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Full Length Research Paper

The Prevalence of the Metabolic Syndrome among Normal Weight Nigerians

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***Aims and Objectives*. In the past, most notions about the metabolic syndrome emphasized the importance of obesity. This study determined the prevalence of the metabolic syndrome (MS), among normal weight BMI Nigerians.**

***Materials and Methods*. Three hundred and sixty-nine subjects, (369, men 207, women 162), aged above 30 years were randomly recruited for the study. Metabolic syndrome was diagnosed using the National Cholesterol Education Programme/ Adult Treatment Panel 111, (NCEP/ATP111), criteria.**

***Results*. Thirty six subjects (9 males, 27 females) had three abnormal factors. Four abnormal factors occurred in 3 female subjects giving a total of 39 subjects that satisfied the criteria for the diagnosis of the MS. These gave the prevalence of MS as 10.6%, 4.3% and 18.5% among all, male and female subjects respectively. MS was distributed evenly in the normal BMI range among the women while among the men more cases were found in the upper range of normal BMI. Elevated waist circumference, (WC), had similar prevalence as MS among the subjects.**

***Conclusions*. Occurrence of MS among normal weight BMI persons is thought to be due to production and release of pro-inflammatory cytokines by adipose tissues and underscore the need to screen non-obese individuals for the MS to prevent type 2 diabetes and cardiovascular diseases.**

Keywords: metabolic syndrome, Normal Weight BMI Nigerians, obesity, abnormal factors,cardiovascular diseases**,** type 2 diabetes

INTRODUCTION

The metabolic syndrome, (MS) is a cluster of cardiovascular risk factors such as central obesity, glucose intolerance or diabetes, hypertension and dyslipidaemia of the high low density lipoprotein cholesterol (LDL-C) and low HDL-C [1, 2]. Insulin resistance and obesity were reported to be the underlying factors of the syndrome,[3, 4, 5]. The MS is affecting the general population in epidemic proportions, [6, 7, 8]. It was estimated that in 2000, 17 million people worldwide will have T2DM and that the figure would double between 2000-2030 [9, 10.] As a non communicable disease, MS is spreading in developing countries faster than it did in developed countries decades ago [9]. This was said to be due to increasing prevalence of obesity and the metabolic syndrome [9]. In the past, most notions about the metabolic syndrome emphasized the importance of obesity. However, there are many individuals who are not obese on the basis of body mass index (BMI), but have the MS. The prevalence of the MS has been examined in personswith normal body mass indexes (BMI; kg/m^2) and in those who are slightly overweight[11-12]. It has been found to increase with rise in BMI within the normal range and more so slightly above the range, depending on sex and ethnicity[12]. In persons at reference body weight, the increased risk of the MS and CVD may have a genetic origin or be a consequence of body-composition abnormalities[12]. The concept of the metabolically obese normal-weight (MONW) individual was originally noted in a large epidemiological study by Abraham et al[13] in 1971. Ruderman et al[14] first proposed and defined the term

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Table 1.Mean (SD) values of factors recorded in the study (age in years; WC in cm; DBP, SBP in mmHg; FPG, TG, HDL-C in mmol/l; and BMI in kg/m^2).

Factor	All Subjects	Male Subjects	Female Subjects	p-Value: Male vs Female
AGE	53.07(22.85)	55.56(13.77)	50.42(11.79)	0.013*
WC	82.67(7.8)	82.79(7.49)	82.47(8.1)	0.118
FPG	4.23(0.74)	4.09(0.62)	4.40(0.86)	0.0044*
DBP	79.15(11.68)	78.10(11.33)	79.45(12.85)	0.909
SBP	132.0(18.53)	133.1(18.33)	128.9(19.48)	0.108
TG	1.23(0.62)	1.25(0.57)	1.19(0.66)	0.242
HDL-C	1.41(0.47)	1.39(0.40)	1.41(0.54)	0.610
BMI	22.85(1.7)	22.88(1.70)	22.64(1.86)	0.311

MONW in 1981. It was suggested that MONW individuals were those whose BMI (weight in kilograms divided by the square of the height in meters) was considered normal, but who had any one of the following metabolic disorders that could be improved via caloric restriction: type 2 diabetes, hypertension, and hypertriglyceridemia. Ruderman et al[15] revisited the definition of MONW in 1998, and included components of metabolic syndrome, polycystic ovarian syndrome (PCOS), premature coronary heart disease (CHD), uric acid, low birth weight, inactivity, ethnic group, and family history of the metabolic disorders. In 2004, St-Onge et al[11] proposed a new definition of metabolically obese, normal-weight individuals as those who have the metabolic syndrome. They revealed that individuals in the upper normal-weight and slightly overweight BMI range have a relatively high prevalence and are at increased risk of having the metabolic syndrome. Normal weight includes BMI ranging between 18.5 to 24.9kg/m^2.

Most prevalence studies in Nigeria were done on apparently healthy individuals but none was done exclusively on normal weight subjects. This paper reports on the prevalence of the MS among normal weight Nigerians.

MATERIALS AND METHODS

Three hundred and sixty-nine subjects, (369, men 207, women 162), aged above 30 years were randomly recruited for the study. The Ethics Committee of the University of Nigeria Teaching Hospital approved the study protocol and informed consent was obtained from all the subjects before data and sample collections. The work was done between March and September, 2006 Inclusion criteria were BMI less than 25kg/m^2 and age above 30 years when the syndrome was said to be more prevalent [16].

Height was measured with the subject standing without shoes on a firm, level surface at right angle to the vertical board of the height measurement device. Readings were taken to the nearest 0.5cm. Body weight in light clothing was measured to the nearest 0.1kg using electronic scale balance. An average of two readings (in kilograms, kg) was taken and body mass index (BMI, kg/m^2) was calculated as weight divided by the square of height in meters (m^2)[17]. The blood pressure measurements were taken three times in the left arm with the participants sitting and after 10 minutes rest using Accusson's mercury sphygmomanometer with appropriate cuff sizes.

Fasting blood samples, (5ml), were collected from patients between 8 am and 11 am each day using standard methods[18]. One milliliter of blood sample was put into heparinized tube and spun at 3000 revolutions per minute for 5 minutes and the plasma was used for glucose estimation within three hours to avoid loss of glucose. The rest of the sample was put into a plain sample tube and allowed to clot at room temperature. They were similarly spun and the serum harvested and used for the determination of triglycerides and high density lipoprotein cholesterol.

Plasma glucose was determined by the method of Trinder[19], serum triglycerides by the method of Buccolo and David [20]. High density lipoprotein cholesterol was estimated in the serum supernatant after precipitating β-apoprotein containing lipoproteins using the method of Allain et al, [21]. Cromatest$^{(R)}$ mono-reagent test kits manufactured by Linear Chemicals, Spain, 2005, were used for biochemical determinations.

Analyses of data were done with GraphPad Prism version 5 statistical programme and the sensitivity, specificity, odd ratio (OR), and positive predictive value, (PPV) of the predictors were calculated to determine their relative significance as predictors of MS in the study population. Diagnosis was made using the National Cholesterol Education Programme/ Adult Treatment Panel 111, (NCEP/ATP111), criteria[22]. Metabolic syndrome was diagnosed in the presence of any three of the following factors: excess waist circumference, men >102cm, women >88cm; raised fasting triglycerides, 1.70mmol/l; raised blood pressure, ≥85mmHg diastolic and/or ≥130mmHg systolic, low HDL-C, men ≤ 1.0mmol/l, women ≤ 1.3mmol/l, fasting blood glucose ≥ 5.6mmol/l .

RESULTS

Thirty six subjects (9 males, 27 females) had three abnormal factors. Four abnormal factors occurred in 3 female subjects giving a total of 39 subjects that satisfied the criteria for the diagnosis of the MS. These gave the prevalence of MS as 10.6%, 4.3% and 18.5% among all, male and female subjects respectively. One third of the male subjects with the MS had BMI in the lower range,

18.5 – 22.2kg/m^2 and two thirds in the upper range, 22.3 – 24.9 kg/m^2. MS was distributed equally in the lower and upper ranges of BMI (18.5 – 22.2kg/m^2 and 22.3 – 24.9 kg/m^2) among the female subjects. Sixty subjects, 16.3%, [men 33(15.9%); women 27(16.7%)] had 2 abnormal factors while one abnormal factor was recorded among 180 (48.8%), [men 99(47.8%) and women 81(50%)] subjects. Zero abnormal factors were recorded in 90 (24.4%), ([men 66(31.9%), women 24(14.8%)] of subjects. Mean values of factors were age 53.07±13.12years, BMI 22.85±1.7kg/m^2, WC 82.67±7.8cm, SBP 132±18.53mmHg, DBP 79.15±11.68mmHg, FPG 4.23±0.74mmol/l, TG 1.23±0.62mmol/l, HDLC 1.41±0.47mmol/l (Table 1). The FPG of the women 4.4±0.86mmol/l differed significantly from that of the men 4.1±0.62mmol/l ($p = 0.004$), (Table 1). BMI correlated significantly with SBP ($r = 0.177$; $p = 0.003$), TG ($r = 0.3722$; $p < 0.0001$) and WC ($r = 0.5407$; $p < 0.0001$).

Abnormal mean WC values, was recorded in 6 male (>102cm) and 33 female (>88cm) subjects. WC gave a prevalence of 20.4%, sensitivity of 60%, specificity of 97%, OR of 46.9 and PPV of 69%. Forty-two (20.3%) male subjects and 30(18.5%) female subjects had mean TG ≥ 1.7mmol/l. The sensitivity, specificity, OR and PPV of TG were 80%, 90%, 35.7 and 48% respectively. FPG ≥ 5.6mmol/l was recorded among 3(1.4%) male and 21(13%), female subjects. The types of obese individuals, metabolically healthy butsensitivity, specificity, OR and PPV of FPG were 6.5%, 26.7%, 96.1%, 9.0 and 44.4% respectively. Thirty (14.5%), male subjects and 69 (42.6%) female subjects had low HDLC (≤ 1.3mmol/l). HDL-C had sensitivity, specificity, OR and PPV of 40%, 72.8%, 1.8 and 14.6% respectively and a prevalence of 26.8%.

Elevated blood pressure was recorded among 40(19.3%) male and 29(17.9) female subjects. More subjects had raised SBP than raised DBP; males, 117(56.5%) and 63(30.4%), and females 81(50%) and 81(35.2%) respectively. SBP and DBP recorded sensitivity, specificity, OR and PPV of 93.8% and 60%, 56.6% and 72.1%, 19.6 and 3.9, 21.1% and 20% respectively.

DISCUSSIONS

Not only obese, but non-obese individuals may also have metabolism associated disorders. There are two obese (MHO) and metabolically obese but normal weight (MONW) [15, 23,] . MHO persons have insulin resistance but favourable lipid profile and no hypertension while MONW individuals despite having normal weight and BMI may have proinflammatory features[24]. The results of this study showed metabolic syndrome was moderately prevalent and BMI-dependent, in individuals with upper normal BMI, so the concept of the metabolically-obese normal weight (MONW) individual need to be emphasized. Tsai in 2009 reported the presence of the MS in an individual with BMI 18.5kg/m^2.[25]. The results showed the same trends as in St-Onge′s and Wildman′s study [11, 26]. Therefore, weight loss in individuals with BMI <25.0 kg/m^2 should be considered if they also have the metabolic syndrome[14] This is important because in the past, most notions about the metabolic syndrome emphasized the importance of obesity. Current weight-loss recommendations do not advise patients with BMI <25.0 kg/m^2 to lose weight, and it is not recommended for patients with BMI <27.0 kg/m^2 to use pharmaceutical agents as adjuncts to weight-loss regimens.[27]

MONW persons were said to have elevated fat mass (>30%) that produce pro-inflammatory cytokines[25] which are significant prognostic indicators of the MS[28, 29, 30]. These cytokines include TNF-alpha, IL-1alpha, IL-1beta, IL-6 and IL-8. These cytokines are produced in a late phase of inflammation and are necessary for the induction and maintenance of the proinflammatory T helper cell 1 immune response[31, 32]. In this study, more women than men had the syndrome. While the occurrence of the MS in the normal weight men increased with BMI within the normal range, it is distributed evenly over the normal BMI range in the women. More women had the MS than men and this agrees with the report of St-Onge et al 2004[11]. This is because at identical BMI, women will, on the average, have more body fat than men [33]. The results tend to de-emphasize elevated BMI as a marker of the MS and suggest that obesity may be defined in terms other than BMI. The same number, (though may not be the same individuals), of persons, (N = 39), with abnormal WC also had the MS in this study. The prevalence of abnormal WC, 20.4%, is close to the prevalence of MS, 18.5% in the overall study population. In addition the high sensitivity, 60%, specificity, 97%, OR, 46.9 and PPV, 69% of WC may indicate the superiority of elevated WC over elevated BMI as marker of cardiovascular risk. WC has been found to correlate with measures of risk of coronary heart diseases such as hypertension and blood lipids [34]. It is a more accurate measure of visceral fat mass that secret proinflammatory cytokines than BMI, [35]. BMI is a good index of body proportions [36] but may not be a good measure of visceral adiposity which is the principal and may not be very reliable in older adults in whom differential loss of lean mass contribute increasingly to variations in weight. The need to screen persons with BMI in the normal range for MS and the use of WC in place of BMI as a marker of cardiovascular risk is, therefore, underscored.

CONCLUSION

Individuals in the upper normal-BMI range have a relatively high prevalence and are at increased risk of having MS and its components. Therefore, physicians should screen metabolic syndrome in not only obese but also non-obese individuals in the prevention of type 2 diabetes and cardiovascular diseases. factor in the causation of insulin resistance in obesity [37]. BMI does not differentiate between lean and fat mass

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