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Research Article

Correlation between HbA1c and lipid profile in diabetes: a primary health concern in Aseer, Saudi Arabia

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) presently affects 537 million adults globally. It has a high prevalence in the Saudi population (31.6%), ranking 2nd highest in the Middle East and 7th worldwide. T2DM is characterized by insulin resistance and hyperglycemia, causing the glycation of hemoglobin, plasma proteins, tissue proteins, and their receptors. The high insulinemic state leads to dyslipidemia. These biochemical alterations can cause complications like atherosclerosis, coronary artery disease, angina, myocardial infarctions, and hypertension. Considering the high prevalence of diabetes in the Saudi population and the lack of studies conducted at primary health care (PHC) centers in Saudi Arabia, this study was done to investigate the status of diabetes control in T2DM patients and propose appropriate measures to prevent the development of future complications.

Method: This cross-sectional study recruited 191 known T2DM patients presenting at the PHC center in the Al Qabil locality of Aseer province of Saudi Arabia. The patient's demographic and glycemic and lipid profile data were recorded and statistically analyzed.

Results: T2DM was more prevalent in males. T2DM patients were found to be obese, and 52% had coexisting hypertension. Patients had deranged glycemic profiles and dyslipidemia despite taking hypoglycemic agents. Hyperglycemia and dyslipidemia were significantly higher in people with diabetes having HbA1c > 7. HbA1c is correlated with dyslipidemia, and dyslipidemia is linked considerably with obesity.

Conclusion: T2DM patients must be regularly followed up to ensure drug compliance, explained about foreseen medical complications, and motivated to adopt lifestyle modification measures to control their weight, BP, and blood glucose.

Keywords: Correlation; HbA1c; lipid profile; Type 2 diabetes mellitus; Saudi Arabia

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the most commonly encountered metabolic disorders in clinical practice and communities worldwide. The prevalence of this chronic disorder is increasing at an alarming rate globally. Presently 537 million adults are living with diabetes worldwide, accounting for about one diabetic person in every ten persons (according to the year 2021 data), and this number is predicted to rise to 643 million by 2030 and 783 million by 2045.[1] The prevalence of diabetes in Saudi population[2] is 31.6% which is relatively high and Saudi Arabia is ranked as the 2nd highest country in the Middle East zone and seventh in the world regarding the prevalence of diabetes mellitus.[3]

Type 2 diabetes mellitus is characterized by insulin resistance leading to hyperglycemia which consequently leads to further biochemical derangements in the body leading to the development of a vast array of clinical complications in due course of time. Insulin resistance leads to a hyperinsulinemia state in the body in an attempt to bring down the blood glucose levels by trying to facilitate the entry of plasma glucose into the tissue cells. This high insulin level leads to dyslipidemia in the body, thereby increasing the propensity to develop cardiovascular complications. Besides this, hyperglycemia leads to the glycation of hemoglobin, plasma proteins, tissue proteins, and their receptors. These biochemical alterations over a chronic period have been known to cause several complications, especially atherosclerosis, coronary artery disease, angina, myocardial infarctions, hypertension, stroke, obesity, retinopathy, neuropathies, nephropathy, and xanthelasmas.[4] Moreover, it is not uncommon to see patients presenting to the medical emergency department having diabetic ketoacidosis or hyperosmolar coma due to poorly controlled diabetes mellitus. Thus, it becomes essential that a patient, once diagnosed with diabetes, is strictly followed up clinically to prevent the development of these medical sequelae that leads to depreciation in their quality of life.

This study has been carried out in the primary health care (PHC) center of the Aseer region on known cases of type 2 diabetes mellitus patients because primary health care serves as the first interface of interaction with patients to provide healthcare to the community. Due to the increasing prevalence of diabetes among the Saudi population and the lack of studies conducted at the primary healthcare level in Saudi Arabia, this study was conducted to investigate the status of diabetes control in T2DM patients and if they had dyslipidemia or not and to propose appropriate measures to be adopted at primary health care level that could help serve the community in a better way to battle this disease that silently affects almost all tissue of the body.

METHOD

This cross-sectional study was carried out after taking ethical permission from our organization's scientific committee of research. Informed consent was taken from the patients to recruit them for the study. The known cases of type 2 diabetes mellitus who presented to the primary health care center (situated at Al-Qabil locality of the Aseer province of Saudi Arabia) for their follow-up were the subjects of this study. Only patients with type 2 diabetes mellitus with at least one year of duration were included in the study. The study was conducted for ten months, from April 2019 to January 2020, and 191 T2DM patients were recruited in the

study group. Diabetic patients who were taking drugs causing hypolipidemia were excluded from the study. Patients having a history of any other metabolic disorder were excluded from the study to avoid getting confounding results. Type 1 diabetes patients and newly diagnosed type 2 diabetics were also excluded from the study. The patients' demographic data were recorded and then asked to undergo biochemistry lab investigations to check their glycemic and lipid profile status. The socio-demographic data included age, gender, body mass index (BMI), blood pressure (BP), and nationality. The glycemic profile of the patients was checked by measuring fasting blood glucose (FBS), random blood glucose (RBS), and glycated hemoglobin (HbA1c) levels. The lipid profile assessment was done by measuring serum total cholesterol (TC), LDL cholesterol (LDL), triglycerides, HDL cholesterol (HDL), and VLDL levels. VLDL levels were determined using Freidwald's formula (VLDL = TG/5). The HbA1c data was used to further categorize the diabetes patients into well-controlled diabetes (HbA1c ≤ 7) and inadequately controlled diabetes groups (HbA1c ≥ 7) for further comparison of glycemic and lipid profiles. The data so obtained from the patients were compiled and statistically analyzed.

Statistical analysis

The data related to age, BMI, FBS, RBS, HbA1c, total cholesterol, LDL cholesterol, triglycerides, HDL cholesterol, and VLDL was parametric and has been expressed as mean ± standard deviation. The glycemic and lipid profile comparison amongst the two groups (well-controlled diabetes group and inadequately controlled diabetes group) has been made using an independent student t-test. Linear regression analysis was used to check the correlations between the biochemical parameters in diabetes patients. P value < 0.05 has been considered significant. The statistical analysis was done using SPSS software (version 20).

RESULTS

The demographic data and glycemic and lipid profiles of diabetes patients have been shown in Table 1. In this study, it was found that the prevalence of type 2 diabetes mellitus was relatively higher in males in comparison to females. The mean age of the study subjects was 54.9 years. The mean BMI of these patients was 30.3 falling in class 1 obese category. Out of 191 diabetes patients, 100 (52%) also had hypertension. The nationality of these patients was Saudi. The diabetic patients showed a hyperglycemic and dyslipidemia blood picture (N=191, Table 1). Table 2 compares glycemic and lipid profiles amongst patients with adequately controlled diabetes and inadequately controlled diabetes. It was found that the patients whose HbA1c was > 7 had significantly higher FBS, RBS, HbA1c, total cholesterol, LDL cholesterol, triglycerides, and VLDL cholesterol level compared to diabetes patients with HbA1c ≤ 7. In Linear regression analysis (Table 3, Figure 1), the HbA1c groups of the diabetes patients showed a significant positive correlation with total cholesterol and LDL levels. Linear regression analysis (Table 3, Figure 2) also revealed that total cholesterol and triglyceride levels of diabetic patients showed a significant positive correlation with BMI.

Table 1. Demographic data, glycemic and lipid profile of diabetes patients (N=191)

Demographic and biochemical variables	Data
Gender	
Male	111(58%)
Female	80 (42%)
Nationality Saudi	191 (100%)
Age (years) (Mean ± SD)	54.9 ± 12.7
BMI (Mean ± SD)	30.3 ± 5.6
Blood pressure	
Hypertensive (BP ≥140/90mmHg)	100 (52%)
Normotensive (BP < 130/85)	91 (48%)
Glycemic and lipid profile parameters	Mean ± SD
Fasting blood sugar (FBS)(mg/dl)	201.3 ± 69.8
Random blood sugar (RBS)(mg/dl)	313.9 ± 84.6
HbA1c (%)	10.3 ± 2.9
Total cholesterol (mg/dl)	210.4 ± 51.4
LDL (mg/dl)	121.7 ± 42.0
HDL (mg/dl)	33.9 ± 6.3
Triglycerides (mg/dl)	201.7 ± 120.3
VLDL (mg/dl)	40.3 ± 24.1

Table 2. Comparison of glycemic and lipid profile amongst patients with adequately controlled diabetes and inadequately controlled diabetes.

Variables	Patients with adequately controlled diabetes (HbA1c ≤ 7) (N=40) Mean ± SD	Patients with inadequately controlled diabetes (HbA1c > 7) (N=151) Mean ± SD	p-value
Fasting blood sugar (FBS) (mg/dl)	137.3 ± 29.1	218.3 ± 67.6	0.000*
Random blood sugar (RBS) (mg/dl)	223.0 ± 36.9	337.9 ± 76.9	0.000*
HbA1c (%)	6.5 ± 0.7	11.3 ± 2.4	0.000*
Total cholesterol (TC) (mg/dl)	184.4 ± 40.7	217.3 ± 51.9	0.000*
LDL (mg/dl)	106.8 ± 15.8	125.6 ± 45.8	0.000*
HDL (mg/dl)	33.2 ± 2.1	34.1 ± 6.8	0.39
Triglyceride (mg/dl)	132.8 ± 85.4	216.8 ± 121.9	0.001*
VLDL (mg/dl)	26.6 (17.1)	43.4 (24.4)	0.001*

*p value < 0.05 is considered significant

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Table 3. Linear regression analysis to check the correlation between the biochemical parameters in diabetes patients

Variables	Correlation coefficient (Beta)	p-value
HbA1c and TC	0.3	0.001*
HbA1c and LDL	0.3	0.000*
HbA1c and triglyceride	0.2	0.053
HbA1c and HDL	0.1	0.533
HbA1c and VLDL	0.2	0.053
Total cholesterol and BMI	0.2	0.037*
Triglyceride and BMI	0.4	0.001*

*p value < 0.05 is considered significant

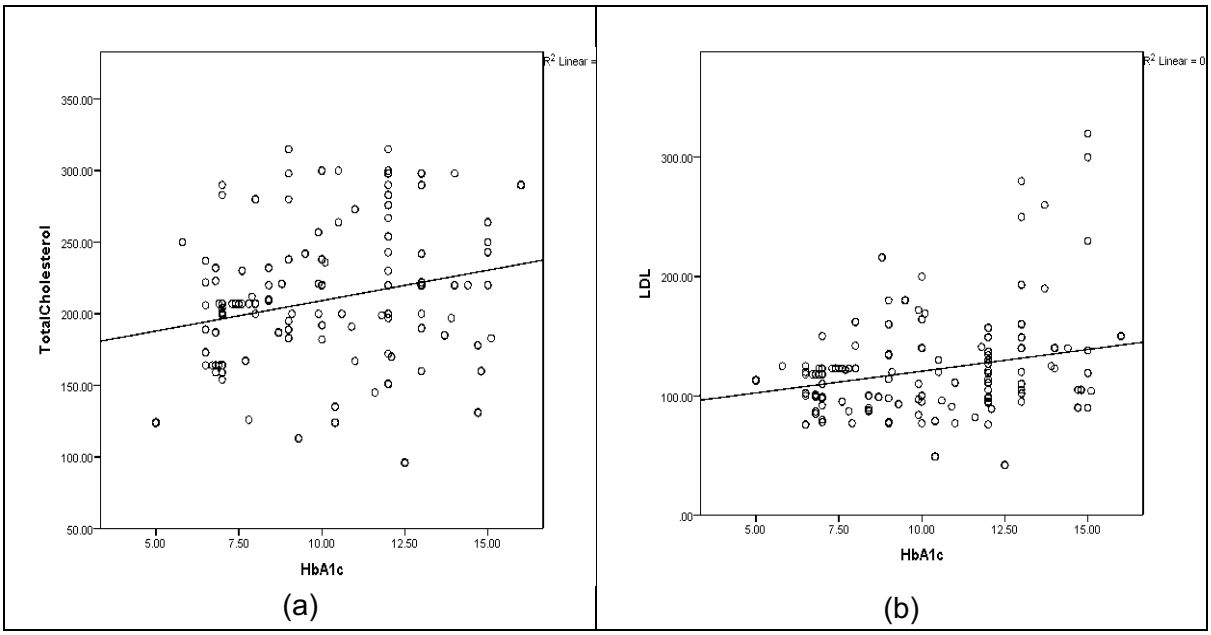

Figure 1. Correlation of HbA1c with total cholesterol (a) and HbA1c with LDL (b)

DISCUSSION

This study shows that type 2 diabetes mellitus was more prevalent in males, and the average age of the patients was 54.9 years. These patients were found to be falling in the obesity class 1 category. These patients were of Saudi nationality. Saudi Arabian diet predominantly contains food items of non-vegetarian origin. The non-vegetarian diets are considered high in cholesterol and triacylglycerol content, which might have been a contributing factor to obesity. A study by Wang et al. has shown that meat consumption is associated with increased BMI and obesity.[5] The study also found that 52% of diabetes patients also had hypertension. The glycemic profile of the study subjects (N = 191) showed the mean with a standard deviation of fasting blood glucose (201.3 ± 69.8), random blood glucose (313.9 ± 84.6, and HbA1c (10.3

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± 2.9) were all out of the normal reference range indicating that these patients' despite of taking oral hypoglycemic drugs and insulin were not able to maintain an average glycemic profile. The lipid profile analysis also revealed that these patients had dyslipidemia. Their mean with a standard deviation of total cholesterol (210.4 ± 51.4), LDL cholesterol (121.7 ± 42.0), triglycerides (201.7 ± 120.3), HDL cholesterol (33.9 ± 6.3), and VLDL (40.3 ± 24.1) were found to be out of normal reference range. According to the NCEP ATP III criteria, the total cholesterol level in the range of 200-239 is considered to be borderline high, LDL cholesterol in the range of 100-129 is considered above the optimal range, HDL cholesterol < 40 is considered to be low and fasting triglyceride level > 150 mg/dl is considered to be high. This study confirmed through linear regression analysis that HbA1c, a glycemic profile indicator, significantly correlated with total serum cholesterol and LDL cholesterol, indicating that hyperglycemia leads to dyslipidemia in diabetic patients.

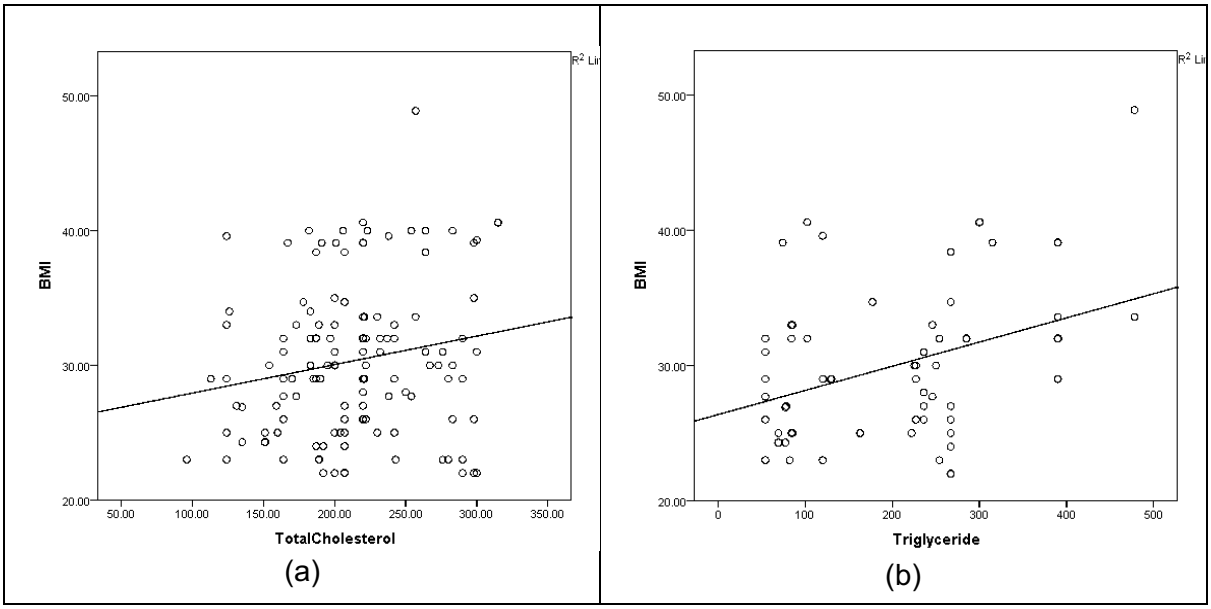

Figure 2. Correlation of total cholesterol with BMI (a) and triglycerides with BMI (b)

The linear regression also confirmed that serum total cholesterol and triglyceride levels were significantly correlated with BMI, indicating that dyslipidemia leads to increased BMI. The mean BMI of the diabetic subjects enrolled in this study was found to be in the obesity category, implying that dyslipidemia could have led to obesity. A study in the literature has shown that approximately 60-70% of patients who are obese are dyslipidemia.[6] Dyslipidemia and obesity[7] are associated with increased risk for cardiovascular complications. Besides this, the presence of hypertension is also considered to be a risk factor for the development of cardiovascular disease.[8]

The adequately controlled diabetic group and inadequately controlled diabetic group, when compared for their glycemic and dyslipidemia profile, showed a significantly deranged glycemic and dyslipidemia picture in the poorly controlled diabetic group (Table 2). This implies that if tight glycemic control is not maintained in diabetes patients, then the pathophysiology of diabetes progresses in an uncontrolled manner leading to the worsening of the lipid profile.

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Dyslipidemia increases the risk for cardiovascular complications mainly because dyslipidemia promotes atherosclerosis. [9,10] High levels of low-density lipoprotein (LDL)[11] and low levels of high-density lipoprotein (HDL)[12] are associated with myocardial infarction (MI) and stroke.[13,14] A study by Tasneem et al. also found that HbA1c can be used as a marker for dyslipidemia and to screen patients with a high risk for cardiovascular complications.[15] A study by Anderson et al. also showed that dyslipidemia is a strong predictor of cardiovascular disease.[16] Dyslipidemia causes endothelial damage[17] and subsequent loss of physiological vasomotor activity that may manifest as increased blood pressure (BP).[18,19] Many studies have recommended treating dyslipidemia to decrease the risk of cardiovascular diseases. [20,21]

Besides cardiovascular complications, hyperglycemia and dyslipidemia in diabetes are also found to be associated with other complications such as diabetic retinopathy, cataract, diabetic nephropathy, diabetic foot, urinary tract infections, skin infections, and xanthomas. Thus, it is of great concern to control diabetes by administering oral hypoglycemic drugs, insulin, and lifestyle modification and maintaining a regular follow-up of diabetic patients.[22] It is our observation that diabetes patients are not very compliant in taking pharmacological treatment regularly, which might be a probable reason in our study that 151 out of 191 diabetes patients (79%) had inadequately controlled diabetes. Diabetic patients must be thoroughly counseled regarding the importance of taking drugs regularly in appropriate doses. Though drugs play an indispensable role in controlling the blood sugar level, the role of lifestyle modification should not be overlooked in type 2 diabetes mellitus.[23] Since type 2 diabetes mellitus is characterized by insulin resistance, these patients must be counseled and encouraged by healthcare practitioners to adopt measures related to lifestyle modification, such as engaging in daily physical exercise to upregulate the peripheral insulin receptors on the cells to decrease the insulin resistance in the body which would eventually help in controlling the blood glucose levels.[24] These patients must be explained about the medical complications associated with diabetes mellitus that they are likely to develop in the future. Besides this, the patients should be advised to consume a smaller number of meats, eggs, and oily foods to improve their lipid profile further and that they should avoid eating foods with high glycemic index and must include complex carbohydrate-rich foods and dietary fibers (salads) in their meals which would further decrease the absorption of cholesterol from intestine into the blood. The patients of T2DM must also be motivated to keep their body weight in control and self-monitor their blood pressure and blood glucose levels continuously by using user-friendly point-of-care testing devices such as digital BP apparatus and glucometers.[25] Since studies conducted at a primary health care center in Saudi Arabia are minimal, our research data has substantial value in formulating health policies for the local population to ensure reasonable control over diabetes mellitus.

CONCLUSION

Type 2 diabetes mellitus patients presenting at the primary health care center of the Aseer region were found to be obese, with 52% of cases having concomitant hypertension. Despite taking oral hypoglycemic drugs and insulin, these patients showed a deranged glycemic and lipid profile. Patients of T2DM in the Aseer region of Saudi Arabia must be regularly followed up to review the ongoing drug therapy and its compliance so that glycemic and lipid profiles can be adequately controlled, given the impending risk of complications associated with

T2DM. The authors also recommend that thorough counseling of these patients regarding lifestyle management measures might be helpful.

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Declarations

Authors' contribution

FR designed the study, collected the data, and reviewed and edited the manuscript. AN statistically analyzed the data, prepared the result, and wrote the manuscript.

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Conflict of interest

There is no conflict of interest in this research.

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