Nigerian Journal of Biochemistry and Molecular Biology
23 (1): 25 - 29, 2008. ISSN 0189-4757
Available online at http://www.njbmb.researchjournals.org

Features of Lipid Profile of Diabetes Mellitus Patients in Delta State

*C.U. Igwe[1], C.O. Ibegbulem[1], H. Ukwamedua[2], And C.I. Ikaraoha[3]
[1]Department of Biochemistry, Federal University of Technology, Owerri, Imo State.
[2]Pathology Department, Federal Medical Centre, Asaba, Delta State.
[3]Department of Chemical Pathology, Igbinedion University, Okada, Edo State.
*Corresponding Author. E-mail: igwechidi@yahoo.com

ABSTRACT

The plasma total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) concentrations were determined spectrophotometrically on 70 fasting Type 1 and 150 fasting Type 2 diabetes mellitus patients and also on 100 apparently healthy, age-matched controls in Delta State, Nigeria. Atherogenic index, glycaemic status and obesity were also assessed on the subjects, within the period of study: July 2004 to July 2005. Of the 220 diabetic patients, 186 (84.5%) had not had a lipid profile test for the past one year, only 48 (21.8%) are aware of the need for the test, and only 148 (67.3%) could not afford the test, annually. The diabetics had significantly ($p<0.05$) higher plasma TC, TG, LDL-C and atherogenic index than the control subjects, with the Type 1 patients having higher mean values than the Type 2 patients ($p<0.05$). HDL-C was, however, significantly ($p<0.05$) lower in the diabetics. The occurrence rates of hyperlipidaemia and abnormal atherogenic index were significant ($p<0.05$) in the Type 1 than in the Type 2 patients. The occurrence of dyslipidaemia among Nigerian diabetics is high. The lipid profile obtained might indicate the occurrence and increased risk of coronary heart disease (CHD) in these subjects. Thus, the need for increased awareness for regular lipid profile testing and effective management of diabetes geared towards correcting dyslipidaemia.

Key Words: Diabetes Mellitus, Type 1, Type 2, Lipid profile testing, Nigeria.

INTRODUCTION

Diabetes mellitus is a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of fat, carbohydrate and protein metabolism resulting from defects in insulin secretion, insulin action or both. Its effects include long-term damage, dysfunction and failure of various organs. Diabetes mellitus has been classified into Type I and Type 2 diabetes mellitus. Others may include gestational diabetes and other specific types (ADA, 2003).

Type 1 results from autoimmune or idiopathic mediated destruction of the beta cells of the pancreas, leading to absolute insulin deficiency (Hothers-Nielsen *et al.,* 1988; Humplery *et al.,* 1998). Patients often become dependent on insulin for survival eventually and are at risk for ketoacidosis (Willis *et al.,* 1996). In Type 2, there is predominantly insulin resistance with relative insulin deficiency or predominantly an insulin secretory defect with or without insulin resistance (Defronzo *et al.,* 1997). Such patients are at an increased risk of developing macrovascular and microvascular complications (Mooy *et al.,* 1995). Diabetics are generally at high risk for dyslipidaemia, cardiovascular disease (CVD) and mortality (ADA, 2002). Dyslipidaemia in diabetes is characterised by elevated plasma triglycerides and very low-density lipoproteins (VLDL), reduced high-density lipoprotein cholesterol (HDL-C) and a shift in low- density lipoprotein (LDL) distribution towards small, dense particles (Packard and Olsson, 2002). To monitor these lipid disorders, ADA (2002) recommended that all adults with diabetes should undergo, at least annually, a fasting lipid profile test. Yet, lipid-testing rates among diabetics have not been ideal, especially among the most vulnerable patients viz African Americans, the economically disadvantaged, and the medically complex (Massing *et al.,* 2003).

Because of the paucity of data relating to plasma lipids and lipoproteins in diabetic patients in Africa and the need for regular lipid profile testing among them, we determined the lipid profile of Types 1 and 2 diabetic patients in Delta State, Nigeria. We also studied the influence of awareness and levels of income of patients on the regularity of lipid profile testing.

MATERIALS AND METHODS

Subjects

The study was approved by the Ethical Committees of the hospitals used. Written informed consent was obtained from all participating subjects. The patients were age-matched with control subjects. The control subjects consisted of 100 apparently healthy non-diabetic (fasting blood sugar < 6.05mmol/l), non-smoking and non-obese

(body mass index, BMI < 25kg/m^2) volunteers (mean age 43 years: 58 males and 42 females). Two hundred and twenty diabetic patients comprising 70 patients aged 10-30 years (mean age 21 years: 49 males and 21 females) with Type 1 diabetes mellitus and 150 patients aged 35-62 years (mean age 47 years: 85 males and 65 females) with Type 2 diabetes mellitus were used for the study between July 2004 and July 2005. All the patients were attending the diabetes clinics at the Federal Medical Centre, Asaba and Central Hospitals in Warri, Agbor, and Ughelli, all in Delta State, Nigeria. The Types 1 and 2 diabetic patients were classified based on reports in their clinical case notes and according to ADA (2003). Demographic information on all the diabetic patients was obtained by the use of questionnaires.

Sample collection To obtain serum, blood was collected by clean venepuncture, after an overnight fast into sodium fluoride (NaF) bottles and lithium heparin containers for plasma glucose and lipid profile estimations, respectively. The plasma samples for lipid profiles were stored at –20^{0}C prior to determination.

Methods

Plasma glucose was determined within 1 hour of sample collection by the glucose oxidase method (Trinder, 1969). Enzymatic methods were also employed for the determination of total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and triglycerides (TG) by the methods of Stein (1987) and Walmsley and White (1994). Low-density lipoprotein cholesterol (LDL-C) was estimated using the formula of Friedewald *et al* (1972).

$$\text{LDL - C} = \text{TC} - (\text{HDL-C} + \frac{\text{TG Level}}{2.2})$$

Body mass index (BMI) was calculated as weight (kg) divided by height (m^2). Atherogenic index was defined as TC (mmol/l) divided by HDL-C (mmol/l), and Obesity as BMI greater than or equal to 30.0kg/m^2 (CDC, 1998).

Statistical analysis

Students' 't'-test of significance and Analysis of Variance (ANOVA) were performed for the continuous variables. Values for $p < 0.05$ were considered statistically significant. Simple percentages were used on discrete variables.

RESULTS

Table 1 shows the summary of the information obtained from the patients based on the demographic study. The results show that of the 220 patients, 34 (15.5%), 61 (27.7%) and 125 (56.8%) underwent a lipid profile test (LPT) in the last one year, between 2 to 5 years, and more than 5 years ago, respectively. One hundred and forty-eight (67.3%) patients blamed the inability to undergo LPT annually on financial difficulties, 38 (17.3%) on no request from physicians, 34 (15.4%) on lack of laboratory facility, while 172 (78.2%) are not aware of the need for an annual LPT.

Table 2 shows the mean ages, body mass index (BMI), duration of illness and plasma glucose concentrations of the Type 1, Type 2 and control subjects. The patients had higher ($P < 0.05$) BMI and plasma glucose concentration than the controls.

The mean values of lipids for the Type 1 and Type 2 patients were significantly higher ($p < 0.05$) than for the non-diabetic (control) subjects except HDL-C (Table 3). Outlined in Table 4, is the distribution of patients with biochemical values above cut-off points which are indicative of hypercholesterolaemia, hypertriglyceridaemia, combined hyperlipidaemia and abnormal atherogenic index among the diabetic patients.

Table 1. Summary of Demographic study of Diabetic patients

Demographic data	Number (%) of patients
When the disease was diagnosed	
≤ 1 year	42 (15.5)
2 –– 5 years	86 (39.1)
> 5 years	92 (41.8)
Time of last LPT	
≤ 1 year	34 (15.5)
2 –– 5 years	61 (27.7)
> 5 years	125 (56.8)
Awareness of the need for annual LPT	
Not aware	172 (78.2)
Aware	48 (21.8)
Reasons for failure of annual LPT	
Financial difficulty	148 (67.3)
Not requested by the Physician	38 (17.3)
Unavailability of a Laboratory facilities	34 (15.4)
Class of income of patient	
Low income class	30 (13.6)
Middle income class	137 (62.3)
High income class	53 (24.1)

Key: LPT – Lipid profile test

Table 2: Other characteristics of the subjects. – cholesterol, high-density lipoprotein cholesterol

Subjects	N (male/female)	Age (years)	BMI (kg/m^2)	Duration of illness (years)	FBS (mmol/l)
Type 1	70(49/21)	20.5 ± 9.1	23.1 ± 4.2	7.5± 3.3	13.5± 5.0
Type 2	150(85/65)	47.3± 8.6	27.4 ± 2.4	8.9± 3.7	11.3 ± 4.9
Control	100(58/42)	43.3± 6.8	22.1± 3.1	-	4.7 ± 1.0

Key: Values are mean ± SD. N – Number of patients, BMI – Body Mass Index FBS – Fasting Blood Glucose

Table 3: Lipid profile of subjects.

Subjects	N	TC (mmol/L)	TG (mmol/L)	HDL-C (mmol/L)	LDL-C (mmol/L)	Atherogenic index TC/HDL-C
Type 1	70	5.7 ±2.5	4.6± 3.3	0.9 ± 0.1	3.4 ± 1.7	7.8 ± 1.8
Type 2	150	5.9 ± 2.4	2.8±1.2	1.1± 0.8	3.2 ± 1.2	5.6 ± 2.5
Control	100	3.8 ± 1.0	1.3 ± 0.9	1.5 ± 1.0	2.3 ± 1.0	4.9 ± 2.0
P value		<0.05	<0.05	<0.05	<0.05	<0.05

Values are Mean ± SD. Key: N – Number of subjects, TC – Total Cholesterol, TG – Triglyceride HDL-C – High-density lipoprotein cholesterol, LDL-C

Table 4: Distribution of patients with biochemical values above cut-off (upper limit of normal) (ADA, 2003; Nduka, 1999).

	Cut-off point	No. of patients (%)	
		Type 1 (N=70)	Type 2 (N= 150)
Hypercholesterolaemia	TC > 6.5 (mmol/l)	41(58.6)	61(40.7)
Hypertriglyceridaemia	TG > 2.5 (mmol/l)	55(78.6)	97(64.7)
Combined hyperlipidaemia	TC > 6.5 + TG > 2.5 (mmol/l)	36(51.4)	42(28.0)
Abnormal Atherogenic index	(TC/HDL-C) > 8.5	54(77.1)	85(56.7)

Low-density lipoprotein cholesterol

DISCUSSION

The result from this study show that of the 220 diabetic patients studied, only 48 (21.8%) were aware of the need for an annual fasting lipid profile test, while 186 (84.5%) patients have not had lipid profile test in the last one-year, 148 (67.3%) patients complained that even in the presence of such awareness, financial constraint may not have availed them the opportunity of undergoing the test. This may be explained by the common Nigerian culture of attending to medical examination or care only at the point of compulsion by deteriorated health conditions (Eke and Sapira, 2002). The cost of these tests could also have contributed to this lack of lipid profile testing culture observed in this study. Our findings revealed that a lipid profile test involving serum assay of total and triglyceride as well as the routine fasting blood glucose, cost an average of N1,200 (9.6US$) in government-owned hospitals. In the private hospitals and medical laboratories, the cost ranges from N1,900 (15.5US$) to N3,500 (28US$). The high percentage of middle and low income earners over that of the high income earners with diabetes mellitus observed might have also contributed to the poor lipid profile testing culture in view of the high cost of LPT. Abnormal lipid metabolism is a common feature in diabetics with associated increased risk of vascular complications (Jenkins *et al.,* 2003*).* In the present study, there were substantial increases in serum total cholesterol, triglyceride and low-density lipoprotein cholesterol as well as the atherogenic index of both the Type 1 and Type 2 diabetic patients, when compared with the non-

Subjects. On the other hand, a substantial decrease in serum HDL - C was observed among the diabetics in comparison with the controls. These observations are characteristic of the lipid profile features of Type 2 and Type 1 diabetes mellitus (Taskinen, 1990; Packard and Olsson, 2002). However, it contradicts the report of Tomkin and Owens (1994) that those with Type 1 usually exhibit a normal conventional lipid profile. These findings buttress the need for more aggressive lipid profile testing and management as suggested by Massing *et al (*2003), especially for diabetics in economically disadvantaged nations like Nigeria.

A study of the characteristics of the patients such as the mean age and body mass index (BMI) indicate that the patients with Type 2 had a higher average age (years) and BMI, than the Type 1 patients. This corroborates the finding that the risk of developing Type 2 increases with age, obesity and lack of physical activity (Harris *et al*., 1995*)*. However, there was no significant change ($p< 0.05$) in the mean BMI in the Type 1 patients when compared with the controls. Hyperglycaemia is a hallmark of diabetes mellitus. Thus, substantial increases were observed in the plasma glucose concentrations of the diabetic patients. The higher plasma glucose values observed in the Type 1 than in the Type 2 might be fallout of absolute insulin deficiency occasioned by possible destruction of the beta cells of the pancreas associated with Type 1, when compared with predominantly insulin resistance in Type 2 (Defronzo *et al*., 1997; Humplery *et al.,* 1998).

The occurrence of hypercholesterolaemia, hypertriglyceridaemia, combined hyperlipidaemia and abnormal atherogenic index were significantly higher ($p<0.05$)in the Type 1 than the Type 2 subjects. The result indicates that the management of these patients still leaves much to be desired. This, however, can be blamed on poverty, which makes it difficult for these patients to go for regular lipid profile testing and maintenance of regular drug regimen as well as poor diet and physical activity, high cost of insulin and inadequate home monitoring. This means that atherosclerosis may be accelerated in these patients, and that the Type 1 subjects may be more prone to developing coronary heart disease (CHD); but does not rule out Type 2 subjects from developing CHD also (Taskinen, 1990; Packard and Olsson, 2002).

Based on result from this study, it could be concluded that plasma total cholesterol, triglyceride and low-density lipoprotein cholesterol as well as atherogenic index are increased in diabetes; and more in the Type 1 than Type 2 subjects. On the other hand, HDL-C concentration is lower in the diabetics than in the control subjects. The high occurrence of dyslipidaemia amongst these patients indicate a greater risk of developing atherosclerotic ischaemic heart disease and thus calls for a more regular lipid profile testing and effective management of diabetics including treatment directed at correcting dyslipidaemia that may increase cardiovascular risk. It further exposes the poor lipid profile testing culture amongst diabetics in Nigeria, which could be hinged on poverty and non-awareness.

ACKNOWLEDGEMENT

The authors wish to express their unreserved gratitude to the staff and patients of Federal Medical Centre, Asaba, Delta State, for their understanding and cooperation throughout the period of this study.

REFERENCES

ADA (2002) Management of dyslipidemia in adults with diabetes. *Diabetes Care*; 25 (Suppl.I): S74- S77.

ADA (2003) Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, *Diabetes Care*; 26(Suppl. 1): S5-S20.

CDC (1998) Clinical Guildlines on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults. National Health and Blood Institute, Washington DC.

Defronzo R.A, Bonadonna R.C., and Ferrannini E. (1997) Pathogenesis of NIDDM. In: Alberti KGMM, Zimmet P., Defronzo R.A, eds. *International Textbook of Diabetes Mellitus.* 2nd ed. John Wiley, Chichester. pp 635-712.

Eke N. and Sapira OB. (2002) Prostate cancer in Port Harcourt, Nigeria – Features and outcome. Urology; 4: 1-2.

Friedewald WT, Levy RI, and Frederickson DS (1972) Estimation of the concentration of low-density lipoprotein cholesterol in plasma without the use of preparative ultra-centrifuge. *Clin. Chem*; 18: 492.

Harris MI, Cowie CC, and Stern MP. (1995) *Diabetes in America*. 2nd Ed. Washington: US Government Printing Office, NIH Publ. 95: 1468.

Hothers-Nielsen O, Faber O, Sorense NS, and Beek-Nielsen H. (1988) Classification of newly diagnosed diabetic patients as insulin requiring or non-insulin-requiring based on clinical and biochemical variables. *Diabetes*; 11: 531-537.

Humplery ARG, McCarty DJ, Mackay IR, Rowley MJ, Dwyer T. and Zimmet P. (1998) Autoantibodies to glutamic acid decarboxylase and phenotypic features associated with early insulin treatment in individuals with adult-onset diabetes mellitus. *Diabetic Med*; 15: 113-119.

Jenkins AJ, Lyons TJ, Zheng D, Otvos JD, Lackland DT, McGee D, Garvey WT, Klein RL and DCC/EDIC Research Group (2003) Serum Lipoproteins in the Diabetes Control and Complications Trial/Epidemiology of Diabetes Intervention and Complications Cohort: Associations with gender and glycaemia. *Diabetes Care*; 26: 810-818.

Massing M.W., Henley N.S., Carter-Edwards L, Schenck, A.P., and Simpson, R.J. Jr. (2003) Lipid testing Among Patients with Diabetes who receive Diabetes Care from Primary Care Physicians. *Diabetes Care*; 26: 1369-1373.

Mooy J.M., Grootenhuis P.A, de Vries H., Valkenburg, H.A., Bonter, L.M., Kostense, P.J. and Heine, R.J. (1995) Prevalence and determinants of glucose intolerance in a Dutch population. The Hoorn Study. *Diabetes Care*; 18: 1270-1273.

Nduka, N. (1999) Clinical Biochemistry for students of Pathology. Longman Nigeria Plc, Ibadan. Pp 225-228.

Packard C. and Olsson A G. (2002) Management of hypercholesterolaemia in the patient with diabetes. *Int. J. Clin. Pract. Suppl*; 130: 27-32.

Stein E.A. (1987) Lipids, Lipoproteins and Apolipoproteins. In: Tietz NW. *Fundamentals of Clinical Chemistry*. 3rd Ed. WB Saunders, Philadelphia, pp 470-479.

Taskinen MR. (1990) Hyperlipidaemia in diabetes. In: Betteridge DJ. *Lipid and lipoprotein Disorders Baillieres Clinical Endocrinology and metabolism*. London, pp 743-775.

Tomkin GH and Owens D. (1994) Insulin and lipoprotein metabolism with special reference to the diabetic state. *Diabetes Metab. Rev*; 10:225-252.

Trinder P. (1969) Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor. *Ann. Clin. Biochem*; 6: 24-27.

Walmsley RN and White GH. (1994) *A Guide to Diagnostic Clinical Chemistry*. 3rd ed. Blackwell Scientific Publications, Melbourne, Australia, pp 348-368.

Willis J.A, Scott A.S, Brown L.J., Forbes, L.V., Schmidli, R.S., Zimmet, P.Z., Mackay, I.R. and Rowley, M.J. (1996) Isletcell antibodies and antibodies against glutamic acid decarboxylase in newly diagnosed adult-onset diabetes mellitus. *Diabetes Res. Clin. Pract*; 33: 89-97.