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Research Article

Prevalence and Pattern of Dyslipidemia among Patients with Type II Diabetes in Al-Baha, Saudi Arabia

Abuobaida E.E. Abukhelaif[1], Abdullah H. Alghamdi[2], Karem Saeed Saadi Alghamdi[2], Omar Rashed Tami Alghamdi[2], Mohammed safer Alghamdi[2]

[1]Assistant Prof, Consultant; Pathology Department, Faculty of Medicine, Al-Baha University; Saudi Arabia.
[2]Medical interns, Faculty of Medicine, Al-Baha University; Saudi Arabia.

***Corresponding Author:** Dr. Abuobaida E.E. Abukhelaif
*Department of Pathology, Faculty of Medicine, Al-Baha University, Saudi Arabia,
Email: aabukhelaif@gmail.com; Tel.: 00966556570763

Abstract
Background: Dyslipidemia is a common and significant metabolic complication in patients with Type 2 Diabetes (T2DM), contributing to an increased risk of cardiovascular diseases (CVD). Our study designed to assess prevalence and pattern of dyslipidemia in patients with Type 2 Diabetes (T2DM). ***Methods:*** This cross-sectional study was conducted at Al-Aqiq Healthcare Center from March 2020 to December 2023. A total of 150 patients with T2D were enrolled. Demographic and clinical information, laboratory values concerning glycemic control (measured by HbA1c), and lipid profile data (total cholesterol, LDL-C, HDL-C, and triglycerides) were collected from patients' medical records. Dyslipidemia was defined according to established guidelines as elevated triglycerides, low HDL-C, and increased LDL-C. The data were analyzed to determine the prevalence and pattern of dyslipidemia. Chi-square test (X2) was considered to explore the association between categorical variables and P-value of <0.05 was selected as the statistically significant level in all tests. ***Results***: records of 150 T2DM patients were analysed, their mean age was 58.3 ±13.54 years and 61.3% were females. The overall prevalence of dyslipidemia was 82.7 %, and significantly (p =.001) higher among females. Significantly higher values (p<0.001) for Total cholesterol (TC), low-density lipoprotein cholesterol (LDLC), and triglyceride (TG) were high in 56.7%, 60.0%, and 73.3% of patients, respectively; high-density lipoprotein cholesterol (HDLC) was low in 63.3%. Mixed dyslipidemia (including raised TC, LDLC, TG, and low HDLC) was the most prevalent 82.7% type. Those with poor glycemic control (HbA1c ≥ 8%) showed significantly worse lipid profile (p < 0.001). ***Conclusions:*** Dyslipidemia was found to be highly prevalent among patients with T2DM at Al-Baha southwest of Saudi Arabia, with a specific pattern of elevated triglycerides and low HDL-C.

Keywords: Type 2 diabetes mellitus; Glycaemic Control; Lipid Profile; Dyslipidemia; Al-Baha; Saudi Arabia.

***Author for correspondence: Email:** aabukhelaif@gmail.com*

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Introduction:
Type 2 diabetes (T2DM) is frequently accompanied by dyslipidemia, which contributes significantly to the elevated cardiovascular risk seen in these patients. Diabetes-related dyslipidaemia is characterized by a distinctive lipid profile such as elevated triglycerides,

reduced high density lipoprotein cholesterol (HDL-C), and increased small dense high LDL-C which increases the risk of atherosclerosis and subsequent cardiovascular events such as myocardial infarction and stroke [1-6] Globally including Saudi Arabia, burden of dyslipidemia in diabetic patients is constantly increasing due to high prevalence of obesity, reduced physical activity, and habits of consumption of unhealthy diets [7-11] . Studies have consistently demonstrated a high prevalence of dyslipidemia among patients with T2DM. The exact prevalence rates vary depending on factors such as age, gender, ethnicity, duration of diabetes, and glycemic control. Some studies suggest that up to 20-60% of individuals with T2DM have dyslipidemia. The prevalence of specific lipid abnormalities, such as elevated TG and reduced HDL-C, tends to be higher in patients with T2DM compared to the general population. As T2DM progresses and becomes poorly controlled, the prevalence and severity of dyslipidemia tend to increase [12-16].

In Al-Baha Saudi Arabia, research concerning the prevalence and pattern of dyslipidaemia is scarce despite the high prevalence and associated complications of dyslipidemia in DM patients. Our study aims to assess the prevalence and patterns of dyslipidemia among patients with T2DM attending their follow-up at chronic illness clinic at Al-Aqiq Healthcare Center, Al-Baha Saudi Arabia.

Methods

Study design and setting

A retrospective study was conducted retrieving the records of T2DM patients that visited the chronic illness clinic at Al-Aqiq Healthcare Center, Al-Baha Saudi Arabia for the period March 2020 to March 2024. The PHCs selection was grounded on its geographic location, coverage area, and availability of diabetic services such as an expert family physician and laboratory services such as HbA1c blood tests. Ethical approval for the study was obtained from the Scientific Research Ethics Committee (REC) at the Faculty of Medicine University of Al-Baha; Saudi Arabia (Approval No.: REC/PAT/BU-FM/2024/3).

Inclusion and exclusion criteria

Files with records of T2DM patients who had been consulted during the study period fulfilling eligible criteria for the study, and on a regular follow-up with the nominated Health Center were enrolled. Those who diagnosed with T2DM for less than three months or reported with gestational hyperglycemia, secondary dyslipidemia (e.g., hypothyroidism, renal disease, or hepatic disorders), on lipid-lowering drugs, and smoking habit were excluded from the study including records with incomplete information.

Study Population and sampling:

The study population constitutes all medical records of eligible type 2 DM patients aged 30 years and above who were followed up or treated during the period of the study. On average, at this clinic about 224 patients were registered and regularly seen at least every six months. One hundred fifty patients' record that met the eligibility criteria was taken as a study sample. Their data was extracted, reviewed from their files and included in the present study for further analysis. The following characteristics were assessed for each study participant: gender, age, body mass index (BMI), duration of DM and their treatment status. We also collected laboratory data concerning fasting plasma glucose, glycosylated hemoglobin (HbA1c) and lipid profile levels. BMI of (18.5-24.9 kg/m2), (25.5 - 29.9 kg/m2) and (>30.0 kg/m2) were regarded as normal-weight, overweight and obese respectively for the purpose of this study. Glycemic control was categorized as good when HbA1C was ≤ 7%, and poor when HbA1C was >7%.Dyslipidemia among our study participant was defined as having total cholesterol (TC) ≥ 200 mg/dl, triglycerides (TG) ≥ 150 mg/dl, low-density lipoprotein-cholesterol (LDL-C) ≥ 100 mg/dl, high-density lipoprotein-cholesterol (HDL-C) ≤ 40 mg/dl (males), and ≤ 50 mg/dl (females). Dyslipidemias were classified by patterns of elevation in lipids and lipoproteins levels as follows:

- Increases in cholesterol (TC) only: Pure or isolated hypercholesterolemia
- Increases in TGs only: Pure or isolated hypertriglyceridemia
- Increases in both cholesterol and TGs: Mixed or combined hyperlipidemias
- High non-HDL-C, high LDL-C, and low HDL-C.

Statistical analysis

All data were tabulated and analyzed by using the Statistical Package for Social Science (SPSS version 24). Data on continuous variables like age, duration of diabetes, BMI, HbA1c and lipid profile were expressed as mean with standard deviation (SD). The Independent student's t test was done to compare continuous variables between two independent groups. Categorical variables were expressed as a percentage and were analyzed by Chi-square test ($\chi 2$). All statistical analysis was carried out at 5% level of significance and P value below 0.05 was considered as significant.

Results

General Characteristics of Study Participants

The study population comprised records of 150 T2DM patients who have visited diabetic clinics for follow-up of their treatment during the study period and who fulfilled the eligibility criteria were enrolled in our study. Out of study subjects, 38.7 % (n=58) were males and 61.3% (n=92) females with a mean age of 51.67 ± 10.42 years as shown in Fig (1).

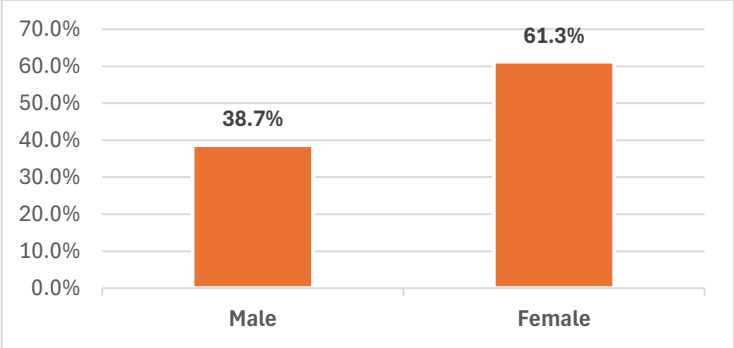

Fig. (1) Gender distribution of the Study Participant

Table (1) Socio-Demographic and Clinical Characteristics of the Study Participant

Variable	Mean ± SD Total (N=150)	Range	Frequency	Percentage
Age (years)	58.3 ±13.54	< 40 years	24	16 %
		40-70 years	118	78.7 %
		> 70 years	8	5.3 %
Diabetes duration (years)	11.9 ± 6.5	< 5 years	19	12.7 %
		5-10 years	36	24%
		>10 years	95	63.3%
BMI	30.8± 6.1	Normal: <25	25	16.7%
		Overweight: 25–29.9	46	30.6 %
		Obese: ≥30	79	52.7 %
FBS level by mg/dl	190.48 ± 38.82	< 126 mg/dl	43	28.7%
		≥ 126 mg/dl	107	71.3%
HbA1c %	8.5 ± 2.9%	Good (≤ 8)	23	15.3%
		Poor (> 8)	127	84.7%
Regularly received treatment for diabetes		Yes	115	76.7 %
		No	35	23.3 %

BMI body mass index (kg/m^2)

The baseline demographic and clinical characteristics of the study participants were shown in table (1). Majority of the study participants (78.7%) were in the age group of 40-70 years. Mean ± SD of the diabetic duration was 10.9 ± 7.1 with about two thirds of the study group 63.3% (n=95) the duration of diabetes was found to be 10.9 ± 7.5 more than 10 years, whereas 24 % (n=36) and 12.7 % (n=19) had diabetes for five to 10 years and less than five years, respectively. Overweight and obesity were noted in 30.6% and 52.7% respectively. Some of the participants (23.3%) do not take their treatment regularly. Analysis of the laboratory records revealed that the mean± SD for fasting blood glucose among our study participants was found to be 190.48 ± 38.82 mg/dl with 71.3% of them showing abnormal findings (≥ 126 mg/dl FBS level) and the mean± SD for HbA1c was 8.5 ± 2.9 with 84.7% patients with poor control (>8.5 ± 2.9%) .

Prevalence of Dyslipidemia among Study Participants

The mean levels of lipid profile among our study participants were shown in table (2) below. The overall prevalence of dyslipidemia was 82.7%, and it was higher among females 86.5% than males76.8%. Among the study participants 56.7% had hypercholesterolemia and 73.3 % of them showed hypertriglyceridemia. Abnormal LDL-C and HDL-C levels were found in 60 % and 63.3 % of patients respectively.

Table 2: Dyslipidemia Prevalence among the Study Participants

Lipid Profile Parameter	**Mean (mg/dL) ± SD**	**Prevalence (%)**
Total Cholesterol	210.4 ± 45.8	56.7%
LDL Cholesterol	134.7 ± 36.5	60.0%
HDL Cholesterol	40.2 ± 9.1	63.3%
Triglycerides	180.6 ± 52.3	73.3%
Overall Dyslipidemia	Any parameter abnormal	82.7%

Lipid Profile Levels Based on Gender:

Gender-wise comparison of general characteristics and laboratory data of the study participant were shown in table (3). Age, duration of diabetes and TG level did not reveal any statistically significant difference (P = 0.425, 0.437 and 0.57 respectively). A statistically significant difference (P < 0.05) was found between male and female regarding HbA1c, FBG, TC, and HDL-C.

Interestingly, females had lower total cholesterol (TC) and HDL-C (202± 48.39 and 56.4±2.28, respectively). Men had lower mean LDL-C and TG levels (168.9±43.8 and157±91.03 respectively) although it did not reach statistical significance (P > 0.05).

Lipid Profile Levels Based on Glycemic Control

Analysis of laboratory values of lipid profiles among different glycemic control groups was shown in Table (4). The mean value of FBG, LDL-C, and TG was significantly higher among poorly glycaemic controlled diabetic patients ($P < 0.05$) than in the poorly glycaemic controlled diabetic patients, while there was no significant difference regarding mean value of TC and HDL-C across both groups (P > 0.05).

Table (3): Gender-wise comparison of basic characteristics of type 2 diabetes mellitus patients

Parameters	Mean ± SD Total (N=150)	Mean ± SD Females (N=141)	Mean ± SD Males (N=65)	P-value
Age (yrs)	58.3 ±13.54	56.53±14.19	58.2 ± 8.9	0.425
BMI(Kg/m2)	30.8± 6.1	31.59± 6.56	29.08± 4.58	0.002*
Duration of diabetes (years)	11.9 ± 6.5	10.9 ± 7.5	11.4 ± 6.9	0.437
FPG (mmol/l)	8.21 ± 3.26	7.88 ± 2.8	8.85±3.27	0.03*
HbA1C (%)	8.5 ± 2.9	8.86± 1.86	8.20± 1.53	0.009*
(TC) (mg/dl)	210.4 ± 45.8	202±48.39	222±57.61	<0.001*
LDL-C (mg/dl)	134.7 ± 36.5	178.9±43.8	168.9±43.8	<0.06
HDL-C (mg/dl)	40.2 ± 9.1	56.4±2.28	60.4±2.28	0.002*
Triglyceride (mg/dl)	180.6 ± 52.3	175±122	157±91.03	0.37

Abbreviations: *BMI, Body mass index; TC: Total cholesterol; LDL-C, Low-density lipoprotein cholesterol; HDL-C, High-density lipoprotein cholesterol; FPG, Fasting plasma glucose*.
** Statistically significant p-value.*

Table (4): Laboratory Parameters Categorized by Patients' Glycemic Control (HbA1c)

Parameter	Controlled (HbA1c≤7%) (n=23)	Uncontrolled (HbA1c>7) (n=127)	p value
FBG(mg/dl)	123.17±15.16	130.79±17.68	0.005*
(TC) (mg/dl)	158.57± 22.82	247.5± 48.68	0.117
LDL-C (mg/dl)	133.7±33.58	190.91±65.25	0.03*
HDL-C (mg/dl)	30.06±6.97	25.85±6.44	0.104
Triglyceride (mg/dl)	143.21±49.67	257.10±102.24	0.003*

*TC: Total cholesterol, LDL: Low-density lipoprotein, HDL: High-density lipoprotein. *Statistically significant*

Discussion:

To our knowledge, this is the first study to report the prevalence of dyslipidemia among Al-Baha; Saudi Arabia. This study had advantages in detecting and categorization of dyslipidemia in T2DM patients to raise the awareness of clinicians to consideration of future risk of cardiovascular disease and take appropriate preventive measures among T2DM patient. Dyslipidemia is a common comorbidity among individuals with type 2 diabetes mellitus (T2DM), contributing significantly to their increased risk of cardiovascular disease (CVD). The interplay between dyslipidemia and T2DM is complex, with both conditions often exacerbating each other. Patients with T2DM often exhibit elevated levels of triglycerides, which is a hallmark feature of diabetic dyslipidemia. Elevated TG levels are associated with increased insulin resistance and are often observed in individuals with poorly controlled T2DM. Low levels of HDL-C, often referred to as "good cholesterol," are commonly observed in patients with T2DM. Reduced HDL-C levels further increase the risk of CVD in these individuals. Although LDL-C levels was not always be elevated in patients with T2DM, the LDL particles tend to be smaller and denser, which makes them more atherogenic and contributes to the development of atherosclerosis.

The purpose of our study was to determine the prevalence and pattern of dyslipidemia among T2DM patients' residence at Al-Baha; Saudi Arabia whose on follow-up at Al-Aqiq Healthcare Center. The findings our study revealed that the prevalence of dyslipidemia among T2DM patients was found to be very high (82.7%) and it was significantly associated with being female patient. The overall prevalence of dyslipidemia was 82.7%, and it was higher among females 86.5% than males76.8%. Among the study participants 56.7% had hypercholesterolemia and 73.3 % of them showed hypertriglyceridemia. Abnormal LDL-C and HDL-C levels were found in 60 % and 63.3 % of patients respectively. This reported prevalence was comparable with national and international studies .Local Saudi studies such as that conducted in Jeddah[14], Almajmaah [15] and Tabuk [17] and also similar international studies with high prevalence of dyslipidemia among T2DM patients such as studies conducted in Jordan[18], Turkey[19] , Pakistan[20] , two studies done at South Africa, ranging between 87.5 [21] and 93.5 % [22], in Cantabria, Spain 85.3% [23] and Tanzania 83% [24], and Thailand 88.9% [25]. The

prevalence rate of dyslipidemia in other studies compared to our study reported variable prevalence rates and patterns of dyslipidemia [26-28]. This variation in the prevalence of dyslipidemia among different study population may be related to variation in the sample size used and the composition of study population. Our study revealed that lipid profile abnormalities were hypertriglyceridemia and low HDL level. These finding were the same as in study done at Saudi Arabia (42.8%) [29].

Raised level of triglyceride among T2DM patient can be attributed to abnormal metabolism of triglyceride-rich lipoproteins as a result of insulin resistance and hyperglycemia, this become clear as our study revealed that the mean value of FBG, LDL-C, and TG was significantly higher among poorly glycaemic controlled diabetic patients ($P < 0.05$) than in the good glycaemic controlled diabetic patients, the prevalence rate of poor glycemic control was found to be 84.7% among our study group. This level is higher than other reported levels in other studies [30-32]. Our study revealed a significant association of dyslipidemia with female diabetic patients. While the effect of gender on dyslipidemia among T2DM patients was not well understood, different studies conducted in different countries reported the same finding as our study with a higher levels of dyslipidemia among females study group compared to male counterpart [23, 33, 34] Dyslipidemia among females may be caused by the effects of estrogen on body fat distribution that lead to differences in altered lipoproteins. Additionally, it can be due to large amounts fat buildup in female.

Conclusion and Recommendation

The results of this study show the high prevalence rate of dyslipidemia among T2DM patients in Al-Baha; Saudi Arabia. Female T2DM patients and those with poor glycaemic control were significantly associated with high levels of dyslipidemia. More attention and efforts should be given towards increasing awareness of diabetic patients to modify their lifestyle and adhere to their diabetic management and follow-up with their physician.

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