

ORIGINAL ARTICLE



Age and gender variations in the prevalence of metabolic syndrome among hypertensive patients in a Nigerian tertiary hospital: a comparative analysis of the World Health Organization (WHO) and International Diabetes Federation (IDF) criteria

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Abstract:

Background: The presence of hypertension alongside other metabolic risk factors is known to increase the risk of occurrence of major cardiovascular events such as stroke and myocardial infarction. This study was carried out to determine and compare the prevalence of the metabolic using the World Health Organisation (WHO) and The International Diabetes Federation (IDF) criteria among patients with essential hypertension in a tertiary hospital, in North-central Nigeria.

Materials and Methods: The study recruited 340 hypertensive subjects (231 females and 109 males) consecutively. Comprehensive assessments, including medical history, physical examinations, and laboratory tests (fasting plasma glucose, fasting serum lipids, and spot urine microalbuminuria), were conducted. Metabolic syndrome was diagnosed using WHO and IDF criteria. Associations between age, gender, and metabolic syndrome were analyzed using the chi-square test, with statistical significance set at $p < 0.05$.

Results: Of the 340 participants enrolled, 32.1% were males ($n=109$) and 67.9% were females ($n=231$). The mean age was 53.61 ± 9.83 years, ranging from 30 to 70 years. Male participants were slightly older on average (54.65 ± 9.68 years) compared to females (53.17 ± 9.76 years). The prevalence of metabolic syndrome was 65.6% and 32.9% for IDF and WHO criteria respectively but it was significantly higher in females using both criteria ($p = 0.016$). Although higher rates were found among participants aged 51 to 60 years with both criteria {WHO; 50% (56) and IDF; 41.3% (92)} this difference was not statistically significant ($p=0.379$).

Conclusion: The IDF criteria identified more patients with metabolic syndrome compared to WHO. The prevalence was higher in females. Early screening for metabolic syndrome in persons with hypertension is advocated

Keywords: Metabolic syndrome, Diabetes, Hypertension, Obesity, cardiovascular

Introduction

Features like metabolic syndrome (MetS) were first described in the 1920s when Kylin¹ recognised a triad of gout, hypertension, and hyperglycemia in his patients. Following this observation, other studies have correlated complications of obesity to body fat, hypertriglyceridemia, hyperinsulinemia, and hypertension.²⁻⁴ In 1988, Raven⁵, in

his Banting lecture, observed how dyslipidaemia, hypertension and hyperglycaemia clustered in the same individuals. He called this clustering “Syndrome X” and emphasized its role as a risk factor for cardiovascular disease. His study patients then were not obese; however, obesity is now seen as an essential component of metabolic syndrome, especially the visceral type of obesity.² The

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metabolic syndrome has been identified as a cluster of risk factors for atherosclerotic cardiovascular disease and type 2 diabetes mellitus and has been described as a global epidemic.⁶ Kaplan⁷ in 1989 named it the “Deadly Quartet”. It was defined by the International Classification of Diseases (ICD) 9th revision code (277.7) as a clustering of known risk factors for atherosclerotic diseases.⁶

The Copenhagan⁸, Progetto Ipertensione Umbria Monitoraggio Ambulatoriale (PIUMA)⁹, and the HOORN¹⁰ studies reported an increasing risk of cardiovascular disease in hypertensive patients with metabolic syndrome beyond that conferred by hypertension alone. This finding was also corroborated by the European Society of Hypertension, the European Society of Clinical Cardiology¹¹ and the Joint National Committee (JNC)¹² on treatment, diagnosis and prevention of Hypertension. They all stressed the need to identify hypertensive patients with MS as a group at higher risk for cardiovascular disease and emphasized the need for prompt treatment and initiation of preventive measures to reduce or prevent its attendant morbidity and mortality.

This study aims to determine and compare the prevalence of metabolic syndrome using the IDF and WHO criteria in patients with essential hypertension. This will help to determine the enormity of the problem in our environment and to add to the existing literature on the subject.

Materials and Methods.

The study was conducted at the Medical and General Outpatient Department of the Jos University Teaching Hospital (JUTH), Jos, North Central Nigeria. Patients seen at these clinics were aged 18 years and above. A total of 350 hypertensive patients were recruited into the study consecutively.

Clinical evaluation

Relevant socio-demographic and medical history was obtained from all study subjects and blood samples were taken for Fasting Plasma Glucose (FPG) and fasting serum lipids. Urine samples were collected for the spot assessment of microalbuminuria using the micral test strips. The following anthropometric measurements were taken: the weight was recorded in kilogrammes to the nearest 0.0kg on a flat scale on a firm horizontal surface with subjects wearing only light clothes and without shoes or headgear. Height measurement was recorded in metres with a stadiometre positioned on a flat surface with the subjects not wearing shoes or head gears to the nearest 0.01metre

Body mass index (BMI) was calculated as weight in kilograms (kg) divided by the square of height in metres i.e. kg/m^2 . The BMI was used to categorize participants as underweight (BMI <18.5 kg/m^2), normal weight (BMI; 18.5 – 24.9 kg/m^2), overweight (BMI; 25.0 – 29.9 kg/m^2) and obese (BMI; $\geq 30\text{kg/m}^2$).¹²

The waist circumference was measured in centimetres with a non-stretch metric tape with light clothing as the horizontal line at the mid-point between the iliac crest and lower costal margin at expiration. It was measured to the nearest centimetre.¹³ The hip circumference (HC) was measured in centimetres with a non-stretch metric tape, with subjects wearing light clothing; as the horizontal level of maximum circumference around the buttocks posteriorly and pubic

symphysis anteriorly.¹³ It was measured to the nearest centimetres. The waist-to-hip ratio (WHR) was calculated as the waist circumference in centimetres (cm) divided by the hip circumference in centimetres (cm).

Blood pressure (BP) measurement – Subjects were instructed not to take caffeine and to avoid smoking one hour before BP measurement. Blood pressure was taken with patients sitting quietly after 5 minutes of rest using a mercury sphygmomanometer (ACCUSONS) in a sitting position with the arm resting on a table at the level of the heart. Systolic BP was recorded at phase 1 Korotkoff, and diastolic BP at phase 5. The pressure was recorded in both arms and the second reading was taken after three minutes with the average of the measurements being recorded.¹⁴ In this study, hypertension was defined as systolic BP $\geq 140\text{mmHg}$ and/or diastolic BP of $\geq 90\text{mmHg}$ or use of antihypertensive drugs.¹⁵

Laboratory evaluation

Blood samples for laboratory investigations were taken during the subject's second visit because of the requirement for fasting. Thus, subjects were instructed to fast overnight (i.e. 8 – 12 hours) before the visit. Each participant had 12 mls of blood drawn, 2 mls was used for fasting plasma glucose (FPG) and 10mls for serum lipid estimation.

Subjects were initially tested for macroalbuminuria, subjects positive for this were noted, while those negative for macroalbuminuria were subsequently subjected to spot assessment of microalbuminuria by Chemstrip Micral test strips. An albumin excretion detection $\geq 20\text{mg/L}$ was considered consistent with microalbuminuria. (30mg/day). Blood sample for estimation of glucose was collected in fluoride oxalate bottles and centrifuged at 100 revolutions/minute for 5 minutes. The supernatant (plasma) was then separated into appropriate containers for analysis (glucose estimation). The remaining 10mls of blood for lipid estimation was placed in a sterile plain container. The samples were either analyzed within 24 hours of collection or stored in a deep freezer at -20°C and analyzed within two weeks. Plasma glucose levels were measured using Trinder's glucose oxidase method.¹⁶ Total cholesterol, HDL cholesterol and triglycerides in serum were estimated using an autoanalyser (HITACHI Roche902). LDL cholesterol was calculated using the Friedwald formula¹⁷

$$\text{LDL cholesterol} = \text{Total cholesterol (mmol/L)} - \text{HDL cholesterol} - \text{TG}/2.2$$

All laboratory investigations were conducted at the JUTH Chemical Pathology Laboratory. The laboratory's cut-off points adhered to the standards set by the International Federation of Clinical Chemistry.

Study definitions.

Dyslipidaemia defined as TG $\geq 1.7\text{mmol/L}$ (150mg/100ml) for both sexes

HDL cholesterol of <1.04mmol/L (40mg/dL) in men and <1.29mmol/L (50mg/dL) in women.⁸

Diabetes Mellitus: is defined as FPG $>7.0\text{mmol/L}$ (126mg/100ml)¹⁸ or if the patient is on treatment for diabetes. Metabolic Syndrome: this is defined using IDF and WHO criteria and components of MS using both WHO and IDF criteria. Study subjects were classified as having Metabolic Syndrome based on the following criteria:

(A) WHO Criteria¹⁵

Metabolic Syndrome was diagnosed in the presence of impaired fasting glycemia (IFG) with fasting plasma glucose (FPG) ≥ 6.1 mmol/L, or type 2 diabetes mellitus (T2DM), defined as either being on treatment for T2DM or having FPG ≥ 7.0 mmol/L, along with at least two of the following: Hypertension: Use of antihypertensive therapy or blood pressure (BP) $\geq 140/90$ mmHg.

Hypertriglyceridemia: Plasma triglycerides (TG) ≥ 1.7 mmol/L (150 mg/dL).

Low HDL Cholesterol: HDL cholesterol < 1.04 mmol/L (< 40 mg/dL) in males or < 1.29 mmol/L (< 50 mg/dL) in females.

Obesity: Body mass index (BMI) ≥ 30 kg/m² or waist-to-hip ratio (WHR) ≥ 0.9 in males and ≥ 0.85 in females.

Microalbuminuria: Positive micral test strip for urinary microalbumin.

(B) IDF Criteria³

Metabolic Syndrome was diagnosed based on the presence of central obesity, defined as a waist circumference (WC) ≥ 94 cm in males and ≥ 80 cm in females, along with at least two of the following:

Hypertension: Use of antihypertensive therapy or BP $\geq 130/85$ mmHg.

Hypertriglyceridemia: Plasma TG > 1.7 mmol/L (150 mg/dL).

Low HDL Cholesterol: HDL cholesterol < 1.04 mmol/L (< 40 mg/dL) in males or < 1.29 mmol/L (< 50 mg/dL) in females.

Hyperglycemia: FPG ≥ 5.6 mmol/L or being on treatment for T2DM.

Statistical analysis

Data analysis was done using Epi-info version 3.5.1.CDC,

Atlanta Georgia; Mean and standard deviation were used to describe continuous variables, while proportions were used for categorical variables. The student's t-test was used to compare group means, and the Chi-Squared (X²) test was used for comparison of proportions and test of significance between categorical variables. A p-value of < 0.05 was considered statistically significant.

Ethical consideration – Ethical clearance was obtained from the research ethics committee of the Jos University Teaching Hospital (JUTH), with the Ethical approval number JUTH/DCS/ADM/127/4545.

Results

Of the 350 study subjects with hypertension enrolled, 340 had complete data. 109 (32.1%) were males and 231 (67.9%) were females, giving a male-to-female ratio of 1:2.1. The mean (SD) age of study subjects was 53.61 (9.83) years with a range of 30 – 70 years. The mean (SD) age of male subjects was slightly older 54.65(9.68) years compared to 53.17(9.76) years for female subjects. This difference was not significant. (t=1. 741, p=0.187). The distribution of subjects by age and sex is shown in Table I. The mean values of various anthropometric, clinical, and biochemical parameters are summarised in Table II

The prevalence of components of the metabolic syndrome using WHO criteria is shown in Table III. Central obesity (using WHR) was found to be the component with the highest prevalence of 71.5% followed by microalbuminuria with a prevalence of 56.8% and in decreasing order of prevalence; TG (49.1%), BMI (42.6%), FPG (31.2%) and the least is HDL cholesterol with a prevalence of 24.1%.

Table I: Age and gender distribution of participants

Age group (years)	Gender		Total (N = 340)
	Male (%); n = 109	Female (%); n = 231	
30 – 40	12 (11.0)	29 (12.6)	41 (12.1)
41 – 50	25 (22.9)	65 (28.1)	90 (26.5)
51 – 60	42 (38.5)	88 (38.1)	130 (38.2)
61 – 70	30 (27.5)	49 (21.2)	79 (23.2)
Total	109 (32.1)	231 (67.9)	340 (100)

X²=1.741, p=0.187

Table II: Anthropometric, clinical, and biochemical parameters of study participants

Variables	All subjects	Gender		t-test	p-value
		Male	Female		
Age (SD) years	56.61 (9.8)	54.65 (9.7)	53.17 (9.7)	1.74	0.187
SBP (SD) mmHg	139.00 (21.3)	142.4 (21.4)	137.75 (21.2)	1.87	0.062
DBP (SD) mmHg	89.40 (12.9)	90.04 (12.1)	88.98 (13.3)	40.77	0.442
TG (SD) mmol/l	1.72 (0.7)	5.33 (1.8)	5.11 (1.3)	1.88	0.225
HDL (SD) mmol/l	1.55 (0.7)	1.45 (0.7)	1.56 (0.6)	1.44	0.150
WHR	0.90 (0.04)	0.95 (0.07)	0.89 (0.08)	5.29	0.000
BMI (SD) kg/m ²	29.33 (6.0)	27.30 (5.5)	30.03 (6.0)	4.03	0.000
WC (SD) cm	94.20 (11.5)	95.20 (12.5)	96.7 (12.3)	1.04	0.299
FPG (SD) mmol/l	5.89 (2.14)	6.02 (2.3)	5.83 (2.0)	0.73	0.462

SBP-systolic blood pressure; DBP-diastolic blood pressure; TG-triglyceride; HDL-High-density lipoprotein cholesterol; WHR-waist-Hip-Ratio; BMI-body mass index; WC-waist circumference; FPG-fasting plasma glucose

Table III: Relationship between the components of metabolic syndrome (as defined by the WHO criteria) and gender of the participants

Variables	All subjects (N = 340)	Gender		X ²	p-value
		Male (109)	Female (231)		
Abnormal BMI					
Yes	145 (42.6)	30 (27.5)	115 (49.8)	15.003	0.000
No	195 (57.4)	79 (72.5)	116 (50.2)		
Abnormal HDL					
Yes	82 (24.1)	21 (19.3)	61 (26.4)	2.060	0.151
No	258 (75.9)	88 (80.7)	170 (73.6)		
Abnormal TG					
Yes	167 (49.1)	45 (41.3)	122 (52.8)	3.939	0.047
No	173 (50.9)	64 (58.7)	109 (47.2)		
Abnormal FPG					
Yes	106 (31.2)	39 (35.8)	67 (29.0)	1.584	0.208
No	234 (68.8)	70 (64.2)	164 (71.0)		
Microalbuminuria					
Present	193 (56.8)	58 (53.2)	135 (58.4)	0.820	0.363
Absent	147 (43.2)	51 (46.8)	96 (41.8)		
Abnormal WHR					
Yes	243 (71.5)	78 (71.6)	165 (71.4)	0.001	0.975
No	97 (28.5)	31 (28.4)	66 (28.6)		

Table IV: Relationship between the components of metabolic syndrome (as defined by the IDF criteria) and gender of the participants

Variables	All subjects (N = 340)	Gender		X ²	p-value
		Male (109)	Female (231)		
Abnormal WC					
Yes	269 (79.1)	60 (55.0)	209 (90.5)	54.140	0.000
No	71 (20.9)	49 (14.4)	22 (37.5)		
Abnormal HDL					
Yes	137 (40.3)	43 (39.4)	94 (40.7)	0.050	0.827
No	203 (59.9)	66 (60.6)	137 (59.3)		
Abnormal TG					
Yes	167 (49.1)	45 (41.3)	122 (52.8)	3.939	0.047
No	173 (50.9)	64 (58.7)	109 (47.2)		
Abnormal FPG					
Yes	169 (49.7)	52 (47.7)	117 (50.6)	0.257	0.612
No	171(50.3)	57 (52.3)	114(49.4)		

Most of the components of the metabolic syndrome were more prevalent in females except for fasting plasma glucose which is more prevalent in males, and this difference is significant for BMI, TG and FPG (p=0.000, 0.047 and 0.002 respectively). Using the IDF criteria, again a measure of central obesity, waist circumference (WC) was the most prevalent at 79.1%. FPG followed this with a prevalence of 49.7%; then TG (49.1%) and the least was HDL cholesterol with a prevalence of 40.3%. All the components were again more prevalent in females and these differences were significant for WC and TG (P=0.000 and 0.047 respectively). This distribution is shown in Table IV above.

Table V below shows the sex distribution of MS using the IDF and WHO criteria. The prevalence rate of MS using both criteria was significantly higher in females than in males (x²=5.751, p=0.016). The prevalence of metabolic syndrome using IDF criteria increased steadily with increasing age reaching a peak in the age group (51-60) years with a slight decline in the age group (61-70) years, this association was not significant (X²=3.081, p=0.379)

Discussion

The prevalence rates for metabolic syndrome in this study were significantly higher in females using the IDF and

Table V: Age and gender variations in the prevalence of metabolic syndrome defined by both criteria

Variables	WHO-criteria-based prevalence (n=112; N=340)	IDF-criteria-based prevalence (n=223; N=340)	X ²	p-value
Gender				
Male	40 (35.7)	52 (23.3)	5.751	0.016
Female	72 (64.3)	171 (76.7)		
Age-groups				
30 – 40	8 (7.1)	26 (11.7)	3.081	0.379
41 – 50	27 (24.1)	59 (26.5)		
51 – 60	56 (50.0)	92 (41.3)		
61 – 70	21 (18.6)	46 (20.6)		

insignificantly higher in males using the WHO criteria. The higher prevalence using the IDF criteria compared to WHO criteria may be due to the prerequisite of central obesity (WC) for identifying subjects with metabolic syndrome by the IDF criteria; it was the most prevalent of all the components of MS in this study. The lower cutoff for WC (80cm and 94cm for females and males respectively) may also be another factor. The other reason may be due to the prerequisite of a higher fasting plasma glucose ≥ 6.1 mmol/L for identifying subjects with metabolic syndrome using the WHO criteria compared to a lower value of ≥ 5.6 mmol/L used for defining the metabolic syndrome by the IDF criteria. The prevalence of metabolic syndrome in this study, based on IDF criteria, was higher than the 34.7% reported in a study¹⁹ from southeastern Nigeria that used the same criteria. This difference could be attributed to the older age of participants in this study (mean age 53.61 ± 9.83 years) compared to the younger population in the southeastern study (mean age 43.8 ± 13.7 years). Additionally, the use of a semi-urban setting in their study, as opposed to the urban population sampled in this study, may account for the disparity. A lower prevalence of 31.2% was also observed in another study from southeastern Nigeria.²⁰ This is likely due to the use of the NCEP ATP III criteria, which have higher waist circumference thresholds for central obesity (102 cm for males and 88 cm for females) compared to the IDF cutoffs (94 cm for males and 80 cm for females). However, in southwestern Nigeria, a study reported a prevalence comparable to this study, at 42.9% and 35% using IDF and WHO criteria, respectively.²¹

Lower prevalences of metabolic syndrome, at 34%, 30.2%, and 37%, were reported in studies conducted in Kuwait and Italy among untreated hypertensive patients.²²⁻²⁴ The lower figures may be attributed to the use of the NCEP ATP III criteria, which have higher thresholds for central obesity. In contrast, higher prevalences, like those observed in this study, were reported in Spain (52%), the United States (62.9%), and Jordan (52%).²⁵⁻²⁷ While these studies were conducted in affluent countries, the comparable prevalence may reflect the increasing adoption of Western lifestyles in developing countries. This shift includes reduced physical activity and a transition from traditional African diets rich in fruits and vegetables to more calorie-dense foods.²⁸

Notably, even higher prevalences were observed among patients with Type 2 diabetes mellitus (T2DM), such as the 54.3% reported in northwestern Nigeria²⁹ and 80% in Lagos, southwestern Nigeria.³⁰ This aligns with the well-established association between metabolic syndrome and T2DM, with metabolic syndrome linked to a fivefold increased risk of developing T2DM.³¹

The prevalence of metabolic syndrome, based on both criteria, was significantly higher in females than in males. This female predominance aligns with findings from studies conducted in southeastern Nigeria^{19,20} and other research reporting higher prevalence rates among females.^{22,28,32-34} However, some studies have found equal prevalence between genders,^{26,35} while others have noted male predominance.^{35,36} The observed gender difference may be attributed to the higher prevalence of obesity among females,³⁴ influenced by genetic and hormonal factors, as well as lower levels of physical activity.³⁷⁻³⁹ Interestingly, the slightly higher prevalence of metabolic syndrome in males according to WHO criteria in this study may be linked to the higher prevalence of elevated fasting plasma glucose in males, a key factor in the WHO definition of metabolic syndrome.

The prevalence of metabolic syndrome has been widely observed to increase progressively with advancing age.^{26,40,41} In this study, the prevalence rose steadily for both IDF and WHO criteria, peaking in the middle-aged group (51–60 years) before declining slightly in the elderly group (61–70 years). A similar pattern was observed across all components of metabolic syndrome, with a peak in the 51–60-year age group and a slight decline in the older age group. Comparable trends have been noted in southeastern Nigeria, where studies observed a progressive rise in prevalence with age.^{19,20} In another study conducted in southwestern Nigeria, the prevalence increased dramatically, from 11% in individuals aged 20–29 years to 89% in those aged 70–79 years.³⁰ This age-associated increase in metabolic syndrome has also been reported in studies from Seychelles, Taiwan, and Italy, highlighting its consistent relationship with ageing across diverse populations.^{32,42,43}

The relationship between increasing age and the rising prevalence of metabolic syndrome may be due to the

relationship of advancing age with the evolution of insulin resistance and an increase in visceral abdominal adipose tissue.⁴⁴ Visceral abdominal adipose tissue as described earlier is associated with increased formation of triglycerides, low HDL and increased small dense LDL particles. The age-related loss of body fat has been adduced as a possible reason for the decline in the metabolic syndrome rate among the elderly age group which is also the finding in this study.¹⁵

Central obesity emerged as the most prevalent component of metabolic syndrome in this study, consistent with findings from previous Nigerian studies.^{19,20,45-47} Similarly, Kelliny et al.³² reported central obesity as the most prevalent component of metabolic syndrome in Seychelles. Furthermore, in a Cameroonian study, central obesity was the most prevalent component of the syndrome, suggesting that central obesity could be a key determinant of the syndrome's prevalence in Sub-Saharan Africa.³³ This association may stem from the unique metabolic characteristics of visceral abdominal fat, which is more resistant to insulin action than peripheral fat. Additionally, visceral fat is more responsive to lipogenic hormones, leading to increased production of free fatty acids (FFAs).¹⁸ FFAs, in turn, provide substrates for the synthesis of triglycerides, small dense LDL particles, and HDL cholesterol, further contributing to the metabolic abnormalities seen in central obesity

Conclusion

Overall, the IDF criteria identified more hypertensives with Metabolic Syndrome compared with the WHO criteria, and it reflected a female preponderance. Central Obesity, described as the deriving factor for the metabolic syndrome, was prevalent in our study subjects. We advocate for the use of the IDF criteria which seems to identify more patients with the syndrome. We advocate for early screening of the syndrome at diagnosis of hypertension. This will help in early identification, treatment and prevention of its attendant complications of type 2 diabetes and cardiovascular disease.

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Declaration of interest

We have none to declare

Contribution of authors

OG conceptualised and designed the study, UJ recruited patients and provided study materials, UJ and AM collected data, FP analysed and interpreted the data, OG and UJ wrote the first draft of the manuscript, All the authors reviewed and contributed to the final manuscript revisions and approved the final version

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