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Original article

Dyslipidaemias in patients with diabetes mellitus type 2 - a cumulative impact on coronary artery disease occurence

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Summary

Introduction. Cardiovascular complications are one of the leading causes of mortality releted to diabetes mellitus typ 2 (T2DM). Dyslipidemia is one of the associated risk factors for coronary artery disease (CAD) in patients with T2DM. The aims of our study were: to determine the characteristics of lipid disorders in persons with T2DM; to determine the cumulative impact of investigated risk factors (gender, age, genetic predisposition, smoking habits, diabetes mellitus, hypertension, obesity) for the occurence of the coronary artery disease; to determine the influence of lipid profile on coronary artery disease development.

Methods. A cross-sectional study was conducted in the Educative Center of the Primary Health Center Banja Luka in the period 01.11.2021–30.04.2022. Adult patients (≥18 years) with T2DM were recruited into the study. The data about socio-demographic characteristics, lifestyle and clinical factors were collected using structural questionnaire as a tool. For all subjects, anthropometric measurements, blood pressure readings, and laboratory findings (fasting blood glucose, HbA1c, lipid profile) were taken.

Results. A total of 221 patients with T2DM participated in the study, 52.03% were males. Hypertriglycerdidemia was found in 63.81% subjects, hypercholesterolemia in 56.60%, low HDL-cholesterol in 49.77% subjects and increased level of LDL-cholesterol in 39.37% subjects. Metabolic dyslipidemia (increased triglyceride levels and low HDL levels), representing the major predictor of CAD, was found in 35.29% subjects. Older age, physical inactivity, obesity, hypertension and high levels of fasting glucose in blood were significantly related to dyslipidaemia in patients with T2DM.

Conclusion. The representation of dyslipidemia in our subjects with T2DM is high, what increases the risk for coronary artery disease. Therefore, it is necessary not only to implement the therapy for glucoregulation, but also the secondary preventive measures for dyslipidemia, and that is the cardiovascular prevention.

Key words: dyslipidemia, diabetes mellitus, risk factors, coronary artery disease

Introduction

Diabetes mellitus type 2 (T2DM) is a metabolic disorder characterized with chronic hyperglycemia and metabolic disorder of carbohydrates, lipids and proteins, as a consequence of impaired secretion of insulin, impaired insulin effect or both [1]. Cardiovascular complications are one of the leading causes of mortality releted to diabetes [2]. Dyslipidemia is one of the main risk factors for coronary artery disease (CAD) in patients with T2DM that is possible to modify [3].

In these patients, the most common determined pattern of dyslipidemia is hypertriglycerdiemia with low HDL-cholesterol and increased LDL-cholesterol levels [4–6]. Dyslipidemia within T2DM is a consequence of insulin resistence and increased free fetty acids levels due to insulin resistence. The etiology that leads to hypertriglyceridemia in patients with T2DM is directly related to hyperglycemia and insulin resistence, leading to hyperproduction of lipoproteins rich in triglycerids and their decreased clearence, and in some cases impaired postprandial metabolism of lipoproteins [7, 8].

The main risk factors for dyslipidemia are hypertension, high Body Mass Index (BMI), aging, physical inactivity and diabetes mellitus [9]. Therefore, it is importnat to identify the factors that can be related to dyslipidemia, to enable the preventive activities for dyslipidemia and CAD. Early diagnosis and classification of dyslipidemia in patients with T2DM can help clinicians to estimate risk factors for cardiovascular diseases in the future, and to undertake adequate maeasures [10, 11].

Globally, the prevention of dyslipidemia is gradually improving (≥ 80% do 90%) in developing countries such as Ethiopia [12], Kenya [13], Sri Lanka [14], India, Bangladesh [3]. The cardiovascular risk is considerably increased among patients with DM due to an existing dyslipidemia [7]. The studies reveal that approximately 70–80% diabetic patients is goinig to die due tu a cardiovascular disease [3, 15].

The aims of our study were: to determine the characteristics of lipid disorders in persons with T2DM; to determine the cumulative impact of investigated risk factors (gender, age, genetic predisposition, smoking habits, diabetes mellitus, hypertension, obesity) for the occurence of the coronary artery disease; to determine the influence of lipid profile on coronary artery disease development.

Methods

A cross-sectional study was conducted in the Educative Center of the Primary Health Center Banja Luka (ECPM) in the period 01.11.2021–30.04.2022.

Adult patients (≥18 years) with T2DM treated at ECPM Banja Luka that regularly visit their family physician because of their chronic disease were recruited into the study.

The data about socio-demographic characteristics, lifestyle and clinical factors were collected using structural questionnaire as a tool, interviewing subjects „face to face".

For all subjects, anthropometric measurements (height and weight) were obtained using the Guidelines of the World Health Organization. BMI was calculated as a ratio of person's weight in kilograms and square of height in meters with the following categorisation: underweight (BMI <18.5), normal weight (BMI = 18.5–24.99 kg/m2), overweight (BMI = 25–29.99 kg/m2) and obesity (BMI ≥30 kg/m2).

The blood pressure readings were taken using mercury sphygmomanometer applied to the subjects' right upper arm in the seated position after 5 minutes rest. Hypertension was defined as systolic blood pressure (SBP ≥140 mmHg) or diastolic blood pressure (DBP ≥90 mmHg) in diabetic subjects.

Each subject of the study had a venipuncture for collecting 5 ml of venous blood sample, after overnight fasting.The samples were taken by skilful laboratory attendant according to the routine procedure. Dyslipidemia

was defined as the presence of one or more lipid profil disorders, such as: total cholesterol >5.2 mmol/l, LDL >1.4 mmol/l, triglycerides >1.7 mmol/l or HDL < 1mmol/l for male and <1.2 mmol for female [16].

Statistical processing

The data were processed and analyzed using software package SPSS (Statistical Package for the Social Sciences) version 26. For the analysis of tested variables, descriptive statistics and frequency tables were used. For the relation between dyslipidemia and independent variables, the bivariate and multivariate logistic regressions were used. The variables having a significant bivariate analysis at *p* value <0.25 were exported to the multivariate analysis. The multivariate logistic regression was used to identify the related risk factors for dyslipidemia. Statistical significance was defined at *p* value <0.05.

According to given *cut-off* values for each variable, we defined triglycerides-HDL status for the following four categories: (1) triglycerides in reference range, HDL in reference range; (2) increased levels of triglycerides, HDL in reference range; (3) triglycerides in reference range, decreased levels of HDL; and(4) increased levels of triglycerides, decreased levels of HDL. The fourth category, increased levels of triglycerides and decreased levels of HDL represents the category of so called methabolic dyslipidemia. Coxproportional hazards regression model was used to calculate Hazard Ratio (HR) for coronary artery disease in relation to the level of triglycerides and HDL cholesterol (triglycerides-HDL status). Regression models were adjusted for gender, smoking habits and physical activity.

Results

A total of 221 patients with diabetes mellitus typ 2 (T2DM) were recruited into the study, 52.03% of them were males (n=115) and 47.97% females (n=106). The average age of subjects was 65.36±9.223, ranging from 36 to 90 years. The majority of subjects, 58.4% (n=129) were 50 to 69 years old. Also, the majority of subjects were married (84.6%), had secondary school education (64.3%) and were retired (51.6%). According to body mass index (BMI), the majority of patients 49.3% (n=109) were overweight, while 25.8% of them (n=57) were obese with average BMI 27.96±3.99, i.e. in a range from 20.00 do 38.80. Almost half of the subjects had increased blood pressure readings, 49.80% (n=110). The average fasting blood glucose levels were 9.39±3.17, and the highest level of fasting glucose was 23.94, while the avegarge value of $HgbA_{1c}$ was 7.73±5.02 (Table 1).

The average levels ± standard deviation (SD) for total cholesterol were 5.42±1.22, for triglycerides 2.34±1.38, for LDL cholesterol 3.45±3.93 and for HDL cholesterol 1.45±2.04 (Table 2).

The analysis of isolated components of dyslipidemia showed that hypertriglyceridemia was found in 63.81% subjects (n=141), hypercholesterolemia was found in 56.60% subjects (n=125), decreased HDL levels were found in 49.77% subjects (n=110) and increased LDL-cholesterol levels were found in 39.37% subjects (n=87).

Furthermore, metabolic dyslipidemia (increased triglyceride and decreased HDL levels) was found in 35.29% subjects (n=78), 17.19% males (n=38) and 18.10% females (n=40) (Table 2).

For each form of dyslipidemia, the greatest number of patients was in age group 50–69 years, and compared to other age groups was statisticaly significant for total cholesterol and HDL-cholesterol.

The bivariate analysis identified the variables- the candidates for the multivariate analysis about the correlation of socio-demographic and clinical characteristics of patients with dyslipidemia in a way that the p-value was less than 0.25%, and: male (COR (95%CI) = 0.65 (0.37, 1.12)), the level of education – primary

Table 1. Socio-demographic and clinical characteristics of patients

Variables	Category	Frequences (Percentage)
Gender	Female	106 (52.00)
	Male	115 (48.00)
Age groups	30–49 50–69	13 (5.90) 129 (58.40)
	≥70	79 (35.70)
Working status	Employed Unemployed	95 (43.00) 12 (5.40)
	Retired	114 (51.60)
Marrital status	Married	187 (84.60)
	Unmarried	8 (3.60)
	Devorved	8 (3.60)
	Widowed person	18 (8.10)
Education	Primary school	40 (18.10)
	Secondary school	142 (64.30)
	High school	27 (12.20)
	Faculty	12 (5.40)
Smoking habits	Yes	36 (16.30)
	No Former smoker	174 (77.40) 14 (6.30)
Duration of diabetes	≤ 4 years 5–9 years 10–14 years 15–20 years ≥20 years	23 (10.40) 59 (26.70) 103 (46.60) 22 (10.00) 14 (6.30)
Use of hipolipidemic drugs	Yes	118 (53.40)
	No	103 (46.60)
Physical activity	Physically inactive Moderately physically active Intensively physically active	60 (27.10) 158 (71.50) 3 (1.40)
Body mass index (kg/m2)	< 25.00	55 (24.90)
	25.00–29.99 (overweight)	109 (49.30)
	≥30.00 (obesity)	57 (25.80)
Hypetension (mmHg)	Yes	110 (49.80)
	No	111 (50.20)
Fasting glucose (mmol/l)	<6.1 mmol/l ≥6.1 mmol/l	22 (10.00) 199 (90.00)

Table 2. Lipid profile classification and gender distribution

Lipidprofile	The average value in total sample±SD	Categories	n (%)	n (%) for male the average value for male ± SD	n (%) for female the average value for female ± SD	p-value***
TC-total cholesterol (mmol/l) [min – max]	5.42±1.22 [2.51 – 8.64]	<5.2	96 (43.44)	61 (27.60) 54 (24.43) 3.74±1.31	35 (15.84) 71 (32.13) 3.92±1.25	0.305
		≥5.2	125 (56.60)			
TG-triglycerides (mmol/l) [min – max]	2.33±1.38 [0.58 – 8.80]	<1.7	80 (36.19)	37 (16.74) 78 (35.29) 3.82±1.24	43 (19.46) 63 (28.51) 3.89±0.18	0.261
		≥1.7	141 (63.81)			
LDL-cholesterol (mmol/l) [min – max]	3.45±3.93 [0.12 – 24.40]	<1.4	134 (60.63)	75 (33.94) 39 (17.65) 1.98±0.85	58 (26.24) 48 (21.72) 2.05±0.71	**0.048**
		≥1.4	87 (39.37)			
HDL-cholesterol (mmol/l) [min – max]	1.44±2.03 [0.63 – 26.00]	≤1.0	110 (49.77)	28 (12.67)* 87 (39.37)* 1.21±0.34	45 (20.36)** 61 (27.60)** 1.23±0.27	0.084
		>1.0	111 (50.23)			

*Cut-off value for HDL cholesterol for male was set as 1.0 mmol/l

**Cut-off value for HDL cholesterol for female was set as 1.2 mmol/l

***p-value: independent t-test, significance at level p >0.05

school (COR (95% CI) = 0.22 (0.04, 1.14)), physical activity (COR (95% CI) 0.80 (0.44, 1.46)), the duration of diabetes 5–9 years (COR (95%CI) 0.22 (0.07–0.67)). The bivariate analysis of correlation between variables (linear regression), based on the results presented in table 3, shows the following:

The LDL cholesterol levels were moderately to highly related to (Pearson's coefficient, p >0.3) age, family history of dyslipidemia, body mass index, hypertension and fasting blood glucose levels. Also, based on the results obtained from COR (*Crude Odds Ratio*) the conclusion is that family history, body mass index, hypertension, fasting blood glucose, smoking habbits and marrital status were related to increased risk of dyslipidemia, with relatively narrow confidence interval (95% CI), indicating causal connection of above mentioned variables with the risk of dyslipdemia.

To asses the correlations and the adjusted odds ratio (AOR), the variables that had p- coefficient <0.25 were analyzed by multivariate analyzis. The obtained results are presented in table 4.

To identify the independent predictors of dyslipidemia in diabetic subjets, the multivariate regression analysis model was used. After adjusting certain variables, the following results were obtained. Patients with T2DM older than 50 years had 4 times greater risk of dyslipidemia. (AOR: 3.9, 95% CI: 1.6–9.48) compared to younger patients. Patients with diabetes that were physically inactive or moderately physically active had greater risk of dyslipidemia (AOR: 0.80 95% CI (0.48–1.32) compared

Table 3. The bivariate analysis of factors related to dyslipidemia

Variables	Categories	Dyslipidemia		COR (95% CI)	p-value
		No	Yes		
Age	30–49	8 (3.62)	5 (2.26)	–	–
	50–69	79 (35.75)	50 (22.62)	0.40 (0.12–1.80)	0.61
	70+	47 (21.27)	22 (9.95)	0.29 (0.09–1.00)	0.78
Gender	Muški	76 (34.39)	39 (13.12)	0.65 (0.37–1.12)	**0.11**
	Ženski	58 (26.24)	46 (20.81)	–	
Marrital status	Oženjen/Udata	117 (52.94)	70 (31.67)	1.34 (0.50–3.55)	0.26
	Neoženjen/Neudata	3 (1.36)	5 (2.26)	0.75 (0.14–4.13)	0.69
	Razveden/a	4 (1.81)	4 (1.81)	1.25 (0.24–6.63)	0.39
	Udovac/ica	10 (4.52)	8 (3.62)	–	
Education	Primary school	21 (9.50)	19 (8.60)	0.22 (0.04–1.14)	**0.16**
	Secondary school	85 (38.46)	57 (25.79)	0.30 (0.06–1.41)	**0.13**
	High school	18 (8.14)	9 (4.07)	0.40 (0.07–2.23)	0.38
	faculty	10 (4.52)	2 (0.90)	–	–
Smoking habbits	No	21 (9.50)	15 (6.79)	–	–
	Yes	104 (47.06)	67 (30.32)	1.11 (0.53– 2.31)	**0.11**
	Former smoker	9 (4.07)	5 (2.26)	1.29 (0.36– 4.62)	**0.21**
Duration of diabetes	≤4 years	18 (8.14)	5 (2.26)	–	–
	5–9 years	26 (11.76)	33 (14.93)	0.22 (0.07– 0.67)	**0.21**
	10–14 years	66 (29.86)	37 (16.74)	0.50 (0.17– 1.44)	0.29
	15–18 years	16 (7.24)	6 (2.71)	1.07 (0.27– 4.17)	0.28
	≥20 years	7 (3.17)	5 (2.26)	0.39 (0.09– 1.77)	0.36
Family history of dyslipdemia	Yes	108 (48.87)	73 (33.03)	1.26 (0.61– 2.56)	0.55
	No	26 (11.76)	14 (6.33)	–	–
Physical activity	Yes	100 (45.25)	61 (27.60)	–	–
	No	34 (15.38)	26 (11.76)	0.80 (0.44–1.46)	**0.21**
Body mass index	<25	29 (13.12)	26 (11.76)	–	–
	25–29.99	71 (32.13)	33 (14.93)	1.68 (0.87–3.24)	0.90
	≥30	34 (15.38)	23 (10.41)	1.33 (0.63–2.88)	0.46
Hypertension	Da	67 (30.32)	43 (19.46)	1.02 (0.60–1.76)	0.57
	Ne	67 (30.32)	44 (19.91)	–	–
Fasting blood glucose	<6.1 mmol/l	13 (5.88)	9 (4.07)	–	–
	≥6.1 mmol/l	121 (54.75)	78 (35.29)	1.07 (0.44–2.63)	0.71

Comments: the correlation between variables does not exist. The variables-candidates for multivariate analyzis p-value <0.25.

COR, *crude odds ratio*, crude ratio of chances (risk index) (COR >1 - indicates that exposition is related to higher risk; COR <1 - exposition is related to less risk)

95% CI, Confidence Interval (the more narrow the interval is, the more precise COR value is and vice versa)

Table 4. The analysis of correlation of lipid profile and predictors for CVD in a group of all subjects

Predictors	TC-total cholesterol		TG-Triglycerides		LDL-cholesterol		HDL-cholesterol	
	r	p	r	p	r	p	r	p
Age	0.51	0.42	0.08	0.17	0.07	0.24	−0.06	0.30
Gender	−0.07	0.22	−0.06	0.28	−0.07	0.26	0.004	**0.94**
Smoking habbits	0.008	**0.89**	0.005	**0.93**	−0.07	**0.91**	0.30	0.64
Hypolipidemic drugs	−0.29	0.64	0.14	0.02	−0.08	0.9	−0.12	0.05
Physical activity	−0.051	0.42	−0.06	0.33	−0.11	0.07	0.07	0.26
BMI	0.11	0.06	0.09	0.12	0.01	0.81	−0.04	0.47
Body weight	0.08	0.17	0.04	0.46	−0.07	0.21	0.07	0.24
Hypertension	0.15	0.01	0.2	0.001	0.25	<0.001	0.01	**0.84**
Fastin blood glucose	0.15	0.013	0.24	<0.001	0.09	0.14	−0.03	0.58

Comment: r - Pearson's correlation coefficient; p - p-value for correlation

Table 5. Multivariate analysis of factors releted to dyslipidemia

Variables	Categories	Dyslipidemia		AOR (95% CI)	p-value
		No	Yes		
Gender	Male	76 (34.39)	39 (13.12)	–	–
	Female	58 (26.24)	46 (20.81)	1.55 (0.98 – 2.45)	**0.850**
Physical activity	Yes	100 (45.25)	61 (27.60)	–	–
	No	34 (15.38)	26 (11.76)	0.80 (0.48–1.32)	**0.505**
Smoking habbits	No	21 (9.50)	15 (6.79)	–	–
	Yes	104 (47.06)	67 (30.32)	0.9 (0.49–1.66)	0.097
	Former	9 (4.07)	5(2.26)	0.78 (0.27–2.27)	**- 0.011**

Comment: AOR - Adjusted Odd Ratio; p-value - Pearson's correlation coefficient

to physically active patients. Overweight and obese patients with T2DM were more likely for dyslipidemia onset (AOR: 5.6, 95% CI: 1.3–23.9) compared to patients with normal weight. Patients with hypertension and T2DM had greater risk for dyslipidemia onset compared to patients with normal range of blood pressure (AOR: 2.65, 95% CI: 1.4–4.9). Patients with diabetes and high fasting blood glucose levels had 3 times greater risk for dyslipidemia. (AOR: 3.1, 95% CI: 1.3–7.2) compared to patients with lower fasting blood glucose levels (Table 4).

The results of the correlation between lipid profil and sociodemographic health-related variables are presented in table 4. There is a signifficant correlation between HDL-cholesterol and gender (p >0.70) and hypertension; between LDL-cholesterol and smoking habbits, between total cholesterol and smoking habbits, between total cholesterol and triglyceride levels. The negative correlation was observed for the use of all hypolipidemic drugs and lipid fractions except triglycerides, as well as for physical activity and lipid fractions except HDL-cholesterol.

Table 5 shows that females with T2DM more often develop LDL-dyslipidemia. Also, the degree of correlation between LDL-dyslipidemia and gender (female) is very high (p > 0.7), while the degree of correlation for physical (in)activity is moderate (p > 0.5). Active smokers and dyslipidemia do not have a significant correlation, while that correlation for former smokers is negative, what indicates that negative effects of smoking on lipid profile are reversible.

The characteristics of subjects related to cardiovascular diseases obtained from medical history were analyzed. Approximately 17.19% of subjects had HDL and triglyceride levels in a reference range (n=38), 36.65% had high levels of triglycerides and HDL levels in a reference range (n=81), and 6.3..3% of subjects had triglyceride levels in a reference range and decreased levels of HDL (n=14), while 35.29% of subjects had incrased levels of triglycerides and decreased levels of HDL (metabolicdyslipidemia, n=78). Analysis showed that metabolic dyslipidemia was more often in female, in persons where duration of T2DM was longer than five years, in smokers (active), in persons with increased waist circumference, in persons with poor regulation of blood glucose levels estimated by HbA_{1c}.

The stratified analysis based on LDL-cholesterol levels was conducted. A predictive value of triglycerides-HDL-total cholesterol profile for coronary artery disease was tested. The analysis showed that the risk for coronary artery disease was greater in patients with decreased HDL-cholesterol with statistical significance ($p < 0.05$) (Table 6).

Table 6. Hazard ratio for coronary artery disease according to triglycerides-HDL-cholesterol ratio

TG-HDL status	HR (95% CI)	Coronary artery disease P value
Normal TG-HDL	–	–
Increased TG, normal HDL	1.21 (0.54–2.70)	0.642
Normal TG, low HDL	**1.98 (1.08–3.62)**	**0.027**
Increased TG, low HDL	**2.06 (1.20–3.54)**	**0.008**

Hazard ratio (HR) was calculated using Cox analyzisadjusted for gender, age, BMI, smoking habits, blood preassure readings, use of antihypertensive drugs, HbA1C, duration of diabetes

Table 7. Hazard ratio for macrovascular complications in total sample (n=221)

	HR (95% CI)	Coronary artery disease P value
HDL-C		
Normal HDL-C	–	–
Low HDL-C	1.25 (1.05–1.47)	**0.010**
TG		
Normal TG	–	–
Increased TG	1.20 (1.02–1.40)	**0.028**
TG-HDL status		
Normal TG-HDL	–	–
Increased TG, normal HDL	1.13 (0.85–1.50)	0.396
Normal TG, low HDL	1.19 (0.94–1.52)	0.155
Increased TG, low HDL	1.37 (1.11–1.69)	**0.004**

Hazard ratio (HR) was calculated using Cox analyzis adjusted for gender, age, BMI, smoking habbits, blood preassure readings, use of antihypertensive drugs, HbA1C, duration of diabetes

HR results for macrovascular complications in total sample according to HDL-cholesterol and triglycerides ratio are shown in table 7. The obtained results showed that the risk of macrovascular complications, precisely coronary macrovascular complications, was increased in persons with low HDL-cholesterol and increased triglycerides levels, with statistical significance ($p < 0.05$). Also, that risk was increased in persons with so called metabolic dyslipidemia, precisely increased triglycerides levels and low HDL-cholesterol.

Discussion

Dyslipidemia is one of the leading, but modifying risk factors for coronary artery disease in persons with T2DM, and therefore, it is one of the leading causes of morbidity and mortality in these patients [16]. Furthermore, it is important to identify factors that are potentially related to dyslipidemia, to control this condition and reduce the incidence of coronary artery disease [17].

The prevalence of dyslipidemia in our study was 63.8%. Dyslipidemia was present in the greatest percentage in males, in patients 50 to 69 years old, in persons with secondary school education, moderately physically active patients, and overweight patients. The independent predictors of dyslipidemia in our study were older age, physical inactivity, obesity and increased fasting blood glucose levels.

Socio-demographic factors have a role in dyslipidemia onset in patients with diabetes. In our study, dyslipidemia is significantly related to older age. Such findings are consistent with the results of the studies conducted in Ethiopia [12], China [17] and Thailand [18]. The total prevalence of dyslipidemia in this study can be compared to the results of the studies conducted in Ethiopia (the prevalence of dyslipidemia was 65.5%) [12] and Nigeria (the prevalence of dyslipidemia was 69.3%) [16]. The prevalence of dyslipidemia itself varies from region to region, what arises from differences in diet and genetic predisposition of population. Also, the differences in a pattern of dyslipdemia reported in patients with T2DM could be the consequence of differences in cut-off values of lipid profile in some studies, cultural factors, and lifestyle in population.

Our study showed a statistically significant relation between dyslipidemia and physical (in) activity. Similar findings were reported in the studies conducted in China [17] and Kenya [13].

In this study, dyslipidemia was significantly related to obesity. The overweight and obese subjects were more likely to develop dyslipidemia compared to subjects with BMI <25.00 kg/m2. Similar findings were reported in Ethiopia [12], Kenya [13] and China [17].

Dyslipidemia in this study was also significantly related to hypertension. The patients with hypertension were 2.65 times likely to develop dyslipidemia compared to persons whose blood pressure readings were in normal range. This result is in accordance with the results of the studies conducted in Ethiopia [12] and Nepal [18].

Besides the prevalence of dyslipidemia, this study also showed potential factors that could increase the risk of dyslipidemia in patients with T2DM. The study showed that female patients with diabetes were more likely to develop dyslipidemia than male patients. Similar studies [12, 13, 19, 20] also showed that female gender was significantly more related to dyslipidemia. Older age was in a positive correlation with dyslipidemia, and that was also the finding of other studies [19, 20]. Our subjects with T2DM older than 50 years had 4 times greater risk of dyslipidemia (AOR: 3.9, 95% CI: 1.6–9.48) compared to younger patients. Although there is no evidence that age is directly related to lipid profile, it is an assumption that inheritable genetic characteristics, insulin resistance and degenerative processes can be related to ageing [21]. Other studies reported that older age was related to dyslipidemia in

persons with T2DM due to exhasution of organism and the insufficient physical activity [9]. Our study showed that the obesity was significantly related to dyslipidemia in patients with T2DM. Overweight and obese patients with T2DM were more likely to develop dyslipidemia (AOR: 5.6, 95% CI: 1.3–23.9) when compared to patients with normal weight. Other studies reported similar results, where dyslipidemia was more present among obese patients with T2DM compared to patients with BMI in normal range [10, 15].

This study emphasized that hypertension was significantly related to the prevalence of dyslipidemia in subjects with diabetes, which was similar to the results of other studies [8]. Patients with hypertension and T2DM had higher risk for the development of dyslipidemia, when compared to patients whose blood pressure was in normal range. This study also reported that physical inactivity was significantly related to dyslipidemia among patients with T2DM. Physically inactive or moderately physically active subjects with diabetes had higher risk for dyslipidemia onset (AOR: 0.80 95%CI (0.48–1.32)) when compared to physically active subjects. This finding is in accordance with the findings of other studies conducted in Ethiopia [12], China [17] and Thailand [18].

Several new studies [19, 20] reported that insufficient physical activity and unhealthy diet could potentially lead to increased levels of blood glucose, leading to dyslipidemia onset in persons with T2DM. Our study also showed that patients with diabetes with higher degree of hyperglycemia had 3 times greater risk for dyslipidemia onset (AOR: 3.1, 95% CI: 1.3–7.2) when compared to patients with lower levels of blood glucose. Based on the obtained results, the conclusion is that regular physical activity can help patients with diabetes to have better control of glycemia and lipid profile.

The obtained results showed that present smoking habits were significantly related to the risk of dyslipidemia onset in patients with diabetes. LDL-cholesterol levels had high degree of correlation with smoking habits, total cholesterol and triglyceride levels. This is in accordance with the results of similar studies where the correlation between dyslipidemia and smoking was proven [21–23].

The results of our research showed that the existence of metabolic dyslipidemia (high triglycerides, low HDL-cholesterol) is a significant predictor of coronary heart disease. A study conducted in the United States of America (USA) reached similar results, showing that metabolic dyslipidemia was a high risk for coronary heart disease and an acute coronary event, but not for stroke [24].

In the countries of the Balkan Peninsula and North Macedonia, there is a continuous increase in the number of patients with T2DM. North Macedonia, like most of the countries of the Balkan Peninsula, has a low or middle income, and in all countries it is necessary to work on educating the population about changing the way of eating in order to reduce the risk of contracting T2DM, achieve good glycoregulation, achieve the target values of components from the lipid profile and control of metabolic syndrome. The Mediterranean diet, which has proven to be effective over the last eight decades, is recommended as the best diet to prevent these metabolic disorders [25].

This study shows that the role of a family physician as a "gatekeeper" in health system is not only to awake patients, but also health care professionals that diabetes mellitus typ 2 is a complex metabolic disorder characterized by hyperglycemia and lipid profile disorder. Therefore, it is essential for patients with T2DM not only to carry out the treatment for glucoregulation, but also to carry out the secondary prevention of dyslipidemia, what prevents cardiovascular diseases. The imperative of therapy protocol for T2DM is screening and following up of lipid profile and lipid profile regulation.

Conclusion

The total prevalence of dyslipidemia among subjects of this study was 63.8%. Dyslipidemia was in the greatest percentage present in male, 50 to 69 years old, with secondary school education, moderately physically active and overweight patients. Hypertriglyceridemia was found in 63.81% subjects, hypercholesterolemia in 56.60%, decreased HDL-cholesterol in 49.77%, and increased LDL-cholesterol in 39.37% subjects. Metabolic dyslipidemia (increased triglyceride and decreased HDL levels) was found in 35.29% subjects. Older age, physical inactivity, obesity, hypertension and increased levels of blood glucose were significantly related to dyslipidemia in patients with T2DM. The results of our study indicate that the risk for macrovascular complications, including coronary artery disease, is increased in persons with metabolic dyslipidemia (decreased HDL-cholesterol and increased triglyceride levels). Family physicians have an important role in regular screening of lipid disorders in patients with T2DM, and pharmacological treatment of these disorders.

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Ethical approval. The Ethics Committee of the University of Banja Luka, Faculty of Medicine, Banja Luka, Republic of Srpska, approved the study and informed consent was obtained from all individual respondents. The research was conducted according to the Declaration of Helsinki.

Conflicts of interest. The authors declare no conflict of interest.

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Dislipidemije kod pacijenata sa dijabetes melitusom tipa 2 - kumulativni uticaj na pojavu koronarne arterijske bolesti

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Uvod. Kardiovaskularne komplikacije su jedan od vodećih uzroka smrtnosti vezanih za dijabetes melitus tipa 2 (T2DM). Dislipidemija je jedan od pridruženih faktora rizika za koronarnu bolest srca (KBS) kod pacijenata sa T2DM. Ciljevi našeg istraživanja su: utvrditi karakteristike lipidnih poremećaja kod osoba sa T2DM; utvrditi kumulativni uticaj ispitivanih faktora rizika (pol, dob, genetska predispozicija, pušački status, dijabetes melitus, hipertenzija, gojaznost) za nastanak koronarne bolesti srca; utvrditi uticaj lipidnog statusa na razvoj koronarne bolesti srca.

Metode. U Edukativnom centru porodične medicine (ECPM), Doma zdravlja Banja Luka, provedena je studija presjeka u periodu od 1.11.2021. do 30.4.2022. godine. U istraživanje su bili uključeni odrasli pacijenti (≥ 18 godina) oboljeli od T2DM. Podaci o socio-demografskim karakteristikama, životnim navikama i kliničkim faktorima su prikupljani uz pomoć strukturisanog upitnika. Svim pacijentima su izvršena antropometrijska mjerenja, izmjeren krvni pritisak i urađene laboratorijske analize (ŠUK, HbA1c, lipidni profil).

Rezultati. U studiji je učestvovao 221 pacijent sa T2DM, 52,03% muškog pola. Hipertrigliceridemija je utvrđena kod 63,81% ispitanika, hiperholesterolemija kod 56,60%, snižen HDL-holesterol kod 49,77% ispitanika i povišen LDL-holesterol kod 39,37% ispitanika. Metabolička dislipidemija (povišeni trigliceridi i snižen HDL) je utvrđena kod 35,29% ispitanika i predstvalja najveći prediktor za KBS. Starija životna dob, fizička neaktivnost, gojaznost, hipertenzija i visok nivo glukoze u krvi su bili značajno povezani sa dislipidemijom među oboljelim od T2DM.

Zaključak. Zastupljenost dislipidemije kod naših ispitanika sa T2DM je visoka, što povećava rizik za koronarnu bolest srca. Zbog toga je neophodno provoditi, osim terapije za glikoregulaciju, i sekundarnu prevenciju dislipidemije čime se vrši i prevencija kardiovaskularnih oboljenja.

Ključne riječi: dislipidemija, dijabetes melitus, riziko faktori, koronarna bolest srca