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Serum High-density Lipoprotein Cholesterol Level and Lifestyle Habits among Japanese Junior High School Students

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Metabolic Syndrome among Children, Adolescents, and Young Adults in Shinshu

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Aim: We examined the relationship between serum high-density lipoprotein cholesterol (HDL-C) level and lifestyle habits among Japanese junior high school students.

Methods: Between April 2006 and March 2009, we conducted a cross-sectional study of 1064 Japanese junior high school students (570 boys and 494 girls, aged 12.1 to 15.0 years) who had annual school health examinations in Nagano Prefecture. They were divided into 4 groups according to HDL-C quartiles.

Results: There was a significant increase in the ratio of waist circumference to body height, percentage of being overweight, triglyceride, non-HDL-C, the ratio of low-density lipoprotein cholesterol to HDL-C, and uric acid in the lowest quartile of HDL-C compared with the highest quartile in both genders. Fasting plasma glucose was also significantly increased in the lowest quartile compared with the highest quartile in boys. With regard to lifestyle habits, the ratios of the students who were often commuting to and from school by car, did not like exercise, did not do sports outside of school, and watched television during meals were significantly higher in the lowest quartile of HDL-C compared with the highest quartile in both genders.

Conclusions: Serum HDL-C level was associated with reduced daily physical activity among junior high school students. This study may provide insights into the role of HDL-C in the school screening system for the development of more effective educational programs on the prevention of lifestyle-related diseases in the Japanese population of school children. *Shinshu Med J 61: 205—215, 2013*

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Key words: high-density lipoprotein cholesterol, Japanese junior high school students, lifestyle habits

I Introduction

A number of large-scale clinical trials have demonstrated an association between a high serum low-density lipoprotein cholesterol (LDL-C) level and the risk of coronary heart disease (CHD) in adults. Many epidemiological studies have revealed a consistent inverse association between high-density lipoprotein cholesterol (HDL-C) level and the risk of CHD events and prognosis, independent of LDL-C, in the general population of adults[1)-5)]. Furthermore, several autopsy studies, such as the Pathological Determinants of Atherosclerosis in

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Youth (PDAY) study[6)7)] and the Bogalusa Heart Study[8)9)], have reported that the presence and extent of atherosclerotic lesions in the aorta and coronary arteries in young to middle-aged adults who had died of accidental causes are closely correlated with cardiovascular (CV) risk factors measured during life. In addition, investigations using carotid ultrasound in young and middle-aged adults have pointed out a positive relationship between childhood and adolescent CV disease risk and subclinical measures of atherosclerosis in adulthood[10)11)]. Based on these results, it is well established that the atherosclerotic process begins in childhood and progresses gradually through adolescence to young adulthood into middle age, and that high LDL-C and low HDL-C in childhood are associated with an increased risk of the development of atherosclerosis and future CV disease in adulthood[12)-14)].

We have previously reported that the prevalence of young Japanese patients with CHD is increasing with a higher rate of onset during the summer months[15)], and that childhood obesity and a lack of regular physical activity are the most important independent risk factors for CHD events[16)]. Our recent observations have also exhibited a strong association between serum uric acid level and cardiometabolic risk factors[17)] and between nonalcoholic fatty liver disease and obesity and lifestyle habits[18)] among Japanese junior high school students. Thus, it would be more effective to start to control the risk factors as early as possible in life. However, there have been only a few reports on the relationship between HDL-C and lifestyle habits among Japanese school children[19)20)]. The aim of the present study was to examine the relationship between serum HDL-C level and lifestyle habits in a sample of healthy Japanese junior high school students living in Nagano Prefecture.

II Methods

A Study design

Between April 2006 and March 2009, we conducted a cross-sectional study of 1064 Japanese junior high school students (570 boys and 494 girls, aged 12.1 to 15.0 years) who had annual school health examinations at 3 schools in the various regions (urban, rural, and mountain communities) of Nagano Prefecture. After written informed consent had been obtained from both the students and their parents, the students underwent measurements of resting systolic and diastolic blood pressure (SBP, DBP), and waist circumference (WC) as well as body height (BH) and weight, and provided overnight fasting venous blood samples. Each participant was then asked to complete a simple 12-item self-administered questionnaire addressing lifestyle factors, such as dietary patterns and habits and physical activity, as well as the co-existence of cardiometabolic risk factors, including dyslipidemia, impaired glucose tolerance, and hypertension. The study protocol was approved by the Medical Ethics Committee of Shinshu University School of Medicine (Nos. 1598, 1711, and 1712).

B Measurements

WC was measured at the level of the umbilicus using a measuring tape, and then the ratio of WC to BH (WC/BH ratio) was derived. Percentage of being overweight (POW) was calculated from an age-height-related standard of weight for healthy Japanese children. The POW was defined as percentage of weight difference from the standard weight. BP was determined after a 10-min rest in the sitting position using a mercury-gravity sphygmomanometer. All laboratory analyses of the blood samples, including serum concentrations of total cholesterol (TC), triglyceride (TG), and uric acid (SUA), fasting plasma glucose (FPG), and hemoglobin (Hb) A_{1C}, were performed using standard methods. Serum HDL-C level was measured by the direct method in 3 laboratories, in which the accuracy was strictly managed and standardized among the laboratories. Serum LDL-C was calculated using Friedewald's equation, except for serum TG level $>$ 400 mg/dL, and non-HDL-C level was calculated by subtracting the HDL-C from the TC concentration. The LDL-C/HDL-C ratio was then derived. Measurement of lipids and FPG was carried out in the participants who had fasted 12 hours or more. The value of HbA_{1C} was described according to the criteria of the National Glycohemoglobin Standardization Program[21]. All participants had no chronic diseases and were receiving no medication in the present study.

C Definition of cardiometabolic risk factors

Abdominal obesity was defined as a WC ≥ 80 cm and/or WC/BH ratio ≥ 0.5[22]. Hypertriglyceridemia was determined by serum concentration of TG ≥ 120 mg/dL[22]. Low HDL-C was identified by serum HDL-C < 40 mg/dL[23] and increased fasting glucose was defined as FPG ≥ 100 mg/dL[22]. In addition, we adopted the criteria of hypertension in Japanese junior high school students at a medical check-up recommended by the Japanese Society of Hypertension, in which hypertension was defined as SBP ≥ 140 mmHg and/or DBP ≥ 85 mmHg in boys and SBP ≥ 135 mmHg and/or DBP ≥ 80 mmHg in girls[24]. Metabolic syndrome in the pediatric setting was identified by the presence of abdominal obesity in association with at least 2 of the 3 conditions, such as hypertriglyceridemia and/or low HDL-C, high BP which was defined as SBP ≥ 125 mmHg and/or DBP ≥ 70 mmHg, and elevated FPG levels according to the criteria proposed by a Task Force financed by the Ministry of Health, Welfare, and Labor Science Research Grants in Japan[22].

D Statistical analysis

Continuous variables with normal distribution were expressed as mean ± SD and those with non-normal distribution, such as TG, were presented as the median. The difference of categorical variables, including lifestyle habits, was examined with the chi-square test or Fisher's exact test. The significance of continuous variables, such as age, WC, WC/BH ratio, POW, SBP, DBP, HDL-C, TG, LDL-C, non HDL-C, LDL-C/HDL-C ratio, FPG, HbA_{1C}, and SUA, between groups was analyzed by using an unpaired t-test or an analysis of variance for repeated measures and Newmann-Keuls post hoc test. All analyses were performed with the SPSS software Version 12.0 for Windows (SPSS, Chicago, IL, USA) and a p value of < 0.05 was considered statistically significant.

III Results

The data were analyzed among boys and girls separately, and gender-specific quartiles of HDL-C levels were used because they were observed to approximate a normal distribution, as shown in **Fig. 1**. HDL-C levels were classified into the following 4 categories : (1) ≤ 55 mg/dL (mean 49 mg/dL), (2) 56 to 63 mg/dL (mean 60 mg/dL), (3) 64 to 73 mg/dL (mean 68 mg/dL), and (4) ≥ 74 mg/dL (mean 81

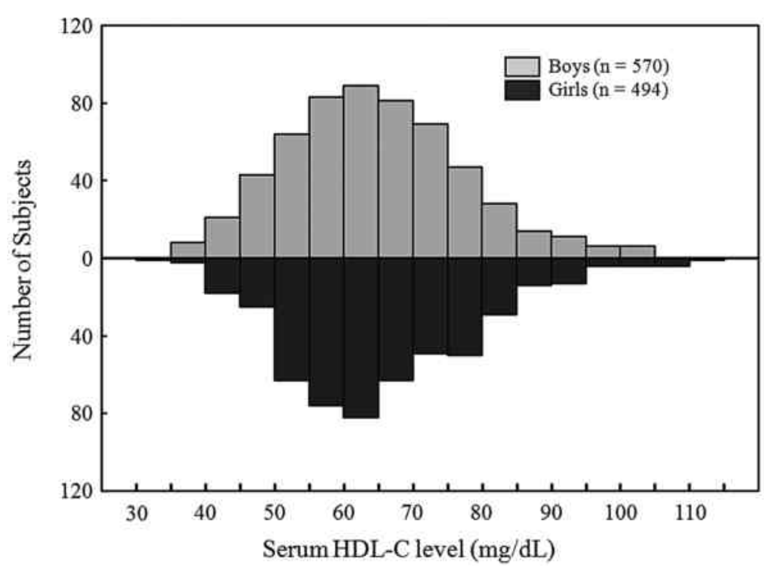

Fig. 1 Distribution of serum high-density lipoprotein cholesterol concentration in boys and girls

Table 1 Baseline Characteristics

	Boys	Girls	p value
Number of subjects	570	494	
Age (yrs)	13.2±0.6	13.1±0.6	0.063
WC (cm)	68.0±7.9	67.5±6.8	0.301
WC/BH ratio	0.42±0.04	0.43±0.04	<0.001
POW (%)	1.0±14.3	0.4±13.9	0.495
Systolic BP (mmHg)	113±12	108±11	<0.001
Diastolic BP (mmHg)	63±10	63±9	0.971
TG (mg/dL)	63	67	<0.001
(95% CI)	(38-122)	(36-110)	
LDL-C (mg/dL)	88±20	94±24	<0.001
HDL-C (mg/dL)	65±13	66±13	0.153
non-HDL-C (mg/dL)	100±12	108±13	<0.001
LDL-C/HDL-C ratio	1.36±0.42	1.42±0.47	0.008
FPG (mg/dL)	88±8	87±7	0.217
Hemoglobin A_{1C} (%)	5.4±0.3	5.3±0.3	0.076
SUA (mg/dL)	5.7±1.1	4.5±0.8	<0.001

Data are presented as numbers or mean±SD or medians.
WC, waist circumference ; BH, body height ; POW, percentage of being overweight ; BP, blood pressure ; TG, triglyceride ; LDL-C, low-density lipoprotein cholesterol ; HDL-C, high-density lipoprotein cholesterol ; FPG, fasting plasma glucose ; SUA, serum uric acid.

mg/dL) for boys and (1) ≤ 56 mg/dL (mean 51 mg/dL), (2) 57 to 64 mg/dL (mean 60 mg/dL), (3) 65 to 74 mg/dL (mean 69 mg/dL), and (4) ≥ 75 mg/dL (mean 82 mg/dL) for girls.

Metabolic syndrome was found in only 5 (0.5 %) of the students (4 boys and 1 girl). The highest number of the students was located at a HDL-C level between 60 mg/dL and 65 mg/dL in both genders, and only 11 (1.0 %) (8 boys and 3 girls) of the students showed low HDL-C (**Fig. 1**). SBP and SUA were significantly higher and WC/BH ratio, TG, LDL-C, non-HDL-C, and LDL-C/HDL-C ratio were lower in boys than in girls (**Table 1**). POW, HDL-C, FPG, and HbA_{1C} did not differ between genders (**Table 1**). The lowest 5th percentile of HDL-C level was 40.0 mg/dL for boys and 40.3 mg/dL for girls. There was no significant difference in HDL-C level among students from the 3 different areas. In boys, TG and LDL-C/HDL-C ratio showed a graded decrease according to HDL-C quartiles. There was a significant increase in WC, WC/BH ratio, POW, non-HDL-C, FPG, and SUA in the lowest quartile of HDL-C compared with the highest quartile (**Table 2**). The prevalence of abdominal obesity, hypertriglyceridemia, and increased FPG was significantly greater in the lowest quartile of HDL-C compared with the highest quartile (**Table 3**). In girls, there was a graded decrease in LDL-C/HDL-C ratio and a significant increase in WC, WC/BH ratio, POW, TG, non-HDL-C, and SUA in the lowest quartile of HDL-C compared with the highest quartile (**Table 2**). The prevalence of abdominal obesity and hypertriglyceridemia was significantly increased in the lowest quartile of HDL-C compared with the highest quartile (**Table 3**). No significant difference was found in the prevalence of hypertension or high LDL-C among quartiles of HDL-C in both genders (**Table 3**).

According to HDL-C quartiles, there was a graded increase in the ratio of students who were doing sports outside of school in both genders and a graded decrease in the ratio of students who were often commuting to and from school by car in girls (**Table 4**). The ratios of the students who were often commuting to and from school by car, did not like exercise, and watched television (TV) during meals

Table 2 Gender-specific Baseline Characteristics According to HDL-C Quartiles

	Quartiles of HDL-C			
	Q1	Q2	Q3	Q4
Boys (n=570)				
Range of HDL-C (mg/dL)	≤55	56-63	64-73	≥74
Number of subjects	143	149	137	141
Age (yrs)	13.3±0.7	13.3±0.7	13.2±0.7	13.2±0.6
WC (cm)	70.4±10.1**	66.7±7.5	66.6±6.4	67.1±8.5
WC/BH ratio	0.43±0.06*	0.42±0.03	0.42±0.03	0.42±0.05
POW (%)	6.0±18.4***	0.5±13.2**	-1.1±13.0	-1.3±10.8
Systolic BP (mmHg)	113±12	113±12	114±11	114±13
Diastolic BP (mmHg)	64±9	63±10	63±10	64±11
TG (mg/dL)	82***	74***	57*	51
(95% CI)	(54-122)	(51-112)	(46-91)	(38-73)
LDL-C (mg/dL)	87±19	89±22	88±19	89±20
non-HDL-C (mg/dL)	102±20*	103±23*	98±20	97±21
LDL-C/HDL-C ratio	1.77±0.37***	1.49±0.36***	1.29±0.29**	1.10±0.27
FPG (mg/dL)	91±7***	88±8	88±7	86±8
Hemoglobin A_{1c} (%)	5.4±0.3	5.4±0.4	5.4±0.3	5.4±0.3
SUA (mg/dL)	5.9±1.2**	5.4±1.1	5.5±1.1	5.5±1.2
Girls (n=494)				
Range of HDL-C (mg/dL)	≤56	57-64	65-74	≥75
Number of subjects	125	125	120	124
Age (yrs)	13.2±0.7	13.1±0.7	13.2±0.7	13.1±0.6
WC (cm)	69.0±7.4***	67.5±6.1*	67.7±6.8*	65.7±6.3
WC/BH ratio	0.44±0.04**	0.43±0.04*	0.43±0.04*	0.42±0.04
POW (%)	3.0±14.9***	1.6±12.0	1.8±16.1	-3.3±11.9
Systolic BP (mmHg)	108±10	109±10	109±11	108±11
Diastolic BP (mmHg)	62±8	62±8	62±11	63±10
TG (mg/dL)	76*	66	64	48
(95% CI)	(53-110)	(41-97)	(40-93)	(35-79)
LDL-C (mg/dL)	95±27	91±27	92±29	93±28
non-HDL-C (mg/dL)	112±23*	107±25	106±27	107±26
LDL-C/HDL-C ratio	1.86±0.46***	1.52±0.41**	1.34±0.39**	1.13±0.31
FPG (mg/dL)	87±7	87±6	87±7	87±7
Hemoglobin A_{1c} (%)	5.4±0.4	5.4±0.3	5.3±0.4	5.3±0.3
SUA (mg/dL)	4.7±0.9*	4.5±0.8	4.5±0.8	4.3±0.8

*$p<0.05$, **$p<0.01$, and ***$p<0.001$ vs Q4. Data are presented as numbers or mean±SD or medians.
Abbreviations as in Table 1.

were significantly higher in the lowest quartile of HDL-C compared with the highest quartile in both genders (**Table 4**). In the lowest quartile of HDL-C, the prevalence of students who were often commuting to and from school by car was significantly higher, and of those who liked exercise was lower, in girls than in boys (**Table 4**).

Ⅳ Discussion

The results of the present study in a school-based sample of Japanese junior high school students demonstrated that serum HDL-C level was associated with reduced daily physical activity. This study may provide insights into the role of HDL-C level in the school screening system for the development of more effective educational programs on

Table 3 Prevalence of Cardiometabolic Risk Factors According to HDL-C Quartiles

	Quartiles of HDL-C			
	Q1	Q2	Q3	Q4
Boys				
Abdominal obesity	16.9***	6.5	5.8	6.4
Hypertension	1.5	0	0	0
Hypertriglyceridemia	11.8**	9.4**	0.7	0
High LDL-C	0.7	2.2	1.3	0.7
Increased FPG	13.1*	5.4	2.9	2.9
Girls				
Abdominal obesity	14.7*	6.5	6.8	4.0
Hypertension	0.9	0.8	2.2	0
Hypertriglyceridemia	12.1**	8.9*	5.2	2.4
High LDL-C	1.7	3.2	4.5	4.8
Increased FPG	4.3	3.2	3.0	3.7

The numbers indicate prevalence of each variable (percentages).
*$p<0.05$ vs Q4, **$p<0.01$ vs Q4, and ***$p<0.001$ vs Q4.
Abbreviations as in Table 2.

Table 4 HDL-C Level and Lifestyle Habits

	Quartiles of HDL-C			
	Q1	Q2	Q3	Q4
Boys (n=570)				
Skipping breakfast (≥2 times/week)	24 (16.8)	17 (11.4)	18 (13.1)	17 (12.1)
Eating quickly	66 (46.2)	64 (43.0)	59 (43.1)	60 (42.6)
Drinking more than half of the broth with noodles	74 (51.7)	76 (51.0)	67 (48.9)	67 (47.5)
Consuming sweetened drinks every day	61 (42.7)	61 (40.9)	55 (40.1)	54 (38.3)
Eating a midnight snack (≥3 times/week)	57 (39.9)	53 (35.6)	45 (32.8)	44 (31.2)
Watching television during meals	128 (89.5)***	115 (77.2)	103 (75.2)	102 (72.3)
Eating cakes/sweet rolls (≥3 times/week)	50 (35.0)	50 (33.6)	43 (31.4)	40 (28.4)
Eating convenience store lunches (≥ once/week)	31 (21.7)	25 (16.8)	22 (16.1)	21 (14.9)
Often commuting to and from school by car	65 (45.5)***	31 (20.8)**	18 (13.1)	14 (9.9)
Playing computer games (≥1 h/day)	109 (76.2)	101 (67.8)	96 (70.1)	94 (66.7)
Liking exercise	70 (49.0)***	113 (75.8)*	109 (79.6)	126 (89.4)
Doing sports outside of school	4 (2.7)***	29 (19.5)***	43 (31.4)**	75 (53.2)
Girls (n=494)				
Skipping breakfast (≥2 times/week)	17 (13.6)	16 (12.8)	13 (10.8)	13 (10.5)
Eating quickly	51 (40.8)	51 (40.8)	47 (39.2)	49 (39.5)
Drinking more than half of the broth with noodles	44 (35.2)	42 (33.6)	36 (30.0)	37 (29.8)
Consuming sweetened drinks every day	33 (26.4)	30 (24.0)	26 (21.7)	29 (23.4)
Eating a midnight snack (≥3 times/week)	39 (31.2)	38 (30.4)	37 (30.8)	35 (28.2)
Watching television during meals	107 (85.6)*	99 (79.2)	98 (81.7)	92 (74.2)
Eating cakes/sweet rolls (≥3 times/week)	35 (28.0)	35 (28.0)	31 (25.8)	27 (21.8)
Eating convenience store lunches (≥ once/week)	16 (12.8)	13 (10.4)	15 (12.5)	10 (8.1)
Often commuting to and from school by car	73 (58.4)***, ‡	59 (47.2)***	24 (20.0)**	11 (8.9)
Playing computer games (≥1 h/day)	33 (26.4)	27 (21.6)	26 (21.7)	25 (20.2)
Liking exercise	24 (19.2)***, §	63 (50.4)*	67 (55.8)	77 (62.1)
Doing sports outside of school	2 (1.6)***	12 (9.6)***	21 (17.5)**	39 (31.5)

*$p<0.05$, **$p<0.01$, and ***$p<0.001$ vs Q4. ‡ $p<0.01$ and § $p<0.001$ vs Q1 in boys. Data are expressed as numbers (percentages).

prevention of lifestyle-related diseases in the Japanese population of school children.

A HDL-C and CV disease risk

HDL-C possesses not only reverse cholesterol transport function but also several beneficial biological properties, including direct endothelial protection, anti-oxidation of LDL, and anti-thrombotic, anti-inflammatory, and anti-apoptotic effects, all of which may contribute to protect against atherosclerosis[25]. Since the Framingham Heart Study[26], a number of epidemiological studies have revealed a consistent negative association of HDL-C level with CV disease risk in adults in Western countries[1)2)]. The incidence of CHD[3] and all-cause mortality[4] has also been inversely related to HDL-C in the adult Japanese general population[27]. A recent cohort study with 12 years of follow-up in the male Japanese population has identified lower HDL-C as an independent risk factor for CHD[5].

In the Japanese population of school children, there was an increase in the prevalence of TC level from 1960 to 1996 in the nation-wide school health program conducted by the Ministry of Education, which was in parallel with an increase in obesity during the same period[28]. However, a recent study on population-based annual screening of fifth-grade elementary school children in a regional district from 1993 to 2008 observed no significant change in TC, non-HDL-C, or HDL-C among school children[29]. Okada et al. proposed new criteria of normal serum lipid levels among Japanese school children aged 9 to 16 years who were enrolled from 19 prefectures and received screening and care programs for prevention of lifestyle-related diseases from 1993 to 1999, in which the level below the 5th percentile of HDL-C was defined to be low and the cut-off value was determined as 40 mg/dL[23]. In the present study, the prevalence of HDL-C $<$ 40 mg/dL was only 1.0 %, but the value of the lowest 5th percentile of HDL-C was consistent with the finding by Okada et al[23]. The finding that students in the lowest quartile of HDL-C showed increased prevalence of abdominal obesity, hypertriglyceridemia, and increased FPG compared with the highest quartile was not surprising because HDL-C and other cardiometabolic risk factors are the components of metabolic syndrome[22].

B HDL-C and lifestyle habits

It is generally recognized that increased physical activity, cessation of smoking, weight loss, moderate alcohol intake, a diet rich in omega-3 polyunsaturated fatty acids, and a diet low in carbohydrates are strategies for HDL-C elevation and that drugs that raise the HDL-C level as the principal pharmacodynamic effect do not exist[30]. In addition, a frequent Japanese-style diet, which is characterized by adequate total calories, increased intake of fish and plant foods, and decreased intake of carbohydrates and animal fat, has been shown to cause an elevation of HDL-C level[31]. A previous study in the Japanese population of fourth-grade elementary school children demonstrated that compared with normal-fat group, high-fat children were less physically active and consumed a larger amount of food, which was associated with decreased HDL-C level[19]. In contrast, a recent observation revealed no change in HDL-C level after dietary treatment combined with exercise treatment in obese Japanese children aged 10.1 years old despite marked improvement of visceral fat and other cardiometabolic risk factors, such as TG, TC, and uric acid, and liver dysfunction[20]. The discrepancies in the results might be due to the differences in the study design, including the subjects and intensity and duration of exercise. In the present study, the ratios of the students who were often commuting to and from school by car, did not like exercise, did not do sports outside of school, and watched TV during meals were significantly higher in the lowest quartile of HDL-C level compared with the highest quartile in both genders. It was of particular interest that in the lowest quartile of HDL-C level, the prevalence of students who were often commuting to and from school by car was significantly higher, and of those who liked exercise was lower, in girls than in boys, despite an almost identical mean HDL-C level. In contrast, no significant relationship of other dietary patterns or habits to HDL-C level was found among the school children. These findings were in accordance with a recent observation by Yoshinaga, et al. that lifestyle conditions, such as participation in school-based extracurricular physical activities and TV-watching time, were inversely correlated with HDL-C level in Japanese healthy adolescent high school students aged 15 to 18 years[32], suggesting that a lower HDL-C level is associated with reduced daily physical activity among school children. Aerobic exercise has been reported to elevate HDL-C level by 5-10 %. Although its precise mechanism is unclear, increased activity of muscle lipoprotein lipase has been suggested as one of the possible contributing factors[33].

C Limitations and Implications

There were several limitations in the present study. First, because this is a cross-sectional study, it remains unknown whether children with lower HDL-C level may show changes in lipid profiles following lifestyle modifications or develop future CV disease if they did not do so. To establish the exact prognostic significance of HDL-C in the development of CV events among children, further longer follow-up studies are required. Second, the questionnaire was very simple and contained only 12 items concerning lifestyle patterns. Furthermore, the association between HDL-C and lifestyle habits was not adjusted for confounding factors, such as the magnitude of physical activity, in the present study ; such factors might influence the relationship, resulting in overestimation or underestimation in the results. Therefore, a more detailed analysis after adjustment by using multivariate analysis or stratified analysis is necessary for precise assessment. Third, it has been reported that lower HDL-C levels are accompanied by several conditions other than reduced daily physical activity in children, such as exposure to environmental tobacco smoke[34] and maternal smoking in pregnancy[35]. In addition, several investigators have observed that children born small who are associated with postnatal rapid weight gain have increased LDL-C, LDL-C/HDL-C ratio, and insulin resistance and decreased HDL-C compared with control subjects and that the unfavorable lipid profiles might track through adolescence[36)-38]. Thus, attention should be focused on not only physical activity but also the relationship between the lipid profiles and the birth weight as well as the catch-up increase in weight early in life. Fourth, although central adiposity as measured by WC has been associated with cardiometabolic risk factors as well as fasting insulin level, independent of body mass index[39][40], and measurement of WC and POW is easily performed in children, whether WC and POW or HDL-C level measurement might be better for identifying children at more risk metabolically and predicting future CV disease remains to be elucidated. Finally, it would be expected that the prevalence of obesity and other cardiometabolic risk factors substantially varies in the different regions of Japan. Thus, a nation-wide prospective survey is required to verify the present findings of an association of lower HDL-C level with lifestyle habits in the entire Japanese population of school children.

It is important to recognize predictors of risk of future atherosclerotic CV diseases for early detection and more effective preventive measures in individual children and adolescents. The results of the present study indicate that HDL-C level is associated with daily physical activity among school children. First of all, it is important to offer educational opportunities that show the relationship between lifestyle pattern, such as reduced daily physical activity, and unfavorable lipid profiles among junior high school students, particularly in girls, because there was a significant difference in the prevalence of students who were often commuting to and from school by car and who liked exercise between both genders in the lowest quartile of HDL-C level. Children and adolescents with lower HDL-C level can be considered as a special target group for implementation of a family-based repeated lifestyle intervention, especially increased daily physical activity.

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Ⅵ Conflicts of Interest

The authors declare no potential conflicts of interest.

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