A Study of Lipid Profile Levels of Type II Diabetes Mellitus

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Abstract
This study consists of two parts; the Part one is to evaluate the level of Blood glucose and lipid profile among diabetic patients (121 patients) which are compared with non-diabetic subjects (60 persons) and part two is to correlate lipid profile with cardiovascular abnormalities among type II diabetic patients. The diabetic patients were collected from Jabir Aboeleiz Center for Diabetes (51.9±11.22 years). Sixty healthy non-diabetic subjects were chosen as controls (52.44±10.76 years). Blood glucose, total cholesterol (TC), triglycerides (TG) and high density lipoprotein (HDL) were measured by enzymatic colorimetric methods in both groups, and low density lipoprotein cholesterol (LDL) was calculated for each sample. Among diabetic patients, there is high glucose level, serum total cholesterol, triglycerides and LDL cholesterol (p<0.5), while low level of HDL cholesterol was observed when compared to non-diabetic subjects. No statistically variation was found in the level of glucose and lipid profile between male and female diabetic patients. In our study, we have found that serum lipid - cholesterol, triglycerides and low-density lipoprotein - levels were significantly (p < 0.05) correlated to cardiovascular abnormalities, while HDL had shown a statistically non-significant correlation (p>0.05). The study concluded that higher level of cholesterol, triglyceride and LDL-cholesterol in diabetic patients compared to non-diabetic subjects with lower level of serum HDL-cholesterol in diabetic patient compared to non-diabetic subjects.

Keywords: Diabetic, Insulin, Mellitus and lipid.

Introduction
The insufficient production of insulin in patients arises the risk of diabetes mellitus, short dose of insulin is limited the function of insulin correctly. The absence of insulin leads to the high amount of glucose in the bloodstream; This situation causes thirst and urination for patients. Indeed, non-fasting triglycerides (TGs) predict the vascular risk better than fasting measurements [1]. Most cases of dyslipidemia have a genetic basis, in some cases, in addition to genetic disorder, there are environmental factors such as diet, exercise and smoking habits also play important role in manifestation and progression of the disease. LDL cholesterol is atherogenic which related with risk of atherosclerosis and its complications [2]. The atherogenic is associated with small and dense LDL cholesterol particles [3]. The great risk for cardiovascular disease compared to its simple quantitative measurement. The diet rich in saturated fats, smoking, lifestyle, and increasing in visceral fat is raising LDL cholesterol level [4]. The lowering of LDL
cholesterol level leads to reduce the risk of coronary heart disease. The increasing in serum cholesterol levels (HDL) raises the risk of incidence of coronary heart disease [5]. Low HDL-cholesterol increases the risk of cardiovascular disease [6]. Although the correlation between serum cholesterol levels and atherosclerosis diminishes with advancing age, when cholesterol is fractioned into its atherogenic LDL and protective HDL components [2].

Objectives:
To estimate fasting blood glucose (12-h overnight fast blood glucose in both diabetic patient and healthy control subjects, determine the lipid profiles (Cholesterol, Triglyceride, HDL-Cholesterol and LDL-Cholesterol), evaluate the body mass index (BMI) to correlate it between patients and Controls, study the effects of age and gender on alteration of lipids profile in the serum samples of type II diabetic patients and assess the lipids profile changes and its correlation with the development of cardiovascular risk in type II diabetic patients in Sudan.

Methods

Study Design is cross-sectional descriptive study, Study area was conducted in Khartoum state, Sudan in 2014, Study duration was extended from 2014-2015. Two study groups were examined in this study; diabetic and control groups. The diabetic group involved one hundred twenty Sudanese diabetic patients, randomly selected from Jabir Aboliez center for diabetic disease, which receives diabetic patients. Control group represented fifty apparently healthy (non diabetic subjects). The mean age of diabetic group subjects was 52±11.06 (20-80 years), where the age of control group was 45.72±11.16 (24-54 years). Ethical clearance was approved by the ethical commission of the collage of postgraduate studies in Al Neelain University.

Data collection: Demographic data (name, sex, age and marital status) and clinical data (Hypertension, smoking, renal or liver dysfunction, ulcer, hospital demission, etc.) was collected by using structured questionnaire. The interview was done only by the principle investigator for all volunteers. The participants were assisted on how to fill the questionnaire.

Anthropometric measurements: (Weight, height and BMI): Body weight was measured to an accuracy of 0.1kg using a standard balance scale manufactured by Microlife®, Switzerland. Subjects were barefoot and wearing light in door clothing. All participants’ weights were measured using the same scale which was regularly calibrated. Body height was recorded to the nearest 0.5cm using a ruler attached to the wall without shoes. BMI was obtained through body weight (kg) divided by the square of their height (m²). The definition of BMI used in this study is the same as the definition and classification of world health organization (WHO) which is:

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.50</td>
</tr>
<tr>
<td>Normal</td>
<td>18.50 – 24.99</td>
</tr>
<tr>
<td>Overweight</td>
<td>≥25</td>
</tr>
<tr>
<td>Obese</td>
<td>≥30</td>
</tr>
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</table>

Estimation of fasting blood glucose (FBG): Plasma FBG was measured using enzymatic colorimetric assay (glucose oxidase method) [7].

Estimation of Triglycerides (TG): Plasma triglycerides measured using enzymatic colorimetric assay (glycerol oxidase phosphate method [8].

Estimation of total cholesterol: Plasma total cholesterol measured using enzymatic colorimetric assay (Cholesterol Oxidase Method) [9].
Estimation of HDL-Cholesterol: Plasma HDL-Cholesterol measured using enzymatic colorimetric direct assay (Cholesterol Direct). All samples were analyzed using the same colorimetric device (Jenway bench colorimeter 6305-UK) and the same chemical reagent kit (HDL-Cholesterol Kit 100ml, Biosystems- Germany). The principle of the test relies on cholesterol from low density lipoprotein (LDL) very density lipoprotein (VLDL) and chylomicron is broken by the cholesterol oxidase in an enzyme reaction. The HDL cholesterol is then spectrophotometrically measured by means of the coupled reaction described below. The normal level of HDL-Cholesterol greater than 50 mg/dl [10].

Low density lipoprotein (LDL) levels calculated using Friedewald equation [11] as follow:

\[ [\text{LDL-chol}] = [\text{Total-chol}] - [\text{HDL-chol}] - ([\text{TG}] / 5) \]

Statistical analysis was performed by use of SPSS version6 (Statistical Package for the Social Sciences). The differences between the groups were tested for significance by student’s t-test, Oneway ANOVA test and chi-square test. Data were expressed as the mean ± SD. P-values < 0.05 are considered statistically significant.

Results

The mean age for type II diabetic patients and control were 51.917±11.221 and 52.440±10.764 years, respectively. These results indicated that the average value of age was similar for both study and control groups. Analysis of body mass index for patients and control subjects has shown that both of them were overweight (Table 1).

Table 2: represents fasting glucose level of type II diabetic patients and control subjects were 214.80 1st 84.135 mg/L, respectively. This indicated that the mean value of fasting glucose level of type II diabetic patients was the highly significant difference at (p=0.001) than that of the non-diabetic subjects (Table 2 and Figure 1).

Table 2 represents the mean value of total cholesterol level for type II diabetic patients and control subjects were 221.545 and 154.067 mg/L, respectively. These results are clearly indicated that cholesterol mean level value in diabetic patients was significantly higher than the mean value of non-diabetic subjects (p=0.001).

Table 2 represents the mean value of total triglyceride level for type II diabetic patients and control subjects were 301.132 and 99.069 mg/L, respectively. These results are clearly indicated that triglyceride mean value in diabetic patients was significantly higher than the mean value of non-diabetic subjects (p=0.001).

Table 2 represents the mean value of LDL-C for type II diabetic patients and control subjects were 316.333 and 152.438 mg/L, respectively. These results are clearly indicated that LDL-C mean value in diabetic patients was significantly (p=0.05) higher than the mean value of non-diabetic subjects.

Table 2 represents the mean value of total HDL-C level for type II diabetic patients and control subjects were 54.363 and 56.728 mg/L, respectively. These results are clearly indicated that triglyceride mean value in diabetic patients was statistically significant (p=0.05) lower than the mean value of non-diabetic subjects. The results have clearly indicated that all serum lipid and lipoproteins were significantly higher in diabetic patients compared to non-diabetic subjects except HDL –C, which is significantly lower in diabetic patients compared to non-diabetic subjects.

Among diabetic patients, people within the age group higher than 60-79 had shown increased levels of HDL, triglycerides, LDL-C and cholesterol as compared to those within lower age groups. Statistically, there is no significant difference (p>0.05), as shown in figure 2, 3, 4, 5 and 6.

Among diabetic patients, males had higher level HDL and lower levels of triglycerides, LDL and cholesterol as compared to females. there is no significant difference (p>0.05 (p> 0.05), as shown in Figure 7.
Correlation analysis was carried out between serum lipid profile and cardiovascular abnormalities among diabetic patients, and it had shown that cholesterol, triglycerides and low-density lipoprotein level were significantly (p < 0.05) correlated to cardiovascular abnormalities, while HDL had shown a statistically non-significant correlation with P-value higher than 0.05 (figure 8).

Table 1: Age (years) and BMI among Diabetic and Healthy Populations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Healthy Controls</th>
<th>Diabetic Patients</th>
<th>P-value (t-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>52.440</td>
<td>51.917</td>
<td>0.001</td>
</tr>
<tr>
<td>BMI</td>
<td>31.519</td>
<td>30.019</td>
<td>&gt; 0.05</td>
</tr>
</tbody>
</table>

Table 2: Glucose Level and Lipid Profile(TC, TG, LDL, and HDL) of Type II Diabetic Patients and Healthy Subjects

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Healthy Controls</th>
<th>Diabetic Patients</th>
<th>P-value (t-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting Glucose</td>
<td>84.135</td>
<td>214.801</td>
<td>0.001</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>154.067</td>
<td>221.545</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>TG</td>
<td>99.069</td>
<td>301.132</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>HDL</td>
<td>56.728</td>
<td>54.363</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>LDL</td>
<td>152.438</td>
<td>216.333</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

Discussion

In this study, there are differences between diabetic and non-diabetic patients in the level of blood glucose. A significant difference was observed (p=0.001). High levels of blood glucose of diabetic patients due to resistance to insulin, same results were found [12]. The fasting blood glucose level in the diabetic group is also elevated, and this indicated that there is poor control of DM. In fact, diabetes mellitus is characterized by hyperglycemia together with biochemical alterations of glucose [6] (Firdous and Khan, 2007).
The result of this study showed significant increased levels of total cholesterol (p=0.001) in diabetic patients compared to non-diabetic subjects, this increase it may be due to an increase in the plasma concentration of VLDL and LDL, which may be caused by increasing hepatic production of VLDL or decreased removal of VLDL and LDL from the circulation[13].

Figure 1: Fasting Glucose Level among Diabetic and Healthy Populations
Figure 2: Fasting Glucose Level among Diabetic and Healthy Populations for LDL
Figure 3: Lipid profile in Diabetic and healthy population for Triglyceride
Figure 4: Lipid profile in Diabetic Health population for Cholesterol
Figure 5: Lipid profile in Diabetic and Health population for HDL
Figure 6: Effect of age on lipid profile for for diabetic (estimate marginal value of HDL)
Figure 7: Effect of age on lipid profile for diabetic (estimate marginal value of LDL)
Figure 8: Effect of age on lipid profile for diabetic (estimate marginal value of Cholesterol)
The study suggests significantly increased level of LDL (p=0.001) in diabetic patients increases the number of LDL receptor, resulting in the increase in LDL-cholesterol value in diabetes mellitus [14]. Significant higher level of triglycerides (p= 0.001) in Sudanese diabetic patients may due to overproduction of VLDL lead to increased plasma levels of triglyceride which, via an exchange process mediated by cholesterol ester transfer protein (CETP), result in lower levels of high density lipoprotein HDL-cholesterol, which results faulty glucose utilization causes hyperglycemia and mobilization of fatty acids from adipose tissue. In diabetes blood glucose is
not utilized by tissue resulting in hyperglycemia. The fatty acids from adipose tissue are mobilized for energy purpose and excess fatty acid is accumulated in the liver, which are converted to triglyceride [15].

![Figure 14: Correlation between Cardiovascular Abnormalities and Lipid Profile](image)

A: LDL; P-value < 0.05  
B: TG; P-value < 0.05  
C: Cholesterol; P-value < 0.05  
D: HDL; P-value > 0.05

Significant lower level of HDL (p=0.001) in diabetic patients compared to nondiabetic subjects. Lower HDL cholesterol level is attributed to triglyceride enrichment by cholesterol ester transfer protein and increased hepatic triglyceride lipase activity [16]. Although liver is produced the HDL particles, a significant part of HDL are formed from remnant particles of TG-rich lipoproteins as metabolized. This metabolism is often defective in diabetes, lowering the production of HDL-C from the liver by protein which is called cholesterol ester transport protein (CETP) transports cholesterol ester away from HDL particles in exchange for TG from the VLDL particles. This transport protein lowers HDL-C in the blood, in addition, it promotes for small, dense LDL particles [17]. Lipid levels affected by glucose levels because metabolism of carbohydrates and lipid is interrelated to each other; because any disorder in metabolism of carbohydrate leads to a disorder in metabolism of lipid, so high concentration of cholesterol, triglycerides and a reduction in HDL cholesterol levels leads to insulin resistance with or without hyperglycemia which is related to qualitative changes in the lipid profile [18].

Report that type II diabetes mellitus usually appears in people over the age of 40, and tends to have a more gradual onset [19]. To some extent, our results have shown an agreement with [19]. Elders had a higher level of triglycerides, LDL, and cholesterol as compared to the Youngers; statistically, there is no significant difference between elders and young in lipid profile (p > 0.05).

Although both male and female for diabetic patients were overweight and the BMI for females is higher than BMI for males. Statistically, There is no significant difference (p>0.05) between them in levels of GL, TC, TG, LDL-C, and HDL-C. It might be related to different degrees of insulin resistance between the two sexes or to a direct effect of the hormonal status on one or more enzymes implicated in lipoprotein metabolism [20].

The variables such as lipid profile might affect by age, duration of diabetes, HbA1c and drug compliance [21]. Dietary compositions seem to affect the lipid profile [22]. Also, it is the effect of physical activities, obesity, hypertension, smoking, contraceptive use, environment, occupation and level of education and certain genetic predisposing factors of the population [23](Ganong, 2003). Higher levels of fat in the cells prevent the action of insulin, and so produce insulin resistance and then the development of type II DM. The high prevalence of obesity has largely been attributed to the dietary habits, which include high intake of fatty and sweet foods and dates, lack of physical activity [24]. Same results were reported by other researches [25].
In diabetes mellitus, the plasma cholesterol level is usually elevated, and this plays a role in the accelerated development of the atherosclerotic vascular disease that is a major long-term complication of diabetes in human [23]. Our study had shown that cholesterol, triglycerides, and low-density lipoprotein levels were significantly (p < 0.05) correlated to cardiovascular abnormalities, while HDL had shown a statistically non-significant correlation with P-value higher than 0.05 (figure 3.6).

These results were in concordance with [26]. The hypercholesterolemia in diabetic patients is characterized by high levels of triglycerides (hypertriglyceridemia), increasing the levels of small LDL particles and low levels of HDL [27].

References
27. Gowri MS., Westhuyzem D., Bridges SR., Anderson JW. et al. Deceased protection by HDL from poorly controlled type2 diabetic subjects against LDL oxidation may be due to the abnormal composition of HDL. Arteriosclerosis, Thrombosis, and Vascular Biology. 1999, 19:2226- 2233