Determinants of prevalence, awareness, treatment and control of high LDL-C in Turkey

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ABSTRACT

Objective: High blood cholesterol is one of the main modifiable risk factors for cardiovascular diseases (CVDs). The aim of the study is to determine the factors associated with the prevalence, awareness, treatment, and control of high "low-density lipoprotein-cholesterol" (LDL-C) among adults aged ≥20 years in Turkey.

Methods: We used data from Chronic Diseases and Risk Factors Survey conducted in 2011–2012. The presence of high LDL-C, lipid-lowering treatment eligibility, and achievement of target LDL-C were defined according to the third Adult Treatment Panel guidelines on treatment of high cholesterol. Multivariate logistic regression analyses were performed to determine the associations between participant characteristics and high LDL-C prevalence, awareness, treatment, and control.

Results: Framingham risk score categorization was performed for 13121 individuals aged ≥20 years. Approximately, 28% of the participants presented with high LDL-C. Among those with high LDL-C, 55.8% were aware of their situation; among those aware of high LDL-C, 46.9% were receiving lipid-lowering medication, and 50.6% of individuals who were receiving treatment achieved target LDL-C levels on the basis of their coronary heart disease (CHD) risk. Control of high LDL-C was negatively associated with the presence of diabetes mellitus (odds ratio: 0.36, 95% CI: 0.27–0.49, p<0.001).

Conclusion: Despite the high awareness rates, there was a high proportion of adults who did not receive treatment or achieve recommended levels of LDL-C during treatment. The low treatment and control levels among individuals based on their CHD risk levels call for a better application of recommendations regarding personal preventive measures and treatments in Turkey. *(Anatol J Cardiol 2016; 16: 370-84)*

Keywords: cholesterol, Framingham risk score, Turkey, coronary heart disease

Introduction

Cardiovascular diseases (CVDs) including coronary heart disease (CHD) are the main cause of morbidity and mortality worldwide. It was estimated that approximately 17.5 million people died from CVDs in the year 2012, which represents 30% of all deaths globally (1). According to the World Health Organization, 80% of CVD-related deaths occurred in low- and middle-income countries, and it is projected that the number of these deaths will reach up to 23.6 million by 2030 (1). In Turkey, CVDs are the leading cause of death, and it was reported that 16.7% of years of potential life lost, which is calculated as the difference between the expected age of death and the age of death due to premature mortality, was caused by ischemic heart diseases (2).

Several modifiable risk factors such as smoking, high blood pressure, diabetes mellitus, obesity, and dyslipidemia are well-documented for CVDs (3). According to a recent study, CVD mortality rates declined by approximately 34% in men and 28% in women who were ≥35 years between 1995 and 2008 in Turkey (4). An epidemiological modeling study revealed that 47% of the decrease in mortality rates in Turkey was attributed to treatment in individuals, and population risk factor reductions resulted in a 42% decrease in CHD mortality (5). A study evaluating the global trends in cholesterol levels revealed that mean cholesterol levels did not change significantly during the last two decades in Turkey (6). However, the prevalence of high low-density lipoprotein-cholesterol (LDL-C) ranges between 29% and 50% according to community-based studies in Turkey (7–9).

Several studies have reported that management of dyslipidemia has beneficial effect in both primary and secondary prevention of CVD. It was shown that treatment of high cholesterol can reduce the relative risk of a CVD by 30% over a 5-year pe-

riod; therefore, it is crucial to detect and treat individuals with high LDL-C levels (10). Prevalence of dyslipidemia and trends in cholesterol levels have been assessed in Turkish population; however, information on the awareness, treatment, and control levels of dyslipidemia in the general population based on CHD risk classifications does not exist. Studies from other countries reported that some of the sociodemographic indicators and lifestyle factors were related to the prevalence, awareness, and control of dyslipidemia; however, because of lack of nation-wide studies on this topic, such information is limited in Turkey (11–13). The purpose of the study is to assess the prevalence, awareness, treatment, and control of high LDL-C among adults in Turkey and identify the characteristics associated with these indicators.

Methods

We used data from the Chronic Diseases and Risk Factors Survey, 2011, conducted by the Ministry of Health. The methodology and descriptive findings of the survey have been described earlier (14).

The sample size was estimated to determine 1% prevalence with 0.15% deviation, and the smallest sample size was calculated as 16622 for the survey. Participants aged ≥15 years were randomly sampled from a population that was registered with family physicians in Turkey. Two individuals from each family physician were randomly sampled by the Turkish Statistical Institute using registration records, and these selected individuals were invited to the Family Health Centre (n=40088). In the survey, 18477 (46.1%) individuals completed the questionnaire and 14887 (37.1%) had their blood sampled.

Consent form explaining the study was provided to individuals, and the participants were informed that the data will be confidential. After obtaining participants' written consent, the survey questions were administered electronically. The required physical examination, anthropometric measurements, and blood pressure measurements were made by family practioners (FPs), and blood sample was obtained for laboratory measurements. The biochemical analyses for blood glucose and lipids were conducted in public health laboratories that are administered by the Ministry of Health on blood samples obtained from the participants after at least 8 h of overnight fasting. LDL-C was calculated using the Friedewald equation. Plasma glucose concentrations were measured using the hexokinase method. The entire process was controlled by the Ministry of Health. This study was based on secondary analysis of data with no participant identifiers from the 2011 Chronic Diseases and Risk Factors Survey, which is freely available upon request from Ministry of Health; therefore, it is not possible to trace any of the data to the actual individual. Thus, formal ethical clearance was not required.

Dependent variables
The dependent variables were prevalence, awareness, treatment, and control of high LDL-C. Cholesterol measurements were obtained from 14887 participants aged >15 years in the study. Before analyzing the data, extreme values for each observation or measurement were dropped from the dataset. In addition, individuals in the 15–19 years age group were not included because Framingham risk score (FRS) equation does not cover this age group; as a result, data from 13121 individuals were used in the analysis. Individuals were considered to have high LDL-C if they had a previous diagnosis by a physician, were currently using lipid-lowering medications, or had a high LDL-C level in the blood sample. In the classification of LDL-C levels, American National Cholesterol Education Program (NCEP) and the third Adult Treatment Panel's (ATP III) criteria were used (15). Briefly, 10-year CHD risk was estimated using Framingham risk equation (15). The Framingham risk score was calculated using information on age, gender, total cholesterol, and high-density lipoprotein-cholesterol (HDL-C), smoking status, systolic blood pressure level, and treatment status for hypertension. Participants were then placed into a risk category (<10% as low risk, 10%–20% as intermediate risk, and >20% as high risk) to determine the qualification for lipid-lowering medication on the basis of the NCEP/ATP III treatment initiation thresholds. Individuals with CHD risk equivalent conditions such as DM or stroke were considered as having a high risk. Awareness of high cholesterol was defined by a confirmative response of the participants to the question "Have you ever been told by a physician that your blood cholesterol level was high?" and participants who answered "yes" were categorized as being aware of having high cholesterol.

Treatment involved current use of lipid-lowering medication, and it was defined by a positive answer to the question "Are you taking a lipid-lowering medication to treat high cholesterol?"

Among participants taking lipid-lowering medication, individuals were considered as having controlled LDL-C level if their LDL-C level was below the CHD risk-specific treatment goal according to NCEP/ATP III guideline. The target LDL-C values for high, intermediate, and low CHD risk categories were <100 mg/dL, <130 mg/dL, and <160 mg/dL, respectively. Control was evaluated only among individuals with high LDL-C levels or those receiving lipid-lowering medication. Definitions for high LDL-C and controlled LDL-C are summarized in Table 1.

Independent variables
The independent variables included sociodemographic characteristics, health variables, lifestyle factors, and anthropometric measurements. Sociodemographic characteristics included age, gender, marital status, educational level, area of residence, geographical area lived, work status, and insurance status. Participant age was categorized into six age groups (20–29, 30–39, 40–49, 50–59, 60–69, and ≥70 years). Marital status was classified as married, divorced/widowed, and single. Educational level was grouped into three levels of education attained: illiterate/literate, elementary school/secondary school, and high school/university. Rural area was defined as a settlement with a population of less than 20000. Geographical area lived (north, south,

Table 1. LDL-cholesterol thresholds for High LDL-cholesterol and LDL-cholesterol control in subjects as defined by the 2004 National Cholesterol Education Program Adult Treatment Panel III

Risk category	High-LDL-Cholesterolemia	Controlled LDL-C
CHD[a] or CHD Risk Equivalents[b] High risk: (10-year risk >20%)	LDL-C ≥100 mg/dL or use of lipid-lowering medications	LDL-C <100 mg/dL
Intermediate risk: (10-year risk 10%–20%)	LDL-C ≥130 mg/dL or use of lipid-lowering medications	LDL-C <130 mg/dL
Low risk: (10-year risk <10%)	LDL-C ≥160 mg/dL or use of lipid-lowering medications	LDL-C <160 mg/dL
CHD indicates coronary heart disease; LDL-C - low-density lipoprotein cholesterol. [a]CHD includes history of myocardial infarction, unstable angina, stable angina. [b]CHD risk equivalents include carotid artery disease, stroke		

west, east, and central), work status (employed/unemployed), and possessing health insurance (yes/no) formed other sociodemographic characteristics.

Lifestyle variables included smoking status, alcohol intake, and physical activity (PA). Smoking status was classified as non-smoker, ex-smoker, or current smoker. Current smokers were individuals who smoked tobacco at least once a day. Alcohol intake was categorized as nonconsumers and consuming any amount of alcoholic beverage once a month or less and twice or more in a month. Individuals were classified as physically active if they undertook PA on at least 5 days/week and did at least 30 min of moderate-intensity activity and/or walking or vigorous activity (running, swimming, playing soccer, etc.) on at least 3 days/week for at least 20 minutes (16).

Individuals were also asked whether they changed their level of PA during the past 6 months (increased/decreased/no change).

The presence of abdominal obesity was assessed by waist circumference, which is measured as a level midway between the lowest rib and iliac crest. Waist circumference was categorized as high if it was ≥102 cm in men and ≥88 cm in women (17). Health variables consisted of self-reported chronic disease history. Respondents were asked to indicate past or present suffering from CHD, stroke, diabetes, and hypertension. Participants were considered as having CHD if they self-reported history of acute myocardial infarction, angina pectoris, or coronary intervention (angioplasty or coronary artery bypass grafting). Stroke was assessed with the question "Have you ever been told by a physician that you had a stroke? (yes/no)." Transient ischemic attack cases were not taken into consideration in the analysis.

Type 2 diabetes was defined as elevated fasting glucose of ≥126 mg/dL or the use of antidiabetic medication (18). Hypertension was defined as a systolic blood pressure of ≥140 mm Hg or diastolic blood pressure of ≥90 mm Hg or current use of antihypertensive medications. Family history of premature CHD was defined as the presence of CHD in first-degree relative (age of onset <55 years for men and <65 years for women) (15).

Statistical analysis

Data were presented as mean and standard deviation for continuous variables and as number and percentage for categorical variables. Bivariate comparisons were performed using Student's t-test or one-way ANOVA followed by post hoc Bonferroni test for continuous variables, and the chi-square test was used for categorical variables. Multivariate analysis was performed using logistic regression. All independent variables were used in the model, and results were expressed as adjusted odds ratio (AOR) and their 95% confidence interval (CI) for showing the effect of exposure variables on prevalence, awareness, treatment, and control of high LDL-C. To correct provincial differences in response rates in the survey, weights from the survey were used. Weights were calculated using the distribution rates of provinces to the total population and the distribution rates of individuals to the provinces (14). Statistical analyses were performed using SPSS 22.0 (Windows, Chicago, IL, USA), and statistical significance was considered for p value <0.05.

Results

Descriptive statistics

Main characteristics of participants according to sex are summarized in Table 2. Out of the 13121 study subjects, 46.3% (n=6072) were men and 53.7% were women (n=7049). The mean age of men and women was 44.5±15.6 and 44.3±16.0 years, respectively (p=0.875). Men had higher education level than women; 34.1% of men had secondary school or higher degree, whereas only 21.7% of women obtained secondary school or higher degree (p<0.001). More women than men had a risky waist circumference (50.5% versus 25.6% males, p<0.001). On the other hand, smoking rates were much higher among men than among women (39.0% versus 12.9% males, p<0.001). Hypertension was more prevalent in females (30.9% versus 25.1% males, p<0.001). Diabetes mellitus was more prevalent among women (12.2%) than among men (11.2%), but the difference between genders was insignificant. Family history of CHD (22.9%) and physical inactivity (93.8%) were significantly more prevalent among women than among men (19.7% and 86.2%, respectively). Conversely, men had a higher rate of CHD (5.3%) than women (2.6%) (p<0.001). In the study population, 20.4% of men and 14.6% of women, in total 2269 participants (17.3%), had a high risk (10-year risk >20%, CHD or CHD risk equivalent). Overall, 9840 (75.0%) participants had low risk (FRS <10%), and 1012 (7.7%) had intermediate risk (FRS=10%–20%).

Mean LDL-C and HDL-C values

Mean levels of LDL-C and HDL-C stratified by gender and independent variables are presented in Table 3. The mean LDL-

Table 2. Characteristics of Study Subjects in Turkey, 2011

Variables	Male n=6072	Female n=7049	P*
Age, years	44.5±15.6	44.3±16.0	0.875
Marital status,%			
Married	81.0	74.4	
Divorced-widowed	4.2	14.5	<0.001
Single	14.7	11.1	
Education,%			
Iliterate/Literate	7.3	25.9	
Elementary/Secondary school	58.6	52.3	<0.001
High school or university degree	34.1	21.7	
Social security, %	90.0	92.8	<0.001
Urban,%	69.1	71.8	0.001
Region,%			
West	49.2	50.3	
South	14.2	15.3	
Central	13.0	12.2	0.124
North	10.5	10.2	
East	13.0	12.1	
Smoking,%			
Current	39.0	12.9	<0.001
Ex-smoker	16.4	4.3	
Non-smoker	44.6	82.9	
Alcohol,%			
None	75.1	95.7	
Once a month or less	14.5	3.2	<0.001
2 times or more	10.3	1.1	
Physical inactivity,%	86.2	93.8	<0.001
Change in physical activity,%			
Not changed	85.7	81.5	
Decreased	7.0	8.7	<0.001
Increased	7.3	9.8	
Waist circumference,			
Males>102 cm, Females>88 cm,%	25.6	50.5	<0.001
Hypertension,%	25.1	30.9	<0.001
CHD, %	5.3	2.6	<0.001
Stroke, %	1.4	1.6	0.211
Diabetes, %	11.2	12.2	0.089
Family history of CHD, %	19.7	22.9	<0.001
Framingham risk categories, %			
<10	65.4	83.2	
10–19	14.1	2.3	<0.001
≥20	20.4	14.6	

n - number of participants; *Student's t-test or chi-square test was used; CHD - coronary heart disease

C value increased with age in both women and men. Highest values were observed in the 50–59 age group in men (118.9±38.4 mg/dL) and the 60–69 age group in women (125.7±37.1 mg/dL). The mean LDL-C values were significantly lower among women in the 20–29 and 30–39 age groups than in men in the same age groups (p<0.05). However, after the age of 50, women had significantly higher mean LDL-C values than men. Mean LDL-C was not statistically different between genders in the 40–49 age group (Fig. 1).

Prevalence

The prevalence, awareness, treatment, and control rates of high LDL-C according to socio-demographic, lifestyle, and medical characteristics of individuals are summarized in Table 4. Based on CHD risk-specific LDL-C thresholds, the prevalence of high LDL-C was 26.7% in females, 29.5% in males, and 28.0% overall (p<0.001). LDL-C increased with age from 4.5% in the 20–29 age group to 58.5% in ≥70 age group (p<0.001). High LDL-C was more prevalent among divorced/widowed [59.2% versus 29.3% (married), p<0.001], ones with social insurance [29.2% versus 15.5% (without insurance), p<0.001], and illiterate/literate [41.2% versus 22.6% (high school/university), p<0.001]. Individuals who do not consume alcohol had lower rates of high LDL-C (27.6%) than individuals who consume alcohol at least twice a month (34.9%, p<0.001). In addition, none or low level of PA [28.5% versus 23.4% (moderate or high PA), p<0.001], decreasing PA level during last 6 months [31.1% versus 23.1% (increasing PA), p<0.001], high waist circumference [39.8% versus 20.5% (normal), p<0.001], and living in southern part of Turkey [31.5% versus24.5% (eastern region)] were related with higher rates of high LDL-C. Similarly, the prevalence of high LDL-C was significantly higher among individuals with personal history of CHD (73.8%), stroke (76.0%), and diabetes (78.5%) and family history of CHD (33.7%) compared with their healthy counterparts (26.2%, 27.1%, 21.3%, and 26.5%, respectively, p<0.001). High LDL-C prevalence was 6.6%, 42.2%, and 67.8% in the low, intermediate, and high CHD risk groups, respectively (p<0.001).
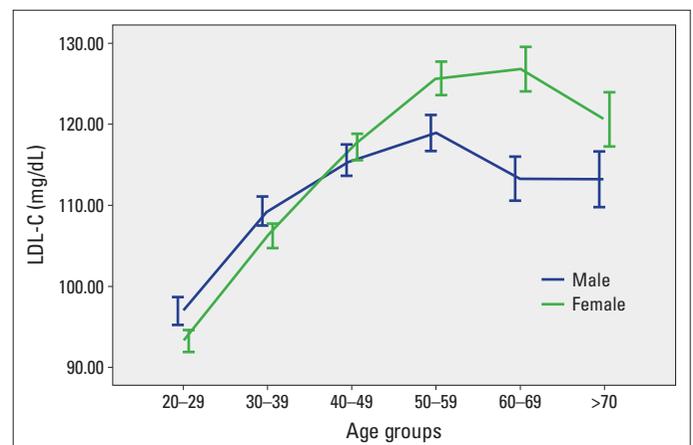

Figure 1. Mean serum LDL-C levels by age and gender

Table 3. Mean values of LDL-cholesterol and HDL-cholesterol in Turkey-2011

Variables	LDL-C, mean±SD*		HDL-C, mean±SD*	
	Male	Female	Male	Female
Age	P<0.001	P<0.001	P<0.001	P<0.001
20–29 (I)	97.0±32.01[b,c,d,e]	93.33±28.6[b,c,d,e,f]	43.5±12.6	51.02±13.0
30–39 (II)	109.3±36.8[c,d]	106.2±32.6[c,d,e,f]	41.9±10.9[a,e,f]	50.9±14.0
40–49 (III)	115.6±36.3	117.2±33.8[d,e]	42.3±10.7	49.1±12.7[a,b]
50–59 (IV)	118.9±38.4	125.7±37.1	43.2±14.4	49.5±13.5
60–69 (V)	113.3±36.3[d]	126.81±39.2	44.0±13.9	50.6±14.9
≥70 (VI)	113.2±36.6	121.02±35.7[e]	45.1±11.3	49.4±13.5
Marital status	P<0.001	P<0.001	P=0.003	P<0.001
Married (I)	112.7±36.6	112.8±35.6	42.7±12.1[c]	49.9±13.3[c]
Divorced/Widowed (II)	106.9±32.8	120.9±37.9	43.4±12.2	50.1±14.6[c]
Single (III)	99.1±34.4[b]	97.4±30.9[a,b]	44.2±13.2	53.1±14.4
Education status	P<0.001	P<0.001	P=0.107	P<0.001
Illiterate/Literate	110.4±38.8	118.1±37.9	43.7±13.4	48.3±13.7[b,c]
Primary school or less	108.8±35.5[c]	111.0±35.1[a]	42.7±12.2	50.1±13.1[c]
University degree or higher	113.2±37.4	108.4±34.8[a,b]	43.3±12.2	53.1±13.7
Social security	P<0.001	P<0.001	P=0.795	P=0.463
No	105.5±37.5	112.9±40.2	42.9±12.9	49.9±13.1
Yes	110.9±36.3	106.1±37.6	43.0±12.2	50.1±13.7
Work	P=0.393	P<0.001	P<0.001	P=0.232
Employed	111.0±37.5	108.9±35.5	43.8±13.5	50.6±14.1
Unemployed	110.2±36.0	113.4±36.0	42.6±11.6	50.2±13.4
Physical activity	P=0.845	P=0.195	P=0.866	P=0.291
Moderate	110.5±36.0	112.2±35.9	43.0±12.3	50.2±13.6
None or low	110.3±39.5	114.5±36.9	43.1±11.9	50.9±12.7
Change in PA	P=0.245	P=0.156	P=0.083	P=0.539
Not changed (I)	110.5±36.1	112.3±35.6	43.1±12.5	50.3±13.4
Increased (II)	110.6±36.7	109.6±36.6	42.8±11.3	50.1±14.1
Decreased (III)	107.4±36.8	114.4±35.5	41.9±10.6	50.9±13.0
Smoking	P=0.001	P=0.001	P<0.001	P<0.001
Non-smoker (I)	109.6±35.3[c]	111.7±35.9[c]	43.6±11.8[c]	50.6±13.6[c]
Current (II)	109.6±37.3[c]	114.1±34.4[c]	41.9±12.8[a,c]	48.1±12.2[a,c]
Ex-smoker (III)	114.4±37.5	119.2±39.9	43.6±12.0	51.2±15.3
Alcohol	P<0.001	P=0.379	P<0.001	P<0.001
None (I)	108.9±35.5[b,c]	112.2±36.0	42.6±12.2[c]	50.1±13.4[b,c]
Once a month or less (II)	113.7±36.9	113.1±35.4	42.8±11.0[c]	52.6±15.8
2 time or more (III)	116.7±36.9	117.9±34.9	45.7±13.9	56.4±13.0
Hypertension	P<0.001	P<0.001	P=0.001	P<0.001
No	108.9±35.6	107.7±34.5	42.6±12.2	50.8±13.4
Yes	115.5±40.3	122.5±37.0	42.8±10.9	49. 2±13.7
Coronary Heart Disease	P=0.737	P=0.051	P=0.003	P=0.088
No	110.5±36.0	112.1±35.7	43.1±12.3	50.3±13.5
Yes	109.7±45.2	118.5±43.2	41.0±12.3	48.6±12.8

Continued Table 3. Mean values of LDL-cholesterol and HDL-cholesterol in Turkey-2011

Variables	LDL-C, mean±SD*		HDL-C, mean±SD*	
	Male	**Female**	**Male**	**Female**
Stroke	*P*=0.843	*P*=0.038	*P*=0.095	*P*=0.087
No	110.4±36.6	112.1±35.6	43.0±12.3	50.3±13.5
Yes	109.6±32.7	120.9±43.9	40.7±9.9	50.1±13.9
Waist circumference	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001
Normal	108.4±36.1	105.0±33.8	43.8±12.6	52.3±13.6
High	116.4±38.9	119.5±36.6	40.5±10.9	48.2±13.1
Diabetes	*P*=0.080	*P*<0.001	*P*=0.004	*P*<0.001
No	110.2±35.6	111.2±.35.2	43.1±12.2	50.6±13.4
Yes	112.7±42.9	120.0±40.1	41.7±12.4	47.8±14.2
Family history of CHD	*P*<0.001	*P*<0.001	*P*=0.087	*P*=0.521
No	109.5±36.3	111.1±35.6	43.1±12.5	50.3±13.3
Yes	114.2±37.2	116.5±36.6	42.4±11.1	50.1±14.2
Area lived	*P*<0.001	*P*<0.001	*P*=0.001	*P*=0.724
Urban	111.9±36.3	113.3±35.6	42.6±11.6	50.2±13.0
Rural	107.0±36.1	110.2±36.9	43.9±13.7	50.4±14.7
Region	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001
West (I)	110.3±36.8[b]	111.6±35.3[b]	43.8±11.3	51.3±12.9[a]
South (II)	116.3±39.2	118.7±38.8	42.0±13.7[a]	49.6±15.1
Central (III)	108.9±33.0[b]	111.6±34.9[b]	41.8±12.5[a]	48.9±13.2[a]
North (IV)	110.6±32.8[b]	112.3±34.7[b]	42.5±11.9	50.0±13.5
East (V)	106.0±37.8[a,b]	107.9±35.8[b]	42.5±14.1	48.4±13.9[a]

*ANOVA and post hoc Bonferroni correction or Student's t-test was used for group comparisons. [a]Significanly lower than I; [b]Significanly lower than II; [c]Significanly lower than III; [d]Significantly lower than IV; [e]Significanly lower than V; [f]Significantly lower than VI; CHD - coronary heart disease; HDL-C - high density lipoprotein-cholesterol; LDL-C - low-density lipoprotein-cholesterol; SD - standard deviation

Awareness

Awareness rates among all individuals with high LDL-C by age groups are presented in Figure 2a. Nearly six out of 10 participants (n=3674, 55.8%) with high LDL-C were aware that they had high LDL-C. Awareness rate increased from 43.4% in the 20–29 age group to 59.9% in the 60–69 age group. Males were significantly less aware of having high LDL-C (44.9%) compared with females (65.2%) (p<0.001). Individuals with a social insurance were significantly more aware of having high LDL-C [55.8% versus 46.2% (without insurance), p=0.014]. Awareness of high LDL-C was significantly higher among employed individuals (57.5%) than among unemployed individuals (50.6%) (p<0.001). Nonsmokers were significantly more aware of their high LDL-C (60.5%) than current smokers (41.1%) (p<0.001). Individuals who consume alcohol at least twice a month had significantly lower awareness rates (45.9%) than those who do not consume alcohol (56.5%) (p<0.001). Awareness rates were higher among individuals with CHD (70.0%), HT (62.3%), family history of CHD (61.4%), and a high waist circumference (61.2%) than individuals without these conditions (53.7%, 47.8%, 53.2%, and 48.0%, respectively) (p<0.001). However, awareness rates among individuals with DM (55.1%) and without DM (55.4%) were similar according to univariate analysis (p=0.860). Individuals with stroke demonstrated lower awareness rates (27.1% versus 76.0%, p<0.001). Participants with high LDL-C living in urban areas (57.4%) had significantly higher awareness rates than individuals living in rural areas (49.5%) (p<0.001). High LDL-C awareness rates were 70.9%, 35.5%, and 48.9% in the low, intermediate, and high CHD risk groups, respectively (p<0.001).

Treatment

Among individuals who were aware of their high LDL-C, 46.9% were using lipid-lowering medication. The treatment rate showed a linear increase with age (p<0.001), and the oldest age group (≥70 years) had the highest rate of treatment (64.9%). Treatment rates did not differ significantly by gender (females: 47.4%, males: 46.0%, p=0.545). Individuals without social insurance (37.5%) were less inclined to get treatment than those with insurance (47.2%); however, this difference was not statistically significant (p=0.087). Individuals, with the lowest educational level (illiterate/literate) [53.4% versus 39.7% (high school/university), p<0.001]; those who do not consume alcohol [48.1% versus 36.1% (consuming less than once a month), p<0.008]; and

Table 4. Prevalence, awareness, treatment and control rates of high low density lipoprotein-cholesterol, Turkey-2011

Variables	High LDL-C, %	P*	Awareness, %	P*	Treatment, %	P*	Control,%	P*
Age	n=13121		n=3674		n=2050		n=961	
20–29	122 (4.5)	<0.001	53 (43.4)	<0.001	2 (3.8)	<0.001	2 (50.0)	0.137
30–39	448 (14.4)		229 (51.2)		59 (25.8)		33 (55.9)	
40–49	741 (27.4)		435 (58.7)		175 (40.2)		98 (54.5)	
50–59	1038 (47.2)		597 (57.5)		292 (48.9)		132 (45.1)	
60–69	780 (56.6)		467 (59.9)		261 (55.9)		143 (54.0)	
≥70	451 (58.5)		202 (44.8)		131 (64.9)		61 (45.0)	
Gender								
Female	1883 (26.7)	<0.001	1227 (65.2)	<0.001	581 (47.4)	0.545	284 (48.6)	0.134
Male	1791 (29.5)		805 (44.9)		370 (46.0)		202 (53.6)	
Marital status								
Married	2972 (29.3)	<0.001	1631 (54.9)	0.035	750 (46.0)	<0.001	388 (50.7)	0.715
Divorced widowed	573 (44.8)		339 (59.2)		187 (55.2)		90 (48.1)	
Single	126 (7.5)		60 (47.6)		14 (23.3)		8 (57.1)	
Education status								
Iliterate/Literate	938 (41.2)	<0.001	548 (58.4)	0.012	292 (53.4)	<0.001	143 (48.1)	0.432
Elementary/S.school	1923 (26.5)		1020 (53.0)		474 (46.6)		253 (52.3)	
H. school or U. degree	813 (22.6)		464 (57.1)		184 (39.7)		90 (48.1)	
Social security								
Yes	3501 (29.2)	<0.001	1952 (55.8)	0.014	922 (47.2)	0.087	474 (50.6)	0.253
No	173 (15.5)		80 (46.2)		30 (37.5)		12 (40.0)	
Work								
Employed	2500 (26.0)	<0.001	1438 (57.5)	<0.001	658 (45.8)	0.137	328 (49.7)	0.602
Unemployed	1174 (33.4)		594 (50.6)		292 (49.4)		158 (51.5)	
Physical activity								
Moderate or high	298 (23.4)	<0.001	161 (54.2)	0.694	69 (42.9)	0.293	452 (50.8)	0.638
None or low	3376 (28.5)		1870 (55.4)		882 (47.2)		34 (47.9)	
Change in PA								
Not changed	2931 (27.9)	<0.001	1581 (54.0)	<0.001	745 (47.1)	0.645	370 (49.1)	0.197
Increased	231 (23.1)		148 (64.1)		64 (43.2)		62 (58.5)	
Decreased	337 (31.1)		220 (65.3)		105 (47.7)		32 (50.0)	
Smoking								
Current	871 (26.7)	<0.001	358 (41.1)	<0.001	166 (52.7)	0.001	78 (54.2)	0.171
Ex-smoker	549 (42.5)		315 (57.4)		139 (38.9)		93 (55.7)	
Non-smoker	2243 (26.3)		1357 (60.5)		645 (47.5)		314 (48.4)	
Alcohol								
≥2 times a month	244 (34.9)	<0.001	112 (45.9)	0.001	46 (40.7)	0.008	19 (42.2)	0.309
Less than once a month	303 (27.4)		152 (50.2)		55 (36.2)		25 (44.6)	
None	3098 (27.6)		1750 (56.5)		842 (48.1)		438 (51.5)	
Waist circumference								
High	2035 (39.8)	<0.001	1246 (61.2)	<0.001	624 (50.1)	<0.001	298 (47.6)	0.012
Normal	1638 (20.5)		786 (48.0)		328 (41.7)		188 (56.1)	

Continued Table 4. Prevalence, awareness, treatment and control rates of high low density lipoprotein-cholesterol, Turkey-2011

Variables	High LDL-C, %	P*	Awareness, %	P*	Treatment, %	P*	Control,%	P*
Coronary heart disease								
Yes	363 (73.8)	<0.001	254 (70.0)	<0.001	185 (72.8)	0.001	397 (51.9)	0.327
No	3311 (26.2)		1778 (53.7)		767 (43.1)		89 (47.6)	
Stroke								
Yes	149 (76.0)	<0.001	59 (39.6)	<0.001	25 (42.4)	0.488	12 (48.0)	0.777
No	3447 (27.1)		1933 (56.1)		907 (46.9)		466 (50.9)	
Hypertension								
Yes	1907 (51.5)	<0.001	1188 (62.3)	<0.001	648 (54.5)	<0.001	48.3 (315)	0.042
No	1766 (18.8)		844 (47.8)		304 (36.1)		171 (55.3)	
Diabetes								
Yes	1206 (78.5)	<0.001	664 (55.1)	0.860	405 (61.0)	<0.001	145 (35.8)	0.001
No	2468 (21.3)		1367 (55.4)		547 (40.0)		341 (61.3)	
Family history of CHD								
Yes	947 (33.7)	<0.001	581 (61.4)	<0.001	252 (43.4)	0.047	130 (51.4)	0.764
No	2727 (26.5)		1450 (53.2)		700 (48.2)		356 (50.3)	
Area lived								
Urban	2576 (28.3)	0.476	1479 (57.4)	<0.001	677 (45.8)	0.113	345 (50.0)	0.527
Rural	1051 (27.6)		520 (49.5)		259 (49.8)		137 (52.3)	
Region								
West	1799 (27.5)	<0.001	1009 (56.1)	0.137	493 (48.8)	0.063	245 (49.2)	0.802
South	612 (31.5)		319 (52.2)		139 (43.6)		72 (50.4)	
Central	451 (27.4)		239 (53.1)		102 (42.7)		56 (54.9)	
North	408 (30.1)		244 (59.7)		126 (51.6)		68 (52.8)	
East	404 (24.5)		220 (54.5)		92 (42.0)		44 (47.8)	

Data are presented as numbers and percentage. *The comparisons of proportions were made using the chi-square test. CHD - coronary heart disease; H. school - high school; LDL-C - low density lipoprotein-cholesterol; PA - physical activity; S. School - secondary school; U. school - university school
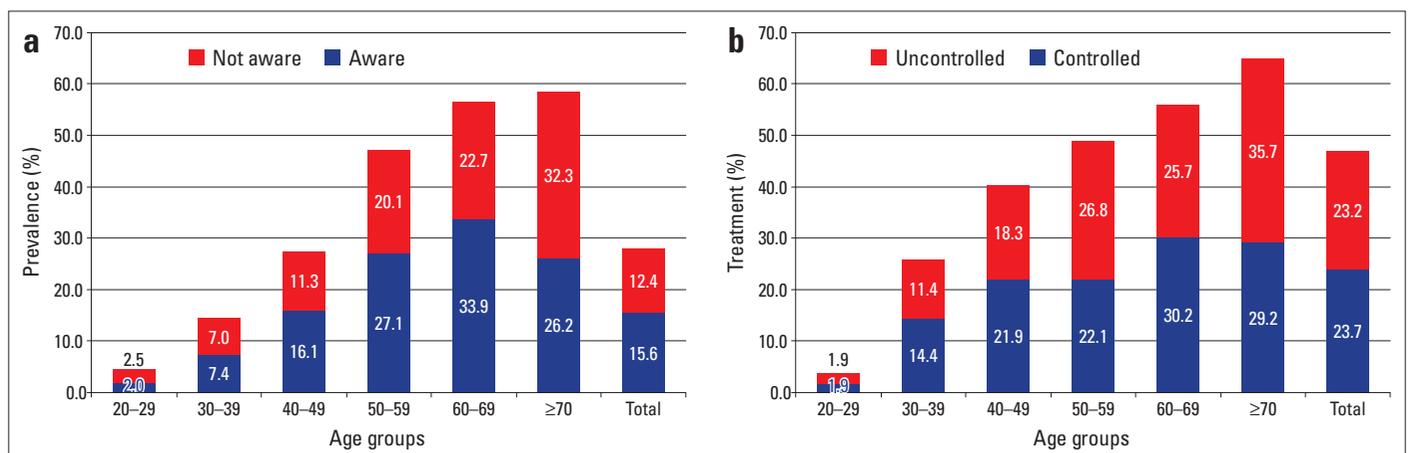

Figure 2. Prevalence, awareness, control, and treatment rates of high LDL-C by age groups, Turkey (2011). (a) awareness rates among all individuals with high LDL-C, (b) control rates among individuals who were receiving lipid-lowering medication

those who have HT [54.5% versus 36.1% (no HT), p<0.001%], CHD [72.8% versus 43.1% (no CHD), p<0.001], or DM [61.0% versus 40.0% (no DM), p<0.001] were significantly more inclined to receive treatment than their counterparts. High LDL-C treatment rates were 35.1%, 45.5%, and 59.8% in the low, intermediate, and high CHD risk groups, respectively (p<0.001).

Control

Control rates among individuals who were receiving lipid-lowering medication by age groups are presented in Figure 2b. In total, 50.6% of participants treated with lipid-lowering medications had controlled levels of LDL-C. Males had higher control rates (53.6%) than females (48.6%), but the difference was insignificant (p=0.134). Participants with a high waist circumference (47.6%) and ones diagnosed with DM (35.8%) and HT (48.3%) achieved significantly lower control rates than their counterparts (56.1%, 61.3%, 55.3%, respectively). The age group 50–59 had the lowest proportion of controlled lipids (45.1%), whereas the 30–39 age group had the highest control rates (55.9%). LDL-C control rates did not differ significantly by geographical area lived, marital status, education level, PA, and alcohol consumption. High LDL-C control rates were 73.7%, 45.3%, and 35.7% in the low, intermediate, and high CHD risk groups, respectively (p<0.001).

Multivariate analysis

The factors significantly and independently related to prevalence, awareness, treatment, and control of high LDL-C were assessed using multivariate logistic regression analysis, and AORs are presented in Table 5. Prevalence of high LDL-C was positively related with increasing age, male gender (OR=1.14, 95% CI: 1.01–1.28), high school or university degree (OR=1.37, 95% CI: 1.15–1.64), alcohol consumption at least twice a month (OR=1.68, 95% CI: 1.50–1.87), being current smoker (OR=1.47, 95% CI: 1.30–1.67), high waist circumference (OR=1.36, 95% CI: 1.22–1.52), presence of CHD (OR=2.50, 95% CI: 1.93–3.23), presence of DM (OR=6.86, 95% CI: 5.97–7.88), HT (OR=1.67, 95% CI: 1.49–1.87), stroke (OR=6.42, 95% CI: 4.23–9.84), and having a family history of CHD (OR=1.18, 95% CI: 1.06–1.33). High LDL-C was negatively associated with living in the rural area (OR=0.78, 95% CI: 0.70–0.88).

Individuals with hypertension (OR=1.72, 95% CI: 1.45–2.03) and CHD (OR=2.15, 95% CI: 1.63–2.83) were more likely to be aware of high LDL-C. Compared with individuals who were illiterate or literate, having at least high school education increased the likelihood of awareness for high LDL-C (OR: 1.20, 95% CI: 1.05–1.62). Awareness of high LDL-C was significantly lower among males (OR=0.46, 95% CI: 0.38–0.56), being current smoker (OR=0.58, 95% CI: 0.48–0.71), having DM (OR=0.77, 95% CI: 0.65–0.91), and living in rural area (OR=0.73, 95%CI: 0.62–0.87).

Treatment uptake rates were positively related with increasing age; the odds of getting treatment were 19.44 in the ≥70 age group compared with the reference age group 20–39. Treatment uptake rates were significantly and positively associated with having CHD (OR=2.64, 95% CI: 1.89–3.69), HT (OR=1.32, 95% CI: 1.05–1.66), and DM (OR=1.85, 95% CI: 1.49–2.30). On the other hand, individuals with stroke (OR=0.54, 95% CI: 0.30–0.98) and a family of history of CHD (OR=0.78, 95% CI: 0.62–0.97) were significantly less likely to receive lipid-lowering medication.

Finally, control of high LDL-C was negatively associated with the presence of DM (OR=0.36, 95% CI: 0.27–0.49). No association was found between the control of high LDL-C and other determinants such as gender, HT, CHD, PA, and waist circumference.

Discussion

This national study provided information on the current prevalence, awareness, treatment, and control rates of high LDL-C in Turkey. Despite the declining CHD mortality rates during last decade in Turkey (4), this study shows that there is still a high proportion of Turkish people with high LDL-C levels according to their CHD risk who are not being treated to the recommended levels. It was found that approximately one-fourth of the study population had high LDL-C, six out of 10 subjects with hyper-LDL-cholesterolemia were aware of their condition, five out of 10 subjects who were aware of their condition were being treated with cholesterol-lowering agents, and five out of 10 subjects receiving treatment had their LDL-C levels under control, implying that 87% of individuals with high LDL-C remained as potentially high-risk subjects for developing CVD.

High LDL-C was significantly more prevalent among males than among females. In our study, the prevalence of high LDL-C increased with age, and ≥70 age group had the highest prevalence of high LDL-C. Previous studies reported that the prevalence of dyslipidemia increases with age (11, 12). According to TEKHARF study conducted in 2001 in Turkey, the prevalence of LDL-C ≥130 mg/dL among individuals aged >30 years was 30.5% for males and 38.1% for females (8). A recent nationwide study from Turkey conducted among 4309 individuals reported that the prevalence of high LDL-C was 36.2% (35% of men and 37.2% of women) (19). According to Turkish Heart Study, borderline high and high LDL-C (>130 mg/dL) prevalence was 37% in men and 38% in women (20). Erem et al. (9) reported the prevalence of high LDL-C as 44.5% in Trabzon city of Turkey. Balçova Heart Study conducted during 2008–2010 in Izmir/Turkey among 12914 individuals aged ≥30 years reported that high LDL-C (>130 mg/dL) rate was more than 50% (7). Our prevalence rates for high LDL-C were lower than figures reported by previous national studies; this could be due to the fact that we used risk-based approach rather than threshold approach for high cholesterol categorization. Although other studies considered LDL-C as >130 mg/dL for all study participants, in our study, the threshold for individuals with FRS <10 LDL-C >160 mg/dL. When we used the definition for high LDL-C >130 mg/dL, prevalence increased to 40.5% for those aged ≥30 and 34.5% for those aged ≥20 and our findings became similar to those from previous studies.

A study from Turkey found that individuals living in rural areas had lower rates of dyslipidemia, and this relationship continued significantly after multivariate adjustment (19). Studies from Thailand, India, Iran, and Turkey reported lower rates of high LDL-C in rural areas compared with urban areas (20–22). This could be due to the differences in lifestyle and diet patterns between urban and rural areas. According to Turkish National

Table 5. Multivariate analysis of factors associated with high low density lipoprotein-cholesterol, Turkey-2011

Variables	High LDL-C (n=13121)		Awareness (n=3674)		Treatment (n=2050)		Control (n=961)	
Age	AOR*	P	AOR*	P	AOR*	P	AOR*	P
20–29	1		1		1		1	
30–39	**2.80 (2.21–3.56)**	**<0.001**	1.42 (0.89–2.25)	0.199	**6.12(1.54–24.29)**	**0.009**	0.46 (0.02–8.87)	0.460
40–49	**5.17 (4.06–6.58)**	**<0.001**	**1.72 (1.09–2.72)**	**0.033**	**10.67 (2.73–41.73)**	**0.001**	0.48 (0.03–9.00)	0.482
50–59	**9.84 (7.68–12.61)**	**<0.001**	1.40 (0.89–2.22)	0.870	**11.74 (3.00–45.90)**	**<0.001**	0.35 (0.02–6.54)	0.353
60–69	**12.23 (9.33–16.02)**	**<0.001**	1.31 (0.82–2.14)	0.792	**14.18 (3.59–56.09)**	**<0.001**	0.52 (0.03–9.65)	0.521
≥70	**13.26 (9.77–17.99)**	**<0.001**	0.68 (0.41–1.14)	0.406	**19.44 (4.78–79.07)**	**<0.001**	0.33 (0.02–6.24)	0.330
Gender								
Female	1		1		1		1	
Male	**1.14 (1.01–1.28)**	**<0.001**	**0.46 (0.38–0.56)**	**<0.001**	1.07 (0.81–1.39)	0.509	1.15 (0.77–1.73)	0.500
Marital status								
Married	1		1		1		1	
Divorced widowed	1.08 (0.91–1.27)	0.546	1.06 (0.84–1.34)	0.854	1.07 (0.80–1.43)	0.913	1.24 (0.82–1.88)	0.300
Single	**0.78 (0.61–0.99)**	**0.047**	0.91 (0.59–1.42)	0.764	0.77 (0.36–1.64)	0.546	2.08 (0.58–7.42)	0.258
Education status								
Iliterate/Literate	1		1		1		1	
Elementary/S. school	0.96 (0.83–1.12)	0.686	0.96 (0.78–1.19)	0.811	1.08 (0.82–1.41)	0.531	1.11 (0.76–1.67)	0.598
H. school or u. degree	**1.37 (1.15–1.64)**	**<0.001**	**1.20 (1.05–1.62)**	**0.005**	1.10 (0.78–1.56)	0.620	0.95 (0.57–1.57)	0.829
Social security								
No	1		1		1		1	
Yes	**1.29 (1.05–1.59)**	**0.017**	1.24 (0.88–1.75)	0.397	1.07 (0.64–1.79)	0.920	1.98 (0.81–4.86)	0.200
Work								
Employed	1		1		1		1	
Unemployed	0.99 (0.88–1.11)	0.681	0.91 (0.76–1.08)	0.298	0.84 (0.66–1.07)	0.112	1.24 (0.76–1.55)	0.655
Physical activity								
None or low	1		1		1		1	
Moderate or high	0.95 (0.80–1.13)	0.716	0.97 (0.74–1.27)	0.733	1.09 (0.75–1.58)	0.576	1.24 (0.70–2.20)	0.455
Change in PA								
Not changed	1		1		1		1	
Increased	1.02 (0.85–1.23)	0.896	**1.36 (1.01–1.84)**	0.004	1.08 (0.74–1.57)	0.696	0.83 (0.48–1.46)	0.514
Decreased	**1.21 (1.01–1.46)**	**0.044**	**1.53 (1.16–2.00)**	**0.002**	1.13 (0.82–1.56)	0.407	1.38 (0.87–2.18)	0.172
Smoking								
Non-smoker	1		1		1		1	
Current	**1.47 (1.30–1.67)**	**<0.001**	**0.58 (0.48–0.71)**	**<0.001**	0.98 (0.74–1.32)	0.972	1.07 (0.68–1.68)	0.768
Ex-smoker	**1.19 (1.01–1.40)**	**0.041**	1.15 (0.92–1.45)	0.332	1.07 (0.80–1.44)	0.778	1.23 (0.80–1.89)	0.342
Alcohol								
None	1		**1**		1		1	
Less than 1 a month	**1.30 (1.09–1.56)**	**0.005**	1.14 (0.86–1.51)	0.566	0.78 (0.51–1.17)	0.756	0.63 (0.33–1.20)	0.163
≥2 times a month	**1.68 (1.50–1.87)**	**<0.001**	1.08 (0.80–1.47)	0.577	0.89 (0.56–1.41)	0.910	0.59 (0.30–1.16)	0.124
Waist circumference								
Normal	**1**		1		1		1	
High	**1.36 (1.22–1.52)**	**<0.001**	1.15 (0.98–1.35)	0.136	1.00 (0.80–1.25)	0.929	0.88 (0.61–1.23)	0.475

Continued Table 5. Multivariate analysis of factors associated with high low density lipoprotein-cholesterol, Turkey-2011

Variables	High LDL-C (n=13121)		Awareness (n=3674)		Treatment (n=2050)		Control (n=961)	
	AOR*	P	AOR*	P	AOR*	P	AOR*	P
Hypertension								
No	1		1		1		1	
Yes	**1.67 (1.49–1.87)**	**<0.001**	**1.72 (1.45–2.03)**	**<0.001**	**1.32 (1.05–1.66)**	**0.010**	0.92 (0.56–1.28)	0.614
Coronary heart disease								
No	1		1		1		1	
Yes	**2.50 (1.93–3.23)**	**<0.001**	**2.15 (1.63–2.83)**	**<0.001**	**2.64 (1.89–3.69)**	**<0.001**	0.88 (0.59–1.29)	0.500
Stroke								
No	**1**		**1**		**1**		1	
Yes	**6.42 (4.23–9.84)**	**<0.001**	**0.43 (0.29–0.62)**	**<0.001**	**0.54 (0.30–0.98)**	**0.043**	1.06 (0.44–2.56)	0.894
Diabetes								
No	1		**1**		**1**		1	
Yes	**6.86 (5.97–7.88)**	**<0.001**	**0.77 (0.65–0.91)**	**0.003**	**1.85 (1.49–2.30)**	**<0.001**	**0.36 (0.27–0.49)**	**<0.001**
Family history of CHD								
No	1		1		**1**		1	
Yes	**1.18 (1.06–1.33)**	**0.005**	1.17 (0.99–1.40)	0.111	**0.78 (0.62–0.97)**	**0.022**	1.12 (0.79–1.60)	0.500
Area lived								
Urban	1		1		1		1	
Rural	**0.78 (0.70–0.88)**	**<0.001**	**0.73 (0.62–0.87)**	**<0.001**	1.12 (0.89–1.42)	0.375	1.03 (0.74–1.44)	0.862
Region								
West	1		1		1		1	
South	**1.39 (1.21–1.60)**	**<0.001**	0.83 (0.67–1.02)	0.081	**0.74 (0.55–0.99)**	**0.043**	1.11 (0.72–1.70)	0.643
Central	1.13 (0.97–1.32)	0.097	0.89 (0.71–1.13)	0.214	0.78 (0.56–1.08)	0.128	1.25 (0.77–2.05)	0.368
North	1.15 (0.98–1.36)	0.059	1.17 (0.91–1.50)	0.302	1.07 (0.77–1.46)	0.734	1.05 (0.67–1.65)	0.828
East	1.13 (0.96–1.33)	0.105	0.95 (0.74–1.23)	0.777	0.75 (0.53–1.06)	0.107	0.98 (0.58–1.66)	0.941

All data are presented as odds ratio (95% Confidence Interval). All variables were entered into the multivariate logistic regression. *AOR - adjusted odds ratio; CHD - coronart heart disease; H. school - high school; LDL-C - low-density lipoprotein cholesterol; n - number of participants; PA - physical activity; S. school - secondary school; U. school - university school. Significant values are presented in bold

Nutrition and Health Survey conducted in 2010, individuals living in urban areas were consuming more processed food, animal fat, and sweetened beverages and less grain, fresh vegetables, beans, and bean products compared with those living in rural areas (23).

In our study, high LDL-C was more prevalent among obese individuals. This finding is in concordance with other study findings from Saudi Arabia, Switzerland, and Turkey where positive association between dyslipidemia and obesity was reported (11). The lipid abnormalities in abdominal obesity are possibly a consequence of insulin resistance (24).

The relationship between marital status and dyslipidemia was reported in previous studies where divorced/separated or widowed individuals were more likely to have suboptimal lipid profiles compared with married ones (25). The Trabzon lipid study reported widows or widowers had significantly higher risk of dyslipidemia (9). According to the Healthy Women Study con-

ducted in the USA, marriages with higher satisfaction level had lower atherosclerotic burden than those with lower satisfaction level or those who are single (26). One reason could be that marital status may impact health conditions via various factors such as social status and financial conditions within the family, and it could affect lifestyle habits, such as smoking, alcohol intake, and PA levels (27).

Smoking alters plasma lipid profiles, and it is considered as an independent risk factor for CHD. Smoking is known to have a negative impact on insulin secretion, and smokers have a higher risk of insulin resistance and developing type 2 diabetes (28). In our case, ex-smokers had higher rates of high LDL-C; however, this relationship became nonsignificant after multivariate adjustment. The inverse relationship between smoking and body weight has been reported; therefore, the high rates of high LDL-C among ex-smokers could be due to the negative impact of smoking cessation on weight gain (8).

As for education, a negative relationship was observed between the level of education and the prevalence of high LDL-C in the univariate analysis because individuals with higher education were also younger who had lower LDL-C levels in our study. However, after multivariate adjustment, high LDL-C became more prevalent among individuals with higher education level. In our study, we could not assess income level. It is highly likely that individuals with higher education level were also wealthier, and high income is in general related to higher cholesterol levels (21).

Awareness

In this study, approximately 56% of the examined subjects were aware of their elevated LDL-C. A study from China conducted among 7138 adult subjects aged 18–79 years in 2011 reported that 11.6% of the participants were aware of their diagnosis (29). According to the National Health and Nutrition Examination Surveys (NHANES) in the USA, awareness rates increased from 48.9% in 1999–2000 to 61.5% in 2009–2010 in the age group ≥20 (30). According to a study using data from the Thai National Health Examination Survey IV conducted in 2009 among 19021 adults aged ≥20 years, high LDL-C awareness rate was 17.8% (31). In our study, awareness rate decreased with age, and it was significantly lower among males. Low awareness rates among males compared with females were also reported by other studies from the USA and China (29, 32). Several recent studies showed that higher levels of education have a positive relationship with the higher awareness of dyslipidemia (29, 32). Regarding the determinants of awareness in our study, higher educational level was associated with higher awareness of high LDL-C. It may be due to the fact that individuals with higher levels of education have higher awareness about health conditions, such as CVD and related risk factors including dyslipidemia, as reported by former studies (33, 34).

Higher awareness of high LDL-C was significantly associated with living in the urban region, and this finding is supported by other studies (13, 31). Higher income level and the relatively better-developed health care infrastructure in urban areas compared with that in rural areas may have a positive impact on the awareness rate of high LDL-C in our study. A recent study revealed that urban–rural differences exist in health care utilization in Turkey (35).

Individuals with hypertension or CHD had higher awareness rates, which may be due to the fact that they were patients in the health service system; thus, the high LDL-C was more likely to be detected and treated during routine examinations of these conditions. On the other hand, individuals with diabetes had lower awareness rates for high LDL-C. It could be due to the fact that DM cases include a high number of newly diagnosed participants in Turkey. According to recent epidemiological studies, awareness rates were reported as 54.5% in the TURDEP study and 74% in Chronic Diseases and Risk Factors study, and it is likely that these individuals did not have a routine clinical examination for LDL-C (36). A study using NHANES data from the USA reported that awareness rate for high LDL-C among individuals with undiagnosed diabetes was 38%, whereas it was 70% among individuals with diagnosed diabetes (37). We found a lower level of awareness among cigarette smokers, and this could be related with smokers' lower levels of concern about their own health or lack of awareness about their CHD risk. A study conducted among physicians found a significant positive relationship between smoking and cholesterol unawareness (38).

Treatment

In this study, approximately three out of 10 participants with high LDL-C were treated in Turkey. This figure is higher than those Iran (7.1%), China (8.4%), and Korea (10.2%) but lower than those the UK (40%), Switzerland (44%), the USA (48%), and other European countries (13, 29, 39–42). The distribution of treatment rates across age groups showed an increasing pattern where older age groups had significantly higher treatment rates than the youngest age group, and this finding is in line with those of other studies (29, 40, 41). In this study, treatment uptake rates were much lower compared with high awareness rates among the young age groups. It was reported that nonadherence to statin treatment was associated with younger age (43). This may be due to the fact that as people get older, they become more worried about their health problems, particularly CVDs, compared with younger people who are less probable to give importance to the perception of diseases.

In our study, treatment rates were not related to education level. Indeed, conflicting results regarding the effect of educational or economic status on the management of dyslipidemia have been published: a study demonstrated higher treatment rates among better-educated participants (32), whereas no differences were found in others (11, 44). The reason for indifference in treatment uptake rates between education levels could be due to the universal access to health care services, which would considerably reduce socioeconomic inequalities in cholesterol treatment in Turkey. Individuals with CHD, HT, and DM were more likely to receive treatment than their healthy counterparts. Other factors did not have a significant effect on treatment uptake rates in Turkey.

Control

In our study, 50.6% of the participants treated for high LDL-C achieved adequate cholesterol levels according to the NCEP/ATP III guidelines. A study from Singapore using the same treatment goals as our study with 10445 participants reported that the control level of LDL-C was 64.4% (45). Control levels among individuals receiving lipid-lowering medication in Iran, Switzerland, China, Korea, and the USA were reported to be 90.9%, 60.0%, 34.8%, 61.7%, and 61.0%, respectively (11, 13, 40). Some studies reported that cholesterol control levels vary by sociodemographic properties (12, 40). However, multivariate analysis in

our study showed that control rate among patients receiving lipid-lowering medication was not significantly related to age, gender, education, geographical area lived, and social insurance. This finding supports that there is equality for sociodemographic determinants of cholesterol control in Turkey. On the other hand, subjects with DM were less likely to have controlled LDL-C after multivariate adjustment. This finding is similar to those of the studies from Switzerland and the USA where CHD risk score-based LDL-C targets were used (11, 46). The lower control rates of LDL-C among those with DM may be due to the use of lower thresholds in the definition of LDL-C control for individuals with two or more CHD risk factors and CHD or CHD risk equivalents.

Control rates were significantly higher among males than among females, and this finding is in line with other studies (11). Univariate analyses revealed that individuals with high waist circumference had significantly lower control rates than those with normal waist circumference values. This finding is supported by other studies (11, 29). One plausible explanation could be that long-term weight loss is challenging, and it is hard to control high cholesterol in overweight or obese people (47). However, this relationship lost its significance after multivariate adjustment. One explanation for this could be the fact that adjusting factors with each other during statistical analysis that are on the causal pathway between a risk factor and outcome measure could dilute the observed strength of that risk factor. Other reasons could be a lack of compliance with the medication or precise use of lipid-lowering drug treatment among individuals who are at high risk of CVD. A study from Turkey reported that 56.2% of the patients with diabetes discontinued statin medication (48). However, the precise reason for the lack of cholesterol control among participants at high risk of CVD receiving treatment remains to be assessed.

Study limitations

Some limitations in our present study should be noted. One limitation is that detailed information on dietary intake associated with dyslipidemia could not be analyzed because of lack of detailed questions assessing dietary intake patterns. We analyzed the impact of oil type and type of bread consumed, and these figures did not show a significant difference in any dependent variable. Another limitation is that the cross-sectional design of our study could only reflect associations between high LDL-C and risk factors; therefore, establishing causal relationship requires caution. Data regarding awareness was based on self-report and could be subject to recall bias. Income was not assessed in this survey, but other studies found a positive relationship between income level and cholesterol awareness, treatment, and control rates. Blood pressure, blood glucose, and cholesterol values were available from only a single point in time, which may have resulted in misclassification of some participants.

Conclusion

We conclude that despite the relatively high awareness rates of high LDL-C in Turkey, a significant proportion of adults with high LDL-C levels did not receive treatment or achieve recommended LDL-C levels during treatment. Males, current smokers, individuals with lower education level, those with DM, and rural residents were less aware of their high LDL-C. Control rates were lower among individuals with DM. This finding highlights the importance of public health programs including screening and education activities targeting vulnerable population to raise awareness about high cholesterol. The treatment gap could be closed by prescribing statins to patients after taking into account the CVD risks they are at and based on up-to-date treatment guidelines. Therapeutic lifestyle guidance including PA, healthy diet, and improving adherence to physician recommendations until normal LDL-C levels are achieved is necessary to improve control rates. We observed some sociodemographic and health-related disparities in prevalence, awareness, treatment, and control of high LDL-C. Further research is warranted to assess patient and healthcare-related factors that may have an impact on awareness, treatment, and control rates. It would be crucial to assess future trends and determinants of high LDL-C to evaluate the effectiveness of national programs targeting CVD risk factors.

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