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ORIGINAL ARTICLE

LIPID PROFILE IN TYPE 2 DIABETICS VERSUS NON-DIABETIC CONTROLS IN ADULT POPULATION OF DISTRICT BANNU, PAKISTAN

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ABSTRACT

Background: High cholesterol, triglyceride and LDL and low HDL are high risk factors in type 2 diabetics in giving rise to cardiovascular diseases. The objectives of this study were to compare the serum concentrations (mg/dL) of cholesterol, TG, HDL and LDL in type 2 diabetics versus non-diabetic controls in adult population of district Bannu, Pakistan.

Materials & Methods: This comparative cross-sectional study was conducted in Department of Pathology, Bannu Medical College, Bannu, Pakistan from March, 2020 to February, 2021. Total known 100 type 2 diabetics along with 50 non-diabetic controls of >35 years age were selected. Those with acute myocardial infarction, acute cerebrovascular accident, chronic renal failure, acute burns, trauma, post-surgery, pregnant women and those taking lipid/ blood pressure lowering drugs were excluded. Socio-demographic variables were age in years, sex, occupation, residence and family income/month in PKR. Serum cholesterol, triglycerides, HDL and LDL were four research variables on ratio scale and were analyzed by mean, SD and range with 95% CI. Independent samples t-test was used to compare the variables between the two groups.

Results: The study group included 100 type 2 diabetics (66 men and 34 women) and 50 (29 men and 21 women) controls. Mean cholesterol concentration (mg/dL) was significantly higher (p=<.0001) in diabetics (208.22±55.24) than controls (150.26±25.29). Mean triglycerides concentration (mg/dL) was significantly higher (p=<.0001) in diabetics (202.58±82.62) than controls (157.88±53.42). Mean LDL concentration (mg/dL) was significantly higher (p=<.0001) in diabetics (148.11±55.06) than controls (113.22±32.97). Mean HDL concentration (mg/dL) was significantly lower (p=.002) in diabetics (42.48±14.24) than controls (49.38±11.76).

Conclusion: The current study concludes that serum concentrations of cholesterol, triglyceride and LDL were significantly higher in type 2 diabetics than controls, while HDL was lower in diabetics than controls. High cholesterol, TG and LDL along with low HDL are high risk factors in type 2 diabetics in giving rise to cardiovascular diseases; that needs evaluation at earlier stages.

KEY WORDS: Diabetes Mellitus Type 2; Triglycerides; HDL; LDL; Cholesterol.

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1. INTRODUCTION

1.1 Background

Diabetes mellitus (DM) is a chronic disorder of humans with increased blood glucose level due to disturbance in carbohydrate, protein and lipids metabolism caused by decreased insulin level or sensitivity to tissues,[1] divided into type-1 and type-2 diabetes mellitus. The American Diabetes Association used several criterions for diagnoses of type 2 diabetic mellitus and one of these is the plasma level of glucose on fasting ≥126 mg/dL in more than one time. Values of plasma glucose on fasting are ideal for simplicity and monitoring of hyperglycemia.[2] Obesity, ethnicity, sedentary life style, sex, family history, hypertension and smoking are threats for the development of type 2 DM.[3] Lipid abnormalities, obesity, hypertension, and cardiovascular diseases

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are more commonly found in diabetics as compared to general population. Globally 462 million peoples get affected with type 2 diabetes corresponding to 6.28% of global population.[4]

According to 1st National Diabetic Survey of Pakistan (1994-1998) by Shear, et al.,[5-7] the prevalence of diabetes in Sindh province was 13.55%, in NWFP province 18.17% and in Punjab province 10.85%. Yar, et al.[8] in Rahim Yar khan, reported the prevalence of DM as 19.38%. The prevalence of DM in Baluchistan province, Pakistan by Shera, et al.[9] was 9.05%. The overall Prevalence of diabetes in year 2015 was 11.77% in a systemic review. The prevalence percentage stated in Second National Diabetic Survey of Pakistan was 26.3% with both known and newly diagnosed patients.[10]

Diabetes mellitus causes secondary hyper-lipidemia and dyslipo-proteinemias or dyslipidemias due to insulin resistance or insulin deficiency or both. Dyslipidemia may be manifested with one or more lipid profile abnormalities of serum, low density lipoproteins, and high density lipoproteins, triglycerides and total cholesterol level in fasting state.[11] Type 2 diabetes mellitus is commonly associated with abnormalities of plasma lipids and lipoproteins with elevation in triglycerides, low density lipoproteins and reduction in HDL concentrations known as dyslipidemia and are leading risk factors for cardiovascular & coronary artery diseases.[12] The lipids changes in diabetics attributed to free fatty acids flux that are secondary to insulin resistance resulting in increased plasma lipids.[13] Lipid abnormalities in diabetics are two times more common with respect to the general population. Cardiovascular and cerebrovascular disorders are frequent complications in diabetes related to dyslipidemia. Mortality from coronary artery disease (CAD) is common in dyslipidemia diabetics' individuals. CAD incidence is 2 to 4 times more frequent in both genders of diabetic patients with cardiovascular disease as compared to non-diabetic population.[14]

Research objectives (ROs)

RO: 1-4: To measure the serum concentrations (mg/dL) of cholesterol, TG, HDL and LDL in type 2 diabetics and non-diabetic controls in adult population of district Bannu, Pakistan.

RO 5-6: To compare serum concentrations (mg/dL) of cholesterol, TG, HDL and LDL in type 2 diabetics versus non-diabetic controls in adult population of district Bannu, Pakistan.

1.2 Research (Null) hypotheses (RHs)

H_{01}: Statistically, there is no difference in the serum concentration of cholesterol in type 2 diabetics versus non-diabetic controls in adult population of district Bannu, Pakistan.

H_{02}: Statistically, there is no difference in the serum concentration of triglycerides (TG) in type 2 diabetics versus non-diabetic controls in adult population of district Bannu, Pakistan.

H_{03}: Statistically, there is no difference in the serum concentration of high density lipoproteins (HDL) in type 2 diabetics versus non-diabetic controls in adult population of district Bannu, Pakistan.

H_{04}: Statistically, there is no difference in the serum concentration of low-density lipoproteins (LDL) in type 2 diabetics versus non-diabetic controls in adult population of district Bannu, Pakistan.

2. MATERIALS & METHODS

2.1 Design, duration & setting: This comparative cross-sectional study was conducted in the Department of Pathology, Bannu Medical College, Bannu, Pakistan from March, 2020 to February, 2021. The sample was collected from Clinical Laboratory of DHQ Teaching Hospital, Bannu, Pakistan. Ethically the study was approved by the Institutional Ethical Review Committee. Consent of the subject was sought before inclusion.

2.2 Population, sample size & technique and selection: Bannu is a southern district of Khyber Pakhtunkhwa province, Pakistan with population size of 1,167,071 in 2017 census.[15] Total 100 type 2 diabetics (study group) along with 50 non-diabetic controls were conveniently selected from this population. Known patients of T2DM and non-diabetic controls of more than 35 years age were eligible. Those with acute myocardial infarction, acute cerebrovascular accident, chronic renal failure, acute burns, trauma, post-surgery, pregnant women and those who were taking lipid/ blood pressure lowering drugs were excluded from the study.

2.3 Blood sample collection and laboratory testing

2.3.1 Blood sample collection and serum separation: Following the criteria of overnight fasting for lipid profile, 3-5 ml of blood was collected from the subjects of both groups using standard vein-puncture technique in yellow tube (gel tube). The serum was separated from collected blood through centrifugation technique at 3000 RPM/min.

2.3.2 Measurement of lipid profile and blood sugar: Blood sugar estimation was done using enzymatic glucose oxidase-peroxidase colorimetric endpoint essay, while lipid profile estimation was done with commercially available kits (Cholesterol: Cholesterol oxidase/p-aminophenazone method[16], Triglycerides: Glycerol-3-Phosphate oxidase/p-aminophenazone method[17], HDL and LDL: Direct. Enzymatic colorimetric method[18]), using Micro-Lab 300 (MERCK) semi-automated chemistry analyzer.

2.4 Data collection & analysis plan: Socio-demographic data was collected for sex, occupation, residence and family income/month in PKR, all on

categorical scale and was described by count and percentage. Age in years was a ratio variable and was described by mean & SD. Serum cholesterol, triglycerides, HDL and LDL were four research variables on ratio scale. Mean, standard deviation, minimum, maximum and range are given for both the groups separately with 95% confidence interval of mean for population for all the four ratio variables. Independent samples t-test was used to compare the variables between the two groups through IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY).

3. RESULTS

3.1 Socio-demographic characteristics of diabetics and control subjects: The socio-demographic characteristic of type 2 diabetics and controls are shown in Table 3.1.

3.2 Descriptive statistics & estimation of parameters

The serum concentration of cholesterol, triglycerides and HDL were higher in diabetics than controls, while LDL was lower in diabetics than controls. (Tables 3.2)

Table 3.1: Socio-demographic characteristic of type 2 diabetics (n1=100) and controls (n2=50) in adult population of district Bannu, Pakistan

Variables		T2DM patients (n1=100)		Control subjects (n2=50)	
		Count	Percentage	Count	Percentage
Sex	Men	66	66%	29	58%
	Women	34	34%	21	42%
Occupation	Field & Office work	74	74%	34	68%
	No work	26	26%	16	32%
Residence	Rural	78	78%	11	22%
	Urban	22	22%	39	78%
Family Income/ month PKR	Low (≤15,000)	30	30%	16	32%
	Moderate (>15,000-≥50000)	48	48%	23	46%
	High (>50000)	22	22%	11	22%
Mean Age		54.76 ± 8.91		49.16 ± 8.46	

T2DM: type 2 diabetes mellitus, n: number

Table 3.2: Descriptive statistics & estimation of parameters for cholesterol, triglycerides, LDL, HDL in T2DM (n1=100) and controls (n2=50) in adult population of district Bannu, Pakistan

Variables	Group	Sample statistics					95% CI of mean	
		Mean	Min	Max	Range	SD	Lower	Upper
Cholesterol (mg/dL)	Diabetics	208.22	122	303	181	55.24	197.26	219.18
	Control	150.26	106	205	99	25.29	143.07	157.45
Triglycerides (mg/dL)	Diabetics	202.58	116	423	307	82.62	186.18	218.98
	Control	157.88	105	372	267	53.42	142.70	173.06
LDL (mg/dL)	Diabetics	148.11	77	268	191	55.06	137.18	159.04
	Control	113.22	74	198	124	32.97	103.85	122.59
HDL (mg/dL)	Diabetics	42.48	24	70	46	14.24	39.65	45.31
	Control	49.38	28	70	42	11.76	46.04	52.72

LDL: low density lipoproteins, HDL: High density lipoproteins, mg/dL: milligram per deciliter SD: Standard deviation, CI; confidence interval

3.3 Hypothesis Testing

3.3.1 Serum Cholesterol (H_{01}): Independent sample t-test was used to compare the mean cholesterol of diabetics and controls at alpha .05. The p-value was less than .05; H_{01} was proved false and hence rejected. The mean cholesterol concentration was significantly higher in diabetics than controls. (Table 3.3.1)

3.3.2 Serum Triglycerides (H_{02}): Independent sample t-test was used to compare the mean triglycerides of diabetics and control subjects at alpha .05. The p-value was less than .05; H_{02} was proved false and hence rejected. The mean triglycerides concentration was significantly higher in diabetics than controls. (Table 3.3.2)

3.3.3 Serum LDL (H_{03}): Independent sample t-test was used to compare the mean LDL of diabetics and control subjects at alpha .05. The p-value was less than .05; H_{03} was proved false and hence rejected. The mean LDL concentration was significantly higher in diabetics than controls. (Table 3.3.3)

3.3.4 Serum HDL ($H_0$4): Independent sample t-test was used to compare the mean HDL of diabetics and control subjects at alpha .05. The p-value was less than .05; H_{04} was proved false and hence rejected. The mean HDL concentration was significantly lower in diabetics than controls. (Table 3.3.4)

Table 3.3.1: Comparison of mean cholesterol in T2DM (n1=100) and controls (n2=50) in adult population of district Bannu, Pakistan

Group	Mean	SD	Mean difference	95% CI of difference		t-value	d.f.	p-value (2-tailed)
				Lower	upper			
Diabetics	208.22	55.24	57.96	44.95	70.96	8.80	148	<.0001
Controls	150.26	25.29	Independent-samples t-test			H_{01} rejected at □ 0.05		

n = Sample size, SD = Standard deviation, d.f. = Degree of freedom

Table 3.3.2: Comparison of mean Triglycerides in T2DM (n1=100) and controls (n2=50) in adult population of district Bannu, Pakistan

Group	Mean	SD	Mean difference	95% CI of difference		t-value	d.f.	p-value (2-tailed)
				Lower	Upper			
Diabetics	202.58	82.62	44.70	22.56	66.83	3.99	148	<.0001
Controls	157.88	53.42	Independent-samples t-test			H_{02} rejected at □ 0.05		

n = Sample size, SD = Standard deviation, d.f. = Degree of freedom

Table 3.3.3: Comparison of mean LDL in T2DM (n1=100) and controls (n2=50) in adult population of district Bannu, Pakistan

Group	Mean	SD	Mean difference	95% CI of difference		t-value	d.f.	p-value (2-tailed)
				Lower	Upper			
Diabetics	148.11	55.06	34.89	20.62	49.15	4.83	148	<.0001
Controls	113.22	32.97	Independent-samples t-test			H_{03} rejected at □ 0.05		

n= Sample size, SD = Standard deviation, d.f. = Degree of freedom LDL = low density lipoproteins

Table 3.3.4: Comparison of mean HDL in T2DM (n1=100) and controls (n2=50) in adult population of district Bannu, Pakistan

Group	Mean	SD	Mean difference	95% CI of difference		t-value	d.f.	p-value (2-tailed)
				Lower	Upper			
Diabetics	42.48	14.24	-6.90	-11.23	-2.56	-3.15	148	0.002
Controls	49.38	11.76	Independent-samples t-test			H_{04} rejected at □ 0.05		

n = Sample size, SD = Standard deviation, d.f. = Degree of freedom HDL: High density lipoproteins

4. DISCUSSION

4.1 Serum Cholesterol (H_{01}): Our study showed that the mean cholesterol concentration was significantly higher (<.0001) in diabetics (208.22 ±55.24 mg/dL) than controls (150.26±25.29 mg/dL).

Idogun, et al.[19] from Nigeria in 2007 reported higher (p=.0001) cholesterol level (mmol/L) in 23 normotensive diabetics (5.68±1.01) than 20 non-diabetic controls (4.01±0.82). Al-Nuaim, et al.[20] from Saudi Arabia included 318 type 2 diabetics, out of which 181 (57%) patients were normolipidemic compared with 137 (43%) dyslipidemic patients; among 318, hypercholesterolemia was found in 44 (44*100/318=14%) patients.

Akber, et al[21] from Jeddah, Saudi Arabia, found metabolic syndrome in 241 out of 428 T2DM patients for the period from 1998-2000. Out 0f 428, 99 (23.13%) were with dyslipidemia. Uttra, et al.[22] from Multan and Hyderabad, Pakistan in 2011 showed that 74 out 100 (74%) diabetics (type 1 and 2) had hyperlipidemia. Out of 100, 10 (10%) had high cholesterol levels. The observation of Syvänne &Taskinen, 1997[23] revealed high cholesterol concentration in NIDDM.

4.2 Serum Triglycerides (H_{02}): Our study showed that the mean triglycerides concentration (mg/dL) was significantly higher (<.0001) in diabetics (202.58±82.62) than controls (157.88±53.42).

Idogun, et al.[19] from Nigeria in 2007 reported higher (p=.0001) triglycerides level (mmol/L) in 23 normotensive diabetics (2.17±0.43) than 20 non-diabetic controls (1.42±0.4). Al-Nuaim, et al.[20] from Saudi Arabia included 318 type 2 diabetics, out of which 137 (43%) had dyslipidemia; among 318 hypertriglyceridemia was found in 46 (15%) patients.

Uttra, et al.[22] from Multan and Hyderabad, Pakistan in 2011 showed that 74 out 100 (74%) diabetics (type 1 and 2) had hyperlipidemia; among 100, 22 (22%) had hypertriglyceridemia.

Nakhjavani, et al.[24] from Iran in 2006 showed that the mean triglyceride in type 2 diabetics was 219.7 mg/dL, which was high. Dalling-thie, et al.[25] from Tehran in 2006 showed elevated plasma triglycerides in type 2 diabetic women. Fontbonne, et al.[26] in Paris in prospective cohort study showed elevated triglycerides (p < 0.006) in diabetic patients that were associated with coronary artery disease. Bhatti, et al.[27] from Pakistan in 2009 reported high triglycerides (266±150 mg/dL) among 328 type 2 diabetics. Firdous, et al.[28] from Lahore, Pakistan in 2012 showed that 38% diabetics has TG >200mg/dL. Khan, et al.[29] in 2003 from Karachi showed high triglycerides (187±69 mg/dL) among 83 type 2 diabetics. Hypertriglyceridemia is a risk factor for CAD.

4.3 Low Density lipoproteins (H_{03}): Our study showed that the mean low density lipoproteins (LDL) concentration (mg/dL) was significantly higher (<.0001) in diabetics (148.11±55.06) than controls (113.22±32.97).

The main function of LDL in to carry cholesterol from liver to tissues, considered to be bad cholesterol associated with atherosclerosis and CAD.[30] Biadgo, et al.[31] in 2015 in Gondar showed that concentration of LDL was significantly higher in diabetic (113.1±43.2 mg/dL) than controls (100.1±36.4). Uttra, et al.[22] from Multan and Hyderabad, Pakistan in 2011 showed that 74 out 100 (74%) diabetics (type 1 and 2) had hyperlipidemia; among 100, high LDL was found in 14 (14%). Mark & Dani,[32] in 2016 in their review concluded that diabetic dyslipidemia is commonest causes of heart disease as supported by Gona & Ray,[33] in 2019 with findings that increased cholesterol, TG, LDL and low HDL increase the risk of cardiac diseases. Mooradian,[34] in 2009 in review showed high LDL values associated with CAD. Chehade, et al.[35] 2013 UN showed high LDL (100mg/dL) in 25.3% diabetics when compared to non-diabetics. Singh & Kumar,[36] from Punjab showed that 98% type 2 diabetic individuals have high LDL values.

4.4 High Density Lipoproteins (H_{04}): Our study showed that the mean high density lipoproteins (HDL) concentration was significantly lower (<.0001) in diabetics (42.48±14.24 mg/dL) than controls (49.38±11.76 mg/dL).

HDL are considered to be good cholesterol due its property to absorb and carry cholesterol to liver for metabolism, the net decrease in HDL cholesterol is an indicator for heart diseases; which increases when triglyceride level increases.[37,38] Shahwan, et al.[39] in 2019 in UAE showed low concentration of HDL (<40 mg/dL) in 54.3% individuals among 291 diabetic patients. Stamouli, et al.[40] in 2014 in Greece showed that 30.12% patients had low HDL among 800 diabetic patients when compared to 200 non-diabetics. Rahmoun, et al.[41] in Algeria showed that among 100 diabetics, 46% diabetic individuals have been found with HDL value less than 40 mg/dL. Cui, et al.[42] in 2016 in China reported HDL (mmol/L) value <1.15 mmol/L in 21.96% males and 15.74% females (p<0.001). Artha, et al.[43] in 2019 showed that HDL values were significantly lower (39.33±4.03) among 54 poor glycemic control (p=0.001) diabetic patients. Ozder,[44] in 2014 in Turkey showed reduced level of HDL in type 2 diabetics (p<0.001), with no significant difference among males (30.2±7.4) and females (31.5±6.7).

CONCLUSION

The current study concludes that serum concentrations of cholesterol, triglyceride and LDL were significantly higher in type 2 diabetics than controls, while HDL was lower in diabetics than controls. High cholesterol, TG and LDL along with low HDL are high risk factors in type 2 diabetics in giving rise to cardiovascular diseases; that needs evaluation at earlier stages.

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CONFLICT OF INTEREST
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

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Acquisition, Analysis or Interpretation of Data:	HUK, IK, AAK, AUR, ZK, RUK
Manuscript Writing & Approval:	HUK, IK, AAK, AUR, ZK, RUK

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.