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Original Research Article

Study on baseline characteristics and lipid profile abnormalities among type 2 diabetic patients attending urban diabetic care hospital, Bangladesh

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ABSTRACT

Background: Altered levels of serum glycated hemoglobin (HbA1c) and lipid profile are prevalent in patients having type 2 diabetic mellitus (T2DM). Aim of the study was to investigate the relationship between serum HbA1c and lipid profile in T2DM to predict diabetic dyslipidemia.
Methods: A structured questionnaire was filled up by each study subject to collect data according to study protocol including age, gender, BMI, BP, residential status, socio-economic status, educational status, physical activity, dietary habit, smoking and duration of diabetes. We collected blood samples from 270 type-2 diabetes mellitus (T2DM) patients aged 30-65 years after overnight fasting (10-12 hours). Then blood samples collected from T2DM patients were used to measure serum levels of HbA1c, fasting blood glucose (FBG), total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL) and high-density lipoprotein (HDL) were estimated by standard laboratory methods.
Results: In this study, increased levels of fasting blood glucose (8.61 mmo/l), HbA1c (7.86%), TC (226.15 mg/dl), TG (193.34 mg/dl) and LDL (147.37 mg/dl), and decreased levels of HDL (40.36 mg/dl) were observed in T2DM patients. Moreover, the strong positive correlation of HbA1c levels with FBG, TC, TG, and LDL levels were found in this study. Besides, a very strong and significant negative correlation (R2=0.1822) between the serum levels of HbA1c and HDL were noted in this study.
Conclusions: This study revealed a strong correlation between dyslipidemia and serum levels of HbA1c in T2DM patients.

Keywords: Glycated hemoglobin, Fasting blood sugar, Type 2 diabetes mellitus, Dyslipidemia, Systolic blood pressure, Diastolic blood pressure

INTRODUCTION

Diabetes mellitus (DM) is one of the most common metabolic disorders spreading globally at an alarming rate.[1] Although genetic factor plays an essential role in DM development. It also owes its rapid growth due to lifestyle changes, food habits, exercise and physical activity.[2,3] Lack of insulin or relatively low levels affects the metabolism of carbohydrate, protein, fat, water and electrolyte balance resulting in diabetes.[4] There is no uniform view on the influence of age and gender on T2DM among researchers. It has been observed that there is wide

sex-ratio diversity in T2DM across countries leading to differences in predisposition, development and clinical presentation and, the differences between males and females could be influenced by culture, lifestyle and socioeconomic status.[5] Although the prevalence of T2DM is rising in all socioeconomic groups, the epidemic is increasing at a greater rate among individuals from a lower socioeconomic position (SEP).[6] In 2011, Agardh et al conducted a systematic review and meta-analysis of the association between SEP and T2DM.[7] An inverse association between SEP and the risk of T2DM has been found in various studies where the majority of these use education, occupation or income to measure SEP.[8,9]

Undesirable lipid levels reduced by diabetes have been found more in women than man.[10] Men have significantly higher risk of CVD than premenopausal women.[11] It is hypothesized that women have a lower incidence of heart disease because of they have higher levels of good cholesterol than men.[12] A significant trend for growing the risk of coronary heart disease, stroke, and all-cause mortality concerning higher baseline HbA1c levels was previously reported in over 11,000 participants with atherosclerosis risk. There was a substantial connection between fasting blood glucose levels and coronary heart disease, stroke, or death from any cause for HbA1c groups between 6.5 percent and 6.5 percent.[13]

Apart from traditional risk factors, including dyslipidemia, high HbA1c has now been identified as an independent risk factor for CVDs in diabetic and non-diabetic individuals. In diabetics, the risk of CVDs is estimated to increase by 18% for every 1% increase in HbA1c level.[14] The UK Prospective Diabetes Study (UKPDS) found that every 1% reduction in glycated hemoglobin (HbA1c) was associated with a 37% decrease in micro-vascular disease and a 14% reduction in myocardial infarction (MI).[15]

Among people with type 2 diabetes, tight blood sugar and blood pressure control have been shown to decrease the risk of any diabetes-related endpoint by 12% and 24% respectively.[16] UK prospective diabetes study group reveled that the risk of death related to diabetes was also reduced by 32% in patients with tight blood pressure control compared with those with less tight control.[17]

Abnormal lipid levels contribute to cardiovascular disease (CVD). Risk and are of serious concern and can be influenced by increased blood glucose, age, gender, BMI. In developed countries the largest number is found in those aged 65 years and above while in developing countries most diabetics are in the age group of 45 to 64 years.[18] Blood glucose and cholesterol levels tend to rise with age in both genders. Diabetic patients are more likely to have dyslipidemia, obesity and hypertension (HTN).[19]

The lipid abnormalities are prevalent in diabetes mellitus because insulin resistance or deficiency effects key enzymes and pathways in lipid metabolism.[20] The term diabetic dyslipidemia comprises a triad of raised triglycerides, reduced high density lipoprotein (HDL) and excess of small, dense, low density lipoprotein (LDL) particles.[21] It has been proposed that the composition of lipid particles in diabetic dyslipidemia is more atherogenic than other types of dyslipidemia.[22]

Objectives of this study were to determine pattern of baseline characteristics (age, gender, BMI, BP, educational status, socioeconomic status, physical activity, smoking habit), fasting blood glucose (FBG), glycated hemoglobin (HbA1c) and lipid profile among the patients of type 2 DM. Aim of the study was to find out the association between serum HbA1c levels and lipid profile in T2DM patients.

METHODS

Patient selection and sample collection

This cross-sectional study was carried out at Bogura Diabetic Hospital, Bogura, Bangladesh and TMSS Medical College & hospital, Bogura, Bangladesh, from February 2019 to January 2020. All participating patients were provided with sufficient information, and all individuals signed an informed consent form. Total 270 T2DM patients aged 30-65 years participated in this study, and they were selected by purposive sampling technique from the outpatient department.

For the diagnosis of T2DM, WHO criteria were followed in this study. American Diabetes Association's (ADA's) and Adult Treatment Panel III (ATP III) guidelines were used to consider patients as T2DM and to separate patients among different groups based on abnormal lipoprotein concentrations which are associated with cardiovascular disease, respectively.[16,17]

The patients with stress factors like trauma, infection, surgery, myocardial infarction, pregnancy, diabetic keto-acidosis, and amputation history were excluded from this study. A prescribed questionnaire sheet was used to record the information. The methods were explained to the patients, and verbal and written consent was taken from all patients. All necessary physical examinations (height, weight, BMI, blood pressure) of the patient were performed. Body weight was measured by a weight machine, and body height was measured by measuring tape. Blood pressure was measured by a sphygmomanometer.

Measurement of blood parameters

At first, 8 ml blood sample was collected from each study subject after overnight fasting of 10-12 hours. From this blood sample, 2 ml was delivered in a fluoride test tube for estimation of fasting plasma glucose (FBG) levels, and 3 ml was delivered in a plain tube for serum lipid profile. The remaining 3 ml of blood sample was collected for HbA1c in an ethylene diamine tetra-acetic acid (EDTA) tube.

Statistical analysis

All data of that study were analyzed using MS excel and SPSS (version 20.0) software. All data are represented as mean±SD. Pearson correlation analysis was performed to assess the relation of HbA1c with the parameters of lipid profile and FBG. Significance levels were analyzed by the chi-square test. Data having a p value<0.05 were considered significant.

RESULTS

Table 1 showed the distribution of the respondents according to their age. It reveals that among all, more than half (53.3%) of the respondents were equal or more than 50 years old and near half (46.7%) of them below 50 years. Mean±SD age of the respondents were 49.89±6.63 years. This table reveals that almost 3/5th (59.6%) DM patients were male remaining 2/5th (40.4%) were female. More than half (55.9 %) of the respondents lived in rural area and remaining (44.1%) belongs to urban area. This table presents the distribution of the respondents according to their BMI status.

It reveals that more than half (51.1%) of the respondents had normal BMI and only few of them were under weight. But one quarter (25.6%) were overweight and 1/5th (20%) of them were obese. Table 1 have showed the distribution of the respondents according to their pattern of maintaining of diet chart advised by physician. It reveals that half (50%) of the respondents had not follow the diet chart regularly advised by their physicians. Only just near one third (32.6%) of them follow the diet chart advised by their physicians.

But near one fifth (17.4%) never follow the diet chart. This table also revealed that maximum (42.2%) respondents were lower middle class and one quarter (24.8%) upper middle class. About 1/5th (19.3%) respondents were poor and only some (13.7%) of them were rich. According to this table above one quarter (26.7%) of respondents had passed HSC and near (22.9%) one quarter had completed primary level of education. About less than 1/5th (14.1%) of them were illiterate and almost similar proportion (14.8% and 15.9% respectively) of them had passed SSC and Bachelor and above degree. It reveals that among all, maximum (30%) respondents were housewives and only some (8%) of them were unemployed.

About almost just above one quarter (26% and 27% respectively) of them were service holder and doing their own business. This table showed the distribution of the respondents according to their physical activities. It reveals that proportionately more than 3/5th (62.6%) of the respondents had moderate physical activities in their daily life. Only 1/10th of them physically highly active and less than one third (27%) had fewer physical activities in their daily life. showed the distribution of the respondents according to their smoking status that about 3/5th (60.7%) of the respondents were nonsmoker and remaining 2/5th (39.3%) were smoker. This table shows that more than one third (36.3%) of the respondents had been suffering from DM for more than 5 years and just near to one quarter (23.3%) of them had been suffering for less than 6 months. But 2/5th (40.4%) of the respondent's duration of DM about 6 months to 5 years.

Table 1 also shows the distribution of the respondents according to their blood pressure status according to JNC 7. It reveals that almost one quarter (24.4%) respondents systolic blood pressure (SBP) were within normal range and remaining similar proportion respondents were prehypertension (37.8%) and hypertension (37.8%) range. Regarding DBP a little more than 2/5th (40.7%) respondents were hypertensive range and only 1/5th (21.9%) of the respondents had normal diastolic blood pressure.

Table 1: Baseline characteristics of the study subjects (N= 270).

Characteristics	Frequency	Percentage (%)
Age category (years)		
<50	126	46.7
≥50	144	53.3
Gender distribution		
Male	109	40.4
Female	161	59.6
Residential status		
Urban	119	44.1
Rural	151	55.9
BMI (Kg/m^2)		
Underweight (<18.5)	8	3
Normal weight (18.5-24.9)	139	51.1
Over weight (25-29.9)	69	25.6
Obesity (≥30)	54	20
Dietary habits		
Follow the diet chart advised by physician	88	32.6
Irregular follow the diet chart	135	50 %

Continued.

Characteristics	Frequency	Percentage (%)
Never follow the diet chart	47	17.4
Socioeconomic status		
Poor	52	19.3
Lower middle class	114	42.2
Upper middle class	67	24.8
Rich	37	13.7
Educational status		
Illiterate	38	14.1
Class 1 to 4	16	5.9
Primary	61	22.9
SSC	40	14.8
HSC	72	26.7
Bachelor & above	43	15.9
Physical activity level		
Less physical activity	73	27.0
Moderate physical activity	169	62.6
High physical activity	28	10.4
Smoking status		
Non-smoker	164	60.7
Smoker	106	39.3
Duration of diabetes mellitus		
<6 months	63	23.3
6 months-5 years	109	40.4
>5 years	98	36.3
Blood pressure status (according to JNC 7)		
SBP (mmHg)		
Within range of normal SBP (<120)	66	24.4
Within range of pre-hypertension (120-139)	102	37.8
Within range of hypertension (≥140)	102	37.8
DBP (mmHg)		
Within range of normal DBP (<80)	59	21.9
Within range of pre-hypertension (80-89)	101	37.4
Within range of hypertension (≥90)	110	40.7

Table 2: Distribution of the respondents according to their controlled or uncontrolled DM on the basis of recommended FBS, HbA1C glycemic goal achieved or not achieved.

Variables	Frequency	Percentage (%)
FBS (Recommended FBS glycemic goal achieved)		
Controlled DM (≤6.0 mmol/l)	109	40.4
Uncontrolled DM (≥7.0 mmol/l)	155	57.4
Below normal (6.1-6.9 mmol/l)	6	2.2
HbA1C		
Controlled DM or HbA1c goal achieved (<7%)	91	33.7
Uncontrolled DM or HbA1c goal not achieved (≥7%)	127	66.3

Table 2 showed the distribution of the respondents according to their controlled or uncontrolled DM on the basis of recommended FBS glycemic goal achieved or not achieved. It reveals that among the respondents more than half (57.4%) had uncontrolled DM and 2/5th of them had controlled DM.

This table also revealed that just more than 2/3rd (66.3%) respondents had uncontrolled DM and just more than 1/3rd (33.7%) had controlled DM. Table 3 shows the distribution of the respondents according to their total cholesterol, triglyceride, LDL cholesterol level on the basis of ATP III guide line cut point. It reveals total cholesterol that among the respondent near half (47%) had desirable and more than half (53%-6.3% borderline high and 46.7% high) of them had high total cholesterol. It also reveals that among the respondent near one quarter (23.7%) had normal and more than three quarter (76.3%) of them had high triglyceride level. It reveals that only near one quarter (23%) of the respondents had optimal level of LDL cholesterol and similar proportion (23%) had near optimal

or above optimal LDL level. More than one quarter (27.8%) of the respondents had very high and some (8.5%) of them had borderline high. About near 1/5th (17.8%) of the respondents also had high level LDL. As a whole a little higher than three quarter (77%) had above optimal or high LDL cholesterol level. It reveals that among the male more than half (57.1%) had below normal HDL cholesterol and among female maximum (92.7 %) had below normal HDL.

Table 4 have showed; the highly significant correlation was observed between FBG and HbA1c (p=0.000). HbA1c also demonstrated direct and significant correlations with TC (r=0.776), TG (r= 0.762), LDL-C (r=0.753), HDL-C (r= -0.654). The correlation of HbA1c with TC, TAG, LDL-C were positive and with HDL-C that were negative and also statistically highly significant (p<0.001).

Table 3: Distribution of the respondents according to their total cholesterol, triglyceride, low density lipoprotein cholesterol, high density lipoprotein cholesterol levels on the basis of ATP III guide line cut point.

Variables	Frequency	Percentage (%)
Total cholesterol (distribution of the respondents on the basis of ATP III guide line cut point value for TC)		
Desirable (<200 mg/dl)	127	47
Borderline high (200-239 mg/dl)	17	6.3
High (≥240 mg/dl)	126	46.7
Serum triglyceride (distribution of the respondents on the basis of ATP III guide line cut point value for TG)		
Desirable (<150 mg/dl)	64	23.7
Borderline high (150-199 mg/dl)	109	40.4
High (≥200 mg/dl)	97	35.9
LDL cholesterol (distribution of the respondents on the basis of ATP III guide line cut point value for LDL-C)		
Optimal (<100 mg/dl)	62	23.0
Near/above optimal (100-129 mg/dl)	62	23.0
Borderline high (130-159 mg/dl)	23	8.5
High (160-189 mg/dl)	48	17.8
Very high (≥190 mg/dl)	75	27.8
HDL cholesterol (distribution of the respondents on the basis of ATP III guide line cut point value for HDL)		
For male HDL cholesterol cut point value (>40 mg/dl)		
Normal (>40 mg/dl)	62	42.9
Below normal (<40 mg/dl)	92	57.1
For female HDL cholesterol cut point value (>50 mg/dl)		
Normal (>50 mg/dl)	8	7.3
Below normal (<50 mg/dl)	101	92.7

Table 4: Relationship between HbA1c and components of serum lipid profile as reflected by pearson correlation.

HbA1c and components of serum lipid profile		
HbA1c	Pearson correlation	1
	Sig. (2-tailed)	
	N	270
Total cholesterol (TC)	Pearson correlation	0.776**
	Sig. (2-tailed)	0.000
	N	270
Triglyceride (TG)	Pearson correlation	0.762**
	Sig. (2-tailed)	0.000
	N	270
HDL-cholesterol	Pearson correlation	-0.427**
	Sig. (2-tailed)	0.000
	N	270
LDL-cholesterol	Pearson correlation	0.753**
	Sig. (2-tailed)	0.000
	N	270
Fasting blood glucose	Pearson correlation	0.852**
	Sig. (2-tailed)	0.000
	N	270

**Correlation is significant at the 0.01 level (2-tailed),

Table 5: Frequency of abnormal lipid status in all subjects and Relation with HbA1c.

Variables	Frequency (%)	HbA1c<7	HbA1c≥7	P value
High TC	126 (46.67)	1	125	0.001
High TG	97 (35.93)	1	96	0.001
High LDLc	79 (29.3)	1	78	0.001
Low HDLc	33 (12.2)	24	9	0.001
No abnormal lipid profile	114 (42.2)	66	48	0.001
One abnormal lipid profile	61 (22.6)	24	37	0.289
Two abnormal lipid profile	29 (10.7)	0	29	0.001
More than two abnormal lipid profile	66 (24.4)	1	65	0.001

DISCUSSION

T2DM is the most common type of diabetes, which is increasing day by day throughout the world. Instead of immense development in medical sciences, curable treatment for that global problem yet to be developed. Dyslipidemia, increased HbA1c, and blood glucose are very common in T2DM. In this present study, we have explored the baseline characteristics such as age, gender, BMI, residential status, dietary habits, educational status, physical activity, smoking status, duration of diabetes mellitus, blood pressure status and FBG, HbA1C, lipid profile levels. Additionally, we have also revealed the association of dyslipidemia with HbA1c in T2DM. This was a cross sectional study carried out among 270 diagnosed adult type 2 diabetic patients. Among them 109 were male and 161 were female. This study included higher proportion of females than males.

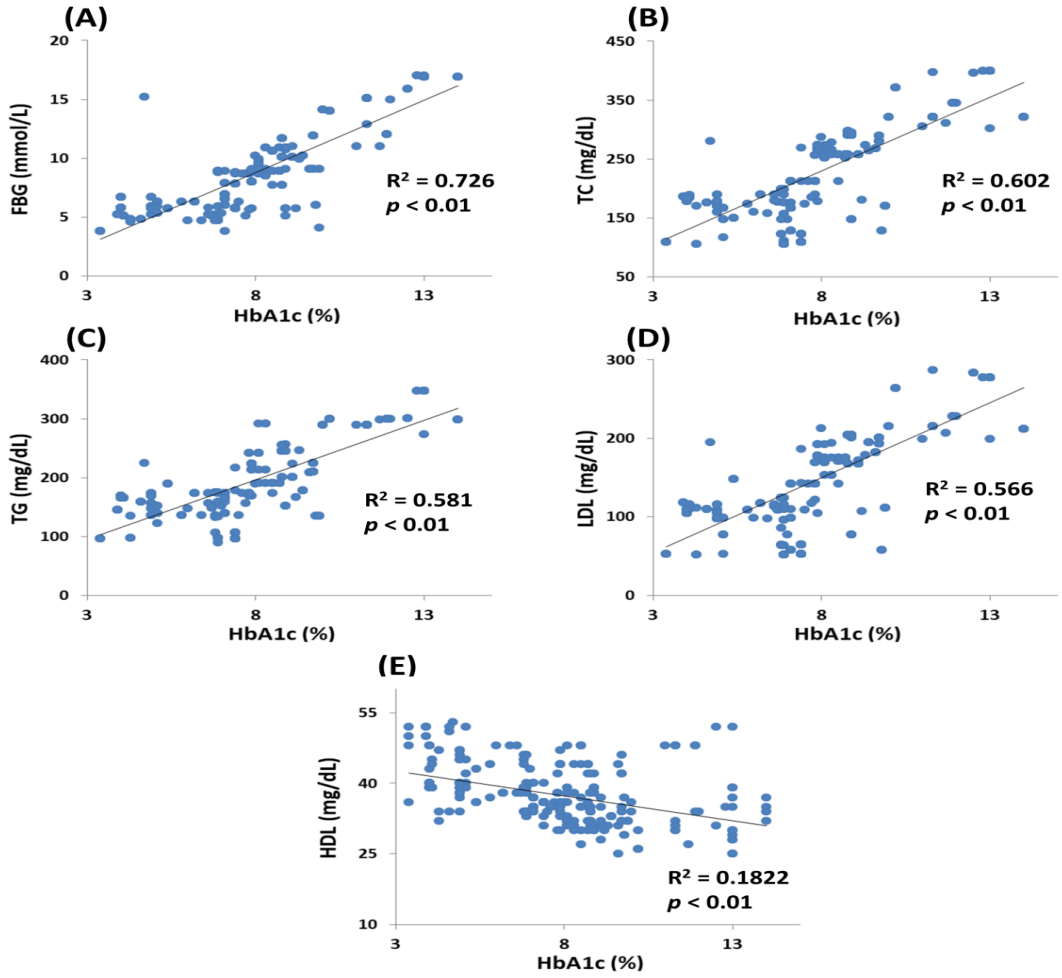

Figure 1: Correlation of HbA1c levels with serum levels of FBG (A), TC (B), TG (C), LDL (D), and HDL (E). The correlation coefficient (R2) and p values are mentioned for each graph.

Subjects were classified into subgroups according to the level of formal education received; Illiterate Class 1 to 4, primary school, SSC, HSC and bachelor and above education. In this study revealed that frequency of type 2 DM more prevalence in HSC and Primary level was 27% and 22% respectively. The European Prospective Investigation into Cancer and Nutrition (EPIC) Inter act study 21 showed that the association between low educational level and the higher risk of T2DM was consistent across all examined eight Western European countries.[23] The inverse correlation of DM with education was observed in previous studies.[24,25] But other studies reported opposite results.[26] Also in an ELSA study, education was not significantly related to DM after adjustment for all covariates.[27] Previous studies revealed that while overweight and obesity are major drivers of the growing diabetes epidemic, the relationship between educational attainment and diabetes risk was not solely attributable to higher BMI.[28,29] This study found T2DM patients are 42% and 25% in Low middle class and high middle-class income family respectively. Other studies showed that additional factors that may mediate this relationship include poor diet quality and physical inactivity, an independent risk factor for type 2 diabetes.[30,34] That may be more prevalent among higher SES (socio-economic society) groups in LMICs (low middle income countries).[40] This study reveals high prevalence of hypercholesterolemia, hypertriglyceridemia, high LDL-C and low HDL-C levels among the diabetic patients whose HbA1C>7 mg% and these are well known risk factors for cardiovascular diseases. The disorder in lipid metabolism was hyper triglyceridemia, high cholesterolemia, high density lipoprotein cholesterol and low-density lipoprotein in our study.

This study 47% individuals have high TC, 36% high TG,30% high LDL. But on study in Pakistan done by Sehran et al had found 54% diabetic individuals had elevated LDL-C and >50% individuals had increased TG. They also reported low HDL-C in 73% individuals. In our study it is 33%.[32] A highly significant correlation between HbA1c and FBG in our study is similar with various previous studies.[33] Our study shows patients have one, two or more than two abnormal lipid profile 22%, 10%, and 24% respectively.

Patients those HbA1C are >7 mg% have shown abnormal lipid profile. This study also observed a strong positive correlation between serum HbA1c level and FBG which is consistent with various previous studies.[33] Serum HbA1c level in T2DM correlates with TC, TG, LDL, and HDL levels.

We also observed a strong positive correlation of serum HbA1c levels with TC, TG, and LDL. A strong negative correlation between serum HDL and HbA1c levels was also found in this study. All these findings are consistent with previous reports.[35] Therefore, T2DM associated with carbohydrates' metabolism also affects the serum levels of TC, TG, LDL, and HDL. HbA1c is also well-known as the gold standard of glycemic control. HbA1c levels ≤7.0% were appropriate for reducing the risk of cardiovascular complications in T2DM patients.[36]

In this study, we divided diabetic patients into two groups depending on HbA1c levels. T2DM patients with HbA1c value >7.0% exhibited a significant increase in serum levels of TC, LDL, and TG and decreased serum levels of HDL compared to patients with an HbA1c value of ≤7.0%. This finding of our current study is also supported by previous reports.[37] The severity of dyslipidemia increases in DM patients, increasing the HbA1c value. As increased serum levels of HbA1c and dyslipidemia are independent risk factors for T2DM patients, dyslipidemia can be considered a very high-risk group for CVDs. Improving glycemic control can substantially reduce the risk of cardiovascular events in diabetics.[38] An elevated level of HbA1C is highly associated with mortality and various cardiac dysfunctions due to dyslipidemia. It has also been estimated that reducing the HbA1c level by 0.2% could lower mortality by 10%.[37] In this study, we did not observe other pathological parameters associated CVDs in T2DM patients.

Further study should be carried out for better understanding about the role of glycemic control to develop more effective therapeutic strategy for the better treatment of T2DM.

Limitations

Limitations of the study were subjects were collected from only one diabetic care hospital; may not represent the whole population of the country; sample size was not enough for multivariate study to find out independent association of socio-demographic risk factors among T2DM patients and diagnostic role of other biomarkers could not be evaluated due to lack of fund.

CONCLUSION

Laboratory evaluation of lipid profile and HbA1c in DM patients aids in early medical intervention to prevent or delay micro-vascular complications. This study observed a significant and strong correlation between serum levels of HbA1c and various circulating lipid parameters in T2DM patients.

This study also revealed a significant difference in the levels of lipid parameters between two groups (≤7.0% and >7.0%) of HbA1c. This study suggests that the patient's glycemic control has a substantial impact on the serum lipid level, and dyslipidemia is frequently encountered in those who have got poor glycemic control.

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