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Internal Medicine Section

Prevalence of Obesity and Predictive Value of Central Obesity among Medical Doctors to Diagnose Hypertension

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ABSTRACT

Introduction: Central obesity has been shown to have worse health outcomes than general obesity and plays a greater role in the causation of cardiovascular diseases. Prevalence of central obesity is high in Nigeria and is associated with increased cardiovascular risk.

Aim: To assess the prevalence of central obesity in medical doctors in Bayelsa state using four obesity indices and to determine the association between these indices and compare the ability of these indices to predict cardiovascular risk.

Materials and Methods: This was a descriptive cross-sectional study conducted between August 2018 and January 2019. Using a structured self-administered questionnaire, data was collected from 244 randomly selected medical doctors. Data included socio-demographic information, work duration and professional cadre, Blood Pressure (BP) was taken. Anthropometric measures which included weight (in Kg), height (in metres), Waist Circumference (WC) and Hip Circumference (HC) in centimeters was taken. From the different measures: Waist-Hip Ratio (WHpR), Waist-Height Ratio (WHtR), Body Mass Index (BMI) was calculated. Based on WHO recommended thresholds, WC, WHpR, WHtR and BMI were used in categorising participants as obese and non-obese. Correlation analysis was done and Receiver Operating Characteristic (ROC) curve was constructed. Statistical significance was set at p-value <0.05.

Results: Most doctors in the study were less than 30-year-old (40.2%), married (54.9%) and female doctors made up a third of the respondents (29.9%). The mean age of study participants was 37.4 years (SD-11.3 years) and mean duration of medical practice was 9 years (SD-11.1 years). The prevalence of elevated BP was 26.6% using a BP threshold of ≥140/90 mmHg. The prevalence of obesity was 18.4% using BMI ≥30 kg/m^2. Based on WC, WHtR, and WHpR categorisations, the prevalence of obesity was 44.3%, 58.2%, and 63.1%, respectively. The weakest relationship existed between BMI and BP (r=0.15; p=0.019); while the correlation coefficient (r) between WC and WHtR showed a very strong positive relationship (r=0.88; p=0.001). ROC curve analysis revealed all anthropometric indices obtained modest performances in predicting Cardiovascular Diseases (CVD) risk as indicated by AUC values that were equal to or higher than 0.60. WC performed best in predicting hypertension in study participants (0.69) while BMI was the worst performer (0.60).

Conclusion: A high prevalence of central obesity in medical doctors is worrisome given the associated cardiovascular risks. This study shows all four anthropometric indices (WC, WHtR, WHpR and BMI) are useful in predicting cardiovascular risk, with the best and worst predictors being WC and BMI, respectively.

Keywords: Blood pressure, Body mass index, Cardiovascular risk, Waist circumference, Waist hip ratio

INTRODUCTION

Obesity is defined by the World Health Organisation (WHO) as abnormal or excessive fat accumulation that may impair health [1]. Obesity is a global epidemic with at least 600 million adults affected worldwide with growing numbers especially in Sub-Saharan Africa [1-3]. Obesity is a public health challenge in many low and middle income countries including Nigeria [3,4]. The prevalence of overweight and obese individuals, range between 20.3-35.1% and 8.1-22.2%, respectively in Nigeria [4]. There is evidence on a global scale that obesity adversely affects individuals' health [3,5]. Obesity is a risk factor for several non-communicable diseases including cardiovascular diseases, cancers, osteoarthritis, pulmonary embolism, cognitive impairment and mental health disorders including depression [6-11].

Several studies have looked at the prevalence of obesity among several professional groups and its effects on workplace performance, physical function and capacity, and cognitive performance [12-15]. Obese employees have been found to have higher rates of sick leaves [11] and workplace employer paid healthcare costs [12-15]. Direct measures of obesity include underwater weighing and Dual Energy X-Ray Absorptiometry (DEXA) but facilities for these measures are largely unavailable in resource-poor settings (like ours) and these measures are also not routinely used in clinical practice. Indirect measures of obesity commonly employed in assessment of obesity include: BMI, WC, WHpR, WHtR, and Skinfold Thickness (ST). BMI is widely used to categorise overweight and obesity and may be regarded an ideal measure of adiposity, because it is easy to measure and closely relates to obesity related health risks [16,17].

However, individuals may be "metabolically obese" (with elevated visceral fat) but fall within the normal BMI category, while sharing many of the health risks for obesity [18,19]. Furthermore, BMI does not distinguish between fat, muscle or bone mass; hence, muscular individuals may be misclassified as being overweight or obese despite having normal body fat percentage [20]. BMI, WHtR, WC and WHpR all independently predict cardiovascular risk [21,22]; however, in comparing the associations of various measures of obesity with cardiovascular risk, cardiovascular mortality and all-cause mortality, measures of central obesity; WC, WHR, WHtR have been shown to be superior to BMI [21-23]. Several studies have found a high prevalence of general obesity and being overweight among medical doctors with rates ranging from 48% to 65% [15-18]. A high prevalence of central obesity has also been recorded among doctors and other health professionals [16,20,24]. Central obesity has worse health outcomes than general obesity and plays a greater role in the causation of CVDs and diabetes mellitus [19,25-27].

Physicians manage the health problems associated with obesity and counsel obese patients on healthy lifestyles and weight loss measures. It is important that the physicians themselves be healthy, in order to attend adequately to patients. A healthy-looking non-obese doctor may also seem more credible when counselling patients on healthy life styles and diet, than an overweight or obese doctor [25,27-33].

This study was conceptualised to assess the prevalence of obesity among physicians in Bayelsa State, in the Niger Delta region of Nigeria. Four anthropometric measures: BMI, WC, WHpR and WHtR were deployed in this assessment, the ability of these measures to predict cardiovascular risk in relation to elevated BP was also compared.

MATERIALS AND METHODS

There was a descriptive cross-sectional study collection conducted between August 2018 and January 2019. Ethical clearance (application form no NDUTH REC/0039b/2017) was obtained.

Inclusion criteria and Exclusion criteria: Inclusion criteria were all medical doctors, irrespective of their cadre, working in Bayelsa state. Exclusion criterion was visibly pregnant female doctors.

Study setting: The study was conducted in Bayelsa state, Nigeria. Two hundred and forty four apparently healthy physicians were recruited from all the medical doctors registered to practice medicine in Bayelsa state. There are about 700 medical doctors registered to practice in the three levels of healthcare service delivery in both public and private health sectors of the state. Participants spanned through different cadre of the profession including house officers, resident doctors, medical officers, consultants and professors in various specialties and sub-specialties of medical practice.

Sample size: Sample size for studying proportions with population <10, 000 [34]

$$nf = \frac{n}{1+\frac{n}{N}}$$

nf=the desired sample size when population is less than 10,000

N=the estimate of the population size (approximately 700 registered doctors in the state)

$$n = \frac{z^2pq}{d^2}$$

Where, z=the standard normal deviate (using 95% confidence level=1.96)

p=the proportion in the target population estimated to be obese (the prevalence of obesity in medical doctors is 48% to 65% [15-18], therefore, midpoint=56.5%)

q=1.0-p

d=degree of accuracy desired, set at 0.05 therefore,

$$n = \frac{(1.96)^2 \times 0.565 \times 0.435}{(0.05)^2} = 377.67$$

$$\text{Hence, } nf = \frac{377.67}{1+377.67/700} = 245$$

The sample size appropriately powered and calculated for this study was 245.

Sampling technique: Three clusters of doctors were created based on the place of primary assignment of the medical doctors. Doctors working in the Federal Medical Centre (FMC), Yenagoa formed cluster one. Cluster two comprised of doctors working in the employment of the Niger Delta University Teaching Hospital (NDUTH), while the other doctors working at the secondary and primary levels of care in the private and public sectors formed the third cluster. The doctors in the third cluster are members of the Association of General Medical Practitioners (AGMPN) of Nigeria (Bayelsa state) and that was the avenue used for their sampling. Eighty-two doctors each were selected from the three clusters using a simple random sampling technique (Balloting). Doctors who declined participation were replaced by picking new names from the balloting box in each of the clusters. The lists of doctors in the two tertiary institutions were obtained from the management of the institutions while the doctors' list in the AGMPN was obtained from the Association's officials.

Study instrument (Questionnaire): The study instrument was a self-administered questionnaire developed from the WHO stepwise approach to Surveillance guidelines [16,35] by the researchers. It explored information on socio-demographic, work duration and professional status/cadre.

Study procedures: Preselected study participants were informed by phone or physically about their selection and an office selected in each of the clusters: FMC Yenagoa, NDUTH Okolobiri and the AGMDP state secretariat was used as the venue of their assessment. The offices were open between 12-3 pm and were manned by Research Assistants (RAs).

Training for two days was given to RAs training lasting three hours each day, emphasising the objectives of the study and how to take the required measurements in the study in a consistently accurate manner. Training ended with a field trial where RAs were watched and corrected to ensure compliance to study procedure.

After participant's submitted the completed self-administered questionnaire, physical measurements were taken by RAs. The average evaluation time for each medical doctor was 20 minutes. Height was measured with each participant standing feet together, without shoes, and with their backs to a rigid tape measure, head held high and looking straight on, at a spot on the opposite wall. A flat ruler was placed on the participant's head to flatten any hairs present and readings were taken off the tape to the nearest 0.1 centimeter, at the point where the flat ruler touched the rigid tape. A standardised weight scale was used to measure body weight in kilograms (to one decimal place) with the participants wearing only light clothing. A non-stretch linear tape was applied approximately midway between the lower margin of the last palpable rib and the top of the iliac crest [35] for measurement of WC to the nearest 0.1 centimeters. HC was measured across the widest diameter of the hips over the greater trochanters, also to the nearest centimeter. An Accoson mercury sphygmomanometer was used to measure the brachial artery systolic and diastolic blood pressure at Korotkoff 1 and 5 respectively, with participants seated, after resting for 5 minutes [36]. Two BP recordings were taken from the left arm of patients with measurements taken at 5-minute intervals. The average of two measurements was then taken as the BP reading.

Data Processing and Analysis

The anthropometric measurement of two doctors was not done though they filled the questionnaire, so they were not included in the data analysis.

BMI was calculated as weight in kg divided by the square of the height in metres (kg/m^2). Using WHO guidelines, obesity was defined as a BMI of ≥30 kg/m^2 [1,35]. The threshold for obesity using WC was 94 cm for men and 80 cm for women [37]. WHpR was obtained by dividing WC by HC and WHpR >0.90 in males and >0.85 in females was categorised as obese [37]. After calculating WHtR by dividing WC by height, WHtR ≥0.5 was considered obese [38]. Hypertension was considered present at Systolic Blood Pressure reading ≥140 mmHg and/or diastolic BP reading ≥90 mmHg [39,40].

All participants with elevated BP (systolic BP reading ≥140 mmHg and/or diastolic BP reading ≥90 mmHg) and classified as obese by the anthropometric measures were deemed to be at risk of cardiovascular disease. Using the BP categorisation as the standard indicator of cardiovascular risk [41], the classification of the WC, WHpR, WHtR and BMI were compared and the sensitivity, specificity, Positive Predictive Value (PPV) Negative Predictive Value (NPV) accuracy of these anthropometric measures in predicting cardiovascular risk was assessed. The ROC curve was constructed and Area Under the Curve (AUC) was obtained for the four anthropometric measures to compare their abilities to predict cardiovascular risk among participants using BP as the standard indicator for cardiovascular risk.

STATISTICAL ANALYSIS

Filled questionnaires were checked for completeness and entered into a Microsoft Excel sheet on a personal computer where data was cleaned. Cleaned data was imported into Statistical Package for Social Sciences (SPSS) version 22 software which was used for data analysis. Correlation analysis was also done to explore the relationship between all the measures of cardiovascular risks deployed in the study. Significant level for Pearson's correlation co-efficient and AUC was set at p-value<0.05

RESULTS

Sociodemographic characteristics of participants

Two hundred and forty four doctors participated in the study. Most of them were less than 30 years old (40.2%) and married (54.9%) and a third were women (29.9%), [Table/Fig-1]. The mean age of study participants was 37.4±11.3 years and mean duration of practice was 9±11.1 years. The data is skewed towards participants who have spent a short duration in their practice in Bayelsa. This may be explained by the brain drain of medical doctors in Nigeria, with many relocating overseas in search of better paying opportunities.

Characteristics	Frequency (N=244)	Percent (%)
Sex		
Male	171	70.1
Female	73	29.9
Age (in years)		
≤30 years	98	40.2
31-40 years	68	27.9
41-50 years	44	18.0
51-60 years	25	10.2
>60 years	9	3.7
Mean age	37.4±11.3 years	
Marital Status		
Single	110	45.1
Married	134	54.9
Professional Cadre/Status		
House officer	98	40.2
Resident/Medical officer	100	41.0
Consultant/Professor	46	18.9
Duration of Practice		
<1 years	88	36.1
1-5 years	55	22.5
6-10 years	24	9.8
11-20 years	36	14.8
21-30 years	28	11.5
>30 years	13	5.3
Mean duration of practice-9.0±11.1 years		

[Table/Fig-1]: Socio-demographic information of study participants.

Prevalence of elevated Blood Pressure (BP) and central obesity among study participants

The prevalence of elevated BP among the study participants was 26.6% [Table/Fig-2]. Almost a fifth of the doctors in the study (18.4%) were obese using the BMI categorisation. However, WC (44.3%), WHtR (58.2%), WHpR (63.1%) showed higher prevalence of obesity compared to the BMI categorisation [Table/Fig-2].

Characteristics	Classification	Frequency N=244 (%)
Blood Pressure (BP) (mmHg)		
Elevated Systolic BP	≥140	35 (14.3)
Elevated Diastolic BP	≥90	61 (25.0)
Elevated BP	SBP ≥140 DBP ≥90	65 (26.6)
Generalised obesity		
Body Mass Index (BMI)	≥30 kg/m²	45 (18.4)
Central obesity		
Waist Circumference (WC)	Male ≥94 cm Female ≥80 cm	108 (44.3)
Waist-to-Hip Ratio (WHpR)	Male ≥0.9 Female ≥0.85	154 (63.1)
Waist-to-Height Ratio (WHtR)	≥0.5	142 (58.2)

[Table/Fig-2]: Prevalence of cardiovascular risk as shown by Blood Pressure (BP) readings and anthropometric measures.

Diagnostic accuracy of BMI, WC, WHpR and WHtR in identifying cardiovascular risk in relation to elevated BP

[Table/Fig-3] shows the cross-tabulation results between elevated BP (reference CVD indicators) and the screening tests (BMI, WC, WHpR, and WHtR) considered in the study. While BMI and BP classified 45 (18.4) and 65 (26.6%) participants as at risk of CVD; WC, WHpR and WHtR categorised 108 (44.3%), 154 (63.1%) and 142 (58.2%), respectively as so. False-positive case classification is highest between elevated BP and WHpR, while false-negative case classification is highest between elevated BP and BMI [Table/Fig-3].

Screening test		CVD risk indicator Elevated BP Present	Absent	Total
WC	Obese	33	75	108
	Non-obese	32	104	136
	Total	65	179	244
WHpR	Obese	51	103	154
	Non-obese	14	76	90
	Total	65	179	244
WHtR	Obese	47	95	142
	Non-obese	18	84	102
	Total	65	179	244
BMI	Obese	17	28	45
	Non-obese	48	151	199
	Total	65	179	244

[Table/Fig-3]: The cross-tabulation results between the screening tests and reference CVD risk assessment test {Elevated Blood Pressure (BP)}

The sensitivity of BMI, WC, WHpR and WHtR in diagnosing cardiovascular risk, considering elevated BP as reference, ranges 26.5% to 78.5% [Table/Fig-4]. The highest NPV was 84.4% between WHpR and elevated BP; while for the PPV the highest proportion was 37.8% for BMI which also has the highest specificity (84.4%).

Relationship between cardiovascular risk screening tests

The Pearson's correlation coefficient between these cardiovascular screening tests shows a positively statistically significant (p<0.05) weak to very strong relationship. The weakest relationship exists between BMI and BP findings [Table/Fig-5]. WC and WHtR show a very strong positive relationship (r=0.88; p=0.001).

[Table/Fig-6] shows the performances of the screening tests (BMI, WC, WHpR and WHtR) as reflected on the ROC curves [Table/Fig-7]. All anthropometric measures demonstrate a moderately accurate performance in predicting cardiovascular risk (hypertension), as indicated by AUC values that are ≥0.60. WC performed best in predicting cardiovascular risk (hypertension) in the study participants.

Diagnostic parameter of screening test	Screening tests			
	WC	WHpR	WHtR	BMI
Sensitivity (%)	50.8	78.5	72.3	26.5
Specificity (%)	58.1	42.5	46.9	84.4
Positive Predictive Value (%)	30.6	33.1	33.1	37.8
Negative Predictive Value (%)	76.5	84.4	82.4	75.9
Accuracy (%)	56.1	52.0	53.7	68.8

[Table/Fig-4]: Diagnostic performance of BMI, WC, WHpR and WHtR in predicting CVD risk in relation to elevated Blood Pressure (BP).

Characteristics	Cardiovascular risk screening tests				
	BMI	WC	WHpR	WHtR	BP
Body Mass Index (BMI)					
Pearson correlation coefficient (r)	1.00				
p-value	-				
Waist Circumference (WC)					
Pearson correlation coefficient (r)	0.67	1.00			
p-value	0.037	-			
Waist-to-hip Ratio					
Pearson correlation coefficient (r)	0.31	0.61	1.00		
p-value	0.001	0.001	-		
Waist-to-height ratio					
Pearson correlation coefficient (r)	0.73	0.88	0.50	1.00	
p-value	0.001	0.001	0.001	-	
Blood Pressure (BP)					
Pearson correlation coefficient (r)	0.15	0.30	0.27	0.21	1.00
p-value	0.019	0.001	0.001	0.001	-

[Table/Fig-5]: Results of correlation between the different cardiovascular risk screening tests.

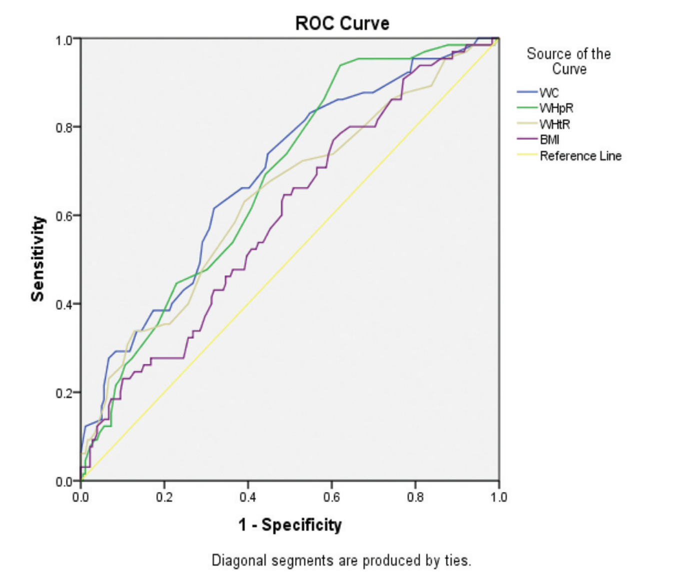
Screening test	Area under the ROC Curve (AUC)	95%CI		p-value
		Min	Max	
Waist Circumference (WC)	0.69	0.62	0.76	0.001
Waist-to-Hip Ratio (WHpR)	0.68	0.61	0.75	0.001
Waist-to-Height Ratio (WHtR)	0.64	0.56	0.72	0.001
Body Mass Index (BMI)	0.60	0.52	0.68	0.019

[Table/Fig-6]: Performance of screening tests in identifying cardiovascular risk {elevated Blood Pressure (BP)} among participants.

DISCUSSION

Prevalence of general obesity among medical doctors, using BMI categorisation, was 18.4% in this study. However, WC (44.3%), WHtR (58.2%), WHpR (63.1%) showed higher prevalence of obesity compared to the BMI categorisation. BMI has been regarded for years as the gold standard for measure of adiposity, given that it is easy to measure and is closely associated with obesity related health risks [42]. However, BMI fails to distinguish between fat, muscle or bone mass [43] and shows significant dependencies on age and sex [44]. BMI also overlooks fat distribution which is an important factor in CVD risk [45].

Previous studies have shown that one of the short comings of BMI is that it may classify persons with central obesity as normal or overweight [43,46-48]. BMI may not be an optimal marker for adiposity in older adults as a result of changes in body composition that occur with aging, such as a gradual increase in fat mass, decreased muscle mass and quality or sarcopenia. Indices such as WC, WHtR and WHpR are simple to measure and useful in identifying and characterising obesity morphology [49-52]; particularly where differences in anthropometry among study participants is relevant



[Table/Fig-7]: ROC curve comparing diagnostic accuracy of WC, WHpR, WHtR and BMI in predicting cardiovascular risk (hypertension).

to consider [45]. Although BMI remains a useful guide to obesity related health problems, measures of central obesity (WC, WHpR, WHtR) are simple alternatives/additives with additional value for predicting cardiovascular and metabolic complications [53-59]. These measures of central obesity have been shown by several studies to be more accurate predictors of cardiovascular health than BMI [46,47,53-59]. Abdominal obesity has been shown to significantly associate with CVD risk factors such as diabetes and dyslipidaemia and CVDs even when the BMI is normal [46,59-62]. Central obesity is also associated with a higher incidence of development of CVD risk factors related to cardiovascular diseases compared with high BMI [60,62]. Therefore, the sole use of BMI in practice-based settings may underestimate obesity and cardiovascular disease risk if central measures of obesity are not also measured and monitored [43-45,46-48,53-59]. The high prevalence of abdominal obesity in the present study further underscores the importance of measuring and monitoring abdominal obesity irrespective of the BMI classification.

In predicting cardiovascular risk using BP levels as the standard, the weakest relationship exists between BMI and BP findings, while measures of central obesity show a very strong positive relationship. Also, WC, WHpR and WHtR showed stronger performance than BMI in predicting hypertension, as indicated by areas under the ROC curve (AUC), with slightly higher AUC for the WC (0.69) in comparison to the other indices. This agrees with previous studies that show accumulation of fat in the upper body, which may reflect both visceral and subcutaneous fat, and, hence, total fatness, predicts hypertension greater than BMI which measures the sum of fat mass and fat-free mass [63-65]. WC which was identified as the best measure in this study has certain peculiar advantages. WC needs only one reading while for others you have to measure two reading. So, it is easier than all and the chance for errors is minimised. Prevalence of abdominal obesity as measured by WC has been found to be currently on the rise faster than general obesity measured using BMI [19,20].

Studies have indicated that WHtR ≥0.50 may more accurately predict HTN and DM than other measurements but those studies were mostly in Asians [66,67]. It is noteworthy that the present study, carried out in black Africans, found waist to height ratio compared favourably with other indices of central obesity in predicting hypertension.

Limitation(s)

The use of hypertension as a proxy measure of CVD risk may have overestimated CVD risk in this population. However, it is important that preventive measures are instituted to curb the rising menace of CVD.

CONCLUSION(S)

Using BMI alone in epidemiologic studies assessing obesity may result in misclassification of some persons as normal or overweight despite being centrally obese and at increased risk for cardiovascular diseases. A high prevalence of central obesity in medical doctors is worrisome given the associated cardiovascular risks. This study shows all four anthropometric indices (WC, WHtR, WHpR and BMI) are useful in predicting cardiovascular risk, with the best and worst predictors being WC and BMI, respectively.

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