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Original Article

Prevalence of dyslipidemia and factors affecting lipid profile in patients with type 2 diabetes

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ABSTRACT

Aim: Dyslipidemia is an established marker for endothelial dysfunction and cardiovascular risk in diabetes. So we aimed to explore the prevalence of dyslipidemia in patients with type2 diabetes mellitus (DM) and to determine the association between dyslipidemia and other health care and biochemical indicators.

Materials and methods: A cross-sectional study was carried out at private health care center. A total of 291 diabetic patients aged 18 years and above attended the clinic from August 2017 through April 2018 were included. Socio-demographic, clinical, and laboratory data were obtained from the medical records of patients. Statistical analysis was carried out using (SPSS, version 23).

Results: out of the 291 diabetes patients recruited 22.3% had hypercholesterolemia (TC $\geq$ 200) and 61.9% had hypertriglyceridemia. Abnormal LDL-C levels ($\geq$130) were found in 8.9% of patients and HDL-C was less than 40 mg/dl in 54.3%. There was a statistically significant difference (P = 0.048) in abnormal HDL levels ($<$ 40 mg/dl) among females (59.3%) and males (47.6). Patients with HbA1c values $\geq$ 7.0%had significantly higher values of total cholesterol (TC) and abnormal LDL-C compared with the patients who had HbA1c $<$ 7.0%.

Conclusion: dyslipidemia is highly prevalent among diabetic population particularly in those with poorly controlled diabetes. This calls for early and universal screening of lipid profile. There is also an urgent demand for measures that target tight glycemic, optimal lipid profile control and life style modifications is also required to all diabetic patients to achieve target value of HbA1C $\leq$ 7.

1. Introduction

Cardiovascular diseases (CVDs) are the leading cause of death and disability in many developed and developing countries in the world including Palestine [1,2]. It is affecting the men and women for almost the same extend [3]. It has been shown that presence of some risk factors such as high levels of blood triglycerides, LDL, VLDL, glycated hemoglobin (HbA_{1c}), microalbuminuria, hypertension, low concentration of HDL and increased body mass index (BMI) are associated with coronary artery disease (CAD) [4]. (see Fig. 1)

Patients with DM have a two to four fold higher risk of CAD [1]. Continuing medical care and ongoing patient self-management education are required to prevent acute complications and to reduce the risk of long-term complications [5]. The international diabetes federation report found that DM affecting more than 415 million with prevalence rate of 9% in adults around the world. Around 90% of total diabetes cases had been found to be from type 2 diabetes. In addition to that, this report predicts that this number will increase to 642 million by the year 2040 [6].

Patients with type 2 DM are at increased risk of accelerated atherosclerosis and premature death [7]. Dyslipidemias may clearly contribute to accelerated atherosclerosis. Mild degrees of dyslipidemia may increase CAD risk considerably in the presence of other CAD risk factors such as diabetes [8]. Abnormal endothelial function was related to an increased low-density lipoprotein cholesterol (LDL-C) in T2DM patients [9]. Subclinical carotid artery disease (increased carotid intima media thickness and plaque) is more prevalent in diabetic patient compared with healthy control

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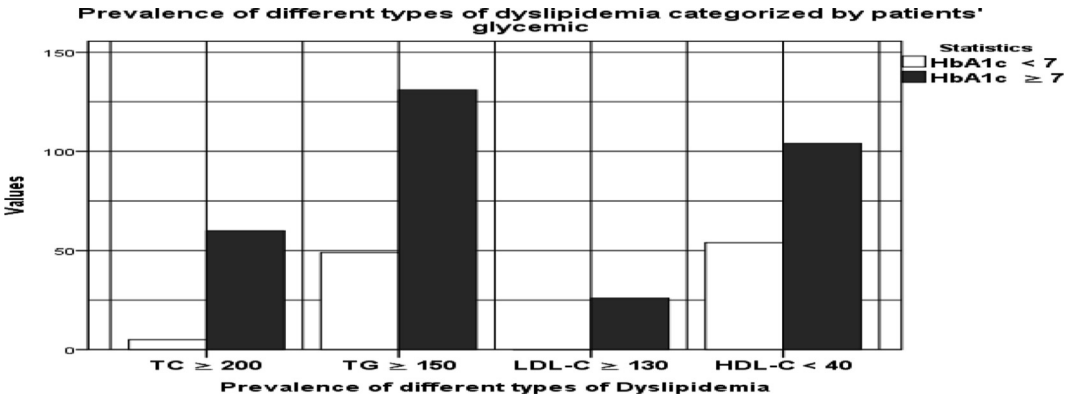

Fig. 1. Bar chart for different types of dyslipidemia categorized by patients' glycemic.

subjects [10]. Total cholesterol (TC) and LDL-C are associated with increased carotid intima media thickness in T2DM [10]. Also, it was found that Intima media thickness in carotid artery in adulthood is associated with childhood LDL cholesterol levels, systolic blood pressure, body mass index (BMI) and smoking regardless of diabetes status [11]. Both diabetes and dyslipidemia are considered major risk factors for CAD [12].

According to the American Diabetes Association (ADA), optimal lipid levels for adults and children with T2DM are LDL-C <100 mg/dl, high-density lipoprotein cholesterol (HDL-C) >35 g/dL and TG < 150 mg/dL [13,14]. Many studies showed that poor glycemic control is associated with increases in TC in patients with T2DM [12]. Among them, 35% had high TC (>200 mg/dL), 27% had high LDL-C (>130 mg/dL) and 12% had high TG (>200 mg/dL) [15]. It has been found that Dyslipidemia remains largely undiagnosed and undertreated in high-risk populations such as patients with type 2 diabetes mellitus [13].

In 2017, it was found that the prevalence of type II diabetes among Palestinian people 10.6% for the age group ranging from 20 to 79 years [6]. This percentage expected to be as high as 20.8% and 60.18% by years 2020 and 2040 respectively. One hundred sixty nine people out of 1000 confirmed having type II diabetes and it is estimated to be around 489 among the same number of population by 2040 [16]. It has revealed that 5.7% of total number of deaths in Palestine are caused by diabetes and its related complications; it is the sixth leading cause of deaths in the country [17].

Due to the increasing frequency of diabetes and dyslipidemias in Palestine, and the lack of studies on these aspects in Palestine, we conducted this study that aims to determine the prevalence of different types of dyslipidemia among patients with type 2 Diabetes Mellitus and to identify the serum lipid profile blood markers associated with poorly controlled type 2 diabetes mellitus diabetes.

2. Subjects, materials and methods

A cross-sectional study was conducted in health care center in Ramallah district, Palestine. It comprised a systematic sample of 291 type 2 diabetic patients from June 2017 through May 2018. The study was approved by the health and ethics committee of the health center, and all the participants gave their informed consent in accordance with the Declaration of Helsinki [18]. Relevant sociodemographic, clinical and laboratory data were obtained from the medical records of the patients including: age, gender, HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglyceride, BMI, Body mass. This information was recorded on the data sheet. Anthropometric measurements were taken, including weight and height.

3. Statistical analysis

The data was analyzed using the SPSS version 23. Qualitative variables were summarized using frequencies and percentages. Graphical representations were provided for all relevant variables. The Chi-square and Fischer Exact tests were used to compare differences in proportions of qualitative variables. A simple and multiple binary logistic regression were used to investigate the association between the poorly controlled type 2 diabetes mellitus diabetes and other significant risk factors. The stepwise method was used for variable selection and model building. A p value < 0.05 was chosen as the criteria to make decisions regarding statistical significance.

4. Definitions

HbA1c ˃ 6.5% were used as the diagnosis criteria for T2DM. HbA1c ≥ 7% were defined as poorly controlled Diabetes Mellitus. For the serum lipid profile, hypercholesterolemia is defined as TC ≥ 200 mg/dl, hypertriglyceridemia when TG is ≥ 150 mg/dl, high LDL-C when the value is ≥ 130 mg/dl, and low HDL-C as a value less than 40 mg/dl. BMI was calculated as the weight in kilograms divided by height in meters squared (kg/m2). BMI was categorized into normal weight (<25 kg/m2), Overweight (25–29.9 kg/m2) and Obese (≥30 kg/m2).

5. Results

A total number of 291 patients with withT2DM were included in this study. Among these patients 42.6% (n = 124) were male and 57.4% (n = 167) were female. Of the 291 patients, 64 (22%) had only one abnormal lipid profile parameter, 125 (43%) had two abnormal lipid parameters and 35 (12%) had more than two abnormal lipid profile parameters. Abnormal HDL levels (˂ 40 mg/dl) were significantly higher in female (59.3%) compared to male (47.6%) (P = 0.048). However, no significant differences were reported between male and female according to other types of dyslipidemia. There was an increase in frequency of hypertriglyceridemia (P ˂ 0.001) and abnormal LDL-C (P = 0.001) in patients with HbA1c values ≥ 7.0%. The results of statistical modeling showed that mean TG, mean HDL-C and mean LDL-Care strong determinants of poorly controlled type 2 diabetes mellitus (HbA1c ≥ 7).

6. Sociodemographic, anthropometric and biochemical characteristics of the participants

The demographic, anthropometric and biochemical characteristics of participants' is shown in Table 1. A total number of 291

Table 1
Basic characteristics, anthropometric and serum lipid profile parameters result for patients with T2DM.

Parameters	All patients (n = 291)			
	Mean	SD	Median	Range
Age (years)	56	9.8	56	28–57
Height (cm)	165.2	10.2	160	150–182
Weight (Kg)	80	14	78	54–118
BMI(kg/m2)	29.4	4.8	28.8	22.5–46.3
Waistline (cm)	98.7	16.4	95	7.8–131
HbA1c (%)	7.8	1.2	7.8	5.8–10.4
TC (mg/dl)	181.5	25.4	181	132–282
TG (mg/dl)	178.4	79.4	168	34–430
HDL-C (mg/dl)	40.7	11.2	38	7–89
LDL-C (mg/dl)	101.8	21.5	98.5	8.7–270

Abbreviations: HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglyceride, BMI, Body mass index.

patients with T2DM were included in this study. Among these patients 42.6% (n = 124) were male and 57.4% (n = 167) were female. The mean age ± S. D of the patients was 56 ± 9.8. The mean age ± S.D of height, weight, BMI, waistline, HbA1c, TC, TG, HDL-C and LDL-C were 165.2 ± 10.2, 80 ± 14, 29.4 ± 4.8, 98.7 ± 16.4, 7.8 ± 1.2, 181.5 ± 25.4, 178.4 ± 79.4, 40.7 ± 11.2 and 101.8 ± 21.5 respectively.

7. Prevalence of different types of dyslipidemia in patients with type 2 diabetes mellitus

Prevalence of different types of dyslipidemia in all the patients and in males and females are shown in Table 2. Overall,22.3% (95% CI: 17.5%–27.2%) of patients with type 2 diabetes had hypercholesterolemia (TC ≥ 200) and 61.9% (95% CI: 56.2%–67.5%) had hypertriglyceridemia. Abnormal LDL-C levels (≥130) were found in 8.9% (95% CI: 5.6%–12.2%) of patients and HDL-C was less than 40 mg/dl in 54.3% (95% CI: 48.5%–60.1%). Of the 291 patients, 64 (22%) had only one abnormal lipid profile parameter, 125 (43%) had two abnormal lipid parameters and 35 (12%) had more than two abnormal lipid profile parameters. Abnormal HDL levels (˂ 40 mg/dl) were significantly higher in female (59.3%) compared to male (47.6%) (P = 0.048). However, no significant differences were reported between male and female according to other types of dyslipidemia.

Prevalence of different types of dyslipidemia stratified by patients' glycemic are shown in Table 3. Patients were divided into two groups as per their glycemic index (HbA1c); the first group consisted of patients with HbA1c ˂ 7.0% and the second group consisted of patients with HbA1c values ≥ 7.0%. Patients with HbA1c values ≥ 7.0% had significantly higher values of total cholesterol (TC) and abnormal LDL-C compared with the patients who had HbA1c ˂ 7.0%. There was an increase in frequency of hypertriglyceridemia (P ˂ 0.001) and abnormal LDL-C (P = 0.001) in patients with HbA1c values ≥ 7.0%.

Table 4 displays the results of simple binary logistic regression model applied to each serum lipid profile separately. This table shows the results for poorly controlled diabetes mellitus (HbA1c ≥ 7). The odds ratios in this table shows the magnitude of the association and their corresponding p-values indicate whether the association is statistically significant or not by using the cut-off values of 0.05 as mentioned in the method section. In this model poorly, controlled diabetes mellitus (HbA1c ≥ 7) significantly associated with mean TG and mean LDL-Ceven after adjustment for sex, age, BMI, abdominal obesity.

To select the set of factors that jointly influence poorly controlled diabetes mellitus (HbA1c ≥ 7), we used the stepwise procedure applied to the multivariate logistic regression model. The results of this procedure showed that mean TG, mean HDL-C and mean LDL-C are jointly highly associated with poorly controlled diabetes mellitus (HbA1c ≥ 7). If TG increases by 10 mg/dl, then the odds of having HbA1c ≥ 7 will be increases by 10%. If HDL-C increases by 10 mg/dl, then the odds of having HbA1c ≥ 7 will be increases by 56%. If LDL-C increases by 10 mg/dl, then the odds of having HbA1c ≥ 7 will be increases by 16%. For more details see Table 5.

Table 2
Prevalence of different types of dyslipidemia in male and female patients with type 2 diabetes mellitus.

Dyslipidemia	All (n = 291)	Male (n = 124)	Female (n = 167)	P.val
T-Chol (mg/dl)				0.512
<200	226 (77.7%)	94 (75.8%)	132 (79%)	
≥200	65 (22.3%)	30 (24.2%)	35 (21.0%)	
TG (mg/dl)				0.075
˂ 150	111 (38.1%)	40 (32.3%)	71 (42.5%)	
≥150	180 (61.9%)	84 (67.7%)	96 (57.5%)	
LDL-C (mg/dl)				0.974
˂ 130	265 (91.1%)	113 (91.1%)	152 (91%)	
≥130	26 (8.9%)	11 (8.9%)	15 (9%)	
HDL-C (mg/dl)				0.048
˂ 40	158 (54.3%)	59 (47.6%)	99 (59.3%)	
≥40	133 (45.7%)	65 (52.4%)	68 (40.7%)	
Abdominal obesity				˂ 0.001
No	47 (16.2%)	34 (27.4%)	13 (7.8%)	
Yes	244 (83.8%)	90 (72.6%)	154 (92.2%)	
BMI				˂ 0.001
(<25 kg/m2)	57 (19.6%)	35 (28.2%)	22 (13.2%)	
25–29.9 kg/m2	136 (46.7%)	66 (53.2%)	70 (41.9%)	
≥30 kg/m2	98 (33.7%)	23 (18.5%)	75 (44.9%)	

Abbreviations:HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-densitylipoprotein cholesterol; TC, total cholesterol; TG, triglyceride, BMI, Body mass index

Table 3
Prevalence of different types of dyslipidemia categorized by patients' glycemic.

Parameter (n = 291)	Glycated Hemoglobin (HbA1c)		P.val
	HbA1c < 7 (n = 86)	HbA1c ≥ 7 (n = 205)	
TC (mg/dl)			
<200	81 (35.8%)	145 (64.2%)	< 0.001
≥200	5 (7.7%)	60 (92.3%)	
TG (mg/dl)			
< 150	37 (33.3%)	74 (66.7%)	0.267
≥150	49 (27.2%)	131 (72.8%)	
LDL-C (mg/dl)			
< 130	86 (32.5%)	179 (67.5%)	0.001
≥130	0 (0)	26 (100%)	
HDL-C (mg/dl)			
< 40	54 (34.2%)	104 (65.8%)	0.060
≥40	32 (24.1%)	101 (75.9%)	
Abdominal obesity			
No	16 (34%)	31 (66%)	0.461
Yes	70 (28.7%)	174 (71.3%)	
BMI			
(<25 kg/m2)	17 (29.8%)	40 (70.2%)	0.016
25–29.9 kg/m2	50 (36.8%)	86 (63.2%)	
≥30 kg/m2	19 (19.4%)	79 (80.6%)	

Abbreviations:HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-densitylipoprotein cholesterol; TC, total cholesterol; TG, triglyceride, BMI, Body mass index.

Table 4
Simple binary logistic regression model applied to each serum lipid profile separately. lipid profile parameters associated with poorly controlled type 2 diabetes mellitus diabetes (HbA1c ≥ 7).

Serum lipid profile	HbA1c ≥ 7 (n = 205)			
	OR	95% CI		P.value
TG (mg/dl)	1.010	1.005	1.015	< 0.001
HDL-C (mg/dl)	1.056	1.026	1.087	< 0.001
LDL-C (mg/dl)	1.016	1.000	1.033	0.055

Abbreviations: OR, odds ratio; CI, confidence interval; HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-densitylipoprotein cholesterol; TG, triglyceride.

8. Discussion

In the present study, we have evaluated the pattern of lipid profile parameters in type2 diabetic subjects and its correlation with HbA1c.There were more females (57.4%) than males (42.6%) with T2DM in this study. The high proportion of females in this study could prove that women are concerning about their health more than men. Moreover, women may have more free time than men as most of them were housewives.

The current study revealed a high prevalence of lipid abnormalities in patients with type 2 diabetes mellitus as most of them had two abnormal lipid profile parameters (43%). This result is in the line with the previous studies which reported that dyslipidemia is a common association with type 2 diabetic patients [19–21].

The most common dyslipidemia a significantly detected in this study was low HDL-c level (54.3%). This is consistent with Abdel-Aal NM et al. as their results showed that more than 80% of their diabetic patients had low HDL-c [22]. Furthermore, this finding is in concord with various studies conducted in different countries [23–25]. In contrast, Hetal Pandya et al. findings illustrated that the most common mixed abnormality detected was hypertriglyceridemia and high LDL level [20]. The wide range of dyslipidemia type among diabetic patients reported in various studies may be due to interaction of genetic and environmental factors in different ethnic groups [26]. While many studies have reported an association between diabetic dyslipidemia and the occurrence of cardiovascular disease, the American Diabetes Association (ADA) recommended that all diabetic patients should assess the cardiovascular risk factors at least annually [27].

HbA1c has been established by the Diabetes Complications and Control Trial (DCCT) to be the gold standard of glycemic control. The level of HbA1c value ≤ 7.0% was determined to be appropriate for reducing the risk of cardiovascular complications [28].

In the present study, the diabetic patients with HbA1c value ≥ 7.0% exhibited a significant increase in TC and LDL-C without any significant alteration in TG and HDL-C in comparison to patients with HbA1c value ≤ 7.0%. In different studies, HbA1c level showed positive correlation with TC, LDL-C and TAG in diabetic patients [20,29,30].

It has been estimated that reducing the HbA1c level by 0.2% could lower the mortality by 10%. Thus, HbA1c can be used as a potential biomarker for predicting dyslipidemia in type 2 diabetic patients in addition to glycemic control [27].

The current study revealed that abnormal HDL levels (< 40 mg/dl) were significantly higher in female (59.3%) compared to male (47.6%). However, no significant differences were reported between male and female according to other types of dyslipidemia. This finding is in consistent with several reported studies [22,31]. Although the effect of gender on dyslipidemia in patients with type2 diabetes remains controversial, different studies conducted in different countries reported a higher incidence of dyslipidemia in females compared to males [32,33]. On the other hand, both Alrabaty et al. and Patiakas et al. found no relationship between dyslipidemia and gender in patients with diabetes [34,35]. Hyperlipidemia in females may be due to the effects of estrogen on body fat distribution, which results in differences in altered lipoproteins [31]. This demonstrates the higher atherogenic risk in females than males which could be due to persistence of less favorable lipid profile [20].

The relation between reduced HDL cholesterol levels with an increased risk of coronary heart disease (CHD) is well documented in the literature [36]. A number of functions of HDL particles may lead to direct cardioprotective effects, including promotion of cellular cholesterol efflux and direct antioxidative and anti-

Table 5
Multivariate logistic regression analysis for factors associated with poorly controlled diabetes (HbA1c ≥ 7).

Serum lipid profile	HbA1c ≥ 7 (n = 205)							
	Unadjusted				Adjusted			
	OR	95% CI		P.value	OR	95%CI		P.value
TC (mg/dl)	1.010	1	1.020	0.058	1.010	0.999	1.020	0.070
TG (mg/dl)	1.007	1.003	1.011	0.001	1.005	1.001	1.009	0.013
LDL-C (mg/dl)	1.022	1.007	1.038	0.004	1.018	1.002	1.034	0.025
HDL-C (mg/dl)	1.023	0.999	1.047	0.060	1.032	1.006	1.059	0.014

Notes: Adjustment for sex, age, BMI, abdominal obesity. P < 0.05 was considered statistically significant.
Abbreviations: OR, odds ratio; CI, confidence interval; HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglyceride, BMI, Body mass index.

inflammatory properties [37].

The American Diabetes Association clearly stated that overweight and obesity is a common association with type 2 diabetic patients [38]. Evidences emphasized on the importance of managing obesity as it will have a positive effect on type 2 diabetes treatment [27]. This can be mainly achieved by lifestyle modifications, including increased physical activity and dietary managements. The American Diabetes Association recommended that modest weight loss (defined as sustained reduction of 5% of initial body weight) in overweight and obese patients with type 2 diabetes to enhance glycemic control and triglycerides [27]. Furthermore, an active collaboration between family members and healthcare providers is strongly required to implement different preventive methods in the management of diabetes [30].

One of the strengths of this study is that it was the first study in Palestine that highlighted the association between serum lipid profile and HbA1c among patients with T2DM in primary healthcare. To the best of our knowledge, there has not been any previous similar study on this group of subjects. Although several important findings in the current study, relatively small sample size can be considered as a limitation.

9. Conclusion

The current study demonstrated that dyslipidemia is highly prevalent in diabetics particularly in those with poorly controlled diabetes. Thus, the lipid profile should be assessed annually in all patients with diabetes. Treatment adequately with drugs, dietary and life style modifications is required to all diabetic patients to achieve target value of HbA1C $\leq$ 7. In addition, improving glycemic control might substantially reduce the risk of cardiovascular events in diabetic patients. Hence, HbA1c can be used as a potential biomarker for predicting dyslipidemia in type 2 diabetic patients in addition to glycemic control. Healthcare providers should counsel overweight and obese patients that higher BMIs increase the risk of CVD and all cause mortality.

Conflicts of interest statement

Authors declare no conflict of interest.

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