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# Correlation between Lipid Profile and Blood Pressure Levels: A Comparative Analysis between Healthy Controls, Type 1 Diabetics and Type 2 Diabetics

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## ABSTRACT

*Objective: Dyslipidemia is one of the major risk factor of cardiovascular disease in diabetes mellitus. The distinctive aspects of diabetic dyslipidemia include high plasma triglyceride concentration, low concentration of HDL cholesterol and increased level of small densely packed LDL-cholesterol particles. Therefore, the objective of this study was to compare the lipid abnormalities with blood pressure in control, type 1 and 2 Diabetes mellitus.*

*Methodology: This was an observational, descriptive study conducted in diabetic outpatient department (OPD) of Jinnah post graduate medical institute, Karachi by using non-probability convenient sampling technique. The duration of study was about six months. The study sample comprised of 30 participants each in the control, type 1 diabetes and type 2 diabetes groups. Blood pressure was measured and blood samples were drawn to assess the biochemical diagnostic parameters such as: Fasting lipid profile (total cholesterol (TC), low density lipoprotein (LDL) cholesterol, high density lipoprotein (HDL) cholesterol, and triglyceride [TG]). Chi-square test and Pearson's correlation was used to determine the variables association with T2DM and T1DM.*

*Results: The study results showed that diastolic blood pressure level was significantly correlated only with the triglyceride level (ρ=-0.419, p=0.021). It was also revealed that among the type 2 diabetes group, systolic blood pressure level was significantly correlated only with the HDL level (ρ=0.454, p=0.012) whereas the diastolic blood pressure level was not significantly correlated with any parameter of the lipid profile while among the type 1 diabetes group, both the systolic and diastolic blood pressure levels were not significantly correlated with any parameter of the lipid profile.*

*Conclusion: This study concluded that systolic blood pressure was significantly higher in dyslipidemic patients with Type 2 Diabetes Mellitus, among them low HDL was frequently observed. Diastolic blood pressure was significantly correlated with Triglycerides level in control group.*

**Key words:** Dyslipidemia, Triglyceride, High density lipoprotein, Type 1 and 2 diabetes mellitus

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## INTRODUCTION

Diabetes mellitus is a chronic state of disease that arises with inadequate production of insulin or ineffectively used of insulin by body. Type 2 diabetic patients have a significantly greater risk of cardiovascular morbidity and mortality than individuals without diabetes [1]. Diabetes

was formerly considered to be a disease of the wealthy individuals and mostly observed in urban areas but owing to urbanization, dietary changes and a more sedentary lifestyle for most of the people, middle-income and low-income countries like Pakistan has been affected [2].

The International Diabetes Federation (IDF) stated in its Atlas the incidence of diabetes for Pakistan to be predicted 6.8% between 20–79 years of age [3]. Although healthcare workers always thought this to be underestimated. Consequently, there were contradictory results with occurrence ranging from7.2% to 19.21% in different regions of the Pakistan [4].

Globally, Type 2 Diabetes Mellitus (T2DM) with associated cardiovascular complications is main public health dilemma. T2DM individuals have two to four times increased probability of coronary artery disease (CAD) that is the primary reason of death among T2DM patients [5]. Dyslipidemia and hypertension are most important variable risk factors for T2DM and associated CAD that is accounted for above 87% of disability in lower and middle class nations [6,7]. Additionally, prediabetes (an intermediary metabolic condition between normal glucose level and T2DM) has also been observed to be related with higher chances for cardiovascular disease [8].

Dyslipidemia in diabetes patients are characteristically recognized by high Total cholesterol (T-Chol), high triglycerides (Tg), low high density lipoprotein cholesterol (HDL-C) and higher levels of small densely packed LDL particles. Low density lipoprotein cholesterol (LDL-C) levels could be normal or moderately increased. Abnormalities in lipid profile are commonly found in T2DM and prediabetes individuals [9,10] but variation in different lipids exist between racial groups, financial levels, and entrance to health care system [11,12]. A currently available meta-analysis revealed that abnormalities in lipid parameters indicate, somewhat, the possibility of T2DM [13]. Moreover, several researches revealed a significant association between CAD and combination of high Tg and low HDL-C in T2DM patients as compared to the individual evaluation of two lipid parameters [14,15].

As far as Type 1 diabetes mellitus (T1DM) is concerned, Dyslipidemia and Hyperglycemia are metabolic discrepancies usually found in these young patients and both augment the probability of cardiovascular disease (CVD). In patients with T1DM, chances of atherosclerosis are increasing that leads to increased morbidity and mortality [16]. A number of researches have described abnormalities of serum lipids along with association between elevated glycosylated haemoglobin (HbA1c) and serum lipid levels in children with T1DM [17,18]. Dyslipidemia is an avoidable risk factor for CVD. Therefore, Screening for dyslipidemia should be carried out almost immediately following diagnosis when diabetes has controlled in all children with T1DM above 10 years of age (International Society for Pediatric and Adolescent Diabetes) and this should be repeated after each 5 year at normal glycemic control. Screening should initiate at 2 year of age when there is a strong family history of hypercholesterolemia and earlier CVD with unknown family history [19].

The experimental trials for emergent innovative remedial policies for diabetes often focused on correcting dyslipidemia [20-22]. The skilled panel of the National Heart, Lung and Blood Institute (NHLBI) in 2011 suggested universal lipid screening for children between 9 to 11 years of age and this has been approved by the American Academy of Pediatrics (AAP) [23]. This principle was produced to give timely recognition of probable risks and support cardiovascular health. In North America, Atherosclerotic cardiovascular disease (CVD) is the principal cause of death in adults [24]. The usual lipid profile involves total cholesterol (TC), high density lipoprotein (HDL) and triglycerides (TG). By the help of these parameters values, low density lipoprotein (LDL), TC/HDL ratio and non-HDL cholesterol are evaluated for clinical assessment. Cut off points for abnormal lipid levels (TC ≥ 200 mg/dL, LDL cholesterol ≥ 130 mg/dL, HDL cholesterol ≤ 35 mg/dL, and TG ≥ 150 mg/dL) were considered [25].

Approximately half of all deaths in type 2 diabetes patients are caused by Cardiovascular disease (CVD) [24], while rising incidence of cardiovascular events are caused by the existence of diabetes at a population level [26]. A number of epidemiological researches have evidently revealed a direct association between blood pressure, blood glucose level, LDL-cholesterol, and the diabetes complications [27,28].

To understand the relationship between serum lipid parameters and different phases of glucose intolerance is of remarkable clinical and public health significance and such statistics can generate the source for future prevention strategies for diabetes and its associated complications in Pakistan. The aim of the present study was to compare the correlation between serum lipid abnormalities and blood pressure in patients with control, type 1 and 2 Diabetes mellitus.

## METHODOLOGY

This was an observational, descriptive study conducted in diabetic outpatient department (OPD) of Jinnah post graduate medical institute, Karachi by using non-probability convenient sampling technique. The duration of study was about six months after taking the approval of synopsis from the concerned department. The study sample comprised of 30 participants each in the control, type 1 diabetes and type 2 diabetes groups. Patients with type I and II diabetes mellitus of both gender, age >40 years for type II diabetes and age >10 years for type I diabetes were included in the study whereas patient taking diuretics therapy, significant co-morbidities like Chronic liver disease, Ischemic heart diseases, patients who have undergone major transplant surgeries, patients with end stage renal disease and gastro intestinal disease were excluded from the study.

Blood samples of participants were drawn from the diabetic clinics of Jinnah Post graduate Medical Center (JPMC), Karachi and Dow University Ojha Campus, Karachi. After taking the permission, blood collected in the non- heparinized tube was instantly centrifuged at 2000 rpm for 20 minutes. The clear supernatants serum was used for measuring a range of biochemical investigative parameters like Random blood glucose levels, Fasting blood glucose levels, HbA1c, Fasting lipid profile (total cholesterol (TC), high density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL) and triglyceride [TG]) in conditions of metabolic stability following minimum 8 hours of fasting. Blood pressure was measured two times in the right arm in both sitting and standing position. Measurements were taken 5 min distant, and average of two readings was recorded for all participants.

Data was collected from diabetic clinics of medical wards of Jinnah Post graduate Medical Center (JPMC) Karachi and analyzed by using SPSS version 23.0. Chi-square test and Pearson's correlation was used to determine the variables association with T2DM and T1DM. $P<0.05$ was taken as statistically significant.

## RESULTS

The study sample comprised of 30 participants each in the control, type 1 diabetes and type 2 diabetes groups.

The study results showed that among the control group, systolic blood pressure level was not significantly correlated with any parameter of the lipid profile whereas the diastolic blood pressure level was significantly correlated only with the triglyceride level ($\rho$=-0.419, p=0.021), as shown in Table 1A and 1B.

The study results further showed that among the type 1 diabetes group, both the systolic and diastolic blood pressure levels were not significantly correlated with any parameter of the lipid profile, as shown in Table 2A and 2B.

The study results also revealed that among the type 2 diabetes group, the systolic blood pressure level was significantly correlated only with the HDL level ($\rho$=0.454, p=0.012) whereas the diastolic blood pressure level was not significantly correlated with any parameter of the lipid profile, as shown in Table 3A and 3B.

**Table 1A: Correlation between lipid profile and systolic blood pressure levels (Control).**

| Variables (n=30) | Systolic Blood Pressure (mmHg) | |
|---|---|---|
| | ρ | P |
| Triglyceride (mg/dL) | -0.289 | 0.121 |
| LDL (mg/dL) | -0.03 | 0.873 |
| HDL (mg/dL) | -0.226 | 0.23 |
| Total Cholesterol (mg/dL) | 0.177 | 0.349 |

**Table 1B: Correlation between lipid profile and diastolic blood pressure levels (Control).**

| Variables (n=30) | Diastolic Blood Pressure (mmHg) | |
|---|---|---|
| | ρ | P |
| Triglyceride (mg/dL) | -0.419 | 0.021 |
| LDL (mg/dL) | -0.147 | 0.439 |
| HDL (mg/dL) | -0.202 | 0.284 |
| Total Cholesterol (mg/dL) | 0.313 | 0.092 |

**Table 2A: Correlation between lipid profile and systolic blood pressure levels (Type 1 Diabetics).**

| Variables (n=30) | Systolic Blood Pressure (mmHg) | |
|---|---|---|
| | ρ | p |
| Triglyceride (mg/dL) | -0.002 | 0.993 |
| LDL (mg/dL) | -0.235 | 0.211 |
| HDL (mg/dL) | -0.132 | 0.486 |
| Total Cholesterol (mg/dL) | -0.158 | 0.403 |

**Table 2B: Correlation between lipid profile and diastolic blood pressure levels (Type 1 Diabetics).**

| Variables (n=30) | Diastolic Blood Pressure (mmHg) | |
|---|---|---|
| | ρ | p |
| Triglyceride (mg/dL) | 0.034 | 0.86 |
| LDL (mg/dL) | -0.189 | 0.316 |
| HDL (mg/dL) | -0.107 | 0.572 |
| Total Cholesterol (mg/dL) | -0.244 | 0.193 |

**Table 3A: Correlation between lipid profile and systolic blood pressure levels (Type 2 Diabetics).**

| Variables (n=30) | Systolic Blood Pressure (mmHg) | |
|---|---|---|
| | ρ | p |
| Triglyceride (mg/dL) | 0.065 | 0.735 |
| LDL (mg/dL) | -0.111 | 0.56 |
| HDL (mg/dL) | 0.454 | 0.012 |
| Total Cholesterol (mg/dL) | -0.261 | 0.164 |

**Table 3B: Correlation between lipid profile and diastolic blood pressure levels (Type 2 Diabetics).**

| Variables (n=30) | Diastolic Blood Pressure (mmHg) | |
|---|---|---|
| | ρ | p |
| Triglyceride (mg/dL) | 0.019 | 0.921 |
| LDL (mg/dL) | -0.156 | 0.411 |
| HDL (mg/dL) | 0.343 | 0.064 |
| Total Cholesterol (mg/dL) | -0.278 | 0.137 |

## DISCUSSION

Dyslipidemia in diabetes mellitus is related with atherosclerosis leads to develop coronary artery disease. This study demonstrated the association of lipid imbalance and blood pressure in patients with type 1 and 2 diabetes mellitus.

One of the studies conducted to find out the pattern of dyslipidemia in type 2 diabetes mellitus patients in a rural medical college. The most frequently observed dyslipidemia in their study was hypertriglyceridemia that was reported in 56% cases, and low HDL was found in 52.9% cases [29] The present study showed the most commonly observed dyslipidaemia was low HDL that was significantly correlated with systolic blood pressure in Type 2 diabetes mellitus (ρ=0.454, p=0.012) although level of triglycerides were also raised but not at significant level.

Another observational cross sectional study investigated the relationship between blood glucose level and serum lipid profile, assuming that timely recognition of lipid abnormalities and early treatment can reduce the chances of atherogenic cardiovascular disorder and cerebrovascular catastrophe in T2DM patients. They also reported that significant correlation was found between HbA1c and serum levels of lipid profile such as TC, TG and HDL-C ($p<0.05$) while no significant correlation observed between HbA1c with LDL-C in T2DM patient [30]. The present study was consistent with the above reported study and revealed that significant correlation was observed between HDL-C and systolic blood pressure (ρ=0.454, p=0.012) in patients with T2DM while showed inconsistency as an insignificant correlation found with triglyceride, LDL and total cholesterol level.

Lipid abnormalities in Diabetes is frequently described by high Total Cholesterol, high Triglycerides, low HDL cholesterol, and raised LDL level [10,31]. It has been illustrated by the research in a rural population of Bangladesh that assessed serum lipid profile independently or in combined form along with their relationship with status of glucose intolerance in T2DM and prediabetes. Therefore, it was revealed that T2DM was significantly associated with high T-Chol level ($p<0.001$), low level of HDL-C (p=0.044), high Triglycerides ($p<0.001$) [31]. As far as the present study

is concerned, significantly low level of HDL (ρ=0.454, p=0.012) was reported in lipid profile of patients with T2DM. Besides, Triglycerides (ρ=0.065, p=0.735) and T-Chol level (ρ= -0.261, p=0.164) had insignificant correlation with blood pressure in T2DM patients.

Another descriptive study determined the association of blood pressure with Non-HDL Cholesterol (Non-HDL.C) in type 2 diabetes patients. Their study reported that there was insignificant association observed between hypertension and Non-HDL.C in type 2 diabetes patients. On the other hand, the increased Non-HDL.C level in most of type 2 diabetic patients showed significant correlation with Total.C, Triglycerides and LDL.C requires its screening regardless of blood pressure status [32]. The present study was not in accordance with the above cited study and reported that systolic blood pressure had significant association with HDL (ρ=0.454, p=0.012) in T2DM whereas insignificant correlation with Total.C (ρ= -0.261, p=0.164), LDL.C (ρ= -0.111, p=0.56) and Triglycerides (ρ=0.065, p=0.735).

Likewise, another cross-sectional study evaluated the dyslipidemia in children and adolescents with T1DM and its association with other risk factors. The major dyslipidemic status was increased level of triglycerides in their study. Their study evidently supports that uncontrolled glycemic level as a probable modifiable risk factor for dyslipidemia [19]. Our study showed that high serum triglycerides levels significantly correlated with blood pressure level in control group (ρ=-0.419, p=0.012) reflecting the risk factor of progression of Diabetes type 1 and 2.

Despite the fact that, various studies reported that the most common dyslipidemia was high LDL, although high LDL was elevated in dyslipidemic group however it did not attain the statistical significant level (p=0.059) [33,34]. Similarly, one study reported positive association between HbA1c and serum lipid thereby presenting the proof of positive effect on serum lipid levels by controlling glycaemic level in children and adolescents [36]. Our study was inconsistent with the above reported studies and stated that most frequent dyslipidemia was low HDL with significant correlation (ρ=0.454, p=0.012) with blood pressure in T2DM patients.

Therefore, it is stated that lipid abnormalities is found commonly in type 1 and 2 diabetes patients and appears to be correlated with glycaemic control. Since it is a significant risk factor that is responsible for coronary heart disease and eventually associated with complication leads to morbidity rate and greater premature mortality, so timely assessment, prevention and treatment of dyslipidemia could avoid or reduce the chances of vascular damages.

## CONCLUSION

This study concluded that systolic blood pressure was significantly higher in dyslipidemic patients with Type 2 Diabetes Mellitus, among them low HDL was commonly observed. Diastolic blood pressure was significantly correlated with Triglycerides level in control group. Furthermore, high LDL, low HDL, Triglyceride were insignificantly correlated with blood pressure in children and adolescents with Type 1 Diabetes Mellitus. Therefore, timely assessment, prevention and treatment of dyslipidemia could avoid or reduce the chances of vascular damages.

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