Preplanned Studies

The Status of Blood Lipids Among Children and Adolescents — China, 2016–2017

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Summary

What is already known about this topic?

Dyslipidemia is attributed to cardiovascular disease (CVD). A recent report suggests dyslipidemia prevalence has increased among children and adolescents.

What is added by this report?

Dyslipidemia prevalence was 19.43% among Chinese children and adolescents aged 6–17 years in 2016–2017. The abnormal blood lipid prevalence and the average blood lipid levels showed a diversified distribution across demographics.

What are the implications for public health practice?

Continued monitoring of abnormal blood lipids among Chinese children and adolescents, especially triglyceride (TG) and high-density lipoprotein cholesterol (HDL-C), may inform public health interventions to promote long-term cardiovascular health and prevent CVD in adulthood.

Cardiovascular disease (CVD) is a leading cause of death globally (*1*). As one of the leading risk factors for CVD, dyslipidemia refers to a group of lipoprotein metabolism disorders caused by genetic variation and (or) environmental factors. A previous study reported dyslipidemia in childhood as a trajectory phenomenon (*2*). The early lesions among dyslipidemia children are vascular endothelial injury and arterial fatty streaks, and further develop into fibrous plates, which may increase the risk of dyslipidemia and CVD among adults. Therefore, screening youth for dyslipidemia may have the potential to identify early affected individuals, reduce long-term cholesterol burden through intervention, and prevent or delay cardiovascular events in adulthood (*3*). This study used cross-sectional data from China Nutrition and Health Surveillance of Children and Lactating Mothers (CNHSCLM) from 2016–2017. The study aims to report the status of blood lipids among Chinese children and adolescents aged 6–17 years at a national level.

In 2016–2017, the CNHSCLM used 275 disease surveillance points across 31 provincial-level administrative divisions (PLADs) and a multistage stratified cluster randomized sampling method to select a representative sample of children and adolescents aged 6–17 years. Similar recruitment methods to those used in the CNHSCLM have been reported elsewhere (*4*). Trained local personnel conducted the face-to-face questionnaire, physical measurements, and blood draw. Venous blood was collected from each subject to test four blood lipids, including total cholesterol (TC), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C). After excluding incomplete data, 68,081 subjects who had been measured TC, TG, LDL-C, and HDL-C were included. The Ethics Committee for Research on Human Subjects of China CDC approved the study protocol (No. 201614). Interviewers obtain written informed consent before the start of the study.

High TC was defined as TC ≥5.18 mmol/L, high TG as TG ≥1.70 mmol/L, high LDL-C as LDL-C ≥ 3.37 mmol/L, low HDL-C as HDL-C <1.04 mmol/L, high non-HDL-C (non-HDL-C = TC – HDL-C) as non-HDL-C ≥3.75 mmol/L, and dyslipidemia was defined as any abnormality of the above indicators (*5*–*6*). A log transformation was applied to fit the normal distribution since some of the variables (TC, TG, and non-HDL-C) were non-normally distributed among participants. The post-stratification adjustment used China's Sixth National Census in 2010 (*7*). Prevalence and means were weighted to represent the national levels. Differences between groups were tested using Rao-Scott Chi-square test and ANOVA test. Linear regression was used to test age trends in abnormal blood lipid prevalence and blood lipid levels. $P<0.05$ was deemed significant. All statistical analyses were conducted using SAS software (version 9.4; SAS Institute, Inc., Cary, NC, USA).

The study included 68,081 children and adolescents aged 6–17 years; 34,017 males and 34,064 females; and 32,371 in urban areas and 35,710 in rural areas (Table 1). In 2016–2017, the overall dyslipidemia prevalence among Chinese children and adolescents was 19.43% [95% confidence interval (*CI*): 18.09%–19.96%], with 19.82% (95% *CI*: 19.07%–20.57%) in males and 18.89% (95% *CI*: 18.23%–19.73%) in females. There was an increasing age trend in dyslipidemia prevalence, from 15.83% for children aged 6–8 to 21.79% for adolescents aged 15–17 (P_{trend}<0.0001). The urban group had a higher dyslipidemia prevalence than the rural group (20.60% *vs.* 18.39%, *P*<0.0001) (Table 1). Table 1 also shows that the prevalence of low HDL-C was the highest, and that high TG was the second highest.

Overall, 11.63% of all children and adolescents had low HDL-C (Table 1). There was an increasing age trend in the prevalence of low HDL-C from 8.31% for children aged 6–8 to 15.49% for adolescents aged 15–17 (P_{trend}<0.0001). Males had a higher prevalence of low HDL-C than females (12.63% *vs.* 10.49%, *P*<0.0001). The prevalence of low HDL-C was greater in rural than urban areas (12.06% *vs.* 11.14%, *P*=0.0283).

Overall, 4.74% of all children and adolescents had high TG (Table 1). There was an increasing age trend in the prevalence of high TG from 2.54% for children aged 6–8 to 4.62% for adolescents aged 15–17 (P_{trend}<0.0001). No differences were seen between gender groups (4.54% *vs.* 4.97%, *P*=0.1323), and no differences were seen between urban and rural areas (4.92% *vs.* 4.58%, *P*=0.2331).

Similarly, with the prevalence of high TG, 4.69% of all children and adolescents had high TC (Table 1). There was a decreasing age trend in the prevalence of high TC from 5.21% for children aged 6–8 to 3.83% for adolescents aged 15–17 (P_{trend}<0.0001). The females had a higher prevalence of high TC than males (5.23% *vs.* 4.21%, *P*=0.0015). The prevalence of high TC was greater in urban than rural areas (6.25% *vs.* 3.31%, *P*<0.0001).

From 2016–2017, the average LDL-C and HDL-C levels were 2.09 mmol/L and 1.42 mmol/L,

TABLE 1. The prevalence of abnormal blood lipids among Chinese children and adolescents aged 6–17 years in 2016–2017. [% (95% *CI*)]

Characteristics	*N**	High TC	High TG	High LDL-C	Low HDL-C	High non-HDL-C	Dyslipidemia
Total	68,081	4.69 (4.37, 5.00)	4.74 (4.45, 5.03)	2.70 (2.47, 2.93)	11.63 (11.22, 12.04)	3.83 (3.54, 4.12)	19.43 (18.09, 19.96)
Gender							
Male	34,017	4.21 (3.80, 4.62)	4.54 (4.13, 4.94)	2.71 (2.37, 3.04)	12.63 (12.03, 13.23)	3.66 (3.27, 4.05)	19.82 (19.07, 20.57)
Female	34,064	5.23 (4.74, 5.72)	4.97 (4.57, 5.38)	2.69 (2.37, 3.01)	10.49 (9.94, 11.03)	4.02 (3.60, 4.45)	18.98 (18.23, 19.73)
χ^2	–	10.0324	2.2649	0.0054	26.9366	1.5140	2.4219
P	–	0.0015	0.1323	0.9413	<0.0001	0.2185	0.1196
Age (years)							
6–8	17,333	5.21 (4.63, 5.80)	2.54 (2.15, 2.92)	3.27 (2.79, 3.74)	8.31 (7.56, 9.05)	3.55 (3.07, 4.04)	15.83 (14.85, 16.81)
9–11	20,485	5.61 (4.89, 6.33)	5.49 (4.84, 6.14)	3.11 (2.56, 3.65)	8.63 (7.97, 9.30)	4.24 (3.60, 4.89)	18.33 (17.26, 19.40)
12–14	16,783	4.27 (3.60, 4.94)	6.38 (5.71, 7.06)	2.39 (1.87, 2.91)	13.12 (12.22, 14.02)	3.92 (3.27, 4.57)	21.11 (19.96, 22.25)
15–17	13,480	3.83 (3.29, 4.36)	4.62 (4.10, 5.13)	2.16 (1.82, 2.50)	15.49 (14.61, 16.36)	3.63 (3.12, 4.13)	21.79 (20.77, 22.82)
t_{trend}	–	−4.45	5.45	−4.46	13.62	−0.02	8.59
P_{trend}	–	<0.0001	<0.0001	0.0011	<0.0001	0.8221	<0.0001
Area							
Urban	32,371	6.25 (5.72, 6.77)	4.92 (4.50, 5.34)	3.67 (3.29, 4.06)	11.14 (10.57, 11.72)	5.09 (4.61, 5.58)	20.60 (19.81, 21.39)
Rural	35,710	3.31 (2.94, 3.67)	4.58 (4.19, 4.97)	1.84 (1.57, 2.11)	12.06 (11.48, 12.64)	2.71 (2.39, 3.03)	18.39 (17.67, 19.11)
χ^2	–	83.5250	1.4218	58.3577	4.8080	67.7579	16.4322
P	–	<0.0001	0.2331	<0.0001	0.0283	<0.0001	<0.0001

Note: "–" indicates no χ^2 or *P* values.
Abbreviation: *CI*=confidence interval; TC=total cholesterol; TG=triglyceride; LDL-C=low-density lipoprotein cholesterol; HDL-C=high-density lipoprotein cholesterol.
* *N* stands for the number of participants.

respectively. The geometric average TC, TG and non-HDL-C levels were 1.57 mmol/L, 0.62 mmol/L and 1.22 mmol/L, respectively. There were differences in the average blood lipid levels between different groups. The females had higher average blood lipid levels than males (all P<0.0001); the average blood lipid levels in urban areas were higher than in rural areas (all P<0.0001) (Table 2). Table 2 also suggests an increasing age trend in average TG, while decreasing age trends in other average blood lipids (all P_{trend}<0.0001).

DISCUSSION

This is the latest study to present the status of current blood lipids on a national level in China containing three key findings. First, our study shows that in 2016–2017, dyslipidemia prevalence among Chinese children and adolescents aged 6–17 was 19.43%. Second, there were differences in the abnormal blood lipid prevalence and the average blood lipid levels between gender or area groups. Our study also demonstrated age trends in abnormal blood lipid prevalence and blood lipid levels.

Dyslipidemia prevalence in China in 2016–2017 (19.43%) was lower than a previous study reported (20.6%) (*8*). The inconsistency of current findings may be attributable to the heterogeneity of study population and study methodology. For example, the results were reported from subjects in Hainan Province (southern China) and Shaanxi Province (northwestern China), and the definition of high TG was based on age. Our findings are similar to the results of a study in western China which used same recruitment methods to select study population and the same criteria for the definition of abnormal blood lipids (*9*), the prevalence of high TC was greater in females, and the females had lower prevalence of low HDL-C. This may be attributed to differences in changes in hormone levels during puberty (*10*). Compared to rural people, urban people were consistently more likely to have high blood lipid levels. This may be explained by socioeconomic status (ie., food security), which may warrant further research. Our study shows increased age trends in the prevalence of low HDL-C and high TG, and decreased trends in the prevalence of high TC and high LDL-C, similar to a previous study (*11*). Of

TABLE 2. The average blood lipids among Chinese children and adolescents aged 6–17 years in 2016–2017. (mmol/L, mean±SD)

Characteristics	TC*	TG*	LDL-C	HDL-C	non-HDL-C*
Total	1.57±0.24	0.62±0.21	2.09±0.6	1.42±0.34	1.22±0.28
Gender					
Male	1.56±0.23	0.61±0.22	2.05±0.60	1.41±0.35	1.20±0.27
Female	1.59±0.25	0.64±0.21	2.13±0.59	1.43±0.33	1.23±0.29
F	220.09	521.60	248.36	54.86	214.44
P	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Age (years)					
6–8	1.59±0.19	0.58±0.18	2.16±0.62	1.49±0.35	1.22±0.23
9–11	1.59±0.22	0.63±0.21	2.13±0.59	1.47±0.35	1.23±0.27
12–14	1.56±0.28	0.65±0.22	2.03±0.59	1.39±0.34	1.21±0.32
15–17	1.55±0.26	0.63±0.22	2.04±0.58	1.35±0.31	1.21±0.30
t_{trend}	−11.42	14.59	−13.15	−26.72	−4.00
P_{trend}	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Area					
Urban	1.59±0.20	0.63±0.23	2.16±0.62	1.43±0.33	1.24±0.24
Rural	1.56±0.27	0.62±0.19	2.03±0.57	1.42±0.34	1.20±0.32
F	284.64	66.33	819.87	18.72	378.89
P	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Abbreviation: SD=standard deviation; TC=total cholesterol; TG=triglyceride; LDL-C=low-density lipoprotein cholesterol; HDL-C=high-density lipoprotein cholesterol.
* Log-transformed value.

the five cholesterol measures examined in this report, the top two abnormalities in blood lipid prevalence were low HDL-C and high TG, closely associated with obesity. One possible pathway is that due to the increasing blood free fatty acids in obese people, TG accumulates in visceral fat, and the liver synthesizes extra TG and releases it into the circulation, causing high TG. In this case, HDL-C disintegrates easily after the action of cholesteryl ester transfer protein and hepatic lipase, causing the decreasing HDL-C Ultimately (*12*).

This study was subject to some limitations. The definition of dyslipidemia in this study referred to the expert consensus standard for the prevention and treatment of dyslipidemia in children and adolescents, which limited the direct comparison with other estimates reported using different criteria. However, it also provides a basis for formulating prevention and treatment strategies and measures for dyslipidemia in children and adolescents. Overall, given the diversified demographics of the current status of blood lipids, continued monitoring of abnormal blood lipid levels among Chinese children and adolescents, especially TG and HDL-C, may inform public health interventions to promote long-term cardiovascular health and prevent CVD in adulthood. Furthermore, attention must be paid to obesity among children and adolescents, due to the relationship between obesity and high TG and low HDL-C.

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