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Original Article

Dyslipidemia Prevalence in Iranian Adult Men: The Impact of Population-Based Screening on the Detection of Undiagnosed Patients

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Purpose: Dyslipidemia has been established as one of the most important modifiable risk factors for cardiovascular disease. Due to the higher prevalence of dyslipidemia in males, this study aimed to estimate the prevalence of dyslipidemia in Iranian urban men.
Materials and Methods: A screening program was conducted in 845 Iranian men 25 years of age and older in 2014. A health interview survey was conducted to evaluate the prevalence of self-reported dyslipidemia and to collect demographic data, as well as serum lipid profile screening by a reference laboratory. Lipoprotein levels was categorized based on the Adult Treatment Panel III criteria and the data were analyzed using the chi-square test and analysis of variance.
Results: The overall prevalence of dyslipidemia was 51.8%, and the prevalence of various forms of dyslipidemia was as follows: hypercholesterolemia (≥240 mg/dL), 11.4%; hyper-low-density lipoprotein cholesterol (≥160 mg/dL), 9.6%; hypertriglyceridemia (≥200 mg/dL), 25%; and hypo-high-density lipoprotein (HDL) cholesterol (<40 mg/dL), 34.3%. With the exception of hypo-HDL, all forms of dyslipidemia were significantly less common in men over 65 years of age ($p<0.05$).
Conclusions: The prevalence of hypo-HDL and hypertriglyceridemia was higher than expected in Iranian adult men, with half of men 25 years of age and older affected by at least one form of dyslipidemia. A large gap in primary and secondary care was observed, because nearly 80% of patients with dyslipidemia were unaware of their status. Urgent preventive programs and lifestyle changes are necessary to reduce the prevalence of cardiovascular risk factors.

Key Words: Dyslipidemia; Hypercholesterolemia; Hypertriglyceridemia; Male; Metabolic diseases

INTRODUCTION

Cardiovascular disease (CVD) is the most prevalent cause of death among non-communicable diseases (NCDs) and disabilities worldwide, in both developed and developing countries [1-3]. Dyslipidemia has been estab-

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lished as one of the most important modifiable risk factors for CVD [4], and patients with dyslipidemia are at a 31% to 46% higher risk for coronary artery disease [2]. Dyslipidemia is a condition in which lipid metabolism is disrupted, leading to an abnormal amount of lipids in the blood [5]. It plays a major role in the expansion and progression of atherosclerosis [6,7]. Moreover, lipid abnormalities are recognized as a major risk factor for early coronary artery disease in particular [1]. A 30-year cohort study showed that each increase of 10 mg/dL in total cholesterol (TC) was associated with increases of 5% and 9% in total mortality and cardiovascular mortality, respectively [7].

The worldwide prevalence of dyslipidemia is increasing, and the risk of mixed forms of dyslipidemia is growing due to the increased prevalence of other metabolic diseases, such as visceral adiposity, metabolic syndrome/insulin resistance, and diabetes mellitus [4,8-10]. These changes have occurred due to urbanization, changes in diet patterns, obesity, reduced physical activity, and other consequences of lifestyle changes [4]. The typical forms of dyslipidemia include elevated TC, elevated triglycerides (TG), elevated low-density lipoprotein (LDL) cholesterol, and reduced high-density lipoprotein (HDL) cholesterol [7].

The relationship between dyslipidemia and other risk factors for NCDs such as hypertension, diabetes mellitus, obesity, and overweight has been previously evaluated in studies and it is established a high prevalence of diabetes mellitus, obesity, hypertension, and overweight in adults [8-12]. A recent study showed overweight and obesity to be the most significant factors contributing to the burden of NCDs [3]. Moreover, overweight and obesity have been reported to have an effect on dyslipidemia [5].

An increasing trend in the prevalence of dyslipidemia has been observed in adults in many countries, including Korea [7], Kuwait [5], and other Persian Gulf countries and neighbors of Iran [3,4,10,13]. Nevertheless, the prevalence of undiagnosed dyslipidemia in the adult male population is unclear, and many men are unaware of their lipid profile, leading to a high prevalence of patients with untreated lipid abnormalities [2,14]. In addition, the prevalence of dyslipidemia is higher in males than females [1,11], and higher levels of HDL and lower ratios of TC to HDL have been reported in females [15]. This study aimed to estimate the prevalence of dyslipidemia in Iranian urban men 25 years of age and older in order to design appropriate health interventions at the primary and secondary levels to reduce CVD events.

MATERIALS AND METHODS

1. Setting and subjects

The study setting was Qom, a metropolis in central Iran. A screening program was conducted in Iranian men 25 years of age and older in 2014. Subjects were selected by two-stage sampling. First, proportional stratified random sampling was used to establish the proportion of each district. Second, systematic random sampling used to select eligible subjects in each stratum. The study subjects comprised a random sample of men at least 24 years of age living in Qom.

2. Measurements

The subjects included 845 urban adult men. A health interview survey was administered to all subjects in order to evaluate self-reported dyslipidemia and to collect demographic data, and then all subjects were referred to a reference laboratory for lipoprotein screening tests. According to the program protocol, all men between 25 to 65 years old were invited to participate in the screening and undergo anthropometric measurements and a measurement of their serum lipid profile. In the current study, all men 25 years of age and older were assessed. The serum lipid profile included TC, HDL, LDL, very low-density lipoprotein (VLDL), and TG. The lipoprotein screening tests were performed after the subjects had fasted for at least eight hours. The data were gathered in two stages. First, an interview was conducted, in which questions about demographic characteristics, including age, marital, and insurance status, the number of children, and self-reported NCD status were asked. Second, the results of the laboratory tests were added to the demographic data. The study participants were made aware of the benefits and harms of the study and, because the laboratory tests were free, all participants provided informed consent. In addition, the study protocol was approved by the ethical committee of the Qom University of Medical Sciences.

3. Statistical analysis

After data collection, the results of the laboratory tests were categorized based on the Adult Treatment Panel III criteria [16]. LDL cholesterol values were calculated based on TC, TG, and HDL. In addition, VLDL was estimated as one fifth of the total lipids in a given blood sample [16,17]. In our study, dyslipidemia was defined as of the presence of hypercholesterolemia (≥240 mg/dL), hypo-HDL (<40 mg/dL), hyper-LDL (≥160 mg/dL), or hyper-TG (≥200 mg/dL), according to the Adult Treatment Panel III criteria presented in Table 1 [7]. Since the target population of the screening program was men between 25 and 65 years of age, the study subjects were categorized as between 25 and 40 years of age, 40 to 65 years of age, and more than 65 years of age. These groups contained 30.3%, 32.8%, and 36.9% of the study sample, respectively. Data were analyzed using the chi-square test and analysis of variance in PASW Statistics ver. 18 (IBM Co., Armonk, NY, USA).

RESULTS

The mean age of participants was 45.3±18.8 years old, 70.7% lived with their spouse, and 98% reported having health insurance. The self-reported prevalence of dyslipidemia and high blood pressure was 16.9% and 19.4%, respectively. In contrast, the overall prevalence of laboratory-confirmed dyslipidemia (*i.e.*, the presence of hypercholesterolemia, hypo-HDL, hyper-LDL, or hyper-TG) was 51.8%. As shown in Table 1, the prevalence of desirable TC was 66.9% and the prevalence of high TC was 11.4%. Hyper-LDL and hypertriglyceridemia were present in 9.6% and 25% of participants, respectively. The prevalence of high VLDL was 25.9%, and the prevalence of normal HDL was 57.8%, whereas 34.3% of participants were affected by hypo-HDL. Finally, the ratio of LDL to HDL was unfavorable in 6.8% of subjects.

According to the results presented in Table 2, 75.3% of the subjects affected by hypercholesterolemia were not aware of their condition. Moreover, 79.6% and 81.8% of the subjects with high and very high levels of LDL, re-

Table 1. Dyslipidemia prevalence in the subjects of our study based on laboratory results and Adult Treatment Panel (ATP) III criteria

Fasting lipoprotein levels based on ATP III criteria		Level (mg/dL)	Frequency (n)	Valid (%)	Cumulative (%)
Total cholesterol	Desirable	<200	546	66.9	66.9
	Borderline high	200~240	177	21.7	88.6
	High	>240	93	11.4	100.0
LDL	Optimal	<100	316	40.0	40.0
	Above optimal	100~129	238	30.1	70.1
	Borderline high	130~159	160	20.3	90.4
	High	160~190	54	6.8	97.2
	Very high	≥190	22	2.8	100.0
HDL	Low	<40	280	34.3	34.3
	Normal	40~59	472	57.8	92.2
	High	≥60	64	7.8	100.0
TG	Desirable	<150	474	58.1	58.1
	Borderline high	150~199	138	16.9	75.0
	High	200~500	189	23.2	98.2
	Very high	≥500	15	1.8	100.0
VLDL	Low	<5	5	0.7	0.7
	Normal	5~40	531	73.4	74.1
	High	>40	187	25.9	100.0
LDL/HDL	Favorable	≤4.5	699	93.2	93.2
	Unfavorable	≥4.5	51	6.8	100.0

LDL: low-density lipoprotein, HDL: high-density lipoprotein, TG: triglycerides, VLDL: very low-density lipoprotein.

spectively, had not been diagnosed. Likewise, 80.4% and 73.3% of the subjects with high and very high TG, respectively, had not been diagnosed. Of the subjects with low HDL, 81.1% had not been diagnosed, as was the case for 80.2% of subjects with high VLDL and 78.4% of subjects with an unfavorable LDL/HDL ratio.

As shown in Table 3, the mean of all lipoprotein levels was lower in men over 65 years of age, with the exception of HDL. Moreover, analysis of variance demonstrated a significant difference in the mean TG and VLDL values between men older and younger than 65 years ($p<0.05$). In addition, lipid profiles were compared across three different age groups. According to results presented in Table 4, all lipid parameters except HDL were different to a statistically significant extent among men 25 to 40 years of age, 40 to 65 years of age, and over 65 years of age. Moreover, dyslipidemia was not found to increase with age. The highest prevalence of dyslipidemia was observed in sub-

Table 2. The prevalence of unknown dyslipidemia in study subjects based on a comparison of self-reported *vs*. laboratory results

Fasting lipoprotein level		Known	Unknown	p-value
Total cholesterol	Desirable	86 (15.8)	460 (84.2)	0.10
	Borderline high	29 (16.4)	148 (83.6)	
	High	23 (24.7)	70 (75.3)	
LDL	Optimal	54 (17.1)	262 (82.9)	0.584
	Above optimal	35 (14.7)	203 (85.3)	
	Borderline high	28 (17.5)	132 (82.5)	
	High	11 (20.4)	43 (79.6)	
	Very high	4 (18.2)	18 (81.8)	
HDL	Low	53 (18.9)	227 (81.1)	0.515
	Normal	74 (15.7)	398 (84.3)	
	High	11 (17.2)	53 (82.8)	
TG	Desirable	70 (14.8)	404 (85.2)	0.239
	Borderline high	27 (19.6)	111 (80.4)	
	High	37 (19.6)	152 (80.4)	
	Very high	4 (26.7)	11 (73.3)	
VLDL	Low	0 (0)	5 (100)	0.417
	Normal	91 (17.1)	440 (82.9)	
	High	37 (19.8)	150 (80.2)	
LDL/HDL	Favorable	116 (16.6)	583 (83.4)	0.230
	Unfavorable	11 (21.6)	40 (78.4)	

Values are presented as number (%).
LDL: low-density lipoprotein, HDL: high-density lipoprotein, TG: triglycerides, VLDL: very low-density lipoprotein.

Table 3. Mean±standard deviation of lipid profiles according to age group

Fasting lipoprotein level	Age group (yr)			p-value
	25~40 (n=332)	40~65 (n=180)	>65 (n=300)	
Total cholesterol	187.3±38.5	191.1±45.9	183.9±43.6	0.196
LDL	111.4±39.1	113.8±37.7	113.2±37.3	0.755
HDL	46.1±18.9	44±10.2	46.3±10.1	0.189
TG	177.1±98.1	182±129.1	137.7±69.2	>0.001
VLDL	34.3±16.6	34.2±17.4	27.7±13.8	>0.001
LDL/HDL	2.62±1.1	3.33±7.68	2.53±1.16	0.073

LDL: low-density lipoprotein, HDL: high-density lipoprotein, TG: triglycerides, VLDL: very low-density lipoprotein.

Table 4. Distribution of dyslipidemia prevalence in Iranian men 25 years of age and older depending on age group

Fasting lipoprotein level		Age group (yr)			p-value
		25～40 (n=332)	40～65 (n=180)	>65 (n=300)	
Total cholesterol	Desirable	177 (71.7)	157 (58.6)	212 (70.4)	0.003
	Borderline high	51 (20.6)	66 (24.6)	60 (19.9)	
	High	19 (7.7)	45 (16.8)	29 (9.6)	
LDL	Optimal	114 (47.7)	90 (34.9)	112 (38.2)	0.020
	Above optimal	69 (28.9)	75 (29.1)	94 (32.1)	
	Borderline high	42 (17.6)	58 (22.5)	60 (20.5)	
	High or very high	14 (5.8)	35 (13.6)	27 (9.2)	
HDL	Low	85 (34.4)	102 (38.1)	93 (30.9)	0.187
	Normal	145 (58.7)	150 (56.0)	177 (58.8)	
	High	17 (6.9)	16 (6.0)	31 (10.3)	
TG	Desirable	131 (53.0)	132 (49.3)	211 (70.1)	<0.001
	Borderline high	43 (31.2)	46 (33.3)	49 (35.5)	
	High or very high	73 (29.5)	90 (33.6)	41 (13.6)	
VLDL	Low	3 (1.3)	0 (0)	2 (0.8)	<0.001
	Normal	156 (68.1)	166 (66.4)	209 (85.7)	
	High	70 (30.6)	84 (33.6)	33 (13.5)	
LDL/HDL	Favorable	229 (96.2)	229 (90.2)	241 (93.4)	0.028
	Unfavorable	9 (3.8)	25 (9.8)	17 (6.6)	

Values are presented as number (%).
LDL: low-density lipoprotein, HDL: high-density lipoprotein, TG: triglycerides, VLDL: very low-density lipoprotein.

jects between 40 and 65 years of age. Desirable levels of all lipoproteins except HDL were more common in participants more than 65 years of age than in subjects between 40 to 65 years of age ($p<0.05$).

DISCUSSION

The overall prevalence of dyslipidemia (*i.e.*, the presence of hypercholesterolemia, hypo-HDL, hyper-LDL, or hyper-TG) was 51.8%. This rate has been found to vary among studies conducted in a range of countries. Similar results were reported in a 2005 study of Korean adults that found the dyslipidemia prevalence in the adult population over the age of 30 years to be nearly 50% [7]. However, in a study of Turkish adults, 78.7% of men and 80.4% of women were diagnosed with at least one lipid abnormality [4]. Moreover, 75.7% of Jordanian adults aged 25 years and older were found to be affected by dyslipidemia [11]. Therefore, the dyslipidemia prevalence in Jordanian and Turkish adults has been reported to be higher than the prevalence observed in our study among Iranian subjects. In contrast, a lower prevalence of dyslipidemia has been identified in Pakistan (32.7% of adults) [18] and Canada (14.0% of adults) [2]. Therefore, different lifestyles, access to care, and variations in race or ethnicity may influence the prevalence of hyperlipidemia. Other studies have found inequities in health care utilization according to demographic factors [19-24].

The self-reported prevalence of dyslipidemia was 16.9%, whereas laboratory results found a prevalence of 51.8%. Therefore, a large proportion of patients with dyslipidemia are unaware of their lipid profile and are not taking measures to treat or control their lipid levels. We found that nearly 80% of people affected by hypercholesterolemia, hyper-LDL, hypo-HDL, and unfavorable HDL to LDL ratios were unaware of this. The overall prevalence of hypercholesterolemia was 11.4% and that of hypo-HDL was 34.3%. Sawant et al [1] studied Indian adults and found that the prevalence of hypercholesterolemia and hypo-HDL in men was 38.7% and 64.2%, respectively. In that study, the prevalence of hyper-LDL and hypertriglyceridemia was 9.6% and 25%, respectively. In a study of Jordanian adults aged 25 years and older 48.8% had high TC levels, 40.7% had high LDL, 40.1% had low HDL, and

43.6% had high TG levels [11]. A nationwide study of the Turkish population, with participants ranging from 20 to 83 years of age, found that 43% had high TC, 41.5% had low HDL, 36.2% had high LDL, and 35.7% had high TG [4].

According to the results of the current study, the most prevalent forms of dyslipidemia were hypo-HDL, hyper-VLDL, and hypertriglyceridemia. Another Iranian study [25] conducted in northwestern Iranian urban adults over 20 years old found a prevalence of hypo-HDL of 63% in men. In addition, hypertriglyceridemia was found in 40.6% of subjects, making it the second most prevalent abnormality, and hypercholesterolemia was observed in 35.4% of subjects. Therefore, the dyslipidemia prevalence reported in our study is concordant with those reported by other studies. The most common forms of dyslipidemia in Korean adults were found to be hypo-HDL and hypertriglyceridemia [7]. Identically to our results, hypo-HDL and hypertriglyceridemia were found to be the most prevalent types of dyslipidemia in Mexican adults [6].

Our results showed the highest prevalence of dyslipidemia in men between 40 and 65 years of age. Moreover, the mean values of all lipid parameters were lower in men over 65 years old, with the exception of HDL. Similarly, a Turkish study showed that the prevalence of high TC, LDL, and TG increased with age, with the highest prevalence in the 46- to 65-year-old age group [4]. Recent studies have found age to be associated with dyslipidemia, especially high TG, high LDL, and high TC [1,7,11]. In one study, hypercholesterolemia and hypertriglyceridemia were found to be more prevalent in the 31- to 40-year-old age group than in subjects younger than 31 years old [1]. Analogously, a study in Taiwan found an overall prevalence of hypertriglyceridemia of 13.4%, decreasing to 12.3% in men over 45 years of age, whereas the hypercholesterolemia prevalence was 2.4% higher in men over 45 years of age than in young adult men [15]. In the Nutrition and Health Survey in Taiwan, Chang et al [15] found that cholesterol levels were lower in men over 45 years of age than in other age groups, whereas TG levels were higher above the age of 45 years.

Other studies have shown inhabitants of metropolitan cities to have higher levels of serum cholesterol than those who live in other areas [15]. Qom is one of the major cities of Iran, and urbanization has affected the lifestyle of the population. Therefore, risk factors for NCDs are common and are often undiagnosed in the urban population. In our study, in addition to the high prevalence of the most common forms of dyslipidemia, the prevalence of high VLDL was 25.9% and the LDL to HDL ratio was unfavorable in 6.8% of subjects. In a Canadian cohort study [2], 63.2% of patients with dyslipidemia were untreated. Of those treated, dyslipidemia was not adequately controlled in 47.2% [2]. Although our study estimated the prevalence of dyslipidemia in different age groups and the prevalence of undiagnosed dyslipidemia, it did not determine how many patients were not treated or were inadequately treated. Moreover, dyslipidemia prevalence was not reported according to demographic characteristics such as body mass index and smoking, making further studies necessary.

CONCLUSIONS

The prevalence of dyslipidemia, especially hypo-HDL and hypertriglyceridemia, was higher than expected in Iranian adult men. More than half of men 25 years of age and older were affected by at least one abnormality in their lipid profile. In addition, nearly 80% of patients with dyslipidemia were unaware of having dyslipidemia, suggesting a gap in primary and secondary care. Therefore, urgent preventive programs and lifestyle changes in the form of community-based intervention strategies are necessary to prevent and manage cardiovascular risk factors.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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