Original Research Article

Is Waist to Height Ratio better than other Indices of Obesity in Determining Cardiovascular Risk?

Abstract

Background: The indices of obesity (measured by Body Mass Index, waist circumference, and weight-to-height ratio) have been observed to be strongly associated with cardiovascular risk. Body mass index (BMI) is a measure of general obesity while waist circumference (WC) and waist-to-height ratio (WHtR) are used to measure central obesity, with the latter suggested to be the indicator for the prediction of cardiovascular risks. This study aimed to determine the advantage of WHtR for cardiovascular risk over the use of other indices of obesity.

Methods: The study was a cross-sectional descriptive design carried out among 441 participants at the Metabolic Research Laboratory LTH Ogbomoso excluding pregnant or breastfeeding mothers, thyroid disease, those diagnosed with hypertension, diabetes, or hyperlipidemia, those on blood-pressure, blood-glucose or lipid-lowering medications; those on weight-control medications or supplements. A structured self-administer questionnaire was distributed to obtain socio-demographic data of participants. Physical examination was done with anthropometry measurements. Fasting blood samples were obtained for blood glucose and lipid profiles. Data analysis was done using SPSS version 21.

Results: The study included 441 subjects with male to female ratio of 1:1.47 mean age of 37.92±11.80 and 34.72±12.16 respectively. Blood pressure, pulse rate, height and other obesity indices except waist circumference were all statistically significantly higher in the males than in the females $p < 0.05$. There was a statistically significant difference in the BMI between the sexes for all categories with the majority of female subjects having abnormal BMI and waist circumference. There was a statistically significant relationship between all the obesity indices (BMI, WHtR& WC) and the cardiovascular risk factors excluding TG and HDLC $P < 0.05$.

Conclusion: It was observed that all indices of obesity measured in this study were sensitive and significant in determining cardiovascular risk. It could be concluded that WHtR does not have a special or greater advantage over BMI and WC as all indices showed a significant association with cardiovascular risks. Also, the level of statistical significance suggested that either of these obesity indices could be used independently as a predictor of cardiovascular risk.

Keywords: Waist to height ratio (WHtR), obesity indices, cardiovascular risk, Nigeria.

Introduction

Cardiovascular diseases have been a major health problem in the developed world and more people die from cardiovascular diseases than from other non-communicable diseases globally [1].Although it was thought to be a disease of the developed world alone, however, data has shown that over 80% of all deaths due to cardiovascular diseases are from low- and middle-income countries [1]. The influential lifestyles of the developed countries are now being imbibedin the developing countries and with it the trend of cardiovascular diseases [2, 3]. Some risk factors have been identified to predispose to developing cardiovascular diseases. While some of them are non-modifiable such as age, gender, and heredity, others are modifiable like obesity, hypertension, cigarette and alcohol intake, lipid profile, and diet [4].

The indices of obesity(measured by Body Mass Index, waist circumference, and weight-to-height ratio) have been observed to be strongly associated with cardiovascular risk [5–9] as reported by studies across the world [7, 9–11]. Therefore, as attempts to reduce the burden of cardiovascular diseases are being made, obesity as a modifiable risk factor can be targeted. Body mass index (BMI) is a measure of general obesity while waist circumference (WC) and waist-to-height ratio (WHtR) are used to measure central obesity, with the latter suggested to be the indicator for the prediction of cardiovascular risks [12–16].

While past studies have shown the association between obesity indices and cardiovascular risks, it is still not established; the indices with the strongest association with cardiovascular risk. Hence, this studyassessed theobesity indices with the strongest association with cardiovascular risk factors in a sample adult Nigerian population.

Methodology

Study Design

The study was a cross-sectional descriptive design carried out in the Ogbomoso community, Oyo State, Nigeria.

Criteria

Pregnant subjectsand/or breastfeeding mothers, those with clinical thyroid disease, those diagnosed withhypertension, diabetes, or hyperlipidemiabefore the commencement of the study; those on blood-pressure or blood-glucose or lipid-lowering medications; those on weight-control medications or supplements; and those who declined to participate in the study were all excluded.

Study Procedure

The subjects who met the study criteria were instructed to fast overnight (8-12 hours) and then reported at the Metabolic Research Laboratory of the LAUTECH Teaching Hospital Ogbomoso, to complete a structured questionnaire and blood sample collection.

The weight (kg) and height were obtained using the stadiometer (Heightiometer and weighing scale Lincoln Mark Medical, England). The body mass index was calculated (kg/m^2 classified according to WHO classification[22]. Waist circumference (WC) was measured midway between iliac crest and lowest rib using a non-stretchable tape measure. The waist-to-height ratio was calculated by dividing the WC by the Ht (i.e. WC/Ht). The blood pressure (BP) and pulse rate (PR) of the participants were obtained using A&D UA767 digital monometer which has been validated by the British Hypertension Society [23]. Blood pressure was taken using an appropriate cuff after ensuring that the participant had rested.

Blood Sample Collection

Ten (10) ml of venous blood specimens were obtained into lithium heparinized bottles for lipid profiles andfluoride oxalate bottles for fasting blood glucose. Blood samples were centrifuged at 3000rpm for 5 minutes and the extracted plasma wasstored at -20^0C until analysis. Fasting plasma glucose was analyzed using the glucose oxidase method. The concentration of total cholesterol (TC), its fractions and triglycerides (TG) were assessed enzymatically using commercially available reagents (Randox Laboratories Ltd, UK). The HDL-C was determined from the supernatant after other fractions were separated by precipitation techniques using sodium phosphotungstate and magnesium chloride [24]. The concentration of low-density lipoprotein cholesterol (LDL-C) was calculated using the Friedewald equation for participants with TG levels<4.5 mmol/L [25]. Accuracy was ensured using commercial quality control sera. Participants with abnormal BP readings, lipid profile and FPG werere-checked. Participants with any persistent abnormal findings were counseled and referred to the health facility of their choice.

Data Analysis

All statistical analyses were done using the Statistical Package for Social Sciences (SPSS) software, version 21. Categorical variables were expressed as proportions and continuous variables as means±, standard deviation. Comparisons between continuous variables were analyzed using the student t-test and analysis of variance (ANOVA) respectively. The chi-squared test was used to determine the degree of association of categorical variables with the Fisher's test applied when appropriate.

Results

A total of 441 subjects were recruited for the study including 178 males and 263 females. The mean age of the males was statistically higher than the females (37.92±11.80 vs 34.72±12.16,*p*=0.006). Blood pressure, pulse rate, height and other obesity indices except waist circumference were all statistically significantly higher in the males than in the females p <0.05 (Table 1).

Table I: Gender distribution of cardiovascular risk factors among the subjects

Variable	Total n=441	Male n=178	Female n=263	*p* – value
Age	36.01±12.10	37.92±11.80	34.72±12.16	0.006*
Weight	70.14±17.00	70.74±16.36	69.74±17.43	0.546
Height	1.63±0.08	1.67±0.08	1.60±0.06	< 0.001*
BMI	26.60±6.83	25.30±6.01	27.48±7.22	0.001*
WC	86.46±15.73	86.07±14.83	86.72±16.33	0.668
SBP	125.86±23.01	131.44±22.24	122.09±22.79	< 0.001*
DBP	78.46±13.99	80.33±14.09	77.19±13.80	0.021*
PR	77.08±13.32	75.14±14.47	78.39±12.33	0.012*
WHtR	53.27±10.33	51.53±9.40	54.45±10.77	0.004*
FPG	5.26±1.68	5.40±1.81	5.16±1.58	0.128
TC	4.52±1.46	4.64±1.48	4.44±1.44	0.143
TG	0.97±0.30	1.18±0.35	0.82±0.50	0.215
HDL – C	1.52±0.58	1.25±0.50	1.70±0.46	0.432
LDL – C	3.11±1.58	3.25±1.64	3.02±1.54	0.123

BMI = Body Mass Index, WC = Waist circumference, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, TC = Total Cholesterol, HDL–C = High density lipoprotein–Cholesterol, LDL–C = Low density lipoprotein–Cholesterol, TG = Triglycerides, PR =Pulse Rate, FPG = Fasting Plasma Glucose
**Statistically Significant*

There is a statisticallysignificant difference in the BMI between the sexes for all categories, more than half (55.5%) of the female subjects have abnormal BMI as opposed to 42.1% of the males using the 2023 NICE guideline: Healthy weight: BMI 18.5 kg/m2 to 24.9 kg/m^2, overweight: BMI 25 kg/m2 to 29.9 kg/m^2, obesity class 1: BMI 30 kg/m^2 to 34.9 kg/m^2, obesity class 2: BMI 35 kg/m^2 to 39.9 kg/m^2, obesity class 3: BMI 40 kg/m^2 or more.Also, the female subjects with abnormal waist circumference are more than their male counterparts (41.8% vs 16.3%, *p*= < 0.001).

Table II: Sociodemographic and family history of the subjects

Variable	Male n(%)	Female	*p*–value
Age			
18-34 years	74 (41.6)	139 (52.9)	0.021*

35-54 years	87 (48.9)	112 (42.6)	
55-74 years	17 (9.6)	12 (4.6)	
Occupation			
Civil servant	115 (64.6)	156 (59.3)	0.154
Student	63 (35.4)	107 (40.7)	
BMI			
Underweight	7 (3.9)	8 (3.0)	0.005*
Normal	103 (57.9)	117 (44.5)	
Overweight	37 (20.8)	53 (20.2)	
Obesity	31 (17.4)	85 (32.3)	
Abnormal WC	29 (16.3)	110 (41.8)	< 0.001*
Abnormal TC	52 (29.2)	66 (25.1)	0.198
Abnormal TG	13 (7.3)	15 (5.7)	0.314
Abnormal HDL – C	31 (17.4)	52 (19.8)	0.311
Abnormal LDL – C	73 (41.0)	95 (36.1)	0.174
Family history of HTN	43 (24.2)	43 (16.3)	0.125
Family history of DM	**18 (10.1)**	**24 (9.1)**	**0.858**

TC = Total Cholesterol, HDL–C = High density lipoprotein–Cholesterol, LDL–C = Low density lipoprotein–Cholesterol, TG = Triglycerides, HTN = Hypertension, DM = Diabetes Mellitus, BMI = Body Mass Index
**Statistically Significant*

There was a statistically significant relationship between all the indices of obesity (BMI, WHtR& WC) and the cardiovascular risk factors except TG and HDLC. P <0.05. (Table III).

Table III: Regression analysis for risk factor levels on WC, WHtR and BMI

Variables	**BMI**	**Waist/Height Ratio**	**Waist circumference**
	Regression coefficient (p-value)	Regression coefficient (p-value)	Regression coefficient (p-value)
FPG	0.13 (0.006*)	0.17 (<0.0001*)	0.18 (<0.0001*)
TC	0.32 (<0.0001*)	0.35 (<0.0001*)	0.34 (<0.0001*)
TG	0.007 (0.872)	-0.0007 (0.987)	-0.006 (0.903)
HDLC	0.03 (0.571)	-0.02 (0.652)	0.03 (0.491)
LDLC	0.33 (<0.0001*)	0.37 (<0.0001*)	0.36 (<0.0001*)
SBP	0.33 (<0.0001*)	0.32 (<0.0001*)	0.36 (<0.0001*)
DBP	0.39 (<0.0001*)	0.40 (<0.0001*)	0.42 (<0.0001*)

FPG = Fasting Plasma Glucose, TC = Total Cholesterol, HDL–C = High-density lipoprotein–Cholesterol, LDL–C = Low-density lipoprotein–Cholesterol, TG = Triglycerides, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure.
**Statistically Significant*

Discussion

This study assessed the most reliable predictor of cardiovascular diseases amidst the various indices of obesity as a form of first-hand pointer while waiting for laboratory results of the full cardiovascular risk markers such as lipid profile.It is however important to note that in low-resource countries like Nigeria where old or manual techniques are still been utilized for most laboratory assays with long turnaround times, seeking a quick or alternate predictor of cardiovascular disease is justified in clinics and for prompt decision making in the line of patient management.

The female subjects in this study were more than their male counterpart and this is as observed in other studies within the country [17, 18] which could be because there are more females in the Nigerian population than males and also due to the willingness of the females to be questioned and follow up than the males [19].

The distribution of the age of the subjects shows that almost all were less than 55 years old as would be expected in a university community of students and civil servants. The mean blood pressure of the male subjects is also higher. This is in agreement with other findings by Adeoye*et al* in a study of 352 health workers in Ibadan, Nigeria [20] and by Wokoma and Alasia in Barako, a rural community in River's state [21].

This present study observed the waist-to-height ratio to be higher among males than females, this is in contrast to a study by Ajani *et al* [22] and Pam *et al* [23] where it was reported to be more among female subjects. There is a statistically significant difference in the BMI between the sexes for all categories, more than half of the female subjects have abnormal BMI. Also, the female subjects with abnormal waist circumference are more than their male counterparts. Therefore, using BMI as a measure of central obesity, the females were more at risk of cardiovascular disease which was in tandem with another report from a similar study [23].

Blood pressure, pulse rate, height and other obesity indices except waist circumference were all statistically significantly higher in the males than in the females. There was a significant relationship between all the indices of obesity (BMI, WHtR& WC) and the cardiovascular risk factors except TG and HDLC. However, using waist-hip ratio and waist circumference to predict the risk of cardiovascular diseases was slightly more significant than using BMI according to our study; this suggests that central obesity predicts the risk of cardiovascular disease more than generalized obesity and when considering cardiovascular risk in a patient, instead of measuring weight, checking the waist circumference could be more beneficial. However,waist-to-hip ratio has been reported to predict more efficiently the risk for other diseases [24, 25].

Conclusion

It was observed that all indices of obesity measured in this study were sensitive and significant in determining cardiovascular risk. It could be concluded from this study that WHtR does not have

a special advantage over BMI and WC as all indices showed a significant association with cardiovascular risks. Also, the level of statistical significance suggested that either of these obesity indices could be used independently as a predictor of cardiovascular risk.

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