

*Original article*

# Correlation between glycated hemoglobin HbA1c and serum lipid profile in patients with type 2 diabetes

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## ABSTRACT

**Background:** Hyperlipidemia is a common risk factor for diabetes that leads to cardiovascular disease, one of the causes of death of diabetic patients. The aim of this study was to investigate the association between HbA1c levels and serum lipids in Libyan patients with type 2 diabetes. **Material and methods:** The study was conducted in 2019 on 325 patients (174 males, 151 females) with type 2 diabetes referred to a private clinical laboratory in Tripoli, Libya. Blood samples were collected for measurement of HbA1c, fasting blood glucose and serum lipid concentrations. Diabetes was defined according to the American Diabetes Association criteria. The data were analyzed using an independent t-test and Pearson's correlation test. **Results:** The ages of the patients ranged from 40 to 83 years, with a mean of  $51.52 \pm 14.32$  years SD. No significant correlation between HbA1c and age was noted ( $r=0.011$ ,  $p=0.063$ ). There was a significant positive correlation between HbA1c level and fasting blood glucose ( $r=0.641$ ,  $p=0.000$ ), low-density lipoprotein ( $r=0.240$ ,  $p=0.000$ ), total cholesterol ( $r=0.223$ ,  $p=0.000$ ) and triglycerides ( $r=0.140$ ,  $p=0.067$ ). The correlation between HbA1c and high-density lipoprotein-C was negative but not significant ( $r=-0.088$ ,  $p=0.123$ ). **Conclusion:** HbA1c could be used as a predictor of dyslipidemia and thus it may serve as an indicator of the development of cardiovascular disease in patients with type-2 diabetes mellitus.

**Keywords:** HbA1c, lipid profile, LDL cholesterol, HDL cholesterol, fasting blood sugar, type 2 diabetes, dyslipidemia

**Citation** Alboesh A, Omar F. Correlation between glycated hemoglobin HbA1c and serum lipid profile in patients with type 2 diabetes 2021;15(2):14-18. Libya J Med Res. <https://doi.org/10.54361/ljmr.15204>

**Received:** 06/09/21; **accepted:** 14/09/21; **published:** 31/12/21

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## INTRODUCTION

on health, quality of life, and healthcare systems. According to the International Diabetes Federation, 463 million adults are currently living with diabetes. Without effective intervention, about 578 million people will have diabetes by 2030 and the number will jump to 700 million by 2045. The proportion of

Diabetes mellitus (T2DM) is a chronic endocrine disorder [1]. It is characterized by abnormal insulin secretion due to peripheral resistance and accounts for 85-90% of all people with diabetes [2].

T2DM is a rapidly growing public health problem worldwide, with a significant impact

In a study on the association of HbA1c with the serum lipid profile, it was suggested that the level of HbA1c could predict the development of dyslipidemia in patients with DM (8). Apart from the classical risk factors for cardiovascular disease (CVD) such as dyslipidemia, elevated HbA1c seems to be another independent risk factor. It is estimated that there is an 18% increased risk of CVD for each 1% rise in absolute HbA1c level in the diabetic population. This positive correlation between HbA1c and CVD has been demonstrated also in non-diabetic people, even within the normal range of HbA1c. [9]

The aim of this study was to evaluate the correlation between HbA1c and serum lipid profile in patients with T2DM as well as to evaluate the importance of HbA1c as an indicator of dyslipidemia.

## MATERIALS AND METHODS:

Blood samples were drawn with a sterile syringe and placed in sterile tubes after 12-14 hours of overnight fasting. The samples were centrifuged at 3000 rpm for 10 minutes and serum was stored at 4°C. FBS and serum lipids were measured by enzymatic methods by using a Roche/Hitachi 912/modular analyzer: CAN 435, Germany). HbA1c was measured by an immunoturbidimetric assay on a BT PLUS Auto analyzer.

The National Cholesterol Education Program criteria (NCEP/ATP III) for the diagnosis of the metabolic syndrome were used [10]. According to these criteria, hypercholesterolemia is defined as TC > 200 mg/dl, high LDL-C when the value > 100 mg/dl, hypertriglyceridemia when TG > 150 mg/dl, and low HDL-C as < 40 mg/dl (10).

## STATISTICAL ANALYSIS

test for independent samples (two tailed) was used to compare mean values. P values < 0.01 were accepted as significant. The value of HbA1c is given as a percentage of the

people with T2DM is increasing in most countries (3). Nearly 80% of people with T2DM live in low and middle-income countries. [4]

It has been estimated that about 37 million people in the Middle East and North Africa region are living with T2DM [5]. Moreover, this region had the highest age-adjusted prevalence of diabetes in adults in 2019 (12.2%), and this percentage is expected to increase to 13.3% by 2030 (3). However, there is very little information on diabetes in Libya.

One of the most common complications linked with uncontrolled hyperglycemia is dyslipidemia. Hence, T2DM patients are prone to diabetic dyslipidemia, which puts them at risk of developing macrovascular diseases (stroke, peripheral vascular disease and coronary artery disease) and microvascular diseases (nephropathy, neuropathy and retinopathy) [6,7].

This cross-sectional study was performed at the Aloomalahia Medical Laboratory in Tripoli, Libya on all T2DM patients with an active record at the laboratory who were referred to the

Laboratory between January and December 2019 (Ethical approval was obtained from the Ethics committee of biotechnology research center).

Patients with type 1 diabetes, gestational diabetes or prednisolone-induced diabetes were excluded from the study, which was conducted on 325 patients.

Whole blood and sera samples were analyzed for fasting blood sugar (FBS), HbA1c, total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C).

The data were analyzed by the SPSS statistical package version 27.0. Pearson's correlation test was used to examine the correlations between HbA1c and the other parameters. Student's t-

expressed as mean  $\pm$  standard deviation (SD)

## RESULTS AND DISCUSSION

Significant, positive correlation between HbA1c and FBS ( $r=0.0641$ ,  $p=0.000$ ), which is Consistent with another Libyan study (11) showing a highly significant direct correlation

Between FBS and HbA1c. A study in Saudi Arabia also showed similar results [12], and Several Studies indicate that HbA1c may be useful as a diagnostic test for diabetes such Metcalf

Et al (13).

HbA1c had a significant direct relationship with total cholesterol ( $r = 0.223$ ,  $p = 0.000^{**}$ )

Triglycerides and LDL ( $r = 0.104$ ,  $p = 0.67$ ) ( $r = 0.240$ ,  $p = 0.000^{**}$ ) but not with HDL

( $r = 0.88$ ,  $p = 0.123$ ). In a study by Ghari Arab and Alireza, HbA1c had a significant

Positive Correlation with total cholesterol, triglycerides, and LDL and HDL levels [14],

These results suggest that the relationship between HbA1c level and serum lipids of patients

With type 2 diabetes might be a useful predictor of CVD in these patients [15].

In Oman, Al-Alawi reported a correlation between improved dyslipidemia and HbA1c

Control (16) As Hyperlipidemia has been associated with the development of CVD,

Dyslipidemia is Likely to be but one of many reasons for the accelerated macro vascular

Disease in diabetic Patients. Nonetheless, treatment of lipid abnormalities has the

potential to

Reduce cardiovascular events more than 50%, to rates that are seen in countries with lower

Cholesterol and less atherosclerotic burden. This leads to the expectation that treatment of

Elevated lipid levels will allow patients with diabetes to lead longer healthier lives. [17].

Our results indicate That HbA1c level might be a useful predictor of CVD in patients with (Table 2 and figure 1).

total hemoglobin and values of all other parameters are given in mg/dl. All values are

A total of 325 patients with T2DM (151 men and 174 women) were included in this study. The mean ages  $\pm$  SD of the male and female patients, respectively, were  $54.0 \pm 14.09$  years and  $48.6 \pm 14.07$  years SD. The mean level of HbA1c was  $8.5\% \pm 7.9\%$  SD, which indicates inadequate glucose control (Table 1). A study in Iran [14] and another in Afghanistan (8) both reported higher mean HbA1c levels (8.83% and 9.19%, respectively).

The mean values of FBS, TC, TG, HDL-C and LDL-C (176.82, 188.53, 157.31, 38.99 and 150.0 mg/dl, respectively) were higher in T2DM patients than the reference normal range (NCEP ATP III guidelines), indicating dyslipidemia and inadequate glycemic control (Table 1).

The association of T2DM with CVD is well-established. Moreover, both lipid profile and DM have been shown to be important predictors of metabolic disorders, including dyslipidemia, hypertension, hyperinsulinemia, and CVD [17].

People with T2DM have higher cardiovascular morbidity and mortality and are disproportionately affected by CVD compared to people without DM. Early detection and treatment of dyslipidemia associated with DM may be one step to reducing the CVD risk (9). HbA1c could be used as a predictor of dyslipidemia, and early diagnosis of dyslipidemia can be used to initiate preventive measure against the development of vascular complications in T2DM. In this work, a positive correlation was observed between HbA1c and TC ( $p = 0.0001$ ) (Figure 1).

In this study, age and HbA1c were not significantly correlated ( $r = 0.011$ ,  $P = 0.063$ ).

These

Findings are consistent with a previous study in Pakistan [4]. On the other hand, there was a

## CONCLUSION

biomarker would facilitate early diagnosis of dyslipidemia by using a relatively inexpensive blood test that is commonly used for the assessment of glycemic control. Screening high-risk T2DM patients would enable timely intervention with lipid-lowering drugs.

HbA1c was significantly and positively associated with the levels of the commonly analyzed serum lipids. This points to the possibility of using HbA1c not only for the assessment of glycemic control, but also as a potential biomarker for predicting dyslipidemia in patients with T2DM. Such a

## Acknowledgment:

We thank Dr. Hajer M. Almouaket for statistical analysis.

## Conflict of interest:

The authors declare that there are no conflicts of interest.

## Funding:

This work was supported by the Biotechnology Research Center, Tripoli, Libya.

## Author contributions:

Asmaa Alboueishi, Fawzi Omar: conceived the study. Yosraelammami, Huda Aldeeb, Mohammed Dali: collected data. Both authors participated in data analysis, manuscript writing and review, and approval of final version.

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## Tables

Table 1: Means of Glycated hemoglobin, fasting blood Glucose and serum lipids in patients with type 2 diabetes mellitus

Parameters	Mean	SD	Range	Normal range
HbA1c (%)	8.05	7.9	5.50 -16.50	Less than 6.5
FBS (mg/dl)	167.82	82.66	95-580	75–120
TC (mg/dl)	188.53	76.66	96-321	≤ 200
TG (mg/dl)	157.31	118.5	45.779	> 150
HDL-C (mg/dl)	38.99	24.20	18-98	< 40
LDL-C (mg/dl)	150.0	17.12	23-256	≤ 100

Table 2. Correlation of hemoglobin levels with age, fasting blood Glucose and serum lipids in patients with type 2 diabetes mellitus

Parameters	Pearson correlation	P value
Age	0.011	0.063
FBS	0.641	0.000*
TC	0.223	0.000**
TG	0.104	0.67*
HDL-C	-0.88	0.123
LDL-C	0.240	0.000**

\*Statistically significant



## Figure legend

**Fig. 1:** Correlation of hemoglobin with age, fasting blood glucose and lipid profile components in adult patients with type 2 diabetes mellitus. HbA1c (percent) is on y-axis.

