	124	58.5
Itsekiri	46	21.7
Isoko	22	10.4
Others	20	9.4

Table 4: Categorization of participants' body-mass Index

BMI		Gender		Total
		Male	Female	
Underweight [less 18.5],	Freq.	0	30	30
	%	0	100	100
Normal [18.5-24.9],	Freq.	30	98	128
	%	23.4	76.6	100
Overweight [25.0-29.9]	Freq.	0	32	32
	%	0.0	100	100
Class I Obesity 30.0- 34.9	Freq.	0	14	14
	%	0.0	100	100
Class II obesity 35.0-39.9	Freq.	0	4	4
	%	0	100	100
Class III obesity, ≥ 40 (extreme Obesity)	Freq.	0	4	4
	%	0	100	100
Total	Freq.	30	182	212
	%	14.2	85.8	100

Thirty [14.2%] males participated in this study. They all had normal BMI. A total of 182 (85.8%) participants were females among whom 98 [53.8%] had normal BMI, 30 [16.5%] underweight, 32 [17.6%] overweight, 14 [7.7%] were Obese while 4 [2.2 %] had type I obesity and another 4 [2.2 %] had type II obesity.

Table 6: Categorization of Waist- Hip Ratio

Gender	WHR	Percentages
Males		
≤ 0.9	30	100
≥ 0.9	--	--
Females		
< 0.81	118	64.8
0.81-0.85	44	24.2
> 0.85	20	11.0

All the male participants had WHR of less than or equal to 0.9 while 118 female participants [64.8%] had WHR of less than 0.81; 44 [24.2%] had WHR of 0.81-0.85 and 20 [11.0 %] had WHR greater than 0.85

To determine if a relationship exist between the participants BMI and their Blood Pressure, correlation was done (Table 7).

Table 7: Correlation between BMI and blood pressure [Systolic and Diastolic]

	BMI
Systole	.315
Diastole	.133

Table 7 showed the relationship between BMI and BP (Systolic and Diastolic). There is a significant positive relationship between Systole and BMI (r= 0.315, P< 0.05) while Diastole has a positive relationship with BMI but not significant (r= .133, P>0.05).

To determine the predictive power of BMI and WHR on Systolic and Diastolic Blood Pressure multiple regression analysis was done. (Table 8).

Table 8: Multiple Regression on the predictive power of BMI and WHR on Systolic blood pressure

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Adj. R^2	F	Prob.
	B	Std. Error	Beta			0.083	5.727	.004[b]
(Constant)	92.643	13.958		6.637	.000			
BMI	.901	.268	.321	3.364	.001			
WHR	-5.360	17.190	-.030	-.312	.756			

Dependent Variable: Systolic Blood Pressure

The analysis showed that BMI has a significant positive effect on systolic blood pressure (β= 0.901; t= 3.364; p<0.05). While WHR has negative effect on the systolic blood pressure, but not significant (β= -5.360; t= -0.312; p>0.05). The F-statistic at a probability value less than 0.05(5%) showed that BMI and WHR have combined significant effect on the systolic blood pressure.

Table 9: Multiple Regression on the predictive power of BMI and WHR on Diastolic blood pressure

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Adj. R^2	F	Prob.
	B	Std. Error	Beta			0.017	1.885	0.157
(Constant)	82.774	11.460		7.223	.000			
BMI	.356	.220	.160	1.618	.109			
WHR	-19.421	14.113	-.136	-1.376	.172			

Dependent Variable: Diastolic Blood Pressure

The analysis shows that, BMI had a positive effect on diastolic blood pressure, but not significant (β= 0.356; t= 1.618; p>0.05). On the other hand, WHR also has negative effect on the diastolic blood pressure, and is not significant (β= -19.421; t= 14.113; p>0.05). The F-statistic at a probability value greater than 0.05(5%) showed that BMI and WHR

have no combined significant effect on the diastolic blood pressure.

Discussion

Anthropometric measurements are important indicators of obesity, overweight and health risk predictors in adolescence and adults. Majority of the participants were adolescence between the ages of 15-20 years and were mostly females. Majority of the females and all the males had normal BMI and WHR except for few females that are overweight and obese. These results are very encouraging as most of them have low or no health risk of developing diseases associated with overweight and obesity and especially fecundity in women. However, they will require follow-up. Overweight and obesity in their own capacity are forms of malnutrition that require adequate monitoring. For continue maintenance of BMI and WHR they are to engage in activities that promote healthy living such as consumption of balanced diets rich in fruits and vegetables and adequate physical activities/ exercises; they are not to engage themselves in activities that do not promote healthy living such as consumption of fatty foods, junk foods, lack of exercises, consumption of alcohol and smoking.

Quest to want to maintain their body esteem may be the reason why some of the participants have low BMI as have been observed in a previous study[13]. High BMI levels during adolescence have been linked to adult mortality, stroke, and coronary heart disease[14,15].

Few of the female participants have high WHR. This may be because they have extra muscles around their hips due to engagement in vigorous exercises or may be carrying more of their weight around their abdomen. Having a high WHR predicts a health risk in the individuals concerned. In females, high WHR has been associated with menstrual irregularity, anovulatory cycles, subfertility and a lower pregnancy rate than in women with a lower WHR, regardless of their BMI in addition to personality disorders, anxiety, depression, fear and poor stress coping skills[8,16,17].

In this study, BMI has a significant positive correlation with systolic blood pressure (SBP) and it is a not significant correlate with diastolic blood pressure (DBP). Additionally, BMI was found to be a significant predictor of systolic blood pressure, but not significant with DBP. WHR had a non-significant negative effect on both the systolic and diastolic blood pressure. Kumal et al. reported a positive correlation between BMI and Systolic BP among participants in their study[18]. Similarly, Song et al. and Tesfaye et al. reported a positive correlation of SBP and DBP with BMI among population subgroups of Asia and Africa[13,19]. These findings are similar to the results obtained from the current study. In a separate study by Landi et. al. BMI iwas strongly associated with BP[20]. In 2023, Song et l., explored the association between body mass index [BMI] and blood pressure. They observed that individuals who are overweight or obese have an elevated risks of 2.05 and 5.44 respectively for hypertension, when compared with individuals with normal weight[21]. A combination of BMI and BP is responsible for more than 60% of cases of cardiovascular

diseases[22]. Some other studies have also confirmed a positive relationship between BMI and BP[4,23,24,25].

Conclusion

BMI and WHR Still remains the commonest, convenient anthropometric measurements use for surveillance purposes in monitoring obesity in adults. It should therefore be included in weight management programs. They are useful measures that guide individuals and health care workers in weight management to identifying risk factors and threats associated with certain diseases early and mitigate against them. Keeping surveillance on the BMI and WHR of university students may be an effective method in preventing future development of diseases associated with overweight and obesity. Strategies to reduce weigh and improve life style will be beneficial to those that are overweight and obese

Conflict of Interest: The authors declare that there is no conflict of interest.

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