

# Prevalence of dyslipidemia in Iranian children and adolescents: A systematic review

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**Background:** Dyslipidemia is considered as an important modifiable risk factor for cardiovascular disease (CVD). The link between childhood dyslipidemia and occurrence of atherosclerosis and its sequels in adulthood are well-documented. This study aimed to systematically review the prevalence of dyslipidemia among Iranian children and adolescents. **Materials and Methods:** An electronic search was conducted on studies published from January 1990 to January 2014. The main international electronic data sources were PubMed and the NLM Gateway (for MEDLINE), Institute of Scientific Information (ISI), and SCOPUS. For Persian databases, we used domestic databases with systematic search capability including IranMedex, Irandoc, and Scientific Information Database (SID). We included all available population-based studies and national surveys conducted in the pediatric age group (aged <21 years). **Results:** In this review, 1772 articles were identified (PubMed: 1464; Scopus: 11; ISI: 58; SID: 90; IranMedex: 149; Irandoc: 57). During three refine steps and after removing of duplicates, 182 articles related to the study domain were selected. After quality assessment, 46 studies were selected for text appraisal, of which 26 qualified articles were evaluated at the final step. The prevalence range of hypercholesterolemia, hypertriglyceridemia, elevated low-density lipoprotein cholesterol, and low high-density lipoprotein cholesterol (HDL-C) were 3-48%, 3-50%, 5-20% and 5-88%, respectively. Low HDL-C and hypertriglyceridemia were the most prevalent lipid disorders in this group of population. **Conclusion:** Dyslipidemia is a common health problem among Iranian children and adolescents. Few data were available in preschool children. This finding provides useful information for health policy makers to implement action-oriented interventions for prevention and early control of this important CVD risk factor.

**Key words:** Dyslipidemia, Iran, lipid profile, pediatrics, prevalence, systematic review

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## INTRODUCTION

Metabolic risk factors (MRFs) including dyslipidemia are considered as the most important determinants of emerging noncommunicable diseases worldwide as reported by the Global Burden of Disease (GBD) studies in 1990, 2000, and 2013.<sup>[1-8]</sup> Dyslipidemia is the disorder of lipoprotein metabolism that result in elevated levels of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides, or decreased high-density lipoprotein cholesterol (HDL-C).<sup>[9]</sup> It is considered as an important modifiable risk factor for cardiovascular disease (CVD) and leading cause of morbidity and mortality worldwide.<sup>[10]</sup>

Though most of its types are not associated with significant adverse health outcomes in childhood, but a growing body of evidence indicated the tracking of CVD risk factors and a link between childhood dyslipidemia

and occurrence of atherosclerosis and its sequels in adulthood.<sup>[11,12]</sup> It is reported that 40-55% of children with dyslipidemia will have hyperlipidemia during adulthood.<sup>[13]</sup> It is well-established that subclinical atherosclerotic abnormalities, which result in CVD events, occurs in childhood.<sup>[14]</sup>

The recent striking increase of CVD risk factors in the pediatric age group, especially in developing countries, suggests that this group of population is at risk of epidemic of premature CVD in the near future.<sup>[15,16]</sup> Prevention and control of CVD risk factors, including dyslipidemia, from early life may act as primordial, primary, or secondary prevention.<sup>[17]</sup> To address this issue, we need scientific evidences on a different aspect of disorder epidemiology. Several studies worldwide have investigated the prevalence of dyslipidemia in children and adolescents, and have reported a wide range of variety in different regions.<sup>[18-20]</sup>

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Iran has been experiencing a rapid epidemiological transition, and is facing a double burden of the diseases due to urbanization and nutrition transition.<sup>[21,22]</sup> A nationwide survey conducted in Iranian and adolescents reported a prevalence of 45.7% for dyslipidemia, notably in terms of low HDL-C and hypertriglyceridemia.<sup>[23]</sup> There are also few regional studies in this field in Iran, but the findings are scattered or are limited to different subgroups of population. There are a few studies on the sub national distribution of the disorder among children, and there is no information about their trends and their effects on the health.<sup>[24-26]</sup>

It seems that a comprehensive epidemiological feature of dyslipidemia would help us to provide baseline information regarding the burden of disease, research priorities, appropriate allocation of health system resources, and establishing proper screening programs.<sup>[27-29]</sup>

Therefore, it can be assumed that planning preventive programs from early life may be considered as a priority for the health system to attenuate the burden of CVDs. The aim of the current study was to systematically review the prevalence of dyslipidemia among Iranian children and adolescents to provide baseline information for policy makers for future preventative and interventional strategies at individual and public health levels.

## MATERIALS AND METHODS

This nationwide study was conducted in the framework of the national and sub-national burden of diseases study. The details of the study are reported previously.<sup>[30,31]</sup>

This study was designed as a systematic review on the prevalence of dyslipidemia among Iranian pediatric population at national and sub-national levels in Iran,

from 1990 to 2013. Regional ethics committee of Isfahan University of Medical Sciences and Tehran University of Medical Sciences approved the protocol of the current systematic review.

### Search strategy

By an electronic search, studies published from January 1990 to January 2014 were used. The main international electronic data sources were PubMed and the NLM Gateway (for MEDLINE), Institute of Scientific Information (ISI), and SCOPUS. For Persian documents, domestic databases with systematic search capability including Iranmedex, Irandoc, and Scientific Information Database (SID), were used. For each database, strategies were run separately regarding the detailed practical instruction including filters and refining processes.

The search terms limited to:

1. National, provincial, district, community population-based studies,
2. The pediatric age group, that is, under 23 years
3. Iran,
4. Human subject, and without restriction on language.

The medical subject headings and Emtree of Scopus were used to reach the most comprehensive and efficient search. For the national search engines, the Persian keywords were equivalent to their English search terms, and all probable combinations were considered [Table 1]. We excluded papers of nonpopulation-based studies or those with duplicate citation. For multiple publications of the same population, only the article with largest sample size was included.

### National data sources

We used the aggregated data of Childhood and Adolescence Surveillance and Prevention of Adult Non-Communicable

**Table 1: Search strategy for dyslipidemia in Iranian pediatric population**

Search strategy for dyslipidemia
Dyslipidemia/hyperlipidemia/lipid profile/HDL-C/LDL-C/cholesterol/triglyceride
Search strategy in PubMed/Medline
(TITLE-ABS-KEY (Dyslipidemia OR hyperlipidemia OR lipid profile OR HDL-C OR LDL-C OR cholesterol OR triglyceride)) AND (TITLE-ABS-KEY (Iran OR Iranian OR I.R. Iran OR Persia) OR (AFFIL (Iran))) AND (TITLE-ABS-KEY (Children OR student OR School-aged OR Preschool OR Preschool OR youth OR Teenagers OR Adolescent OR Boy OR Girl))
Search strategy in ISI Web of Science
(TITLE-ABS-KEY (Dyslipidemia OR hyperlipidemia OR lipid profile OR HDL-C OR LDL-C OR cholesterol OR triglyceride)) AND (TITLE-ABS-KEY (Iran OR Iranian OR I.R. Iran OR Persia) OR (AFFIL (Iran))) AND (TITLE-ABS-KEY (Children OR student OR School-aged OR Preschool OR Preschool OR youth OR Teenagers OR Adolescent OR Boy OR Girl))
Search strategy in Scopus
(TITLE-ABS-KEY (Dyslipidemia OR hyperlipidemia OR lipid profile OR HDL-C OR LDL-C OR cholesterol OR triglyceride)) AND (TITLE-ABS-KEY (Iran OR Iranian OR I.R. Iran OR Persia) OR (AFFIL (Iran))) AND (TITLE-ABS-KEY (Children OR student OR School-aged OR Preschool OR Preschool OR youth OR Teenagers OR Adolescent OR Boy OR Girl))
IranMedex, SID and Irandoc
"Dyslipidemia," "hyperlipidemia," "lipid profile," "HDL-C," "LDL-C," "cholesterol," "triglyceride," "charbi e khun," "student," "children," "adolescent," "daneshamouzan," "koudakan"

LDL-C = Low-density lipoprotein cholesterol; HDL-C = High-density lipoprotein cholesterol; SID = Scientific Information Database

Disease (CASPIAN I and III) study as the main available national data source for the cardio MRFs of children and adolescents in Iran.<sup>[32,33]</sup>

### Study selection and quality evaluation

The entire text or summary of all searched articles, documents, and reports were extracted. After reviewing and studying the titles of documents, the repeated items were excluded, and then, the full texts of articles were carefully studied by researchers. The related articles were selected, and the irrelevant ones were excluded.

The quality of the documents was evaluated independently by two research experts for the objective of each research project, study method, sample size, sampling method, data collection tool, variables evaluation status, and the studied target group. Using Cohen's kappa statistic, the kappa statistic for agreement for quality assessment was 0.92. After selection of eligible papers, data were extracted to predefined standard electronic data extraction sheets.

## RESULTS

In this review, 1772 articles were identified through electronic database search (PubMed: 1464; Scopus: 11; ISI: 58; SID: 90; IranMedex: 149; Irandoc: 57). During three refine steps and after removing of duplicates, 182 articles related to the study domain were selected. After quality assessment, 46 studies were selected for text appraisal, of which 26 qualified articles were evaluated at the final step.<sup>[34-59]</sup> Overall, 4 of 26 articles were from the CASPIAN I and III studies [Figure 1]. Three of the selected papers were from Tehran Lipid and Glucose Study, which is a

cohort study, the rest of papers were cross-sectional studies conducted in different parts of Iran.

Considering the whole data of systematic review results and national data sources; the number of total population and points of data were 40,440, and 92, respectively. From reported points of data, 36 of them were for total population and 29 and 27 of them were for girls and boys, respectively. As well as regarding the geographically distribution, we find 2 national, 7 provincial, and 5 district level points of data.

The difference between two above values is related to some cases that did not report separation of two different sexes or in some of the studies, the studied population were only girls.

One of the articles (1 out of 26) was related to lipid measurements in the neonatal period.<sup>[43]</sup> According to that study, female neonates had higher TC and HDL-C than male neonates ( $81.4 \pm 28.3$  vs.  $75.2 \pm 21.1$ ,  $P = 0.02$ , and  $31.18 \pm 9.97$  vs.  $28.8 \pm 8.7$ ,  $P = 0.02$ , respectively).

Data related to children below 6 years old were available only in Tehran Lipid and Glucose Study.<sup>[39,47]</sup> Accordingly, prevalence of hypercholesterolemia, hypertriglyceridemia, elevated LDL-C, and low HDL-C among children below 6 years old were 8% (95%CI: 5.47-11.12), 3% (95%CI: 1.6-5.34), 10% (95%CI: 7.10-5.34), and 12% (95%CI: 8.93-15.8), respectively. All types of dyslipidemia in this age group except hypertriglyceridemia were significantly higher in girls than boys.<sup>[39]</sup>

Most of the studies (76.9%; 20/26) presented data related to children above 6 years old. The findings of CASPIAN I and III studies which were the only nationwide study in children aged 6-18 years, showed that estimate prevalence rate of hypercholesterolemia, hypertriglyceridemia, elevated LDL-C and low HDL-C in CASPIAN I (2003-2004) was 6.4% (5.27-7.13), 24.5% (23.29-15.07), 6.3% (5.63-7.03), and 24.8% (23.58-26.08), respectively. Estimated prevalence rate of hypercholesterolemia, hypertriglyceridemia, elevated LDL-C, and low HDL-C in CASPIAN III (2009-2010) was 5.6% (5.0-6.20), 7.9% (7.2-8.6), 5.7% (5.1-6.3), and 35.36% (34.1-36.6), respectively.

Tables 2-5 represent the prevalence of hypercholesterolemia, hypertriglyceridemia, elevated LDL-C, and low HDL-C in population-based studies in Iranian children and adolescences during 1990-2013. The prevalence of different types of dyslipidemia was based on definitions used in mentioned studies.

In Table 2, the prevalence rates of hypercholesterolemia reported by national and regional studies, in different

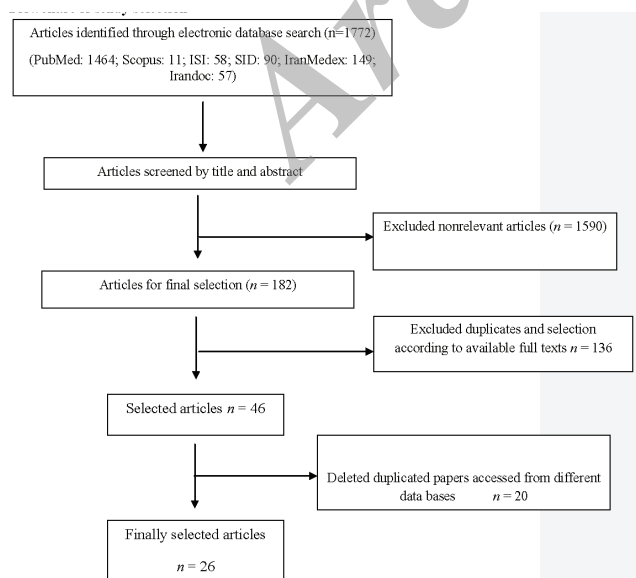


Figure 1: Flowchart of study selection

**Table 2: The prevalence of hypercholesterolemia in population-based studies in Iranian children and adolescences of Iran: 1990-2013**

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI mean	Prevalence (%)	95% CI prevalence
Kelishadi <i>et al.</i> 2014 <sup>[31]</sup>	Isfahan	1993	6-18	Both	Urban	1	4800	-	-	-	26.5	25.2-27.8
		1999	6-18	Both	Urban	1	4800	-	-	-	28.2	26.88-29.53
		1999-2000	3-19	Both	Urban	3	T: 3147 G: 1699 B: 1448	T: 170 G: 173 B: 167	33 32 33	168.84-171.15 171.47-174.52 165.32-168.67	T: 16 G: 18 B: 14	3 14.7-17.31 16.1-19.8 11.87-15.4
Azizi <i>et al.</i> 2001 <sup>[32]</sup>	Tehran TLGS	1999-2000	3-6	Both	Urban	3	T: 389 G: 191 B: 198	T: 172 G: 174 B: 170	28 29 28	169.2-174.79 169.86-178.13 166.07-173.92	T: 16 G: 19 B: 14	3 12.6-20.2 13.56-25.12 9.18-19.21
		1999-2000	7-10	Both	Urban	1	T: 668 G: 353 B: 313	T: 175 G: 179 B: 171	34 35 32	172.41-177.58 175.33-182.66 167.44-177.58	T: 17 G: 21 B: 15	3 14.14-19.97 16.83-25.58 11.24-19.46
		1999-2000	11-13	Both	Urban	3	T: 715 G: 381 B: 334	T: 172 G: 173 B: 170	33 34 31	169.57-176.42 169.75-176.52 166.66-173.33	T: 18 G: 18 B: 17	3 15.29-21.06 14.37-22.35 13.18-21.53
		1999-2000	14-16	Both	Urban	3	T: 729 G: 389 B: 340	T: 166 G: 170 B: 162	33 31 36	163.60-168.39 166.9-173.09 158.15-165.84	T: 13 G: 14 B: 12	3 10.67-15.69 10.6-17.72 8.79-16.00
					1						1	1
											T: 10 G: 10 B: 10	7.93-12.42 7.22-13.45 7.02-13.69

Table 2: (Continued)

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI mean	Prevalence (%)	95% CI prevalence
Kotcharian <i>et al.</i> 2002 <sup>[33]</sup>	Tehran	1999-2000	17-19	Both	Urban	3	T: 646 G: 383 B: 263	T: 167 G: 170 B: 163	32 31 33	164.52-169.47 166.88-173.11 158.99-167.00	3 T: 16 G: 18 B: 13	3 13.2-18.99 14.29-22.23 9.12-17.59
Azizi <i>et al.</i> 2002 <sup>[34]</sup>	TLGS	1999-2001	3-19	Both	Urban	2	T: 4269-4526 G: 2269-2366 B: 2000-2160	G: 172 B: 166	32 33	-	1 T: 11 G: 12 B: 10	1 8.68-13.66 8.92-15.69 6.55-14.14
Ghods <i>et al.</i> 2004 <sup>[35]</sup>	Tabriz	2002-2003	14-18	G	Urban	3	232	158.07	42.7	152.5-163.5	19.4	14.5-25.1
Badiee <i>et al.</i> 2008 <sup>[36]</sup>	Isfahan	2008	Neonates	Both	Urban	-	T: 378 G: 191 B: 187	T: 78.3 G: 81.4 B: 75.2	2.8 28.3 21.2	78.0-78.58 77.4-85.4 72.1-78.2	-	-
Fesharakinia <i>et al.</i> 2008 <sup>[37]</sup>	South Khorasan province	2006	7-12	Both	Both	3	T: 1326 G: 685 B: 641	T: 152.1 G: 154 B: 150	24.2 23.2 25.3	150.8-153.4 152.2-155.7 148.0-151.9	3	2-4
Mirhosseini <i>et al.</i> 2009 <sup>[38]</sup>	Mashhad	2007	7-12	Both	Urban	3	1028	152	23.7	150.5-153.4	-	-
Fesharakinia <i>et al.</i> 2009 <sup>[39]</sup>	South Khorasan province	2006	9-11	Both	Both	2	T: 954 G: 521 B: 433	T: 151.7	24.2	150.2-153.26	T: 3.4	2.39-4.82
Kelishadi <i>et al.</i> 2009 <sup>[27]</sup>	CASPIAN I	2000	9-11	Both	Urban	2	730	-	-	-	3.3	2.1-4.8
Moradi <i>et al.</i> 2011 <sup>[40]</sup>	TLGS	2000	9-11	Both	Rural	2	224	-	-	-	4.0	1.8-7.4
			6-18	Both	Both		T: 4811 T: 505 G: 175 B: 330	148.8 T: 171.73 G: 173.3 B: 170.9	33.9 1.67 2 1.5	147.9-149.8 171.58-171.87 173.00-173.59 170.73-171.06	T: 6.4	5.72-7.13
		2000	7-12	Both	Urban		T: 1480 G: 500 B: 980	T: 174.87 G: 176.6 B: 174	1.16 1.5 1	174.81-174.92 176.46-176.73 173.93-174.06	G: 28.7 B: 21.1	45.9-51.5 38.2-44.04
		2000	13-17	Both	Urban		T: 1634 G: 573 B: 1061	T: 168.05 G: 170 B: 167	1.07 1.2 1	167.99-168.10 169.90-170.09 166.93-167.06		
		2003	3-6	Both	Urban		T: 258 G: 83 B: 175	T: 162.24 G: 165.3 B: 160.8	2.6 3.3 2.3	161.92-162.55 164.57-166.02 160.45-161.14		

(Continued)

Table 2: (Continued)

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI mean	Prevalence (%)	95% CI prevalence
2003			7-12	Both	Urban		T: 710	T: 164.89	1.50	164.77-	G: 32.7	29.12-36.46
							G: 244	G: 166.6	1.9	1665.00	B: 27.3	23.7-31.03
							B: 466	B: 164	1.3	166.36-166.83		
2003			13-17	Both	Urban		T: 942	T: 152.48	1.13	1613.88-164.11		
							G: 324	G: 153.4	1.4	152.40-152.55		
							B: 618	B: 152	1	153.24-153.55		
2005			3-6	Both	Urban		T: 219	T: 162.54	2.76	151.92-152.07		
							G: 66	G: 167.3	3.6	161.1-161.89		
							B: 153	B: 160.5	2.4	166.41-168.18		
2005			7-12	Both	Urban		T: 671	T: 161.55	1.54	160.11-160.88		
							G: 231	G: 162.6	2.0	161.38-161.61	G: 32.4	28.5-36.5
							B: 440	B: 161	1.3	162.34-162.85	B: 23.8	20.33-27.53
2005			13-17	Both	Urban		T: 773	T: 151.95	1.36	160.87-161.12		
							G: 254	G: 153.9	1.7	151.85-152.04		
							B: 519	B: 151	1.2	153.68-154.11		
2000-2001	Isfahan		11-18	Both	Both	3	T: 486	T: 165.30	32.44	150.89-151.10	T: 12.13	9.3-15.3
							G: 269	G: 169.35	32.13	162.40-168.19	G: 14.5	10.6-12.5
							B: 217	B: 160.30	32.84	165.3-173.3	B: 9.2	5.7-13.8
Mirhosseini <i>et al.</i> 2012 <sup>(42)</sup>	Mashhad		15-18	G	Urban	4	477	154	30	78-200	21	17.3-24.8
Khashayar <i>et al.</i> 2013 <sup>(35)</sup>	CASPIAN III	2009-2010	10-18	Both	Both	3	T: 5738	T: 148.4	31.7	147.57-149.22	T: 5.6	5.0-6.2
							G: 2875	G: 145.5	31.5	144.34-146.65	G: 5	4.2-5.8
							B: 2863	B: 51.1	31.6	50.34-52.65	B: 6.3	5.4-7.2

Cut off: >90<sup>th</sup> percentile = 1; >95 percentile = 2; >200 mg/dl = 3; >170 mg/dl = 4. CI = Confidence interval; T = Total; B = Boys; G = Girls; CASPIAN = Childhood and adolescence surveillance and prevention of adult nonCommunicable disease; TLGS = Tehran lipid and glucose study; SD = Standard deviation

age and sex groups are presented. The number of total population and points of data were 40,440, and 89 (34 for total, 29 for girls and 26 for boys), respectively. A wide range of hypercholesterolemia was reported by mentioned studies. Some of them reported a rate of <10%, some between 10% and 20% and there were studies which reported >30%. The rate was 5-7% and 5-6% in CASPIAN I and III, respectively. It seems that hypercholesterolemia was more prevalent among girls, but it was not different between urban and rural areas.

In Table 3, the prevalence rates of hypertriglyceridemia in different age and sex groups reported by national and regional studies are presented. The number of total population and points of data were 39782 and 76 (29 for total, 25 for girls and 22 for boys), respectively. Reported prevalence rates of hypertriglyceridemia varied with a range of 3-50%. The rate was 24-26% and 7-9% in CASPIAN I and III, respectively. The rate was similar between urban and rural. The prevalence rates regarding gender differences were varied in different studies.

Reported prevalence rates of elevated LDL-C reported by national and regional studies according to age and sex groups are presented in Table 4. The number of total population and points of data were 38,194 and 92 (36 for total, 27 for girls and 29 for boys), respectively. The range of elevated LDL-C in Iranian children and adolescences were between 5% and 20%, there was one report for 30%. The rate was 5-7% in both CASPIAN I and III studies. The rate was similar between urban and rural. The prevalence rates regarding gender differences were varied in different studies.

The prevalence rates of low HDL-C according to national and regional reports in different age and sex groups are presented in Table 5. The number of total population and points of data were 40,194 and 77 (30 for total, 25 for girls and 22 for boys), respectively. The prevalence of low HDL-C has been reported to be between 6% and 33%, there were two studies with a higher rate of low HDL-C (53-57%) among adolescents. The rate was 24-26% and 34-37% in CASPIAN I and III, respectively. The rate of low HDL-C was higher in one study among the rural population. The prevalence rates regarding gender differences were varied in different studies.

## DISCUSSION

In this study, we systematically reviewed studies that reported the prevalence of dyslipidemia among Iranian pediatric population. Iranian neonates have a higher level of TG in comparison with other countries.<sup>[43]</sup> Hypertriglyceridemia and low HDL-C are considered as

the most common lipid disorder among Iranian children and adolescents (34, 35, 38-450).<sup>[31,34]</sup>

Children with dyslipidemia are predicted to have symptomatic coronary artery disease before the age of 30.<sup>[60]</sup> So that it shall be considered as the main target of intervention for preventive strategies.<sup>[61]</sup> Some experts propose screening of dyslipidemia in children and adolescents.<sup>[11]</sup>

Available data have indicated an increasing prevalence rate of dyslipidemia in most countries worldwide. A recent study indicated that dyslipidemia is affecting 1 in 5 adolescents, although most are mild or moderate abnormalities.<sup>[62]</sup>

The National Health and Nutrition Examination Survey (NHANES) (1999-2006) in the United States of America (USA) have reported that the prevalence of dyslipidemia among 3,125 youths aged 12-19 years was 20.3%.<sup>[63]</sup> But, according to a recent report, the prevalence of hypercholesterolemia, high LDL-C, and high TG continue to decrease in the USA.<sup>[64]</sup> The increasing trend is more significant in developing countries as Iran because of urbanization, epidemiologic transition, notably nutrition transition.<sup>[65,66]</sup>

In our literature review, we did not find any systematic review on the prevalence of dyslipidemia among children. Prevalence of dyslipidemia among the adult Iranian population was reported in a recent study.<sup>[67]</sup> Data regarding the prevalence of dyslipidemia in different parts of the world are obtained from cross-sectional, longitudinal, and national studies.

In the current study, the most commonly used sources of data were from different surveys of the CASPIAN study, as the only nationwide study in this field in Iran.<sup>[28,34,35]</sup> In addition, the data of a number of community-based epidemiological studies at smaller scales were included, as well.

The results of this review showed that the prevalence range of hypercholesterolemia, hypertriglyceridemia, elevated LDL-C, and low HDL-C among Iranian children and adolescents were 3-48%, 3-50%, 5-20%, and 5-88%, respectively.

According to the results of Korea NHANES IV (2007-2009), the prevalence of hypercholesterolemia, high LDL-C, high TG, and low HDL-C was 6.5%, 4.7%, 10.1%, and 7.1%, respectively, among 2363 subjects aged 10-18 years.<sup>[18]</sup>

Prevalence of hypercholesterolemia among 200 schoolchildren aged 12-18 years was 50% in India.<sup>[68]</sup>

**Table 3: The prevalence of hypertriglyceridemia in population-based studies in Iranian children and adolescences of Iran: 1990-2013**

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI	Prevalence (%)	95% CI prevalence
Kelishadi <i>et al.</i> 2014 <sup>[31]</sup>	Isfahan	1993	6-18	Both	Urban	1	4500	-	-	-	26.5	25.2-27.8
Azizi <i>et al.</i> 2001 <sup>[32]</sup>	Isfahan	1999	6-18	Both	Urban	1	4500	-	-	-	32	30.63-33.38
	Tehran	1999-2000	3-19	Both	Urban	1	T: 3148 G: 1701 B: 1447	T: 106 G: 108 B: 103	59 56 62	103.93-108.06 105.33-110.66 99.80-106.19	T: 10 G: 10 B: 10	8.94-11.07 8.60-11.51 8.45-11.61
	TLGS		3-6	Both	Urban	1	T: 388 G: 191 B: 197	T: 87 G: 90 B: 84	36 37 35	83.40-90.59 84.71-95.28 79.08-88.91	T: 3 G: 3 B: 3	1.6-5.34 1.16-6.71 1.12-6.51
			7-10	Both	Urban	1	T: 669 G: 356 B: 313	T: 96 G: 98 B: 93	49 47 51	92.28-99.71 93.1-102.89 87.32-98.67	T: 7 G: 7 B: 6	5.20-9.23 4.59-10.19 3.69-9.31
Kotcharian <i>et al.</i> 2002 <sup>[33]</sup>	Tehran	2002	11-13	Both	Urban	1	T: 716 G: 382 B: 334	T: 117 G: 128 B: 105	64 69 65	112.3-121.69 121.05-134.94 98.00-119.99	T: 15 G: 19 B: 11	12.41-17.76 14.81-22.85 7.66-14.6
			14-16	Both	Urban	1	T: 729 G: 389 B: 340	T: 111 G: 114 B: 107	61 59 63	106.56-115.43 108.11-119.88 100.27-113.72	T: 11 G: 11 B: 11	8.79-13.47 8.11-14.59 7.77-14.68
			17-19	Both	Urban	1	T: 646 G: 383 B: 263	T: 110 G: 100 B: 124	66 49 84	104.9-115.43 95.07-104.92 113.80-134.19	T: 11 G: 7 B: 16	8.68-13.66 4.91-10.39 11.75-20.96
			12	Both	Urban	1	T: 927 G: 460 B: 467	T: 105.6 G: 106.9 B: 104.3	52.7 48.06 56.56	102.2-108.9 102.5-111.3 99.1-109.4		
Azizi <i>et al.</i> 2002 <sup>[34]</sup>	TLGS	1999-2001	3-19	Both	Urban	2	T: 4269-4526 G: 2269-2366 B: 2000-2160	G: 106 B: 103	54 60	- -	T: 5.0 G: 5.1 B: 5.0	T: 4.4-5.6 G: 4.2-6.0 B: 4.1-5.9
Ghods <i>et al.</i> 2004 <sup>[35]</sup>	Tabriz	2002-2003	14-18	G	Urban	4	232	94.9	42.6	89.4-100.4	3	1.2-6.1
Badiee <i>et al.</i> 2008 <sup>[36]</sup>	Isfahan	2008	Neonates	Both	Urban	-	T: 378 G: 191 B: 187	G: 62 (median) B: 61 (median)		30-350 28-172		
Fesharakinia <i>et al.</i> 2008 <sup>[37]</sup>	South Khorasan province	2006	7-12	Both	Both	3	T: 1326 G: 685 B: 641	T: 87 G: 87 B: 87	36.8 34.1 39.7	85.0-88.9 84.4-89.5 83.9-90.1	T: 5.4	4.2-6.7
			7-12	Both	Urban	3	1028	86	34.7	83.9-88.1		
			9.6±1.2	Both	Rural	3	298	92	41.8	87.2-96.8		
Mirhosseini <i>et al.</i> 2009 <sup>[38]</sup>	Mashhad	2007	7-12	Both	Rural	5	622	94.9	41.5	91.6-98.2	24.5	21.1-28.0
Fesharakinia <i>et al.</i> 2009 <sup>[39]</sup>	South Khorasan province	2006	15-17	G	Urban	2	T: 954 G: 521 B: 433	T: 88.0	35.6	85.7-90.2	T: 6.5	5.0-5.2
			16.2 (0.9)	Both	Both	2	730					
			9-11	Both	Urban	2	224				6.3	4.6-8.3
			9-11	Both	Rural	2					7.1	4.1-11.3

Table 3: (Continued)

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI	Prevalence (%)	95% CI prevalence
Kelishadi <i>et al.</i> 2009 <sup>[27]</sup>	CASPIAN I		6-18	Both	Both		4811	96.3	21.7	94.9-97.7	24.5	23.29-25.74
Moradi <i>et al.</i> 2011 <sup>[40]</sup>	TLGS	2000	3-6	Both	Urban		T: 505 G: 175 B: 330	T: 87.36 G: 89 B: 86.5	2.17 2.7 1.9	87.17-87.54 88.59-89.40 86.29-86.70		
		2000	7-12	Both	Urban		T: 1478 G: 500 B: 978	T: 101.89 G: 105.6 B: 100	1.73 2.2 1.5	101.80-101.97 105.40-105.79 99.90-100.09	T: 13.9 G: 15.2 B: 13.2	12.79-15.07 13.25-17.31 11.27-15.32
		2000	13-17	Both	Urban		T: 1634 G: 573 B: 1061	T: 113.96 G: 113.9 B: 114	2.17 2.5 2.0	113.85-114.06 113.69-114.10 113.87-114.12		
		2003	3-6	Both	Urban		T: 258 G: 83 B: 175	T: 81.12 G: 83.5 B: 80	2.75 3.7 2.3	80.78-81.45 82.69-84.30 79.65-80.34		
		2003	7-12	Both	Urban		T: 710 G: 244 B: 466	T: 102.02 G: 105.9 B: 100	2.74 3.4 2.4	101.99-102.40 105.47-106.32 99.78-100.21	T: 10.9 G: 12.2 B: 10.3	9.57-12.42 9.78-14.94 8.00-12.97
		2003	13-17	Both	Urban		T: 942 G: 324 B: 618	T: 103.96 G: 102 B: 105	2.20 2.6 2.0	103.81-104.1 101.71-102.28 104.84-105.15		
		2005	3-6	Both	Urban		T: 219 G: 66 B: 153	T: 76.68 G: 78.8 B: 76	2.42 3.4 2.0	76.35-77.00 77.96-79.63 75.68-76.31		
		2005	7-12	Both	Urban		T: 671 G: 231 B: 440	T: 93.47 G: 98.2 B: 91	2.34 3.2 1.9	93.29-93.64 97.78-98.61 90.82-91.17	T: 8.83 G: 11.2 B: 7.6	7.51-10.30 8.6-14.1 5.5-10.09
		2005	13-17	Both	Urban		T: 773 G: 254 B: 519	T: 103 G: 103 B: 103	1.74 0.4 2.4	102.87-103.12 102.95-103.04 102.79-103.20		
Kelishadi <i>et al.</i> 2012 <sup>[41]</sup>	Isfahan	2000-2001	11-18	Both	Both	2	T: 486 G: 269 B: 217	T: 118.55 G: 121.85 B: 114.47	52.75 50.56 55.47	113.84-123.25 115.7-127.9 106.9-121.8	T: 43.20 G: 44.6 B: 41.5	38.75-47.74 38.5-50.8 34.8-48.3
Mirhosseini <i>et al.</i> 2012 <sup>[42]</sup>	Mashhad	2007	15-18 16.4 (0.9)	G	Urban	5	477	95.3	41.8	26.5-302.4	24.5	20.7-28.6
Mehrkash <i>et al.</i> 2012 <sup>[43]</sup>	Gorgan		15-18 G: 16.34±0.77 B: 15.66±0.68	Both	Urban	1	T: 450 G: 225 B: 225	T: 113.4 G: 121.41 B: 105.35	54.1 38.20 70.11	108.4-118.4 116.4-126.4 96.1-114.5	T: 40 G: 52.4 B: 27.6	35.4-44.6 45.7-59.1 21.8-33.9
Khashayar <i>et al.</i> 2013 <sup>[35]</sup>	CASPIAN III	2009-2010	10-18 14.7 (2.4)	Both	Both Rural: 30.6 Urban: 69.3	6	T: 5738 G: 2875 B: 2863	T: 93.0 G: 91.8 B: 94.2	42.6 44.3 40.8	91.89-94.10 90.18-93.42 92.70-95.69	T: 7.9 G: 7.8 B: 8	7.2-8.6 6.8-8.8 7.0-9.05

Cut-off G: >90 percentile = 1; >95 percentile = 2; >200 = 3; >400 = 4; >114 = 5; >150 = 6. CI = Confidence interval; T = Total; B = Boys; G = Girls; CASPIAN = Childhood and adolescence surveillance and prevention of adult noncommunicable disease; TLGS = Tehran lipid and glucose study; SD = Standard deviation

Table 4: The prevalence of elevated LDL-C in population-based studies in Iranian children and adolescences of Iran: 1990-2013

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI	Prevalence (%)	95% CI prevalence
Kelishadi <i>et al.</i> 2014 <sup>[31]</sup>	Isfahan	1993	618	Both	Urban	1	4800				13.2	12.22-14.22
	Isfahan	1999	618	Both	Urban	1	4800				15.1	14.05-16.16
	Tehran TLGS	1999-2000	319	Both	Urban	3 1	T: 3113 G: 1688 B: 1425	T: 105 G: 107 B: 102	29 29 29	103.98-106.01 105.61-108.38 100.49-103.50	3 T: 16 G: 18 B: 14 1 T: 10 G: 11 B: 8	3 14.7-17.33 16.14-19.86 12.20-15.87 1 8.95-11.09 9.5-12.5 6.64-9.53
Azizi <i>et al.</i> 2001 <sup>[32]</sup>	Tehran TLGS	1999-2000	36	Both	Urban	3 1	T: 372 G: 184 B: 188	T: 108 G: 111 B: 105	25 25 26	105.45-110.54 107.36-114.63 101.25-108.74	3 T: 16 G: 19 B: 15 1 T: 10 G: 11 1: 9	3 12.29-19.97 13.62-25.66 10.13-20.80 1 7.10-13.44 6.77-16.28 5.35-14.08
	Tehran TLGS	1999-2000	710	Both	Urban	3 1	T: 660 G: 353 B: 307	T: 109 G: 112 B: 105	30 31 29	106.70-111.29 108.75-115.24 101.74-108.25	3 T: 17 G: 21 B: 14 1: T: 11 G: 13 B: 9	3 14.18-20.05 16.83-25.58 10.04-18.03 1 8.63-13.54 9.45-16.68 5.87-12.53
	Tehran TLGS	1999-2000	1113	Both	Urban	3 1	T: 712 G: 380 B: 332	T: 104 G: 105 B: 104	29 31 37	101.86-106.13 101.87-108.12 100.00-107.99	3 T: 18 G: 16 B: 19 1 T: 11 G: 17 B: 11	3 15.22-20.99 12.27-19.85 15.17-23.93 1 8.75-13.48 13.21-20.99 7.71-14.69
	Tehran TLGS	1999-2000	1416	Both	Urban	3 1	T: 726 G: 389 B: 337	T: 101 G: 104 B: 98	30 28 31	98.81-103.18 101.20-106.79 94.67-101.32	3 T: 13 G: 17 B: 12 1 T: 9 G: 10 B: 7	3 10.59-15.60 13.37-21.07 8.61-15.81 1 6.97-11.26 7.22-13.45 4.61-10.41

Table 4: (Continued)

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI	Prevalence (%)	95% CI prevalence
Kotcharian <i>et al.</i> 2002 <sup>[33]</sup>	Tehran TLGS	1999-2000	1719	Both	Urban	3	T: 643 G: 382 B: 261	T: 102 G: 105 B: 98	28 27 29	99.83-104.16 102.28-107.71 94.46-101.53	3 T: 16 G: 19 B: 13	3 13.26-19.08 15.04-23.13 8.86-17.29
Azizi <i>et al.</i> 2002 <sup>[34]</sup>	TLGS	1999-2001	319	Both	Urban	2	T: 4269-4526 G: 2269-2366 B: 2000-2160	T: 101.01 G: 97.89 B: 104.08	38.11 30.57 44.1	98.6-103.5 94.9-100.6 99.9-108.0	T: 15.9 G: 14.5 B: 17.3	13.6-18.4 11.4-18.1 13.9-21.0
Ghodsi <i>et al.</i> 2004 <sup>[35]</sup>	Tabriz	2002-2003	1418 16.97 (0.79)	G	Urban	3	232	G: 106 B: 102	28 29	98.1-108.7	T: 4.9 G: 4.9 B: 4.9	T: 4.3-5.5 G: 4.0-5.8 B: 4.0-5.8
Badiee <i>et al.</i> 2008 <sup>[36]</sup>	Isfahan	2008	Neonates	Both	Urban	-	T: 378 G: 191 B: 187	T: 34.0 G: 35.9 B: 32.1	19.4 22.4 16.3	32.0-35.9 32.7-39.1 21.7-34.4	T: 9 G: 11 B: 7	6.92-11.50 8.03-14.57 4.13-10.68
Fesharakinia <i>et al.</i> 2008 <sup>[37]</sup>	South Khorasan province	2006	712 9.6±1.2	Both	Both	-	T: 1326 G: 685 B: 641	T: 90.1 G: 93 B: 87	22.3 21.9 22.7	88.9-91.3 91.3-94.6 85.2-88.8	4.1	3.0-5.2
Mirhosseini <i>et al.</i> 2009 <sup>[38]</sup>	South Khorasan province	2006	712 9.6±1.2	Both	Urban	-	1028	91	22.1	89.6-92.3	21.1	16.0-26.9
Moradi <i>et al.</i> 2009 <sup>[39]</sup>	South Khorasan province	2006	911 16.2 (0.9)	Both	Both	2	T: 954 G: 521 B: 433	T: 90.3	22.4	88.9-91.7	T: 4.4	3.1-5.9
Kelishadi <i>et al.</i> 2009 <sup>[27]</sup>	CASPIAN I	2000	911	Both	Urban	2	730	85.3	30.1	84.5-86.2	4.4	3.0-6.1
Moradi <i>et al.</i> 2011 <sup>[40]</sup>	TLGS	2000	618	Both	Both	2	224	T: 108.26 G: 109.6 B: 107	1.57 1.9 1.4	108.13-108.40 110.41-110.98 106.84-107.15	4.5	2.1-8.0
Moradi <i>et al.</i> 2011 <sup>[40]</sup>	TLGS	2000	36	Both	Urban	2	T: 4775 G: 486 B: 169	T: 107.88 G: 109.6 B: 107	1.06 1.4 0.9	107.82-107.93 109.47-109.72 106.94-107.05	T: 38.70 G: 41.6 B: 37.2	37.10-40.32 35.93-45.66 33.16-41.42
Moradi <i>et al.</i> 2011 <sup>[40]</sup>	TLGS	2000	1317	Both	Urban	2	T: 1619 G: 571 B: 1048	T: 119.90 G: 154.6 B: 101	0.87 1 0.8	119.85-119.94 154.51-154.68 106.94-107.05	T: 38.70 G: 41.6 B: 37.2	37.10-40.32 35.93-45.66 33.16-41.42

(Continued)

Table 4: (Continued)

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI	Prevalence (%)	95% CI prevalence
Kelishadi <i>et al.</i> 2012 <sup>(42)</sup>	Isfahan	2003	36	Both	Urban		T: 258	T: 104.6	2.32	104.31-104.88		
							G: 83	G: 108	3	107.34-108.65		
							B: 175	B: 103	2	102.70-103.29		
		2003	712	Both	Urban		T: 706	T: 101.86	1.24	101.76-101.95	T: 35.29	33.14-37.48
							G: 243	G: 103.5	1.7	103.28-103.71	G: 36.3	33.55-39.13
							B: 463	B: 101	1	100.90-101.09	B: 34.8	32.47-37.18
		2003	1317	Both	Urban		T: 940	T: 93.24	1.10	93.16-93.31		
							G: 324	G: 93.7	1.3	93.23-94.16		
							B: 616	B: 93	1	92.92-93.07		
		2005	36	Both	Urban		T: 202	T: 100.75	2.58	100.39-101.1		
							G: 60	G: 104.9	3.5	103.99-105.80		
							B: 142	B: 99	2.2	98.63-99.36		
		2005	712	Both	Urban		T: 638	T: 95.4	1.23	95.30-95.49	T: 24.9	22.86-27.20
							G: 218	G: 96.2	1.7	95.97-96.42	G: 22.2	20.09-24.41
							B: 420	B: 95	1	94.90-95.09	B: 26.3	24.29-28.37
		2005	1317	Both	Urban		T: 733	T: 88.79	1.16	88.7-88.87		
							G: 243	G: 90.4	1.5	90.21-90.58		
							B: 490	B: 88	1	87.91-88.08		
Kelishadi <i>et al.</i> 2012 <sup>(42)</sup>	Isfahan	2000-2001	1118	Both	Both		T: 486	T: 96.83	29.73	94.18-99.47	T: 11.11	8.45-14.24
							G: 269	G: 100.66	30.30	92.02-104.29	G: 13.8	9.8-18.45
							B: 217	B: 92.09	29.03	88.13-95.90	B: 7.6	4.6-12.24
Mirhosseini <i>et al.</i> 2012 <sup>(43)</sup>	Mashhad	2007	1518 16.4 (0.9)	G	Urban		477	98.2	26.1	37-270.6	-	
Khashayar <i>et al.</i> 2013 <sup>(35)</sup>	CASPIAN III	2009-2010	1018 14.7 (2.4)	Both	Both Rural: 30.6 Urban: 69.3	3	T: 5738	T: 84.1	27.2	83.39-84.80	T: 5.7	5.1-6.3
							G: 2875	G: 82.1	44.3	80.48-83.72	G: 5.3	4.4-6.1
							B: 2863	B: 86.1	27.2	85.10-87.09	B: 6.2	5.3-7.1

Cut-off G: >90 percentile = 1; >95 percentile = 2; >130 = 3. CI = Confidence interval; T = Total; B = Boys; G = Girls; CASPIAN = Childhood and adolescence surveillance and prevention of adult noncommunicable disease; TLGS = Tehran lipid and glucose study; LDL-C = Low-density lipoprotein cholesterol; SD = Standard deviation

In a Study in Saudi Arabia, among 1390 boys and girls aged 9-12 years, the prevalence of hypercholesterolemia, elevated LDL-C, and hypertriglyceridemia is reported as 32.7%, 33.1%, and 34.1%, respectively.<sup>[19]</sup>

In a cross-sectional study in Thailand, among 348 schoolchildren aged 6-17.8 years, the prevalence of hypercholesterolemia and hypertriglyceridemia was 1.2% and 10.6%, respectively.<sup>[69]</sup>

Reported prevalence rate for different types of dyslipidemia in reviewed studies from Iran had a wide range. It may be due to differences in studied age and sex groups, genetic and ethnic background in various parts of a vast country like Iran, year of study, sampling methods, as well as different laboratory methods and the criteria used to define dyslipidemia in the pediatric age group.

Though comparing our results with other studies would not be conclusive enough because of differences in studied population, lab methods etc., it seems that the prevalence of dyslipidemia among Iranian children and adolescents is high specially hypertriglyceridemia and low HDL-C. The prevalence rate of hypertriglyceridemia and low HDL-C decreased and increased, respectively, from CASPIAN I to III possibly due to factors such as studied population (23 provinces in CASPIAN I and 27 provinces in CASPIAN III), the age group studied (6–18 years in CASPIAN-I and 10–18 years in CASPIAN-III) and positive effect of some interventions or nationwide educational programs in this field.<sup>[34,35]</sup> In addition, the role of dietary habits, physical activity level, and nutrition transition in Iran should be considered as well.

Several studies demonstrated sex, race, and ethnic differences in lipid profiles and prevalence of dyslipidemia in different regions<sup>[70-73]</sup> of special concern are the ethnic differences in the type and the prevalence of dyslipidemia. While most studies conducted in Western countries documented high prevalence rates of elevated TC and LDL-C, many epidemiologic studies have shown a high prevalence of hypertriglyceridemia and low HDL-C in the adult and pediatric population of the Middle East, even among immigrants from this region to Western countries (367,367).

National studies in Iran revealed a markedly high prevalence of this disturbance in adults as well as in the pediatric age group, even in normal-weight children and adolescents.<sup>[34]</sup> Moreover, the 5<sup>th</sup> percentile of serum HDL-C level of Iranian children and adolescents is lower than their European and American counterparts suggesting that the leftward shift in the distribution of this trait among Iranians begins in childhood.<sup>[27,29]</sup>

Considering the results of the current review, the prevalence of dyslipidemia among rural and urban population was studied in few studies (CASPIAN study and Fesharakinia *et al.*). According to the results of CASPIAN study, dyslipidemia was more prevalent among urban population. In reminder studies, there was no significant difference between different type of dyslipidemia among rural and urban population except for low HDL-C, which was higher in rural areas.<sup>[46]</sup>

Some studies showed that dyslipidemia is more prevalent among children with higher socioeconomic levels and higher-income families.<sup>[74,75]</sup> Contrary, in a study in Ecuador, children in the rural area were 2.8 times more likely to have dyslipidemia than those from the urban area.<sup>[76]</sup> Unhealthy lifestyle, improper type of fat used for food preparation, using deep fried foods and unhealthy snacks may explain the differences in lipid levels and dyslipidemia in various living areas.

It seems that according to this review, the overall prevalence of dyslipidemia among females is higher than males. But regarding different types of dyslipidemia, the results had heterogeneity.

Several studies reported gender differences in the prevalence of dyslipidemia in children. Among Korean children, girls had higher TC and LDL-C than boys. Girls also tended to have higher HDL-C than boys after the age of 12-13 years, the period of pubertal development.<sup>[18]</sup>

Similar results obtained from a nationwide study in Japan among schoolchildren.<sup>[77]</sup> In a study in Turkey, among 2896 children (1467 girls, 1429 boys) aged 7-18 years, the prevalence of dyslipidemia according to nonHDL-C levels was higher (13.2%) in girls than boys (8.9%) ( $P < 0.001$ ).<sup>[78]</sup> Whereas, using the data of NHANES 1999-2006 for participants aged 6-17 years, Ford *et al.* have reported a higher level of cholesterol and LDL-C among boys than girls.<sup>[60]</sup>

The main strength of this review is its novelty in the pediatric age group. There was limited number of comprehensive study for sub-national trends of the disorders in Iran.<sup>[79-81]</sup> The superiority of the findings of this review to the GBD studies is that we benefit from more data driven estimations rather than the model driven results.<sup>[1,4-8]</sup> We also benefited from all available national and sub-national sources of data alongside the advanced comprehensive search approaches. All of the domestic databases were searched exactly with all of English/Persian equivalent search terms. We had the availability to use the highest level of access to the published, available unpublished and gray literature, as well as the main national sources of CASPIAN study.<sup>[33,82]</sup>

Table 5: The prevalence of low HDL-C in population-based studies in Iranian children and adolescences of Iran: 1990-2013

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI	Prevalence (%)	95% CI prevalence
Kelishadi <i>et al.</i> 2014 <sup>[31]</sup>	Isfahan	1993	6-18	Both	Urban	1	4500				25	23.74-26.29
Azizi <i>et al.</i> 2001 <sup>[32]</sup>	Tehran TLGS	1999	6-18	Both	Urban	1	4500				25.7	24.41-26.99
		1999-2000	3-19	Both	Urban	1	T: 3115	T: 45	11	44.61-45.38	T: 14	12.79-15.26
							G: 1689	G: 45	11	44.47-45.52	G: 14	12.35-15.71
							B: 1426	B: 45	11	44.42-45.57	B: 14	12.26-15.93
1999-2000		3-6	Both	Urban	1	T: 373	T: 46	T: 44.88-47.11	11	44.88-47.11	T: 12	8.93-15.8
						G: 184	G: 45	43.40-46.59	11	43.40-46.59	G: 12	7.64-17.5
1999-2000		7-10	Both	Urban	1	B: 189	B: 47	45.42-48.57	11	45.42-48.57	B: 11	7.01-16.48
						T: 660	T: 47	46.15-47.84	11	46.15-47.84	T: 9	6.8-11.37
1999-2000		11-13	Both	Urban	1	G: 353	G: 47	45.74-48.25	12	45.74-48.25	G: 9	6.2-12.55
						B: 307	B: 47	45.76-48.23	11	45.76-48.23	B: 9	5.8-12.53
1999-2000		14-16	Both	Urban	1	T: 713	T: 44	43.19-44.80	11	43.19-44.80	T: 14	11.55-16.79
						G: 381	G: 43	41.09-44.00	10	41.09-44.00	G: 17	13.18-20.93
1999-2000		17-19	Both	Urban	1	B: 332	B: 46	44.81-47.18	11	44.81-47.18	B: 11	7.71-14.69
						T: 726	T: 43	42.27-43.72	10	42.27-43.72	T: 18	15.31-21.03
1999-2000			Both	Urban	1	G: 389	G: 43	41.90-44.09	11	41.90-44.09	G: 17	13.37-21.07
						B: 337	B: 43	41.92-44.07	10	41.92-44.07	B: 18	14.13-22.63
1999-2000			Both	Urban	1	T: 643	T: 43	42.22-43.77	10	42.22-43.77	T: 14	11.40-16.92
						G: 382	G: 45	43.99-46.00	10	43.99-46.00	G: 9	6.24-12.21
1999-2000			Both	Urban	1	B: 261	B: 40	38.90-41.09	9	38.90-41.09	B: 21	16.28-16.52
1999-2001	Tehran	2002	12	Both	Urban	2	T: 942	T: 48.34	12.53	47.5-49.1	T: 8.3	7.5-9.1
							G: 469	G: 50.42	13.49	49.2-51.6	G: 6.6	5.6-7.6
1999-2001	TLGS		3-19	Both	Urban	3	B: 473	B: 46.29	11.14	45.3-47.3	B: 10.2	8.9-11.5
							T: 4269-4526	G: 44	10		54.7	48.0-51.2
2002-2003	Tabriz	2008	14-18	G	Urban	3	G: 2269-2366	B: 44	11			
							B: 2000-2160					
2008	Isfahan		Neonates	Both	Urban	-	T: 378	T: 29.9	9.3	28.9-30.8		
							G: 191	G: 31.1	9.9	29.7-32.5		
2006	South Khorasan province		7-12	Both	Both	3	B: 187	B: 28.8	8.7	27.5-30.1		
							T: 1326	T: 44.7	9.0	44.2-45.2	T: 14.1	12.3-16.1
2006			9.6±1.2	Both	Urban	1028	G: 685	G: 44	9.2	43.3-44.7		
							B: 641	B: 45	8.8	44.3-45.7		
2007	Mashhad		7-12	Both	Rural	298		44	9.1	43.4-44.5		
								43	8.9	41.9-44.0		
2007			15-17	G	Urban	622		36.6	5.2	36.2-47.0	57	52.9-60.8
2006	South Khorasan province		9-11	Both	Both	2	T: 954	T: 44.2	9.2	43.6-44.8	16.3	13.7-18.5
							G: 521					
2006			9-11	Both	Urban	2	B: 433					
							730				14.8	12.3-17.6
2006			9-11	Both	Rural	2	224				20.1	15.0-25.9

Table 5: (Continued)

Reference	Location	Year	Age-group (year)	Sex	Urban/rural (%)	Cut-off point (mg/dl)	Sample size (n)	Mean (mg/dl)	SD	95% CI	Prevalence (%)	95% CI prevalence
Kelishadi <i>et al.</i> 2009 <sup>[27]</sup>	CASPIAN I		6-18	Both	Both		T: 4806	44.3	12.5	43.9-44.6	24.8	23.58-26.08
Moradi <i>et al.</i> 2011 <sup>[40]</sup>	TLGS	2000	3-6	Both	Urban		T: 486 G: 169 B: 317	T: 44.8 G: 44.4 B: 45	0.57 0.7 0.5	44.74-44.85 44.29-44.50 44.94-45.05		
		2000	7-12	Both	Urban		T: 1471 G: 499 B: 972	T: 46.23 G: 45.7 B: 46.5	0.37 0.5 0.3	46.21-46.24 45.65-45.74 46.48-46.51	T: 75.9 G: 75 B: 76.5	74.52-77.35 72.5-77.4 73.9-78.9
		2000	13-17	Both	Urban		T: 1629 G: 573 B: 1056	T: 42.64 G: 42.9 B: 42.5	0.34 0.4 0.3	42.62-42.65 42.86-42.93 42.48-42.51		
		2003	3-6	Both	Urban		T: 256 G: 81 B: 175	T: 41.03 G: 41.4 B: 41	0.8 1 0.7	41.03-41.22 41.17-41.62 40.89-41.1		
		2003	7-12	Both	Urban		T: 718 G: 253 B: 465	T: 42.33 G: 42 B: 42.5	0.47 0.6 0.4	42.29-42.36 41.92-42.07 42.46-42.53	T: 61.27 G: 62 B: 60.9	59.05-63.46 58.17-65.78 56.94-64.85
		2003	13-17	Both	Urban		T: 942 G: 324 B: 618	T: 38.8 G: 39.4 B: 38.6	0.34 0.4 0.3	38.77-38.82 39.35-39.44 38.57-38.62		
		2005	3-6	Both	Urban		T: 211 G: 63 B: 148	T: 46.1 G: 46.4 B: 46	1.1 1.4 0.8	45.95-46.24 46.04-46.75 45.87-46.12		
		2005	7-12	Both	Urban		T: 669 G: 230 B: 439	T: 46.36 G: 45.5 B: 46.8	0.57 0.7 0.5	46.31-46.40 45.4-45.59 46.75-46.84	T: 80.12 G: 80.4 B: 80	78.10-82.02 77.2-83.4 76.5-83.3
		2005	13-17	Both	Urban		T: 760 G: 243 B: 517	T: 42.19 G: 43 B: 41.8	0.47 0.6 0.4	42.15-42.22 42.92-43.07 41.76-41.83		
Kelishadi <i>et al.</i> 2012 <sup>[41]</sup>	Isfahan	2000-2001	11-18	Both	Both	2	T: 486 G: 269 B: 217	T: 44.84 G: 44.32 B: 45.50	11.17 10.57 11.92	43.84-45.83 43.05-45.58 43.90-47.09	T: 18.51 G: 19.3 B: 17.3	15.16-22.26 14.7-24.56 12.7-23.23
Mirhosseini <i>et al.</i> 2012 <sup>[42]</sup>	Mashhad	2007	15-18 16.4 (0.9)	F	Urban	4	477	36.6	5.1	23-49	56.9	52.2-61.3
Mehrkash <i>et al.</i> 2012 <sup>[43]</sup>	Gorgan		15-18 G: 16.34±0.77 B: 15.66±0.68	Both	Urban	1	T: 450 G: 225 B: 225	T: 47.2 G: 51.09 B: 43.35	9.8 10.53 9.15	46.3-48.1 49.7-52.5 42.1-44.5	T: 11.4 G: 5.6 B: 17.3	8.5-14.6 3.1-9.7 8.4-17.5
Khashayar <i>et al.</i> 2013 <sup>[35]</sup>	CASPIAN III	2009-2010	10-18 14.7 (2.4)	Both	Both	5	T: 5738 G: 2875 B: 2863	T: 46.2 G: 45.9 B: 46.4	14.2 14.3 14.2	45.83-46.56 45.37-46.42 45.87-46.92	T: 35.36 G: 37 B: 33.7	34.1-36.6 35.2-38.8 31.9-35.47

Cut-off G: <10<sup>th</sup> percentile = 1; <5<sup>th</sup> percentile = 2; <35 = 3; <37 = 4; <40 = 5. CI = Confidence interval; T = Total; B = Boys; G = Girls; CASPIAN = Childhood and adolescence surveillance and prevention of adult noncommunicable disease; TLGS = Tehran lipid and glucose study; SD = Standard deviation; HDL-C = High-density lipoprotein cholesterol

We have also faced with some limitations. The most important limitations of this review were diversities related to the geographical scopes of studies (local, district, and national levels), quality of data, methodology of the studies and studied population (children, adolescents or both), which limited our ability to compare presented data. So that, findings of this review indicated that the reported prevalence range of all subgroups of dyslipidemia had large variations. It seems that because of ethical concerns and difficulties in blood sampling from young children, data were scarce on the prevalence of dyslipidemia among preschool-aged children, that is, under 5 years of age. Most studies included in this review have been conducted in school-aged children and adolescents. Moreover in almost all cases with missing data our contacts with the authors of the studies were not effective and did not provide us any additional data than those reported in their articles. Considering above, to comparing the results, aggregating the data, and imputing the trends, we provide more modern practical statistical methods.<sup>[30,83,84]</sup>

The implication of this study was that reviewing the results of different studies of dyslipidemia from different regions of Iran, in different years, age and sex groups provide us comprehensive baseline information in this field. Obtained data could be used for future studies and planning health-related policies in this regard.

## CONCLUSION

Reviewing existing data in the field of children dyslipidemia in Iran, the results indicated that dyslipidemia is one of the common and important CVD risk factors among Iranian children, which emphasize on the necessity of effective interventional trials implementation.<sup>[31,85]</sup> The feature of dyslipidemia among Iranian children with a higher rate of hypertriglyceridemia and low HDL-C indicates the priority of our future interventions also. In addition, regarding the fact that few data were available in preschool children, it seems that screening of dyslipidemia considered as a priority for health care system in our country to eliminate the burden of disease and preventing it related increasing rate of CVD in future.

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## AUTHOR'S CONTRIBUTIONS

SH contributed in the conception of the work, conducting the study, drafting and revising the draft, approval of the

final version of the manuscript, and agreed for all aspects of the work. RK contributed in the conception of the work, drafting and revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. Sh Dj contributed in the conception of the work, conducting the study, drafting and revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. FF contributed in the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. SHN contributed in the conception of the work, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. MQ contributed in the conception of the work, drafting and revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work.

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