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Original Article

Metabolic Syndrome among Apparently Healthy Nigerians with the Harmonized Criteria: Prevalence and Concordance with the International Diabetes Federation (IDF) and Third Report of the National Cholesterol Education Programme - Adult Treatment Panel III (NCEP-ATP III) Criteria

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ABSTRACT

Background: The prevalence of metabolic syndrome varies by the definition used and the population studied. In order to make comparison among various studies possible, a new criterion which harmonizes the previous definitions was proposed. This study aims to determine the prevalence of metabolic syndrome with the harmonized criteria, and its concordance with the International Diabetes Federation (IDF), and National Cholesterol Education Programme-Adult Treatment Panel (NCEP-ATP III) criteria. **Methods:** One hundred and two apparently healthy individuals who participated in health screening were evaluated for metabolic syndrome. The blood pressure and anthropometric parameters were measured according to standard protocol, and fasting plasma glucose and lipid profile were determined. Metabolic syndrome was defined using the Harmonized, IDF and ATP III criteria. The agreement among the three diagnostic criteria was determined with kappa statistics. **Results:** The prevalence of metabolic syndrome was 4.9%, 3.9% and 4.9% with harmonized, IDF, and NCEP-ATP criteria respectively. Compared to the males, the prevalence was greater in females: Males vs Females (harmonized, 2.2% vs 7.0%; IDF, 2.2% vs 5.3%; NCEP-ATP III, 2.2% vs 7.0%). The commonest risk factor in this population was low HDL occurring in 93.0% and 37.8% of females and males respectively, followed by central obesity (50.9% in females, 13.3% in males with harmonized and IDF criteria; 33.3% in females, 4.4% in males with NCEP-ATP criteria), hypertension (12.5% in females, 18.6% in males) and hyperglycaemia (4.2% in females, 0.0% in males) in that order. None of the participants had elevated Triglyceride. There was a substantial concordance between the harmonized and the IDF (k=0.884) as well as the harmonized and NCEP-ATP III (k=1.000) definitions. **Conclusion:** The prevalence of metabolic syndrome was low in this population. There was a substantial agreement among the three diagnostic criteria.
Key words: Concordance, Diagnostic criteria, Metabolic syndrome, Prevalence.

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INTRODUCTION

The co-existence of risk factors for cardiovascular disease (CVD) such as high blood pressure, dyslipidemia, hyperglycemia, and obesity, now known as metabolic syndrome (MS), has been recognized by researchers for decades.[1,2] The importance of recognizing this syndrome lies in the fact that it is a risk factor for type 2 diabetes mellitus, coronary artery disease, stroke, and cancers and all-cause mortality.[3-9]

The criteria for diagnosing MS have been proposed by various relevant authorities.[10-14] These criteria have both contrasting and similar features [Table 1]. Specifically, risk factors such as hypertension, obesity, dysglycemia and dyslipidemia are recognized by all the authorities, although the diagnostic cut-offs and measures of some of the risk factors differ/varies among some definitions. For example, the diagnostic cut-off for dysglycemia, and hypertension was higher in the World Health Organization (WHO) definition and the measures of obesity in the WHO (body mass index [BMI] or waist to hip ratio [WHR]) and American Association of Clinical Endocrinologists (AACE) [BMI] definitions differ from the other criteria. Unlike the other criteria the European Group for the study of Insulin resistance (EGIR) and WHO definitions included insulin resistance, while the WHO definition also included microalbminuria as one of the criteria. Furthermore, unlike other definitions, the International Diabetes Federation (IDF), EGIR, AACE and WHO definitions included compulsory criteria. Finally, factors such as family history of type 2 diabetes, CVD or hypertension, sedentary lifestyle, advancing age, polycystic ovarian syndrome, and ethnic groups with high risk of type 2 diabetes and CVD were considered in the AACE criteria.

The prevalence of the metabolic syndrome varies by the definition used and the population studied. Nigerian studies have estimated the point prevalence of MS to be between 2.4% -26.4%, with a higher rate among women in the general populace.[15-19] The prevalence was also higher in the urban compared to the rural areas.[17,18-20] Among patients with type 2 diabetes, prevalence of MS ranged between 59.1%-87.1%,[21-24] while in patients with hypertension, the prevalence ranged between 24.7%-40.74%.[17-25] These Nigerian authors used the WHO, IDF, and Adult Treatment Panel (ATP-III) criteria in their studies. Prevalence rates for MS in Ghana,[26] Cameroon,[27] South Africa,[28] India,[29] America,[30,31] United Kingdom[32] and Europe[33] ranged between 0% to 49.2% depending on the population studied and the criteria used. Generally, the prevalence was higher among women than men,[15-19-23-26] and with the IDF definition.[18-26]

In order to make comparison among various studies possible, a new criterion which harmonizes the previous definitions was proposed.[34] However, there is scanty report on the prevalence of MS with the harmonized criteria Nigeria. Whether this new criterion compares with or is better than the previous ones in identifying persons with metabolic syndrome in Nigeria is unknown. Knowledge of this is important since the use-

fulness of diagnosing metabolic syndrome has been shown to be both definition and ethnic specific.[35,36]

This study aims to determine the prevalence of metabolic syndrome with the harmonized criteria, and its concordance with the IDF and NCEP-ATP III criteria among apparently healthy Nigerians.

MATERIALS AND METHODS

This is cross-sectional descriptive study conducted at Sagamu and Remo North local government area of Ogun State, Nigeria. Ogun State is a state in western Nigeria. Yoruba is the main ethnic group in Ogun State.

Approval for the study was obtained from the ethic and research committee of the Olabisi Onabanjo University Teaching Hospital, Sagamu, Ogun State (REF: OOUTH/DA.326/508). The consent of the king and community leaders was also sought. The consent of each participant was also obtained.

Materials

The participants were apparently healthy individuals aged 20-70 years chosen by convenience sampling. They included market men and women, artisans, farmers, drivers, and civil servants. Initial sensitization visits were paid to the communities, and the people that met the inclusion criteria were told to meet at designated points such as motor parks, town hall or the king's palace for screening. All the people who gave their consent were included in the study. Individuals who are wheelchair bound, pregnant women and lactating mothers were excluded.

Procedure and measurements

The height, weight, waist and hip circumferences and blood pressure were determined. The height was measured (in metres) to the nearest 0.1metre with a calibrated meter rule placed horizontally against the wall, with the participants barefooted. The weight was measured (in kilograms) with a weighing scale without shoes and with the patient wearing light clothing, to the nearest 0.1kg. The Body Mass Index (BMI) was taken as the ratio of weight (kg) to the square of the height (m^2). The waist circumference (in centimetres) was taken midway between the inferior margin of the last rib and the iliac crest in a horizontal plane. The circumferences were measured to the nearest centimeter at the end of normal expiration. Hip circumference was measured to the nearest centimeter at the level of the greater trochanters with the subjects wearing underwear or light clothing. The waist-to-hip ratio (WHR) was calculated from the values of the waist and hip circumferences.

The blood pressure was measured with a standard mercury sphygmomanometer (Accossons, England), with the subjects in the sitting position and the arm resting on a table at the same level of the heart. The first and fifth Korotkoff sounds were taken as the systolic and diastolic blood pressures respectively.

Laboratory analysis

Venous blood was drawn after an overnight fast into fluoride oxalate bottles (for glucose estimation) and EDTA (for lipid profile). Plasma glucose was determined using the glucose oxidase method. The HDL-cholesterol and Triglycerides were determined by colorimetric method using spectrophotometer (UNICO 2100, Esselite, USA). Friedwald formular was used to calculate LDL-cholesterol.

Definition of metabolic syndrome

Metabolic syndrome was defined according to the IDF,[13] NCEP-ATPIII[14] and Harmonized criteria.[34]

Statistical Analysis

Data were analysed using the statistical package for social sciences (SPSS) version 20.0 (Chicago, Illinois, USA). Continuous variables were expressed as means. Student's t-test was employed to determine the differences between means. Differences between categorical variables were determined with Chi-square. The agreement between the definitions of metabolic syndrome was determined with kappa statistics.

RESULTS

One-hundred and two participants comprising of 45(44.1%) males, mean age 37.0±13.97, and 57(55.9%) females, mean age 39.95±16.69, with full lipid panel were included in the analysis. Table 2 shows the clinical, anthropometric and laboratory characteristics of the participants.

Table 1: Definitions of Metabolic Syndrome

Criteria	WHO (1998)[10]	EGIR (1999)[11]	NCEP (2001)[12]	AACE (2003)[13]	IDF (2005)[14]
Compulsory criteria	DM, IGT, IFG, IR	Insulin in top 25%	None	IGT or IFG and any of the following	WC: ≥ 94 cm (men), ≥80 cm (women)
Number of other criteria	and ≥2 of :	and ≥2 of:	≥3 of:	Not specified	and ≥2 of:
Obesity	BMI ≥ 30kg/m^2&/or WHR: > 0.9 (men) &>0.85 (women)	WC: ≥ 94 cm (men), ≥80 cm (women)	WC: ≥ 102 cm (men), ≥88cm (women)	BMI ≥25 kg/m^2	Compulsory criteria
Fasting glucose (mg/dl)	>110, IGT	≥110 orIGT but no diabetes	≥100 or Rx	IFG or IGT but no diabetes	≥100 or Rx
TG (mg/dl)	≥ 150 or Rx	≥150	≥ 150 or Rx		≥ 150 or Rx
HDL-C (mg/dl)	<35 (men), <39 (women)	<40	<40 (men) & <50 (women) or Rx	<40 (men) & <50 (women) or	<40 (men) & <50 (women) or Rx
BP (mmHg)	≥140/90	≥140/90	130/85 or Rx	130/85	130/85 or Rx
Micro-albuminuria	Urinary albumin ≥20µg/min or albumin-creatinine ratio >30mg/g	-	-	-	-
Others	-	-	-	Other features of insulin resistance	-

HDL-C, high density lipoprotein cholesterol; TG, triglyceride; IDF, International Diabetes Federation; NCEP, National Cholesterol Education Programme-Adult Treatment Panel III; EGIR, European Group for the study of Insulin resistance; AACE, American Association of Clinical Endocrinologists; WHO, World Health Organization

Table 2: Clinical, Anthropometric and Laboratory Characteristic of the Participants

Variable	ALL	MALE N=45	FEMALES N=57	P
Age (years)	38.65(15.54)	37.0 (13.97)	39.95(16.69)	0.344
Weight (kg)	63.02(11.98)	64.42(10.64)	61.91(12.94)	0.296
Height (m)	1.63(0.84)	1.68(0.06)	1.58 (0.07)	<0.001
BMI (kgm^2)	23.89(4.65)	22.79(3.52)	24.76(5.24)	0.026
WC (cm)	81.14(13.11)	79.12(10.56)	82.73(14.71)	0.154
HC (cm)	91.22(10.13)	88.17(8.28)	93.62(10.85)	0.006
WHR	0.89(0.067)	0.89(0.06)	0.88(0.07)	0.209
SBP (mmHg)	120.37(21.52)	123.1(23.1)	118.3(20.2)	0.277
DBP (mmHg)	75.51(11.29)	75.0(11.5)	75.9(11.2)	0.699
FPG (mmol/L) (N=83)	4.33(0.46)	4.33(0.43)	4.33(0.49)	0.987
TG (mmol/L)	0.80(0.23)	0.76 (0.20)	0.83 (0.24)	0.154
TC (mmol/L)	3.32(0.53)	3.24(0.49)	3.39(0.56)	0.165
HDL-C (mmol/L)	1.05(0.14)	1.05(0.13)	1.06(0.15)	0.646
LDL-C(mmol/L)	1.94(0.44)	1.86(0.39)	1.99(0.46)	0.118

The female participants had a greater BMI than their male counterparts (24.76±5.24 vs 22.79±3.52, p=0.026). The other obesity indices, blood pressure and laboratory parameters were similar in both men and women [Table 2].

The most prevalent metabolic abnormality was low HDL (68.6% of participants), followed by central obesity, hypertension and hyperglycaemia in that order. None of the participants had abnormal TG. Low HDL was more prevalent among the females compared to the males (93.0% vs 37.8%, p<0.001). Similarly more females had central obesity than males, either with the ATP criteria (33.3% vs 4.4%, p<0.001), or IDF/Harmonized criteria (50.9% vs 13.3%, p<0.001) Table 3.

The overall prevalence of MS was 3.9% with the IDF definition and 4.9% with the ATP 111 and harmonized definitions. More females had MS than males but the difference was not statistically significant Table 4. There was substantial agreement among the three definitions in identifying people with metabolic syndrome (k =0.884-1.000). The NCEP-ATP III agreed perfectly with the harmonized criteria (k=1.00, p<0.001, {95% CI, 0.000-0.029}) Table 5.

DISCUSSION

Preamble

This study seeks to determine the prevalence of MS among apparently healthy people in rural/semi-urban towns in south-western Nigeria using the harmonized criteria as well as the concordance between the harmonized criteria versus the IDF and NCEP-ATP III criteria. To our knowledge, it is the first study to determine the prevalence of MS using the harmonized criteria in rural communities in Nigeria. Most of the previous reports concentrated on the urban centres, and used other diagnostic criteria other than the harmonized criteria. In view of this, a systematic review on the MS in Nigeria suggested future studies in rural communities.[37]

Table 3: Frequency of Components of the Metabolic Syndrome in the Population Studied

COMPONENTS	All n(%)Male n(%)Female n(%)p
Central obesity (1) IDF and Harmonized	35 (34.3)6(13.3)29(50.9)< 0.001
Central obesity (2) NCEP-ATP III	21(20.6)2(4.4)19(33.3)<0.001
Hypertension	15(15.2)8(18.6)7(12.5)0.401
Increased FPG	2(2.4)0(0.0)2(4.2)0.506
Increased TG	0 (0)0 (0)0 (0)N/A
Decreased HDL-C	70(68.6)17(37.8)53(93.0)<0.001

FPG, fasting plasma glucose; TG, triglyceride; TC, total cholesterol; HDL-C, high density lipoprotein cholesterol; IDF, International Diabetes Federation; NCEP-ATP III, National Cholesterol Education Programme-Adult Treatment Panel III

Table 4: Prevalence of Ms withthe Three Definitions

CRITERIA	ALL n (%)	MALE n(%)	FEMALE n(%)	P
IDF	4(3.9)	1(2.2)	3(5.3)	0.628
NCEP-ATP	5(4.9)	1(2.2)	4(7.0)	0.380
HARMONY	5(4.9)	1(2.2)	4(7.0)	0.380

IDF, International Diabetes Federation; NCEP, National Cholesterol Education Programme-Adult Treatment Panel III

Table 5: Agreement among Three Definitions of Metabolic Syndrome

CRITERIA	k	p (95%CI)	Agreement
IDF vs NCEP-ATPIII	0.884	<0.001 (0.000-0.029)	substantial
IDF vs HARMONIZED	0.884	<0.001 (0.000-0.029)	substantial
NCEP-ATP III vs HARMONIZED	1.000	<0.001 (0.000-0.029)	substantial

IDF, International Diabetes Federation; NCEP-ATP III, National Cholesterol Education Programme-Adult Treatment Panel III

Frequency of occurrence of cardiometabolic risk factors

The commonest risk factor in this population was low HDL occurring in 93.0% and 37.8% of women and men respectively, followed by central obesity, hypertension and hyperglycemia in that order. None of the participants had elevated TG. Low level HDL in the setting of normal triglyceride was also found in a previous study in south-west Nigeria.[15] These authors reported a low TG level (1.9%) among their participants. Unlike in our study, a Ghanaian study found that central obesity was the most prevalent risk factor among the participants, followed by low HDL.[26]

A study among African women revealed that only 3 out of 102 (2.9%) had elevated TG.[35] In fact some workers reported that hypertriglyceridemia was almost non-existent (0.3%) among the rural African community studied.[27] In contrast to the above a study conducted in Ghana found that 10.4% of the participants had elevated TG, although a sub-analysis of the data revealed that none of the men who were below 45years of age had elevated TG.[26] Africans are known to have lower cholesterol compared to the Caucasians, and there may be a genetic basis for this.[38]

Central obesity was the second most common cardiometabolic risk factor especially among women in our study. Adoption of western lifestyle

by many Nigerians could contribute to this. Previous studies showed that central obesity was common among rural dwellers, and that it was more prevalent among women.[15-17,27] We earlier reported that 11 women had central obesity for every man with the condition.[39] Other workers also reported a 10-fold prevalence of obesity in women compared to men irrespective of the definition used and suggested that it may be the key factor in the diagnosis of MS.[27] The high prevalence of obesity among women could be attributed to sedentary lifestyle, hormonal changes, as well as pregnancy and deliveries.[40,41]

Hypertension was found in 15.2% of the participants with no difference between the men and the women. Although the prevalence was lower than what Oladapo *et al*[16] reported, this rate was high considering the population studied and the age-adjusted National prevalence of 9.3% documented earlier.[42] The rising prevalence could also be due to the epidemiological transition that Nigeria is undergoing currently.

Only 2 (4.1%) female and no male participants had elevated plasma glucose. Low rate of hyperglycemia was documented in previous studies.[16] A study in rural Cameroon also reported the prevalence of hyperglycemia to be between 1.1-1.6%, using IDF and ATP definitions.[28] In contrast to the above the study from rural Ghana revealed a high prevalence (5.3-12.1%) of hyperglycemia.[27]

Prevalence of metabolic syndrome

Studies on the prevalence of MS have found variable rates, depending on the criteria used and the population studied. The prevalence of MS in this study ranged between 3.9% (IDF criteria) to 4.9% (NCEP-ATPIII and harmonized criteria). Unlike the IDF definition, the harmonized definition resembles the NCEP definition in that it has no compulsory criterion. The need for compulsory criterion may exclude some people with MS, and this has been observed by some workers in India.[30] However, the WC cut-off for the harmonized criteria is same for the IDF definition. The prevalence of MS in this study is similar to what was found by Oladapo *et al* (2.4%)[16] in a rural community in south- western Nigeria using the ATP criteria. It is also similar to the findings of Adediran *et al*[19] (3.7%) in a rural community of Northern Nigeria using the ATP criteria. A higher prevalence of 7.7% was however found using the IDF criteria in their study.

Some researchers from Cameroon also found a low prevalence (for MS) of 0.0% in the rural community in both men and women with the ATP criteria, and prevalence 0.3% and 0.0% in women and men respectively with the IDF criteria.[28] The low prevalence of elevated TG and hyperglycemia may contribute to the low prevalence of MS in their study.

A Nigerian study [17] found a high prevalence of 12.4% in rural community in south-western Nigeria, while a Ghanaian study [27] also found a high prevalence of 35.9% with IDF criterion and 15.0% with ATP criterion. Compared to our study, their participants were older. Advancing age is associated with insulin resistance, obesity, hypertension and hyperglycemia. These are the key components of the MS. In fact the ACE criteria[14] included advancing age as one the criteria for diagnosing MS feature.[14] Studies have also shown consistently that the prevalence of MS increases with age [23, 27, 31, 32, 43]

Some Nigerian studies found a prevalence of between 10%-35.42% among the general populace.[18, 20, 21] Specifically, Ulasi *et al*.[18] and Similayi *et al*.[21] using IDF and ATP criteria found a prevalence of between 10.0%-23.19% in suburban centres. These were higher than what we found probably because one of the studies was hospital-based, thus the possibility of recruiting people with many cardiovascular risk factors.[21] The study of Ulasi *et al*.[18] which was community based on the other hand revealed that about 13% of the participants had hypertriglyceridemia unlike in our study where none of the participants had elevated triglyceride.

The prevalence of MS in this study is less than what researchers from western world [31-34] and Asia[30] found. Their studies however were conducted in the urban centres. Generally, MS prevalence is higher in the urban compared to the rural centres.[18-21-28]

Taken together the low prevalence of MS in our study could be due to the age and location of the people studied, non-existent hypertriglyceridemia, and the low frequency of occurrence of some of the other risk factors in the definitions.

Gender differences in the prevalence of metabolic syndrome

Similar to our findings, most studies revealed a higher prevalence of MS among women than men.[16-20-24-27] Obesity, particularly central obesity which is a compulsory criterion in one of the definitions is commoner among women. In our study central obesity was more in women than men irrespective of the definition: 50.9% vs 13.3% with IDF/Harmonized criteria and 33.3% vs 4.4% with ATP criteria. Nevertheless, some workers reported a higher prevalence of MS in men compared to women.[44-45]

Concordance among definitions of metabolic syndrome

Among other things, the prevalence of MS depends on the definitions used. Most authors reported a higher prevalence with the IDF criteria probably because of the lower cut-off mark for waist circumference.[19-27-44-45] In order to make comparison among various studies possible, a new criterion which harmonizes the previous definitions was proposed.[35]

In our study, there were substantial agreements among the three diagnostic criteria. The ATP III criteria identified all the people diagnosed with MS by the harmonized criteria (k=1.0). Similarly, the IDF criteria identified most people diagnosed with the harmonized criteria (k= 0.884). Reports on the concordance among the diagnostic criteria for MS in Nigeria are very scanty. Specifically, published works on the concordance among the diagnostic criteria for MS in the general population is very rare. One report among people with Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) on HAART, using the three criteria we studied revealed a moderate to substantial agreement among the criteria (k= 0.583-0.878).[46] Various studies[47,48,49] found substantial agreement between the IDF and ATP criteria while some[27-50] found moderate agreement between the two criteria. These suggest that the two criteria identify essentially the people with MS equally.

Limitations

It is necessary to confirm our findings in a larger study because of the small sample size. This study did not look at the concordance between the harmonized and the criteria by WHO, AACE and EGIR for diagnosing MS.

CONCLUSION

The prevalence of metabolic syndrome is relatively low in rural south-western Nigeria. Low HDL, central obesity and hypertension were the most prevalent components of MS in this population. There was a substantial concordance among the IDF, ATP and the Harmonized criteria for the diagnosis of metabolic syndrome.

CONFLICT OF INTEREST

None

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ABBREVIATION USED

AACE: American Association of Clinical Endocrinologists; **EGIR:** European Group for the study of Insulin resistance; **IDF:** International Diabetes Federation; **NCEP-ATP III:** The National Cholesterol Education Program - Adult Treatment Panel III; **WHO:** World health organization; MS: Metabolic syndrome; **CVD:** Cardiovascular disease; **FPG:** Fasting Plasma Glucose; **HDL:** High density lipoprotein; **LDL:** Low density lipoprotein; **TG:** Triglyceride; **TC:** Total cholesterol; **BMI:** Body mass index; **WC:** Waist circumference; **HC:** Hip circumference; **WHR:** Waist to hip ratio; **SBP:** Systolic Blood Pressure; **DBP:** Diastolic Blood Pressure.

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