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Waist circumference, waist to hip ratio, and body mass index in the diagnosis of metabolic syndrome in Nigerian subjects

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Summary: Metabolic syndrome is the commonest controllable precursor of cardiovascular and end stage renal diseases. While central obesity is recognized universally as its strongest component, there is the need for an accurate and affordable tool to screen for the presence of metabolic syndrome in every community. The easiest and cheapest measures of obesity are the body mass index (BMI), waist circumference (WC) and waist to hip ratio (WHR). This study investigated the potential of BMI, WHR and WC in diagnosis of metabolic syndrome (MS) in Nigerian subjects.This cross sectional study involved three hundred and thirty eight apparently healthy adult Nigerians recruited within the University College Hospital and its environs were evaluated for the features of metabolic syndrome using the World Health Organisation and the NCEP ATP 111 criteria. BMI, WC, WHR, Blood Pressure, Fasting Lipid Profile and Fasting Plasma Glucose were measured in each participant. Correlation between BMI, WC, WHR and Blood Pressure, Fasting Lipid Profile and Fasting Plasma Glucose which are other components of MS was determined and empirical Receiver Operating Characteristics (ROC) analysis was used to evaluate each of them as predictors of MS. The prevalence of MS in the studied population was significantly higher (36.7%) using NCEP definition than (23.7%) using WHO definition ($p<0.05$). By both definitions, this prevalence was higher in females than in males ($p<0.05$). WC was positively correlated with FPG and TG ($r=0.560$ and 0.436 respectively; $P=0.000$) in the NCEP category while WC was positively correlated with FPG, SBP and DBP ($r=0.254$, 0.480, and 0.490 respectively; $P>0.05$) in the WHO category. ROC Analysis shows WC having the highest AUC (0.785) hence diagnoses MS more accurately than both BMI (0.733) and WHR (0.783) using in the NCEP ATP 111 criteria. The highest Area Under Curve (AUC) was observed in WHR (0.837) followed by WC (0.799) in the WHO category. Both WC and WHR are shown to be good predictors of the presence of MS. It will be appropriate to incorporate WC measurement into routine general physical examination in our clinics.

Keywords: Anthropometric indices, Metabolic Syndrome, Nigerian

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INTRODUCTION

The metabolic syndrome as defined by Fezeu et al, (2007) is a cluster of the most dangerous, inter-related and often undiagnosed heart attack risk factors of metabolic origin. These include diabetes or raised fasting plasma glucose, abdominal obesity, high cholesterol and high blood pressure. First described by Reaven in the late 1940s, it became clearly defined as a clinical entity in the 1980s (Wannamethee et al, 2005. Einhorn et al, 2003). In 1998, the World Health Organization (WHO) was the first organization to provide a definition of the metabolic syndrome. In response, the European Group for the Study of Insulin Resistance (EGIR) countered with a modification of the WHO definition (Balkau & Charles, 1999). In 2001, the National Cholesterol Education Program (NCEP) released its definition. Subsequently, the American Association of Clinical Endocrinologists (AACE) offered its views regarding the definition of the metabolic syndrome (Einhorn et al, 2003). The proliferation of definitions suggested

that a single unifying definition was desirable (Ford, 2004). In the hope of accomplishing this task, the International Diabetes Federation (IDF) proposed a new definition of the metabolic syndrome in April 2005.

While Insulin resistance has been the pivotal feature in the WHO criteria, waist circumference (WC) rather than body mass index (BMI) has been the differentiating aspect of MS definition in the NCEP ATP-III panel. The International Diabetes Federation (IDF) proposed a slight modification in the ATP-III definition in 2005 where presence of abdominal obesity was considered mandatory for MS diagnosis.

The main focus in this new definition is central obesity (IDF, 2005). To have the metabolic syndrome, a person must have central adiposity defined on the basis of waist circumference and two or more of the following four factors: elevated concentrations of triglycerides, reduced concentrations of HDL cholesterol, elevated blood pressure, and dysglycemia (Ford, 2004; IDF, 2005). According to the WHO, the diagnosis of MS is accomplished by finding at least 1 of the following: (i) Type 2 DM (ii) Impaired Fasting Glucose (iii) Insulin Resistance, plus at least 2 of the following: (i) Hypertension (ii) Obesity (iii) Hypertriglyceridaemia or low HDL and (iv) Microalbuminuria (Balkau& Charles, 1999). Other components of MS which are not of diagnostic significance include hyperuricaemia, hypercoagulability and hyperleptinaemia (Zimmet et al, 2001).

It was estimated that around 20-25 percent of the world's adult population have the metabolic syndrome and they are twice as likely to die from and three times as likely to have a heart attack or stroke compared with people without the syndrome. People with the metabolic syndrome also have four to five fold increased risk of developing type 2 diabetics compared to those without the syndrome and each year, 3.2 million people around the world die from complications associated with diabetes (UKPDS Group, 1996).

The 'clustering' of metabolic abnormalities that occur in the same individual appear to confer a substantial additional cardiovascular risk over and above the sum of the risk associated with each abnormality (Golden et al, 2002). The more components of the metabolic syndrome that are evident, the higher is the cardiovascular mortality rate (Hu et al, 2004).

It was estimated that in 2003 for the 25 European Union countries the total direct healthcare costs of all diabetes in 20 to 79 year olds was up to 64.9 billion ID, the equivalent to 7.2 per cent of the total health expenditure for these countries (IDF, 2005.).The annual direct healthcare cost of diabetes worldwide for this age group is conservatively estimated to be as much as 286 billion ID, or even more (Hu 2004, IDF, 2005). If diabetes prevalence continues to rise as anticipated, it is likely that this figure will increase to 396 billion ID by 2025 (IDF, 2005.). This will mean an expenditure of up to 13 per cent of the world's healthcare budget on diabetes care, with high prevalence countries spending up to 40 per cent of their budget (IDF & IASO, 2004). It is important to note that these estimates of burden on national healthcare systems are for type 2 diabetes only and do not, as yet, estimate the additional burden of CVD associated with metabolic syndrome where clinical diabetes is not yet present (IDF & IASO, 2004; IDF, 2005).

The prevalence of metabolic syndrome in most sub-Saharan African countries, although thought to be low; is largely unknown except for Cameroon where the highest prevalence of 5.9% was reported in urban women using the WHO diagnostic criteria (Fezeu et al, 2007). However, a rising prevalence of obesity has been reported in some of these countries including Nigeria especially in sub-urban populations (Bakari et al, 2007).

Obesity noted to provide the key stimulus for insulin resistance and type 2 Diabetes in other parts of the world; is becoming more prevalent in Nigeria (Bakari et al, 2007). So is the prevalence of type 2 diabetes and hypertension which are cardinal features of the so called 'metabolic syndrome'. Both of these conditions often co-exist, and are amenable to simple measures of weight reduction, diet and physical exercise if diagnosed early.

Obesity has surrogate markers in simple and inexpensive anthropometry which can be performed outside the hospital, in the village setting and in offices to identify people at risk for these disorders. There is then the need to embark on local studies of Nigerian to examine the efficacy of anthropometric indices in the diagnosis of these disorders. This study was therefore designed to investigate the association between waist circumference, waist to hip ratio, and body mass index in the diagnosis of metabolic syndrome in Nigerian subjects.

MATERIALS AND METHODS

Design: This is a cross-sectional study conducted within the University of Ibadan, University College Hospital, Ibadan and their immediate environs.

Subjects: These include apparently healthy, adult volunteers from hospital and University staff and students. Participants comprised all volunteers who

gave free informed consent among apparently healthy, adult (not less than 25 years old) members of staff, postgraduate students and retirees from the College of Medicine, University of Ibadan/University College Hospital Ibadan and from petty traders and artisans who live or have their shops in the immediate vicinities around the University of Ibadan and the University College Hospital, Ibadan. Ethical Approval for the study was sought and obtained from the joint ethical review committee of the University of Ibadan and the University College Hospital, Ibadan. Sample size was determined using the Formula $N=Z^2PQ/D^2$ (N is sample size, Z is 1.96, P is prevalence, Q is 1-P, and D is 0.05). Since the prevalence of MS in Nigeria is not known, 5.9%, the prevalence of MS in urban women in Cameroon which was the highest prevalence found in Cameroonian populations by Fezeu et al in 2007 was used in this calculation which yielded a minimum sample size of 85.3. Therefore, three hundred and thirty eight physically healthy adults who were not less than 25years were studied.

Measurements: The rationale and research protocol of the study were explained to the participants and they signed an informed consent form. Thereafter, blood Pressure, Weight, Height, WC and hip circumference were measured. Family history of diabetes or hypertension and treatment for either or both conditions were taken and recorded in a questionnaire. They were then asked to fast overnight and come to the metabolic research ward the following morning for blood collection. Five milliliters (5mL) of blood was collected from each participant via the anti-cubital vein into lithium heparin bottle for the determination of fasting plasma lipids.

Weight was measured to the nearest 0.1kg with a Tanita digital bathroom weighing scale (Model HD358 manufactured by Our Weigh, UK.) calibrated on a daily basis using standard weights while height was measured using a stadiometer calibrated in metres to the 0.01metre. BMI was calculated from the weight and height using the standard formula.

Both waist and hip circumferences were measured in centimeters to the nearest 0.5cm with a non stretch tape. WC was measured at a point midway between the iliac crest and the lower rib margin on both sides. HC was measured at the widest point of the buttocks. WHR was calculated by dividing the waist circumference by the hip circumference.

BP was measured in those who are not on drug treatment for hypertension using mercury in glass sphygmomanometer following standard procedure. Three readings were taken at a sitting and the average was recorded as the subject's BP. Diagnosis of metabolic syndrome was made based on the WHO and NCEP ATP 111 criteria.

FPG was determined from finger prick specimens using a glucometer (Accu-check®) based on the enzymatic, glucose oxidase method. FPG was not done in known diabetics who are on medications. The blood samples for lipid analysis were centrifuged, separated and store frozen at -20^0C until analysis. All samples were analysed within a week of collection.

Total and HDL-Cholesterol and Triglyceride were analysed using standard enzymatic methods using kits manufactured by DialabGmbh, Austria. LDL-Cholesterol was calculated using the Friedwald's formula (LDL Chol=Total Chol-HDL Chol-TG/5). Control samples supplied by the manufacturers were analysed with each assay batch for glucose, total cholesterol, HDL cholesterol and triglyceride. The results for all assays were within control limits.

Interpretation

- A FPG>110mg/dl (or treatment for type 2 diabetes) was considered a positive criterion and a necessary condition in the diagnosis of metabolic syndrome by the WHO definition.
- A systolic BP>140mmHg and/or diastolic BP>90mmHg or both (on drug treatment for hypertension) is considered another positive criterion by WHO. A systolic BP of 130mmHg and/or diastolic of 85 mmHg (on antihypertensive drug treatment) is considered a positive criterion by NCEP ATP 111.
- A HDL<35mg/dl (men), HDL<39mg/dl (women) is a criterion by WHO. HDL<40mg/dl (men), HDL<50mg/dl satisfies same criterion by ATP 111
- Triacylglycerol (TG)>150mg/dl in both sexes is considered another positive criterion by both definitions.
- WHR>0.95 (men), WHR>0.8 (women) is a criterion by the WHO.
- WC>102cm (men), WC>88cm (women) is a criterion by ATP 111.

Both WHO and NCEP-ATP III criteria were applied in diagnosing MS in this study. The WHO requires the presence of the first criterion above with any other two WHO criteria for the diagnosis of MS. The presence of any three of the ATP 111 criteria suffices for the diagnosis of MS using ATP 111 definition.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) 15 was the software used for the data analysis. Overall age range was reported as mean ± standard deviations. Then, the ages were grouped into five categories (tables 3&4) and the frequencies of MS in both sexes were determined for the different age groups.

Correlation profile analysis was used to examine the correlations between obesity indices (BMI, WHR and WC) and major diagnostic components of MS. These indices were also compared in their abilities to correctly diagnose MS in both WHO & NCEP ATP 111 diagnostic categories using Receiver Operating Characteristic (ROC) curves. Statistical significance was defined as a P-value of <5%.

RESULTS

A total of 338 subjects comprising 144 males and 194 females aged between 25 and 73years (47.4years±25.4years) participated in the study. The overall prevalence of MS was higher in females than in males by both definitions (Table 1) 26.4% in males and 86(44.3%) females have metabolic syndrome by the NCEP-ATP III standard; while 26 (18%) males and 54 (27.8%) females have metabolic syndrome by the WHO standard (Tables 1). The proportion of participants with metabolic syndrome in females are higher than in males except for those below 35 years of age in the WHO group and those older than 65years in the NCEP ATP 111 group (Tables 4&5).
MS prevalence was higher in males than in females with positive WC criterion in both groups. A total of 26 males and 98 females have WCs >102cm and 88cm for males and females respectively out of which 22 males and 78 females have MS in the NCEP diagnostic category ($p>0.05$). In the WHO category, 18 out of 26 males and 48 out of 98 females have MS (Tables 2 & 3).

A total of 58 males and 148 females satisfy the WHO obesity criterion for the diagnosis of MS. Out of these, 32 males and 84 females have MS in the NCEP diagnostic category while 26 males and 30 females have MS in the WHO diagnostic category. Among the overweight (BMI>25<30) totaling 140, 56 (40%) in the NCEP category and 34 (24.3%) in the WHO have MS while among the obese (BMI≥30) comprising a total of 58 participants, 44 (75.9%) and 36 (62.1%) have MS in the NCEP and WHO categories respectively (see tables 2 and 3).

Table 1:
Prevalence of MS among Adult Nigerian subjects using both WHO and NCEP ATP III criteria

Groups	Number	MS	Non MS	Prevalence (%)
NCEP	Male 144	38	106	26.4
	Female 194	86	108	44.3
	Total 338	124	214	36.7
WHO	Male 144	26	118	18.1
	Female 194	54	140	27.8
	Total 338	80	258	23.7

Table 2:
Physical and Biochemical characteristics of adult Nigerian subjects with or without MS (diagnosed by the NCEP-ATP III criteria

Parameters	Criteria	Number	MS	Non MS
WC (cm)	Male > 102	26	22	4
	Female >88	98	78	20
WHR (cm)	Male > 0.95	58	32	26
	Female > 0.80	148	84	64
FPG (mg/dl)	<110	212	22	190
	<110	126	102	24
BP mmHg	Sys >130	178	102	76
	Dias > 85	144	44	100
HDL (mg/dl)	Male <40	48	32	16
	Female <50	188	182	6
TG (mg/dl)	≥150	46	40	6
	<150	292	124	168
BMI (Kg/m^2)	>25<30	140	56	84
	≥30	58	44	14

Table 3:
Physical and biochemical characteristics of adult Nigerian subjects with or without MS (diagnosed by WHO criteria)

Parameters	Criteria	Number	MS	Non MS
WC (cm)	Male >102	26	18	8
	Female > 88	98	48	50
WHR (cm)	Male > 0.95	38	26	32
	Female > 0.80	52	30	118
BMI (Kg/m^2)	>25<30	140	34	106
	>30	58	36	22
FPG (mg/dl)	<110	212	0	212
	≥110	126	40	86
BP mmHg	Sys > 140	169	63	106
	Dias > 90	66	36	30
HDL (mg/dl)	Male < 35	18	4	14
	Female < 39	54	8	46
TG (mg/dl)	≥ 150	46	30	16
	< 150	292	40	242

Table 4: Prevalence of Metabolic Syndrome by NCEP-criteria by Age

Age-Groups (Years)	Gender	No. of Participants	MS	Non MS
25-34	Male	22	4 (18.0%)	18 (82.0%)
	Female	38	6 (15.8%)	32 (84.2%)
35-44	Male	38	4 (10.5%)	34 (89.5%)
	Female	52	14 (26.9%)	38 (73.1%)
45-54	Male	20	4 (20.0%)	16 (80.0%)
	Female	52	24 (46.1%)	28 (53.9%)
55-64	Male	36	10 (27.8%)	26 (72.2%)
	Female	44	36 (81.8%)	8 (18.2%)
>65	Male	26	16 (61.5%)	10 (38.5%)
	Female	10	6 (60.0%)	4 (40.0%)
Total	Male	144	38 (26.4%)	106 (73.6%)
	Female	194	86 (44.3%)	110 (55.7%)

Table 5: Prevalence of MS by WHO criteria by Age

Age-Groups (Years)	Gender	No. of Participants	MS	Non MS
25-34	Male	22	0(0.0%)	22 (100.0%)
	Female	36	4 (11.1%)	32 (88.9%)
35-44	Male	36	4 (11.1%)	32 (88.9%)
	Female	52	12(23.0%)	40 (77.0%)
45-54	Male	20	2 (10.0%)	18 (90.0%)
	Female	52	12 (23.0%)	4 (77.0%)
55-64	Male	36	8 (22.2%)	28 (77.8%)
	Female	44	28 (63.3%)	16 (36.7%)
>65	Male	26	12 (46.1%)	14 (53.9%)
	Female	10	2 (20.0%)	8 (80.0%)
Total	Male	144	26 (18.0%)	118 (82.0%)
	Female	194	54(27.8%)	140 (72.2%)

Table 6: Correlation Profile of BMI, WHR and WC with other components of MS in adult Nigerian subjects

Parameter	NCEP					WHO				
	FPG	HDL	TG	SBP	DPB	FGP	HDL	TG	SBP	DBP
BMI	0.541[s]	0.018	0.363[s]	-0.100	-0.060	0.204	0.262	-0.010	0.300	0.330
WHR	0.340[s]	0.156	0.213[s]	-0.010	-0.012	0.231	0.111	0.165	0.430	0.470
WC	0.560[s]	0.016[s]	0.432[s]	-0.180	-0.010	0.254	0.108	0.082	0.480	0.490

[s]Statistically significant (P<0.05), SBP: Systolic BP, DBP: Diastolic BP, HDL: High Density lipoprotein, TG: Triglycerides, FPG: Fasting Plasma Glucose.

Table 7: Areas under the curves for BMI, WHR and WC in ROC curves for MS

	Area under the curve	
Test Variable	WHO	NCEP-ATP III
WC	0.799	0.785
WHR	0.837	0.783
BMI	0.779	0.733

Among participants with positive BP criteria totaling 178 and 169 in the NCEP and WHO groups respectively, 102 (57.3%) and 63 (37.3%) respectively have MS in the NCEP and the WHO groups (Tables 2 and 3).

HDL criteria correctly diagnosed MS in 32 (67%) males and 182 (97%) females in the NCEP group while correctly diagnosing 4 (22.2%) males and 8 (14.8%) females in the WHO group. TG criteria on the other hand correctly diagnosed 86.9% of males & 42.5% of females in the NCEP group and 65.2% of males & 13.7% of females in the WHO group (Tables 2 and 3),

Among those diagnosed as having MS, all three indices are strongly positively and significantly correlated (r=0.44-0.77; P=0.000) and with other metabolic indices. WC was most strongly positively correlated with FPG (r=0.560; P=0.000) in the NCEP category while WC was positively but not significantly correlated with FPG (r=0.254), systolic BP (r=0.480), and diastolic BP (r=0.490) in the WHO category (Table 6). ROC Analysis (Figures 1&2) show WC having the highest AUC value followed by WHR in the NCEP category while the WHR has the highest AUC value followed by WC in the WHO category (Table 7).

DISCUSSION

The multiplicity and variability of criteria for the diagnosis of MS as proposed by various expert groups working in different parts of the world have made the diagnosis controversial and complex. However, almost all working groups agree on the importance of visceral adiposity/central obesity and insulin resistance in the diagnosis of MS. Obesity is a rapidly growing health problem all over the world, conferring substantial excess risk for morbidity and mortality, especially from type 2 diabetes and atherosclerotic cardiovascular disease (CVD).

The WHO and the NCEP-ATP III criteria were the only ones considered for the diagnosis of MS in this study because they are the only definitions easily applicable to the clinical setting while they also do not compulsorily require any of the three anthropometric indices studied to make a diagnosis.

In this study, the overall prevalence of MS by the NCEP ATP-III criteria (36.7%) was significantly higher than by the WHO criteria (23.7%; p< 0.05). This finding is remarkably higher than envisaged and sharply contrasts with the findings of Fezeu et al (2007) who reported a prevalence of 7.9% in urban men in Cameroon using the WHO definition and a prevalence of <2% using the NCEP definition. This difference is observed in spite of the fact that both studies were conducted on adults within the sub-Sahara African region and both studies employed both the WHO and NCEP criteria for the diagnosis of MS. However, there are some striking differences between this study and the Cameroonian study which may account for the observed incongruity.

The Cameroonian study is general population based and recruited 1986 participants from both urban and rural communities around Yaounde, while the present study was conducted mainly on volunteers within two academic, communities of the University of Ibadan and the University College Hospital in Ibadan even though a few respondents were obtained from artisans, technicians and petty traders from adjoining areas outside both institutions; this may not be enough to make this study truly representative of the general population of inhabitants of Ibadan.

Secondly, a considerable proportion (≈20%) of respondents in the Cameroonian study had no lipid profile results which necessitated their exclusion from the final analysis which may therefore not be a perfect reflection of population statistics. Some of those of those excluded may have diagnostic fasting lipid values which could possibly have increased the number of those diagnosed with MS by either/or both definitions. All parameters of interest were measured

in every participant in this study and all the 338 participants have their data imputed into the final analysis making it representative of the studied population.

Thirdly, a majority of the respondents in the Cameroonian study fall within the younger age groups and this may be responsible for the relatively low prevalence of MS reported in that study because the prevalence of MS increases with age. Another reason may be that the prevalence of MS found in either or both of the studies is artifactual because European cut off values were applied to Africans in making MS diagnosis, this is a result of non-availability of ethnic specific values for sub-Saharan Africans (IDF, 2005). This on its own is capable of biasing the statistics in either or both studies. MS is diagnosed in other parts of the world using ethnic specific cut-off values for WC, WHR and BMI in the various definitions (IDF, 2005; Liu et al, 2006).

This higher prevalence of MS using NCEP definition in this study agrees however with that of Kanjilal et al (2008) who did a similar study in India and made diagnosis of MS using several criteria which included the NCEP ATP III criteria and the WHO criteria. In their findings, the NCEP criteria predicted a significantly higher prevalence of MS than the WHO criteria among the Indian population. However, the respective MS prevalence of 36.7% & 23.7% found in this study are both lower than 40.3% and 30.6% found in the Indian population. The difference here may reflect ethnic and genetic differences between the populations studied but more importantly may be because of the differences in parameters used to arrive at MS diagnosis in the two populations. The recommended lower BMI cut-off for defining 'overweight' in Asian Indians is 23 kg/m^2 , modified WC measures is ≥94cm and ≥80cm and a waist–hip ratio (WHR) of 0.89 and 0.81 for men and women respectively (Kanjilal et al, 2008) while this study adopted European cut-off values (IDF, 2005).

This study also found a prevalence rate of MS which is higher in women than in men in both diagnostic categories (table 1) which is in keeping with that of Ravalgia et al (2006) who studied the prevalence of MS among elderly Italians using NCEP criteria and found a higher prevalence in women (33.3%) than in men (19.6%) in 2006. However, this study recruited adults above 25years of age while the Italian study was conducted on elderly subjects aged 65 to 95 years. This finding is however in contrast to that of Fezeu et al (2007) who in a similar study found the highest prevalence of MS in Urban men in Cameroon. This may be due to the differences in both studies as alluded to earlier.

In this study, among those diagnosed with MS; WC was found to have statistically significant positive correlation with FPG and TG higher than those of WHR and BMI in the NCEP-ATP III category while WC shows strong positive but not statistically significant correlation with DBP, SBP and FPG higher than those for BMI and WHR in the WHO category.

The most important finding in this study is from the ROC analysis of BMI, WHR and WC which shows that WC (with the highest AUC) is superior to both WHR and BMI in diagnosing MS using the NCEP criteria. ROC analysis also shows WC to be comparable with WHR and superior to BMI in the diagnosis of MS using WHO criteria (table 7). These findings are in keeping with those of Dobbelstein et al, (2001) who studied 9913 adult men and women selected among the participants of the Canadian Heart Health Survey which ended in 1992. This subgroup represents participants who have complete record of their WC, WHR and BMI. In their report, WC was also observed to have the largest AUC followed by WHR in an ROC analysis and concluded that WC may be the single best indicator of other individual and multiple CVD risk factors in adult Canadians.

The superiority of WC to both BMI and WHR in the study discussed above is slightly different from the findings of Ryan et al, (2008) who compared WC and BMI in 402 Europeans and found BMI as useful as WC in identifying persons with MS[47]. The study by Ryan et al (2008) employed both IDF and ATP III criteria (while this study employed WHO instead of IDF) in the diagnosis of MS. Ryan et al did not employ ROC analysis to arrive at its conclusion as it is the case in this study. The Ryan's study also did not include WHR in its analysis.

This study and previous ones discussed above have all confirmed the reliability of WC as a predictor of metabolic risk. Incidentally, WC is the easiest of the obesity-related anthropometric parameters to measure because; (1) it involves a single parameter measurement of the waist while both BMI and WHR are indices derived from two different parameters, (2) it requires a simple, cheap and portable instrument (the non-stretch tape), (3) it requires less technical skill to measure, (4) respondents are more likely to co operate because it does not require the exposure of private body parts. These make WC more easily applicable to population screening studies while it can also be incorporated into routine general clinical physical examination at no additional cost to the patient. The limitation of WC as an anthropometric parameter lies in the non uniformity of its measurement method across working groups.

It is important to conduct separate studies in future to determine appropriate cut-off values for obesity indices (WC, WHR & BMI) that are consistent with metabolic and cardiovascular disease risk in sub-saharan African populations. Applying such ethnic-specific anthropometric cut-offs (which may differ from the currently applied European values) in diagnosing MS in these population will result in more accurate prevalence rates for MS in this part of the world.

Conclusion

Metabolic Syndrome prevalence may be high among apparently healthy Nigerians; WC is a cheap and reliable screening tool for metabolic syndrome. It is desirable to incorporate WC measurement into routine general clinical physical examination. It is important to determine appropriate WC cut off value for the diagnosis of Metabolic Syndrome in Nigerians.

It is important to determine the correlation between WC values derived in the same individuals using the various methods of WC measurement available, and to determine the correlation between the values obtained and visceral adiposity estimated by other methods.

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