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Metabolic syndrome in the Gambia: Comparison of the International Diabetes Federation and Adult Treatment Panel III definitions

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Abstract

Background: The metabolic syndrome is a cluster of risk factors for cardiovascular diseases and diabetes mellitus. Objective: To compare and determine the level of agreement between International Diabetes Federation (IDF) and National Cholesterol Education Program Adult Treatment Panel III (ATP) metabolic syndrome in the adult Gambian. Design: Cross-sectional study. Setting: Outpatient clinics of Edward Francis Small Teaching Hospital and Medical Research Council Laboratories in Banjul, The Gambia. Methods: Two hundred and eight consecutive patients with systemic hypertension on treatment and 108 non-hypertensive patients aged over 25years were enrolled. A questionnaire was filled and anthropometric measurements were taken. An oral glucose tolerance test (OGTT) was done as well as blood investigations including total cholesterol (TC), high-density lipoprotein cholesterol (HDL) and triglycerides (TG). Low-density lipoprotein cholesterol (LDL) was calculated using the Friedwald formula. Results: Three hundred and one participants with complete results were included in the analysis. The overall prevalence of IDF metabolic syndrome was 42% while that of ATP was 33%, with IDF identifying significantly more cases of metabolic syndrome than ATP ($p < 0.0001$). The kappa statistics for the agreement between the IDF and ATP metabolic syndrome for all the participants was substantial ($k= 0.719$, $p<0.0001$). 86.7% of participants were classified similarly as having metabolic syndrome or not by both criteria. Conclusion: The prevalence of metabolic syndrome was high by both the IDF and ATP criteria in Banjul and the level of agreement between the two criteria was substantial.

Keywords

Metabolic Syndrome, Systemic Hypertension, IDF, ATP

1. Introduction

The metabolic syndrome is a cluster of cardiovascular risk factors including diabetes mellitus (DM), raised plasma glucose, high blood pressure and raised cholesterol levels. [1]–[3] Metabolic syndrome has attracted the attention of researchers and clinicians worldwide as it has been associated with adverse outcomes such as coronary artery disease, chronic kidney disease and DM which are reaching alarming proportions worldwide. [4]-[7] It affects approximately 20 – 25% of the adult population worldwide and confers a fivefold greater risk of developing DM compared to adults without the syndrome. The risk of dying from heart attack and stroke are also increased by two and three times respectively by the metabolic syndrome. [8]

Reaven in 1988 noted a cluster of risk factors for cardiovascular disease which he termed syndrome x. [9] He proposed insulin resistance as the underlying or primary risk factor for this syndrome leading to the alternate name of insulin resistance syndrome but did not provide any clear cut diagnostic criteria. [9] The World Health Organization (WHO) provided the first definition of metabolic syndrome in 1998

which placed emphasis on insulin resistance. [10] Since then various groups such as the European Group for the Study of Insulin Resistance (EGSIR), National Cholesterol Education Program (NCEP), American Association of Clinical Endocrinologists (AACE) and the International Diabetes Federation (IDF) have provided diagnostic criteria for metabolic syndrome. [10-14] These criteria place emphasis on different parameters and also give different cutoff values for the parameters.

Comparative studies have been done in various populations using two or more definitions in order to assess the prevalence of metabolic syndrome and also determine if the diagnostic criteria selected makes any difference. These studies also aim to determine the degree to which the various diagnostic criteria are able to predict adverse outcomes from metabolic syndrome.

One such research was conducted by Earl S. Ford and Wayne H. Giles using data from the Third National Health and Nutrition Examination Survey (NHANES III) to compare the prevalence of metabolic syndrome amongst US nationals using the WHO and National Cholesterol Education Program Adult Treatment Panel III (ATP) criteria. Participants were Whites, African-Americans, Mexican-Americans and other races aged 20 years and above and numbered 8,608 in total. The ATP definition identified 23.9 % of participants as having metabolic syndrome whiles the WHO definition classified 25.1% although 86.2 % were classified similarly under both criteria. [15] Fezeu et al also conducted a survey using the WHO, ATP and IDF in Cameroon. Here again, the highest prevalence recorded was with the WHO definition, while the ATP criteria gave the lowest prevalence rate. [16] In another study conducted by Earl S. Ford to compare the prevalence of metabolic syndrome using the ATP and IDF criteria in 3,601 subjects aged 20 years and above from the 1999–2002 National Health and Nutrition Examination Survey, the unadjusted prevalence of the metabolic syndrome was 34.5% among all participants, based on the ATP criteria. The IDF definition, gave an unadjusted prevalence of 39.0% among all participants. 92.9% of the participants were similarly classified as having or not having metabolic syndrome by both criteria. [17]

To date there has been no published report of a metabolic syndrome study conducted in The Gambia, a small West African country with very few cardiovascular studies. In our study of the relationship between insulin resistance and left ventricular hypertrophy in The Gambia we measured the various components of metabolic syndrome and in this article we present the findings. [18], [19] The aim of this study is to compare the metabolic syndrome in the adult Gambian using the IDF and ATP criteria and determine the level of agreement between these two criteria.

2. Materials and Methods

This cross sectional study was conducted in The Gambia from January to May 2000. The participants were recruited from the Medical Research Council (MRC) Laboratories, Fajara and the Edward Francis Small Teaching Hospital (EFSTH), Banjul. Patients who reported with minor infectious diseases, who had no cardiovascular disease or diabetes mellitus who in addition did not have hypertension were recruited as the non-hypertensives at the Gate Clinic of the MRC Laboratories. At the hypertension clinic of EFSTH, patients with systemic hypertension who reported for treatment were consecutively recruited into the study. The exclusion criteria for this study were as follows; systemic or metabolic diseases, cardiovascular disease (excluding hypertension) or labile hypertension, morbid obesity (BMI > 35) and severe inter-current illnesses. Patients with known DM were excluded but cases that were not known DM but were diagnosed after undergoing an oral glucose tolerance test (OGTT) were included in the study.

A field worker administered a questionnaire using the appropriate local language and one physician carried out a physical examination on the participants. A plastic tape measure was used to measure the hip and waist circumferences and these were recorded to the nearest 0.5 cm. The height was measured to the nearest 0.5 cm without footwear or head gear using standardised stadiometers. Weight was measured (to the nearest 0.1 kg) on electric scales (Secca r 770, CMS London), with subjects wearing light clothes and without footwear. The blood pressure (BP) was measured with digital blood pressure machines (Omron r HOM – 705 CP, Japan) on the left arm of the participants and these were calibrated to the standard mercury sphygmomanometer every two weeks. Three readings were taken, the first was discarded and the mean of the later two readings was used in the analysis. [20]

An OGTT was carried out on participants using 75g anhydrous glucose in 300-350 ml of water. A Haemocue analyser (Haemocue AB, Sweden) was used to immediately determine blood glucose level on fasting, 30 min and 120 min samples. The detailed results of the OGTT are presented in another article which is in print. However the information on the fasting blood glucose (FBG) levels was used in classifying the participants in this study. Additional venous blood samples were collected and analysed for total cholesterol (TC), high-density lipoprotein cholesterol (HDL) and triglycerides (TG) at the MRC Biochemistry Laboratory using a centrifugal biochemical analyzer (Cobas Fara, Roche, UK). The Friedwald formula was used in calculating the level of low-density lipoprotein cholesterol (LDL). [21]

The following definitions were adopted for this study. Overall Obesity was defined as Body Mass Index (BMI) ≥ 30 kg / m^2 while High Waist Hip Ratio (WHR) was defined as WHR > 0.9 for males and > 0.8 for females. [22] The ATP metabolic syndrome was defined as three or more of the following risk factors; (a) Central Obesity – Waist Circumference (WC) > 102 cm in men and > 88 cm in women (b) raised TG – TG ≥ 1.7 mmol/L (c) Reduced HDL – HDL < 1.03 mmol/L in men and < 1.29 mmol/L in women (d) Raised BP - systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg (e) Raised FBG – FBG ≥ 6.1 mmol/L. [12] The IDF metabolic syndrome was defined as follows; WC ≥ 94cm in men or ≥ 80 cm in

women plus two or more of the following four risk factors: (a) Raised TG – TG ≥ 1.7 mmol/L or specific treatment for this lipid abnormality (b) Reduced HDL - HDL < 1.03 mmol/L in men and < 1.29 mmol/L in females, or specific treatment for this lipid abnormality (c) Raised BP - systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg, or treatment of previously diagnosed hypertension (d) Raised FBG - FBG ≥ 5.6 mmol/L or previously diagnosed type 2 DM. [14]

Data analysis was carried out using Microsoft Excel 2010 and Stata version 8.0 statistical package. Percentages were calculated for discrete variables and these were compared using Pearson Chi-square test. The mean and standard deviation were calculated for continuous variables, and were compared using the Student t-test. P-values of less than 0.05 were taken as statistically significant. The level of agreement between the ATP and the IDF metabolic syndrome were compared using Pearson Chi-square test and kappa statistics (k). The level of agreement is considered very good with k > 0.80, substantial with k = 0.61 to 0.80, moderate with k = 0.41 to 0.60, fair with k = 0.21 to 0.40 and poor with k ≤ 0.20. [23]

All the participants after careful consideration and explanation gave a formal consent by signing or thumb printing an informed consent form. The study was approved by The Gambia Government / MRC Ethical Committee.

3. Tables

Table 1a. *The clinical characteristics of participants by sex*

	Male (n=103) Number (%)	Female (n=198) Number (%)	All (n=301) Number (%)	P (χ^2 test)
Age Range (yr)	31 - 81	27 - 85	27 - 85	
Smoking	54 (52.4)	14 (7.1)	68 (22.6)	< 0.001
BMI ≥ 30	11 (10.8)	67 (33.8)	78 (26.0)	< 0.001
HIGH WHR	41 (39.8)	175 (88.4)	216 (71.8)	< 0.001

Table 1b. *The clinical characteristics of participants by sex*

	Male (n=103) Mean (SD)	Female (n=198) Mean (SD)	All (n=301) Mean (SD)	P (t test)
Age (years)	54.7 (10.5)	52.9 (12.6)	53.5 (12.0)	0.21
Weight (kg)	69.8 (15.6)	71.5 (15.7)	71.0 (15.6)	0.37
Height (m)	1.70 (0.08)	1.61 (0.06)	1.64 (0.08)	< 0.0001
BMI (kg/m^2)	24.1 (5.5)	27.7 (6.0)	26.5 (6.1)	< 0.0001
WC (cm)	88.2 (12.9)	95.0 (12.1)	92.7 (12.8)	< 0.0001
HC (cm)	99.4 (11.1)	108.7 (12.2)	105.5 (12.6)	< 0.0001
WHR	0.89 (0.06)	0.87 (0.07)	0.88 (0.06)	0.15
SBP (mmHg)	139 (28)	135 (28)	137 (28)	0.28
DBP (mmHg)	83 (16)	83 (14)	83 (14)	0.73

Table 2a. *The determinants of metabolic syndrome by sex*

	Male (n=103) Number (%)	Female (n=198) Number (%)	All (n=301) Number (%)	P (χ^2 test)
Raised BP	74 (71.8)	144 (72.7)	218 (72.4)	0.87
Central Obesity (IDF)	32 (31.1))	178 (89.9)	210 (69.8)	< 0.001
Central Obesity (ATP)	12 (12.6)	137 (69.2)	150 (49.8)	< 0.001
FBG ≥ 5.6 mmol/L	36 (35.0)	70 (35.4)	106 (35.2)	0.95
FBG ≥ 6.1 mmol/L	23 (22.3)	46 (23.2)	69 (22.9)	0.86
Reduced HDL	34 (33.0)	100 (50.5)	134 (44.5)	< 0.01
Raised TGL	6 (5.8)	21 (10.6)	27 (9.0)	0.17

Table 2b. *The determinants of metabolic syndrome by hypertension status*

	Hypertension (n=195) Number (%)	No Hypertension (n=106) Number (%)	All (n=301) Number (%)	P (χ^2 test)
Raised BP	195 (100)	23 (21.7)	218 (72.4)	< 0.001
Central Obesity (IDF)	148 (75.9)	62 (58.5)	210 (69.8)	< 0.01
Central Obesity (ATP)	112 (57.4)	38 (35.9)	150 (49.8)	< 0.001
FBG ≥ 5.6 mmol/L	78 (40.0)	28 (26.4)	106 (35.2)	0.02
FBG ≥ 6.1 mmol/L	54 (27.7)	15 (14.2)	69 (22.9)	< 0.01
Reduced HDL	89 (45.6)	45 (42.5)	134 (44.5)	0.60
Raised TGL	18 (9.2)	9 (8.5)	27 (9.0)	0.83

Table 3. *The biochemical characteristics of participants by sex*

	Male (n=103) Mean (SD)	Female (n=198) Mean (SD)	All (n=301) Mean (SD)	P (t test)
FBG (mmol/L)	5.9 (3.3)	5.6 (1.8)	5.7 (2.4)	0.32
HDL (mmol/L)	1.20 (0.46)	1.32 (0.49)	1.28 (0.48)	0.04
TGL (mmol/L)	0.97 (0.54)	0.93 (0.58)	0.94 (0.57)	0.61

Table 4. *Metabolic syndrome by hypertension status and sex*

	Hypertension			No Hypertension			
	Male (n=64) Number (%)	Female (n=131) Number (%)	P (χ^2 test)	Male (n=39) Number (%)	Female (n=67) Number (%)	P (χ^2 test)	All (n=301) Number (%)
IDF	14 (21.9)	91 (69.5)	< 0.001	4 (10.3)	18 (26.9)	0.42	127 (42.2)
ATP	13 (20.3)	74 (56.5)	< 0.001	2 (5.1)	10 (14.9)	0.13	99 (32.9)

Table 5. *Association between IDF and ATP metabolic syndrome and various variables*

	IDF P (t or χ^2 test)	ATP P (t or χ^2 test)
Smoking	0.02 (χ^2)	0.12 (χ^2)
BMI ≥ 30	< 0.001 (χ^2)	< 0.001 (χ^2)
HIGH WHR	< 0.001 (χ^2)	< 0.001 (χ^2)
Age	0.13 (t)	< 0.01 (t)
Weight	< 0.0001 (t)	< 0.0001 (t)
Height	< 0.01 (t)	0.02 (t)
BMI	< 0.0001 (t)	< 0.0001 (t)
HC	< 0.0001 (t)	< 0.0001 (t)
WHR	< 0.001 (t)	< 0.0001 (t)

4. Results

From outpatient clinics 208 consecutive patients (138 (66%) females) with hypertension on treatment and 108 non-hypertensive patients (69 (64%) females) were enrolled for our initial study [18], [19] and 301 patients with complete data were included in this analysis. These were made up 195 hypertensives (131 (67%) females) and 106 non-hypertensive participants (67 (63%) females). The mean (± standard deviation (sd)) age of the participants was 53.5 (12.0) years.

Smoking was common among the participants (23%). The prevalence of general obesity (BMI ≥ 30) was 26% while high WHR was 72%. The mean (± sd) BMI was 26.5 (6.1), WHR was 0.88 (0.06), systolic blood pressure (SBP) 137 (28) mmHg and diastolic blood pressure (DBP) 83 (14) mmHg (Table 1). Smoking was significantly common in the males while the prevalence of general obesity and high WHR were higher in the females. Mean BMI, WC and hip circumference (HC) were also higher in the females. The other characteristics were similar in the two sexes.

Table 2 shows the characteristics used to determine metabolic syndrome either by IDF or ATP. Prevalence of raised BP was 72%, IDF and ATP central obesity were 70% and 50% respectively, reduced HDL was 45% and raised TGL 9%. The proportion of participants with FBG ≥ 5.6 mmol/L was 35% while 23% had FBG ≥ 6.1 mmol/L. Out of the 106 non-hypertensive participants, 23 (22%) met the criteria for raised BP. The prevalence of both central obesity and reduced HDL were significantly higher in the females while there were no sex difference in raised BP, FBG ≥ 5.6 mmol/L, FBG ≥ 6.1 mmol/L and raised TGL. The prevalence of both central obesity, FBG ≥ 5.6 mmol/L and FBG ≥ 6.1 mmol/L were significantly higher in the hypertension patients compared to the non-hypertensives while there was no significant difference in reduced HDL and raised TGL. Mean FBG was 5.7 (2.4) mmol/L, mean TG 0.94 (0.57) mmol/L, mean HDL 1.28 (0.48) mmol/L and while mean HDL was significantly higher in the females, mean FBG and HDL were similar in the two sexes (Table 3).

The overall prevalence of IDF and ATP metabolic syndrome were 42% and 33% respectively (Table 4). There was strong correlation between IDF and ATP metabolic syndrome ($p < 0.0001$, Pearson Chi-square test). However IDF identified significantly more cases of metabolic syndrome than ATP (42% vs. 33%, $p < 0.0001$).

Both IDF and ATP metabolic syndrome were statistically significantly common in females than the males [IDF (Females 55.1% vs. Males 17.5%, $p < 0.001$) ATP (Females 42.2% vs. Males 14.6%, $p < 0.001$)]. Both criteria were also statistically significantly common in the hypertensives compared to those who were not hypertensive [IDF (Hypertension 53.9% vs. No hypertension 20.8%, $p < 0.001$) ATP (Hypertension 44.6% vs. No hypertension 11.3%, $p < 0.001$)].

The kappa statistics for the agreement between the IDF and ATP metabolic syndrome for all the participants was substantial ($k = 0.719$, $p < 0.0001$). 86.7% of participants were classified similarly as having metabolic syndrome or not by both criteria. When the hypertensive and the non-hypertensives participants were considered separately the level of agreement between the two criteria was substantial in both cases, ($k = 0.695$, $p < 0.0001$) ($k= 0.655$, $p < 0.0001$) respectively. The level of agreement between the IDF and ATP metabolic syndrome was also substantial for the females ($k = 0.731$, $p < 0.0001$) while it was moderate for the males ($k = 0.532$, $p <0.0001$).

There were significant association between the IDF and ATP metabolic syndrome and various variables in the dataset (Table 5). There was no association between ATP metabolic syndrome and smoking while the association between IDF metabolic syndrome and smoking and age were not up to statistical significance.

5. Discussion

This study has shown that metabolic syndrome is common in this Gambian population with the prevalence in females higher than that in the males and the prevalence in hypertensives also higher than that in non-hypertensives. The ATP criteria detected less metabolic syndrome in this Gambian population as it gave a prevalence rate of 33% compared with the 42% detected by the IDF definition. The two definitions similarly classified 87% of the participants as having or not having the metabolic syndrome showing a close relationship between the two definitions. The kappa statistics for the level of agreement between the IDF and ATP metabolic syndrome was substantial.

This phenomenon of IDF criterion detecting a higher prevalence of metabolic syndrome compared to the ATP criterion has been attributed to the fact that the ATP criterion gives higher cutoff values for fasting blood glucose and central obesity compared with the IDF, by other authors. [24] In a study conducted by Gyakobo et al, the prevalence of the metabolic syndrome was 15.0% and 35.9% by the ATP and IDF criteria, respectively. [24] Earl S. Ford in the US, reported almost 40% of participants as having the metabolic syndrome by the IDF criteria a prevalence higher compared to the 34.5% estimated by the ATP definition. [17] Kow Nanse Arthur et al. in Kumasi, Ghana reported a prevalence of 25.6% by ATP

criteria compared to 29.2% by IDF criteria in premenopausal and postmenopausal women. [25] In Qatar, Bener and others found a prevalence of 33.7% by IDF criteria while the ATP criteria yielded a prevalence of 26.5%.[26] Other studies have found the reverse however. In a study in Turkey, Can and others reported a prevalence of 38% by ATP and 20% by IDF criteria while Ko et al. study among Hong Kong Chinese yielded a prevalence of 7.4% by IDF criteria and 9.6% by ATP criteria. [27], [28]

The level of agreement between IDF and ATP criteria for all participants in our study was substantial. This is similar to several reported studies. The level of agreement between the IDF and ATP criteria was substantial in the Arkhangelsk Study in Russia (k = 0.70) and the Tehran Lipid and Glucose Study in Iran (k = 0.66). [29]-[31] In the Turkey study the level of agreement was very good (k = 0.84), while in the Norwegian HUNT 2 study Hildrum et al. found a substantial level of agreement between the two criteria (k = 0.66). [27], [32] In the study by Kow Nanse Arthur et al. in Kumasi, Ghana the level of agreement was moderate in postmenopausal women (k = 0.54) and substantial in premenopausal women (k = 0.70). [25] However in a rural population in Ghana, Gyakobo et al found the kappa statistics for the level of agreement to be moderate (k = 0.45). [24]

By both the IDF and ATP criteria the commonest determinants of metabolic syndrome were high BP, central obesity, reduced HDL, FBG $\geq$ 6.1 or FBG $\geq$ 5.6 and raised TGL in that order. The prevalent determinants for most of the African studies have been similar, with either high BP or central obesity being on top of the list with raised TGL being the least prevalent determinant, [24], [25], [33], [34] compared to studies in Caucasians where raised TGL are common. [29], [35]-[37] Both criteria were significantly associated with other measures of obesity such as BMI and WHR. This is in consonance with other studies on metabolic syndrome. [26], [38]

This study is one of the few cardiovascular studies which have been undertaken among Gambian participants. Further, to date there has not been any published data on metabolic syndrome from The Gambia, a small West African country. This is the major strength of this pioneering study which has shown a substantial level of statistical agreement between the IDF and ATP metabolic syndrome criteria. The main weakness of the study was the fact that it was a hospital based study and such studies are subject to various biases including proximity and selection biases. The other potential limitation of this study was the fact that the original study was designed to determine the association between insulin resistance and left ventricular hypertrophy. And though this provided all the data needed to determine IDF and ATP metabolic syndrome , there were not enough information to determine metabolic syndrome by other criteria like the WHO, EGSIR and AACE. We would therefore recommend further cardiovascular studies in The Gambia generally but more specifically community based cross sectional studies with larger sample size to study metabolic syndrome using all these different diagnostic criteria.

6. Conclusion

The level of agreement between the IDF and ATP metabolic syndrome criteria was substantial and the prevalence of metabolic syndrome was high by both criteria though IDF criterion identified more participants with metabolic syndrome than the ATP criteria.

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