Elevated Serum Cholesterol Levels in Bangkok Children and Adolescents

UMAPORN SUTHUTVORAVUT, M.D.*, SOMSRI CHAROENKIATKUL, D.Sc.**,
CHUREEPORN CHITCHUMROONCHOKCHAI, M.S.**, VONGSVAT KOSULWAT, Ph.D.**,
PAT MAHACHOKLERTWATTANA, M.D.*, NIPA ROJROONGWASINKUL, M.S.**

Abstract

Hypercholesterolemia is a major cardiovascular risk factor. This study aimed to assess serum total cholesterol (TC) levels of children and adolescents living in Bangkok, Thailand. During 1995-1997, nonfasting blood samples were obtained from 570 healthy school children and adolescents aged 9-18 years. The mean TC levels ranged from 143-180 mg/dl in males and from 145-202 mg/dl in females. The prevalences of hypercholesterolemia (TC $\geq$ 200 mg/dl) were 12.2 per cent and 20.3 per cent in males and females, respectively. Twenty-eight per cent of males and 26.9 per cent of females had borderline values (TC 170-199 mg/dl). TC inversely correlated with age ($r = -0.16$, $P < 0.01$) in males. The findings indicate that notable percentage of these children had elevated cholesterol levels and warrant additional study concerning risk factors and tracking of lipoprotein levels from childhood into adulthood.

Key word : Cholesterol, Hypercholesterolemia, Adolescent

High blood cholesterol is one of the major risk factors of coronary heart disease[1,2]. Lowering blood cholesterol levels in adults results in reduction of coronary heart disease incidence and mortality[3,4]. Children and adolescents with elevated cholesterol are more likely than the general population to become hypercholesterolemic adults [5-9]. This association warrants screening of children and adolescents for hypercholesterolemia, especially those at increased risk of having high blood cholesterol levels. For example, adolescents who have a family history of premature cardiovascular disease or have a parent with hypercholesterolemia. The selective screening strategy, targeted only at high-risk individuals, has been recommended by the American Academy of Pediatrics[10]. However, selective screening does not adequately identify all children with hypercholesterolemia[11,12].

* Department of Pediatrics, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok 10400,
** Institute of Nutrition, Mahidol University, Nakhon Pathom 73170, Thailand.

Changes in life-style factors during the past decade, especially nutrition and physical activity, possibly affect blood cholesterol levels of Thai children. The objective of this study was to assess serum total cholesterol (TC) levels of children and adolescents living in Bangkok.

SUBJECTS AND METHOD

Subjects

The cross-sectional survey was conducted during 1995-1997. The study population consisted of 570 healthy students (280 males and 290 females) aged 9-18 years from public schools in Bangkok who were invited to participate in the study. The majority of participants were from one elementary and one secondary schools. The rest were from two undergraduate schools.

Subject inclusion criteria were as follows: weight and height within median ± 2 standard deviations of NCHS references, no chronic illness, no mental or physical handicap, and no chronic drug consumption. Informed consents were obtained from the participants and their parents. All protocols in the study were reviewed and approved by the Institutional Review Board, Faculty of Medicine, Ramathibodi Hospital, Mahidol University.

The children's diet was assessed by food frequency questionnaires. Weight was measured with a calibrated balance scale. Height was measured with a stadiometer. Pubertal stages were assessed according to the method of Tanner and Whitehouse[13]. Venous blood was collected in the morning between 8-10 a.m. without fasting.

Biochemical analysis

Serum TC was determined by enzymatic colorimetric method[14] (Wako Cholesterol C II, Osaka, Japan). Cholesterol esters in the serum are hydrolyzed to free cholesterol and fatty acids by cholesterol ester hydrolase. In the subsequent enzymatic oxidation by cholesterol oxidase, hydrogen peroxide is formed. This is converted into a red quinone pigment in a reaction with 4-aminoantipyrine and phenol catalyzed by peroxidase. The total amount of cholesterol is determined by measurement of the absorbance of the red color at its maximal absorption wavelength of 505 nm.

The accuracy of this method was checked through serial replication of control sera (Qualitrol HSN, Merck, Germany) and by comparison of pooled plasma samples used twice during each running sample set. In this laboratory, the CV for serum TC analysis was 3.2 per cent.

Statistical analysis

Values were expressed as mean ± standard deviation. Unpaired *t*-test and analysis of variance were used to compare group means. Relationships between variables were studied by Pearson's correlation.

Total cholesterol levels were classified as acceptable, borderline and high if the values were < 170, 170-199 and ≥ 200 mg/dl, respectively[10,15].

RESULTS

The percentages of males and females in pubertal stages 1, 2, 3, 4 and 5 were as follows. Males : 16.8 per cent, 15.4 per cent, 5 per cent, 7.1 per cent and 55.7 per cent. Females : 7.6 per cent, 7.3 per cent, 23.3 per cent, 35.8 per cent and 26 per cent. The mean ± SD of relative body mass index (expressed as percentage of median value) was 101.6 ± 12 per cent.

Means ± SD of intake of fresh milk, flavored milk and combination of both were 217 ± 269, 74 ± 147 and 291 ± 273 ml/day, respectively.

The mean serum TC levels by age and gender are shown in Table 1. The values ranged from 143-180 mg/dl in males and from 145-202 mg/dl in females. Overall, females had higher mean TC than males. Two age groups of males and 3 age groups of females had borderline values. Mean TC was high in females aged 16 years.

As shown in Tables 2 and 3, the percentages of children with acceptable TC levels were only 59.6 and 52.8 in males and females, respectively. The prevalences of hypercholesterolemia (TC $\geq$ 200 mg/dl) were 12.2 per cent in males and 20.3 per cent in females. Twenty-eight per cent of males and 26.9 per cent of females had borderline values. According to age groups, the prevalence of hypercholesterolemia ranged from 0-28.5 per cent in males and from 0-46.6 per cent in females.

We assessed the association of TC with age, pubertal stage, relative body mass index, intakes of fresh milk, flavored milk and combination of both. In males, TC levels correlated inversely with age ($r = -0.16$, $P < 0.01$). In females, no association was found between TC and any of these variables. There was no significant difference between TC levels of children within the first (42 ± 39 ml/day) and fourth (672 ± 240 ml/day) quartiles of milk (fresh plus flavored) intake.

Table 1. Mean (SD) serum total cholesterol levels of children and adolescents by age and gender.

Age (y)	Male			Female		
	N	Total cholesterol, mg/dl		N	Total cholesterol, mg/dl	
9	26	164	(27)	27	179	(31)
10	29	180	(26)	34	168	(34)
11	37	167	(26)	36	162	(26)
12	34	143	(23)	36	145	(24)
13	27	166	(33)	28	165	(42)
14	34	151	(37)	31	175	(44)
15	35	158	(34)	32	174	(51)
16	35	179	(38)	30	202	(46)*
17	18	165	(35)	20	169	(38)
18	5	155	(32)	16	152	(26)
Total	280	163	(33)	290	169	(40)*

* Significantly different between genders by unpaired *t*-test, $P < 0.05$

Table 2. Distribution (%) of male adolescents by serum total cholesterol levels and age.

Total cholesterol (mg/dl)	Age (yr)										Total
	9	10	11	12	13	14	15	16	17	18	
< 170	57.7	37.9	48.6	85.3	55.6	73.5	71.4	42.9	61.1	60	59.6
170-199	38.5	37.9	43.2	11.8	33.3	17.6	14.3	28.6	33.3	40	28.2
≥ 200	3.8	24.2	8.2	2.9	11.1	8.9	14.3	28.5	5.6	-	12.2
No. of subject	26	29	37	34	27	34	35	35	18	5	280

Table 3. Distribution (%) of female adolescents by serum total cholesterol levels and age.

Total cholesterol (mg/dl)	Age (yr)										Total
	9	10	11	12	13	14	15	16	17	18	
< 170	37	50	52.8	80.6	57.1	58.1	43.8	26.7	55	68.8	52.8
170-199	37	32.4	44.4	19.4	17.9	16.1	25	26.7	15	31.2	26.9
≥ 200	26	17.6	2.8	-	25	25.8	31.2	46.6	30	-	20.3
No. of subject	27	34	36	36	28	31	32	30	20	16	290

DISCUSSION

In this community-based study, the notable percentage of apparently healthy children and adolescents with hypercholesterolemia is a cause for concern and further investigation. Few studies have determined the prevalence of hyperlipidemia in Thai children. Tienboon et al recently found that among 342 Chiang Mai boys and girls aged 6-15 years from well-to-do families, 0-37.5 per cent and 0-43.8 per cent, respectively, had TC ≥ 200 mg/dl[16,17].

We measured serum TC in venous blood samples from nonfasting subjects. The expert panel on blood cholesterol levels in children and adolescents[15] and the American Academy of Pediatrics [10] recommend the initial screening test be a measurement of total cholesterol because it is more

convenient and less expensive than a lipoprotein analysis. The child does not have to be fasting for this test[15]. Wilder et al found that mean 3-hour TC concentration was not significantly different from the mean fasting level, whereas the 5-hour level was only 1.3 per cent higher, which was clinically insignificant[18]. In addition, the sensitivity and specificity of the TC measurement using screening analyzers was the same in samples from fasting and nonfasting subjects[19]. Therefore, the children with hypercholesterolemia were accurately identified in this study. The limitation of our study was that each subject had a single TC measurement. Since there is significant day-to-day variability of serum TC, multiple measurements should be done for risk assignment according to TC levels[20]. A fasting lipoprotein analysis should be measured later if indicated[15].

Previous studies in children indicate that dietary fat intake, particularly saturated fatty acids and cholesterol, influences TC and low-density lipoprotein cholesterol[21,22]. We did not determine total dietary fat intake in our subjects. However, we found that low to moderate intake of milk, which contained saturated fatty acids and cholesterol, did not adversely affect TC levels. Physical activity is another factor which influences blood cholesterol. Harrell et al found a reduction in TC level in elementary school children after intervention with exercise program and health education[23]. Our subjects should be further assessed to identify risk factors of having elevated blood cholesterol and to track their lipoprotein levels from childhood into adulthood.

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ภาวะโคเลสเตอรอลในเลือดสูงในเด็กและวัยรุ่นในกรุงเทพมหานคร

อุมาพร สุทัศน์วรวุฒิ, พ.บ., สมศรี เจริญเกียรติกุล, วท.ด.**, จุรีพร จิตจำรูญโชคไชย, วท.ม.**, วงสวาท โกศัลวัฒน์, ปร.ด.**, พัฒน์ มหาโชคเลิศวัฒนา, พ.บ.*, นิภา โรจน์รุ่งวศินกุล, วท.ม.***

ภาวะโคเลสเตอรอลในเลือดสูงเป็นปัจจัยเสี่ยงที่สำคัญของโรคหัวใจและหลอดเลือด การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาระดับโคเลสเตอรอลในเด็กและวัยรุ่นอายุ 9–18 ปี ซึ่งเป็นนักเรียนโรงเรียนรัฐบาลในเขตกรุงเทพมหานคร ทำการศึกษาระหว่าง พ.ศ.2538–2540 ได้ตรวจหาระดับโคเลสเตอรอลในซีรัม ของเด็กที่มีสุขภาพดี จำนวน 570 ราย ค่าเฉลี่ยของระดับโคเลสเตอรอลในเพศชายและหญิงเท่ากับ 143–180 มก./ดล. และ 145–202 มก./ดล. ตามลำดับ ความชุกของภาวะโคเลสเตอรอลในเลือดสูง (≥ 200 มก./ดล.) เท่ากับร้อยละ 12.2 ในชาย และร้อยละ 20.3 ในหญิง ร้อยละ 28.2 และ 26.9 ของชายและหญิง มีระดับโคเลสเตอรอลก้ำกึ่ง (170–199 มก./ดล.) ระดับโคเลสเตอรอลมีความสัมพันธ์แบบผกผันกับอายุในเพศชาย ($r = -0.16$, $P < 0.01$) การที่พบว่าเด็กและวัยรุ่นเหล่านี้มีจำนวนไม่น้อยที่ระดับโคเลสเตอรอลในเลือดสูง ควรนำไปสู่การศึกษาเพิ่มเติมถึงระดับไลโปโปรตีนในเลือด ปัจจัยที่เกี่ยวข้องและระดับโคเลสเตอรอลในวัยผู้ใหญ่ของเด็กกลุ่มนี้

คำสำคัญ : โคเลสเตอรอล, ภาวะโคเลสเตอรอลในเลือดสูง, วัยรุ่น

* ภาควิชากุมารเวชศาสตร์, คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี, กรุงเทพฯ 10400
** สถาบันวิจัยโภชนาการ, มหาวิทยาลัยมหิดล, ศาลายา, นครปฐม 73170