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Research Article

ASSOCIATION BETWEEN INSULIN LEVEL, SERUM LIPIDS AND BODY MASS INDEX IN DIABETIC PATIENTS

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ABSTRACT

Background: a strong relation was observed between body mass index and insulin resistance which were associated with type 2 DM.
Objective: to correlate between bodies mass index and levels of insulin and lipids among type 2 diabetic patients with different body mass index.
Methods: this study was conducted in Khartoum state, it included 80 with type 2 diabetes mellitus, and another 80 apparently healthy with normal body mass index were included as control. Serum insulin level and lipids profile were estimated using chemistry analyzers.
Results: the mean concentration of serum insulin level was significantly higher in type 2 DM than control (P=0.004), and also it was positively correlates with BMI (R=0.54, P=0.003). Also in case group, there were significant higher levels of serum lipids (TC, TG, and LDL) while there was a significant reduction of HDL.
Conclusion: levels of serum insulin, TC, LDL, and TG were significantly higher in Sudanese type 2 DM patients, and insulin level correlates positively with BMI.

INTRODUCTION

Diabetes is a lifelong condition that occurs when the body cannot metabolize sugar [1]. In diabetic patient there is either not enough insulin made or resistance to the insulin where the body does not respond to it, or a combination. Insulin which is a hormone made in the pancreas controls the rate where sugar is sent to other organs and body cells for use as fuel [1].

There are different types of diabetes

- ***Type 1:*** in this type the body does not manufacture enough insulin and need daily injection or the patient suffers from autoimmune problem.
- ***Type 2:*** the pancreas cannot keep up with insulin demand; causes may be obesity and lack of exercise.
- ***Type 3:*** Gestational that can occur during pregnancy, and may be a transition to type 2 during later years in life [1].

Insulin resistance is defined as the diminished ability of cells to respond to the action of insulin in transporting glucose from the bloodstream into muscles and other tissues [2]. A fasting serum level, greater than 25mlU/L or 174pmol/L is considered insulin resistance. If the same values exist after 3 hours of last meal this confirms the result[2]. Insulin resistance is associated with obesity, glucose intolerance and dyslipidemia [3].

The prevalence of insulin resistance in obesity is not known. In Pima Indians, insulin sensitivity, measured by the euglycemic clamp technique, has been shown to decline with increasing body mass index (BMI). The function was, however, nonlinear, with most of the decrement in insulin sensitivity occurring for small increments in BMI. In other studies of insulin resistance in obesity, the groups were generally too small to assess its prevalence[4]

Furthermore, the obese groups often included subjects with impaired glucose tolerance, a condition in itself associated with insulin resistance. In obese as well as in non-obese subjects, the presence of insulin resistance signals the concomitance of other metabolic and hemodynamic abnormalities, a cluster known as the insulin resistance syndrome [4].

The metabolic syndrome and type 2 diabetes mellitus (T2DM) cluster several abnormalities, including insulin resistance, dyslipidemia, and markers of cardiovascular disease. The fasting serum lipid profile [triglycerides (TGs), total cholesterol (TC), and LDL- and HDL-cholesterol (LDL-C and HDL-C)] is used to calculate lipid ratios (TC/HDL-C, LDL-C/HDL-C, and

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TG/HDL-C) that allow identification of individuals at increased risk for cardiovascular disease [5]. Because these individuals are also frequently insulin resistant, several studies analyzed the relationships between lipid ratios and insulin sensitivity[5].

Increased serum concentrations of LDL-cholesterol (LDL-C) 4 are atherogenic, whereas increased HDL-cholesterol (HDL-C) is considered cardio protective. Increased serum concentrations of triglycerides (TGs) have also been recognized as a risk factor for cardiovascular disease [5]. Obesity and insulin resistance are considered by some scientists as strong predictors of coronary heart disease(CHD) risk, and insulin resistance at any given degree of obesity increases the risk of CHD and T2DM[6]. A common finding in obese adults is an altered lipid profile that further increases the risk of CHD and insulin resistance. Prevention of T2DM, CHD and metabolic syndrome can be achieved through early treatment of insulin sensitivity and improvement of lipid profile. Positive correlation was detected between triglyceride level and TG/HDL-C ratio with insulin resistance. TG/HDL-C ratio can easily be obtained and it can serve as a good biomarker for insulin resistance[7].

In 2014, a study conducted by Ozder investigated the association between serum lipid profile and blood glucose. A total of 132 patients with T2DM were recruited. The results showed significantly higher mean serum levels of TC, TG, and LDL and significantly lower mean serum levels of HDL. A significantly positive correlation was observed between FBG with TC ($p \leq 0.05$) and TG (($p \leq 0.05$). Furthermore, significant correlations were detected between serum levels of TC, TG, LDL, and hepatosteatosis and HbA1c (($p \leq 0.05$)[8].

Another study was carried outby Kawamoto *et al*. to demonstrate the associations between newly addressed lipid profiles and metabolic syndrome (MetS)- associatedvariables. They concluded that in Japanese community-dwelling adults, lipid ratios of TG/HDL-C, T-C/HDL-C,LDL-C/HDL-C as well as TG and HDL-C were consistently associated with MetS, insulin resistance and serum HMW adiponectin. Lipid ratios may be used as reliable markers [9].

In 2007, a study by Stein *et al*., aimed to examine the association between plasma lipid concentrations and insulin resistance in African Americans and to determine if insulin resistance is present at a lower triglyceride (TG) threshold than is used for metabolic syndrome criteria. Their conclusion stated that insulin resistance is associated with triglyceride levels below the current metabolic syndrome threshold criterion[10]. A study by Brehm *et al*. that investigated the relationship between serum lipoprotein ratios and insulin resistance in obesity, demonstrated that the TG / HDL- C ratio positively correlates with insulin resistance in severely obese non-diabetic individuals[5].

Steinberger *et al*. explored the relation between lipid levels and insulin resistance in obese adolescents in comparison with non-obese adolescents. The results showed that the degree of insulin resistance plays an important role in the variance in the levels of triglycerides, LDL-C, and HDL-C[11]. Another study by Chung *et al*. showed that BMI has independent positive association with indices of insulin and an inverse association with β-cell function adjusted for insulin resistance in Korean patients newly diagnosed with T2DM[12].

A review article by Roland and Krauss on lipids and lipoproteins in patients with T2DM concluded that insulin resistance plays a key role in the development of diabetic dyslipidemia. Each of the lipid abnormalities (low HDL, small dense LDL, and elevated triglycerides) is associated with an increased risk of CHD[13].

Research studies have shown that people with BMI >35have a higher risk of developing T2DM. As diabetes, obesity, and hyperlipidemia are usually associated together and are considered as important predecessors for CHD, this study is aimed to assess this association.

This study is aimed to identify the relationship between insulin level, lipid profile, and BMI among patients with T2DM. The permission of this study was obtained from the ministry of health in addition to the different hospitals involved. All the participants were informed about the aims and benefits of the study during interviews prior to filling of questionnaire and sample collection.

MATERIALS AND METHODS

The study was designed as a quantitative, descriptive, analytic case-control study. It was conducted in Khartoum state. Participants enrolled in this study were selected from different hospitals in Khartoum state during the period January to March 2015.

Population of this study was categorized into case T2DM (134 patients) and control groups (140 healthy individuals).

Data Collection and Clinical Examination

Clinical data from each participant was collected using questionnaires. The permission of this study was obtained from the ministry of health in addition to the agreement of different hospitals involved. All the participants were informed about the aims and benefits of the study during interviews prior to filling of questionnaire and sample collection.

Laboratory methods

Insulin level was estimated by radio immunoassay. The four basic necessities for a radio immunoassay system are: a specific antiserum to the antigen in human insulin, the availability of radioactive labeled form of human insulin, a method whereby antibody –bound tracer can be separated from the unbound tracer, and finally, an instrument to count radioactivity.

The human insulin assay utilizes labeled 1251-insulin and a human insulin antiserum to determine the level of human Insulin in serum by the double antibody /PEG technique. Triglycerides and total cholesterol were estimated using enzymatic spectrophotometric method.

Low density lipoprotein and high density lipoprotein were estimated using indirect precipitation method.

Calculation of body mass index (BMI):

$$\text{BMI} = \frac{\text{Weight/kg}}{\text{Square of height/cm}}$$

Data analysis

Data was analyzed using SPSS program version 20, the result of body mass index, serum insulin and lipid profile were expressed as mean ± standard deviation (M±SD) and comparison between the different parameters was done using independent T-test with P-value ≤ 0.05 was considered significant.

The accuracy of the results was checked using reference material.

RESULTS

A total of 274 volunteers participated in this study, 134 were cases matched in age and gender with 140 control.

As shown in the table below, a significantly higher BMI values were observed in T2DM compared to control (24.23±3.13), (27.02±5.34) respectively, p.value <0.05. Insulin level was significantly higher in T2DM than in control (26.43±12.79), (12.31±15.62) respectively, p.value <0.05. Also total cholesterol and triglycerides were significantly higher in cases than control, for cholesterol (164±20.20), (164.91±41.56), triglycerides (118.94±7.42), (151.86±57.41) respectively. While HDL levels were lower in cases as compared to controls (19.52±3.98) ,(17.35±7.95) but the result did not achieve a significant difference, p.value >0.05. It was also found that LDL is significantly higher in cases (117.86±35.08) than in controls (107.55±12.49), p.value=<0.05.

The correlation analysis showed that there were a significant correlation between insulin levels and BMI (R=0.54, P=0.03).

Comparison of lipid profile, BMI and insulin level between the control and case groups

Variable	Patients (n= 134)	Control (n=140)	P.Value
BMI	27.02±5.34	24.23± 1.13	0 .010
Cholesterol	165.91±41.56	164± 20.20	0.009
Insulin	26.43 ±12.79	12.31 ± 15.62	0.004
Triglyceride	151.86± 57.41	118.94± 7.24	0.001
LDL- Cholesterol	117.86± 35.08	107.55± 12.49	0.010
HDL-Cholesterol	37.35± 7.95	55.52± 3.98	0.035

DISCUSSION

Results of the current study showed a significant increase in the mean of the insulin levels in T2DM compared to the control group (P=0.010). This result is in accordance with the result observed by Jin Ook Chung *et al* who reported that the scores of BMI had independent positive associations with indices of insulin resistance and inverse association with β-Cell function[12].

Also there is a significant increase in the mean of cholesterol and triglycerides in the case group compared to the control group (P=0.009, 0.001) respectively. This result agrees with the result observed by Mingming who reported that there was a significant increase of insulin in T2DM of their study. But it in contrast with results from the study by Songa *et al* where it showed no significant difference between the cholesterol levels between the cases and controls; whereas the level of triglycerides was very high in the cases[14]. On the other hand, the study by Aljabri *et al*, showed significantly higher serum triglycerides level and lower cholesterol, LDL and HDL in T2DM[15].

The current study showed that there is no significant difference between the HDL and LDL in both groups, this result disagrees with the result observed by Julia Steinbergr *et al* (2005) who reported that there was a significant increase in the serum LDL and a significant decrease in the HDL in the case group[11]. The study by Ozder also revealed a significant increase in the mean serum levels of LDL and a significant decrease in the mean serum level HDL in the case group[8]. This difference between the result in this study and the previous study may be due to the small sample size, the fasting status can be another factor.

The present data demonstrated that there is a significantly strong positive correlation between insulin resistance, BMI, cholesterol, and triglyceride.

CONCLUSION

From the results of this study it can be concluded that, the BMI, serum levels of insulin, cholesterol and triglycerides were significantly increased in diabetic patients.

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