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# INCIDENCE AND MAJOR METABOLIC RISK FACTORS OF METABOLIC SYNDROME IN TYPE 2 DIABETIC OUT-PATIENTS VISITING TAMALE TEACHING HOSPITAL IN GHANA

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**Abstract**

The study involved 300 (92 males and 208 females) type 2 diabetic patients and was conducted at the Tamale Teaching/Regional Hospital from June 2006 to May 2007. Metabolic syndrome was diagnosed using the National Cholesterol Education Programme, Adult Treatment Panel III (2001) criteria. The incidence of the metabolic syndrome was 60.3 per cent in the 300 type 2 diabetic out-patients, 11.0 per cent of whom were males and 49.3 per cent females. The incidence of central obesity and hypertension was 69.6 per cent, low HDL cholesterol 58.6 per cent and hypertriglyceridaemia 56.4 per cent in the patients. The metabolic syndrome is a common finding in type 2 diabetic out-patients visiting Tamale Teaching Hospital in Ghana, especially female type 2 diabetic out-patients. Central obesity and hypertension, the major metabolic risk factors of the metabolic syndrome, should be selectively targeted for treatment and prevention of the metabolic syndrome, and, hence. for prevention of cardiovascular disease in type 2 diabetic out-patients visiting Tamale Teaching Hospital in Ghana.

## Introduction

Metabolic syndrome has been described as a "clustering" of several risk factors for cardiovascular disease (CVD) and type 2 diabetes, namely central (abdominal) obesity, insulin resistance, hyperglycaemia, dyslipidaemia and hypertension (Reaven, 1988; Zimmet, 1992). Several other abnormalities, including microalbuminuria, hyperuricaemia, endothelial dysfunction, abnormalities in fibrinolysis and coagulation, non-alcoholic fatty liver and elevated levels of chronic inflammation had been linked to the metabolic syndrome (Yudkin, 1999; Steinberg *et al.*, 1996; Groop *et al.*, 1993; Laaksonen *et al.*, 2004). Cardiovascular disease is the leading cause of death in type 2 diabetes (De Marco *et al.*, 1999). The total cardiovascular risk attributable to the syndrome exceeds the sum of the risk from each of the separate components (Bonora *et al.*, 2003).

The World Health Organization (WHO) (1999) has stated a working definition for diabetes. WHO and the National Cholesterol Education Programme (NCEP) Adult Treatment Panel III (ATPIII) have also produced working definitions for the metabolic syndrome (WHO, 1999; NCEP ATPIII, 2001). Since then, a great deal of research has been undertaken to define the epidemiology of the metabolic syndrome. In many countries, the prevalence of the metabolic syndrome appears to be increasing (Alexander, 2003). Prevalence varies markedly by race or ethnicity and the environment (Alexander, 2003). To date, no studies have examined the incidence of the major metabolic risk factors of the metabolic syndrome in the Northern Region of Ghana. Therefore, the objectives of the study were to determine the incidence of the major metabolic risk factors of the metabolic syndrome in type 2 diabetic out-patients visiting Tamale Teaching Hospital in Ghana.

## Experimental

The study was carried out at the Clinical Biochemistry Laboratory of the Tamale Teaching Hospital, the main referral tertiary health facility in the Northern Region, from June 2006 to May 2007. The ethical approval of study protocols was obtained from the Hospital. All participants gave their informed consent to participate in the research. Type 2 diabetic patients with disease duration of 1 year or more, who were on diet and oral hypoglycaemic drugs, were selected. The sample size was 300, made up of 92 (30.7%) males and 208 (69.3%) females. A standardized questionnaire and patient medical history folders were used to collect information on demographic and clinical characteristics such as age, sex, ethnicity (tribe) duration of diabetes, family history of diabetes, hypertension, other physician-diagnosed diseases, stress and medication profile of diabetes and hypertension.

Height and weight of patients were measured and the body mass index (BMI) was calculated as weight in kg divided by height in $m^2$ ($kg/m^2$). Waist circumference was measured to the nearest 0.1 cm. with a plastic anthropometric tape on bare skin of patient while standing, during midrespiration at the narrowest indentation midway between the lowest rib and the iliac crest and at the level of the umbilicus (Isomaa *et al.*, 2001; Oh *et al.*, 2004; Katzmarzyk *et al.*, 2005). Duplicate measurements were made and averages were used in the analysis.

Blood pressure was measured twice for each patient with 5 min intervals in the sitting position after 30 min of rest and the mean recorded. Venous blood samples of patients were taken at (25 °C) after a 12-14-h overnight fast. Venous blood was collected into fluoride-oxalate bottles and vacutainer tubes without anticoagulant. The blood samples in the fluoride bottles were immediately centrifuged at 1,000 g for 5 min and analyzed for fasting glucose levels. The samples in the vacutainer tubes were also centrifuged after 30 min at 1,000 g for 15 min at (25 °C). Serum was separated into plain sample containers and frozen at −20 °C for 1 - 2 weeks and analyzed for cholesterol, triglycerides and high density lipoproteins (HDL) cholesterol. Fasting glucose, triglycerides and HDL cholesterol were measured by enzymatic methods using the procedures of ATAC PAK® glucose reagent kits (product No. 532-018), ATAC PAK® triglyceride reagent kits (product No. 589-018), ATAC PAK® HDL cholesterol reagent kits (product No. 541-004) and ATAC 8000 Random Access Chemistry System (autoanalyzer Elan diagnostics, A4-001-1198).

The reagents and autoanalyzer were obtained from 2 Thurber Boulevard, Smithfield, Rhode Island 02917, USA, through Talor and Talor Inc., Accra. The procedures are described by the manufacturer in a manual for glucose (ATAC 8000, 1999) and a combined manual for triglycerides and HDL cholesterol (ATAC 8000, 1998).

Metabolic syndrome was diagnosed using the NCEP A TP III (2001) criteria. By this criteria a person has the metabolic syndrome if he or she has three or more of the following factors: waist circumference in males > 102 cm and in females > 88 cm, triglycerides $\geq$ 1.70 mmol $l^{-1}$, HDL cholesterol in males < 1.00 mmol $l^{-1}$ and in females < 1.30 mmol $l^{-1}$, blood pressure $\geq$ 130/85 mm Hg or on antihypertensive medication and fasting glucose $\geq$ 6.1 mmol $l^{-1}$. All patients in the study were coded as positive for hyperglycaemia (i.e. glucose $\geq$ 6.1 mmol $l^{-1}$).

The NCEP ATPIII for the metabolic syndrome was used in the study because it relies on variables that are easily ascertainable by physicians and, thus, is convenient operationally (Domanski & Proscham, 2004). Data were analysed using the statistical package for social sciences (SPSS) for windows programme version 11.0.

## Results

The mean age of the patients was 57.8 ± 11.3 years (range: 21– 90 years). The mean duration of diabetes was 6.0 ± 5.0 years (range: 1–30 years).

Body mass index (BMI) mean value was 25.3 ± 4.6 kg $m^{-2}$ (range: 18.7– 42.0 kg $m^{-2}$). The metabolic syndrome was present in 181 (60.3%) patients, made up of 33 (11.0%) males and 148 (49.3%) females.

TABLE 1
*Distribution of components of the metabolic syndrome in type 2 diabetics suffering from metabolic syndrome*

| *Metabolic syndrome components* | *Diabetic patients with metabolic syndrome (N=181)* | | *Males (N=33)* | | *Females (N =148)* | |
|---|---|---|---|---|---|---|
| | No | % | No | % | No | % |
| Central obesity | 126 | 69.6 | 12 | 6.6 | 114 | 63.1 |
| Hypertriglyceridaemia | 102 | 56.4 | 26 | 14.4 | 76 | 42.0 |
| Low HDL cholesterol | 106 | 58.6 | 18 | 10.0 | 88 | 48.6 |
| Blood pressure ≥ 130/85mmHg and, or on medication | 126 | 69.6 | 23 | 12.2 | 103 | 56.9 |

TABLE 2
*Distribution of major combinations of components of the metabolic syndrome in type 2 diabetics suffering from metabolic syndrome*

| *Frequent combinations of metabolic syndrome factors* | *Diabetic patients with metabolic syndrome(N=181)* | | *Males (N = 33)* | | *Females (N=148)* | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| Hyperglycaemia, central obesity and hypertension | 88 | 48.6 | 10 | 5.5 | 78 | 43.1 |
| Hyperglycaemia, central obesity and low HDL cholesterol | 65 | 35.9 | 2 | 1.1 | 63 | 34.8 |
| Hyperglycaemia, hypertension and low HDL cholesterol | 60 | 33.1 | 12 | 6.6 | 48 | 26.5 |
| Hyperglycaemia, central obesity and hypertriglyceridaemia | 63 | 34.8 | 9 | 5.0 | 54 | 29.8 |
| Hyperglycaemia, hypertension and hypertriglyceridaemia | 63 | 34.8 | 16 | 8.8 | 47 | 26.0 |
| Hyperglycaemia, low HDL cholesterol and hypertriglyceridaemia | 56 | 30.9 | 14 | 7.7 | 42 | 23.2 |

Central obesity was observed in 126 (69.6%) of the 181 metabolic syndrome patients, made up of 12 (6.6%) males patients and 114 (63.0%) females (Table 1). Hypertriglyceridaemia was present in 102 (56.4%) of the metabolic syndrome patients, comprising 26 (14.4%) males patients and 76 (42.0%) females. Among the same group of patients, 106 (58.6%) had low HDL cholesterol. Eighteen (10.0%) of the male patients and 88 (48.6%) of the female patients had low HDL cholesterol. One hundred and twenty six (69.6%) of the metabolic syndrome patients were hypertensive, made up of 23 (12.7%) males and 103 (56.9%) females.

Among type 2 diabetics with the metabolic syndrome, the most frequent combination of different components was hyperglycaemia, central obesity and hypertension, which were found in 88 (48.6%) of the patients (Table 2). This was followed by the combination of hyperglycaemia, central obesity and low HDL cholesterol which were found in 65 (35.9%) of the patients. Among the diabetic patients with metabolic syndrome, 63 patients had hyperglycaemia, central obesity and hypertriglyceridaemia. The same number (63) had hyperglycaemia, hypertension and hypertriglycaeridaemia. Next in the order of magnitude was hyperglycaemia, hypertension, and low HDL cholesterol 60 (33.1%), and lastly, hyperglycaemia, low HDL cholesterol and hypertriglyceridaemia with 56 (30.9%) patients.

The corresponding values in males, and females as detailed out in Table 2, shows that in males hyperglycaemia, hypertension and hypertriglyceridaemia were the most frequent combination with 16 (8.8%) patients. In females, hyperglycaemia, central obesity and hypertension were the most frequent combination with 78 (43.1%) patients.

## Discussion

Metabolic syndrome has been used to predict cardiovascular and coronary heart disease mortality in two Finnish studies (Isomaa *et al*., 2001; Lakka *et al.,* 2002). The NCEP ATP III proposal, but not the WHO criteria, more clearly identifies the burden of coronary heart or cerebrovascular disease associated with the metabolic syndrome, and it is associated with a 38.0 per cent increased risk (Marchesini *et al.*, 2004; Scuteri *et al.,* 2005).

In the study, type 2 diabetic patients were selected until the sample size was achieved. There were more ( twice as many) female type 2 diabetics than males in the study population. Similarly, the incidence of the metabolic syndrome in female diabetics was twice as many as that in male diabetics. The overall incidence (60.3%) of the metabolic syndrome among type 2 diabetic patients visiting Tamale Teaching Hospital in the Northern Region of Ghana was slightly lower than a prevalence value of 78.0 per cent obtained for Caucasian type 2 diabetic patients from Bologna, Italy (Marchesini *et al.,* 2004). Immediately after detection, aggressive treatment of metabolic syndrome is important because, in type 2 diabetics, the syndrome is associated with cardiovascular disease and premature death (Isomaa *et al.,* 2001; Lakka *et al.,* 2002).

Apart from hyperglycaemia (which was common to all patients), central obesity (69.6%) and hypertension (69.6%) were the major metabolic risk factors of the metabolic syndrome in the study population. This confirm reports that moderate weight loss improves cardiovascular risk profiles in obese patients with type 2 diabetes (Goldstein, 1992). Additionally, it also explains why randomized clinical trials demonstrated reduction of cardiovascular events by lowering blood pressure to < 130/80 mmHg in individuals with diabetes (Chobanian *et al.,* 2003). In females, central obesity was the major metabolic risk factor of the metabolic syndrome, followed by hypertension. In males hypertriglyceridaemia was the major metabolic risk factor, followed by hypertension. Palaniappan *et al.* (2004) found central obesity to be the dominant predictor

followed by low HDL cholesterol, in non-diabetic adults by the NCEP ATPIII criteria.

The major metabolic risk factors of the metabolic syndrome found in the study further revealed that hyperglycaemia, central obesity and hypertension were the most frequent combination of different components among the overall type 2 diabetics with the metabolic syndrome. This combination was also true for female type 2 diabetics with the metabolic syndrome (Table 2). However, in male diabetics with the metabolic syndrome, hyperglycaemia, hypertension and hypertriglyceridaemia were the most frequent combination of different components. This shows the influence of hypertriglyceridaemia as the major metabolic risk factor or component among male diabetics with the metabolic syndrome.

## Conclusion

Metabolic syndrome was frequent among type 2 diabetic patients visiting Tamale Teaching Hospital in the Northern Region of Ghana. The incidence in females was higher than that in males. The major metabolic risk factors were central obesity and hypertension. In females, central obesity was the major metabolic risk factor of the metabolic syndrome, followed by hypertension. In males, hypertriglyceridaemia was the major metabolic risk factor, followed by hypertension.

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