ORIGINAL ARTICLE

EVALUATION OF LIPID PROFILES, DYSLIPIDEMIA AND ATHEROGENIC INDEX OF PLASMA IN DIABETIC PATIENTS

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Objective: To study the pattern of lipid profile, dyslipidemia and atherogenic index of plasma in Diabetic patients.

Method: A case-control study was conducted among 1024 individuals; 512 diabetics and 512 were healthy controls at Kantipur General Hospital, Basundhara in between January 2019 to December, 2021. Lipid profile tests; total Cholesterol, triglyceride, high density lipoprotein (HDLC), low density lipoprotein (LDL) was measured on automated analyzer and ratios were calculated.

Findings: 61.2% of patients showed dyslipidemia, 34% hypertriglyceridemia, 73.4% had low HDL (<40mg/dl) and 93.8% atherogenic index of plasma (AIP) >0.21. Hypo-HDL-cholesterolemia was prevalent dyslipidemia in our study. Pearson correlation coefficient of total cholesterol, triglyceride, HDL, LDL, total lipids, AIP were 0.688, 0.917, 0.069, 0.182, 0.17, 0.901, 0.744 respectively on glucose-gender basis.

Conclusion: Dyslipidemia is one of the major risk factors which is widely prevalent in patients with diabetic mellitus and is more prevalent in males. We recommend paying more attention to serum lipids, modifiable risk factors like proper diet, medication, eating habits and physical exercises for its prevention.

Keywords: ***Dyslipidemia, Atherogenic index of plasma (AIP), Total lipids, LDL***

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INTRODUCTION

Dyslipidemia is defined as the presence of abnormal blood concentrations of one or more of the following lipids; total cholesterol, HDL, LDL and triglycerides and is associated with diabetes mellitus, stroke, coronary heart disease (CHD), hypertension, obesity and metabolic syndrome, but it is modifiable by lifestyle variations, medications. The incidence of dyslipidemia is rapidly increasing in developing countries.[1] The ailment is characterized by an anomalous lipid profile, which can include elevated levels of serum total cholesterol and low-density lipoprotein cholesterol, triglycerides, and decreased high density lipoprotein cholesterol. [2,3]

Dyslipidemia increases free fatty acid flux secondary to insulin resistance, is aggravated by increased inflammatory adipokine levels and is described as elevated plasma concentration of triglycerides, total cholesterol and their blood transporting lipoproteins; HDL and LDL. According to Framingham Heart Study, in diabetic patients, the prevalence rates for high cholesterol levels were 13% in males and 24% in females, and these rates for high plasma triglyceride levels were 19% in male and 17% in females. A multicentered study in Thailand showed 80% diabetic patients had dyslipidemia but only 40% of them had received lipid lowering medications. Lipid profile and concentration of lipoproteins of individuals are utilized for diagnosis and treatment of lipid relevant disorders notably cardiovascular disease (CVD). [4,5]

Atherogenic index of plasma is a novel index and is regarded as superior marker of atherogenicity, multiple chronic diseases and cardiovascular complications and is also associated with the size of pre- and anti-atherogenic lipoprotein particle. [6] It has been used to quantify blood lipid levels and commonly used as optimal indicator of dyslipidemia and associated diseases. The objective of our study is to finding the lipid pattern in diabetic patients with growing urbanization and industrialization.

MATERIAL AND METHODS

A case-control study was conducted among 1024 individuals; 512 Type 1 and 2 diabetics and 512 were matched healthy controls at Kantipur General Hospital, Basundhara in between January 2019 to December, 2021. The patients signed an informed consent and the study was approved the Institutional Ethical Committee of Kantipur Dental College Teaching Hospital and Research Center. Lipid profile tests; total Cholesterol (TC), triglyceride (TG), high density lipoprotein (HDL), low density lipoprotein (LDL) was measured on automated analyzer and ratios were calculated. Total lipid (also known as Non-HDL) was calculated using formula; [(TG+TC) x 2]. Another parameter for observing dyslipidemia is by finding the ratio of TG/HDL. The following atherogenic indices were then calculated and analyzed: Atherogenic index of plasma (AIP) = log (TG/ HDL)

The data were analyzed using Microsoft Excel and SPSS

version 20. The data were expressed as mean±standard deviation, independent t-test, ANOVA and Pearson's Correlation coefficient were analyzed. In all the calculation, $p<0.05$ was considered as statistically significant level.

RESULTS

The study population consisted of 1024 participants; among them 512 were diabetic case (which included both type 1 and 2 diabetic cases) and 512 were healthy matched control and their age ranged from 15 to 80 years (mean ± SD, 46.76±13.65). According to our study elevated dyslipidemia were detected in diabetic patients with respect to many factors which includes, higher cholesterol, triglycerides, total lipids, lower HDL levels.73.4% of the study group showed lower HDL and 69.3% had higher TG levels, 45% of the cases had higher LDL. Total lipids (also known as non-HDL) was 96%. TG/ HDL ratio was calculated and we found 61.2% had higher and 14% had intermediate high levels. AIP was also calculated, 93.8% of our study group showed increased risk of CAD and 2.9% showed intermediate increased AIP levels as showed in Table 1 and 2.

On calculation with respect to lipid levels, the mean ± SD of AIP was 0.66 ± 0.26 and according to AIP category, 93.85% (n=484) were at high risk group CVD, 2.9% (n=15) were in intermediate risk group and 3.3% (n=13) were in low risk group. The mean TG (mg/dl) in male was 192.71 ± 8.28 and 168.10 ± 77.69, LDL in males was 93.59 ± 42.20 and in females 104.45 ± 64.26, AIP in males was 0.7 ± 0.27 and female 0.62 ± 0.24 and total lipids in male was 491.52 ± 14.26 and female 466.58 ± 19.81 showed a significant relation when compared according to gender basis. Female study group had significantly lower lipid values and lower AIP and total lipids as compared to their male counterparts.

The total lipids were also categorized into 3 groups as <130-200mg/dl, 200-249 mg/dl and >249mg/dl and on ANOVA analysis statistically significant relationship were detected with age, total cholesterol, triglycerides, VLDL an AIP as shown in Table 3. On Pearson correlation, lipid parameters showed a significant relation as compared with sugar-gender basis, total lipids and AIP category as shown in Table 4.

Table 1: Biochemical Parameters of Diabetic Patients

Parameter	Class	n	Percent (%)
Age-code (yrs)	15-40	158	30.6
	41-60	281	54.5
	61-90	72	14
Gender	Male	297	57.6
	Female	215	41.7
Glucose code (mg/dl)	<140, Normal	448	86.8
	≥140, High	64	13.2
Glucose-Gender code	<140 -female	196	38
	>140 -female	29	5.6
	<140-male	254	49.2
	>140-male	32	6.2
TG (mg/dl)	<150, Normal	206	39.9
	150-199, Borderline high	130	25.2
	200-499, High	175	33.9
	>500, very high	1	0.2
HDL (mg/dl)	<40, Low	379	73.4
	40-60, Borderline	119	23.1
	>60, High	13	2.5
LDL (mg/dl)	<100, Optimum	279	54.1
	100-129, Desirable	120	23.3
	130-159, Borderline	75	14.5
	160-189, High	24	4.7
	>190, Very high	13	2.5
AIP	<0.11, Low risk	13	3.3
	0.11-0.21, Medium risk	15	2.9
	>0.21, High risk	484	93.8
TG/HDL ratio	<3, Optimum	124	24
	3.1-3.8, Intermediate	72	14
	>3.8, High	316	61.2
Non-HDL, mg/dl (Total Lipids)	<130-200, Optimum	3	0.6
	200-249, Intermediate	11	2.1
	>249, High	498	96.5

Table 2: Lipid profile analysis of normal and diabetic patients.

Parameters	Gender	Diabetic Case (512) Mean±SD	Normal (512) Mean±SD	p- value	p-value case versus control
Age (years)	Male	46.69±13.42	47.12 ± 9.23	0.864	0.051
	Female	46.84±13.99	45.22±10.09		
FBS (mg/dl)	Male	106.42±24.45	90.34 ± 10.11	0.044	0.032
	Female	110.69±38.26	92.07±9.05		
PPBS (mg/dl)	Male	150.75±63.87	115.28±9.26	0.062	0.048
	Female	157.35±77.38	120.30±10.11		
RBS (mg/dl)	Male	108.37±36.36	120.23±10.11	0.206	0.061
	Female	112.22±25.28	118.06±11.14		
TC (mg/dl)	Male	184.68±44.28	123.11±23.33	0.101	0.031
	Female	190.11±49.59	117.04±9.03		
TG (mg/dl)	Male	192,71±88.28	139.26±13.16	0.001	0.020
	Female	168.10±77.69	140.29±9.39		
HDL (mg/dl)	Male	38.80±3.03	64.23±10.09	0.046	0.010
	Female	37.12±9.46	58.36±8.34		
LDL (mg/dl)	Male	93.59±42.20	79.08±9.04	0.022	0.031
	Female	104.45±64.26	70.61±11.08		
VLDL (mg/dl)	Male	38.54±17.66	29.07±1.07	0.001	0.001
	Female	33.62±15.54	29.02±2.11		
Total lipids (mg/dl)	Male	491.52±14.26	220.06±10.21	0.048	0.011
	Female	466.58±19.81	245.09±11.04		
AIP	Male	0.70±0.27	0.19±0.04	0.001	0.034
	Female	0.62±0.24	0.18±0.16		

Note: p<0.05, the level of significance (Independent t-test)

Table 3: ANOVA-test of diabetic case with respect to Total Lipid classes

Parameters	Class	frequency	Mean ± SD	P-value
Age	<200	3	27.01±18.25	0.023
	200-249	11	42.36±17.93	
	>249	498	46.36±13.45	
TC	<200	3	84.0±17.35	0.000
	200-249	11	113.27±16.34	
	>249	498	189.21±45.14	
TG	<200	3	43.33±13.20	0.000
	200-249	11	60.73±16.24	
	>249	498	185.90±82.24	
HDL	<200	3	21.5±4.67	0.410
	200-249	11	32.48±8.39	
	>249	498	38.32±26.17	
LDL	<200	3	54.17±19.38	0.075
	200-249	11	70.70±19.84	
	>249	498	99.03±53.20	
VLDL	<200	3	8.66±2.64	0.000
	200-249	11	12.15±3.24	
	>249	498	37.18±16.64	
AIP	<200	3	0.296±0.23	0.000
	200-249	11	0.27±0.18	
	>249	498	0.68±0.25	

Note: Sugar gender code includes following: male, female, glucose level <140mg/dl, and >140mg/dl, sugar gender code is glucose-gender code. (Pearson coeff.=r, p<0.05, the level of significance

Table 4: Correlation of Sugar-gender code with Lipid Parameters

Parameters	Sugar-gender code		Total Lipid		AIP	
	r	P-value	r	P-value	r	P-value
TC	-0.033	0.461	0.688	<0.001	0.193	<0.001
TG	0.166	<0.001	0.917	<0.001	0.858	<0.001
HDL	-0.031	0.487	-0.069	0.0119	-0.401	<0.001
LDL	0.093	0.035	-0.182	<0.001	-0.026	0.561
VLDL	0.166	<0.001	0.917	<0.001	0.858	<0.001
Total Lipid	0.144	0.010	1.000	<0.001	0.744	<0.001
AIP	0.181	<0.001	0.744	<0.001	1.000	<0.001

Note: Sugar gender code includes following : MAle, female. gulcose level <140mg/dl, and >140 mg/dl, suger gender code is gulcose-gender code.

DISCUSSION

In this study, we estimated the association between total Lipids, AIP and other risk factors in participants with diabetes mellitus; female diabetic participants had increased post-prandial glucose levels. The lipid levels were significantly increased in male diabetic group as compared to females. These findings are in agreement with previous studies that show strong association between abnormalities of blood lipoproteins and different habits of people, such as lifestyle and eating habits. [4-7] Framingham Heart Study in diabetic patients reveals, the prevalence rates for high cholesterol levels were 13% in males and 24% in females, and these rates for high plasma triglyceride levels were 19% in male and 17% in females. [1,3,4] A multicentered study showed 80% diabetic patients had dyslipidemia but only 40% of them had received lipid lowering medications, but our study found more than 85% of individuals are suffering from dyslipidemia and more than 90% are at increased risk of atherosclerosis because of high AIP value. Socioeconomic development and lifestyle changes such as consumption of western-style diets, reduced physical activity, and changes in type of work have contributed to the increased dyslipidemia prevalence among the population. Furthermore, this study demonstrated that there is a concordance between increased sugar-gender and significant increase in value of TC, TG, LDL and VLDL.[3]

The alteration of the serum levels of lipid profile, i.e., increased total cholesterol, triglyceride and LDL as well as decreased HDL are major contribution to CVD. As non-invasive parameters, AIP reveals the presence of LDL or TG in serum and investigators have demonstrated that these parameters can be considered as predictors of CVD. Furthermore, in conditions where other atherogenic risk parameters seem normal, AIP may be the choice.[1,7-12]

Abnormalities in the lipid profile, specifically hypertriglyceridemia and low levels of HDL have been shown to be a strong predisposing issue to many diseases including obesity, diabetes and CVD. It has been estimated that the risk of CVD decreases by 2 to 3% for every 1mg/dl increase in HDL.

According to Karki DB, 2004 5 triglycerides, lipoprotein(a) and small dense LDL cholesterol are found to be high in Asian population. Total cholesterol may be normal or slightly increased. HDL cholesterol level is usually on the lower side, various reports suggest that triglyceride level is an independent risk factor for myocardial infarction in men and for coronary heart disease in women.

The reports provide evidence-based recommendations on management of high blood cholesterol and relates disorders and also given the values for lipid levels. [13-15]

Dyslipidemia is defined as the presence of abnormal blood concentrations of one or more of the following lipids; total cholesterol, HDL, LDL and triglycerides. The human body requires the right types and amounts of lipids for the proper functioning of the body's physiological systems by storing energy, synthesizing various hormones, absorption of fat-soluble vitamins (A, D, E and K), and forming cell membranes and organelles. However, the buildup of excessive lipids in arteries can obstruct blood flow, resulting in organ dysfunction and damage.[16,17]

Lipid abnormalities may be the result of the unbalanced metabolic state of diabetes (i.e. hyperglycemia and insulin resistance) and improved control of hyperglycemia does moderate diabetes patients are likely to play an important role in development of atherosclerosis and so are called atherogenic dyslipidemia.[18-20] According to Shrestha and Khanal, 2017 [7] and the study conducted at Yemen,[8] Saudi Arabia[21] reported diabetes mellitus as a common secondary cause of hyperlipidemia, particularly if glycemic control is poor, which in turn is an important risk factor for atherosclerosis and coronary heart disease. [22]The spectrum of dyslipidemia in diabetes can include all the various types of dyslipidemia identified in the general population; however, one phenotype is particularly common in diabetes, which is attributed mostly to insulin resistance and insulin deficiency. The characteristic features of this phenotype are high plasma triglyceride concentration, low HDL and increased small dense LDL particle.[8, 23]

Kassahun Haile et al, 2021 [24] reported low HDL level was the most frequent lipid profile abnormality (67.2%), which was comparable with the study findings from Jordan, Iran, India, Sri Lanka, Yemen and Bangladesh and Nepal. The author also reported that this might be attribute due to an increase in urbanization, obesity and reduced physical activity. The elevated levels of LDL are a major risk factor for CVD and its reduction is the primary target of pharmacotherapy. They also revealed a lower prevalence of elevated total Cholesterol (14.2%) compared to studies conducted in Brazil 54.8% and 41% Philippines but it was consistent with a study reported from Jiangxi province, China 15.8%, Chongqing, China 14.7%, India 13.8% and Addis Ababa, Ethiopia 11.85%. [1,3,4,6,22]

High blood glucose value and hypertension were independent predictors of dyslipidemia. A significant high burden of dyslipidemia (66.2%) was observed in older study participants, and older age was an independent predictor of dyslipidemia. Their findings are in line with studies done in Ethiopia and China. [3,22]

Obesity and central obesity are associated with dyslipidemia. In their study, dyslipidemia was significantly associated with fasting blood glucose. The study participants with higher blood glucose values were twice more likely to develop dyslipidemia than normal values, a similar study was reported from Ethiopia, north-western Tanzania and southern Uganda, China and India. [1, 3,6,10,11,16,22]

Our study has a few advantages that justify stating; at first this is a hospital based diabetic case and healthy control study investigating various lipid levels, and it proves AIP is the superior predictive power than conventional lipid profiles for both the gender. All the information collection and laboratory assay were conducted with strict quality controls. In addition, the

findings of a strongest association between AIP and diabetes.

There were also boundaries that should also be mentioned: first the relationship of diabetes with obesity, blood pressure, waist-hip ratio, body mass index should have been recorded; second the data of other confounders like diet, medical and drug history, tobacco-alcohol consumption as well as physical activity were not included in this study

CONCLUSION

Increased lipid abnormalities/ dyslipidemia was identified in early age and both the genders in our study population (type 1 and 2 diabetes mellitus). The most prevalent lipid abnormality in our study was high LDL followed by low HDL. We also recommend a nationwide study to search for underlying factors such as physical activity, eating habits and food choices. It is a matter of concern and has to be addressed by regular screening in early age and health education to create awareness among population and to motivate to modify the risk factors

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AUTHOR CONTRIBUTIONS

Principal investigator: N.L.M. Conceived of the study, participated in its design, coordination and drafted manuscript, supervision, statistical analysis, S.S.T. Conceived of the study, participated in its design and coordination and drafted manuscript, both the authors revised the draft critically and have approved the final manuscript.

COMPETING INTERESTS

Authors declare no any conflict of interests