Association Between Glycaemic Control and Serum Lipid Profile of Type 2 Diabetic Patients in University College Hospital Ibadan, Oyo State, Nigeria

Funmilayo Esther Omotoye[*], Grace Tanimoowo Fadupin

Department of Human Nutrition, Faculty of Public Health, University of Ibadan, Ibadan, Oyo State, Nigeria

Email address:

funmiomotoye2013@gmail.com (F. E. Omotoye)
[*]Corresponding author

Abstract: Diabetes mellitus is a chronic disease that requires long term medical attention both to limit the development of its devastating complications and manage them when they occur. Lowering high blood sugar in patients with diabetes (glycaemic control) is essential to reduce their risk of complications associated with diabetes. This study was designed to assess the effect of glycaemic control on the serum lipid profile of type II diabetic patients in the university college hospital Ibadan, Oyo State. The study was descriptive cross sectional in design to assess the effect of glycaemic control on serum lipid profile of the participants. A total of 50 consenting adults, aged 40-72 years, 20 (40%) males and 30 (60%) females, type II diabetic patients were studied between March and August 2006. The demographic characteristics and dietary pattern of the participants were assessed through a semi-structured interviewer administered questionnaire and food frequency questionnaire. The serum lipids of participants for the last six months and the mean of their last four fasting blood glucose (FBG) levels were assessed from their hospital records. The effect of the glycaemic index on their lipid profile was determined using correlation coefficient and chi-square. The mean age of the respondents was 57.82±3.3 years. They were predominantly 45 (90%) Yorubas. A total of 68% had either secondary or post secondary/tertiary education. Their main source of energy was from cereals, grains and tuber crops while legumes were their major source of protein. A total of 33 (66%) had controlled (normal) fasting blood glucose while 17 (34%) did not have their FBG controlled. Only 17 (34%) had normal high density lipoprotein (HDL) cholesterol while 35 (70%) and 33 (66%) had normal low density lipoprotein (LDL) cholesterol and total cholesterol respectively. The FBG of participants had an inverse relationship with HDL but positive relationship with LDL, total cholesterol and triglyceride levels of the participants. However, the effect of FBG was only significant on triglyceride level of respondents (P=0.033) and not significant on HDL, LDL, and total cholesterol (P>0.05). Good glycemic control significantly improves dyslipidemia in type 2 diabetic patients.

Keywords: Type II Diabetes, Serum Lipids Profile, Glycaemic Control, Fasting Blood Glucose

1. Introduction

Diabetes mellitus is a common chronic disease characterized by high level of blood glucose, insulin resistance and abnormal insulin secretion. Increasing prevalence of diabetes mellitus is considered a global public health concern. According to the World Health Organization, 210 million people were suffering from diabetes in 2010 worldwide. Type 2 diabetes is a much more prevalent form of

diabetes and responsible for 90% of the disease prevalence. This type of diabetes is associated with several complications such as obesity, hypertension, and hyperlipidemia that may lead to cardiovascular diseases [1]

Diabetic patients with accompanied (unnoticed) dyslipidemia are soft targets of cardiovascular deaths. Patients with type II diabetes often exhibit an atherogenic lipid profile, which greatly increases their risk of CVD compared with people without diabetes. An early

intervention to normalize circulating lipids has been shown to reduce cardiovascular complications and mortality [2].

Impaired lipid metabolism resulting from uncontrolled hyperglycaemia has been implicated in cardiovascular complications in diabetes patients [3].

Dyslipidemia characterized by the elevation of plasma total cholesterol (TC), triglycerides (TG) and TG-rich very-low-density lipoprotein cholesterol (VLDL-C), reduced high-density lipoprotein cholesterol (HDL-C), and increased low-density lipoprotein cholesterol (LDL-C) contributes significantly to the excess risk of CVD [4]. The aim of this study was to examine the impact of glycaemic control on the lipid profile of diabetic patients

2. Background

Diabetes mellitus is a group of metabolic disease characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action, or both. Diabetes causes about 5% of all deaths globally each year. The chronic hyperglycaemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels. Fifty percent of people with diabetes die of cardiovascular disease (primarily heart disease and stroke) [2].

Patients with type 2 diabetes have an increased prevalence of lipid abnormalities, contributing to their high risk of cardiovascular diseases (CVD) [2]. Impaired lipid metabolism resulting from uncontrolled hyperglycaemia has been implicated in cardiovascular complications in diabetic patients [3].

Types of treatment that could be applied in managing type 2 diabetes include Nutrition therapy, physical activity, weight management, medication via oral hypoglycaemic drugs and monitoring with insulin injection [5].

These treatment are aimed at glycemic control which is the maintenance of fasting blood glucose level of <126mg/dL or 7.0mmol/L [6]. The major aim of the study is to assess the association between glycemic control and serum lipid profile of type II diabetic patients.

3. Methods

3.1. Study Design

The study was descriptive cross sectional in design to assess the association between glycemic control and blood lipid level in type II diabetic patients.

3.2. Study Location

The study was carried out at the university college hospital, Ibadan, Oyo State, Nigeria. A total of 50 type II diabetic patients (20 males and 30 females) attending the medical outpatient clinic (MOP) of the university college hospital (UCH), Ibadan, Oyo State, Nigeria from March to August 2006 were included in this study. All the type II diabetic patients who gave their consent and had their serum lipid profile assessed within the last six months was evaluated. Only those in attendance for two consecutive months took part in the study. Record of their fasting blood glucose (FBG), lipid profile: low density lipoprotein (LDL), high density lipoprotein (HDL), Total cholesterol (TC) and Triglyceride (TG) were obtained from their hospital record.

3.3. Data Collection Technique

A semi structured interviewer administered questionnaire was used to interview each patient that gave their consent to participate in the study and also had his/her lipid profile assessed within the last six months. Dietary pattern was determined with a semi-quantitative, food frequency questionnaire (FFQ) designed for the study population.

Information with regards to the participants' socio-economic data namely, age, sex, income, tribe, religion, occupation, and educational status were obtained with the aid of the questionnaire. In addition, medical history including family history of diabetes mellitus, information on duration of illness, diagnosis, type of treatment given and food consumption pattern of the participants were obtained.

Records of their fasting blood glucose in form of means of the last four fasting blood glucose and record of their lipid profile level were obtained from their hospital records. Fasting blood glucose level <7.00 mmol/L (126mg/dl) was regarded as controlled (good glycemic control) while The target lipid values are LDL<130mg/dl, HDL >40mg/dl, Triglyceride <150mg/dl, and Total cholesterol <200mg/dl.

By using the guidelines of the Third Report of the National Cholesterol Education Program

Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) for serum lipid profile reference level, hypercholesterolemia was defined as TC>200mg/dl, high LDL-C when value is ≥130mg/dl, hypertriglyceride as TG>150mg/dl, and low HDL-C as <40mg/dl. Dislipidemia was defined by presence of one or more abnormal serum lipid concentration. Definition for Normal TC was <200mg/dl, LDL-C was <130mg/dl, TG was <150mg/dl and HDL-C was ≥40mg/dl [7]. Diabetes was defined as per American Diabetes Association (ADA) criteria. The current world health organisation (WHO) diagnostic criteria for diabetes was fasting plasma glucose ≥ 7.0mmol/l (126mg/dl) or 2–h plasma glucose ≥ 11.1mmol/l (200mg/dl) while normal FBG was <100mg/dL (5.6mmol/l) [6, 8].

3.4. Data Analysis

The data were evaluated by Statistical Package for Social Sciences (SPSS) 11.0 version software. Pear-son's correlation test was performed to examine various correlations. Independent samples t-test (2-tailed) was used to compare means of different parameters between males and females. The results were considered statistically significant when $P \leq 0.05$. The effect of glycaemic control on serum lipid profile was evaluated by one way analysis of variance (ANOVA).

4. Results

A total of 50 participants; 20 (40%) males and 30 (60%) females were recruited for the study. The mean age of the participants was 57.82±3.3 years (male and female respectively) while their age ranges between 40 and 72 years. The participants were predominantly Yorubas (90.0%) and 94% were married.

The result of the food consumption pattern of the participants showed that rice, bread and maize as cereals/products, cassava, and yam as roots and tubers, cowpea, and products as legumes, green leafy vegetables and egg plants were frequently consumed by participants. Groundnut seed and ogbono soup were occasionally taken. Fruits, milk and its products, palm oil, vegetable oil, and margarine were taken occasionally. Soft drinks and alcohol were avoided.

Table 1. *Serum fasting blood glucose, Lipid profile and age of male and female type 2 diabetic patients.*

Parameters	Male (n=20)		Female (n=30)		
	Mean±SD	Range	Mean±SD	Range	p
FBG	114.10±33.5	68-222	113.20±29.3	45-207	>0.05
Serum lipid Profile					
Cholesterol	155.30±61.9	45-271	175.20±46.1	96-274	>0.05
Triglyceride	94.50±44.4	31-216	96.74±37.5	20-170	>0.05
HDL	46.95±15.0	15-72	52.30±21.4	18-105	>0.05
LDL	111.95±41.9	31-185	110.50±41.9	31.217	>0.05
Glycemic control level					
Mean=6.3mmol/L	N (%)		N (%)	Total n (%)	
3.33-7.22 (controlled)	13 (65.0)		20 (66.7)	33 (66.0)	>0.05
7.28-7.72 (borderline)	2 (10.0)		3 (10.0)	5 (10.0)	
>7.78 (not controlled)	5 (25.0)		7 (23.3)	12 (24.0)	
Age (Years)					
Mean Age	60.85±8.0		55.80±8.57	57.82±3.3	

The result (Table 1) showed that the mean of the last four blood glucose level of about a third (34.0%) of the participants was not controlled above the normal level of 7.2mmol/L while 66.0% had controlled fasting blood sugar level (below 7.2mmol/L). The difference in the blood glucose level of the male and female participants was not significant.

Table 2. *Association between blood glucose and fasting lipid profile.*

FASTING LIPID PROFILE				
FBG	HDL	LDL	Total cholesterol	Triglyceride
Controlled	51.81±20.2	108.00±34.2	164.69±48.4	88.43±34.7
Not controlled	45.46±15.2	111.38±44.7	168.14±55.5	116.92±47.5
r-value	-0.074	-0.022	-0.030	0.342
p-value	0.418	0.567	0.542	0.033*

*Statistically significant

Table 2 showed a week negative relationship between FBG and HDL, LDL and total cholesterol of the participant while a significant positive relationship was observed between FBGC and the serum triglyceride of participants. The mean of all the lipid profile of respondents with controlled fasting blood glucose were lower than those whose FBG was not controlled.

Table 3. *Correlation between lipid profile and fasting blood glucose and age of type 2 diabetes patient.*

Parameters	Fasting blood glucose		Age	
	Pearson correlation	p	Pearson correlation	p
Cholesterol	0.008	>0.05	0.023	>0.05
Triglyceride	0.43	<0.05*	-0.237	>0.05
HDL	-0.282	<0.05*	0.110	>0.05
LDL	-0.122	>0.05	0.044	>0.05

*Statistically significant

5. Discussion

The pattern of lipid profile parameters was evaluated in diabetic patients in this study.

Although there were no significant difference between male and females parameters, TG, TC and HDL-C levels were higher in female as compared to male type 2 diabetic patients. This finding is in agreement with a previous study [1]. Hyperlipidemia in females may be attributed to the

effects of sex hormones on body fat distribution, which leads to differences in altered lipoproteins [1].

In the study of [9] a sex difference in diabetes prevalence was reported with women having higher rates than men. Similarly in this study using randomized selection, more women presented than men. This indicates that women could be a higher risk population for type 2 diabetes than men. This study revealed that the participants were 40 years and above which is similar to the report [10, 11] which indicates that type II diabetes mostly affect individuals older than 40 years.

Type 2 Diabetes (T2D) is associated with increased frequency of risk factors for cardiovascular disease (CVD) regardless of sex, but the increase is relatively greater in women. Abdominal obesity, which increases in women after menopause, is a stronger risk factor for CVD in women compared with men [12]. Women with T2D are more likely than men to have hypertension, with more deleterious effects on cardiovascular health. Total cholesterol and LDL may be more important risk factors for CVD in men, while TG has a greater impact in women and is often elevated in women with T2D. Data indicate that men with T2D suffer more microvascular complications, while women have higher morbidity and mortality in CVD and also fare worse psychologically [13]. Another study by [14] showed that women with diabetes have more than a 40% greater risk of incident coronary heart disease (CHD) compared with men with diabetes. Being the prime cause of morbidity and mortality, cardiovascular disease (CVD) risk is great in diabetic patients, with more than a 200% greater risk of CVDs than non-diabetic individuals [4].

A study by [15] showed that cardiovascular event rates were significantly greater in type 2 diabetic patients with dyslipidaemia. A causal association exists between elevation of TGs-rich particles and their remnants, low HDL-C and cardiovascular risk as is shown in large data from case-control, genetic, and large observational studies. The above discussion clearly indicates the clinical significance of various lipid parameters including total cholesterol, TG, HDL and LDL in predisposing diabetic patients to cardiovascular complications.

A study showed that dyslipidemia in T2D patients as lipids triad is characterized by increased insulin levels, hypertriglyceridemia, low HDL-C levels and increased LDL-particles (independent of LDL-cholesterol) and increased TG-rich remnant lipoprotein (TGRLs) concentrations. In this manner, low HDL-C levels associated with hyperinsulinemia or insulin resistance and insulin signaling for insulin-mediated glucose disposal characterized by higher fasting plasma glucose and insulin levels.

Glycemic control can also modify circulating triglycerides levels, especially in T2D mellitus patients with hypertriglyceridemia and poor glycemic control [16].

It was also reported by [17] that lifestyle modification and glucose control may improve the lipid profile. These agree with the result of this study which showed that fasting lipid profile improves with decrease in fasting blood glucose. The diabetic patients with poor glycaemic control exhibited a significant increase in cholesterol and TG and a decrease in HDL without any significant alteration in LDL.

This study reveals high prevalence of hypercholesterolemia (34%), Hypertriglyceridemia (14%), high LDL-C (30%) and low HDL-C (20%) levels which are well known risk factors for cardiovascular diseases. Insulin affects the liver apolipoprotein production. It regulates the enzymatic activity of lipoprotein lipase (LpL) and Cholesterol ester transport protein. All these factors are likely cause of dyslipidemia in Diabetes mellitus [1]. The percentages of lipid profile parameters showing dyslipidemia were not higher than the figures stated because their glycemic control. Moreover, insulin deficiency reduces the activity of hepatic lipase and several steps in the production of biologically active LpL may be altered in diabetes mellitus [1]. The main disorder in lipid metabolism was hypercholesterolemia, in our study. This finding is in concord with a previous study [1].

6. Conclusion

The study on the effect of glycaemic control on the fasting serum lipid profile of type 2 diabetic patients was carried out to determine glycaemic control of participants, assess their blood lipid profile and to determine the association between glycaemic control and their blood lipid profile.

A sex difference in diabetes prevalence was observed in the patients with type 2 diabetes with women having higher prevalence rate than men. A strong association was observed between the fasting blood glucose level of the participants and raised total serum cholesterol, LDL, and low HDL. Glycemic control significantly improves dyslipidemia in type 2 diabetic patients.

Recommendation

Based on the findings of this study the following recommendations were made; in routine treatment of patients with type 2 diabetes, there should be greater emphasis on lipid modification, because of their fat, greater average coronary heart disease risk and that this should concentrate on lowering high triglyceride and increasing HDL-cholesterol in addition to LDL-cholesterol reduction.

Type 2 diabetic patients should adhere strictly to dietary counsel in order to have a good glycaemic control and to avoid the risk of artherosclerosis and coronary heart diseases. They should check their blood lipids levels regularly.

Continuous nutrition education should be ensured for diabetic patients and the needed hyperglycaemic drugs should be taken in order to aid glycaemic control.

References

[1]   M. Mohammadi, S. Eghtesadi, M. Vafa et al. Effects of Hesperidin Supplementation on Glycemic Control, Lipid Profile and Inflammatory Markers in Patients with Type 2 Diabetes: A Randomized Double Blind Placebo Control Clinical Trial. Acta Biologica Indica 2015, 4 (1): 75-83.

[2]   R. VinodMahato, P. Gyawali, P. P. Raut et al. Association between glycaemic control and serum lipid profile in type 2 diabetic patients: Glycated haemoglobin as a dual biomarker. Biomed Res 2011; 22 (3): 375-380.

[3]   H. A. Khan, S. H. Sobki, S. A. Khan. Association between glycemic control and serum lipid profile in type II diabetic patients: HbA1c predicts dyslipidaemia. Clin Exp Med. 2007: 7 (1): 24-29.

[4]   SM Manohar, SR Vaikasuvu, K Deepthi, A Sachan, SRPVL Narasimha. An association of hyperglycemia with plasma malondialdehyde and atherogenic lipid risk factors in newly diagnosed Type 2 diabetic patients. J Res Med Sci 2013; 18: 89-93.

[5]   B. Redmon, D. Caccamo, P. Flavin, R. Michels, P. O'Connor, J. Roberts, S. Smith, J. Sperl-Hillen. Diagnosis and Management of Type 2 Diabetes Mellitus in Adults. Institute for Clinical Systems Improvement. 2014; 16: 1-33.

[6]   World Health Organization. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia: Report of a WHO/IDF Consultation. II. International Diabetes Federation WHO Press, 20 Avenue Appia, 1211 Geneva 27, 2006 bookorders@ who.int. pp 1

[7]   Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). National Institutes of Health. 2001; 01-3670, 3-18 pp.

[8]   American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes care 2010; 33; suppl 1: S 62-69.

[9]   E. H. Hilawe, H. Yatsuyah, L. Kawaguchi et al. Differences by sex in the prevalence of diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance in sub-Saharan African: a systematic review and met-analysis. Bulletin of WHO 2013; 91 (9): 621-715.

[10] D. K. Tobias, A. Pan, C. L. Jackson, et al. Body-Mass Index and Mortality among Adults with Incident Type 2 Diabetes. N Engl J Med 2014; 370: 233-244.

[11] American Diabetes Association. Classification and Diagnosis of Diabetes. Diabetes Care 2016; 39 (Suppl 1): S 13-S 22.

[12] Sattar N. Gender aspects in type 2 diabetes mellitus and cardio-metabolic risk. Best Pract Res Clin Endocrinol Metab. 2013; 27 (4): 501–507.

[13] L. Arnetz, N. R. Ekberg, M. Alvarsson. Sex differences in type 2 diabetes: focus on disease course and outcomes. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy 2014; 7: 409–420.

[14] Peters SA[1], Huxley RR, Woodward M. Diabetes as risk factor for incident coronary heart disease in women compared with men: a systematic review and meta-analysis of 64 cohorts including 858,507 individuals and 28,203 coronary events. Diabetologia. 2014; 57 (8): 1542-51.

[15] Iciar Martín-Timón, Cristina Sevillano-Collantes, Amparo Segura-Galindo, Francisco Javier del Cañizo-Gómez. Type 2 diabetes and cardiovascular disease: Have all risk factors the same strength? World J Diabetes 2014; 15; 5 (4): 444-470.

[16] Tangvarasittichai. Oxidative stress, insulin resistance, dyslipidemia and type 2 diabetes mellitus. World J Diabetes. 2015; 15; 6 (3): 456-480.

[17] W. Liya, K. G. Parhofer. Diabetic dyslipidemia. Metabol. 2014; 63: (12): 1469–1479.