Incidence of Dyslipidemia and Hyperglycemia Among Healthy Female Teachers in Nablus, Palestine

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Abstract

Cardiovascular diseases are associated with several risk factors such as hyperlipidemia and diabetes mellitus. This study was conducted to estimate the prevalence of undiagnosed dyslipidemia and hyperglycemia among healthy female teachers. A cross-sectional study included 229 healthy female teachers in Nablus city of Palestine. A questionnaire and laboratory investigations were used to obtain personal and medical information, and all data was categorized and analyzed. The overall prevalence of undiagnosed dyslipidemia, pre diabetes and diabetes mellitus (DM) was 44.9%, 9.6% and 2.2%, respectively. Age showed a significant influence on dyslipidemia (total cholesterol (TC), $p = 0.002$ and low-density lipoprotein cholesterol (LDL), $p = 0.03$), as well as DM ($p < 0.001$). About 47.8% and 21.7% of obese participants had high TC ($p = 0.04$) and hyperglycemia ($p = 0.02$). Waist-to-hip ratio was significantly associated with hyperglycemia ($p < 0.001$) and hypertriglyceridemia (TG) ($p = 0.002$). Participants with high TC ($p = 0.036$) and high LDL ($P = 0.047$), were less likely to engage in adequate physical activity. Elevated blood pressure notably correlated with hyperglycemia ($p < 0.001$), while postmenopausal transition associated significantly with DM ($p = 0.004$), high TC ($p < 0.001$) and high LDL ($p < 0.001$). The prevalence of undiagnosed dyslipidemia and DM among healthy female teachers was high. Many factors, including age, obesity, waist-to-hip ratio and menopause were significantly associated with dyslipidemia and DM.

Keywords: Cardiovascular diseases, hyperglycemia, dyslipidemia, female, teachers, Palestine

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Introduction

Cardiovascular diseases (CVD) stand as the primary cause of mortality worldwide (Kosendiak, Felińczak, & Szymańska-Chabowska, 2021). Dyslipidemia and diabetes mellitus (DM) are recognized as significant modifiable risk elements in the progression of CVD, exerting a direct impact on its severity (Rabbani et al., 2016). Both dyslipidemia and DM advance insidiously, often remaining asymptomatic until late stages when serious and potentially avoidable complications have already arisen ("Standards of medical care in diabetes--2009," 2009). Consequently, early identification and effective management of dyslipidemia and DM have emerged as fundamental strategies in the management and prevention of CVD and its associated complications (Daniel, 2011).

Dyslipidemia, characterized by abnormalities in lipoprotein metabolism, may present as elevated total cholesterol (TC), increased low-density lipoprotein (LDL), elevated triglycerides (TG), or diminished high-density lipoprotein (HDL) ("Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: summary report," 2011). Diabetes mellitus progresses silently, sometimes going undiagnosed for years, thereby paving the way for the development of numerous preventable macro-vascular and microvascular complications, which chiefly contribute to diabetes-related mortality and morbidity ("Standards of medical care in diabetes--2009," 2009). Dyslipidemia is highly prevalent in type 2 diabetes mellitus, affecting approximately 72%-85% of patients(Vergès, 2015). Age, gender, educational attainment, smoking status, level of physical activity, central obesity, and blood pressure (BP) are all closely intertwined with DM and dyslipidemia (Li, Zhao, Yu, & Ding, 2018).

In Palestine, the estimated prevalence of DM in 2010 was approximately 15.3% of the populace, with projections indicating a significant increase (Abu-Rmeileh, Husseini, Capewell, & O'Flaherty, 2013). A cross-sectional observational study involving Palestinian male educators revealed an overall dyslipidemia prevalence of 66.4% (Ali et al., 2019). Gender differences in body fat distribution and brown adipose tissue mass and function mean that men may start experiencing DM-related risk at a lower body mass index (BMI) compared to women (Garawi, Devries, Thorogood, & Uauy, 2014). Following menopause, women become vulnerable to various hormonal changes, such as hyperglycemia, elevated lipid profiles, obesity, and hypertension (HTN), placing them at notably higher risk of CVD with increased mortality rates, and survivors are more prone to recurrent and severe complications (Khamis, Ammari, & Mikhail, 2016). The aims of the present study are to ascertain the prevalence of undiagnosed dyslipidemia and DM and explore the associated risk factors.

Materials and Methods

This cross-sectional observational investigation took place between September 2019 and August 2020 to evaluate the prevalence of undiagnosed dyslipidemia and diabetes mellitus (DM) among female educators in Nablus city, Palestine. Fourteen primary schools were chosen using a simple random sampling method, with teachers selected from each school via convenient sampling. The study cohort comprised healthy female teachers aged 20-60 years with no prior diagnosis of dyslipidemia or DM. A total of 229 participants were included based on sample calculations, with exclusion criteria encompassing females previously diagnosed with dyslipidemia/DM or those using medications affecting glucose or lipid levels.

A structured questionnaire divided into four sections of closed-ended questions was utilized. The socio-demographic section included inquiries regarding age, residency, marital status, number of children, income, and means of transportation. The second section encompassed factors potentially associated with dyslipidemia or DM, including BMI, waist-to-hip ratio (WHR), BP, smoking, physical activity, and workload. The third section focused on prior lipid profile testing, glucose testing, routine medical checkups, medication history, past medical/surgical history, and family history of dyslipidemia and DM. The final section addressed obstetrics and gynecology history, including gravidity, parity, dates of first and last pregnancies, menarche and menopause age, menstrual regularity, contraceptive use, pregnancy complications, and number of children with macrosomia.

Fasting venous blood samples of 5 mL were collected by a lab technician and referred to An-Najah National University Hospital (NNUH) laboratory for lipids and glucose testing. Criteria for high total cholesterol (≥ 200mg/dL), elevated triglycerides (≥ 130mg/dL), high LDL levels (≥ 130mg/dL), and low HDL levels (< 40 mg/dL) were applied (Grundy et al., 2019). Hemoglobin A1C (HbA1C) levels ≥ 6.5% indicated DM, while levels between 5.7% - 6.4% suggested pre-diabetes (PD), and 4% - 5.6% were considered normal (Association, 2018). BMI classifications included underweight (< 18.5 kg/m^2), normal (18.5 - 24.9 kg/m^2), overweight (25 - 29.9 kg/m^2), and obese (≥ 30 km/m^2)(Centers for Disease Control and Prevention). WHR was categorized into three groups: ≤ 0.80, 0.81 – 0.85, and ≥ 0.86. Blood pressure thresholds for normal (systolic < 140 and diastolic < 90) and hypertension (systolic ≥ 140 and diastolic ≥ 90) were defined (Unger et al., 2020). The criteria for "house work" in Table 2 were based on the frequency and intensity of household tasks performed. "Full loads" refer to performing all major household chores daily, "partial loads" indicate performing some but not all tasks, and "none" means little

Table 1. The effect of socio-demographic characteristics on HbA1C and lipids

Variable	Category	Total No (%)	HbA1C			High TC	High TG	High LDL	Low HDL
			Normal No (%)	PD No (%)	DM No (%)	No (%)	No (%)	No (%)	No (%)
Age	20-30 31-40 41-50 51-60	26(11.4) 75(32.8) 82(35.8) 46(20.0)	26(100) 74(98.6) 71(86.6) 31(67.4)	0(0.0) 0(0.0) 11(13.4) 11(23.9)	0(0.0) 1(1.4) 0(0.0) 4(8.7)	5(19.2) 16(21.3) 34(41.5) 22(47.8)	1(3.8) 5(6.6) 10(12.2) 3(6.5)	5(19.2) 12(16) 23(28) 18(39.1)	1(3.8) 1(1.4) 3(3.66) (2.2)
	p Value		<0.001			0.002	0.430	0.03	0.784
Residency		48(21.0) 171(74.4) 10(4.4)	41(85.4) 151(88.3) 10(100)	7(14.6) 15(8.8) 0(0.0)	0(0.0) 5(2.9) 0(0.0)	17(35.4) 56(32.7) 4(40)	5(10.4) 13(7.6) 1(10)	12(25) 43(25.1) 3(30)	2(4.2) 3(1.75) 1(10)
			0.183			0.820	0.814	0.941	0.331
Marital status	Single Married	28(12.2) 201(87.8)	25(89.3) 177(88)	2(7.15) 20(10)	1(3.6) 4(2.00)	10(35.8) 66(32.3)	0(0.0) 19(9.5)	8(28.6) 50(24.8)	0(0.0) 6(3.00)
	p value		0.792			0.762	0.140	0.674	0.902
Monthly income (US$)	≤1200$ >1200$	146(64.3) 81(35.7)	126(86.3) 75(92.6)	16(10.9) 5(6.17)	4(2.74) 1(1.23)	50(34.2) 26(32.1)	15(10.3) 4(4.9)	36(24.6) 21(25.9)	5(3.42) 1(1.23)
	p value		0.334			0.822	0.37	0.833	0.425
Transportation to work	On feet By car	29(12.7) 207(90.4)	23(79.3) 179(86.5)	6(20.7) 16(7.7)	0(0.0) 5(2.4)	8(27.6) 68(32.8)	2(6.9) 17(8.2)	7(24.4) 51(24.6)	2(6.9) 4(1.9)
	p value		0.082			0.493	0.765	0.875	0.168
Number of kids	≤4 >4	185(80.8) 44(19.2)	164(88.6)3 8(86.4)	17(9.2) 5(11.4)	4(2.1) 1(2.3)	63(34.1) 13(29.5)	11(5.9) 8(18.2)	51(27.5) 7(15.9)	3(1.6) 3(6.8)
	p value		0.909			0.568	0.014	0.11	0.087

HbA1C=Hemoglobin A1C. PD=Pre diabetes. DM= Diabetes mellitus. TC= Total cholesterol. TG= Triglycerides. LDL= Low density lipoprotein. HDL= High density lipoprotein. Camp= Refugee camp.

to no involvement in housework. Adequate physical activity was defined as 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity activity weekly(World Health Organization). A participant was classified as a smoker if she had smoked at least 100 cigarettes in her lifetime, regardless of current or former smoking status(Centers for Disease Control and Prevention). A 20 minutes' water-pipe smoking session was considered equivalent to smoking 25 cigarettes (Masters, Tutt, & Yaseen, 2012). Hemoglobin (Hb) levels < 12 mg/dL were classified as low, while levels between 12-15 mg/dL were considered normal(Turner, Parsi, & Badireddy, 2021).

A pilot study involving 20 participants was conducted, and subsequent modifications were made to the questionnaire. Ethical clearance was obtained from the Institutional Review Board (IRB) at ANNU. Informed consent was obtained from all participants before their enrollment in the study, ensuring they were fully aware of the study's objectives, procedures, potential risks, and their right to withdraw at any time. Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 20. Descriptive analysis, including frequencies and proportions, was performed, with the relationship between two nominal variables examined using the

Table 2. Risk factors associated with DM/dyslipidemia

Variable	Category	Total No (%)	HbA_{1C}			High TC	High TG	High LDL	Low HDL
			Normal No (%)	PD No (%)	DM No (%)	No (%)	No (%)	No (%)	No (%)
BMI	Normal	85(37.1)	81(95.3)	4(4.7)	0(0.0)	23(27)	3(3.5)	16(18.8)	1(1.2)
	Overweight	98(42.8)	85(86.7)	8(8.1)	5(5.1)	31(31.6)	7(7.1)	26(26.5)	2(2)
	Obese	46(20.1)	36(78.2)	10(21.7)	0(0.0)	22(47.8)	8(17.4)	16(34.8)	3(6.5)
	p value		0.021			0.041	0.047	0.089	0.018
WHR	≤0.8(LHR)	108(47.2)	102(94.4)	5(4.6)	1(0.9)	30(27.8)	3(2.8)	20(18.5)	2(1.8)
	0.81-0.85(MHR)	75(32.8)	66(88)	9(12)	0(0.0)	26(34.7)	7(9.3)	23(30.7)	4(5.3)
	≥0.86(HHR)	46(201)	34(73.9)	8(17.4)	4(8.7)	21(45.6)	9(19.6)	15(32.6)	0(0)
	p value		<0.001			0.158	0.002	0.079	0.111
Physical activity	Sufficient	30(13.1)	27(90)	3(10)	0(0.0)	15(50)	4(13.3)	12(40)	0(0)
	insufficient	199(86.9)	175(87.9)	19(9.5)	5(2.5)	61(30.6)	15(7.5)	46(23.1)	6(3)
	p value		0.491			0.036	0.314	0.047	0.902
House work	Full load	166(72.5)	148(89.1)	15(9)	3(1.8)	53(31.9)	15(9) 4	37(22.3)	4(24.1)
	Partial load	58(25.3)	50(86.2)	6(10.3)	2(3.4)	22(37.9)	(6.9)	19(32.8)	1(17.2)
	none	5(2.2)	4(80)	1(20)	0(0.0)	2(40)	0(0)	2(40)	1(20)
	p value		0.863			0.796	0.565	0.229	0.256
Smoking	Yes	53(23.1)	46(86.8)	5(9.4)	2(3.8)	16(30.2)	2(3.8)	14(26.4)	2(3.8)
	No	176(76.9)	156(88.6)	17(9.7)	3(1.7)	60(34.1)	17(9.7)	44(25)	4(2.3)
	p value		0.697			0.597	0.141	0.835	0.505
BP	Normal	201(87.8)	183(91)	17(8.5)	1(0.5)	63(31.3)	17(8.5)	49(24.4)	4(2)
	High	28(12.2)	19(67.9)	5(17.9)	4(14.3)	13(46.4)	2(7.1)	9(32.1)	2(7.1)
	p value		<0.001			0.112	0.81	0.376	0.159
FH of DM	Yes	135(59.2)	115(85.2)	16(11.9)	4(2.9)	42(31.1)	13(9.6)	31(22.9)	5(3.7)
	No	93(40.8)	87(93.5)	6(6.5)	0(0.0)	35(37.6)	6(6.5)	27(29)	1(1.1)
	p value		0.041			0.253	0.394	0.301	0.405
FH of Dyslipid-emia	Yes	88(38.6)	74(84.1)	12(13.6)	2(2.3)	31(35.2)	9(10.2)	27(30.7)	3(3.4)
	No	140(61.4)	128(91.4)	10(71.4)	2(1.4)	46(32.9)	10(7.1)	31(22.1)	3(2.3)
	p value		0.243			0.847	0.412	0.150	0.566
Previous glucose testing	Yes	95(41.5)	82(29.5)	10(10.5)	3(3.2)	37(38.9)	7(7.4)	27(28.4)	2(2.1)
	No	134(58.5)	120(89.5)	12(8.9)	2(1.5)	40(29.9)	12(8.9)	31(23.1)	4(2.9)
	p value		0.638			0.203	0.668	0.365	0.678
Previous lipid testing	Yes	58(25.3)	45(77.6)	11(18.9)	2(3.4)	24(41.3)	6(10.3)	19(32.8)	3(5.2)
	No	171(74.7)	157(91.8)	11(6.4)	3(1.8)	53(30.9)	13(7.6)	39(22.8)	3(1.8)
	p value		0.022			0.125	0.582	0.132	0.189
Regular medical checkups	Yes	36(15.8)	30(83.3)	4(11.1)	2(5.6)	18(50)	6(16.7)	12(33.3)	1(2.8)
	No	192(84.2)	171(89.1)	18(9.4)	3(1.6)	59(30.7)	13(6.8)	46(23.9)	5(2.6)
	p value		0.389			0.021	0.091	0.236	0.953
Surgical history	Yes		102(85.7)	14(11.8)	3(2.5)	36(30.3)	9(7.6)	28(23.5)	3(2.5)
	No		100(91.7)	8(7.3)	1(0.9)	40(36.7)	10(9.2)	30(27.5)	3(2.9)
	p value		0.319			0.320	0.660	0.489	0.904

HbA1C= Hemoglobin A1C. PD= Pre diabetes. DM= Diabetes Mellitus. TC= Total cholesterol. TG= Triglycerides. LDL= Low density lipoprotein. HDL= High density lipoprotein. BMI= Body mass index. WHR= Waist-hip ratio. LHR= Low health risk. MHR= Moderate health risk. HHR= High health risk. BP= Blood pressure. FH= Family history. DM= Diabetes mellitus.

Pearson Chi-Square test and Fisher's exact test. All calculations were two-tailed, with a p-value < 0.05 considered statistically significant.

Results

A total of 229 female teachers were enrolled in the study, and various variables were examined for their correlations with both lipid parameters and HbA1C levels. The prevalence of undiagnosed dyslipidemia was found to be 44.9% (Table 1), with the age variable demonstrating a significant correlation with high total cholesterol ($p = 0.002$). Additionally, age was found to correlate with LDL levels ($p = 0.03$), with LDL being notably elevated among participants aged 40 years and above. Participants with four or more children exhibited higher triglyceride levels (18.2%) compared to those with fewer children (5.9%) ($p = 0.014$). The overall prevalence of undiagnosed PD was 9.6%, while the prevalence of diabetes mellitus (DM) was 2.2%. Remarkably, age significantly influenced hyperglycemia ($p < 0.001$), as all participants with P

D were aged over 40 years, and four out of the five participants with DM were over 50 years old. Other variables such as residency, marital status, monthly income, means of transportation, and blood group did not show a significant relationship with the prevalence of dyslipidemia, PD, or DM.

Based on BMI calculations, 42.8% of participants were classified as overweight, while 20.1% were categorized as obese. When assessed by waist-to-hip ratio (WHR), approximately 53% of participants exhibited a WHR > 0.81 (Table 2). Additionally, 86.9% of participants reported insufficient exercise, with the majority (72.5%) indicating a full workload at home. Smoking was reported by 23.1% of participants, while 12.2% had hypertension (HTN). Family history of dyslipidemia and diabetes mellitus (DM) was reported by 38.6% and 59.2% of participants, respectively. Furthermore, approximately 74.7% of participants had never undergone lipid testing, 58.5% had never been screened for DM, and the majority (84.2%) had never undergone regular medical checkups. Body mass index was significantly associated with elevated total cholesterol (TC) ($p = 0.041$), elevated triglycerides (TG) ($p = 0.047$), and low high-density lipoprotein (HDL) levels ($p = 0.018$). Among participants with high TG levels, 19.6% had a WHR > 0.85, 9.3% had a WHR between 0.81 and 0.85, and 2.8% had a WHR < 0.81. Inadequate physical activity particularly influenced elevated TC and LDL levels, as 61 participants with high TC and 46 participants with high LDL did not engage in

Table 3. Obstetrics and gynecology history and DM/dyslipidemia

Variable	Category	Total No (%)	HbA_{1C}			High TC	High TG	High LDL	Low HDL
			Normal No (%)	PD No (%)	DM No (%)	No (%)	No (%)	No (%)	No (%)
Post menopause	Yes	53(23.1)	40(75.5)	10(19.2)	3(5.6)	29(54.7)	2(3.8)	25(47.2)	3(5.6)
	No	174(76.7)	161(92.5)	12(6.9)	1(0.6)	48(27.6)	17(9.8)	33(20.1)	3(1.7)
	p value		0.004			<0.001	0.257	0.001	0.15
Menstrual regularity	Regular	150(85.7)	141(94)	8(5.3)	1(0.7)	41(27.3)	13(8.7)	29(19.3)	3(2)
	Irregular	25(14.3)	22(88)	3(12)	0(0.0)	6(24)	3(12)	4(16)	0(0.0)
	p value		0.440			0.812	0.705	0.688	0.334
AUB	Yes	8(3.9)	7(87.5)	1(12.5)	0(0.0)	3(37.5)	1(12.5)	0(0.0)	0(0.0)
	No	196(96.1)	177(90.3)	15(7.6)	4(2)	61(31.1)	17(8.7)	47(23.9)	6(3.1)
	p value		0.770			0.684	0.529	0.202	0.485
Contraceptive method	OCP	24(12.7)	21(87.5)	3(12.5)	0(0.0)	10(41.7)	3(12.5)	7(29.2)	1(4.2)
	IUD	47(24.9)	45(95.7)	2(4.3)	0(0.0)	11(23.4)	4(8.5)	6(12.8)	0(0.0)
	Nothing	118(62.4)	107(90.7)	9(7.6)	2(1.7)	33(28)	11(9.3)	26(22)	5(4.2)
	p value		0.482			0.265	0.865	0.225	0.174
History of GDM	Yes	17(8.8)	14(82.3)	3(17.7)	0(0.0)	6(35.3)	2(11.8)	5(29.4)	0(0.0)
	No	177(91.2)	157(88.7)	16(9)	4(2.3)	55(31.1)	16(9)	41(23.2)	6(3.4)
	p value		0.412			0.720	0.661	0.572	0.29
History of HTN during pregnancy	Yes	22(11.3)	19(86.4)	3(13.6)	0(0.0)	8(36.4)	3(13.6)	7(31.8)	1(4.5)
	No	172(88.7)	152(88.4)	16(9.3)	4(2.3)	53(30.8)	15(8.7)	39(22.7)	5(2.9)
	p value		0.519			0.598	0.437	0.342	0.693
Excessive WG during pregnancy	Yes	47(24.1)	40(85)	6(12.8)	1(2.1)	17(38.3)	3(6.4)	11(23.4)	0(0.0)
	No	148(75.9)	132(89.2)	13(8.8)	3(2)	44(29.7)	15(10.1)	35(23.6)	6(4.1)
	p value		0.735			0.407	0.570	0.973	0.066
History of macrosomia baby delivery	Yes	6(3.1)	3(50)	3(50)	0(0.0)	2(33.3)	2(33.3)	0(0.0)	0(0.0)
	No	188(96.9)	168(89.4)	16(8.5)	4(2.1)	58(30.8)	15(8)	45(23.9)	6(3.2)
	p value		0.034			0.898	0.088	0.339	0.066
Hemoglobin level	Low	138(62.4)	117(84.8)	19(13.8)	2(1.4)	46(33.3)	11(8)	36(26.1)	4(2.9)
	Normal	83(37.6)	78(93.9)	3(3.6)	2(2.4)	28(33.7)	8(9.6)	20(24.1)	1(1.2)
	p value		0.030			0.951	0.668	0.742	0.653

HbA_{1C}=Hemoglobin A1C. PD=Pre diabetes. DM= Diabetes mellitus. TC= Total cholesterol. TG= Triglycerides. LDL= Low density lipoprotein. HDL= High density lipoprotein. AUB= Abnormal uterine bleeding. GDM= Gestational Diabetes mellitus. HTN= Hypertension. OCP= Oral contraceptive. IUD= Intrauterine device. WG= Weight Gain.

sufficient physical activity. Previous lipid testing, elevated blood pressure (BP), smoking, family history of dyslipidemia, workload, and surgical history showed no significant correlation with dyslipidemia. Both body mass index and WHR were significantly correlated with hyperglycemia ($p = 0.021$, $p < 0.001$, respectively). Elevated BP was significantly associated with hyperglycemia ($p < 0.001$), while family history of DM exhibited a notable correlation with hyperglycemia ($p = 0.041$). Conversely, physical activity, housework, smoking, and surgical history showed no significant relationship with hyperglycemia.

The associations between dyslipidemia/hyperglycemia and elements of gynecological history are presented in Table 3. Approximately 23.1% of participants were in the postmenopausal phase, with 14.3% reporting irregular menstruation and 62.4% having never used contraceptive methods. Among postmenopausal women, almost 24.8% exhibited hyperglycemia, compared to 7.5% of premenopausal women. Furthermore, 54.7% of postmenopausal women had high total cholesterol (TC), whereas only 27.6% of premenopausal women had high TC ($P<0.001$). Similarly, 47.2% of postmenopausal women had elevated low-density lipoprotein (LDL) levels, contrasting with 20.1% of premenopausal women ($P = 0.001$). Among the six participants with a history of macrosomic babies, three were diagnosed with pre-diabetes PD ($p = 0.034$). Interestingly, 62.4% of all participants had low hemoglobin (Hb) levels, with 15.2% of them exhibiting hyperglycemia ($P = 0.030$). However, no significant correlation was found between contraceptive use, abnormal uterine bleeding (AUB), history of gestational diabetes mellitus (GDM), pregnancy-related hypertension (HTN), excessive weight gains during pregnancy, and either dyslipidemia or DM.

Table 4. Diabetes and Dyslipidemia

Variable	Category	Total	High TC	High TG	High LDL	Low HDL
		No (%)	No (%)	No (%)	No (%)	No (%)
TC level	Normal	152(61)	-	9(5.9)	5(3.2)	6(3.9)
	High	77(33.4)	-	10(13.2)	53(68.8)	0(0.0)
	p Value		-	0.06	<0.001	0.182
TG level	Normal	210(92)	-	-	54(25.7)	4(1.9)
	High	25(10.9)	-	-	4(16)	2(8)
	p value		-	-	0.788	0.08
LDL level	Normal	171(74.7)	-	-	-	5(2.9)
	High	58(25.3)	-	-	-	1(1.7)
	p value		-	-	-	0.904
HDL level	Normal	233(97.4)	-	-	-	-
	Low	6(2.6)	-	-	-	-
	p value		-	-	-	-
HbA1C	Normal	202(88.2)	65(32.1)	15(7.4)	47(23.2)	4(1.9)
	PD	22(9.6)	10(45.4)	3(13.6)	10(45.5)	2(9.1)
	DM	5(2.2)	2(40.0)	1(20.0)	1(20.0)	0(0.0)
	p value		0.421	0.454	0.095	0.241

HbA1C= Hemoglobin A1C. PD= Pre diabetes. DM= Diabetes mellitus. TC= Total cholesterol. TG= Triglycerides. LDL= Low density lipoprotein. HDL= High density lipoprotein.

The prevalence rates of elevated total cholesterol (TC), elevated triglycerides (TG), elevated low-density lipoprotein (LDL), and low high-density lipoprotein (HDL) were 33.4%, 10.9%, 25.3%, and 2.6%, respectively (Table 4). It is noteworthy to mention that one participant exhibited a significantly high TG level (>500mg/dl) (results not displayed), while four participants demonstrated very high LDL levels (results not displayed). A significant correlation was observed between elevated TC and elevated LDL ($p < 0.001$). However, no significant correlation was found between hyperglycemia and dyslipidemia. Among the hyperglycemic participants, twelve had elevated TC, four had elevated TG, eleven had elevated LDL, and two had low HDL.

Discussion

Undiagnosed diabetes mellitus (DM), particularly when combined with undiagnosed dyslipidemia, has the potential to diminish quality of life and place a significant burden on the healthcare system (Marshall & Flyvbjerg, 2006). Our findings revealed that the overall prevalence rates of undiagnosed DM and PD were 2.2% and 9.6%, respectively. These figures were slightly lower compared to results from a meta-analysis study conducted in the Eastern Mediterranean region (Mirahmadizadeh et al., 2020) and among African Americans (Asmelash & Asmelash, 2019), but more aligned with prevalence rates reported among U.S. adults (Centers for Disease Control and Prevention). The overall prevalence of undiagnosed dyslipidemia in our study was 44.97%, with high total cholesterol (TC) being the most prevalent lipid disorder, observed in 33.6% of all participants. This figure is consistent with findings from a Canadian study reporting a 45% prevalence rate of dyslipidemia among Canadians aged 18–79 years (Joffres, Shields, Tremblay, & Connor Gorber, 2013), and a meta-analysis of Chinese citizens indicating a prevalence rate of nearly 41.9% in the adult population (Huang, Gao, Xie, & Tan, 2014). However, prevalence rates were lower in Saudi Arabia, where 8.5% of Saudis had hypercholesterolemia and 19.6% had borderline hypercholesterolemia, with 65.1% of hypercholesterolemic Saudis being previously undiagnosed (Basulaiman et al., 2014). In our study, 25.3% of participants had high LDL levels, 10.9% had high triglyceride (TG) levels, and 2.6% had low high-density lipoprotein (HDL) levels. Contrastingly, in Jordan, the prevalence rates were 44.3%, 41.9%, 75.9%, and 59.5% for high TC, high TG, high LDL, and low HDL, respectively (Abujbara et al., 2018), which were greater than the prevalence rates observed in a previous study among Palestinian men (Ali et al., 2019). In India, the prevalence of high LDL, high TG, and low HDL was reported as 79%, 29.5%, and 11.8%, respectively (Joshi et al., 2014). Similarly, among Turkish females, the prevalence rates of high LDL, high TG, and low HDL were 30.2%, 41.3%, and 50.7%, respectively (Kayıkçıoğlu et al., 2018). These disparities in the prevalence of dyslipidemia and DM across different societies may be attributed to various factors, including genetic predisposition, socioeconomic status, dietary patterns, lifestyle choices, and other environmental influences.

Aging is a well-established risk factor for the development of diabetes mellitus (DM), primarily due to the combined effects of insulin resistance and declining pancreatic function(Kirkman et al., 2012). Similarly, age-related insulin resistance and other metabolic changes contribute to the accumulation of low-density lipoprotein (LDL) and the onset of dyslipidemia with advancing age(Liu & Li, 2015). Consistent with these findings, our study revealed a high prevalence of undiagnosed DM and prediabetes (PD) among participants over the age of 40, with the highest prevalence observed in the 51–60 age group. This pattern aligns with trends reported in the US National Diabetes Statistics Reports(Centers for Disease Control and Prevention). Additionally, the prevalence of undiagnosed high total cholesterol (TC) and elevated LDL levels increased significantly in individuals aged 41–50 and peaked among those aged 51–60, supporting the notion of progressive cholesterol accumulation with age(Abujbara et al., 2018; Liu & Li, 2015). Findings from Turkey indicate that dyslipidemia rates are significantly lower in rural areas compared to urban centers (Bayram et al., 2014). However, in Kazakhstan, despite lower awareness and diagnosis of dyslipidemia in rural populations often linked to lower socioeconomic and educational status—urban residents exhibited significantly less favorable lipid profiles (Supiyev et al., 2017). In contrast, our study found no significant differences in the prevalence of DM or dyslipidemia based on participants' place of residence. This lack of disparity may be attributed to minimal lifestyle differences between urban and rural populations in Palestine.

Body mass index (BMI) exhibits a J-shaped association with overall mortality, with BMI outside the healthy range being associated with several years of lost lifespan (Bhaskaran, Dos-Santos-Silva, Leon, Douglas, & Smeeth, 2018). Our study highlighted a significant association between BMI and both dyslipidemia and DM. Among obese participants, high TC was prevalent in 47.8%, high TG in 17.4%, and low HDL in 2.1%, while among those with a normal BMI, the corresponding figures were 27%, 18.8%, and 1.2%, respectively. This aligns with findings from a study in the U.S. that revealed a strong correlation between obesity and dyslipidemia (Nguyen, Magno, Lane, Hinojosa, & Lane, 2008). Additionally, we found that 19.6% of participants with a waist-to-hip ratio (WHR) ≥ 0.86 had high LDL levels, compared to 2.8% of those with a WHR ≤ 0.8. Furthermore, our results indicated that 4 out of 5 participants with DM had a WHR > 0.86 ($p < 0.001$), and 45.5% of participants with PD were obese ($p = 0.021$). Obesity can promote insulin resistance in cells (Purkayastha, Zhang, & Cai, 2011).

Regular exercise enhances quality of life and well-being, exerting a profound impact on physical, social, and emotional aspects of life (Valencia, Stoutenberg, & Florez, 2014). Our study identified a significant correlation between regular exercise and dyslipidemia, with 61 participants exhibiting high TC and 46 participants demonstrating high LDL levels reporting inadequate physical activity. However, no significant correlation was found between exercise and HDL, TG, or HbA1C levels.

High blood pressure (BP) was found in 12.2% of participants, and our results revealed a significant correlation between high BP and DM, with 14.3% of undiagnosed DM and 17.9% of undiagnosed PD exhibiting high BP. The co-existence of BP and DM places individuals at a four-fold increased risk for cardiovascular disease (CVD) compared to healthy normotensive nondiabetics (Pavlou et al., 2018). This finding is supported by conclusions from two cohort studies in Mexico and Framingham, which specifically indicated that the development of hypertension and DM predicts each other over time(Tsimihodimos, Gonzalez-Villalpando, Meigs, & Ferrannini, 2018), likely due to shared pathways and risk factors between DM and hypertension (Cheung & Li, 2012). Although our results did not reveal a significant correlation between hypertension and dyslipidemia, 2.2% of all participants exhibited a combination of high HbA1C levels, hypertension, and dyslipidemia.

Genetics is a recognized risk factor for DM, with individuals having diabetic parents having a 40% higher chance of developing DM (Park, 2011). We found a significant correlation ($p = 0.041$) between DM and a family history of DM. A cross-sectional study in Saudi Arabia revealed that a positive family history of DM in a first-degree relative is significantly associated with the diagnosis of DM at a younger age (Alharithy, Alobaylan, Alsugair, & Alswat, 2018). However, no significant correlation between dyslipidemia and family history was found in our study.

The menopausal transition represents a significant milestone for midlife women, characterized by rapid changes in physiological characteristics including endogenous sex steroid hormones, body composition, and body fat distribution(Harlow et al., 2012). Our study revealed a significant correlation between menopause and abnormal HbA1C levels, with 24.8% of postmenopausal participants exhibiting hyperglycemia compared to 7.5% of premenopausal participants ($p < 0.001$). A survey of more than 10,000 Japanese women reported a particular association between postmenopausal status and DM compared to premenopausal women (Heianza et al., 2013). Moreover, 54.7% of postmenopausal women had high TC levels ($p < 0.001$), and 47.2% had high LDL levels ($p < 0.001$), consistent with findings from a Chinese study indicating a higher prevalence of dyslipidemia in postmenopausal women compared to premenopausal women (Wang, Qin, & Cui, 2016). We observed that 24% of participants with irregular menstrual cycles had high TC levels ($p < 0.001$), although there was no significant correlation between irregular menstrual cycles and other lipid elements or DM.

Of the six participants with a history of delivering macrosomic infants, three were diagnosed with pre-diabetes, none of whom had a prior diagnosis of gestational diabetes. Although statistically significant ($p = 0.034$), such statistics may be unreliable due to the limited number of participants. Anemia in DM patients is a common and often neglected complication, which may have negative consequences on the development and progression of other DM-related macrovascular and microvascular complications(Taderegew, Gebremariam, Tareke, & Woldeamanuel, 2020). Our study revealed a significant correlation between low hemoglobin levels and abnormally high HbA1C levels, possibly explained by a high-calorie diet and obesity(Aigner, Feldman, & Datz, 2014), in addition to abnormal renal function in some patients (Chen, Knicely, & Grams, 2019). Furthermore, we found a significant association between high LDL and high TC levels ($p < 0.001$), increasing the risk of developing CVD, as LDL can combine with other fats and substances in the blood, leading to blockages in the arteries.

Conclusion and Recommendations

In this study, we observed a considerable prevalence of undiagnosed dyslipidemia, PD, DM, and disturbed lipid and glucose metabolism among healthy female teachers, with rates of 44.9%, 9.6%, 2.2%, and 2.2%, respectively. Various factors such as age, physical activity, BMI, WHR, family history, Hb levels, menstrual regularity, and menopause status demonstrated significant correlations with DM and dyslipidemia. Therefore, we recommend regular screening for lipid and glucose levels to identify individuals with asymptomatic metabolic disorders. Early detection and intervention can help mitigate the progression of these conditions and improve overall health outcomes.

Strengths and Limitations

This study represents the inaugural investigation into the prevalence of undiagnosed dyslipidemia and DM within the Palestinian healthy female teacher population. It comprehensively examines the influence of diverse factors, encompassing medical, surgical, gynecological, and reproductive history, alongside sociodemographic and lifestyle factors. Individuals with abnormal results were strongly encouraged to seek guidance from healthcare professionals promptly to initiate early management, thereby potentially delaying or averting complications. It is important to note that while this cross-sectional study can corroborate or refute assumptions, it cannot definitively establish causal relationships between variables. Nonetheless, the study faces certain limitations, including the homogeneity of participants who were predominantly female teachers with similar lifestyles and socioeconomic backgrounds. Furthermore, BP measurements were taken twice, with a ten-minute interval after rest during the same visit, which may introduce inaccuracies. Additionally, smoking status assessment was limited by discrepancies, as some participants occasionally smoked water pipes, while others were hesitant to provide detailed information about their smoking habits.

Ethics Approval and Consent to Participate

Ethical approval was secured from the Institutional Review Board and hospital authorities. Participants were informed about the study and signed a written consent form prior to participation.

Funding

This study was supported by An-Najah National University, Nablus, Palestine. The funding body had no role in the design of the study, data collection, analysis, interpretation of data, or in writing the manuscript.

Acknowledgements

The authors would like to express their sincere gratitude to all participants in this study for their time, cooperation, and trust. We also thank the staff of An-Najah National University Hospital for their valuable support and assistance throughout the data collection process. Their contribution was essential to the success of this research.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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