Prevalence of Dyslipidemia in Iran: A Systematic Review and Meta-Analysis Study

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ABSTRACT

More than 80% cardiovascular disease (CVD) is preventable despite the fact that it is currently the ultimate cause of disability in the world. Assessment of the nationwide prevalence of dyslipidemia as a major CVD risk factor is essential to efficiently conduct prevention programs. We extracted data according to the cut-off points of dyslipidemia used in each study. All published papers on this topic in Iranian and international journals with affiliation of "Iran" were reviewed using standard keywords up to September 2011. We included all available population-based studies and national surveys conducted in individuals aged ≥ 15 years. We excluded studies with < 300 individuals, non-population-based studies, or duplicated citations. We analyzed by random effect method due to between-study heterogeneity. The estimated prevalence and 95% confidence intervals in 29 eligible articles and one un-published data for hypercholesterolemia (≥200 mg/dl), hypertriglyceridemia (≥150 mg/dl), high levels of low density lipoprotein cholesterol ([LDL-C] [≥ 130 mg/dl]) and low levels of high density lipoprotein cholesterol ([HDL-C] <40 mg/dl in males, <50 mg/dl in females), in Iranian people were 41.6% (36.1-47.0), 46.0% (43.3-48.7), 35.5% (24.0-47.1) and 43.9% (33.4-54.4), respectively among both sexes and in both rural and urban areas. Hypercholesterolemia, high LDL-C and low HDL-C were more prevalent in women, whereas hypertriglyceridemia was more prevalent in men. All types of lipid component abnormalities were more prevalent in urban residents. Prevalence of dyslipidemia is considerable in Iran. It is necessary to enforce current measures of dyslipidemia control in the Iranian people to reduce CVD burden.

Keywords: Cardiovascular disease, dyslipidemia, Iran

Review Article

INTRODUCTION

According to World Health Organization (WHO) statistics four non-communicable diseases (NCDs) including cardiovascular disease (CVD), cancer, chronic respiratory disease and diabetes were the major causes of mortality in the world in 2008.[1] 35 million deaths (60% of total global mortality) annually are due to these diseases.[1] It is anticipated that the mortality rate of NCDs

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will increase by 17% in the next 10 years.[1] Despite this increasing trend of NCDs throughout the world, fortunately more than 80% of heart disease, stroke and type 2 diabetes (and almost one-third of cancers) are preventable.[1]

CVD is a common in the general population. It is not only the ultimate cause of death in adults,[2] but also predictably the definitive cause of disability in the world between the years 2000 and 2025[3] due to increased life expectancy, consumption of western diets, physical inactivity and smoking.[4] As well as in Iran, the most of in-patient admissions for CVD (75%) were suffering from coronary heart disease (CHD).[5] In addition, the economic cost of CVD is high. In 2008, the direct and indirect economic costs of CVD in European Union were estimated at 192 billion Euros.[6] This figure was estimated at 475 billion $ in the US in the same year.[7]

Atherosclerosis of the arterial vessel walls is the most important underlying cause of CVD and dyslipidemia is a major and primary risk factor of atherosclerotic CVD. Plasma levels of lipids vary in normal individuals in different communities due to genetic and life-style differences including variations in dietary and physical activity habits.[8,9] For example, the average levels of total cholesterol (T-C) in western men is reported 202 mg/dl[10] compared to 165 mg/dl among Chinese men.[11]

In the WHO multinational monitoring of trends and determinants in cardiovascular disease (MONICA) project the mean of T-C in 30 countries varied from 158 mg/dl in China-Beijing to 246 mg/dl in Luxemburg among men and from 162 mg/dl in China-Beijing to 246 mg/dl in UK-Glasgow among the women.[12]

Dyslipidemia covers the broad spectrum of lipid abnormalities. However, elevations of T-C and low density lipoprotein cholesterol (LDL-C) have received the most attention. Besides the elevation of T-C and LDL-C levels, other types of lipid profile abnormalities such as low high density lipoprotein cholesterol (HDL-C) levels could also predispose to CVD. Overall, dyslipidemia is defined by T-C, LDL-C, triglyceride (TG), apolipoprotein B and lipoprotein (a) levels in upper the 90th percentile or HDL-C and apolipoprotein A1 levels below the 10th percentile of the general population.[13]

The value of reducing T-C and LDL-C in primary and secondary prevention of CVD is evident based on several epidemiological studies. The seven countries study, WHO MONICA project, multiple risk factor intervention trial, Framingham Heart Study, Migration and Stockholm studies have established the association of plasma cholesterol with risk of CVD.[14-19] The results of a meta-analysis study of 10 large cohort studies revealed that for each 0.6 mmol/l reduction of serum T-C levels in adults aged ≥ 60 years, the risk of CHD end points decreased by 27%.[20]

The national cholesterol education program adult treatment panel III (NCEP ATP III) 2001 guidelines defined hypercholesterolemia as T-C ≥ 240 mg/dl.[21] However, the evidence shows that the risk of CVD events increases with T-C levels > 150 mg/dl.[22] Hence, the precise cut-off value for definition of hypercholesterolemia is a formidable task. In addition according to NCEP ATP III approximately 20% of individuals with desired levels of T-C (150-250 mg/dl) suffering from CVD events; therefore it is crucial to recognize the high risk people in this range of cholesterol levels.[23] The relationship between low HDL-C and CVD risk and protective effect of HDL-C against atherosclerosis are also well-established.[22,24-27] Based on the above mentioned data the decline of the coronary events could be possible by modifying the serum lipid levels. For conducting programs to prevent CVD, first we should know the prevalence of CVD risk factors in the community. Hence, we decided to assess the prevalence of dyslipidemia as a major risk factor of CVD in Iran in a systematic review and meta-analysis study.

METHODS

To obtain all related studies, we searched in Persian databases; Iran Medex, Magiran, SID, Irandoc and also in English databases; Scopus, ISI web of Science and PubMed up to September 2011. The search terms were "lipid," "dyslipidemia," "CVD," "hypercholesterolemia," "hypertriglyceridemia," "prevalence," "public health" and "epidemiology," with affiliation to "Iran" for searching in the English databases and also we used the Farsi equivalent of these terms for search in Persian databases. Moreover, the references of selected citations and non-published national surveys were hand-searched. In addition, we sent at least 3 E-mails to corresponding authors in cases that had incomplete data.

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Inclusion and exclusion criteria

We included all available population-based studies including local, subnational studies and national surveys, which were carried out on individuals with age ≥ 15 years. We excluded studies with fewer than 300 individuals, non-population-based studies, or those with duplicate citation. When there were multiple publications from the same population, only the largest study was included.

Data extraction

Data were collected according to a standard protocol independently by two authors. Disagreement was resolved by discussion between them. In cases could not reach a consensus, a third author was consulted. The extracted information from literature included the name of the first author, the year of publication, the study region, type of study (local study or survey), total sample size, age and sex groups, urban/rural areas, cut-off point of prevalence, reported prevalence and its 95% confidence interval (CI).

Statistical analysis

Heterogeneity of reported prevalence was assessed by the Chi-square-based *Q*-test and was regarded to be statistically significant at $P < 0.1$. In order to gain better insight into the prevalence of dyslipidemia and its heterogeneity throughout Iran, we analyzed our findings using meta-analysis random effect methods model (using the DerSimonian and Laird method) analysis due to the presence of between-study heterogeneity by cut-off values of NCEP ATP III. The analyses were conducted with STATA software, version 11.0, Produced by StataCorp, USA.

RESULTS

In the primary search, we found 181 full text articles that were related to our topic. After considering inclusion and exclusion criteria, we selected 29 articles and 1 hand-searching (non-published, in press) data.[28-57] The number of the initial search results and included studies are shown in the Figure 1. The extracted data from these studies are shown separately in four tables [Tables 1-4]. This includes the prevalence of high levels of T-C, TG, LDL-C and also low levels of HDL-C, respectively according to the population-based studies in the cities of Iran. Due to severe heterogeneity of reported prevalence ($P < 0.001$), meta-analysis was performed by using a random effect method. We estimated the prevalence of each lipid component according to sex, which is observed in a separate table [Table 5]. We found 14 and 11 eligible studies for prevalence of hypercholesterolemia (≥200 mg/dl) and hypertriglyceridemia (≥150 mg/dl), respectively with a total sample size equal to 1,134,874 subjects for hypercholesterolemia and 44,958 subjects for hypertriglyceridemia. The eligible studies for estimation of the prevalence of high LDL-C (≥130 mg/dl) or low HDL-C levels (<40 among males, <50 among females) were 11 and 14 articles, respectively with a total sample size of 26,454 subjects for high LDL-C levels and 74,216 subjects for low HDL-C levels. Our estimated prevalence of hypercholesterolemia and hypertriglyceridemia in those aged > 19 years old among both sexes were 41.6% (CI: 95% 36.1-47.0) and 46.0% (CI: 95% 43.3-48.7), respectively. These figures for prevalence of high LDL-C and low HDL-C levels were 35.5% (CI: 95% 24.0-47.1) and 43.9% (CI: 95% 33.4-54.4), respectively.

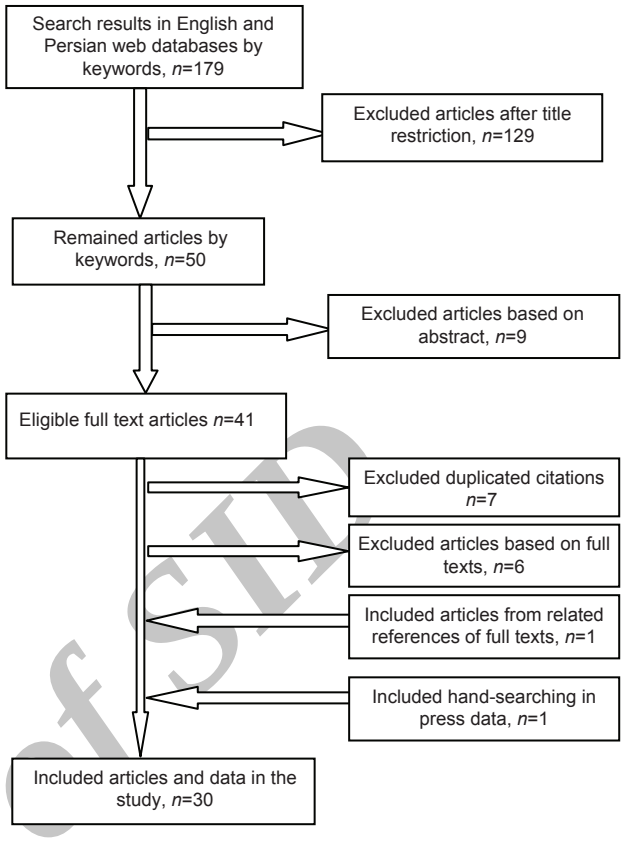

Figure 1: Flow diagram of the study selection process

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Women had a higher prevalence of hypercholesterolemia while men had a higher prevalence of hypertriglyceridemia. These figures for prevalence of hypercholesterolemia were 41.8% (CI: 95% 31.5-52.0) in women versus 38.9% (CI: 95% 31.3-46.5) in men. In hypertriglyceridemic status, the prevalence was 47.0% (CI: 95% 44.3-49.7) in men versus 42.5% (CI: 95% 39.4-45.7) in women.

Table 1: The prevalence of hypercholesterolemia in population-based studies in cities of Iran

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Rafiei *et al*.[28]	Isfahan, local study	1994	19-70	Both	U	>200	T: 2,200 M: 1,000 F: 1,200	T: 66.3 M: 59.9 F: 71.7	T: 64.0-68.0 M: 56.8-62.9 F: 69.0-74.2
Navaei *et al*.[29]	Tehran, local study	1994	>30	Both	R	>239	T: 2,705 M: 1,296 F: 1,409	T: 15.4	T: 14.1-16.8
Barzygar *et al*.[30]	Someesara, local study	1996	>25	Both	Both	>200	T: 2,330 M: 973 F: 1,357 U: 1,007 R: 1,323	T: 46.5	T: 44.4-48.5
Health deputy[31]	Country, national survey	1996	≥15	Both	Both	≥240	T: 61,140	T: 11.1	T: 10.7-11.2
Fakhrzadeh *et al*.[32]	Bushehr, local study	1996-1997	30-64	Both	U	≥200	T: 1,036 M: 370 F: 666	T: 47.6 M: 43.9 F: 50.3	T: 44.5-50.7 M: 38.7-49.0 F: 46.4-54.2
Saeedi *et al*.[33]	Kermanshah, local study	1998	≥20	Both	U	≥200	T: 922 M: 329 F: 593	T: 37.5 M: 34.8 F: 39.1	T: 34.4-40.7 M: 29.5-40.1 F: 35.2-43.2
Karimi *et al*.[34]	Bushehr, local study	1999	>19	Both	U	≥200	T: 1,213 M: 410 F: 796	T: 34.1 M: 29.9 F: 36.2	T: 31.5-36.9 M: 25.6-34.7 F: 32.8-39.6
Azizi *et al*.[35]	Tehran, local study	1999-2001	≥20	Both	U	≥240	T: 11,740 M: 5,069 F: 6,971	T: 23.6 M: 19.3 F: 26.7	T: 22.8-24.4 M: 18.1-20.5 F: 25.6-27.8
Fakhrzadeh *et al*.[36]	Qazvin, local study	2000	>25	Both	U	≥200	T: 1,000 M: 499 F: 501	T: 31.7	T: 28.8-34.7
Shamseddini *et al*.[37]	Kerman, local study	2000	>20	Both	U	≥240	T: 2,048 M: 756 F: 1,292	T: 13.3 M: 12.8 F: 13.6	T: 11.8-14.8 M: 10.5-15.4 F: 11.8-15.6
Mohamadi-fard *et al*.[38]	Isfahan-Najafabad-Arak, local study	2000-2001	>19	Both	Both	>240	T: 12,514 Isfahan, Najafabad T: 6,175 U: 4,873 R: 1,302 Arak T: 6,339 U: 4,220 R: 2,119	 Isfahan, Najafabad T: 20.9 U: 21.4 R: 19.3 Arak T: 16.2 U: 14.1 R: 20.5	 Isfahan, Najafabad T: 20.0-22.0 U: 20.2-22.6 R: 17.2-21.5 Arak T: 15.1-16.9 U: 13.1-15.2 R: 18.8-22.3

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Table 1: Contd...

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Fakhrzadeh *et al*.[39]	Tehran, locall study	2002	25-64	Both	U	>240	T: 1,573 M: 615 F: 958	T: 13.9 M: 10.2 F: 16.3	T: 12.3-15.8 M: 8.0-12.9 F: 14.0-18.8
Agheli *et al*.[40]	Rasht-Qazvin, local study	2003	>30	Both	U	≥240	T: 1,100 Rasht T: 550 M: 285 F: 265 Qazvin T: 550 M: 274 F: 276	 Rasht T: 14.3 M: 6.3 F: 23.0 Qazvin T: 14.2 M: 17.8 F: 10.7	 Rasht T: 11.2-17.2 M: 3.8-9.8 F: 18.1-28.6 Qazvin T: 11.2-17.2 M: 13.5-22.9 F: 7.1-14.7
Amiri *et al*.[41]	Bushehr, local study	2003	25-64	Both	U	≥240	T: 2,092 M: 992 F: 1,100	T: 24.0 M: 21.0 F: 26.7	T: 22.2-25.9 M: 18.5-23.6 F: 24.1-29.4
EsmaeiliNadimi *et al*.[42]	Rafsanjan, local study	2004	>20	Both	U	≥240	T: 491 M: 247 F: 244	T: 20.6	T: 17.1-24.4
Namayandeh *et al*.[43]	Yazd, local study	2004	20-74	Both	U	>200	T: 2,000 M: 1,000 F: 1,000	T: 35.4	T: 32.9-37.1
Nabipour *et al*.[44]	Persian Gulf (Bushehr, Genaveh, Deilam), local study	2004	25-64	Both	Both	≥240	T: 3,723 M: 1,746 F: 1,977	T: 21.9 M: 18.7 F: 24.8	T: 20.7-23.4 M: 16.9-20.6 F: 22.9-26.7
Seyffarshad *et al*.[45]	East Azerbaijan, local study	2004	15-64	Both	Both	>240	T: 3,740 M: 1,876 F: 1,864	T: 10.9 M: 9.0 F: 12.8	T: 10.0-12.0 M: 8.1-9.9 F: 11.7-13.9
Chehrei *et al*.[46]	Arak, national study	2005	25-58	Both	Both	≥200	T: 750 M: 170 F: 580	T: 28.5 M: 30.2 F: 22.9	T: 25.3-31.9 M: 23.2-37.5 F: 19.6-26.6
Alikhani *et al*.[47]	Country, national Survey (NCD)	2005	25-64	Both	Both	>200	T: 65,781 M: 32,842 F: 32,932	T: 45.1 M: 42.7 F: 47.5	T: 44.6-45.7 M: 42.0-43.5 F: 46.8-48.2
Ghoddosi *et al*.[48]	Tehran, local study	2006	≥20	Both	U	≥240	T: 9,483 M: 4,040 F: 5,443	T: 24.0 M: 19.7 F: 26.9	T: 23.1-24.9 M: 18.5-21.0 F: 25.7-28.1
Javadi *et al*.[49]	Minoodar, local study	2007	≥20	F	U	≥240	F: 400	F: 21.0	F: 17.1-25.3
Hatmi *et al*.[50]	Tehran, local study	2007	≥18	Both	Both	>200	T: 3,000 M: 1,619 F: 1,381	T: 61.0	T: 59.2-62.7
Asgari *et al*.[51]	Country, national Survey (NCD)	2007	25-64	Both	Both	≥200	T: 19,017 M: 9,078 F: 9,939	T: 32.9 M: 29.5 F: 36.4	T: 31.6-34.2 M: 27.8-31.3 F: 34.7-38.1

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Table 1: Contd...

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Asgari *et al*.[51]	Country, national survey (NCD)	2007	25-64	Both	Both	≥250	T: 19,017 M: 9,078 F: 9,939	T: 7.3 M: 5.6 F: 8.9	T: 6.7-7.9 M: 5.0-6.3 F: 8.0-9.9
Sharifi *et al*.[52]	Northwestern of Iran, local study	2008	>20	Both	U	>200	T: 2,941	T: 35.4	T: 33.3-36.7
Health Ministry[53]	Country, national survey (NCD)	2011	25-64	Both	Both	>200	T: 5,438 M: 2,029 F: 3,406	T: 27.1 M: 21.0 F: 17.0	T: 25.8-28.2 M: 19.2-22.8 F: 15.7-18.3
Health Ministry[53]	Country, national survey (NCD)	2011	25-64	Both	Both	>250	T: 5,438 M: 2,029 F: 3,406	T: 5.3 M: 4.1 F: 6.6	T: 4.7-6.0 M: 3.2-4.9 F: 5.8-7.5

n=Number, CI=Confidence interval, T=Total, M=Male, F=Female, NCD=Non-communicable disease, U=Urban, R=Rural

Table 2: The prevalence of hypertriglyceridemia in population-based studies in cities of Iran

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Rafiei *et al*.[28]	Isfahan, local study	1994	19-70	Both	U	>200	T: 2,200 M: 1,000 F: 1,200	T: 44.8 M: 47.0 F: 43.0	T: 42.0-46.1 M: 43.9-50.1 F: 40.2-45.8
Navaei *et al*.[29]	Tehran, local study	1994	>30	Both	R	>200	T: 2,705 M: 1,296 F: 1,409	T: 33.0	T: 31.2-34.8
Barzygar *et al*.[30]	Someesara, local study	1996	>25	Both	Both	>240	T: 2,330 M: 973 F: 1,357 U: 1,007 R: 1,323	T: 23.0	T: 21.3-24.8
Azizi *et al*.[54]	Tehran, local study	1998-2001	≥20	Both	U	≥150	T: 9,846 M: 4,223 F: 5,623	T: 46.0 M: 51.0 F: 42.0	T: 45.0-47.0 M: 49.5-52.5 F: 40.7-43.3
Karimi *et al*.[34]	Bushehr, local study	1999	>19	Both	U	≥200	T: 1,213 M: 410 F: 796	T: 13.0 M: 19.0 F: 10.0	T: 11.2-15.0 M: 15.3-23.2 F: 8.0-12.3
Azizi *et al*.[35]	Tehran, local study	1999-2001	≥20	Both	U	>400	T: 11,740 M: 5,069 F: 6,971	T: 4.2 M: 5.3 F: 3.4	T: 3.8-4.6 M: 4.6-6.0 F: 2.9-3.9
Fakhrzadeh *et al*.[36]	Qazvin, local study	2000	>25	Both	U	≥150	T: 1,000 M: 499 F: 501	T: 55.0	T: 51.8-58.1
Shamseddini *et al*.[37]	Kerman, national study	2000	>20	Both	U	≥150	T: 2,048 M: 756 F: 1,292	T: 44.0 M: 39.0 F: 41.0	T: 41.8-46.2 M: 35.5-42.6 F: 38.3-43.8

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Table 2: Contd...

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Mohamadi-fard *et al*.[38]	Isfahan-Najafabad-Arak, national study	2000-2001	>19	Both	Both	>200	T: 12,514 Isfahan, Najafabad T: 6,175 U: 4,873 R: 1,302 Arak T: 6,339 U: 4,220 R: 2,119	 Isfahan, Najafabad T: 22.9 U: 28.7 R: 32.9 Arak T: 23.8 U: 26.5 R: 18.5	 Isfahan, Najafabad T: 21.9-24.1 U: 27.4-30.0 R: 30.3-35.5 Arak T: 22.9-25.1 U: 25.2-27.8 R: 16.9-20.3
Gharipour *et al*.[55]	Isfahan-Najafabad-Arak, local study	2000-2001	≥20	Both	Both	≥150	T: 12,514 Isfahan, Najafabad T: 6,175 U: 4,873 R: 1,302 Arak T: 6,339 U: 4,220 R: 2,119	 Isfahan, Najafabad T: 49.2 U: 49.0 R: 50.0 Arak T: 43.3 U: 46.0 R: 38.0	 Isfahan, Najafabad T: 47.7-50.2 U: 47.6-50.4 R: 47.2-52.7 Arak T: 41.8-44.2 U: 44.5-47.5 R: 35.9-40.1
Fakhrzadeh *et al*.[39]	Tehran, local study	2002	25-64	Both	U	>200	T: 1,573 M: 615 F: 958	T: 33.2 M: 34.1 F: 32.6	T: 30.7-35.4 M: 30.8-37.4 F: 30.3-34.9
Agheli *et al*.[41]	Rasht-Qazvin, local study	2003	>30	Both	U	>200	T: 1,100 Rasht T: 550 M: 285 F: 265 Qazvin T: 550 M: 274 F: 276	 Rasht T: 37.9 M: 36.0 F: 40.0 Qazvin T: 29.0 M: 27.0 F: 31.0	 Rasht T: 33.9-42.2 M: 30.5-42.0 F: 34.0-46.2 Qazvin T: 25.3-33.1 M: 21.8-32.7 F: 25.7-37.0
Amiri *et al*.[40]	Bushehr, local study	2003	25-64	Both	U	≥150	T: 2,092 M: 992 F: 1,100	T: 56.0 M: 49.0 F: 53.0	T: 53.8-58.1 M: 45.8-52.1 F: 50.0-56.0
Nabipour *et al*.[44]	Persian Gulf (Bushehr, Genaveh, Deilam), local study	2003-2004	25-64	Both	Both	≥150	T: 3,723 M: 1,746 F: 1,977	T: 49.3 M: 53.0 F: 46.0	T: 47.4-50.6 M: 50.6-55.3 F: 43.8-48.2
EsmaeiliNadimi *et al*.[42]	Rafsanjan, local study	2004	>20	Both	U	>200	T: 491 M: 247 F: 244	T: 32.0	T: 27.9-36.3
Chehrei *et al*.[46]	Arak, local study	2005	25-58	Both	Both	≥150	T: 750 M: 170 F: 580	T: 29.0 M: 31.0 F: 29.0	T: 25.7-32.3 M: 24.3-38.7 F: 25.3-32.8

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Table 2: Contd...

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Malek *et al*.[56]	Semnan-Damghan-Shahrood-Garmsar, local study	2005	30-70	Both	Both	≥150	T: 3,799 M: 1,695 F: 2,104 U: 2,715 R: 1,084	T: 47.3 M: 49.0 F: 46.0 U: 49.0 R: 43.0	T: 45.4-48.6 M: 46.6-51.4 F: 43.9-48.2 U: 47.1-50.9 R: 40.0-46.0
Ghoddosi *et al*.[48]	Tehran, local study	2006	≥20	Both	U	>400	T: 9,483 M: 4,040 F: 5,443	T: 4.0 M: 5.0 F: 3.0	T: 3.6-4.4 M: 4.3-5.7 F: 2.5-3.5
Javadi *et al*.[49]	Minoodar, local study	2007	≥20	F	U	>150	F: 400	F: 36.0	F: 31.3-40.9
Hatmi *et al*.[50]	Tehran, local study	2007	≥18	Both	Both	>200	T: 3,000 M: 1,619 F: 1,381	T: 32.0	T: 30.3-33.7
Asgari *et al*.[51]	Country, national survey (NCD)	2007	25-64	Both	Both	≥200	T: 19,017 M: 9,078 F: 9,939	T: 19.2 M: 21.8 F: 16.6	T: 18.6-19.8 M: 20.4-23.2 F: 15.3-18.1
Sharifi *et al*.[52]	Northwestern of Iran, local study	2008	>20	Both	U	>150	T: 2,941	T: 40.6	T: 39.2-42.8
Health Ministry[53]	Country, national survey (NCD)	2011	25-64	Both	Both	≥200	T: 5,435 M: 2,029 F: 3,406	T: 19.4 M: 21.5 F: 17.4	T: 18.0-20.1 M: 19.2-22.8 F: 15.7-18.3

n=Number, CI=Confidence interval, T=Total, M=Male, F=Female, NCD=Non-communicable disease, U=Urban, R=Rural

Table 3: The prevalence of high level of LDL-C in population-based studies in cities of Iran

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Rafiei *et al*.[28]	Isfahan, local study	1994	19-70	Both	U	>130	T: 2,200 M: 1,000 F: 1,200	T: 63.3 M: 54.0 F: 71.0	T: 60.9-65.0 M: 50.8-57.1 F: 68.3-73.5
Navaei *et al*.[29]	Tehran, local study	1994	>30	Both	R	>130	T: 2,705 M: 1,296 F: 1,409	T: 41.0	T: 39.1-42.9
Barzygar *et al*.[30]	Someesara, local study	1996	>25	Both	Both	>130	T: 2,330 M: 973 F: 1,357 U: 1,007 R: 1,323	T: 41.0	T: 39.0-43.0
Karimi *et al*.[34]	Bushehr, local study	1999	>19	Both	U	≥130	T: 1,213 M: 410 F: 796	T: 24.0 M: 20.0 F: 27.0	T: 21.6-26.5 M: 16.2-24.2 F: 23.9-30.2
Azizi *et al*.[35]	Tehran, local study	1999-2001	≥20	Both	U	≥160	T: 11,740 M: 5,069 F: 6,971	T: 22.8 M: 19.8 F: 24.9	T: 22.0-23.6 M: 18.6-21.0 F: 23.8-26.0

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Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Fakhrzadeh *et al*.[36]	Qazvin, local study	2000	>25	Both	U	>130	T: 1,000 M: 499 F: 501	T: 25.0	T: 22.3-27.8
Mohamadi-fard *et al*.[38]	Isfahan-Najafabad-Arak, local study	2000-2001	>19	Both	Both	>160	T: 12,514 Isfahan, Najafabad T: 6,175 U: 4,873 R: 1,302 Arak T: 6,339 U: 4,220 R: 2,119	Isfahan, Najafabad T: 31.2 U: 31.0 R: 31.8 Arak T: 30.4 U: 26.0 R: 39.1	Isfahan, Najafabad T: 29.8-32.2 U: 29.7-32.3 R: 29.3-34.4 Arak T: 28.9-31.1 U: 24.7-27.4 R: 37.0-41.2
Fakhrzadeh *et al*.[39]	Tehran, local study	2002	25-64	Both	U	>160	T: 1,573 M: 615 F: 958	T: 1.7 M: 1.3 F: 2.0	T: 1.1-2.5 M: 0.8-1.8 F: 1.3-2.7
Agheli *et al*.[40]	Rasht-Qazvin, local study	2003	>30	Both	U	≥150	T: 1,100 Rasht T: 550 M: 285 F: 265 Qazvin T: 550 M: 274 F: 276	Rasht T: 18.3 M: 12.0 F: 25.0 Qazvin T: 16.5 M: 14.0 F: 19.0	Rasht T: 14.9-21.5 M: 8.4-16.3 F: 19.8-30.6 Qazvin T: 13.0-19.3 M: 10.0-18.5 F: 14.4-24.0
Amiri *et al*.[41]	Bushehr, local study	2003	25-64	Both	U	≥130	T: 2092 M: 992 F: 1,100	T: 49.7 M: 46.0 F: 53.0	T: 47.8-52.2 M: 42.8-49.1 F: 50.0-56.0
Nabipour *et al*.[44]	Persian Gulf (Bushehr, Genaveh, Deilam), local study	2003-2004	25-64	Both	Both	≥160	T: 3,723 M: 1,746 F: 1,977	T: 19.6 M: 17.0 F: 22.0	T: 18.3-20.9 M: 15.3-18.8 F: 20.2-23.9
EsmaeiliNadimi *et al*.[42]	Rafsanjan, local study	2004	>20	Both	U	≥130	T: 491 M: 247 F: 244	T: 33.0	T: 28.8-37.3
Namayandeh *et al*.[43]	Yazd, local study	2004	20-74	Both	U	>130	T: 2,000 M: 1,000 F: 1,000	T: 26.7	T: 25.1-29.0
Chehrei *et al*.[46]	Arak, local study	2005	25-58	Both	Both	≥130	T: 750 M: 170 F: 580	T: 20.0 M: 27.0 F: 25.0	T: 17.2-23.0 M: 20.5-34.4 F: 21.5-28.7
Ghoddosi *et al*.[48]	Tehran, local study	2006	≥20	Both	U	≥160	T: 9,483 M: 4,040 F: 5,443	T: 20.0 M: 25.0 F: 2.0	T: 19.2-20.8 M: 23.7-26.4 F: 1.6-2.4

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Table 3: Contd...

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Javadi *et al*.[49]	Minoodar, local study	2007	≥20	F	U	≥160	F: 400	F: 4.0	F: 2.3-6.4
Hatmi *et al*.[50]	Tehran, local study	2007	≥18	Both	Both	>130	T: 3,000 M: 1,619 F: 1,381	T: 45.5	T: 43.7-47.3
Health Ministry[53]	Country, national survey (NCD)	2011	25-64	Both	Both	>130	T: 5,409 M: 2,030 F: 3,379	T: 13.4 M: 12.2 F: 14.5	T: 12.1-13.9 M: 10.6-13.5 F: 12.8-15.2

n=Number, CI=Confidence interval, T=Total, M=Male, F=Female, NCD=Non-communicable disease, U=Urban, R=Rural, LDL-C=Low density lipoprotein cholesterol

In addition, hypercholesterolemia and hypertriglyceridemia were more common among urban than rural residents.

The prevalence of high LDL-C and low HDL-C levels were greater among women and urban residents. These figures for prevalence of high LDL-C were 40.2% (CI: 95% 19.8-60.5) in women versus 34.7% (CI: 95% 16.8-52.6) in men. The prevalence of low HDL-C were 47.6% (CI: 95% 30.9-64.2) in women versus 40.6% (CI: 95% 23.6-57.6) in men. The details of these estimations are shown in Table 5.

DISCUSSION

Our findings indicate that the prevalence of dyslipidemia regarding sex differences is considerable in Iran. Overall the abnormalities of lipid components were more common among men in urban areas. Speedy urbanization, unhealthy diet and inactivity are underlying reasons for the high prevalence of dyslipidemia in Iran.[58,59] Usually, in practice only T-C is measured, whilst low level of T-C may result in hiding the abnormal level of TG and HDL-C. So, we considered all components of lipid in our systematic search. In the following sections, we discuss and compare our findings with those of other countries.

Hypercholesterolemia

According to the report of Tehran Lipid Glucose Study which was held in the metropolitan city of Tehran among nearly half of Tehranian adults, mean T-C level was 210 mg/dl.[35] So, the prevalence of hypercholesterolemia in Iran was expected to be high. We estimated the overall prevalence of high T-C (≥200 mg/dl) levels in adult aged ≥ 18 years in our country to be 41.6% (36.1-47.0). This was according to the population-based studies in different cities of Iran among both sexes and in both rural and urban areas. This figure shows that the prevalence of hypercholesterolemia in Iran is higher relative to Eastern Asian countries. The corresponding figure was approximately 33% in Chinese aged 35-74 years,[60] 17.2% in Nepali people[61] and 23.2% in Eastern Indians.[62] On the other hand in western European countries, hypercholesterolemia is prevailing more relative to our country. The prevalence of high T-C was 48% in the UK adults aged 19-64 years[63] and 56.7% in adults aged 30-70 in Portugal.[64] In U.S, it was reported to be 40.5% and 45.8% among non-Hispanic white men and women, respectively aged ≥ 20 years by the American Heart Association in 2013.[65] The prevalence of hypercholesterolemia in our neighbouring countries in the middle east crescent varies from 54% in Saudi Arabians aged 30-70 years,[66] to 37.5% in Turkish people aged ≥ 20 years,[67] and 36.9% of Lebanese aged 18-65 years.[68] We found that similar to most of the other studies hypercholesterolemia was more prevalent in Iranian women.

Hypertriglyceridemia

In our study, the reported prevalence of adult hypertriglyceridemia (≥150 mg/dl) in both sexes and in both rural and urban areas was 46.0% (43.3-48.7). This figure shows that the prevalence of hypertriglyceridemia in Iran is higher relative to most other western or eastern countries.

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Table 4: The prevalence of low level of HDL-C in population-based studies in cities of Iran

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Navaei *et al*.[29]	Tehran, local study	1994	>30	Both	R	<35	T: 2,705 M: 1,296 F: 1,409	T: 44.0	T: 42.1-45.9
Barzygar *et al*.[30]	Someesara, local study	1996	>25	Both	Both	<35	T: 2,330 M: 973 F: 1,357 U: 1,007 R: 1,323	T: 28.0	T: 26.2-29.8
Saeedi *et al*.[33]	Kermanshah, local study	1998	≥20	Both	U	<35	T: 922 M: 329 F: 593	T: 14.0	T: 11.8-16.4
Azizi *et al*.[54]	Tehran, local study	1998-2001	≥20	Both	U	M: <40 F: <50	T: 9,846 M: 4,223 F: 5,623	T: 69.0 M: 64.0 F: 73.0	T: 68.1-69.9 M: 62.5-65.4 F: 71.8-74.2
Karimi *et al*.[34]	Bushehr, local study	1999	>19	Both	U	<35	T: 1,213 M: 410 F: 796	T: 16.0 M: 21.0 F: 14.0	T: 14.0-18.2 M: 17.1-25.2 F: 11.6-16.5
Azizi *et al*.[35]	Tehran, local study	1999-2001	≥20	Both	U	<35	T: 11,740 M: 5,069 F: 6,971	T: 21.1 M: 32.0 F: 13.3	T: 20.3-21.9 M: 30.6-33.4 F: 12.4-14.2
Fakhrzadeh *et al*.[36]	Qazvin, local study	2000	>25	Both	U	<40	T: 1,000 M: 499 F: 501	T: 54.0	T: 50.8-57.1
Mohamadi-fard *et al*.[38]	Isfahan-Najafabad-Arak, local study	2000-2001	>19	Both	Both	<40	T: 12,514 Isfahan, Najafabad T: 6,175 U: 4,873 R: 1,302 Arak T: 6,339 U: 4,220 R: 2,119	Isfahan, Najafabad T: 23.5 U: 24.1 R: 21.2 Arak T: 27.2 U: 29.8 R: 22.1	Isfahan, Najafabad T: 21.9-24.1 U: 22.9-25.3 R: 19.0-23.5 Arak T: 25.9-28.1 U: 28.4-31.2 R: 20.4-24.0
Fakhrzadeh *et al*.[39]	Tehran, local study	2002	25-64	Both	U	<40	T: 1,573 M: 615 F: 958	T: 13.9 M: 19.6 F: 10.3	T: 12.3-15.8 M: 19.4-19.8 F: 8.8-11.8
Agheli *et al*.[40]	Rasht-Qazvin, local study	2003	>30	Both	U	<35	T: 1,100 Rasht T: 550 M: 285 F: 265 Qazvin T: 550 M: 274 F: 276	Rasht T: 46.5 M: 60.0 F: 32.0 Qazvin T: 10.0 M: 15.0 F: 5.0	Rasht T: 41.8-50.3 M: 54.0-65.7 F: 26.5-38.1 Qazvin T: 7.6-12.8 M: 10.9-19.7 F: 2.8-8.4

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Table 4: Contd...

Reference	Location and type of study	Year	Age-group (year)	Sex	Urban/ Rural	Cut-off point (mg/dl)	Sample size (*n*)	Prevalence (%)	CI 95% prevalence
Amiri *et al*.[41]	Bushehr, local study	2003	25-64	Both	U	<40	T: 2,092 M: 992 F: 1,100	T: 61.0 M: 28.0 F: 52.0	T: 58.9-63.1 M: 25.2-30.9 F: 49.0-55.0
Nabipour *et al*.[44]	Persian Gulf (Bushehr, Genaveh, Deilam), local study	2003-2004	25-64	Both	Both	<40	T: 3,723 M: 1,746 F: 1,977	T: 47.4 M: 58.0 F: 38.0	T: 45.4-48.6 M: 55.7-60.3 F: 35.8-40.2
EsmaeiliNadimi *et al*.[42]	Rafsanjan, local study	2004	>20	Both	U	<35	T: 491 M: 247 F: 244	T: 8.0	T: 5.7-10.7
Namayandeh *et al*.[43]	Yazd, local study	2004	20-74	Both	U	M: <40 F: <50	T: 2,000 M: 1,000 F: 1,000	T: 24.2	T: 22.1-26.0
Chehrei *et al*.[46]	Arak, local study	2005	25-58	Both	Both	<40	T: 750 M: 170 F: 580	T: 32.0 M: 29.0 F: 42.0	T: 28.7-35.5 M: 22.1-36.2 F: 38.0-46.2
Malek *et al*.[56]	Semnan-Damghan-Shahrood-Garmsar, local study	2005	30-70	Both	Both	M: <40 F: <50	T: 3,799 M: 1,695 F: 2,104 U: 2,715 R: 1,084	T: 30.6 M: 9.0 F: 48.0 U: 29.0 R: 36.0	T: 28.5-31.5 M: 7.6-10.4 F: 45.8-50.2 U: 27.3-30.7 R: 33.1-38.9
Barzin *et al*.[57]	Tehran, local study	2005-2008	≥20	Both	U	<40	T: 9,483 M: 4,043 F: 5,440	T: 45.0 M: 62.0 F: 32.0	T: 44.0-46.0 M: 60.5-63.5 F: 30.8-33.3
Ghoddosi *et al*.[48]	Tehran, local study	2006	≥20	Both	U	<35	T: 9,483 M: 4,040 F: 5,443	T: 7.0 M: 31.0 F: 13.0	T: 6.5-7.5 M: 29.6-32.4 F: 12.1-13.9
Javadi *et al*.[49]	Minoodar, local study	2007	≥20	F	U	<35	F: 400	F: 15.0	F: 11.6-18.9
Hatmi *et al*.[50]	Tehran, local study	2007	≥18	Both	Both	<35	T: 3,000 M: 1,619 F: 1,381	T: 5.0	T: 4.2-5.8
Asgari *et al*.[51]	Country, national survey (NCD)	2007	25-64	Both	Both	M: <40 F: <50	T: 19,057 M: 9,090 F: 9,967	T: 60.4 M: 49.7 F: 70.2	T: 59.7-61.1 M: 47.5-51.9 F: 68.5-71.8
Sharifi *et al*.[52]	Northwestern of Iran, local study	2008	>20	Both	U	M: <40 F: <50	T: 2,941	T: 73.0	T: 71.3-74.6
Health Ministry[53]	Country, national survey (NCD)	2011	25-64	Both	Both	M: <40 F: <50	T: 5,438 M: 2,034 F: 3,404	T: 53.9 M: 45.0 F: 62.9	T: 52.7-55.3 M: 42.8-47.2 F: 61.4-64.6

n=Number, CI=Confidence interval, T=Total, M=Male, F=Female, NCD=Non-communicable disease, U=Urban, R=Rural, HDL-C=High density lipoprotein cholesterol

The corresponding figure is 27% in US,[65] 25% in Sweden,[69] 19.2%in Italy,[70] 26% in Portugal,[64] and 12.5% in Switzerland.[71] In Asia, the prevalence of high TG is reported to be 26.35% in Taiwanese aged 40-65 years,[72] 29.3% in Malaysia,[73] 37.7% in Eastern India[62] and 48.3% in Nepal.[61] The report

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Table 5: The overall prevalence of lipid components according to ATPIII cut-off among sex by random effect meta-analysis of data extracted from population-based studies in Iran

Variable	Cut-off point (mg/dl)	Extracted articles (*n*)	Sample size (*n*)	Prevalence (%)	CI 95%
T-C	>200	M=9	M=48,567	M: 38.9	M: 31.3-46.5
		F=9	F=54,019	F: 41.8	F: 31.5-52.0
		T=14	T=113,874	T: 41.6	T: 36.1-47.0
Heterogeneity T-C	I2square	M: 99.9%	*P*<0.001		
		F: 100.0%	*P*<0.001		
		T: 99.9%	*P*<0.001		
TG	>150	M=9	M=21,013	M: 47.0	M: 44.3-49.7
		F=10	F=20,401	F: 42.5	F: 39.4-45.7
		T=11	T=44,958	T: 46.0	T: 43.3-48.7
Heterogeneity TG	I2square	M: 98.3%	*P*<0.001		
		F: 98.8%	*P*<0.001		
		T: 99.3%	*P*<0.001		
LDL-C	>130	M=6	M=6,798	M: 34.7	M: 16.8-52.6
		F=6	F=10,828	F: 40.2	F: 19.8-60.5
		T=11	T=26,454	T: 35.5	T: 24.0-47.1
Heterogeneity LDL-C	I2square	M: 99.9%	*P*<0.001		
		F: 100.0%	*P*<0.001		
		T: 100.0%	*P*<0.001		
HDL-C	M: <40	M=11	M=33,701	M: 40.6	M: 23.6-57.6
	F: <50	F=11	F=34,574	F: 47.6	F: 30.9-64.2
		T=14	T=74,216	T: 43.9	T: 33.4-54.4
Heterogeneity HDL-C	I2square	M: 100.0%	*P*<0.001		
		F: 100.0%	*P*<0.001		
		T: 100.0%	*P*<0.001		

T-C=Total cholesterol, TG=Triglyceride, LDL-C=Low density lipoprotein cholesterol, HDL-C=High density lipoprotein cholesterol, T=Total, M=Male, F=Female, CI=Confidence interval. *Just in one article was reported prevalence of dyslipidemia according to sex

from our neighbouring Middle Eastern countries vary from 40.3% in Saudi Arabia[66] and 41.6% in Iraq,[74] to 35.3% in Lebanon,[68] 30.4% in Turkey,[67] and 20.7% in Oman.[75] The higher prevalence of high TG in our country relative to most of the studies elsewhere might be due to higher intake simple carbohydrates and higher ratio of simple to complex carbohydrate consumption by the Persian people.[76] We observed higher prevalence of hypertriglyceridemia in Iranian males similar to findings in most other countries.

High LDL-C levels

The reported prevalence of high LDL-C (≥130 mg/dl) levels in adults of both sexes in both rural and urban areas was 35.5 (24.0-47.1) % in our study. The corresponding figure was 30.1% and 29.3%, respectively in adult US non-Hispanic white men and women,[65] 20.8% in Switzerland,[71] 24.8% in China,[60] and 46.9% among Indians aged ≥ 20 years.[62] The reports from our neighbouring countries in the middle East varied from 32.1% from Lebanon,[68] to 44.5% in Turkey.[67] These figures were higher among urban women in most of the studies.

Low HDL-C levels

The reported prevalence of low levels of HDL-C (<40 in males, <50 in females) among adults of both sexes and in both rural and urban areas was 43.9 (33.4-54.4) %. This figure was reported as 33.1% and 12.4%, respectively in adult US non-Hispanic white men and women[65] and 53.4% in Switzerland.[71] The corresponding figure

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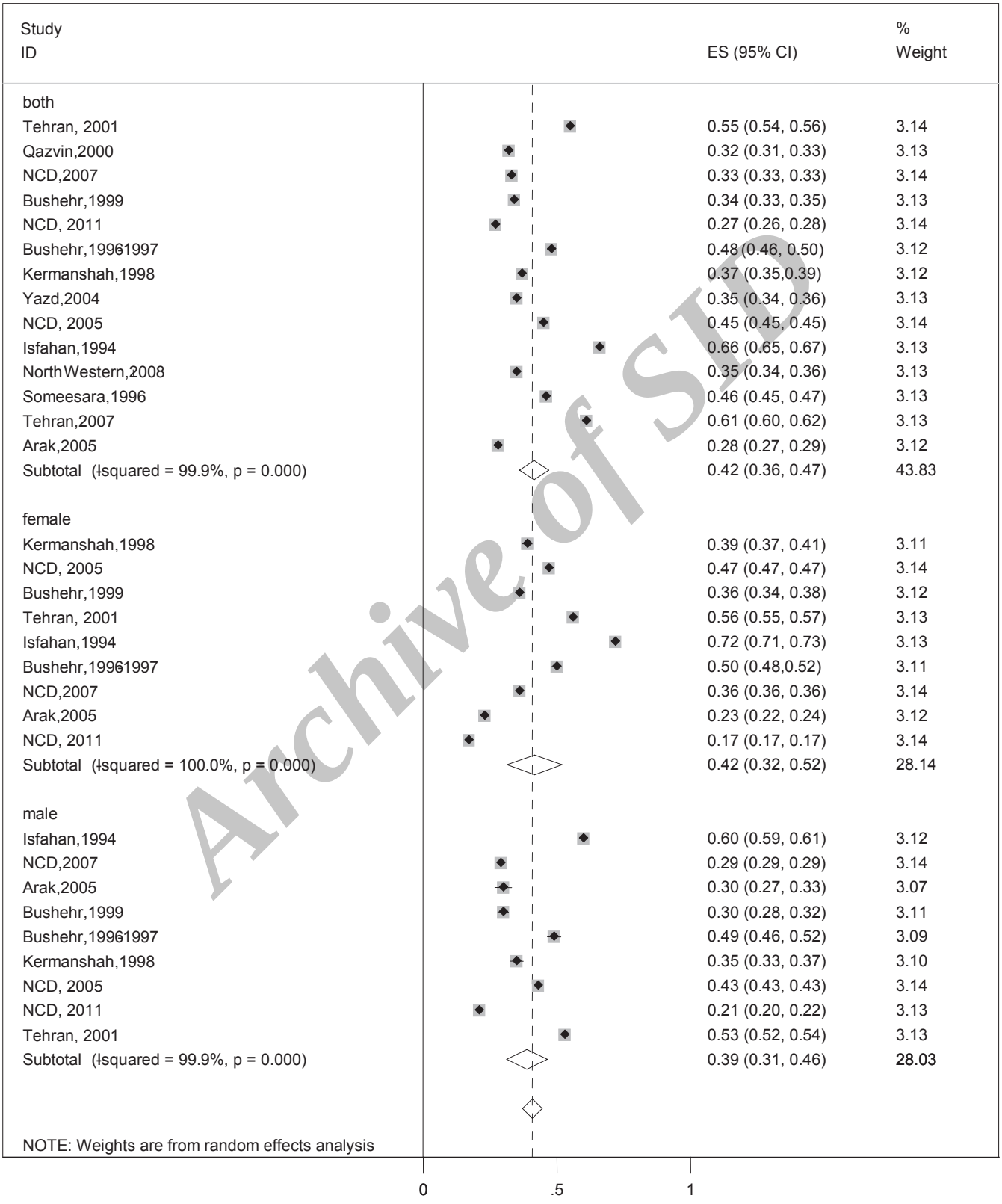

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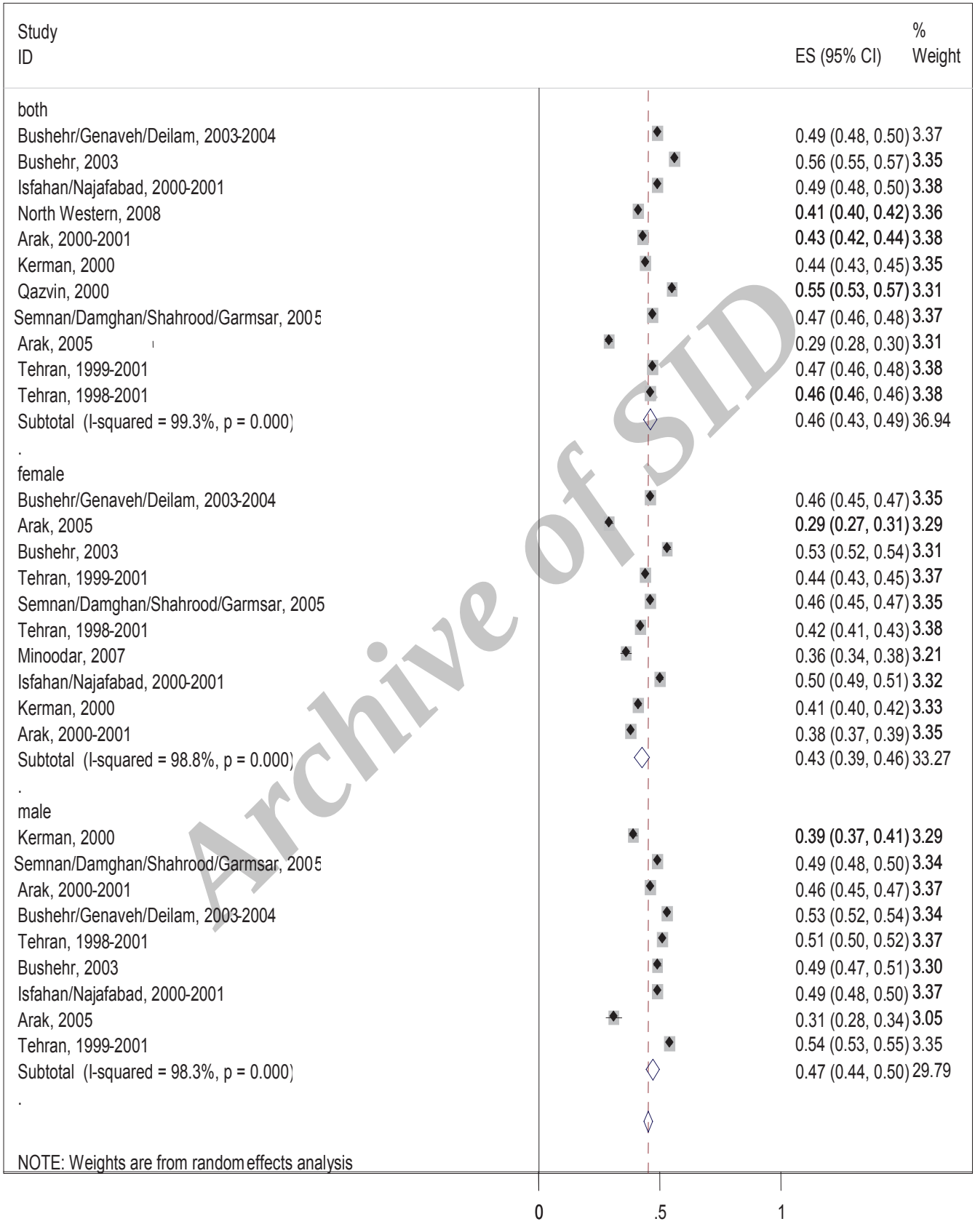
TG



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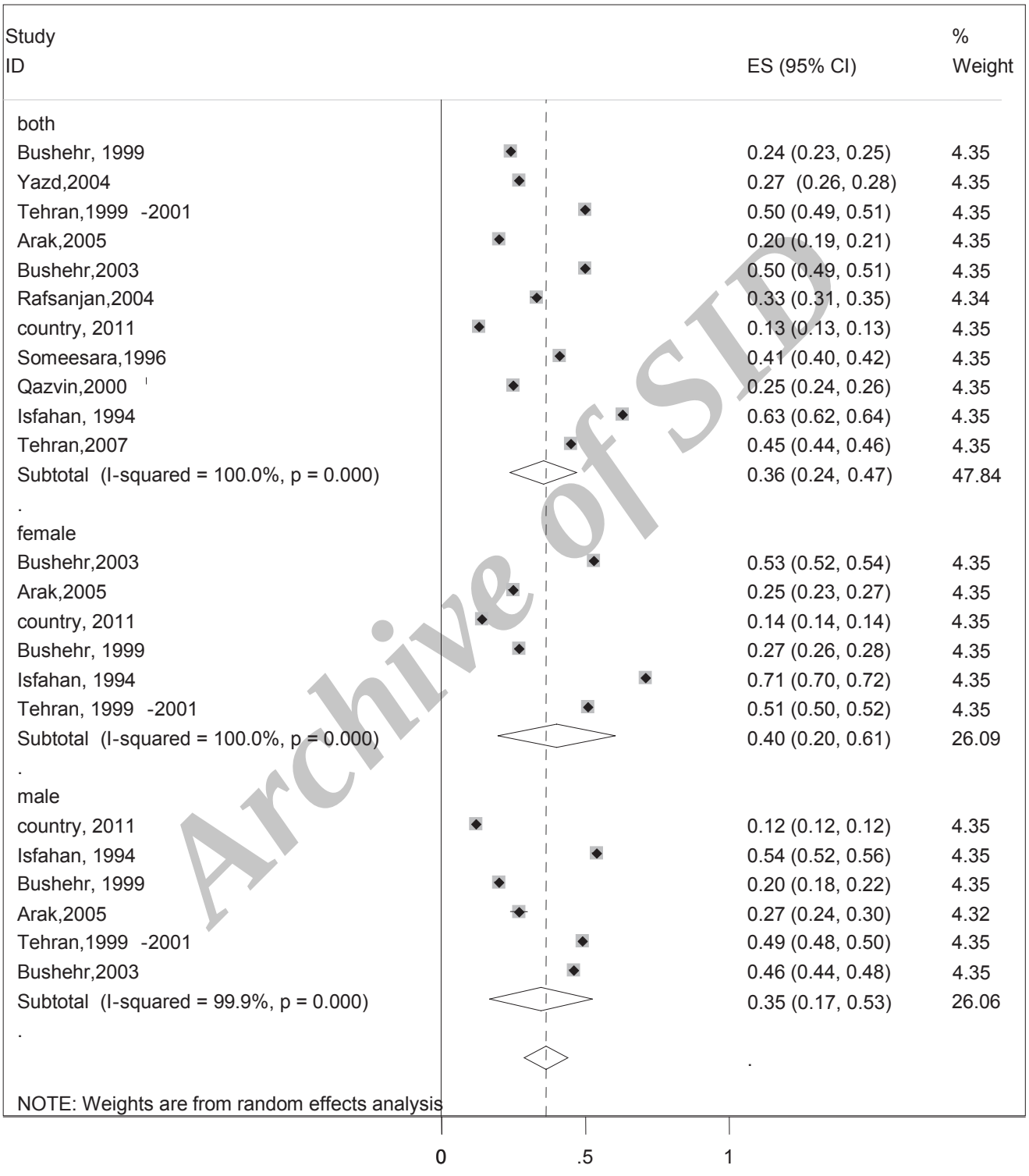
LDL



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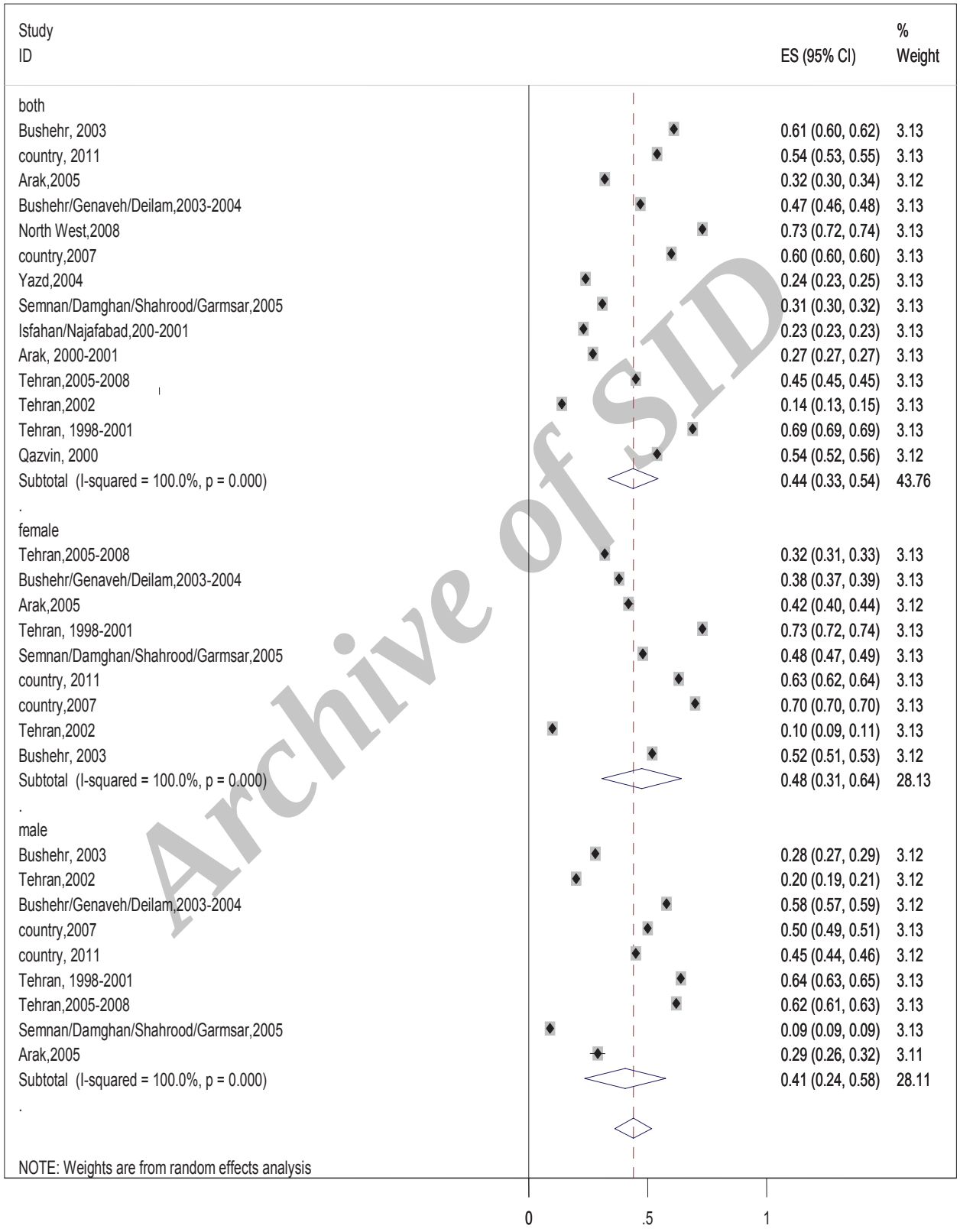
HDL



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in the East Asian region was 56.7% in Nepal,[61] 54.75% in Taiwan,[72] 37.2% in Malaysia,[73] 33.4% in Korea,[77] 22.5% in Eastern India,[62] and 19.2% in China.[60] The reports from our neighbouring countries were 49.9% in Iraq,[74] 49.3% in Lebanon,[68] 21.1% in Turkey,[67] and 75.4% in Oman.[75] In our study in contrast to others this figure among females was higher than males.

CONCLUSIONS

Based on the above study it can be concluded that although different population-based studies have been performed in Iran to define the prevalence of lipid profile abnormalities, we observed some heterogeneities in the data expressed by different authors. Although determining the definite prevalence of dyslipidemia is an arduous task by these population-based studies, it is obvious that abnormalities in lipid components are fairly prevalent in Iran.

So Health Care Organizations in Iran should execute well-defined programs to control of dyslipidemia in the general population more efficaciously. For example, lipid clinic can be effective in the management of lipid profile and cardiovascular risk of dyslipidemic patients.[78]

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