Evaluation of dyslipidemia based on ATP Ⅲ guideline in adults of southwest Iran: A population-based study

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Research Article

Additional Declarations: No competing interests reported.

Abstract

Background

Dyslipidemia is a main risk factor for cardiovascular disease. The prevalence of dyslipidemia was 22.6–81% across Africa, South East Asia, Europe, the Americas and Iran. We aimed to investigate the occurrence of dyslipidemia and its associated risk factors in the southwest region of Iran.

Methods

This population-based cross-sectional study was conducted on 9846 participants aged 35–70 years of the Hoveyzeh Cohort Study in southwest Iran during 2016–2018. Information on socioeconomic factors, demographic characteristics, comorbidities, laboratory tests, anthropometric measurements, and lifestyle was collected. The criteria for dyslipidemia were based on the ATP III classification for adults. The chi-square test was used for analysis. Also, multiple logistic regression was used to control the potential confounders.

Results

Among 9846 participants, the mean ± SD of age was 48.8 ± 9.2 years, and 59.1% of them were women. The overall prevalence of dyslipidemia was 43.5%, and abnormal HDL, LDL, TC, and TG were 17.9%, 21.8%, 36.2%, and 44%, respectively. The multiple logistic regression showed that male (OR=1.92, 95%CI: 1.74 – 2.14), obese participants (OR 3.0, 95%CI: 2.02–4.45), low physical activity (OR 0.80, 95%CI: 0.76–0.97), smokers (OR 1.17, 95%CI: 1.05 – 1.31), rich people (OR 1.19, 95%CI: 1.04–1.36), and diabetic patients (OR 1.63, 95%CI: 1.47 – 1.80) had a higher odds of dyslipidemia (all P-values were < 0.05).

Conclusion

Our findings suggest that dyslipidemia is a complex condition that is influenced by various biological and lifestyle factors. Different prevention and treatment strategies may be needed for different population subgroups.

Background

Dyslipidemia is a condition characterized by an imbalance of lipids, including cholesterol, low-density lipoprotein cholesterol (LDL-C), triglycerides(TG), and high-density lipoprotein (HDL)(1). It can arise from various factors, such as diet(1), tobacco exposure(2), genetics, age(3), gender(2), alcohol use, diabetes, hypertension, body weight, and abdominal obesity(1).

The prevalence of dyslipidemia varies across different regions of the world, with hypercholesterolemia ranging from 22.6–54% across Africa, South East Asia, Europe, and the Americas (4–6). In Iranian adults, the prevalence of dyslipidemia was found to be 81.0% (80.2–81.9), affecting 84.4% of women and 75.7% of men(7). According to estimates from the World Health Organization (WHO), dyslipidemia, significantly elevated total cholesterol (TC), is responsible for 2.6 million deaths annually and 29.7 million disability-adjusted life years (DALYs) globally(8).

Dyslipidemia is a significant global risk factor for cardiovascular disease and mortality (1). It can lead to premature atherosclerosis, potentially resulting in angina or heart attacks (9). Elevated lipid levels are risk factors for atherosclerosis and can lead to symptomatic coronary artery disease and peripheral arterial disease(10). However, dyslipidemia can be managed through lifestyle changes such as diet and exercise, as well as medications such as statins(1). Therefore, the study of dyslipidemia is essential for improving the prevention, diagnosis, and management of cardiovascular disease and in improving the quality of life for individuals affected by it.

Material and methods

Study design and participants

This population-based cross-sectional study was performed on baseline data of 9846 individuals who participated in the Hoveyzeh Cohort Study (HCS), aged 35–70 years during 2016–2018(11). HCS is a part of the Prospective Epidemiological Research Studies in Iran (the PERSIAN Cohort Study)(12). Inclusion criteria consisted of the age of 35–70 years old, resident of Hoveyzeh, without severe mental disorders, ability to answer the questionnaires without help. We excluded 163 pregnant women and finally, 9846 people were assessed in the analysis.

Dyslipidemia definition and quality control of laboratory

An individual is considered to have dyslipidemia if their lipoprotein levels fall outside of the desirable/optimal ranges for TG, LDL, HDL, and TC. The criteria for dyslipidemia were present in at least one of the above disorders based on the ATP III classification in adults from an individual's lipoprotein levels, which can be obtained by obtaining a complete lipoprotein profile after a 10 to 12-hour fast(13).

The ATP III classification of LDL, total cholesterol, and HDL (mg/dL) was used to determine an individual's risk for coronary heart disease. The cut-offs for LDL, total, and HDL cholesterol (mg/dL) based on the ATP III classification were as follows(13, 14) LDL cholesterol: Optimal: <100 mg/dL; Near optimal/above optimal: 100–129 mg/dL; Borderline high: 130–159 mg/dL; High: 160–189 mg/dL; Very high: ≥190 mg/dL, TC: Desirable: <200 mg/dL; Borderline high: 200–239 mg/dL; High: ≥240 mg/dL, HDL: Low: <40 mg/dL; High: ≥60 mg/dL.

The LDL Cholesterol targets and threshold values for implementing Therapeutic Lifestyle Changes (TLC) and Drug Therapy (DT) varied across different risk categories: CHD or CHD Risk Equivalents (10-year risk

> 20%) (LDL Goal: <100 mg/dL; ≥100 mg/dL: LDL Level at which TLC should be initiated; ≥130 mg/dL: LDL Level at which to contemplate DT, 2 + Risk Factors (10-year risk < 20%) LDL Cholesterol Goals:<130 mg/dL, LDL Level at which TLC should be initiated:≥130 mg/dL; LDL Level at which to contemplate DT 10-year risk 10−20%:≥130 mg/dL; 10-year risk < 10%:≥160 mg/dL), 0−1 Risk Factor: LDL Cholesterol Goals:<160 mg/dL LDL Level at which TLC should be initiated:≥160 mg/dL, LDL Level at which to contemplate DT ≥ 190 mg/dL).

From each participant, 27 cc of blood was drawn. The tubes containing the blood clots were left at room temperature for 30 to 40 minutes before being placed in a centrifuge under a Class II laminate laboratory hood. During this time, the serum was separated from the rest of the blood. Then, the clot tubes were placed in the centrifuge (Sigma, Germany) and spun at 3000 rpm for 10 to 15 minutes. The levels of serum required were measured using the BT 1500 autoanalyzer (Biotecnica Instruments, Italy). Normal and pathogen control serum samples were defined and tested on the BT 1500 device. The results of the control serum samples were evaluated using the Westgard and Levy Jennings quality control chart. From this data, the mean and standard deviation (SD) were calculated. A Levy Jennings chart was created with the warning limits set at x + 2SD and the control limits set at x + 3SD. The percent coefficient of variation (CV) was determined by multiplying the SD by 100 and dividing it by the mean value of the results in a set of replicated measurements. A smaller CV indicates higher precision. The biochemical tests for Cholesterol, TG (GPO-PAP), HDL (IMMUNO), and FBS were performed using quantitative diagnostic kits from Pars Azmoun company in Iran and analyzed using the BT 1500 autoanalyzer (Biotecnica Instruments, Italy).

Data collection

Demographic variables, including age groups: 35−39, 40−44, 45−49, 50−54, 55−59, 60−64, and ≥ 65 years; gender: males and female; place of residence: urban or rural; the educational levels: illiteracy, primary school, secondary school, high school diploma, and university); Body mass index (BMI): <18.5 underweight, 18.5−24.9 normal weight, 25.0-29.9 overweight, and ≥ 30 obesity was collected. Additionally, the physical activity score based on the Metabolic Equivalent Task (MET) was divided into quartiles(Q1-Q4), and a smoker is defined as an individual who has consumed a minimum of 100 cigarettes throughout their lifetime (Yes, No). Furthermore, the Wealth Index utilized in this study serves as a household's assets. This index is calculated by considering various factors, such as the ownership of certain assets, including televisions, bicycles, cars, and computers, among others. The calculated wealth scores were subsequently transformed into five quintiles, ranging from the poorest to the richest categories. The Framingham risk score (FRS) was utilized to evaluate the risk of cardiovascular disease (CVD), taking into account six coronary risk factors such as age (in years), gender (male/female), TC (in mg/dl), HDL-cholesterol (in mg/dl), systolic blood pressure (in mm Hg), and smoking habits (Yes/No). To calculate the FRS, the following thresholds were considered: TC < 160, 160−199, 200−239, 240−279, and ≥ 280 mg/dL; for systolic blood pressure: <120, 120−129, 130−139, 140−159, and ≥ 160 mmHg; and for HDL-C: <40, 40−49, 50−59, and ≥ 60 mg/dL. The total points determined the ten-year risk in percentage scored (1 point = 6%, 2 points = 8%, 3 points = 10%, 4 points = 12%, 5 points = 16%, 6 points = 20%, 7

points = 25%, 10 points or more > 30%). Based on the total score, the risk of CVD over ten years was categorized into three groups: low risk (< 10%), intermediate risk (10–20%), and high risk (> 20%) of developing CVD within 10 years(15).

Data analysis

In Descriptive statistics, means and standard deviations for quantitative data and frequency and percent for categorical variables were applied. The Chi-square test was performed to evaluate the association between two categorical variables. The logistic regression model was used to evaluate the determinants of dyslipidemia, controlling for the potential confounders. Variables with $P < 0.25$ in the univariate regression analysis were entered into the multiple logistic analyses. All the reported p-values were based on two-tailed tests and compared to a significance level of 0.05. IBM® SPSS® Statistics 24.0 was used for the statistical analysis.

Results

Among 9846 participants, the mean ± SD of age was 48.8 ± 9.2 years, and 59.1% of them were women. The overall prevalence of dyslipidemia was 43.5% (CI 95%:42.51–44.48), 52.7% (n = 2122) in men and 37.1% (n = 2160) in women (. The mean levels of triglyceride, LDL-c, and HDL-c were 149.0 ± 70.0 mg/dL, 127.2 ± 34.5 mg/dL, and 41.9 ± 11.4 mg/dL, respectively.

The prevalence of dyslipidemia was significantly higher in men, the elderly, those with higher education levels, married, the obese, urban residents, smokers, rich people, participants with less physical activity, and individuals with diabetes or hypertension. (Table 1).

Table 1
Basic characteristics of the participants by dyslipidemia status.

Variables		Dyslipidemia		
		No n (%)	**Yes** n (%)	**P-value**
Age	35−39	1,068 (19.2)	789 (18.4)	0.009*
	40−44	1,173 (21.1)	821 (19.2)	
	45−49	1,004 (18.0)	769 (18.0)	
	50−54	810 (14.6)	653 (15.2)	
	55−59	664 (11.9)	606 (14.2)	
	60−64	458 (8.2)	325 (7.6)	
	>=65	387 (7.0)	319 (7.4)	
Sex	Male	1,904 (34.2)	2,122 (49.6)	< 0.001*
	Female	3,660 (65.8)	2,160 (50.4)	
Education level	Illiterate	3,626 (65.2)	2,467 (61.9)	< 0.001*
	Primary school	879 (15.8)	758 (17.7)	
	Secondary school	335 (6.0)	331 (7.7)	
	High school diploma	357 (6.4)	376 (8.8)	
	University	367 (6.6)	350 (8.2)	
Marital State	Single	219 (3.9)	124 (2.9)	0.011*
	Married	4,829 (86.8)	3,792 (88.6)	
	Widow	413 (7.4)	304 (7.1)	
	Divorced	103 (1.9)	62 (1.4)	
BMI	Underweight	111 (2.0)	35 (0.8)	< 0.001*
	Normal	1,439 (25.9)	778 (18.2)	
	Overweight	1,965 (35.3)	1,691 (39.5)	
	Obese	2,049 (36.8)	1,778 (41.5)	
Residence Type	Urban	3,310 (59.5)	2,767 (64.6)	< 0.001*
	Rural	2,254 (40.5)	1,515 (35.4)	

Variables		Dyslipidemia		
		No n (%)	Yes n (%)	P-value
Smoking	Nonsmoker	4,552 (81.8)	3,218 (75.2)	< 0.001*
	Smoker	1,012 (18.2)	1,064 (24.8)	
Wealth score	Poorest	1,203 (21.6)	759 (17.7)	< 0.001*
	Poor	1,170 (21.0)	830 (19.4)	
	Moderate	1,086 (19.5)	871 (20.3)	
	Rich	1,042 (18.7)	940 (22.0)	
	Richest	1,063 (19.1)	882 (20.6)	
Diabetes	No	4,553 (81.8)	3,091 (72.2)	< 0.001*
	Yes	1,011 (18.2)	1,191 (27.8)	
Hypertension	No	4,184 (75.2)	3,053(71.3)	< 0.001*
	Yes	1,380 (24.8)	1,229 (28.7)	
Physical activity(MET)	Q1	1,251 (22.5)	1,221 (28.5)	< 0.001*
	Q2	1,402 (25.2)	1,051 (24.5)	
	Q3	1,478 (26.6)	975 (22.8)	
	Q4	1,433 (25.8)	1,035 (24.2)	

*P < 0.05 significant for chi-square test

Table 2 shows the frequency and distribution of HDL, LDL, TC, and TG levels by sex. The prevalence of abnormal lipid profiles, including HDL, LDL, TC, and TG, were 17.9% (CI 95%:17.13–18.66), 21.8% (CI 95%:20.99–22.63), 36.2% (CI 95%:35.25–37.16), and 44% (CI 95%:43.01–44.98) respectively.

There was a significant association between HDL levels and sex (p < 0.001). The proportion of individuals with low HDL levels as a risk factor for CVDs was higher among males. Also, a significant relationship between LDL levels and sex was seen (p = 0.009). The frequency of individuals with optimal LDL levels was higher among males. Furthermore, a significant association between TC levels and sex was seen (p < 0.001). The proportion of individuals with desirable TC levels was higher among males. There was a significant relationship between TG levels and sex (p < 0.001). The frequency of individuals with normal TG levels was higher among females, while the proportion of individuals with very high TG levels was higher among males.

Overall, as risk factors for CVDs, higher levels of TC and LDL were seen in women in comparison to men. Vice versa, lower levels of HDL and higher levels of triglyceride were more prevalent in men.

Table 2
The prevalence of dyslipidemia in the participants based on ATP III Classification by gender

Variable		Total N (%)	Female n (%)	Male n (%)	P-value*
HDL					
< 40	Low	1761(17.90)	652(11.2)	1109(27.5)	< 0.001
40−59	Normal	6135(62.30)	3619(62.2)	2516(62.5)	
≥ 60	High	1950(19.80)	1549(26.6)	401(10.0)	
LDL					
< 100	Optimal	4259(43.40)	2464(42.4)	1795(44.8)	0.009
100−129	Near optimal/above optimal	3410(34.70)	2019(34.8)	1391(34.7)	
130−159	Borderline high	1581(16.10)	965(16.6)	616(15.4)	
160−189	High	441(4.50)	274(4.7)	167(4.2)	
≥ 190	Very high	125(1.30)	88(1.5)	37(0.9)	
TC					< 0.001
< 200	Desirable	6282(63.80)	3654(62.8)	2628(65.3)	
200−239	Borderline high	2603(26.40)	1541(26.5)	1062(26.4)	
≥ 240	High	961(9.80)	625(10.7)	336(8.3)	
TG					
< 150	Normal	5514(56.00)	3566(61.3)	1948(48.4)	< 0.001
150−199	Borderline high	1985(20.20)	1125(19.3)	860(21.4)	
200−499	High	2218(22.50)	1086(18.7)	1132(28.1)	
≥ 500	Very high	129(1.30)	43(0.7)	86(2.1)	

# *P < 0.05 significant for chi-square test

The crude and adjusted odds ratios using logistic regression analysis are shown in Table 3. Because the crude odds ratios for all the assessed variables, except age, were statistically significant (p < 0.05); therefore, we excluded age and included the other covariates in the multiple logistic regression model.

Based on the Hosmer–Lemeshow test results, the model's goodness of fit was acceptable (Chi-square = 7.57, df = 8, P = 0.48).

The adjusted odds ratios using the multiple logistic regression models are provided. There was a significant association between sex and dyslipidemia. The odds of having dyslipidemia in men were higher than in women OR = 1.92(1.74–2.14), (p < 0.001). A direct and significant association between BMI and dyslipidemia was seen, so the odds of having dyslipidemia in obese participants were three times higher than in underweight people, OR = 3.00(2.02–4.45), (p < 0.001). There was an inverse and significant association between physical activity level and dyslipidemia. The odds of having dyslipidemia decreased with increasing physical activity levels, so the participants located in quartile 4 of physical activity had 25% lower odds of dyslipidemia than the people in quartile 1, OR = 0.80(0.71–0.90), (p < 0.001). We found an association between smoking and dyslipidemia. The odds of having dyslipidemia were higher in smokers compared to nonsmokers, OR = 1.17(1.05–1.31), (p < 0.001). A significant relationship was seen between diabetes and dyslipidemia. The odds of having dyslipidemia in diabetic patients were higher than in non-diabetic individuals, OR = 1.63(1.47–1.80), (p < 0.001). On the other hand, there were no significant associations between education level, residence type, wealth index, and hypertension with dyslipidemia (p > 0.05). Overall, BMI, sex, and diabetes had the strongest association with dyslipidemia, respectively.

Table 3
Crude and Adjusted odds ratios with 95% CI for dyslipidemia using univariate and multiple logistic regression models

Covariates	Crude OR (CI 95%)	P-value	Adjusted OR (CI 95%)	P-value
Age				
35−44 year	1		-	-
45−54 year	0.87(0.74−1.02)	0.95	-	
55−64	0.95(0.81−1.12)	0.547	-	
≥ 65	1.01(0.85−1.19)	0.940	-	
Sex				
Female	1		1	
Male	1.88(1.74−2.04)	< 001	1.92(1.74−2.14)	< 0.001
Education level				
Illiterate	1		1	
Primary school	1.27(1.14−1.42)	< 001	1.08(0.95−1.22)	0.231
Secondary school	1.45(1.24−1.71)	< 001	1.09(0.92−1.31)	0.324
High school	1.55(1.33−1.81)	< 001	1.15(0.97−1.37)	0.113
University	1.40(1.20−1.64)	< 001	1.01(0.84−1.22)	0.896
BMI				
Underweight	1		1	
Normal	1.72(1.16−2.53)	0.007	1.65(1.11−2.45)	0.014
Overweight	2.73(1.86−4.01)	< 001	2.66(1.80−3.95)	< 0.001
Obese	2.75(1.87−4.05)	< 001	3.00(2.02−4.45)	< 0.001
Residence Type				
Urban	1.24(1.15−1.35)	< 001	1.09(0.99−1.19)	0.080
Rural	1		1	
Physical activity				
Q1	1		1	
Q2	1.35(1.21−1.51)	< 001	0.92(0.81−1.03)	0.143
Q3	1.04(0.93−1.16)	0.519	0.86(0.76−0.97)	0.012*

Covariates	Crude OR (CI 95%)	P-value	Adjusted OR (CI 95%)	P-value
Age				
Q4	0.91(0.82−1.02)	0.118	0.80(0.71−0.90)	< 0.001*
Smoke				
No	1		1	
Yes	1.49(1.35−1.64)	< 001*	1.17(1.05−1.31)	0.006*
Wealth index				
Poorest	1		1	
Poor	1.12(0.99−1.28)	0.071	1.07(0.94−1.22)	0.293
Moderate	1.27(1.12−1.44)	< 001*	1.09(0.95−1.25)	0.209
Rich	1.43(1.26−1.62)	< 001*	1.19(1.04−1.36)	0.011*
Richest	1.32(1.16−1.49)	< 001*	1.01(0.87−1.16)	0.953
Hypertension				
No	1		1	
Yes	1.22)1.12−1.34)	< 001*	1.06(0.96−1.18)	0.238
Diabetes				
No	1		1	
Yes	1.74(1.58−1.91)	< 001*	1.63(1.47−1.80)	< 0.001*

# *P < 0.05 significant for the logistic regression model

Among the major risk factors that modify LDL goals, age (38%), hypertension (26.5%), and smoking (21.1%) had the higher prevalence rates. Furthermore, age (58.2% vs 38%), smoking (40.6% vs 21.1%), and low HDL (27.5% vs 17.9%) were more prevalent risk factors among men compared to women. In comparison, the prevalence of hypertension (28.6% vs 23.4%) and diabetes (22.7% vs 21.9%) were higher among women compared to men (Fig-1).

The participants were classified into three classes based on the number of risk factors and the level of Framingham Risk Score. Most of the patients, 7729(78.5%), were in the group with two or more risk factors and FRS < 20%. Our results showed in the CHD or FRS > 20 categories, 56.5% needed TLC, and 26.8% needed DT. In the FRS ≤ 20% group or the patients with two or more risk factors, about 20% needed TLC and about 8% needed DT. Also, in the patients with 0−1 risk factor or FRS < 10% category, 4.19% needed TLC, and 0.83% needed DT(Fig-2).

Discussion

This study investigated the occurrence of dyslipidemia and its associated risk factors in the southwest region of Iran. The overall prevalence of dyslipidemia was 43.5%, and abnormal HDL, LDL, TC, and TG were 17.9%, 21.8%, 36.2%, and 44%, respectively. The most important factors affecting dyslipidemia were male gender, obese participants, low physical activity, smokers, rich people, and Diabetic patients.

The overall prevalence of dyslipidemia was 43.5% (52.7% in men and 37.1% in women). The Tehran lipid and glucose study in Iranian adults reported the prevalence of dyslipidemia for both sexes, male and female were 63.4%, 66.5% and 61.3% respectively(16). In this study, the odds of experiencing dyslipidemia were found to be higher than in men compared to women. The higher prevalence of dyslipidemia in males may be due to a combination of lifestyle factors, hormonal factors, age, and genetics. Men are more likely to engage in unhealthy behaviors such as smoking and drinking alcohol, which can increase the risk of dyslipidemia (2). Furthermore, testosterone levels have been linked to dyslipidemia, and men generally have higher levels of testosterone than women (17). On the other hand, dyslipidemia tends to increase with age, and men have a higher prevalence of dyslipidemia at younger ages than women(2, 18), Some genetic factors may contribute to the higher prevalence of dyslipidemia in males(19).

We found a direct and significant association between BMI and dyslipidemia. Obesity is a major risk factor for dyslipidemia due to abnormalities in lipid metabolism, insulin resistance, inflammation, and unhealthy lifestyle factors. These factors can contribute to the development of dyslipidemia by altering lipid metabolism and increasing the production of pro-inflammatory cytokines. Obesity is associated with abnormalities in lipid metabolism, including increased levels of triglycerides, low-density lipoprotein cholesterol, and total cholesterol, and decreased levels of high-density lipoprotein cholesterol (20, 21). These abnormalities can contribute to the development of dyslipidemia. Obesity is also associated with insulin resistance, which can lead to dyslipidemia by increasing the production of very low-density lipoprotein and decreasing the clearance of triglyceride-rich lipoproteins(22). Furthermore, obesity is characterized by a chronic low-grade inflammatory state, which can contribute to developing dyslipidemia by altering lipid metabolism and increasing the production of pro-inflammatory cytokines(21, 22). Additionally, obesity is often associated with unhealthy lifestyle factors such as a high-fat diet, lack of exercise, and tobacco use, which can contribute to dyslipidemia(21). In addition to, the presence of a significant association between obesity and dyslipidemia, a biological gradient (dose-response relationship) was also seen in this association, so that, as the BMI categories enhanced, the odds of having dyslipidemia enhanced too. This can increase the probability of a causal relationship according to Hill's criteria for causality.

We found a direct association between smoking and dyslipidemia. It can be due to the disruption of lipid metabolism, oxidative stress and inflammation, unhealthy lifestyle factors, and the duration and intensity of smoking. These factors can contribute to the development of dyslipidemia by altering lipid metabolism and promoting the formation of atherosclerotic plaques. Cigarette smoking has been shown to disrupt

lipid metabolism, leading to an increase in triglyceride and low-density lipoprotein cholesterol levels and a decrease in high-density lipoprotein cholesterol levels (6, 23). Additionally, smoking is associated with increased oxidative stress and inflammation, which can contribute to the development of dyslipidemia by altering lipid metabolism and promoting the formation of atherosclerotic plaques (23). Also, smokers are more likely to engage in unhealthy lifestyle behaviors such as a high-fat diet, lack of exercise, and excessive alcohol consumption, which can further increase the risk of dyslipidemia (24). The risk of dyslipidemia may be influenced by the duration and intensity of smoking, with long-term and heavy smokers having a higher risk than short-term and light smokers(25).

In this study, there was an inverse and significant association between physical activity level and dyslipidemia. Several studies have shown that physical activity can help reduce the risk of dyslipidemia by promoting weight loss (26), increasing HDL cholesterol levels (27), lowering LDL cholesterol levels (27), and improving insulin sensitivity (28).

Our results showed that a significant relationship was seen between diabetes and dyslipidemia. This finding may be explained based on abnormalities in lipid metabolism, insulin resistance, inflammation, and unhealthy lifestyle factors. These factors can contribute to the development of dyslipidemia by altering lipid metabolism and increasing the production of pro-inflammatory cytokines. Diabetes is associated with abnormalities in lipid metabolism, including increased levels of triglycerides, low-density lipoprotein cholesterol, and total cholesterol, and decreased levels of high-density lipoprotein cholesterol (29–31). Additionally, diabetes is also associated with insulin resistance, which can lead to dyslipidemia by increasing the production of very low-density lipoprotein and decreasing the clearance of triglyceride-rich lipoproteins (30). Also, diabetes is characterized by a chronic low-grade inflammatory state, which can contribute to the development of dyslipidemia by altering lipid metabolism and increasing the production of pro-inflammatory cytokines (30). On the other hand, individuals with diabetes are at a higher risk of adopting unhealthy lifestyle habits, including consuming a diet rich in fats, lack of exercise, and tobacco use, all of which can contribute to the development of dyslipidemia(31).

In this study, there were no significant associations between education levels with dyslipidemia. Several studies have investigated the association between education level and dyslipidemia, and the results have needed to be more consistent. Some studies have found significant associations between education and blood lipid levels (32, 33), while others have not. Education level may have a weaker influence on dyslipidemia than other factors such as lifestyle and genetics. Lifestyle factors such as diet and physical activity may play a more critical role in developing dyslipidemia (33). One study found that the association between education and dyslipidemia differed by sex and income level (34). The studies may have used different definitions of dyslipidemia and different cut-off values for lipid levels, which could affect the results (32, 33).

The results of our study did not show a statistically significant relationship between residence types with dyslipidemia. A study in rural and urban China found that the prevalence of dyslipidemia was similar among rural and urban participants(2). Another study of adult residents of Mekelle City, Northern Ethiopia

found that the prevalence of dyslipidemia was unacceptably high among all residents, regardless of their wealth index(35). A study of adults in rural and urban China found that the prevalence of dyslipidemia was similar in participants with low, medium, and high socioeconomic status(36). The reasons for these differences are not entirely clear, but some factors that may contribute include differences in lifestyle, diet, and access to healthcare(2)

In line with our study, studies in Ethiopia and China found no significant association between wealth index and dyslipidemia (2, 37). These findings indicate that while socioeconomic status and wealth index may influence certain health outcomes, the prevalence of dyslipidemia does not consistently show a significant difference based on these factors. Other factors such as lifestyle, diet, and access to healthcare may have a more prominent impact on the prevalence of dyslipidemia in different populations (2, 32).

Our study showed there were no significant associations between hypertension and dyslipidemia. The result of young adults in Poland found that hypertension and dyslipidemia were major risk factors for cardiovascular disease. However, some studies did not find any significant association between the two conditions (38, 39). The prevalence of dyslipidemia and hypertension may show an interplay, but the relationship between the two conditions is complex. Various epidemiological studies have shown the coexistence of dyslipidemia and hypertension in a range of 15 to 31% (39). These findings suggest that while there may not be a direct difference in the prevalence of dyslipidemia and hypertension, there is an interplay between the two conditions (40).

This study had some limitations, including the cross-sectional design, which can only establish associations and not causality. In this study, the family history of hyperlipidemia was not investigated, which should be part of future studies. Furthermore, lifestyle variables, including smoking, physical activity and diet intake, were assessed by self-report, which may have led to response bias. On the other hand, the present study had several strengths. The measurement of dyslipidemia was done with standard equipment and kits based on the valid guidelines of ATPIII, which can reduce measurement errors and improve the accuracy of the prevalence estimates. The accuracy of lipid level measurements can be affected by factors such as the timing of the test, fasting status, and the use of different laboratory methods. Therefore, we used a standard laboratory protocol and laboratory quality control to increase the accuracy of laboratory findings. Our study had a large sample size, which can increase the statistical power and precision of the estimates and representative population, which can enhance the generalized of the results to the broader population. This study was conducted on context longitudinal design. Additionally, we used multivariate analysis to adjust for potential confounding factors, which can increase the validity of the prevalence estimates and identify the independent effects of different risk factors.

Conclusion

These results suggest that dyslipidemia is a complex condition influenced by various biological and lifestyle factors. Different prevention and treatment strategies may be required for various subgroups within the population. The potential implications of the study's findings for developing public health interventions can vary depending on the specific research and its relevance to the population and health issues being addressed. Public health interventions aimed at preventing dyslipidemia may need to focus on other factors, such as lifestyle, diet, and access to healthcare. Policies that promote healthy eating habits, physical activity, and regular health check-ups may effectively reduce the prevalence of dyslipidemia. Additionally, policies promoting health literacy, community-based health programs, and affordable healthcare services may help alleviate the burden of dyslipidemia.

Abbreviations

Low-density lipoprotein cholesterol (LDL-C), Triglycerides(TG), High-density lipoprotein (HDL), World Health Organization (WHO), Total cholesterol (TC), Disability-adjusted life years (DALYs), Hoveyzeh Cohort Study (HCS), Prospective Epidemiological Research Studies in Iran (the PERSIAN Cohort Study), Therapeutic Lifestyle Changes (TLC), Drug Therapy (DT), Coefficient of variation (CV), Body mass index (BMI), Metabolic Equivalent Task (MET), Cardiovascular disease (CVD).

Declarations

Ethics approval and consent to participate

The ethics committee approved the study protocol of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1400.616). This study was conducted based on the Helsinki Declaration and its later amendments. On the registration day, informed written consent was obtained from the study participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that there are no competing interests related to this manuscript.

Funding

Authors' contributions

ZR conceptualized the idea. BCh prepared the design and research instrument. ZR performed the data collection and processing. ZR and BCh carried out data analysis and were a major contributor to the writing of the manuscript. NS, SAH, BCh, SS and SJH interpreted the research data. All authors reviewed the manuscript.

Acknowledgments

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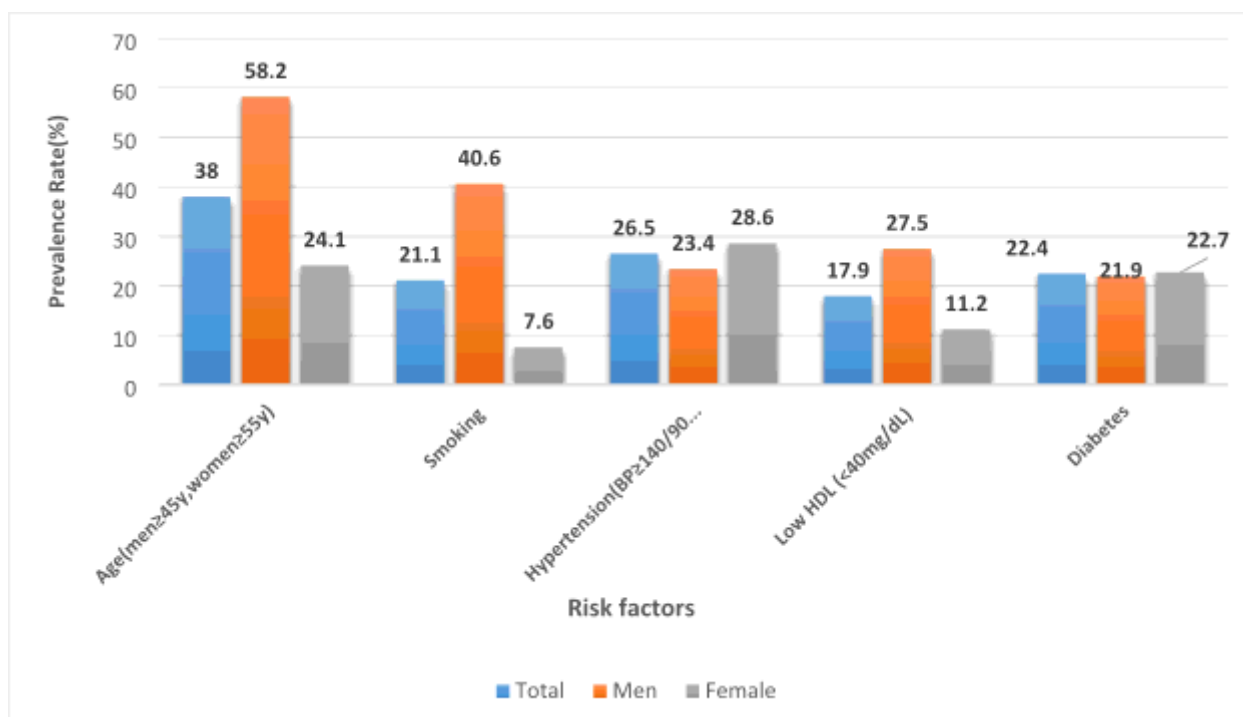
Figures

Figure 1

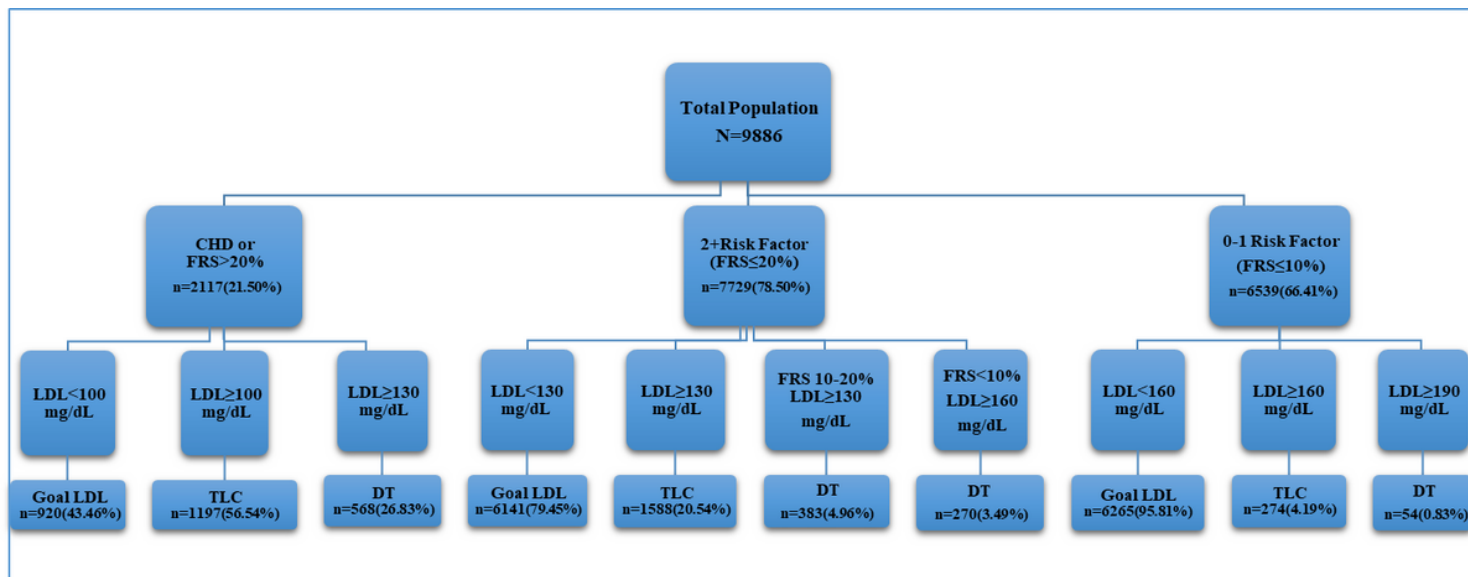Major Risk Factors (Exclusive of LDL Cholesterol) that Modify LDL Goals

Figure 2

LDL Cholesterol Goals and Cut points for Therapeutic Lifestyle Changes and Drug Therapy in Different Risk Categories