HYPERLIPIDEMIA IN 12 YEAR-OLD CHILDREN LIVING IN TEHRAN

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Abstract: ***There is now clear evidence that the atherosclerotic process begins in childhood. A major and important cause of atherosclerosis and coronary heart disease (CHD) is elevated cholesterol level. In order to clarify the significance of elevated Total Cholesterol (TC) in children who live in Tehran, we measured the lipid profiles including TC, Triglyceride (TG), and High Density Lipoprotein Cholesterol (HDL-C) of 1000 twelve-year-old children. Low Density Lipoprotein Cholesterol (LDL-C) value was calculated by using Friedwald formula. The mean level of TC in all cases reached 170 ± 39mg/dl. The mean level of LDL-C, HDL-C and TG were 101 ± 38mg/dl, 48 ± 12mg/dl, and 105 ± 52mg/dl, respectively. TC level in 16.4% of the cases was above 200mg/dl and 16% had LDL-C levels more than 130mg/dl. Mean LDL-C level in the boys was 6.2mg/dl (with 95% confidence interval of 1.3 to 11.1) more than girls. Also mean HDL-C level in the girls was 4.1mg/dl (with 95% confidence interval of 2.5 to 5.7) more than that of boys (p-value in both=0.000). TC and HDL-C levels in the northern parts of Tehran were significantly higher than the southern parts. Mean LDL-C and TG levels didn't show any differences. Regarding the normal range of TC (<170mg/dl), the prevalence of hypercholesterolemia in Tehran seems unacceptable.***
Acta Medica Iranica: 40(1): 20-25; 2002

Keywords: ***Cholesterol, children hyperlipidemia, LDL-C, HDL-C, triglyceride, prevalence***

INTRODUCTION

Our rationale for paying attention to cholesterol levels in children and adolescents is based on the evidence that the atherosclerotic process begins early in the life and that this plays a role in the development of adult atherosclerosis (1). Eating patterns and genetics play a role in the development of coronary heart disease (CHD) by their effects on blood cholesterol level.

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Children with elevated total cholesterol (TC) levels are likely to have elevated TC levels as adults (2 - 6). Therefore reducing blood TC level in children and adolescents will be beneficial. Accomplishing any educational or an interventional program in the society to reduce TC level in children depends on our knowledge about the lipid profile in this group. In this research which was carried out in all districts of the Great Tehran, the mean levels of different blood lipids including TC, Low-Density Lipoprotein Cholesterol (LDL-C), High-Density Lipoprotein Cholesterol (HDL-C) and Triglycerides (TG), and the prevalence of hypercholesterolemia in children were measured.

To increase the reliability of the obtained results, 12-year-old children were chosen. In this way, the environmental factors like nutritional status were excluded. Effects due to hormonal variations during adulthood around the age of fifteen are also expected to have been eliminated (7-8).

MATERIALS AND METHODS

Based on city divisions made by the Ministry of Education, we divided Tehran into four parts: north, south, east, and west. A list of all 12-year-old students in each part was prepared. Regarding the number of students in these parts, we divided the sample size into different groups with equal numbers of boys and girls. The total number of boys and girls were nearly equal. First the schools to be examined were systematically randomized according to the list of schools in each part. Then in each school based on the list of 12-year-old students, the samples of the project were randomized. Children who had been in Tehran for more than ten years were regarded as Tehranian. The physicians examined the children throughout the study. None of the children had symptoms and signs of secondary hypercho-lesterolemia such as hypothyroidism, nephrotic syndrome, liver disease, and diabetes mellitus. None of them were receiving continuous medical therapy (9).

Children who were suspicious of having the aforementioned diseases were eliminated from the study and referred to a pediatrician for follow-up. These children were substituted with other random samples of the same school. A consent form for drawing blood was filled by the children's parents. After 14 hours of fasting, 5cc clotted venous blood was drawn from the children and immediately transferred in cold condition to the laboratory. The absent children and those not fasting were asked to come later.

Finally 251 children from south, 170 from north, 350 from east and 229 from west were examined. The total number was 1000, with 495 boys, and 505 girls.

Table 1. Serum total cholesterol levels* in 12-year-old children living in Tehran

Area	Number	Overall mean (±SD)	Percentiles						
			5	10	25	50	75	90	95
All	951	170.25±39.16	119	129	148	169	190	212	224
East	336	172.89±47.58	121	134.7	151	170	190	212	224.15
West	212	168.15±31.08	124.9	130	146.2	166	186.7	209.7	220.4
North	164	174.15±35.15	125.2	132	148.2	174.5	193.7	217.5	233
South	239	165.75±34.47	115	123	142	165	189	212	222
Male	476	171.01±45.5	119	129	146	169	190	210	223.4
Female	475	169.5±31.47	119	129	149	168	189	213	225

***The values are in mg/dl**

Table 2. Serum low - density lipoprotein (LDL-C) levels* in 12-year-old children living in Tehran

Area	Number	Overall mean (±SD)	Percentiles						
			5	10	25	50	75	90	95
All	917	101.01±38.11	54.3	63.6	79.7	99.3	119.2	139.9	150.2
East	328	101.99±48.71	50.1	62.4	80.0	99.7	120.3	140.6	150.1
West	204	99.29±27.63	58.9	67.1	80.8	97.3	116.1	132.9	147.3
North	157	104.91±31.26	62.3	66.8	82.0	100.9	127.5	145.7	155.3
South	228	98.48±32.46	49.1	59.5	74.4	97.8	118.9	141.8	149.7
Male	463	104.08±44.1	61.7	66.7	81.4	101.7	127.6	140	150.3
Female	454	97.89±30.57	48.5	59.6	77.5	97.1	118.7	140.1	150

*** The values are in mg/dl**

Table 3. Serum high - density lipoprotein (HDL-C) * levels in 12-year-old children living in Tehran

Area	Number	Overall mean (±SD)	Percentiles						
			5	10	25	50	75	90	95
All	942	48.34±12.53	31.5	35	38.5	45.5	56	66.5	70
East	346	49.73±12.93	31.5	35	42	49	59.5	66.5	73.5
West	209	49.14±11.25	32.5	35	42	49	56	63	68.2
North	162	48.67±12.52	27.1	35	41.1	49	59.5	65.4	70
South	237	45.44±12.64	28	31.5	35	45.5	52.5	63	70
Male	473	46.29±11.14	31.5	34.4	38.5	45.5	52.5	63	66.5
Female	469	50.42±13.49	31.5	35	42	49	59.5	66.5	73.5

*** The values are in mg/dl**

Table 4. Serum triglycerides (TG) levels* in 12-year-old children living in Tehran

Area	Number	Overall mean (±SD)	Percentiles						
			5	10	25	50	75	90	95
All	927	105.6±52.7	48.4	56	72	93	125	169	199.8
East	330	105.07±47.51	50	58.1	73.7	94	124.2	161.8	199.7
West	207	99.25±49.35	48	56	70	89	118	159.2	187
North	160	105.41±64.61	45	50	68	94.5	121	163.9	202.9
South	230	112.22±52.28	48.5	56.2	74.7	102	139	177.9	207.2
Male	467	104.3±56.56	47.4	53.8	71	91	123	169	197
Female	460	106.92±48.06	50	58.1	74	95.5	127	171.9	202.9

*** The values are in mg/dl**

Table 5. Prevalence of hypercholesterolemia (total cholesterol* and low-density lipoprotein†) in 12-year-old living in Tehran

Group	Number	Normal	Intermediate	High
All				
Total cholesterol	951	50.9%	32.7%	16.4%
LDL-C	917	64.3%	19.7%	15.9%
Male				
Total cholesterol	476	50.4%	33.8%	15.8%
LDL-C	463	61.6%	21.2%	17.3%
Female				
Total cholesterol	475	51.4%	31.6%	17.1%
LDL-C	454	67.2%	18.3%	14.5%
East				
Total cholesterol	336	49.1%	34.5%	16.4%
LDL-C	328	64.3%	20.4%	15.2%
West				
Total cholesterol	212	55.2%	29.2%	15.6%
LDL-C	204	69.6%	18.1%	12.3%
North				
Total cholesterol	164	42.1%	40.2%	17.7%
LDL-C	157	57.3%	20.4%	22.3%
South				
Total cholesterol	239	55.6%	28.0%	16.3%
LDL-C	228	64.5%	19.7%	15.8%

*** Total cholesterol less than 170 mg/dl is considered as normal and between 170 and 199 mg/dl is considered as intermediate and more than 200 mg/dl is considered as high.**

† Low-density lipoprotein less than 110 mg/dl is considered as normal and between 110 and 129 mg/dl is considered as intermediate and more than 130 mg/dl is considered as high.

Laboratory assessments

Blood samples were drawn from individuals who had fasted overnight in sitting position. The samples were collected in tubes without anticoagulant and were allowed to clot for 2 hours at room temperature and the serum was obtained by low-speed centrifugation (1500 ×g for 15 minutes). Analysis was done using the specific cone analyzer. The assay for TC was made using the enzymatic method, which is an enzymatic calorimetric test with cholesterol esterase and cholesterol oxidase (ChoD-PAP) (10). TG was also assayed using an enzymatic calorimetric test with glycerol phosphate oxidase (GPO-PAP) (11).

HDL-C was measured using ChoD-PAP enzymatic method after precipitation and separation of VLDL and LDL-C by phosphor-tungstic acid and $MgCl_2$ (12). LDL-C value was calculated by using Friedwald formula (13):

$$LDL\text{-}C = (TC - HDL\text{-}C) - TG/5$$

Assay performance was monitored using the lipid control serum, in normal and pathologic range (percinorm. and percipath. Boehringer Mannheim GmbH. Germany).

RESULTS

As it is seen in tables 1 to 4, the mean TC, LDL-C, HDL-C and TG were assessed once for all samples and once for samples sorted according to sex and residential district. The mean TC was 170 ± 39 (Mean ± SD) mg/dl. No significant difference in the mean value was observed comparing boys and girls. The mean TC in northern Tehran (174mg/dl), was 8.4 mg/dl (with 95% confidence interval 1.5 to 15.3) more than the value in southern Tehran (165.7 mg/dl) (p-value = 0.01). The mean LDL-C in all samples was 101 ± 38 (Mean ± SD) mg/dl. This value in boys (104 mg/dl) was 6.2 mg/dl (with 95% confidence interval 1.3 to 11.1) more than that of girls (97.9 mg/dl) (p-value = 0.01). LDL-C level didn't show any significant difference among different parts (regions) of the city. HDL-C level in all samples was 48.3 ± 12.5 (Mean ± SD) mg/dl. This value in boys (46.3 mg/dl) was 4.1 mg/dl (with 95% confidence interval 2.5 to 5.7) lower than that of girls which was 50.4 mg/dl (p-value=0.000). In southern Tehran mean HDL-C level (45.4 mg/dl) was 3.2 mg/dl (with 95% confidence interval 0.7 to 5.7) lower than the value in northern Tehran (48.7 mg/dl) (p-value= 0.01).

The mean TG level in all samples was 105.6 ± 2.5 (Mean ± SD) mg/dl with no significant difference regarding sex and residential district. The LDL-C / HDL-C ratio was 2.4 in boys and 2.14 in girls and this difference (0.24) is significant (with 95% confidence interval 0.1 to 0.4) (p-value = 0.001).

DISCUSSION

From 1 to 19 years of age, for both sexes, the 95% percentile for TC is roughly 200 mg/dl and for LDL-C it is about 130 mg/dl (14). High blood TC is regarded as the levels higher than 200 mg/dl, high LDL-C levels higher than 130 mg/dl, and borderline TC and LDL-C as 170-190 mg/dl and 110-129 mg/dl respectively (15), then 16.4% of samples have high TC and 16% have high LDL-C. 15.8% of boys have high TC level and 17.4% of them have high LDL-C level. These values for girls are 17.1% and 14.7%, respectively (Table 5). The difference between prevalence of hypercholesterolemia in boys and girls using Chi-square test is not significant. As it is seen, the prevalence of hypercholesterolemia especially in northern Tehran, where people have higher socioeconomic status is much higher than that was expected. The measured mean value in this research was higher than those of similar researches in many other countries such as Ghana (16-17), Hungary (17-18), Italy (16, 18), Japan (19-20), Pakistan (17), the Philippines (16-18), Portugal (17-18), Spain(21-23), Sweden (24) and the United States (17-18).

The value was lower than the estimated results in some countries like: Australia (26), Austria (17-18), Denmark (17), Finland (27), France (28), Germany (18), Greece (29), Saudi Arabia (30), and Switzerland (31) .

HDL-C estimation is difficult because in addition to the effects of genetics and geographical condition, the type and the method of laboratory measurement also influence the results. Compared with the ultracentrifuge method, dextran sulfate and phosphortungstate produce slightly lower results, whereas heparin- Ca (II) method gives somewhat higher results. The method using dextran sulfate-mg (II) (MW 50000) has been reported as the selected method for clinical chemistry (32). The mean HDL-C measured in this research was lower than the obtained results in all industrialized countries like Italy (16, 18), Japan (19, 20), Spain (21-23), Sweden (24), the United States (25); and it was higher than those of developing countries like Ghana (16, 17), Nigeria (17), Pakistan (17), and the Philippines (16-18) and approximately equal to Saudi Arabia (30). In children, the major nutritional determinant of (the observed) differences in serum TC levels between countries appears to be the proportion of saturated fat in the diet; for example, in countries such as the Philippines, Italy and Ghana, saturated fat constitutes about 10% or less of the dietary energy intake, and serum TC level in boys of 7-9 year old age is generally below 160 mg/dl. These countries also have lower dietary cholesterol intakes. In boys from countries such as the USA, the Netherlands and Finland, the saturated fat intake varies between 13.5% and 17.7% of energy intake, and the mean serum cholesterol levels are equal to or greater than 160 mg/dl.

Although blood TC levels are lowest in countries where nutrition is not optimal and growth is delayed, there are many industrialized countries where children have lower TC levels and where normal growth is maintained. In general, higher serum TC levels in children are associated with higher levels in middle-aged adults in the same country, and with higher CHD mortality rates in the adult population (1).

On the whole, regarding the major influences of the diet on blood lipid levels and the high prevalence of hypercholesterolemia and low levels of HDL-C measured in this research, it seems that directing educational and instructive programs for the people are mandatory, other wise, we will face an increase in mortality due to cardiovascular diseases in future.

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