Evaluation of Serum Lipid Profiles in Turkish Children Aged Two to Eighteen Years

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ABSTRACT

Objective: *The purpose of this study was to evaluate dyslipidaemia in children according to age, gender, percentiles, mother's education level, breastfeeding duration and areas of residence.*
Methods: *A total of 285 children (137 girls; 148 boys), aged between two and 18 years, were enrolled in this cross-sectional, epidemiologic study. Lipid profiles were assessed and its relation with socio-demographic features was evaluated.*
Results: *Dyslipidaemia prevalence was 37.4% (n = 107). High very low-density lipoprotein cholesterol (VLDL-C) and low high-density lipoprotein cholesterol (HDL-C) levels are related with percentiles of the children (p = 0.006, p = 0.03, respectively). Gender was a significant factor for VLDL-C, which was higher in girls than boys (p = 0.04). Total cholesterol levels were high in 14 children (4.9%); 72 of the study group (25.3%) had high triglyceride levels; HDL-C levels were low in 52 children (18.2%).*
Conclusion: *All the parameters of dyslipidaemia are not so high in our region. However, as early detection of dyslipidaemia should begin in childhood, we should perform periodic checks to prevent cardiovascular risks.*

Keywords: Children, lipids, serum lipids, Turkey, Turkish children

Evaluación de Perfiles de Lípidos Séricos en Niños Turcos de Dos a Dieciocho Años de Edad

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RESUMEN

Objetivo: *El propósito de este estudio fue evaluar la dislipidemia en niños de ambos sexos, según edad, género, percentiles, nivel de educación de la madre, duración de la lactancia materna y zonas de residencia.*
Métodos: *Un total de 285 niños (137 niñas; 148 niños) de edades comprendidas entre dos y 18 años, fueron inscritos en este estudio epidemiológico transversal. Se evaluaron los perfiles de lípidos, y se evaluó su relación con las características sociodemográficas.*
Resultados: *La prevalencia de dislipidemia fue de 37.4% (n = 107). Los niveles altos de colesterol de lipoproteína de muy baja densidad (VLDL-C), y los niveles bajos de colesterol de lipoproteína de alta densidad (HDL-C) están relacionados con los percentiles de los niños de ambos sexos (p = 0.006, p = 0.03, respectivamente). El género fue un factor significativo para VLDL-C, el cual fue más alto en las niñas que en los varones (p = 0.04). Los niveles de colesterol total fueron altos en 14 menores de ambos géneros (4.9%); 72 del grupo de estudio (25.3%) tuvieron niveles altos de triglicéridos; los niveles de HDL-C fueron bajos en 52 niños y niñas (18.2%).*
Conclusıón: *Todos los parámetros de la dislipidemia no son tan altos en nuestra región. Sin embargo, como la detección temprana de la dislipidemia debe comenzar en la infancia, debemos realizar revisiones periódicas para prevenir riesgos cardiovasculares.*

Palabras claves: Niños y niñas, lípidos, lípidos séricos, Turquía, niños y niñas turcos

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INTRODUCTION

Childhood obesity and related cardiovascular diseases (CVD) are widespread and growing problems in the world. Most of the clinical burden of CVD occurs in adulthood. However, research over the last 40 years has increasingly indicated that the atherosclerotic process of CVD begins early in life and is progressive throughout the life span (1, 2). If premature development of cardiovascular disease can be anticipated during childhood, the disease might be prevented in adult patients, as the lowering of lipid levels results in primary and secondary prevention of cardiovascular disease (2–6). Data from the Lipid Research Clinics prevalence studies have shown that the concentration of serum lipids and lipoproteins increases during early childhood and reach concentrations similar to those seen in young adults by approximately two years of age (7). In the Bogalusa Heart Study, approximately 70% of the children with elevated cholesterol levels continued to have cholesterol elevations in young adulthood (8).

The strongest risk factors for CVD include a high concentration of low-density lipoprotein cholesterol (LDL-C), a low concentration of high-density lipoprotein cholesterol (HDL-C), elevated blood pressure, Type 1 or 2 diabetes mellitus, cigarette smoking and obesity (9, 10). The current obesity epidemic among children has increased the need for paediatric healthcare professionals and family physicians to be knowledgeable of the risk factors for CVD and to implement the changes in practice (3). Besides genetic factors, environmental factors such as diet and physical activity are important risk factors for obesity in childhood (3). Therefore, early detection of dyslipidaemia and long-term prevention of atherosclerosis by controlling risk factors should begin in childhood.

In July 2008, the American Academy of Pediatrics (AAP) released updates to their lipid screening and cardiovascular health recommendations (3). The more recent guidelines agree with most of the National Cholesterol Education Programme (NCEP) guidelines but are more specific, recommending precise ages and more aggressive repeat testing in high-risk patients. Initial screening should take place between age two and 10 years; if levels are within normal limits for age, repeat testing does not need to be obtained for 3–5 years (1, 3).

Atherosclerosis has become one of the leading causes of death in Turkey. The studies about cardiovascular risk factors and lipid profiles among children are insufficient for our country. The aim of the study is to evaluate dyslipidaemia for cardiovascular risks in Turkish children aged two to 18 years and their relation with some sociodemographic features. This cross-sectional epidemiological survey is the first population based epidemiological research of children for Afyon city, Turkey.

SUBJECTS AND METHODS

This study, which is a part of a wide-ranging study including all age groups and all health problems, was conducted in Afyon, a middle Anatolian city. It was approved by the Afyon Kocatepe University Faculty of Medicine Clinical Research Ethics Committee and written informed consent was obtained from all participants.

A total of 285 children from 75 different screening regions (18 urban, 57 rural) of the city were detected according to the population records of the year 2000, which appropriately represent the population of the area. The research team consisted of 15 physicians, a nurse and a driver for each place visited. The records of the regional health institutions were used in order to determine the subjects.

Children between two and 18 years were included in this study. According to the 2000 census of the Turkish Statistical Institute, the total population of the city was 812 416, of which 17% was children (0–18 years). Ratios of the district to the total population and gender were taken into account to determine the sample population. Our research is a part of a larger study in which the individuals were selected with regards to the age groups (0−18 years old, 19–40 years old, 41–64 years old, 65 years and over) and gender. The formula $n = NZ_{\alpha}^{2}P(1-P)/[(N-1)d^{2} + Z_{\alpha}^{2}P(1-P)]$ was used with the precision level (d) 0.02, error level (α) 0.05 and the prevalence value (P). If the "P" of the population is unknown, "0.5" value is used; thus, enough observation was done without regard to the real value (11) of 50.0% (P); the number of the study group was determined as 2387 people when d = 0.02. The total number of children was 403 excluding the age group of 19 years and over (n = 1990). After also excluding the children under two years of age, the children from whom we could not get blood samlpes or whose families did not consent to their children's blood being taken, the study group comprised 285 children. We determined the base age as two years, as this age was advised by NCEP as the initial lipid screening age and also because AAP does not recommend screening before two years of age (3).

Mean serum total cholesterol (TC) levels tended to be steady during the prepubertal years, dropping during puberty in both genders, and then rising again during adolescence (12). Regarding these changes in puberty, we evaluated the children in two age groups: 2–9.9 years old and 10 years old and over.

The study group was selected randomly from the "Family Cards" of the primary health centres regarding gender and age. Only one child from one family was included in the study. As thyroid dysfunction is an important factor that affects the lipid profile, thyroid-stimulating hormone (TSH) levels were evaluated to detect hypo/hyperthyroid cases and affected children were excluded from the study. The children who were diagnosed with abnormal TSH levels

(13) and/or who had a history of thyroid dysfunction were not included in the study. The families were informed about the study by telephone interviews one night before they gave their approval and were transported to the health institutions where the study would be conducted. The data were collected by a questionnaire in a face-to-face survey method performed by the physicians.

The study population of interest consisted of children and adolescents for whom measures of serum TSH, lipid levels and body mass index (BMI) data were available. Blood samples were taken at least four hours after the last meal for younger age groups, whereas for the children aged 12 years and over, these were taken after eight hours of fasting. In the study, BMI was calculated by the formula [weight (kg)/height (m^2)] and categorized in groups according to the criteria of Olcay *et al* and their percentiles identified as < 5, normal, > 85 and > 95 (14). Total cholesterol, LDL-C, VLDL-C, non-HDL-C and trigliceride (TG) levels were assessed in all children; the relationship between lipid parameters and sociodemographic features were evaluated.

For determining dyslipidaemia, serum TC level of > 200 mg/dL, LDL-C of > 130 mg/dL and TG level of > 140 mg/dL 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. Unfavourable lipid profile according to non-HDL-C levels was described as above 150 mg/dL (3, 15–17). We defined “dyslipidaemia” as high levels of LDL-C and/or VLDL-C or/and TC or/and TG or/and low levels of HDL-C. We also investigated TSH levels and excluded the children from the study who had low and/or high TSH levels (13) and also had thyroid disease history. The breastfeeding duration was evaluated as the total period where the child was fed with only human milk and also with other nutrients beside human milk (mixed-fed duration).

All statistical analyses were performed with the SPSS software for Windows (Chicago, version 13.0). The comparisons of prevalence between dichotomous categories were made using χ^2 test, and $p < 0.05$ was considered statistically significant.

RESULTS

There were 285 children in our study: 137 (48.1%) girls; 148 (51.9%) boys. We evaluated the study group as 2–9.9 years of age (n = 169; 59.3%) and 10 years and over (n = 116; 40.7%). According to weight and height features (percentiles), 41 of them (14.4%) were under 5th percentile, 227 (79.6%) children were in the normal range; 12 of them were > 85th (4.2%) and five children were > 95th (1.8%) percentile. Means of serum lipid levels according to the age groups and gender are shown in Tables 1−3.

Table 1: Serum lipid levels (n = 285)

	Mean ± SEM* (mg/dL)	Min – max (mg/dL)
Total cholesterol	142.39 ± 1.98	48.00 – 234.00
TC	105.54 ± 3.91	21.00 – 497.00
HDL-C	43.76 ± 0.67	10.00 – 81.00
LDL-C	77.09 ± 1.62	5.00 – 164.80
VLDL-C	21.01 ± 0.78	4.20 – 99.40

*SEM: standard error of mean, TC: total cholesterol, HDL-C: high-density lipoprotein cholesterol, LDL-C: low-density lipoprotein cholesterol, VLDL-C: very low-density lipoprotein cholesterol

In general, dyslipidaemia prevalence in our study group was 37.5% (n = 107). We could not find a significant relationship with dyslipidaemia and gender, age groups, mother’s educational level, place of residence and breastfeeding duration. Although there were no significant differences in all lipid values in both genders according to the age groups ($p > 0.05$), we found that TC, TG, HDL-C, LDL-C and VLDL-C levels were usually higher in girls than boys in all ages.

High VLDL-C and low HDL-C levels were related with percentiles of the children ($p = 0.006$ and $p = 0.03$, respectively); gender was also a significant factor for VLDL-C which was higher in girls than boys ($p = 0.04$). Total cholesterol levels were high in 14 children (4.9%), while 72 of the study group (25.3%) had high trigliceride levels. High-density lipoprotein cholesterol were low in 52 children (18.2%). The distribution of HDL-C, LDL-C, VLDL-C, TG

Table 2: Serum lipid levels according to the age groups

Lipids	2−9 years (n = 169)		10 years and over (n = 116)	
	Mean ± SEM* (mg/dL)	Min – max (mg/dL)	Mean ± SEM (mg/dL)	Min – max (mg/dL)
Total cholesterol	146.22 ± 2.60	50.00 – 234.00	136.81 ± 3.02	48.00 – 225.00
TC	103.41 ± 4.89	21.00 – 497.00	108.64 ± 6.46	39.00 – 435.00
HDL-C	44.49 ± 0.87	20.00 – 78.00	42.69 ± 1.06	20.00 – 81.00
LDL-C	80.69 ± 2.20	28.80 – 164.80	71.85 ± 2.31	5.00 – 149.40
VLDL-C	20.77 ± 0.98	14.20 – 99.40	21.36 ± 1.28	4.60 – 87.00

*SEM: standard error of mean, TC: total cholesterol, HDL-C: high-density lipoprotein cholesterol, LDL-C: low-density lipoprotein cholesterol, VLDL-C: very low-density lipoprotein cholesterol

Table 3: Mean values of serum lipid levels in both genders according to the age groups

	TC Mean ± SEM* (mg/dL)	TG Mean ± SEM* (mg/dL)	HDL-C Mean ± SEM* (mg/dL)	LDL-C Mean ± SEM* (mg/dL)	VLDL-C Mean ± SEM* (mg/dL)	*p*
Girls						
2−9 years	148.66 ± 35.04	111.23 ± 77.14	44.5 3 ± 10.69	81.14 ± 29.64	22.43 ± 15.49	0.105
10 years and over	138.99 ± 31.21	120.09 ± 76.11	43.09 ± 9.93	71.49 ± 24.37	23.98 ± 15.24	
Boys						
2−9 years	143.77 ± 3.55	95.49 ± 4.92	44.46 ± 1.31	80.24 ± 2.03	19.10 ± 0.98	0.113
10 years and over	135.03 ± 4.21	99.34 ± 7.88	42.37 ± 1.58	72.15 ± 3.18	19.23 ± 1.54	

*SEM: standard error of mean, TC: total cholesterol, HDL-C: high-density lipoprotein cholesterol, LDL-C: low-density lipoprotein cholesterol, VLDL-C: very low-density lipoprotein cholesterol

and TC levels according to gender, mother's educational level, place of residence, breastfeeding duration, age groups and percentiles are shown in Tables 4–8. There were no significant differences between the levels of HDL-C LDL-C, TG and TC regarding the age groups (before and after 10 years of age) in both genders.

Table 4: Distribution of total cholesterol levels according to gender, mother's education level, place of residence, breastfeeding duration, age and percentiles

	Normal n (%)	High n (%)	Total n (%)
Gender (χ^2 = 1.55, *p* = 0.276)			
Boys	143 (96.6)	5 (3.4)	148 (51.9)
Girls	128 (93.4)	9 (6.6)	137 (48.1)
Mother's education level (χ^2 = 0.69, *p* = 0.76)			
Primary	233 (95.1)	12 (4.9)	245 (87.2)
High school	26 (92.9)	2 (7.1)	28 (10.0)
University	8 (100.0)	0 (0.0)	8 (2.8)
Residence (χ^2 =0.43, *p* = 0.59)			
Urban	150 (94.3)	9 (5.7)	159 (55.8)
Rural	121 (96.0)	5 (4.0)	126 (44.2)
Breastfeeding duration (χ^2 = 3.29, *p* = 0.32)			
No	3 (100.0)	0 (0.0)	3 (1.2)
0−6 months	86 (92.5)	7 (7.5)	93 (36.9)
7−12 months	27 (11.3)	0 (0.0)	27 (10.7)
13 months and over	124 (96.1)	5 (3.9)	129 (51.2)
Age groups (χ^2 = 0.89, *p* = 0.34)			
2−9.9 years old	159 (94.1)	10 (5.9)	169 (59.3)
10 years old and over	112 (96.6)	4 (3.4)	116 (40.7)
Percentiles (χ^2 = 1.16, *p* = 0.79)			
< 5	40 (97.6)	1 (2.4)	41 (14.4)
Normal	215 (94.7)	12 (5.3)	227 (79.6)
> 85	11 (91.7)	1 (8.3)	12 (4.2)
> 95	5 (100.0)	0 (0.0)	5 (1.8)

In the study group, most of the children (n = 129; 51.2%) were fed with human milk for 13 months and over, three (1.2%) children never received human milk, 93 of them (36.9%) received it up to six months and 27 of them (10.7%)

Table 5: Distribution of low-density lipoprotein cholesterol levels according to gender, mother's education level, place of residence, breastfeeding duration, age and percentiles

	Normal n (%)	High n (%)	Total n (%)
Gender (χ^2 = 3.05, *p* = 0.08)			
Boys	147 (99.3)	1 (0.7)	148 (51.9)
Girls	132 (96.4)	5 (3.6)	137 (48.1)
Mother's education level (χ^2 = 0.46, *p* < 1.0)			
Primary	240 (98.0)	5 (2.0)	245 (87.2)
High school	27 (96.4)	1 (3.6)	28 (10.0)
University	8 (100.0)	0 (0.0)	8 (2.8)
Residence (χ^2 = 1.25, *p* = 0.41)			
Urban	157 (98.7)	2 (1.3)	159 (55.8)
Rural	122 (96.8)	4 (3.2)	126 (44.2)
Breastfeeding duration (χ^2 = 1.02, *p* = 0.79)			
No	3 (100.0)	0 (0.0)	3 (1.2)
0−6 months	90 (96.8)	3 (3.2)	93 (36.9)
7−12 months	27 (100.0)	0 (0.0)	27 (10.7)
13 months and over	126 (97.7)	3 (2.3)	27 (10.7)
129 (51.2)			
Age groups (χ^2 = 1.46, *p* = 0.22)			
2–9.9 years old	164 (97.0)	5 (3.0)	169 (59.3)
10 years old and over	115 (99.1)	1 (0.9)	116 (40.7)
Percentiles (χ^2 = 1.56, *p* = 0.72)			
< 5	41 (100.0)	0 (0.0)	41 (14.4)
Normal	221 (97.4)	6 (2.6)	227 (79.6)
> 85	12 (100.0)	0 (0.0)	12 (4.2)
> 95	5 (100.0)	0 (0.0)	5 (1.8)

were fed with human milk for 7–12 months. Most of the mothers had a low educational level (245; 87.2%), 28 (10.0%) were high school graduates and only eight (2.8%) had finished university. A total of 159 (55.8%) children lived in urban areas while 126 (44.2%) lived in rural areas.

According to the results, residence, gender, age and breastfeeding duration were not significant factors for percentile in our study group ($p > 0.05$). However, the educational level of the mother was a significant factor ($p = 0.00$), as the children whose mothers had less education had lower percentiles.

Table 6: Distribution of very low-density lipoprotein cholesterol levels according to gender, mother's education level, place of residence, breastfeeding duration, age and percentiles

	Normal n (%)	High n (%)	Total n (%)
Gender ($\chi^2 = 4.13$, $p = 0.04$)			
Boys	139 (93.6)	9 (6.1)	148 (51.9)
Girls	119 (86.9)	18 (13.1)	137 (48.1)
Mother's education level ($\chi^2 = 0.28$, $p = 0.90$)			
Primary	221 (90.2)	24 (9.8)	245 (87.2)
High school	26 (92.9)	2 (7.1)	28 (10.0)
University	7 (87.5)	1 (12.5)	8 (2.8)
Residence ($\chi^2 = 0.18$, $p = 0.68$)			
Urban	145 (91.2)	14 (8.8)	159 (55.8)
Rural	113 (89.7)	13 (10.3)	126 (44.2)
Breastfeeding duration ($\chi^2 = 1.03$, $p = 0.81$)			
No	3 (100.0)	0 (0.0)	3 (1.2)
0–6 months	82 (88.2)	11 (11.8)	93 (36.9)
7–12 months	24 (88.9)	3 (11.1)	27 (10.7)
13 months and over	118 (91.5)	11 (8.5)	129 (51.2)
Age groups ($\chi^2 = 0.16$, $p = 0.68$)			
2–9.9 years old	152 (89.9)	17 (10.1)	169 (59.3)
10 years old and over	106 (91.4)	10 (8.6)	116 (40.7)
Percentiles ($\chi^2 = 16.24$, $p = 0.006$)			
< 5	37 (90.2)	4 (9.8)	41 (14.4)
Normal	209 (92.1)	18 (7.9)	227 (79.6)
> 85	10 (83.3)	2 (16.7)	12 (4.2)
> 95	2 (40.0)	3 (60.0)	5 (1.8)

Table 7: Distribution of high-density lipoprotein cholesterol levels according to gender, mother's education level, place of residence, breastfeeding duration, age and percentiles

	Normal n (%)	High n (%)	Total n (%)
Gender ($\chi^2 = 0.09$, $p = 0.76$)			
Boys	120 (81.1)	28 (18.9)	148 (51.9)
Girls	113 (82.5)	24 (17.5)	137 (48.1)
Mother's education level ($\chi^2 = 2.23$, $p = 0.38$)			
Primary	198 (80.8)	47 (19.2)	245 (87.2)
High school	24 (85.79	4 (14.3)	28 (10.0)
University	8 (100.0)	0 (0.0)	8 (2.8)
Residence ($\chi^2 = 0.09$, $p = 0.76$)			
Urban	131 (82.4)	28 (17.6)	159 (55.8)
Rural	102 (81.0)	24 (19.0)	126 (44.2)
Breastfeeding duration ($\chi^2 = 1.26$, $p = 0.748$)			
No	2 (66.79)	1 (33.3)	3 (1.2)
0–6 months	78 (83.9)	15 (16.1)	93 (36.9)
7–12 months	23 (85.2)	4 (14.8)	27 (10.7)
13 months and over	103 (20.2)	26 (20.2)	129 (51.2)
Age groups ($\chi^2 = 0.45$, $p = 0.49$)			
2–9.9 years old	136 (80.5)	33 (19.5)	169 (59.3)
10 years old and over	97 (83.6)	19 (16.4)	116 (40.7)
Percentiles ($\chi^2 = 8.95$, $p = 0.03$)			
< 5	35 (85.4)	6 (14.6)	41 (14.4)
Normal	184 (81.1)	43 (18.9)	227 (79.6)
> 85	12 (100.0)	0 (0.0)	12 (4.2)
> 95	2 (40.0)	3 (60.0)	5 (1.8)

Table 8: Distribution of triglyceride levels according to gender, mother's education level, place of residence, breastfeeding duration, age and percentiles

	Normal n (%)	High n (%)	Total n (%)
Gender ($\chi^2 = 2.16$, $p = 0.14$)			
Boys	116 (78.4)	32 (21.6)	137 (48.1)
Girls	97 (70.8)	40 (29.2)	148 (51.9)
Mother's education level ($\chi^2 = 0.002$, $p = 0.99$)			
Primary	183 (74.7)	62 (25.3)	245 (87.2)
High school	21 (75.0)	7 (25.0)	28 (10.0)
University	6 (75.0)	2 (25.0)	8 (2.8)
Residence ($\chi^2 = 0.05$, $p = 0.82$)			
Urban	118 (74.2)	41 (25.8)	159 (55.8)
Rural	95 (75.4)	31 (24.6)	126 (44.2)
Breastfeeding duration ($\chi^2 = 1.15$, $p = 0.81$)			
No	3 (100.0)	0 (0.0)	3 (1.2)
0–6 months	68 (73.1)	25 (26.9)	93 (36.9)
7–12 months	20 (74.1)	7 (25.9)	27 (10.7)
13 months and over	97 (75.2)	32 (24.8)	129 (51.2)
Age groups ($\chi^2 = 0.01$, $p = 0.93$)			
2–9.9 years old	126 (74.6)	43 (25.4)	169 (59.3)
10 years old and over	87 (75.0)	29 (25.0)	116 (40.7)
Percentiles ($\chi^2 = 3.89$, $p = 0.27$)			
< 5	32 (78.0)	9 (22.0)	41 (14.4)
Normal	171 (75.3)	56 (24.7)	227 (79.6)
> 85	8 (66.7)	4 (33.3)	12 (4.2)
> 95	2 (40.0)	3 (60.0)	5 (1.8)

DISCUSSION

Cardiovascular risk scores such as the Framingham Risk Score and Assessing the Cardiovascular Risk using Scottish Intercollegiate Guidelines Network (ASSIGN) score have been identified for adults in many studies. Gender, age, blood pressure, smoking, diabetes and lipid profiles are common for most of them (18). In our country, assessment of cardiovascular risk profile among children will allow the physicians to pay attention to early screening of children for cardiovascular risk factors. Therefore, knowing the prevalence and the risk groups are important.

According to our results, the total prevalence of high LDL-C levels is 2.1% which is lower than in some other studies conducted in Turkey (4.2%) or in other countries [3.9%] (19–22). We can also say that prevalences of low levels of HDL-C, hypercholesterolaemia and hypertriglyceridaemia are lower than in other studies. The prevalence of hypercholesterolaemia is 4.9% in our study which is low when compared with research conducted in other countries: 16% (3–19 years) and 13.5% (6–11 years of age) in Iran, 8.1% in Tunisia (13–19 years of age), 18% in Belgium (12–19 years), 8.4% in the United States of America (USA) [5–17 years] and 18% in Spain [2–18 years] (19, 23–28). Conversely, Savar *et al* found the prevalence of low HDL-C as 10.8%, hypercholesterolaemia as 2.7% and hypertriglyceridaemia as 20% in the 5–15-year age group in

Ankara, Turkey (20). The research conducted by Derinoz *et al*, also in Ankara, Turkey, showed that in the 5–17-year age group (n = 2096), 8.1% of them had hypercholesterolaemia and 5.1% had high serum levels of LDL-C (29).

In some other studies conducted in school-aged children in three different cities of Turkey, hypercholesterolaemia prevalences had been reported to be 2.5%, 14.1% and 11.8%, respectively (30–32). Similarly, high LDL-C, VLDL-C and TG levels (as 2.1%, 9.8% and 25.5%, respectively) in our study are not too high according to most other countries' results (3, 33–35). However, there were also similar lower results like ours. For example, hypercholesterolaemia and hypertriglyceridaemia were 1.2% and 10.6%, respectively in Thailand in the age group 6–17.8 years (36). Although the age groups were not similar, we can say that hypercholesterolaemia prevalence was lower than in those countries. We think the low prevalence in our study is related to the study group's features which are selected both from urban and rural population. The eating habits of children who live in urban areas have changed to fast food and they spend more time being inactive (*eg* on computer).

A higher percentage of girls had abnormal TC and LDL-C levels compared with boys in some other studies (3, 22). Moreover, in the Child and Adolescent Trial for Cardiovascular Health, 13.3% of children in the 4th grade had total cholesterol concentrations of > 200 mg/dL. The prevalence of total cholesterol concentrations of > 200 mg/dL was 15.6% in girls and 11.1% in boys (37).

In the present study, LDL-C, VLDL-C, TC and TG levels were higher among girls than boys, but these results were statistically significant for VLDL-C and LDL-C levels which were higher in girls than boys for both age groups. We know that females tended to have higher HDL-C, higher total cholesterol and LDL-C concentrations than did males after pubertal development had occurred. Investigators for the Project Heart Beat study reported that lipid and lipoprotein concentrations changed in different ways for males and females during development (38). It could be explained by the hormonal modifications in relation to puberty which starts earlier among girls than boys.

Low HDL-C prevalences appeared to be similar for boys and girls which we expected to be higher in boys than girls before puberty, according to other studies (22, 39, 40). In general (both girls and boys), we can expect HDL-C levels to be lower than in other countries because it was reported that serum HDL-C levels were typically 10–15 mg/dL lower in Turkish adults than in Europeans and North Americans and lower levels of HDL-C appeared to be largely of genetic origin (40‒42). A physician should always keep in mind that low HDL-C is an important cardiovascular risk factor alone, but high LDL-C levels must also be considered as a treatment target (43).

As a whole, the lower non-HDL-C levels of our study possibly were due to the features of the study group which was selected from both urban and rural areas. Children who live in rural areas have healthier eating habits, play more in open air and are more active in daily life while a child living in an apartment (in urban areas) usually spends his/her time on the computer and has more tendency to eat fast food. The eating habits of children in our region should also be considered as they usually consume natural foods and fresh vegetables, especially in rural areas. This point of view explains why most of our results are closer to the normal values. This factor leads us to conclude that attention should be paid to educating the parents about their children's healthy nutrition. In our study, prevalence of dyslipidaemia in our region was 37.5% (n = 107). We could not find a significant relation with dyslipidaemia and age groups, education level of the mother and breastfeeding duration.

Childhood obesity is associated with unfavourable lipid profile, suggesting that obese children should be screened for hypercholesterolaemia. Friedland *et al* found mean serum cholesterol and TG levels significantly higher ($p < 0.05$) among the obese children whose BMI were > 85% and the degree of obesity (BMI 85–95% *vs* BMI > 95%) had no effect on serum lipids (44). In the study by Zhang *et al*, compared with non-obese children, obese children screened by Chinese BMI and weight-for-height index had increased levels of TG, LDL-C, apo B, insulin, decreased levels of HDL-C, apo A and significantly higher prevalence of hypertriglyceridaemia and high LDL-C (45). The results were similar to the study by Hamidi *et al* (46).

Our study also shows that dyslipidaemia correlates with BMI, while high VLDL-C and low HDL-C levels were found statistically significant in children whose percentiles were > 85%. However, in our study, there were only 17 obese children (> 85%). A larger study is needed to show the real correlation between lipid profile and percentiles. Body mass index is also affected by many factors. For example, physical activity is as important as diet to lower serum lipid levels (47). Also, environmental, genetic and nutritional habits are important factors. Unfavourable lipid levels were relatively common among obese children, suggesting that obesity should be considered a risk factor for hypercholesterolaemia and that screening obese children for hypercholesterolaemia should be considered. Although the breastfeeding duration was not a significant factor for per-centiles in our study group ($p > 0.05$), in the literature, some studies showed that adolescents who had short duration of breastfeeding (< 6 months), or had early introduction of infant formula, had higher mean values of TC (47).

According to our study results, the educational level of the mother was a significant factor for BMI of a child ($p = 0.00$). If the mother's education level is less, the percentiles of the children are lower. On the other hand, high VLDL-C and low HDL-C levels were related to percentiles of the children ($p = 0.006$, $p = 0.03$, respectively). These results show that education of the mother may help to create healthy generation by means of healthy nutrition, and feeding the baby with human milk as long as possible would result in normal physical development and controlled lipid levels of the child. Educating mothers and fathers on how to be better parents could help stem the alarming rise in childhood obesity – even when exercise and nutrition are not part of the school curriculum – according to a new study from NYU Langone Medical Center. Generally, low educated mothers do not have enough knowledge on healthy body weight for children, thus failing to recognize that their children are obese (48).

There were some limitations to the study. On one hand, it was difficult to compare the prevalence of dyslipidaemia with other studies, as each of them evaluated different age ranges and assessment methods, diagnostic criteria, period and samples. Also, we could not exclude the effects of eating habits on dyslipidaemia because we could not get detailed nutritional history. On the other hand, selecting the study group as representing our region, the wide range of age group, being the first research on this subject and being a product of a multidisciplinary team work are the strengths of our study.

CONCLUSION

In conclusion, all the parameters of dyslipidaemia are not so high in our region. Dyslipidaemia correlates with BMI, while high VLDL-C and low HDL-C levels are statistically significant in children whose percentiles are > 85%. High VLDL-C and low HDL-C levels are related to percentiles of the children and gender is also a significant factor for VLDL-C (higher in girls than boys).

This research is the first epidemiologic study on dyslipidaemia in children in our region. Therefore, early detection of dyslipidaemia and long-term prevention of atherosclerosis by controlling the risk factors should begin in childhood in order to protect their heart with periodic lipid profile checks and to educate mothers and children on healthy nutrition and the importance of physical activity.

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