

Full Length Research Paper

Lipid profile of type 2 diabetic patients at a rural tertiary hospital in Nigeria

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Diabetic dyslipidaemia is characterized by raised triglycerides, low high-density lipoprotein, raised apo-B, and small dense low density lipoprotein particles. Because detection and treatment of dyslipidemia is one means of reducing cardiovascular disease (CVD) risk, determination of serum lipid levels in people with diabetes is now considered a standard of care. Lipid profile and fasting blood sugar (FBS) of 113 diabetic subjects were assessed. Dyslipidaemia was defined using the national cholesterol education programme – adult treatment panel III (NCEP-ATP III) criteria. BMI and waist and hip circumferences were measured. The mean total cholesterol (4.07 ± 1.3 vs 4.8 ± 0.8 , $p = 0.001$), high density lipoprotein C (HDL-C) (1.26 ± 0.4 vs 1.45 ± 0.35 , $p = 0.047$), low density lipoprotein C (LDL-C) (2.38 ± 1.1 vs 2.93 ± 0.71 , $p = 0.005$) were higher among the female subjects, while triglyceride was higher among the male subjects (1.23 ± 1.1 vs 0.82 ± 0.6 , $p = 0.068$). Fifty-seven diabetic patients had at least one lipid value or the other outside of the clinical target giving it a prevalence of 50.4%. The most frequent lipid combination was total cholesterol (TC) +HDL-C. Among the male subjects, there was significant correlation between the Waist Circumference (WC) and TC ($r = 0.560$); WC and LDL-C ($r = 0.612$); WC and triglyceride (TG) ($r = -0.386$); Hip Circumference (HC) and TC ($r = 0.595$); HC and LDL-C ($r = 0.606$); BMI and TC ($r = 0.641$); BMI and LDL-C ($r = 0.653$) and BMI and TG ($r = -0.393$). It is important to realise that hyperlipidaemia and the resultant macro vascular disease can develop even in the 'prediabetic phase' of type 2 DM. Hence, early detection and correction of dyslipidaemic state is essential in the management of diabetic patients.

Key words: Lipid, profile, diabetes, cholesterol, anthropometric indices.

INTRODUCTION

Dyslipidaemia is a well recognised and modifiable risk factor for cardiovascular diseases which is currently a leading cause of morbidity and mortality world-wide (Yach et al., 2004). Diabetic dyslipidaemia is characterized by raised triglycerides, low high-density

lipoprotein, raised apo-B, and small dense low density lipoprotein particles. It may be present at the diagnosis of type 2DM and it is a component of the metabolic syndrome. The pathogenesis of heart disease in diabetes is complex, but serum lipids are frequently abnormal and likely contribute to the risk of coronary artery disease (Barrett-Connor et al., 1982; Sowers and Lester, 1999; Laasko, 1996; Miller, 1999). Because detection and treatment of dyslipidemia is one means of reducing CVD risk, determination of serum lipid levels in people with

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diabetes is now considered a standard of care (National Cholesterol Education Program, 1993; American Diabetes Association, 1999). Race and sex differences in patterns of serum lipids have been noted in diabetes (Summerson et al., 1992; Werk et al., 1993). African-Americans with type 2 diabetes reportedly have lower Triglyceride (TG) and high density lipoprotein (HDL) cholesterol concentrations than Caucasians, and women with diabetes have Low Density Lipoprotein (LDL) and HDL cholesterol concentrations than their male counterparts (Summerson et al., 1992; Werk et al., 1993).

Developing nations are currently witnessing rapid urbanisation, industrialisation as well as increased economic capabilities; which has the propensity of leading to abnormal weight gain and development of various complications of obesity and diabetes. Obesity has been linked with lipid abnormalities in Africans (Njeleka et al., 2002). In Nigeria, hypertension and diabetes mellitus are noted to occur in 10 - 15% and 2 - 4% of the population respectively (Akinkugbe, 2000). Diabetes and hypertension however, are known to coexist though they are independent risk factors for dyslipidaemia. Typical diabetic dyslipidaemia was reported by Ko et al. 2001 in China, while other patterns have been reported in Kuwait and Nairobi (Al-Adsani et al., 2004; Otieno et al., 2005).

Diabetes is associated with a greater risk of morbidity and mortality from cardiovascular disease (CVD), and heart disease is the leading cause of death among people with diabetes (American Diabetes Association, 1996). Therefore, efforts to reduce the risk of heart disease through evaluation of risk factors and the introduction of preventive and therapeutic measures into a treatment program must be a primary focus when caring for the diabetic patients. In this study, we look at the lipid profile of Type 2 diabetic Nigerians attending the investigative department of a rural tertiary hospital.

MATERIALS AND METHODS

This cross-sectional study was carried out at the investigative department of chemical pathology Federal Medical Centre, Ido-Ekiti, Ekiti State in the western region of Nigeria. The centre is a tertiary health institution provided by the government of the country to serve as a referral centre. Ido-Ekiti is a rural town with the majority of the inhabitant and surrounding towns being farmers and traders. After adequate education on the purpose of the study, a total of 113 diabetic subjects who gave their consent and are not on insulin were recruited. Patients who were on lipid lowering medications were also excluded. All this subjects had been attending the diabetic clinic of the Centre. The ethical committee of Federal Medical Centre gave approval for the study. After an overnight fast, blood samples were collected for lipid profile (which includes Total Cholesterol (TC), high density lipoprotein C (HDL-C), low density lipoprotein C (LDL-C) and triglyceride) and Fasting Blood Sugar (FBS) assessment. The total cholesterol was determined using the enzymatic method (Allain et al., 1974), HDL-C was determined using the precipitation method (Grove, 1979) and triglyceride was determined using the enzymatic method (Esders and Michira, 1997). LDL-C was determined from the Friedwald's formula: $LDL-C = TC - HDL-C - (TG/5)$ (Friedwald et al., 1972). The

plasma sugar was determined using the glucose oxidase enzymatic method (Trinder, 1969). Dyslipidaemia was defined using the National Cholesterol Education Programme – Adult Treatment Panel III (NCEP-ATP III) (National Cholesterol Education Program, 2001) criteria as follows: Total Cholesterol > 5.2 mmol/l, LDL-C > 3.4 mmol/l, HDL-C < 1.03 mmol/l for males, < 1.3 mmol/l for females and Triglyceride > 2.3 mmol/l

Blood pressure was measured on left arm by auscultatory method using mercury sphygmomanometer. The individuals were made comfortable and seated at least for five minutes on the chair before measurement. Hypertension was defined as systolic blood pressure (sbp) > 140 mmhg and/or diastolic blood pressure (DBP) > 90 mmHg as per US seventh joint national committee on detection, evaluation and treatment of hypertension (JNC VII) criteria (Chobanian et al., 2003).

Body weight was measured (to the nearest 0.1 kg) with the subject standing motionless on the bathroom weighing scale (Jelliffe and Jelliffe, 1989).

Each weighing scale was standardized every day with a weight of 50 kg. Height was measured (to the nearest 0.1 cm with the subject standing in an erect position against a vertical scale of portable stadiometer and with the head positioned so that the top of the external auditory meatus was in level with the inferior margin of the bony orbit. BMI was calculated as weight in kilograms divided by squared height in meter. Conventional BMI cut off points were applied to classify the study populations into underweight (BMI < 18.5 kg/m²), normal BMI (18.5 ≤ BMI < 25 kg/m²) and overweight (BMI ≥ 25 kg/m²).

Waist and hip circumferences were measured twice to the nearest centimeter and the mean was used for subsequent analysis. Waist circumference (WC) was measured half way between the xiphisternum and the umbilicus while Hip Circumference (HC) was measured at the level of the greater trochanters. The waist hip ratio (WHR) and the waist to height ratio (WHtR) were then computed for each patient. Elevated WC was defined as WC = 102 cm for men and 88 cm for women (Lean et al., 1995), while elevated WHR was defined as WHR = 0.95 for men and 0.88 for women (US Department of Agriculture Report, 1990).

The statistical software SPSS (version 15) was use for data analysis. The mean values of WC, HC, BMI, WHR, WHtR and BP was determined. The Mann-Whitney U Test was use to compare between the variables. Statistical significance was taken as $p < 0.05$. Correlations between the variables were examined using the Spearman Rho correlation coefficients. Multivariate regression analysis was use to investigate the correlations between the lipid variables and gender.

RESULTS

The clinical and biochemical characteristics of the subjects in this study are shown in Table 1. Of the 113 diabetics studied 70 were female while 43 were male giving a male to female ratio of 1:1.6. The mean age, duration of DM and BMI were similar in both sexes. The waist circumference, hip circumference and waist to height ratio were significantly higher among the female diabetics. The mean TC (4.07 ± 1.3 vs 4.8 ± 0.8 , $p = 0.001$), HDL-C (1.26 ± 0.4 vs 1.45 ± 0.35 , $p = 0.047$), LDL-C (2.38 ± 1.1 vs 2.93 ± 0.71 , $p = 0.005$) were significantly higher among the female subjects, while triglyceride was higher among the male subjects but was not statistically different from the female (1.23 ± 1.1 vs 0.82 ± 0.6 , $p = 0.068$). There was no statistical difference

Table 1. Clinical and biochemical characteristics of the subjects.

| Characteristics | Men (Mean ± SD) | Women (Mean ± SD) | P-value |
|--------------------------------------|-----------------|-------------------|---------|
| Number of subjects | 43 | 70 | |
| Age (years) | 62.1 ± 12.2 | 60 ± 11.5 | 0.36 |
| Duration of DM (years) | 3.71 ± 2.3 | 3.92 ± 3.6 | 0.73 |
| Body mass index (kg/m ²) | 26 ± 6.1 | 27.32 ± 5.7 | 0.25 |
| Waist circumference (cm) | 94.3 ± 13.1 | 101.5 ± 13.1 | 0.005 |
| Hip circumference (cm) | 99.3 ± 13.5 | 106 ± 13.7 | 0.003 |
| Waist hip ratio | 0.95 ± 0.005 | 0.95 ± 0.005 | 0.8 |
| Waist height ratio | 0.569 ± 0.01 | 0.644 ± 0.01 | 0.0001 |
| Total cholesterol (mmol/l) | 4.07 ± 1.3 | 4.8 ± 0.8 | 0.001 |
| LDL-C (mmol/l) | 2.38 ± 1.1 | 2.93 ± 0.71 | 0.005 |
| HDL-C (mmol/l) | 1.26 ± 0.4 | 1.45 ± 0.35 | 0.047 |
| TG (mmol/l) | 1.23 ± 1.1 | 0.82 ± 0.6 | 0.068 |
| FBS (mmol/l) | 7.94 ± 3.5 | 8.23 ± 3.5 | 0.707 |

Table 2. Distribution of lipid profile among dyslipidaemic type 2DM.

| | Male | | Female | | Combined | |
|--------------|-----------|------|-----------|------|-----------|------|
| | Frequency | % | Frequency | % | Frequency | % |
| TC+↓HDL+LDLC | 2 | 10.5 | 2 | 5.3 | 4 | 7 |
| TC+LDLC | 6 | 31.6 | 12 | 31.6 | 18 | 31.6 |
| TC+↓HDL | 0 | 0 | 0 | 0 | 0 | 0 |
| LDLC+↓HDL | 2 | 10.5 | 2 | 5.3 | 4 | 7 |
| TG+↓HDL | 2 | 10.5 | 0 | 0 | 2 | 3.5 |
| TG only | 2 | 10.5 | 4 | 10.5 | 6 | 10.5 |
| ↓HDL only | 4 | 21.1 | 12 | 31.6 | 16 | 28.1 |
| LDLC only | 0 | 0 | 0 | 0 | 0 | 0 |
| TC only | 1 | 5.3 | 6 | 15.7 | 7 | 12.3 |
| Total | 19 | 100 | 38 | 100 | 57 | 100 |

Table 3. Spearman's correlations between lipid profile and anthropometric indices.

| | TCHOL | | HDL-C | | LDL-C | | TG | |
|------|--------|---------|--------|--------|--------|---------|----------|----------|
| | Female | Male | Female | Male | Female | Male | Female | Male |
| WC | 0.099 | 0.495** | 0.037 | 0.157 | 0.126 | 0.562** | -0.174 | -0.584** |
| HC | -0.041 | 0.567** | -0.063 | 0.340 | 0.097 | 0.633** | -0.391** | -0.656** |
| BMI | -0.079 | 0.624** | 0.052 | 0.034 | -0.045 | 0.722** | -0.168 | -0.470** |
| WHR | 0.200 | 0.101 | 0.074 | -0.159 | 0.123 | 0.058 | 0.280* | 0.272 |
| WHtR | 0.050 | 0.409** | 0.056 | -0.014 | 0.048 | 0.490** | -0.127 | -0.485** |

*Correlation significant at P = 0.05, **Correlation significant at P = 0.01.

in the FBS of both subjects. Table 2 shows the frequency pattern of lipid profile among type 2 dm with dyslipidaemia. Based on the NCEP-ATP III criteria, 57 diabetic patients had at-least one lipid value or the other outside of the clinical target giving it a prevalence of 50.4%, with 66.7% of them being female. None of the subjects has all the four lipid value outside the clinical target; only 10.5% of male and 5.3% of female have three

lipid values outside the target. The most frequent lipid combination was TC + HDLC (31.6% in both sexes), followed by HDLC only in 31.6% of the female and 21.1% of the male subjects. The sex distribution frequency of the lipids analyte studied among the subjects is shown in Figure 1. Table 3 shows the Spearman's correlation coefficient between the lipid profile and the anthropometric indices. Among the male diabetics there was a

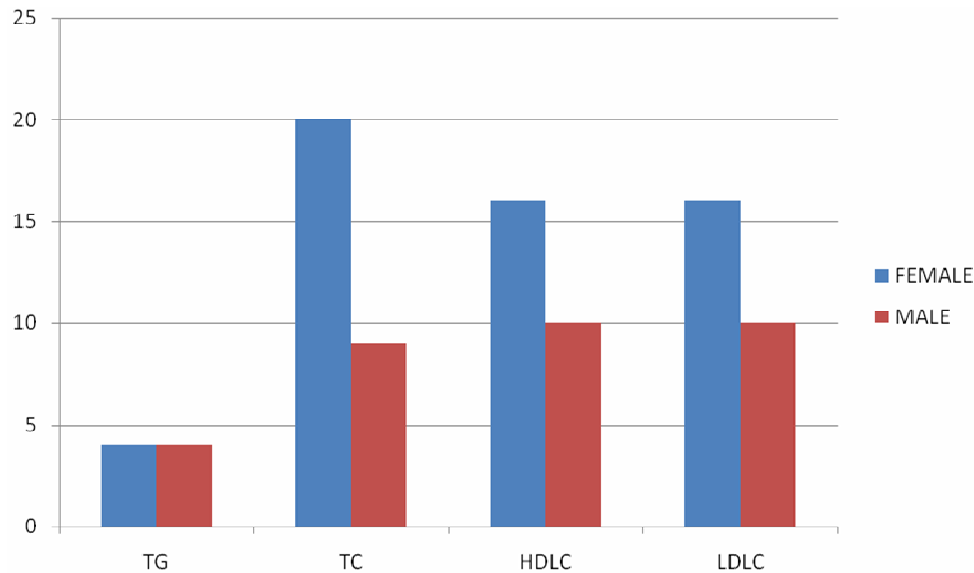


Figure 1. Frequency distribution of lipid analyte among the dyslipidaemic diabetics.

statistically significant correlation between the WC and TC ($r = 0.495$); WC and LDL-C ($r = 0.562$); WC and TG ($r = -0.584$); HC and TC ($r = 0.567$); HC and LDL-C ($r = 0.633$); BMI and TC ($r = 0.624$); BMI and LDL-C ($r = 0.722$) and, BMI and TG ($r = -0.470$). Among the female diabetics there was a significant negative correlation between HC and TG ($r = -0.391$). A one-way between groups multivariate analysis of variance was performed to investigate sex differences in lipid profile. There was a statistical significance difference between males and females on the combined lipid variables: $F(4.105) = 5.01$, $p = 0.000$. When the lipids were considered separately, TC $F(1.108) = 15.09$, $p = 0.000$; HDL-C $F(1.108) = 6.55$, $p = 0.012$ and LDL-C $F(1.108) = 11.85$, $p = 0.001$ were significantly different.

DISCUSSION

Diabetes mellitus has been associated with abnormal lipid profiles (Ko et al., 2001; Al-Adsani et al., 2004; Otieno et al., 2005). This may not be unrelated to insulin resistance which has been closely associated with diabetes dyslipidaemia and hypertension (Mgonda et al., 1998). Hypertriglyceridaemia is associated with increased postprandial lipidaemia and accumulation of atherogenic remnant particles (Haffner, 1998). Lipoprotein lipase (LPL) is the main enzyme for the catabolism of chylomicrons and very low density lipoprotein (VLDL) particles which enable them to form remnants that are cleared by APO E or APO B receptors in the liver. LPL is an insulin dependent enzyme and insulin resistance will lead to increased TG levels. Metabolism of HDL cholesterol in Type 2 DM is not well understood but its

clearance is thought to be mediated by VLDL receptors, which are mainly located in the liver. Insulin has been said to play a role in regulation of VLDL receptor binding and internalization leading to a decrease in HDL catabolism. Orchard (Orchard, 1990) proposed that there is an increased direct removal of VLDL and APO B100 in patients with Type 2 DM. This then causes a reduction in the production of HDL and thereby compensating for reduced clearance. There is an inverse relationship between VLDL clearance and HDL-cholesterol, thus there is a decrease in HDL concentration in Type 2 DM. HDL cholesterol levels may also be further reduced in T2DM due to elevated hepatic lipase activity, which catabolizes HDL-Cholesterol (Harno et al., 1980).

Although, concentrations of total and LDL cholesterol in diabetic individuals are reportedly comparable with levels found in people without diabetes, low levels of HDL cholesterol and elevated TG levels, both probable contributors to CVD, have been reported in Type 2 diabetes (Barrett-Connor et al., 1982; Sowers and Lester, 1999; Laasko, 1996; Miller, 1999). The value of total cholesterol, LDL-C and Triglyceride were found to be lower; while that of the HDL-C was higher to those of diabetic patients studied by Okafor et al. (2008) in Lagos an urban area of the country. This same pattern was also the case among African-American diabetics studied in USA though the ADA criteria were used in their own study (Sapna et al., 2008). The life style, environment, occupation and level of education may account for these differences. The female subjects in this study had significantly higher HDL and LDL cholesterol but lower triglyceride level than their male counterpart. This is consistent with previous studies in African Americans (Sapna et al., 2008). Race and sex differences in patterns of serum lipids have been noted in

diabetes (Summerson et al., 1992; Werk et al., 1993). African-Americans with Type 2 diabetes reportedly have lower TG and higher HDL cholesterol concentrations than Caucasians, and women with diabetes have higher LDL and HDL cholesterol concentrations than their male counterparts (Summerson et al., 1992; Werk et al., 1993). However in an Indian diabetic population higher level of TC, LDL-C and TG was found among the male subjects (Sapna et al., 2008).

Dyslipidaemia was found to be 50.4% among the diabetes studied, much lower than the prevalence found in other studies done in Lagos 89.1% (Ogbera et al., 2009; Cook et al., 2000), Edo 60.4% (Agboola-Abu and Onabolu, 2000) both in Nigeria and South Africa 90.3%(35). Urbanization in the population of the other studies may account for this higher prevalence. Increasing urbanization has been observed to be associated with modernization of lifestyle, which is largely characterised by physical inactivity, change in dietary pattern and consequently, development of obesity (Hodge et al., 1997). About 32% of the subjects had two-lipid value outside of the target value, the most frequent combination of TC+↓HDL. This is similar to that of Cook et al. (2000) where 54% of the studied subjects has only two lipid value outside the targeted value and combination of reduced HDLC and increased LDLC being the most frequent. Okafor et al in their study found reduced HDLC has the most frequent lipid abnormality. Ogbera et al. (2009) in Lagos also found elevated LDL-C (74%) and TC (53%) being the most frequent lipid abnormality among diabetes patients (Cook et al., 2000). None of the patients in our study had elevated LDLC only above targeted goal. There was significant correlations between the anthropometric indices and the lipid profile, the male subjects had more correlations than their female counterpart.

However, in a study on non-diabetic Iranian population (Chehrei et al., 2007) men had higher correlations between lipid profile and the anthropometric indices than their female. This difference may be explained by different ethnicity, different nutritional status and level of urbanization. Individuals with a similar BMI can vary considerably in their abdominal fat mass, also its limitations are recognised by its dependency on race, with Asians having large percentages of body fat at low BMI values and its change according to age. For these reasons, a measure of obesity that takes into account the increased risk of obesity related illnesses because of the accumulation of abdominal fat is desirable. There is a new tendency to use waist circumference or waist to height ratio rather than waist to hip ratio, because studies with computed tomography have disclosed them to closer relationship with intra-abdominal fat and with changes in intra-abdominal fat. The combination of WC and height that is W/Ht could manifest better in the morphology of an enlarged abdomen with inappropriate short stature. There is enough evidence in literature to support the beneficial effect of lowering of serum lipids in retarding

macro-vascular disease. It is important to realise that hyperlipidaemia and the resultant macro vascular disease can develop even in the 'prediabetic phase' of Type 2 DM. Hence, early detection and correction of dyslipidaemic state is essential in the management of diabetic patients.

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