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Relationships between serum lipid profile and HbA1c levels in patients with diabetes

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Abstract

Background: Diabetes mellitus (DM) is a metabolic disease characterized by hyperglycemia, disturbed lipid metabolism, and cardiovascular disease (CVD). Poor glycemic control results in lipid and lipoprotein abnormalities, suggesting that dyslipidemia is secondary to insulin resistance or factors closely related to insulin resistance. Glaciated hemoglobin (HbA1c) is a routinely used marker for long-term glycemic control. This form of hemoglobin is chemically processed through post-translational glycosylation that reflects the plasma glucose concentration during the last two to three months.

Methods: This cross-sectional study was conducted on blood samples from 592 cases referred to Dezyani Specialty Clinic, affiliated with the Golestan University of Medical Sciences. In patients with diabetes mellitus (DM) and non-diabetic individuals, hemoglobin A1c (HbA1c), total cholesterol (T-chol), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) were measured.

Results: In the study, there were 460 female participants (76.9%) and 132 male participants (23.1%). Among them, 403 (67.4%) were diabetic patients, and 193 (32.4%) were non-diabetic. HbA1c levels were significantly lower in younger individuals than in middle-aged participants ($p=0.000$). No significant difference was found between middle-aged and older individuals ($p>0.121$). LDL levels were significantly lower in the young group than in the middle-aged group ($p<0.001$). Total cholesterol (TC) was also significantly lower in the young group compared to middle-aged and older groups ($p<0.001$).

Conclusion: HbA1c can be a helpful lipid and glycemic control marker in diabetes.

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Introduction

Diabetes mellitus (DM) is a metabolic disease characterized by hyperglycemia, disturbed lipid metabolism, and cardiovascular disease (CVD). It develops when insufficient insulin is produced or when the available insulin does not function correctly. In both types of diabetes (Types 1 and 2), hyperglycemia is commonly associated with hyperlipidemia, which is usually defined by marked elevation of LDL-C, Total Cholesterol (T-chol), and TG and low levels of HDL-C (1).

Approximately 100 million people worldwide are estimated to have diabetes mellitus, and the incidence of diabetes is increasing. Diabetes leads to an increase in body fat due to decreased insulin levels, insulin resistance, and the accumulation of toxic substances in the body (2). Diabetes mellitus is responsible for approximately 5% of all deaths globally on an annual basis. This is due to the fact that chronic hyperglycemia is associated with long-term complications and morbidities and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels due to micro- and macro-vascular complications (3).

Obesity, hypertension, aging, smoking, and a sedentary lifestyle are as known CVD risk factors. Patients with diabetes, especially those with Type 2 diabetes mellitus (T2DM), face increased morbidity and mortality, as they are at a greater risk of cardiovascular death compared to non-diabetic individuals. Patients with T2DM often have an atherogenic lipid profile characterized by high plasma levels of triglyceride (TG), total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C) but low levels of high-density lipoprotein cholesterol (HDL-C) (4,5).

Poor glycemic control results in lipid and lipoprotein abnormalities, suggesting dyslipidemia may be secondary to insulin resistance or factors closely related to insulin resistance (6). This may be due to increased free fatty acid secondary to insulin resistance and increased proinflammatory cytokines from enlarged adipose tissue (7). The combination of hyperglycemia and dyslipidemia produces an atherogenic environment within the circulation, accelerating the progression to atherosclerosis (8).

Glaciated hemoglobin (HbA1c) is a routine marker for long-term glycemic control. This type of hemoglobin, which is the product of a chemical process called post-translational glycosylation and reflects the amount of plasma glucose concentration during the preceding two to three months, is used for monitoring glycemic control in patients with diabetes (9). However, it does not reflect short-term glycemic control. There is evidence that there is a correlation between HbA1c and CV (Cardiovascular) complications in diabetic patients. In patients with diabetes, high HbA1c levels significantly increase the risk of cardiovascular disease (CVD), and numerous studies have shown a strong association between HbA1c and CVD. Therefore, it can be suggested that HbA1c may predict dyslipidemia and CVD as a biomarker.

Correlating the HbA1c levels, lipid profiles, and related risk ratios in diabetic patients would be of great assistance. This would facilitate using HbA1c as a dual marker for glycemic control and dyslipidemia in T2DM patients, thereby reducing the cost of monitoring both conditions, particularly in low-resource settings (10). Therefore, this study was designed to determine the relationship between HbA1c and lipid profile in DM patients and non-DM individuals attending the Dezyani Specialty Clinic affiliated with the Golestan University of Medical Sciences in Gorgan.

Methods

This prospective cross-sectional descriptive study was conducted between April and August 2023, and participants were recruited from Dezyani Specialty Clinic Affiliated with Golestan University of Medical Sciences. The patients over 18 who were not pregnant, had no malignancy, were not under dialysis, and received no anti-lipid medication were included. Based on the questionnaire and HbA1C level, the patients were divided into two diabetic and non-diabetic groups. For the study, 5 ml blood samples were collected from each participant. The blood was centrifuged within one hour of collection, and the serum was transported in a suitable container. All tests were done on the same day as the blood sampling. The HbA1c levels were measured by the Dyazin kit (Iran), and all lipid profile tests were performed using the Pars Azmon kit (Iran). The data were analyzed using SPSS 21 software. The Kolmogorov-Smirnov test was conducted to assess the normal distribution of the results, while the student's t-test was employed to compare the results between the two groups.

Results

Study participants were 460 females (76.9%) and 132 (23.1%) males; 403 (67.4%) were diabetic patients, and the other 193(32.4%) were nondiabetic participants. The mean age in DM patients was 52.9±11.3, and in the DM group, it was 40.4±15.6. One hundred sixty-three (27.3%) patients were younger than 40, 307(51.3%) were between 40 and 60, and 127 (21.4%) were older than 60 years old (Table 1).

Results of this study showed lower HbA1c levels in younger ages than middle-aged persons ($p=0.000$), while the difference was not significant between the middle-aged and older individuals ($p>0.121$). LDL plasma level was significantly lower in the young group than in the middle-aged group ($p<0.001$), and there was no significant difference between the middle-aged and older age groups ($p<0.285$). TC was significantly lower in the young age group compared to the middle and old age groups ($p<0.001$). HDL-C and TG plasma levels were not significantly different among all age groups. There were no significant

differences in HDL-C plasma levels among different age groups. In contrast, regarding other parameters, there were significant differences in plasma levels in DM and non-DM groups (Table 2). Studied parameters significantly differed between female and male DM and non-DM groups, but HDL-C was not statistically significant in males (Table 3).

HbA1c level in the non-DM group was significantly correlated with plasma TG and total cholesterol levels (p=0.05 & p=0.01). At the same time, there was no significant correlation between LDL-C and LHL-C plasma levels. This parameter had a significant inverse relationship with LDH-C plasma levels (p=0.05) in DM patients, and no significant relationship was seen between TG and total cholesterol levels.TG plasma levels were significantly correlated with plasma LDL-C and total cholesterol levels (p=0.01 in both) in the DM group without any significant relationship with HDL-C. An inverse relationship was seen between HDL-C, LDL-C, and fasting blood sugar (FBS) in the non-DM group (p=0.01) (Table 4).

Table 1. Results of laboratory variables based on age in the population under study

Age range		A1c	LDLC	HDLC	TG	Cholesterol
Young	N Mean Std. Deviation	163 6.577 2.4695	163 99.64 31.536	163 50.18 17.470	163 246.83 784.300	163 181.10 58.236
Middle age	N Mean Std. Deviation	307 9.016 5.6950	307 118.02 68.720	307 47.99 28.475	307 253.43 246.796	307 204.09 49.706
Old	N Mean Std. Deviation	126 8.292 2.2659	127 111.86 35.936	126 52.60 38.285	126 222.78 135.251	126 200.91 53.068

Table 2. Laboratory variables result in two diabetic and non-diabetic groups

Diabetes status		Age	LDLC	HDLC	TG	Cholesterol
Non-diabetic	N Mean Std. Deviation	193 40.35 15.563	193 89.01 22.079	192 52.73 32.033	192 99.05 39.472	192 160.43 26.137
Diabetic	N Mean Std. Deviation	403 52.89 11.273	403 122.53 62.385	403 48.06 26.576	403 314.59 533.263	403 214.46 54.686
P-value		0.001	0.000	0.062	0.001	0.000

Table3. Analysis of investigated variables in women

Variables	Diabetes status	N	Mean	Std. Deviation	P-value
Age	Non-diabetic Diabetic	158 302	39.23 53.24	14.604 11.027	0.001
LDLC	Non-diabetic Diabetic	158 302	87.53 121.61	21.823 69.146	0.001
HDLC	Non-diabetic Diabetic	157 302	53.55 48.05	33.78 14.705	0.045
TG	Non-diabetic Diabetic	157 302	95.11 328.35	38.249 604.203	0.001
Cholesterol	Non-diabetic Diabetic	157 302	159.86 214.01	26.568 54.94	0.001

Table 4. Analysis of investigated variables in men

Variables	Diabetes status	N	Mean	Std. Deviation	P-value
Age	Non-diabetic diabetic	35 100	45.43 51.86	18.723 12.035	0.21
LDLC	Non-diabetic Diabetic	35 100	95.71 125.14	22.298 35.428	0.001
HDLC	Non-diabetic Diabetic	35 100	49.06 47.97	22.622 47.006	0.898
TG	Non-diabetic Diabetic	35 100	116.74 274.79	40.569 205.646	0.001
Cholesterol	Non-diabetic Diabetic	35 100	163.00 215.86	24.303 54.442	0.001

Discussion

DM is characterized by hyperglycemia and disruption of carbohydrate, lipid, and protein metabolism. In this study, we investigated the association between serum lipid profile and HbA1c in DM patients and healthy individuals. 76.9% of the participants were females, and 23.1 % were males. The higher proportion of women may be attributed to the fact that women had more free time and paid more attention to their health than men in the studied region.

Most organ damage in DM patients can be attributed to complications due to hyperglycemia, which results in disturbances in fat metabolism and immune inflammatory response, such as platelet activation, due to endothelial injury (10).

It is documented that management of lipid abnormalities by early detection of serum lipid status can prevent CVD and CVA (Cardiovascular accident) in DM patients. Investigation of lipid profiles and metabolic changes in DM patients can be challenging as various parameters influence blood indicators such as diabetes duration, control, and patient's conditions such as genetic background, age, and ethnicity. In a study, DM-related CVD mortality in older individuals with diabetes was reported as 47% in those with early intervention and 54% in those with delayed intervention (11). Still, poor randomization and data collection limits the power of this study.

The association between hyperglycemia, high HbA1c plasma levels, high TC, TG, LDL-C levels, and low HDL-C levels is well-known and reported in most studies. This study investigated the association between HbA1c and lipid profiles in DM and non-DM patients. Consistent with our findings, Ghari Arab et al. reported that HbA1-c levels were directly associated with lipid profiles in DM patients (12). In both groups, plasma glucose, A1C levels, TC, and LDL-C levels were lower in younger patients. In Nanaware A, and Moss et al., and Moss et al. studies, the results were similar to ours (13,14). Mahajan et al. observed that plasma HbA1c levels were associated with LDL-C, TG, TC, and VLDL-C (Very low-density lipoprotein) levels (15). Similarly, a study from Bangladesh suggested that HbA1c plasma levels could predict and prevent hyperglycemia in DM patients (16). Parsanassab et al. reported a significant correlation between HbA1c and HDL-C, LDL-C, TC, and TG. However, this was regardless of age group. This study detected no significant association between age parameters and lipid profiles, except for HbA1c and HDL-C levels, which were inversely correlated. In one study, LDL-C, TG, and TC levels were lower in DM patients with HbA1c levels lower than 7, while these levels were higher in patients with more than HbA1c levels higher than 7 (17). Despite inconsistencies among studies, HbA1c levels and related parameters may serve as helpful laboratory markers for diabetes management.

Conclusion

In conclusion, this study's findings can enhance our understanding of the complex relationship between glycemic control and lipid metabolism in managing diabetes. Regular monitoring and early intervention could significantly improve patient outcomes and reduce the burden of diabetes-related complications. As healthcare evolves, integrating new insights into clinical practice can enhance the quality of diabetes care.

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Ethical statement

This research was conducted as part of a thesis at Shahrood Azad University, identified by the code 162633792.

Conflicts of interest

The authors confirm that they have no conflicts of interest to disclose.

Author contributions

Habibeh Sadat Mousavi: data collection and study performance; Mohammad Taher Hojjati: study design, data analysis, and manuscript writing; Khodaberdi Kalavi: study design and manuscript writing.

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