Serum lipid profiles including non-high density lipoprotein cholesterol levels in Turkish school-children

Türk okul çocuklarında serum lipid profili ve non-HDL kolesterol düzeyleri

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ABSTRACT

Objective: Early detection of dyslipidemia and long-term prevention of atherosclerosis by controlling risk factors should begin in childhood. The purpose of this study was to evaluate the prevalence of dyslipidemia according to non-high density lipoprotein cholesterol (non-HDL-C) levels in children and also evaluate serum non-HDL-C levels according to age groups, gender difference and living areas.

Methods: Overall, 2896 children (1467 girls, 1429 boys) aged between 7-18 years, residing in urban and rural parts of Eskişehir, Turkey, were enrolled in this randomized cross-sectional study. Serum non-HDL-C, total cholesterol (TC) and triglyceride (TG) levels were assessed in all participants of the study. Statistical analysis was performed Student's independent-samples T test for comparison of lipid parameters and relations between lipid parameters and age, anthropometric measurements, body fat percentage were evaluated by Pearson correlation test.

Results: Serum non-HDL-C levels were significantly higher in girls (115.5±31.5mg/dl) than boys (106.7±30.2 mg/Dl) ($p<0.001$). For girls, serum non-HDL-C levels were higher in 7-10 year age group than in 11-14-year and 15-18-year age groups ($p<0.01$ and $p<0.05$, respectively). For boys serum non-HDL-C levels of 7-10 year age group were significantly higher than in 11-14-year and 15-18-year age groups ($p<0.001$ for both). Serum non-HDL-C, total cholesterol and triglyceride levels were higher in girls than in boys especially in the 7-10-year-old age group. Serum TC, LDL-C, and HDL-C levels were higher in urban area residents, while serum TG levels were higher in rural area residents ($p<0.001$). Serum non-HDL-C levels were similar in residents of different living areas ($p>0.05$). In both sexes, non-HDL-C levels positively correlated with age and lipid parameters except HDL-C levels and also negatively correlated with HDL-C levels. In boys, non-HDL-C levels also correlated with total body fat percentage, weight, height. The prevalence of dyslipidemia according to non-HDL-C levels was higher (13.2%) in girls than boys (8.9%) ($p<0.001$). The prevalence of elevated non-HDL-C levels was higher in urban area residents than in rural area residents ($p<0.05$). The dyslipidemia prevalence according to non-HDL-C levels was similar with dyslipidemia prevalence according to serum LDL-C levels.

Conclusion: Our results are indicative of the prevalence of dyslipidemia in children is considerably common in our population. Serum non-HDL-C levels could be used as an appropriate tool for detecting dyslipidemia in childhood. *(Anadolu Kardiyol Derg 2007; 7: 415-20)*

Key words: Children, lipid, lipoprotein, non-HDL, Turkey

ÖZET

Amaç: Dislipidemin erken dönemde saptanması ve uzun süreli korumada ateroskleroz için tanımlanmış risk faktörlerinin erken dönemde kontrolünün çocukluk yaş grubunda başlanması önerilmektedir. Bu çalışmada çocuklarda serum yüksek dansiteli lipoprotein dışı kolesterol (non-HDL-K) düzeylerine göre dislipidemi prevalansının belirlenmesi ve serum non-HDL-K düzeylerinin yaş grupları, cinsiyet ve yaşam alanına göre değerlendirilmesi planlandı.

Yöntemler: Eskişehir kent ve kırsal bölgesinde yaşayan 7-18 yaşları arasında 2896 çocuk (1467 kız, 1429 erkek) bu randomize kros-seksiyonel çalışmaya alındı. Tüm çocuklarda serum non-HDL-K, total kolesterol (TK) and trigliserid (TG) düzeyleri ölçüldü. İstatistiksel analizde lipid parametrelerin karşılaştırması Student bağımsız örneklem T testi ile yapıldı. Lipid parametrelerin yaş, antropometrik ölçümleri, total vücut yağ yüzdesi ile ilişkileri Pearson korelasyon testi ile incelendi.

Bulgular: Serum non HDL-K düzeyleri kız çocuklarında (115.5±31.5 mg/dl) erkek çocuklarına (106.7±30.2mg/dl) göre yüksek olarak saptandı ($p<0.001$). Yedi-10 yaş grubundaki kız çocuklarında serum non-HDL-K düzeyleri 11-14 yaş ve 15-18 yaş grubundaki kız çocuklarından yüksek olarak saptandı (sırasıyla $p<0.01$, $p<0.05$). Yedi-10 yaş grubundaki erkek çocuklarında serum non-HDL-K düzeyleri, 11-14 yaş ve 15-18 yaş grubundaki erkek çocuklarından yüksek olarak saptandı (her iki grup için de $p<0.001$). Serum non-HDL-K, total kolesterol ve trigliserid düzeyleri 7-10 yaş grubunda, kız çocuklarında erkek çocuklarından yüksek olarak saptandı. Serum total kolesterol, LDL-K ve HDL-K düzeyleri kentlerde yaşayan çocuklarda yüksek olarak saptanırken, serum trigliserid düzeyleri kırsal alanda yaşayan çocuklarda yüksek olarak saptandı ($p<0.001$). Serum non-HDL-K düzeyleri için kentsel ve kırsal alanda yaşayan çocuklarda fark saptanmadı ($p>0.05$). Her iki cinsiyette de serum non-HDL-K düzeyleri yaş ve HDL-K dışındaki diğer lipid parametreleri ile pozitif, serum HDL-K düzeyleri ile negatif korelasyon saptandı. Erkek çocuklarında, serum non-HDL-K düzeyleri aynı zamanda total vücut yağ yüzdesi, vücut ağırlığı ve boy ile korelasyon saptandı. Serum non-HDL-K düzeylerine göre dislipidemi prevalansı kız çocuklarında (%13.2) erkek çocuklarına (%8.9) göre yüksek olarak saptandı ($p<0.001$). Serum non-HDL-K düzeylerine göre dislipidemi prevalansı kentte yaşayan çocuklarda kırsal alanda yaşayan çocuklara göre yüksek olarak saptandı ($p<0.05$). Çocuklarda serum non-HDL-K düzeylerine göre dislipidemi prevalansı serum LDL-K düzeylerine göre dislipidemi prevalansı ile benzerdi.

Sonuç: Çalışmamızın sonunda çocuklarda dislipidemi prevalansı beklenenden yüksek olarak saptandı. Ayrıca çocukluk çağında dislipideminin saptanmasında serum non-HDL-K düzeylerinin kullanılabileceği sonucuna varıldı. *(Anadolu Kardiyol Derg 2007; 7: 415-20)*

Anahtar kelimeler: Çocuk, lipid, lipoprotein, non-HDL, Türkiye

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Introduction

Coronary heart disease (CHD) is a leading cause of death in worldwide. Because of the atherosclerotic process begins in childhood before clinical symptoms, it seems prudent to minimize adult coronary risk factors in younger as well as in adults (1-4). For this reason, some authors recommended that routine screening program for blood lipid levels to be performed in all children and have provided guidelines to identify and treat children who are at risk for the development of accelerated atherosclerosis in early adult life (4-5). While serum low-density lipoprotein cholesterol (LDL-C) levels were considered as the gold standard for determination of coronary risk factors and dyslipidemia, limitations of the use were recently reported (6-7). Srinivasan et al. (7) reported that non-high density lipoprotein cholesterol (non-HDL-C) levels could be useful for determination of lipoprotein related risk assessment. Measurement of non-HDL has been proposed for screening program because of non-HDL-C includes both cholesterol-rich and triglyceride rich atherogenic apolipoprotein-B containing lipoproteins and the measurement do not require overnight fasting (7).

This cross-sectional study was designed to measure plasma lipids and lipoprotein levels, to evaluate the prevalence of dyslipidemia according to non-HDL-C levels and evaluate serum non-HDL-C levels according to age groups, gender difference and living areas in school-children aged between 7 to 18 years in Eskişehir, Turkey.

Methods

As a part of our previously published study (8), 2896 school-children (1467 girls, 1429 boys) aged between 7 to 18 years, who were randomly selected from the students attending 11 schools located in the different regions of Eskişehir city center (urban area) and Çifteler county (rural area) in Turkey, were included in this randomized cross-sectional study.

Eskişehir, which is one of the big cities of Turkey with population of 500.000 is an industrial and commercial center and has two universities. Çifteler county is located 64 km from Eskişehir city center and has population of 11.000, who maintain their living mainly by agriculture.

The selected schools were socio-economically representative of the region. The eligible population included all school age children living in the study area after written parental content. Study group was divided into three different subgroups for both sexes consisting of age 7-10, 11-14, and 15-18 years age groups.

Permission for the study was requested from schools, parents and children themselves. The study protocol was approved by the Local Ethical Committee of Eskişehir Osmangazi University. Before the study day, the students were informed about the aim and the design of the study and a written message was sent to their families for instructing at least 12 hours fasting before blood sampling.

A study team consisting of pediatricians, research assistants and interns of pediatrics who were previously trained regarding the study, visited the schools during morning hours. The questionnaire forms included the demographic data, smoking status and self-reported daily physical activity degree.

The children were classified into 3 physical activity groups according to-their self-reporting information: 1) children who make only activities that do not require physical effort such as reading, watching TV, etc. and go to school by motor-vehicles without walking; 2) children who go to school by walking and make some mild physical activities such as walking, riding bicycle or etc.; 3) children who make some heavy physical activities such as joining competitive sports, making severe training regularly or doing heavy garden works. Those children in the lowest of the three physical activity groups were considered to be at risk as sedentary life-style (9).

Height and weight of children was measured with wearing minimum indoor clothing, without shoes, using scales calibrated several times during the day. Body mass index (BMI) was estimated by the formula of weight (kg) / height (m^2). Skinfold thickness was obtained from four sites (over triceps, biceps, subscapular and suprailiac regions) by skinfold caliper for estimation of total body fat percentage according to the method of Durnin and Rahaman (10). Blood pressure (BP) was measured twice from the right arm by sphygmomanometer using a cuff of appropriate size, while the subject sitting quietly for at least 5 minutes. The mean of the two measurements was recorded (11).

Approximately 5 ml venous blood samples were obtained from the antecubital veins and centrifuged within 1.5-2 hours. Serum total cholesterol (TC) and triglyceride (TG) concentrations were analyzed in a BM-Hitachi-747 auto analyzer (Boehringer Mannheim GmbH, Mannheim, Germany) by enzymatic-colorimetric methods using original kits. Serum high-density lipoprotein cholesterol (HDL-C) levels were analyzed by enzymatic method after precipitating serum reagents with phosphotungstic acid and magnesium. Serum LDL-C and very low low-density lipoprotein cholesterol (VLDL-C) values were estimated by the formula of Friedewald et al (12). Non-HDL levels were calculated by the formula of "total cholesterol minus HDL-C" (7).

For determining dyslipidemia, serum TC level of >200 mg/dl, LDL-C of >130 mg/dl, and TG level of >140 mg/dl, which were determined as the 95th percentile values and serum HDL-C level of <35 mg/dl, determined as the 10th percentile value for children and adolescents, were accepted as the risk thresholds (13). Unfavorable lipid profile according to non-HDL-C levels were described as above 150 mg/dl (4).

Statistical analysis

The sample size was calculated according with the results of our previous study (8) with power of the study of 80% and significance level of 5%.

All statistical analysis was conducted using SPSS version 10.0 (Statistical Package for Social Sciences, Chicago, IL, USA). Lipid parameters values are expressed as mean±SD for nonskewed distributed data, the comparison of the data was performed using Student's independent-samples T test and categorical variables were analyzed by Chi-square test. Relations between lipid parameters and age, anthropometric measurements, body fat percentage were evaluated by Pearson correlation test was used for correlations. P values of <0.05 were considered significant.

Results

Mean serum lipid and lipoprotein levels and percentile values of our study population (Tables 1, 2) and their levels according to sex and living areas are shown in Table 3. Serum non-HDL-C levels were significantly higher in girls (115.5±31.5 mg/dl) than in boys (106.7±30.2 mg/dl) ($p<0.001$) and they were higher in girls than in boys for each age group ($p<0.01$, $p<0.01$ and $p<0.0001$ respectively). For girls, serum non-HDL-C levels were higher in 7-10-year age group than 11-14-year age group and 15-18-year age group ($p<0.01$ and $p<0.05$, respectively). For boys serum non-HDL-C levels of 7-10- year age group were significantly higher than in 11-14-year age group and 15-18-year age group ($p<0.001$ for both).

Serum TC and HDL levels were higher in children living in urban area than those of children living in rural area ($p<0.001$). Serum TG levels were higher in children living in rural area than in those of children living in urban area ($p<0.001$). Serum LDL-C levels were higher in children living in urban area than in those residing in rural without statistically significant difference ($p>0.05$). Serum non-HDL-C levels were similar in residents of different living areas ($p>0.05$).

Table 1. Mean and percentile (5th, 50th and 95th) values of serum lipid and lipoprotein levels in girls

Age,	TC, mg/dl				TG, mg/dl				LDL-C, mg/dl				HDL-C, mg/dl				Non-HDL-C, mg/dl			
years	Mean±SD	5	50	95	Mean±SD	5	50	95	Mean±SD	5	50	95	Mean±SD	5	50	95	Mean±SD	5	50	95
7	171.7±31.3	122	168	225	83.6±34.4	30	79	158	105.3±31.2	60	103	160	48.9±14.2	32	47	80	121.7±32.3	75	118	184
8	171.4±29.4	121	175	213	85.2±39.5	29	82	163	105.2±32.5	53	106	150	48.7±13.3	30	46	78	122.3±33.1	61	120	171
9	173.1±37.3	121	167	234	88.5±36.4	34	84	159	101.8±39.1	42	97	168	52.7±13.2	34	52	77	119.5±39.7	59	114	191
10	165.5±29.7	115	166	215	90.7±37.5	42	83	166	89.6±25.6	43	92	136	53.4±13.8	35	51	85	106.9±26.9	64	106	152
11	168.3±28.0	120	168	220	104.4±40.2	50	97	199	94.4±27.8	51	96	140	54.0±15.1	35	51	90	115.0±28.9	67	113	160
12	168.4±26.0	132	168	213	103.4±41.5	52	97	175	92.0±26.6	46	93	139	55.2±15.4	35	53	87	112.7±27.4	66	111	159
13	167.8±27.7	126	166	215	102.7±35.5	53	97	177	94.0±27.1	56	93	143	52.9±13.3	33	53	78	114.6±27.9	72	112	165
14	163.5±30.0	119	159	221	90.0±38.6	46	82	155	92.9±29.9	45	92	145	52.5±13.7	34	50	81	110.9±32.1	61	109	169
15	167.5±29.4	121	164	219	88.4±42.5	44	80	158	97.2±27.8	51	98	148	52.7±12.8	35	51	77	115.1±29.2	72	115	167
16	167.9±32.5	121	168	219	78.2±29.5	41	75	135	97.8±29.5	56	96	150	54.9±15.2	36	53	79	113.3±31.1	69	110	168
17	177.7±34.6	126	178	249	83.8±26.0	28	72	127	103.6±33.4	52	104	155	60.3±24.0	37	55	99	118.3±34.8	65	117	176
18	176.5±37.9	103	181	244	88.2±23.6	20	70	144	106.2±36.4	57	108	160	54.7±15.8	32	56	92	122.6±38.7	37	121	189
TOTAL	169.1±30.8	122	167	222	89.6±28.5	41	83	161	97.6±30.4	51	96	149	53.3±15.1	34	51	81	115.5±31.5	67	113	169

Data presented are Mean±standard deviation for continuous variables. HDL-C- high density lipoprotein cholesterol, LDL-C- low density lipoprotein cholesterol, non-HDL-C- non high density lipoprotein cholesterol, TC- total cholesterol, TG- triglyceride

Table 2. Mean and percentile (5th, 50th and 95th) values of serum lipid and lipoprotein levels in boys

Age,	TC, mg/dl				TG, mg/dl				LDL-C, mg/dl				HDL-C, mg/dl				Non-HDL-C, mg/dl			
years	Mean±SD	5	50	95	Mean±SD	5	50	95	Mean±SD	5	50	95	Mean±SD	5	50	95	Mean±SD	5	50	95
7	163.6±26.0	124	159	222	75.7±32.1	32	68	161	96.9±29.8	49	92	147	51.9±14.9	32	49	77	111.2±29.7	67	107	173
8	163.0±29.0	125	161	215	78.8±38.8	30	75	156	95.9±28.9	54	92	144	50.7±15.5	32	49	83	111.2±29.6	68	106	161
9	172.9±36.3	125	168	241	85.2±33.5	37	82	150	103.1±34.1	51	101	164	52.2±14.3	34	51	83	120.1±37.0	66	117	191
10	170.3±33.2	122	163	236	85.8±36.3	39	77	152	85.7±28.0	42	82	139	57.1±13.2	37	56	83	101.0±28.7	58	96	152
11	166.4±31.2	123	161	224	90.2±42.2	43	81	184	96.2±30.3	55	93	150	52.2±11.1	35	52	74	114.1±33.7	68	108	183
12	166.7±30.1	118	165	216	93.2±41.0	45	85	182	94.9±27.6	52	94	144	53.2±13.9	35	50	81	113.5±29.5	67	113	159
13	160.0±28.5	114	159	208	86.3±41.7	39	81	180	90.4±27.7	49	90	145	52.1±12.2	32	51	74	107.6±30.2	65	106	159
14	153.9±26.5	109	151	206	85.9±35.2	44	79	154	83.5±24.0	45	82	128	52.8±13.0	35	52	76	100.6±25.2	60	98	146
15	149.7±25.1	114	147	196	87.7±38.5	45	79	169	83.1±25.2	49	79	130	49.1±12.4	29	48	71	100.7±25.9	65	96	150
16	151.5±32.2	103	148	224	84.2±43.7	38	73	147	86.3±31.6	45	81	148	48.2±13.6	30	46	78	103.3±33.4	56	99	170
17	149.7±27.8	104	148	207	87.3±36.5	41	83	171	83.8±26.0	37	82	131	48.2±14.5	32	45	80	101.0±27.5	57	101	152
18	153.6±30.6	113	149	258	99.0±43.5	39	97	179	88.2±23.6	47	85	161	45.0±12.5	30	43	83	107.1±26.5	68	105	186
TOTAL	159.2±30.5	115	155	214	86.7±38.9	41	80	163	89.6±285	49	86	141	51.1±13.5	32	49	76	106.7±30.2	65	103	159

HDL-C- high density lipoprotein cholesterol, LDL-C- low density lipoprotein cholesterol, non-HDL-C- non high density lipoprotein cholesterol, TC- total cholesterol, TG- triglyceride

Serum non-HDL-C levels correlated with serum TC, TG, HDL, LDL and VLDL levels in both sexes especially significantly with serum LDL-C levels (r=0.970, p<0.001 for girls and r=0.959, p<0.001 for boys). While in boys, serum non-HDL-C levels positively correlated with age, weight, height (p<0.001, p<0.001, p0.001 consecutively), in girls, serum non-HDL-C levels positively correlated with age (p<0.05) and did not correlate with height and weight. Serum non-HDL-C levels positively correlated total body fat percentage in boys (r=0.139, p<0.001) unlike girls. Serum non-HDL-C levels were not correlated with BMI and physical activity status for both sexes.

Prevalence of dyslipidemia for both sexes are shown in Table 4. The proportion of the children with hypercholesterolemia, with LDL-C levels and non-HDL-C levels above the 95th percentile values in girls were higher than in boys (p<0.001 for both). The prevalence of dyslipidemia according to non-HDL-C levels was 13.2% in girls and 8.9% in boys (p<0.0001). The prevalence of dyslipidemia in girls was significantly higher than in boys in 15-18 years age group (p<0.001). In 7-10 years age group, the proportion of the girls who had serum non-HDL-C levels above the 95th percentile value was higher than in those of 11-14 years age group (p<0.05).

For boys, hypercholesterolemia, elevated LDL-C and non-HDL-C levels were common in 7-10 years age group than in other age groups (p<0.001). The proportion of the boys with decreased HDL-C levels in 7-10 years and 15-18 years age groups were significantly higher than in those of 11-14 years age group (Table 4).

The prevalence of dyslipidemia for living areas is shown in Table 4. In spite of hypercholesterolemia was common in urban area (p<0.001), hypertriglyceridemia was commonly observed in rural area (p<0.05). The prevalence of elevated LDL-C levels and decreased HDL-C levels were not different in urban and rural areas (p>0.05). The prevalence of elevated non-HDL-C levels were higher in urban area than in rural area (p<0.05).

Discussion

In our study the prevalence of dyslipidemia according to LDL-C and non-HDL-C levels were similar for both sexes. These findings may support opinion that non-HDL-C levels may be used for determining dyslipidemia in children. Non HDL-C has been proposed as a better screening tool for coronary artery disease risk assessment and treatment with the rationale being that non-HDL-C includes both cholesterol-rich and TG-rich atherogenic apolipoprotein -B containing lipoproteins (VLDL, IDL, LDL, lipoprotein-a) and the measurement does not require overnight fasting (7). In adult's elevated non-HDL-C concentration are associated with advanced atherosclerotic lesions and increased risk of clinically manifested atherosclerotic disease (14-15). In a recent study carried out in young persons, fatty streaks and raised lesions in the right coronary artery and in the abdominal aorta were associated with increased non-HDL-C concentration, hypertension, impaired glucose tolerance, obesity and low HDL-C (4). Interestingly the 95th percentile values of our children were higher than in those of Bogalusa Heart Study's population (7). In our study serum non-HDL-C levels were

Table 3. Serum lipid and lipoprotein levels according to sex and living areas*

	TC, mg/dl	TG, mg/dl	LDL-C, mg/dl	HDL-C, mg/dl	Non-HDL-C, mg/dl
Girls (n=1467)	169.1±30.8	89.7±38.5	97.6±30.4	53.3±15.1	115.5±31.5
7-10 years (n=420)	170.7±32.3[a]	86.8±36.9[b,c]	102.0±33.5[b]	50.6±13.7[d,e]	119.1±34.3[c,d]
11-14 years (n=538)	166.8±28.0[f]	99.5±39.5[g]	93.2±27.9[f]	53.6±14.3	113.0±29.3
15-18 years (n=509)	170.1±32.1	81.9±36.6	99.0±30.0	55.0±16.7	115.4±31.4
Boys (n=1429)	159.2±30.5	86.7±38.9	89.6±28.5	51.1±13.5	106.7±30.2
7-10 years (n=349)	168.5±32.6[h,i]	82.6±35.5[j]	96.5±31.4[i,k]	52.9±14.6[i]	112.2±32.9[h,i]
11-14 years (n=591)	160.8±29.2[e]	88.4±39.8	90.3±27.4[l]	52.6±12.7[l]	107.9±29.7[l]
15-18 years (n=489)	150.5±28.3	87.6±39.8	84.5±27.0	48.3±13.3	101.9±28.3
p1	<0.001	<0.05	<0.001	<0.001	p<0.0001
Urban area (n=2230)	165.3±31.6	87.2±37.3	94.3±30.2	52.8±15.1	111.5±31.7
Rural area (n=666)	160.5±28.8	91.7±43.0	91.8±28.3	50.3±11.6	110.2±29.4
p2	<0.001	<0.001	ns	<0.001	ns

Data presented are Mean±standard deviation for continuous variables.
p1- unpaired Student t test comparisons between girls and boys p2- unpaired Student t test comparisons between urban and rural area
Age groups comparisons - unpaired Student t test

For girls;

a 7-10 years group and 11-14 years group, (p<0.05)
b 7-10 years group and 11-14 years group, (p<0.001)
c 7-10 years group and 15-18 years group, (p<0.05)
d 7-10 years group and 11-14 years group, (p<0.01)
e 7-10 years group and 15-18 years group, (p<0.001)
f 11-14 years group and 15-18 years group, (p<0.01)
g 11-14 years group and 15-18 years group, (p<0.001)

For boys

h 7-10 years group and 11-14 years group, (p<0.001)
i 7-10 years group and 15-18 years group, (p<0.001)
j 7-10 years group and 11-14 years group, (p<0.05)
k 7-10 years group and 11-14 years group, (p<0.01)
l 11-14 years group and 15-18 years group and (p<0.001)

HDL-C-high density lipoprotein cholesterol, LDL-C-low density lipoprotein cholesterol, non-HDL-C-non high density lipoprotein cholesterol, ns -not significant, TC-total cholesterol, TG – triglyceride

positively correlated with other lipid parameters for both sexes and also were correlated with weight and total body fat percentage in boys unlike girls. Dyslipidemia prevalence for non-HDL-C levels was higher in girls than in boys and similar with the dyslipidemia prevalence according to serum LDL-C levels.

In our study, serum non-HDL-C levels were higher before puberty and significantly decreased after 10 years age up to 16 years age. This decline may be explained with decrease of TC levels and increased HDL-C levels during puberty in girls. In boys, this decline was not statistically significant.

Mean serum TC levels tended to be steady during prepubertal years, dropped during puberty in both sexes being more pronounced in boys, and then rise again during adolescence after maturation is completed (16). In our study, serum TC levels showed a more pronounced decline starting from 9 years of age until 15 years of age, and then started to rise at 17 years of age. Recent studies reported different prevalence of dyslipidemia according to TC levels among the countries (3, 5, 13, 16-17). The prevalence of hypercholesterolemia of our study population was 11.8% and mean TC levels of our study was 169 mg/dl in girls and 159 mg/dl in boys, being similar with some reports from different countries (3, 13, 16-17). Mean TC values of Muscatine study (5) and Boreham et al.'s (18) study were higher, 181 mg/dl and 178 mg/dl respectively, than our study values. Yavuz and Bayraktaroglu (19) reported that mean TC of their study population were 131 mg/dl and prevalence of hypercholesterolemia was 2.5% in their region, in Turkey. These differences may be explained with study design, genetic and nutritional factors such as low intake of animal foods or high fiber and carbohydrate consumption (19-20). Serum LDL-C levels showed a similar trend to that of TC levels by age in our population, as reported in the literature (21-22).

Navarra and Muscatine studies (5, 21) reported that serum TG levels increased with age in children and serum TG levels were lower in girls than in boys after 13 years age. In our study, in girls, serum TG levels were stable except a slight increase during puberty (11-13 years) and after 17 years age. In boys, younger than 15 years age, serum TG levels were higher than in girls of the same age, but after 15 years, serum TG levels were slightly higher in girls than in boys.

Reports from Turkey demonstrated that serum HDL-C levels were typically 10-15 mg/dl lower in Turkish adults than in European and North Americans and lower level of HDL-C appears to be largely of genetic origin (23-25). In our study, mean HDL-C levels for each age in both sexes, were above 45 mg/dl. Mean serum HDL-C level was 57.1 mg/dl at 10 years of age, but it decreased to 45 mg/dl at 18 years of age. Mahley et al. (24) reported a greater decrease in HDL-C levels of Turkish children

Table 4. Prevalence of dyslipidemia according to age groups in both sexes and living areas

	Hypercholesterolemia		Hypertriglyceridemia		Elevated LDL-C		Decreased HDL-C		Elevated non-HDL-C	
	n	%	n	%	n	%	n	%	n	%
Girls (n=1467)	207	14.1	130	8.9	202	14.5	77	5.5	183	13.2
7-10 years (n=420)	73	17.4[a]	40	9.5[b]	78	21.1[b,c]	31	8.4[d]	66	15.7d[a, e]
11-14 years (n=538)	53	9.9[f]	66	12.3[g]	53	10.2	27	5.2	60	11.1
15-18 years (n=509)	81	15.9	24	4.7	71	14.2	19	3.8	57	11.1
Boys (n=1429)	136	9.5	116	8.1	123	9.1	104	7.7	119	8.9
7-10 years (n=349)	56	16.0[a,b]	23	6.6	47	16.2[b,c]	27	9.3[a]	40	11.4[c]
11-14 years (n=591)	52	8.8	48	8.1	46	8.0	25	4.3[d]	51	8.6[d]
15-18 years (n=489)	28	5.7	45	9.2	30	6.2	52	10.8	28	5.2
Total (n=2896)	343	11.8	246	7.5	325	11.9	181	6.6	302	10.4
p1	<0.001		ns		<0.001		<0.05		<0.0001	
Urban Area (n=2230)	293	13.1	177	7.9	257	12.4	143	6.9	243	10.9
Rural Area (n=666)	50	7.5	69	10.4	68	10.2	38	5.7	59	8.9
Total (n=2896)	343	11.8	246	7.5	325	11.9	181	6.6	302	10.4
p2	<0.001		<0.05		ns		ns		<0.05	

Data presented are the number and % of patients for categorical variables.
* p1 – Chi-square test for comparison between girls and total boysp2- Chi-square test for comparisons between rural and urban areas
Age groups comparisons - Chi-square test

For girls
a 7-10 years group and 11-14 years group, (p<0.01)
b 7-10 years group and 15-18 years group, (p<0.01)
c 7-10 years group and 11-14 years group, (p<0.001)
d 7-10 years group and 15-18 years group (p<0.01)
e 7-10 years group and 11-14 years group (p<0.05)
f 11-14 years group and 15-18 years group (p<0.01)
g 11-14 years group and 15-18 years group (p<0.001)

For boys
a 7-10 years group and 11-14 years group, (p<0.01)
b 7-10 years group and 15-18 years group, (p<0.001)
c 7-10 years group and 11-14 years group, (p<0.001)
d 11-14 years group and 15-18 years group, (p<0.001)

HDL-C- high density lipoprotein cholesterol, LDL-C- low density lipoprotein cholesterol, non-HDL-C- non high density lipoprotein cholesterol, ns- not significant, TC- total cholesterol, TG- triglyceride

after puberty, which was significantly pronounced in boys than in girls, like our study. High levels of hepatic lipase activity and protein mass are characteristics of Turkish people and may explain their low HDL-C levels (26). However, recent large cohort performed in adults for the determination of the prevalence of metabolic syndrome in our Turkey showed that 47.64% of the women had HDL-C levels above the 50 mg/dl and 58.42% of the man had serum HDL-C levels above the 40 mg/dl. Overall, 44.1% of the total study population had lower serum HDL-C levels (27). The difference of frequency between the studies may be explained with the laboratory technique as precipitation or direct method.

Conclusion

In conclusion, age, sex and living areas, such as urban or rural area are important factors for serum lipid and lipoprotein levels in Turkish children. The prevalence of dyslipidemia in children is considerably common in our region. Non-HDL-C level may be an appropriate tool for detecting dyslipidemia in childhood. Early detection of dyslipidemia and long-term prevention of atherosclerosis by controlling the risk factors including elevated non-HDL-C level should begin in childhood.

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