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Prevalence, awareness, treatment, and control of dyslipidemia and associated factors among adults in Jordan: Results of a national cross-sectional survey in 2019

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ABSTRACT

Dyslipidaemia is increasing with low awareness and treatment in low resourced countries.

The aim of the study was to evaluate the prevalence, distribution, and correlates of dyslipidaemia and its awareness, treatment, and control among people (18–69 years) in Jordan.

In a national cross-sectional survey, a total of 3,132 individuals (mean age: 41.7 years) that took part in the Jordan cross-sectional STEPS survey in 2019 and had complete lipid measurements. Dyslipidemia was defined using the guidelines of the Adult Treatment Panel III.

The prevalence of dyslipidemia was 81.6%, 74.0% low high-density lipoprotein cholesterol (HDL-C), 28.2% high triglyceride (TG), 10.1% high total cholesterol (TC) and 8.7% high low-density lipoprotein cholesterol (LDL-C). Among those with dyslipidaemia, 9.3% were aware. Among those who knew, the proportion of lipid-lowering drug treatment was 50.3%, and among those taking lipid-lowering drugs, 25.4% had their dyslipidaemia controlled. In adjusted logistic regression, in both sexes, overweight (AOR: 2.14, 95% CI: 1.49–3.36), obesity (AOR: 2.47, 95% CI: 1.55–3.94), diabetes (AOR: 2.63, 95% CI: 1.30–5.34) were positively and moderate physical activity (AOR: 0.60, 95% CI: 0.37–0.95) was negatively associated with prevalence of dyslipidemia. Older age, overweight, obesity, hypertension, diabetes, and cardiovascular disease were positively associated, and moderate physical activity was negatively associated with awareness of dyslipidemia.

Four out of five adults in Jordan had dyslipidaemia and less than one in ten were aware. Several factors associated with the prevalence, awareness, and treatment of dyslipidaemia were identified that can be used to target public health interventions.

1. Introduction

Dyslipidemia constitutes one or a combination of low high-density lipoprotein cholesterol (HDL-C), elevated triglyceride (TG), high low-density lipoprotein cholesterol (LDL-C), and elevated total cholesterol (TC) (Pirillo et al., 2021; Gebreegziabiher et al., 2021). Dyslipidaemias are associated with changes in the plasma lipid profile leading to major clinical conditions, such as cardiovascular disease (CVD), and the global burden has significantly increased over the past 30 years (Pirillo et al., 2021). CVDs contribute to 37% of mortality in 2018 in Jordan (World Health Organization (WHO), 2018). In a cohort study in Jordan, the main risk factors for ischemic stroke included hypertension, diabetes mellitus, hyperlipidaemia, and coronary artery disease (Alawneh et al., 2020). "Dyslipidaemias can be genetically determined (primary or familial dyslipidaemias) or secondary to other conditions (such as diabetes mellitus, obesity or an unhealthy lifestyle), the latter being more common" (Pirillo et al., 2021). Based on our review, we were unable to find national data on prevalence, awareness, treatment, and control of dyslipidemia in Jordan. A national prevalence study on the lipid profile in Jordan in 2017 found that the proportion of high TC was 44.3%, high TG 41.9%, high LDL-C 75.9%, and low HDL-C 59.5% (Abujbara et al., 2018), and in a cross-sectional study in Sarih in northern Jordan in 2006, 48.8% had high TC, 40.7% high LDL-C, 40.1% low HDL-C, 43.6% high TG, and 75.7% had at least one abnormal lipid level (Khader et al., 2010).

In 35 low- and middle-income countries (LMIC) (≥15 years), the

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prevalence of high TC (≥240 mg/dL) was 7.1%, and high LDL-C (≥160 mg/dL) 7.5%, ≥31% of them were aware of their diagnosis, ≥29% were treated, and ≥ 7% were controlled (Marcus et al., 2021). In China (>18 years), the prevalence of dyslipidaemia was 34.0% (Pan et al., 2016), and 31.0% were aware, 19.5% in treatment and 8.9% were controlled (Pan et al., 2016). In Northern Ethiopia (≥20 years), the prevalence of dyslipidaemia was 66.7%, elevated TC 30.8%, elevated TG 40.2%, low HDL-C 16.5%, and high LDL-C 49.5% (Gebreegziabiher et al., 2021), in Turkey (≥20 years), high LDL-C was 36.2%, high TG 35.7%, low HDL-C 41.5%, and high TC was 43%, and dyslipidaemia (at least one abnormal lipid value) ≥79% (Bayram et al., 2014), and in Pakistan (≥20 years) high TC 39.3%, high TG 48.9%, high LDL-C 39.7%, and low HDL-C (87.4%) (Basit et al., 2020).

Sociodemographic factors associated with dyslipidaemia include increased age (Gebreegziabiher et al., 2021; Pan et al., 2016), male sex (Pan et al., 2016; Xi et al., 2020), ethnicity (Xi et al., 2020) and living in urban areas (Pan et al., 2016; Xi et al., 2020). Health risk factors associated with dyslipidaemia include obesity (Gebreegziabiher et al., 2021; Pan et al., 2016; Bayram et al., 2014; Zhang et al., 2017), central obesity (Xi et al., 2020), cardiovascular disease (Pan et al., 2016), diabetes (Pan et al., 2016; Bayram et al., 2014; Xi et al., 2020; Zhang et al., 2017; Tripathy et al., 2017), and hypertension (Pan et al., 2016; Bayram et al., 2014; Xi et al., 2020; Zhang et al., 2017; Tripathy et al., 2017). Risk factors for health behaviours associated with dyslipidaemia include smoking (Xi et al., 2020), physical inactivity (Gebreegziabiher et al., 2021), dietary pattern (grain-egg-nut complex diet (Liu et al., 2020) and red meat (Diarz et al., 2020), and fruit and vegetable intake lowered high TG (Kjøllesdal et al., 2016), and alcohol use had lower odds of dyslipidaemia (Abujbara et al., 2018).

Factors associated with high TC include older age (Huang et al., 2021), female sex (Huang et al., 2021), lower education (Basit et al., 2020; Huang et al., 2021; Erem et al., 2008), hypertension (Abujbara et al., 2018; Basit et al., 2020; Tripathy et al., 2017), diabetes (Abujbara et al., 2018; Basit et al., 2020; Tripathy et al., 2017; Huang et al., 2021), obesity (Abujbara et al., 2018; Basit et al., 2020) and smoking (Basit et al., 2020). Factors associated with high LDL-C include increasing age (Huang et al., 2021), female sex, hypertension, diabetes, and obesity (Basit et al., 2020). Factors associated with low HDL-C include decreased age (Huang et al., 2021), female sex (Basit et al., 2020), male sex (Huang et al., 2021), higher education (Huang et al., 2021), hypertension (Abujbara et al., 2018), diabetes (Abujbara et al., 2018; Basit et al., 2020; Huang et al., 2021), obesity (Abujbara et al., 2018; Basit et al., 2020; Huang et al., 2021), and smoking (Huang et al., 2021; Malta et al., 2019). Factors associated with high TG include male sex (Tripathy et al., 2017; Huang et al., 2021), higher education (Huang et al., 2021), hypertension (Abujbara et al., 2018; Tripathy et al., 2017; Huang et al., 2021), diabetes (Abujbara et al., 2018; Basit et al., 2020; Tripathy et al., 2017; Huang et al., 2021), obesity (Abujbara et al., 2018; Basit et al., 2020; Tripathy et al., 2017), physical inactivity (Huang et al., 2021), and smoking or current tobacco use (Abujbara et al., 2018; Tripathy et al., 2017; Huang et al., 2021).

Factors associated with awareness of dyslipidaemia diagnosis include older age (Marcus et al., 2021), living in urban areas (Huang et al., 2021), higher education (Huang et al., 2021), higher BMI (Marcus et al., 2021; Huang et al., 2021), comorbid diagnosis of diabetes (Marcus et al., 2021; Huang et al., 2021), hypertension (Marcus et al., 2021; Huang et al., 2021), and CVD (Huang et al., 2021). Factors associated with the treatment of dyslipidaemia or hypercholesterolemia include women (Basit et al., 2020), comorbid hypertension, diabetes (Marcus et al., 2021), and CVD (Huang et al., 2021). Factors positively associated with control of dyslipidaemia include women (Basit et al., 2020), urban residence (Basit et al., 2020), obesity (Basit et al., 2020), comorbid diabetes (Marcus et al., 2021), and CVD (Huang et al., 2021), and overweight/obesity and underweight (Rao et al., 2016), and physical inactivity were negatively associated with control of dyslipidaemia (Huang et al., 2021).

The aim of the study was to assess the prevalence, distribution, and correlates of dyslipidaemia its awareness, treatment and control among people aged 18 to 69 years in Jordan in 2019.

2. Methods

2.1. Participants and procedures

National cross-sectional data with complete lipid measurements from the Jordan STEPS 2019 survey (World Health Organization (WHO), 2018) were analyzed; Study response rates were 95% for Step 1, 93% for Step 2, and 63% for Step 3 (Ministry of Health, 2019). According to the STEPS survey procedures,

> "Socio-demographic and behavioural information was collected in Step 1. Physical measurements such as height, weight, and blood pressure were collected in Step 2. Biochemical measurements were collected to assess blood glucose and cholesterol levels in Step 3. A multi-stage stratified sampling process was carried out to randomly select participants from the target population of adult Jordanians and Syrians. One individual within the age range of the survey (18–69 years) was selected per household. Ethics approval was provided by the Jordan Ministry of Health Ethics Committee for Scientific Research, and written informed consent was obtained from all participants.' (World Health Organization (WHO), 2018; Ministry of Health and Survey, 2019)

Data collection followed the "WHO three STEPS methodology: Step 1 included the administration of a structured questionnaire (sociodemographics, medical history, medication use, and health risk behaviour); Step 2 consisted of blood pressure and anthropometric measurements, and Step 3 included biochemical tests (blood glucose and blood lipids)." (World Health Organization (WHO), 2018) Anthropometric measurements were taken using a "portable Seca stadiometer and a pre-calibrated portable digital weighing scale (Seca)" (Ministry of Health, 2019). Of the three blood pressure measurements using "Omron M3 devices" (Ministry of Health, 2019); the last two readings were averaged (World Health Organization (WHO), 2021). Cardiochek PA devices were used to measure the blood-related measurements (glucose and lipids) (Ministry of Health, 2019). Blood samples were taken after overnight fasting (not to consume any food or drinks except water until the morning of the following day) early in the morning.

2.2. Measures

Dyslipidaemia was classified (NCEP, 2001) as:

> "Being on antilipidemic medication or having one or more of the following: elevated total cholesterol (TC): ≥5.17 mmol/l (200 mg/dl), high triglycerides (TG): ≥1.70 mmol/l (150 mg/dl), low HDL-C: female ≤ 1.29 mmol/l; ≤male 1.03 (<50 mg/dl in women, <40 mg/dl in men) and high LDL-C: ≥3.36 mmol/l (130 mg/dl)."

The awareness rate of dyslipidemia was defined as:

> "Having been diagnosed by a health care provider as having high cholesterol among those with dyslipidaemia. The rate of dyslipidaemia treatment was defined as the self-reported use of lipid lowering drugs among participants who were aware of dyslipidaemia. The control rate for dyslipidaemia was classified as the proportion among those treated for dyslipidaemia who reach the lipid standard: TG < 1.70 mmol/L, TC < 5.18 mmol/L, HDL-C ≥ 1.04 mmol/L and LDL-C < 3.37 mmol/L." (NCEP, 2001)

Being on antilipidemic medication was assessed with the question, "In the past two weeks, have you taken any oral treatment (medication) for raised total cholesterol prescribed by a doctor or other health worker?" (Yes/No).

Other biological measures included measured central obesity ("waist

circumference ≥ 94 cm in men, ≥80 cm in women") (Harvard School of Public Health, 2020); measured *Body Mass Index* (BMI) (kg/m^2): "<18.5 kg/m^2 underweight, 18.5–24.4 kg/m^2 normal weight, 25–29.9 kg/m^2 overweight, and ≥30 kg/m^2 obesity" (World Health Organization (WHO), 2022); *Hypertension/raised blood pressure* (BP): "systolic BP ≥ 140 mm Hg and/or diastolic BP ≥ 90 mm Hg or where the participant is currently on antihypertensive medication." (Chobanian et al., 2003 Dec) *Diabetes:* "fasting plasma glucose levels >=7.0 mmol/L (≥126 mg/dl); or using insulin or oral hypoglycaemic drugs" (World Health Organization (WHO), 2021).

Behavioural measures included current smoking, alcohol use, daily intake of fruits and vegetables, salt intake, and low, moderate, and high physical activity based on the "Global Physical Activity Questionnaire" (Armstrong and Bull, 2006). Sociodemographic variables included age (years), sex (male, female), education, monthly household income in the Jordanian Dinar (JD) (1st June 2019: $1 USD = JD 0.709), residence, nationality, and region (Ministry of Health, 2019).

History of CVDs included self-reported "Have you ever had a heart attack or chest pain from heart disease (angina) or a stroke (cerebrovascular accident or incident)? (Yes, No)" (Ministry of Health, 2019).

2.3. Data analysis

All statistical analyses were conducted with "STATA software version 14.0 (Stata Corporation, College Station, TX, USA)". "Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population compared to the target population" (Ministry of Health, 2019). Descriptive statistics are used to describe lipid profiles. Logistic regressions were used to assess the associations between sociodemographic and health factors and dyslipidaemia profiles. To account for the multi-stage sample design, Taylor linearization methods were utilized. P-values < 0.05 were considered significant and missing values were discarded.

3. Results

3.1. Sample characteristics

The sample with complete lipid measurements included 3,132 people (18–69 years), with a mean age of 41.7 years (SD = 13.7 years) in

Table 1
Sample description and prevalence of dyslipidemia and its subtypes in Jordan, 2019.

Variable	Subcategory	Sample	High TC	High TG	Low HDL-C	High LDL-C	Dyslipidae mia
		N (%[a])	%[b]	%[b]	%[b]	%[b]	%[b]
Total		3132	10.1	28.2	74.0	8.7	81.6
Age (years)	18–29	674 (21.5)	4.3	14.3	69.7	3.8	75.4
	30–39	813 (26.0)	9.3	27.1	72.2	8.9	79.7
	40–49	712 (22.7)	14.7	37.9	80.2	11.9	86.7
	50–59	510 (16.3)	18.6	41.0	76.6	15.2	86.7
	60–69	423 (13.5)	10.5	38.9	75.1	8.9	88.5
Gender	Female	2085 (66.6)	13.1	25.8	73.4	9.8	82.3
	Male	1047 (33.4)	6.9	30.9	74.7	7.5	80.8
Education (in years)	0–6	976 (31.2)	9.8	35.4	75.0	6.9	83.8
	7–11	1101 (35.2)	10.8	29.5	77.5	8.7	84.4
	≥12	1055 (33.7)	9.8	25.2	71.2	9.2	78.9
Monthly household income (in Jordanian Dinar)	<200	804 (27.9)	13.2	33.8	75.1	11.5	85.2
	200–349	1210 (42.0)	9.8	26.8	75.6	7.8	81.9
	≥350	865 (30.0)	10.1	27.9	72.5	9.3	80.5
Nationality	Syrian	1691 (54.0)	9.8	25.7	72.0	7.9	77.8
	Jordanian	1441 (46.0)	10.2	28.5	74.3	8.8	82.0
Residence	Rural	585 (18.7)	9.1	29.6	71.5	7.7	82.0
	Urban	2547 (81.3)	10.3	28.0	74.5	8.9	81.5
Region	Center	1730 (55.2)	10.5	25.6	72.7	9.2	80.8
	North	1264 (40.4)	9.4	31.7	75.4	8.2	82.8
	South	138 (4.4)	10.7	31.7	77.3	7.7	82.0
Body Mass Index	Normal	674 (23.0)	6.8	16.1	68.6	6.6	73.3
	Underweight	67 (2.3)	0.3	1.1	49.2	0.2	55.6
	Overweight	896 (30.6)	12.0	29.9	78.2	10.1	86.0
	Obesity	1295 (44.2)	11.1	38.5	79.8	9.9	87.4
Central obesity	No	868 (30.1)	6.3	16.6	67.0	6.0	73.1
	Yes	2013 (69.9)	11.8	34.7	79.3	10.2	86.5
Hypertension	No	2098 (68.4)	8.5	24.9	73.0	7.8	79.5
	Yes	969 (3 1 6)	14.2	37.2	77.3	10.9	87.6
Diabetes	No	2741 (90.4)	9.9	25.4	74.2	8.4	81.1
	Yes	290 (9.6)	14.7	59.3	83.0	11.6	93.7
Cardiovascular disease	No	2865 (91.5)	10.2	28.2	74.0	8.8	81.5
	Yes	267 (8.5)	9.1	29.1	74.6	7.9	82.2
Physical activity	Low	991 (32.3)	11.4	34.8	77.5	10.2	86.7
	Moderate	728 (23.7)	9.7	25.4	72.6	7.6	78.5
	High	1349 (44.0)	9.7	25.5	73.2	8.4	80.2
Fruit/Vegetable intake	≥5 servings	323 (10.7)	11.8	33.7	70.2	9.5	81.4
	<5 servings	2703 (89.3)	10.0	27.7	74.6	8.6	81.7
Always/often salt with food	No	2168 (69.2)	10.0	28.5	73.2	8.4	80.8
	Yes	963 (30.8)	10.4	27.5	75.8	9.5	83.3
Always/often processed food high in salt	No	2375 (75.9)	10.3	29.3	74.3	9.1	81.8
	Yes	753 (24.1)	9.9	25.8	73.5	7.9	81.2
Current smoking	No	2263 (72.3)	11.4	27.1	72.8	9.6	80.7
	Yes	869 (27.7)	8.3	30.0	75.9	7.4	82.9
Ever alcohol use	No	3053 (97.5)	10.3	27.8	73.8	8.9	81.2
	Yes	79 (2.5)	6.8	37.0	78.4	5.7	88.1

[a]unweighted; [b]weighted.

2019. The prevalence of dyslipidemia was 81.6%, 10.1% high TC, 28.2% high TG, 74.0% low HDL-C and 8.7% high LDL-C. Further sample characteristics are described in Table 1 (see Table 1).

Table 1.

3.2. Distribution of dyslipidaemia awareness, treatment, and control

Among those with dyslipidemia, 9.3% were aware. Among those who knew, the proportion of lipid-lowering drug treatment was 50.3%, and among those taking lipid-lowering drugs, 25.4% had their dyslipidaemia controlled (see Table 2).

3.3. Associations with prevalence of dyslipidemia

In adjusted logistic regression, in both sexes, overweight (AOR: 2.14, 95% CI: 1.49–3.36), obesity (AOR: 2.47, 95% CI: 1.55–3.94), diabetes (AOR: 2.63, 95% CI: 1.30–5.34) were positively and moderate physical activity (AOR: 0.60, 95% CI: 0.37–0.95) was negatively associated with the prevalence of dyslipidemia (see Table 3).

3.4. Associations with prevalence of dyslipidaemia subcategories

In the adjusted logistic regression analysis, older age was positively associated with high TC, high TG, and high LDL-C but not with low HDL-C. The male sex was negatively associated with high TC. Higher education was associated with high LDL-C. Living in the northern region was associated with high TG. Overweight and obesity were positively associated with high TG and low HDL-C. Diabetes increased the odds and moderate physical activity decreased the odds of high TG (see Table 4).

3.5. Associations with dyslipidaemia awareness and treatment

In the adjusted logistic regression analysis, older age, overweight, obesity, hypertension, diabetes and cardiovascular disease were positively, and moderate physical activity was negatively associated with dyslipidaemia awareness. Among those who were aware of their state of dyslipidaemia, being Jordanian as opposed to Syrian, and diabetes was positively associated and overweight and obesity was negatively associated with the treatment of dyslipidaemia (see Table 5).

4. Discussion

The study presents new national data on the prevalence, awareness, treatment, and control of dyslipidaemia in people 18–69 years of age in Jordan in 2019. The proportion of dyslipidemia in Jordan (81.6%) was higher than in Sarih in northern Jordan in 2006 (75.7%) (Khader et al., 2010), in China (>18 years, 34.0%) (Pan et al., 2016), Northern Ethiopia (≥20 years, 66.7%) (Gebreegziabiher et al., 2021), similar to Turkey (≥20 years, ≥79%) (Bayram et al., 2014), and lower than in Pakistan (≥20 years, 96%) (Basit et al., 2020). The most prevalent component of dyslipidemia was low HDL-C (74.0%), followed by high TG (28.2%), high TC (10.1%) and high LDL-C (8.7%). A similar order of prevalence of components of dyslipidaemia was found in the, in the Sylhet region, Bangladesh (Kathak et al., 2022), in Pakistan (Basit et al., 2020), and China (Pan et al., 2016), with a low HDL-C having the highest prevalence. While in the two previous surveys in Jordan in 2006, high TC was the highest, followed by low HDL-C (Khader et al., 2010), and in 2017 high LDL was the highest, followed by low HDL (Abujbara et al., 2018). Abnormally low levels of low HDL-C are a risk factor for coronary heart disease (NCEP, 2001).

The prevalence of high TC (10.1%) in this study was lower than in the two surveys in Jordan (44.3% in 2017 and 48.8% in 2006) (Abujbara et al., 2018; Khader et al., 2010), lower than in Northern Ethiopia (≥20 years, 30.8%) (Gebreegziabiher et al., 2021), in Turkey (≥20 years, 43%) (Bayram et al., 2014), and Pakistan (≥20 years, 39.3%) (Basit

Table 2
Dyslipidemia awareness, treatment, and control in Jordan, 2019.

Variable	Subcategory	Dyslipidemia		
		Awareness (N = 2578)	Treatment (N = 302)	Control (N = 129)
		N (%)	N (%)	N (%)
Total		302 (9.3)	149 (50.3)	32 (25.4)
Age (years)	15–29	7 (0.6)	0 (0.0)	1 (0.8)
	30–39	24 (4.8)	5 (28.1)	1 (44.7)
	40–49	55 (9.1)	19 (41.2)	2 (19.9)
	50–59	94 (22.5)	51 (53.6)	11 (33.8)
	60–69	122 (29.1)	74 (65.9)	17 (29.1)
Gender	Female	194 (8.9)	87 (44.6)	23 (42.6)
	Male	108 (9.7)	62 (56.2)	9 (13.6)
Education (in years)	0–6	124 (15.9)	60 (60.9)	12 (36.6)
	7–11	86 (8.1)	44 (49.4)	6 (9.7)
	≥12	92 (8.0)	45 (44.2)	14 (25.8)
Monthly household income (in Jordanian Dinar)	<200	73 (9.1)	38 (62.8)	5 (49.9)
	200–349	120 (10.8)	61 (52.9)	12 (22.7)
	≥350	83 (8.0)	37 (45.0)	12 (25.5)
Nationality	Syrian	118 (6.1)	51 (35.6)	8 (14.9)
	Jordanian	184 (9.6)	98 (51.3)	24 (25.9)
Residence	Rural	34 (5.4)	19 (35.3)	4 (29.3)
	Urban	268 (10.0)	130 (51.7)	28 (24.9)
Region	Center	189 (10.5)	95 (51.1)	21 (24.2)
	North	97 (7.0)	47 (51.6)	10 (27.7)
	South	16 (10.9)	7 (41.4)	1 (31.0)
Body Mass Index	Normal	20 (2.3)	11 (84.9)	2 (10.9)
	Underweight	1 (8.4)	1 (1 0 0)	2 (58.4)
	Overweight	73 (9.5)	37 (48.5)	10 (21.3)
	Obesity	197 (13.5)	95 (47.3)	18 (27.1)
Central obesity	No	30 (3.4)	14 (48.5)	4 (18.3)
	Yes	256 (12.1)	126 (51.0)	28 (30.0)
Hypertension	No	86 (3.9)	30 (38.6)	6 (24.8)
	Yes	209 (22.0)	115 (56.4)	26 (26.3)
Diabetes	No	202 (7.0)	81 (37.7)	17 (14.8)
	Yes	84 (28.3)	56 (70.8)	11 (28.0)
Cardiovascular disease	No	222 (7.8)	91 (45.5)	21 (27.2)
	Yes	80 (26.8)	58 (66.8)	11 (21.1)
Physical activity	Low	145 (14.6)	78 (48.6)	15 (28.9)
	Moderate	61 (7.1)	32 (65.5)	7 (19.4)
	High	93 (6.7)	37 (45.2)	9 (25.9)
Fruit/Vegetable intake	≥5 servings	37 (11.5)	18 (42.0)	6 (50.9)
	<5 servings	260 (9.1)	126 (51.8)	26 (21.4)
Always/often salt with food	No	203 (9.1)	99 (51.2)	25 (27.0)
	Yes	99 (9.6)	50 (48.5)	7 (21.9)
Always/often processed food high in salt	No	239 (9.2)	118 (55.7)	28 (30.1)
	Yes	63 (9.3)	31 (38.3)	4 (12.8)
Current smoking	No	229 (10.0)	112 (49.5)	26 (27.9)
	Yes	73 (8.3)	37 (51.7)	6 (21.4)

(continued on next page)

Table 2 (*continued*)

Variable	Subcategory	Dyslipidemia		
		Awareness (N = 2578)	Treatment (N = 302)	Control (N = 129)
		N (%)	N (%)	N (%)
Ever alcohol use	No	291 (9.3)	144 (50.2)	31 (25.1)
	Yes	11 (9.6)	5 (52.4)	1 (31.2)

et al., 2020) but similar to the 35 LMIC study (≥15 years, 7.1%) (Marcus et al., 2021). The prevalence of high TG (28.2%) in this study was lower than in the previous two surveys in Jordan (41.9% in 2017 and 43.6% in 2006) (Abujbara et al., 2018; Khader et al., 2010), and lower than in Turkey (35.7%) (Bayram et al., 2014), and lower than in northern Ethiopia (40.2%) (Gebreegziabiher et al., 2021) and Pakistan (48.9%) (Basit et al., 2020). The prevalence of high LDL-C (8.7%) in this study was lower than in the previous two surveys in Jordan (75.9% in 2017 and 40.7% in 2006) (Abujbara et al., 2018; Khader et al., 2010), lower than in Northern Ethiopia (49.5%) (Gebreegziabiher et al., 2021), Turkey (36.2%) (Bayram et al., 2014), and in Pakistan (39.7%) (Basit et al., 2020) but similar to in 35 LMICs (7.5%) (Marcus et al., 2021), The prevalence of low HDL-C (74.0%) in this survey was higher than in the previous two surveys in Jordan (59.5% in 2017 and 40.1% in 2006) (Abujbara et al., 2018; Khader et al., 2010), higher than in Turkey (41.5%) (Bayram et al., 2014) and the Yangon Region, Myanmar (53.4%) (Htet et al., 2017), but lower than in the Sylhet region, Bangladesh (78.8%) (Kathak et al., 2022), and in Pakistan (87.4%) (Basit et al., 2020). Some of these prevalence differences may be attributed to the use of different cut-off po.

According to previous research (Gebreegziabiher et al., 2021; Pan et al., 2016; Bayram et al., 2014; Xi et al., 2020; Zhang et al., 2017; Tripathy et al., 2017), overweight, obesity, and diabetes increased the odds, and moderate physical activity decreased the odds of dyslipidemia in both sexes. The tendency to have a higher prevalence of dyslipidaemia with higher levels of BMI can be attributed to "global metabolic effects of insulin resistance and an excess of visceral fat." (Chan et al., 2016). A nutritional transition in Jordan (Mehio Sibai et al., 2010) may have led to the high prevalence of overweight or obesity (43.3%) found, increasing the risk of dyslipidaemia. Unlike some previous (Abujbara et al., 2018; Pan et al., 2016; Xi et al., 2020; Zhang et al., 2017; Tripathy et al., 2017; Liu et al., 2020; Diarz et al., 2020; Kjøllesdal et al., 2016), we did not find associations between sex, age, residence status, hypertension, cardiovascular disease, smoking, alcohol use, dietary pattern and dyslipidaemia.

Factors associated with high TC in this study included older age, and female sex. In previous studies (Abujbara et al., 2018; Basit et al., 2020; Tripathy et al., 2017; Huang et al., 2021; Malta et al., 2019), older age, female sex, lower education, hypertension, diabetes, and obesity were associated with high TC. Factors associated with high TG in this study included older age, living in the Northern Region, overweight, obesity, diabetes, and physical inactivity. In previous studies (Abujbara et al., 2018; Basit et al., 2020; Tripathy et al., 2017; Huang et al., 2021), male sex, higher education, hypertension, diabetes, obesity, and smoking or current tobacco use were associated with high TG. Factors associated with low HDL-C in this study included overweight and obesity. In previous studies (Abujbara et al., 2018; Huang et al., 2021; Erem et al., 2008), increased age, hypertension, diabetes, obesity, and smoking were associated with low HDL-C. Factors associated with high LDL-C in this study included older age, and higher education. In previous studies (Abujbara et al., 2018; Huang et al., 2021), hypertension, diabetes, and obesity were associated with high LDL-C.

The prevalence of awareness of dyslipidemia (9.3%), treatment (50.3%), and control (25.4%) was lower in terms of awareness in the 35 LMIC study (31/36%) but higher in terms of treatment and control (29/

Table 3
Associations with prevalence of dyslipidemia.

Variable	Subcategory	Male	Female	Both sexes
		AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age (years)	18–44	1 (Reference)	1 (Reference)	1 (Reference)
	45–69	1.11 (0.61, 2.04)	1.20 (0.70, 2.06)	1.15 (0.74, 1.77)
Gender	Female			1 (Reference)
	Male			0.91 (0.62, 1.35)
Education (in years)	0–6	1 (Reference)	1 (Reference)	1 (Reference)
	7–11	2.26 (0.83, 6.16)	1.24 (0.69, 2.23)	1.61 (0.90, 2.88)
	≥12	0.94 (0.35, 2.56)	0.97 (0.54, 1.75)	0.94 (0.53, 1.66)
Nationality	Syrian	1 (Reference)	1 (Reference)	1 (Reference)
	Jordanian	1.18 (0.63, 2.21)	1.35 (0.92, 1.99)	1.28 (0.89, 1.85)
Residence	Rural	1 (Reference)	1 (Reference)	1 (Reference)
	Urban	1.14 (0.54, 2.44)	0.98 (0.58, 1.65)	1.10 (0.70, 1.72)
Region	Center	1 (Reference)	1 (Reference)	1 (Reference)
	North	1.33 (0.68, 2.58)	1.12 (0.72, 1.75)	1.18 (0.79, 1.77)
	South	2.22 (0.47, 10.62)	0.97 (0.54, 1.75)	1.63 (0.52, 5.12)
Body Mass Index	Normal/ Underweight	1 (Reference)	1 (Reference)	1 (Reference)
	Overweight	2.30 (1.18, 4.46)*	2.25 (1.36, 3.74)**	2.14 (1.49, 3.36)***
	Obesity	2.17 (0.89, 5.30)	2.86 (1.70, 4.81)***	2.47 (1.55, 3.94)***
Hypertension	No	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.06 (0.49, 2.30)	1.44 (0.92, 2.25)	1.12 (0.71, 1.78)
Diabetes	No	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	4.42 (1.16, 16.83)*	1.12 (0.53, 2.36)	2.63 (1.30, 5.34)**
Cardiovascular disease	No	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.21 (0.45, 3.27)	0.83 (0.44, 1.57)	0.79 (0.40, 1.55)
Physical activity	Low	1 (Reference)	1 (Reference)	1 (Reference)
	Moderate	0.34 (0.16, 0.71)**	0.84 (0.49, 1.45)	0.60 (0.37, 0.95)*
	High	0.49 (0.25, 0.98)*	1.03 (0.67, 1.59)	0.70 (0.48, 1.03)
Fruit/Vegetable intake	≥5 servings	1 (Reference)	1 (Reference)	1 (Reference)
	<5 servings	1.39 (0.62, 3.14)	0.94 (0.59, 1.49)	1.23 (0.76, 1.98)
Always/often salt with food	No	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.38 (0.74, 2.60)	1.13 (0.74, 1.72)	1.37 (0.93, 2.01)
Always/often processed food high in salt	No	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.41 (0.68, 2.91)	0.88 (0.57, 1.37)	0.99 (0.68, 1.44)
Current smoking	No	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.44 (0.80, 2.60)	1.31 0.87, 1.98)	1.32 (0.83, 2.08)
Ever alcohol use	No	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	2.01 (0.62, 6.51)	1.60 (0.57, 4.49)	1.96 (0.55, 7.02)

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; COR = Crude Odds Ratio; AOR = Adjusted Odds Ratio; CI = Confidence Interval.

33%, and 7/19%, respectively) (Marcus et al., 2021). Awareness was also much lower than in China (31.0%), but treatment (19.5%) and control (8.9%) was higher than in China (Pan et al., 2016). In particular, the low awareness of dyslipidaemia emphasizes the need for opportunistic screening in Jordan. Consistent with previous results (Marcus et al., 2021; Zhang et al., 2017; Opoku et al., 2021), older age, overweight, obesity, hypertension, diabetes, cardiovascular disease, and physical inactivity were associated with increased awareness of dyslipidaemia in this study. The association between general obesity and awareness of dyslipidaemia may be attributed to lipids being part of weight management, yet overweight and obesity were negatively associated with dyslipidaemia treatment. Similar results were found for dyslipidemia control in China, highlighting the greater difficulty of dyslipidemia control among obese compared to people of normal weight (Opoku et al., 2021). Compared to Syrians, Jordanians had a higher rate of treatment, which emphasizes the need to increase treatment services for Syrians.

In this study, overweight and obesity, having diabetes, and low physical activity were significantly associated with the increased risk of dyslipidaemia. As all are modifiable risk factors, it is crucial to administer interventions in health behavior on the identified risk factors (Obsa et al., 2022). In addition to physical activity, dietary interventions are crucial by substituting unprocessed meat for plant proteins, low saturated fat, and animal proteins (Zhubi-Bakija et al., 2021). The recommended "daily allowances (RDAs) for total fiber intake for men and women aged 19–50 are 38 g/day and 25 g/day, respectively." (Soliman, 2019) "All adults should consume a healthy diet that emphasizes the intake of vegetables, fruits, nuts, whole grains, lean vegetable or animal protein, and fish and minimizes the intake of trans fats, red meat and processed red meats, refined carbohydrates, and sweetened beverages. For adults with overweight and obesity, counseling and caloric restriction are recommended to achieve and maintain weight loss. Adults should engage in at least 150 min per week of accumulated moderate-intensity physical activity or 75 min per week of vigorous-intensity physical activity" (Arnett et al., 2019).

The strengths of the study include the use of a large nationally representative sample and the standardized STEPS methodology and measures. Some variables were evaluated by self-report, which may have biased responses, and the cross-sectional design precludes causative conclusions between the evaluated variables. Familial hyperlipidemia and specific diet behaviors were not evaluated and should be included in future research. Due to the low prevalence of control of dyslipaedimia in this study, no determinants were estimated. A further limitation was that the response rate for Step 3 of the survey (which included lipid analysis) was low (63%), which may have further biased responses.

5. Conclusions

Four in five adults in Jordan had dyslipidaemia and less than one in ten were aware. Several factors, including sociodemographic and health factors, were identified for the prevalence, awareness, and treatment of dyslipidemia. The high prevalence and low awareness of dyslipidaemia

Table 4
Associations with prevalence of dyslipidemia subcategories.

Variable	Subcategory	High TC AOR (95% CI)	High TG AOR (95% CI)	Low HDL-C AOR (95% CI)	High LDL-C AOR (95% CI)
Age (years)	18–44	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	45–69	2.30 (1.45, 3.65)***	1.48 (1.09, 2.01)*	0.84 (0.60, 1.18)	2.08 (1.30, 3.33)**
Gender	Female	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Male	0.47 (0.30, 0.74)***	1.22 (0.87, 1.70)	1.25 (0.88, 1.78)	0.87 (0.54, 1.38)
Education (in years)	0–6	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	7–11	1.36 (0.82, 2.26)	0.97 (0.67, 1.41)	1.29 (0.82, 2.05)	2.10 (1.21, 3.64)**
	≥12	1.26 (0.76, 2.10)	0.73 (0.50, 1.07)	0.87 (0.59, 1.30)	2.06 (1.23, 3.44)**
Nationality	Syrian	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Jordanian	0.91 (0.62, 1.32)	1.11 (0.83, 1.49)	1.34 (1.00, 1.79)	0.98 (0.65, 1.47)
Residence	Rural	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Urban	1.24 (0.74, 2.06)	1.01 (0.70, 1.46)	1.19 (0.79, 1.81)	1.24 (0.69, 2.22)
Region	Center	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	North	1.00 (0.65, 1.54)	1.44 (1.02, 2.02)*	1.30 (0.93, 1.82)	0.85 (0.53, 1.37)
	South	1.17 (0.47, 2.91)	1.43 (0.90, 2.29)	1.83 (0.78, 4.31)	0.76 (0.31, 1.86)
Body Mass Index	Normal/Underweight	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Overweight	1.77 (0.94, 3.36)	2.51 (1.67, 3.77)***	1.69 (1.16, 2.48)**	1.67 (0.83, 3.35)
	Obesity	1.36 (0.76, 2.45)	3.60 (2.36, 5.50)***	2.03 (1.37, 3.02)***	1.48 (0.80, 2.72)
Hypertension	No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.44 (0.92, 2.25)	1.13 (0.81, 1.56)	0.84 (0.59, 1.20)	1.11 (0.70, 1.76)
Diabetes	No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.12 (0.53, 2.36)	3.03 (1.93, 4.75)***	1.59 (0.96, 2.64)	1.03 (0.45, 2.38)
Cardiovascular disease	No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	0.83 (0.44, 1.57)	0.69 (0.44, 1.09)	0.89 (0.54, 1.48)	0.76 (0.38, 1.51)
Physical activity	Low	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Moderate	0.84 (0.49, 1.45)	0.66 (0.45, 0.97)*	0.78 (0.51, 1.20)	0.75 (0.40, 1.39)
	High	1.03 (0.67, 1.59)	0.79 (0.56, 1.10)	0.83 (0.60, 1.14)	0.91 (0.57, 1.45)
Fruit/Vegetable intake	≥5 servings	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	<5 servings	0.94 (0.59, 1.49)	0.91 (0.64, 1.29)	1.29 (0.86, 1.93)	0.87 (0.51, 1.48)
Always/often salt with food	No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.13 (0.74, 1.72)	0.98 (0.71, 1.34)	1.26 (0.92, 1.73)	1.20 (0.75, 1.93)
Always/often processed food high in salt	No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	0.88 (0.57, 1.37)	0.92 (0.65, 1.28)	0.96 (0.69, 1.34)	0.86 (0.53, 1.40)
Current smoking	No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.31 (0.87, 1.99)	1.30 (0.94, 1.79)	1.06 (0.76, 1.49)	1.00 (0.62, 1.61)
Ever alcohol use	No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
	Yes	1.60 (0.57, 4.89)	1.75 (0.90, 3.39)	0.93 (0.42, 2.09)	0.79 (0.22, 2.84)

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; AOR = Adjusted Odds Ratio; CI = Confidence Interval.

Table 5
Associations with prevalence of dyslipidemia awareness and treatment.

Variable	Subcategory	Awareness AOR (95% CI)	Treatment AOR (95% CI)
Age (years)	18–44	1 (Reference)	1 (Reference)
	45–69	4.01 (2.31, 6.96)***	1.47 (0.52, 4.21)
Gender	Female	1 (Reference)	1 (Reference)
	Male	1.41 (1.15, 3.81)	1.88 (0.75 4.69)
Education (in years)	0–6	1 (Reference)	1 (Reference)
	7–11	1.27 (0.73, 2.19)	1.43 (0.56, 3.63)
	≥12	1.42 (0.89, 2.25)	0.72 (0.28, 1.88)
Nationality	Syrian	1 (Reference)	1 (Reference)
	Jordanian	0.99 (0.63, 1.55)	3.04 (1.36, 6.79)**
Residence	Rural	1 (Reference)	1 (Reference)
	Urban	1.52 (0.82, 2.81)	0.73 (0.23, 2.38)
Region	Center	1 (Reference)	1 (Reference)
	North	0.77 (0.49, 1.22)	1.06 (0.46, 2.46)
	South	1.11 (0.56, 2.20)	1.95 (0.43, 8.84)
Body Mass Index	Normal/	1 (Reference)	1 (Reference)
	Underweight	3.71 (1.80, 7.63)***	0.14 (0.03, 0.66)*
	Overweight	4.67 (2.19, 9.97)***	0.11 (0.02, 0.50)**
	Obesity		
Hypertension	No	1 (Reference)	1 (Reference)
	Yes	4.34 (2.72, 6.90)***	2.29 (0.90, 5.81)
Diabetes	No	1 (Reference)	1 (Reference)
	Yes	2.67 (1.55, 4.60)***	3.41 (1.40, 8.27)**
Cardiovascular disease	No	1 (Reference)	1 (Reference)
	Yes	2.22 (1.22, 4.05)**	2.06 (0.81, 5.28)
Physical activity	Low	1 (Reference)	1 (Reference)
	Moderate	0.47 (0.24, 0.92)*	2.15 (0.73, 6.33)
	High	0.85 (0.51, 1.39)	0.84 (0.37, 1.90)
Fruit/Vegetable intake	≥5 servings	1 (Reference)	1 (Reference)
	<5 servings	1.29 (0.72, 2.31)	1.34 (0.45, 3.98)
Always/often salt with food	No	1 (Reference)	1 (Reference)
	Yes	1.29 (0.72, 2.31)	1.22 (0.53, 2.80)
Always/often processed food high in salt	No	1 (Reference)	1 (Reference)
	Yes	1.45 (0.90, 2.34)	0.70 (0.30, 1.62)
Current smoking	No	1 (Reference)	1 (Reference)
	Yes	1.17 (0.72, 1.89)	0.95 (0.41, 2.20)
Ever alcohol use	No	1 (Reference)	1 (Reference)
	Yes	1.46 (0.64, 3.33)	0.53 (0.14, 2.01)

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; AOR = Adjusted Odds Ratio; CI = Confidence Interval.

in Jordan warrants enhanced public health interventions, including screening, better diagnosis, treatment, and control of dyslipidemia.

6. Data sharing statement

The data source is publicly available at the World Health Organization NCD Microdata Repository (URL: https://extranet.who.int/ncdsmicrodata/index.php/catalog).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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