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Full Length Research Paper

A study of the prevalence of the metabolic syndrome and its predictors among type 2 diabetes mellitus of the University of Nigeria Teaching Hospital, Enugu Nigeria

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The aim of this study is to study the prevalence of the metabolic syndrome (MS) and its predictors among type 2 diabetes mellitus (T2DM) outpatients of the University of Nigeria Teaching Hospital, Enugu Nigeria using the National Cholesterol Education Programme/Adult Treatment Panel 111(NCEP/ATP111) criteria. A total of 366 T2DM patients, (210 men and 156 women), who were registered and receiving treatment for type 2 diabetes mellitus(T2DM) in the hospital, participated in the study. Bio-data measurements and laboratory determinations were done using standard methods. The prevalence of MS among the T2DM patients was 67.8%. More female patients (84.6%) had the syndrome than male patients, (55.2%). The female patients had more unfavourable anthropometric parameters than men. Excess waist circumference was found in 150, (41%) of the patients and was strongly associated with the metabolic syndrome 92%. Low high density lipoprotein cholesterol (HDL-C) concentrations and raised systolic blood pressure occurred less commonly, 39 and 28% respectively, but were nonetheless strongly associated with the syndrome, 89 and 85% respectively. All four predictors, (except hyperglycaemia), were found in 18(5%), of the patients, 2(1.7%) men and 16(12%) women while three of them, excess waist circumference, low HDL-C and raised triglycerides clustered with hyperglcaemia in 90(25.6%) patients; 36(31%) men and 54(41%) women with the syndrome. The prevalence of MS among the T2DM patients was lower than figures reported elsewhere. More women than men had the syndrome due probably to differences in weight. Raised diastolic blood pressure and low HDL-C were strong predictors of the syndrome while raised triglycerides may be used for screening for the syndrome in the study population.

Key words: metabolic syndrome, low HDL-C, diseases, hyperglcaemia**,** 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 (Reaven, 1988; Kaplan, 1989). Insulin resistance and obesity are reported to be the underlying factors of the syndrome (Zimmet, 1995; Ferrannini et al., 1991; Bulhoes and Araujo, 2007). The MS is affecting the general population in epidemic proportions (Haffner and Taegtmeyer, 2005; Reilly and Rader, 2003; Kereiakes and Willerson, 2003). It was estimated that in 2000, 17 million people worldwide

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will have T2DM and that the figure would double between 2000 to 2030 (Misra and Khurana, 2008; Ogbera, 2010). This is due to increasing prevalence of obesity and the metabolic syndrome (Misra and Khurana, 2008). As a non communicable disease, MS is spreading in developing countries faster than it did in developed countries decades ago (Misra and Khurana, 2008). Ogbera reported a prevalence of 86% among T2DM patients in Lagos Nigeria. The researcher did not record any significant sex-dependent difference in the study (Ogbera, 2010). Moshin, Zafari, Imran, Zaheer, Khizar and Qazi in Pakistan reported a prevalence of 85.8% while Olutayo and Olatunde also in Lagos Nigeria reported a prevalence of 25.2% (Moshin et al., 2007; Olutayo and Olatunde, 2004). A similarly low prevalence (20.5%) was reported by Isezuo and Ezunu in Sokoto (Isezuo and Ezunu, 2005) and by Wahab, Sani, Gbadamosa and Yandutse (22%) in Katsina town in northern Nigeria (Wahab et al., 2008). Using the WHO criteria, the former observed a prevalence of 59.1% in the same study population. Oli et al. (2009) working in the same locality as this study reported very high prevalence of insulin resistance, 95.5% among T2DM subjects. Most other prevalence studies in Nigeria were done on apparently healthy individuals including the report by Ulasi et al. (2010) from Enugu.

Though diabetes and prediabetes are factors of the MS, all diabetic subjects do not develop the syndrome. When diabetes is not yet present in MS, risk for progression to T2DM averages 5-fold increase compared with those without the syndrome (Laaksonen et al., 2002). Those with diabetes can further acquire a host of complications, including renal failure, diabetic cardiomyopathy and various neuropathies (Laaksonen et al., 2002; Park et al., 1994; Park et al., 2002). Identification of diabetes subjects with the MS, therefore, has therapeutic and management implications to prevent higher morbidity and mortality. Apart from the report by Oli et al. (2009) from which the prevalence of the MS can indirectly be deduced, there has been no other report on the prevalence of the MS among T2DM subjects in Enugu.

MATERIALS AND METHODS

Three hundred and sixty-six subjects, (366, men 210, women 156), aged above 35 years were randomly recruited from the Diabetes Clinics of the University of Nigeria Teaching Hospital, Ituku/Ozalla in Enugu Southeast, Nigeria. The Ethics Committee of the 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 type 2 diabetes diagnosed in accordance with the WHO criteria (WHO, 1999) and age above 35 years when the syndrome was said to be most prevalent (Lorenzo et al., 2003).

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. A height board mounted at right angle to a calibrated vertical height bar was used. Readings were taken to the nearest 0.5 cm. Body weight in light clothing was measured to the nearest 0.1 kg 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) (World Health Organization Expert Committee on Physical Status, 1995). The blood pressure measurements were taken three times in the left arm with the participants sitting and after 10 min rest using Accusson's mercury sphygmomanometer with appropriate cuff sizes.

Fasting blood samples, (5 ml), were collected from patients between 8 am and 11 am each day using standard methods (Dacie and Lewis, 1975). One milliliter of blood sample was put into heparinized tube and spun at 3000 revolutions per minute for 5 min 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 (1969), serum triglycerides by the method of Buccolo and David (1973). High density lipoprotein cholesterol was estimated in the serum supernatant after precipitating β-apoprotein containing lipoproteins using the method of Allain et al. (1974). 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 2 statistical programme. Diagnosis of metabolic syndrome was made using the National Cholesterol Education Programme/ Adult Treatment Panel 111, (NCEP/ATP111), criteria (National Cholesterol Education Programme (NCEP), 2002). Metabolic syndrome was diagnosed in the presence of any three of the following factors: excess waist circumference, men >102 cm, women 88 cm; raised fasting triglycerides, ≥1.70 mmol/l; raised blood pressure, >85 mmHg diastolic and/or >140 mmHg systolic, low HDL-C, men ≤ 1.0 mmol/l, women ≤ 1.3 mmol/l. Since they all were diabetic, presence of any two or more of the factors was diagnostic of metabolic syndrome.

RESULTS

A total of 248 diabetic patients satisfied the criteria for the diagnosis of the metabolic syndrome giving a prevalence of 67.8%. This was made up of 116 men and 132 women giving prevalence of 55.2 and 84.6% among men and

Table 1. Clinical characteristics of diabetic patients.

Parameter	All patients (N = 366)	Male patients (n = 210)	Female patients (n = 156)	p-value (male v female)
Fasting Plasma Glucose (FPG)	10.3 ± 5.7	9.9 ± 5.3	11.1 ± 6.1	<0.05
Fasting Plasma riglycerides (FTG)	1.8± 0.4	1.8 ± 0.4	1.9± 0.5	<0.05
High Density Lipoprotein Cholesterol (HDL-C)	1.3± 0.4	1.3 ± 0.4	1.3 ± 0.4	>0.05
Diastolic Blood Pressure (DBP)	86± 13	86 ± 14	87 ± 14	>0.05
Systolic Blood Pressure (SBP)	148 ± 25	153 ± 28	142 ± 28	<0.05
Waist Circumference (WC)	93.4± 13.1	92.5 ± 11	94.7 ± 15.4	>0.05

Table 2. Diabetic patients, (men and women) with hypertension, raised serum triglycerides, low high density lipoprotein cholesterol and excess waist circumference.

Variable	DBP	SBP	FTG	HDL-C	WC
Number of Subjects.	334	334	324	336	362
Abnormal Results.	94	194	232	132	150
% of Total	28	58	66	39	41
Abnormal with MS	80	154	198	116	138
% of abnormal results	85	79	85	89	92

DBP = Raised diastolic blood pressure, >90 mmHg. SBP = Raised systolic blood pressure, >140 mmHg. FTG = Raised fasting triglycerides; ≥ 1.7 mmol/l. HDL-C = low high density lipoprotein cholesterol; men ≤1.0 mmol/l; women ≤ 1.3 mmol/l. WC = Excess waist circumference; men > 102 cm; women >88 cm.

Table 3. Male diabetic patients with hypertension, raised serum triglycerides, low high density lipoprotein cholesterol and excess waist circumference.

Variable	DBP	SBP	FTG	HDL-C	WC
Number of Subjects.	192	192	206	188	208
Abnormal Results.	62	126	126	58	48
% of Total	32	66	61	31	23
Abnormal with MS	48	90	94	52	40
% of abnormal results	77	71	75	90	83

DBP = Raised diastolic blood pressure, >90 mmHg. SBP = Raised systolic blood pressure, >140 mmHg. FTG = Raised fasting triglycerides; ≥ 1.7 mmol/l. HDL-C = low high density lipoprotein cholesterol; men ≤1.0 mmol/l; WC = Excess waist circumference; men > 102 cm.

women respectively.

The T2DM patients had meant fasting blood glucose (FPG) that reflected their diabetic state (10.3 ± 5.7 mmol/l), adequate HDL-C (1.3 ± 0.4 mmol/l) but raised fasting triglycerides (FTG, 1.8 ± 0.4 mmol/l). A moderate number of the patients had abnormal levels of predictors of the metabolic syndrome and most of these abnormal results were found in patients with the syndrome, SBP (148 ± 25 mmHg), DBP (86 ± 13 mmHg) and WC (93.4 ± 13.1 cm) (Tables 2, 3 and 4).The male and the female subjects had statistically similar HDL-C, DBP, and WC values ($p > 0.05$), while the female patients had higher FPG, FTG, and less SBP than the men ($p < 0.05$) (Table 1). A moderate number of the patients had abnormal levels of predictors of the syndrome and most of these abnormal results were found in patients with the syndrome (Tables 2, 3 and 4). Raised FTG occurred most (66%) followed by raised SBP (58%) in the general patients population (Table 2) Among the male T2DM patients, raised SBP occurred most of the time (66%) followed by raised FTG (61%) (Table 3) Among the female T2DM patients, raised FTG occurred most (73%) followed by raised WC, 66% (Table 4). A few of the female patients, 23%, had raised DPB and all of them also had the MS (Table 4). The mean FTG (1.8 ± 0.4 mmol/l) and SBP (148 ± 25 mmHg) were raised beyond the reference limits, 1.7 mmol/L and 140 mmHg respectively.

More men than women had raised DBP and SBP. However, among the women the number of these

Table 4. Female diabetic patients with hypertension, raised serum triglycerides, low high density lipoprotein cholesterol and excess waist circumference.

Variable	DBP	SBP	FTG	HDL-C	WC
Number of Subjects.	142	142	146	148	154
Abnormal Results.	32	68	106	74	102
% of Total	23	48	73	50	66
Abnormal with MS	32	64	104	64	98
% of abnormal results	100	94	93	90	96

DBP = Raised diastolic blood pressure, >90 mmHg. SBP = Raised systolic blood pressure, >140 mmHg. FTG = Raised fasting triglycerides; ≥ 1.7 mmol/l. HDL-C = low high density lipoprotein cholesterol; women ≤ 1.3 mmol/l. WC = Excess waist circumference; women >88 cm.

abnormal results associated with the syndrome was higher, (Tables 3 and 4). Raised serum triglycerides, low HDL-C and excess WC occurred more among the women than men. These abnormal results were equally found more in the female than male MS patients (Tables 3 and 4).

There were no significant differences between the mean DBP, HDL-C and WC of the male and female patients, ($p > 0.05$; Table 1). All four predictors, (except hyperglycaemia), were found in 18(5%), of the patients, 2(1.7%) men and 16(12%) women, with the syndrome while three of them, excess waist circumference, low HDL-C and raised triglycerides clustered with hyperglycaemia in 90(25.6%) patients; 36(31%) men and 54(41%) women with the syndrome.

DISCUSSION

More than half of the diabetic patients, (67.8%), had the metabolic syndrome. This is lower than the figures reported by Ogbera, (86%) in Lagos [11] and Moshin Zafari, Imran, Zaheer, Khizar and Qazi (85.8%) in Pakistan (Moshin et al., 2007). In other studies, Ogbera and Azenabor reported a prevalence of 60% while Adeniran, Edo, Jimoh and Ohwovoriole reported a prevalence of 51% for the same class of patients in the same locality (Ogbera and Azenabor, 2010; Adediran et al., 2007). The latter workers, however, used the World Health Organization criteria while the former used the new International Diabetes Federation (IDF) criteria (Albert et al., 2005). The reported prevalence of insulin resistance, (95.5%) by Oli (2009) among the study population indicates a possible high prevalence rate of MS in the population.

The prevalence of 67.8% is, however much higher than the figures reported by Isezuo and Ezunu in Sokoto (20.5%) (Isezuo and Ezunu, 2005)˙ and Wahab Sani, Gbadamosa and Yandutse in Katsina town Nigeria, (22%) (Wahab et al., 2008). It is estimated that a large majority of patients with T2DM or impaired glucose tolerance have the MS (Isezuo and Ezunu, 2005). MS is the consequence of transition from a native dietary habit to a foreign one and is associated with urbanization (Ben-Bassey et al., 2007). The risk factors, especially obesity and sedentary lifestyle, are more common in urban than in rural areas (Misra and Khurana, 2008; Ulasi et al., 2010). The prevalence of MS is therefore expected to parallel the degree of urbanization of a locality. This may also explain the differences in reported prevalence rates of MS in Nigeria which is one of the countries with increasing urbanization status (Food and Agriculture Organization, 2004). Prevalence rates reported for Lagos Nigeria (86%) is similar to that of US by Alexander et al. (2003). The latter workers reported a prevalence of 86% in US diabetic population above the age of 50 years and 26% among subjects with impaired glucose tolerance. Prevalence rate of 59.6% has been reported among overweight and obese populations respectively (Laaksonen et al., 2002). Obesity and overweight are conditions associated with glucose intolerance (Park et al., 2002; Ford et al., 2002). The prevalence reported for the US diabetic population may have been worsened by excess body weight over the result of this study.

Less number of patients had raised DBP than raised SBP yet a larger percentage of the former had the metabolic syndrome than the latter implying that DBP may be a stronger predictor of the syndrome than SBP in the study population. The strongest predicators of the syndrome in the study population were excess WC followed by low HDL-C since 92% and 89% respectively of abnormal results predicted the syndrome (Table 1). This agrees with earlier reports (Ogbera, 2010; Moshin et al., 2007).

Low HDL-C was associated with the syndrome among the men more than excess waist circumference. All the four factors, raised triglycerides, raised blood pressure, low HDL-C and excess WC, may be equally significant in predicting the syndrome in the diabetic patients. However, more patients had hypertriglyceridaemia than any other factor. If a factor occurred in a large number of the patients as well as in a large number of those with the syndrome, such a factor may be a good parameter for screening in the population. Its absence in any individual indicates a high probability of the absence of the syndrome in the individual. In this study, raised triglycerides,

low HDL-C and excess waist circumference satisfy this condition in the female patients while raised systolic blood pressure and triglycerides are good for screening among the male patients. In the general patient population, therefore, raised serum triglycerides is a common screening factor of the MS.

The higher prevalence of the metabolic syndrome among the female patients may be due to excess weight. Some authors regard overweight and insulin resistance as the underlying factors of the metabolic syndrome while some label overweight an exacerbating factor (Grundy et al., 2005). Both positions may be correct. If metabolic derangement was caused by insulin resistance overweight will be an exacerbating factor. Overweight is often associated with insulin resistance (Ashok, 2004). Whichever position applies, therefore, the syndrome will be more prevalent in the presence than in the absence of overweight. More women, (66%) than men, (23%), were overweight/obese and had the metabolic syndrome also, 84.6 and 55.2% respectively.

On the other hand some of the predictors seem to be more predictive of the syndrome than others. Such factors may not be seen in a large number of the patients but their presence is invariably associated with the syndrome. Their presence indicates such a high probability of the presence of the metabolic syndrome as to be diagnostic. In this study, all 32 female patients with raised diastolic blood pressure also had the metabolic syndrome and 52 out the 58, (90%), male patients with low HDL-C also had the syndrome. Therefore raised DBP and low HDL-C may be diagnostic of the MS in the female and male subjects respectively.

Conclusion

The prevalence of metabolic syndrome among the diabetic patients was high though lower than figures reported elsewhere. More women than men had the syndrome due probably to differences in weight. Raised diastolic blood pressure and low HDL-C are strong predictors of the syndrome while raised triglycerides may be used for screening for the syndrome in the study population. A reversion to native dietary practices and regular exercise are recommended as means of stemming the rise in the prevalence of MS in the population and avoiding unpleasant consequences of the MS.

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