

TREND OF ATHEROSCLEROSIS RISK FACTORS IN CHILDREN OF ISFAHAN

Roya Kelishadi, MD, Mahin Hashemipour, MD¹,
Nizal Sarraf-Zadegan, MD², Masoud Amiri, MS³
Department of Pediatrics
¹Department of Pediatric Endocrinology
²Department of Cardiology
³Department of Epidemiology
Isfahan Cardiovascular Research Center
Isfahan, Iran

ABSTRACT

The prevalence of major atherosclerosis risk factors in Iran was evaluated in 1993 and again in 1999 in 4500 randomly selected children aged 2 to 18 years. Serum lipid levels were significantly higher than standard values in both sexes and in all age groups in the 1993 and 1999 studies. The increase in serum lipid levels was most marked in teenagers. High-density lipoprotein cholesterol was significantly lower than standard values in both studies. There were no significant differences in blood pressure percentiles or the prevalence of hypertension compared to standard values in 1993 and 1999. No case of diabetes mellitus was found. Although the prevalence of obesity was low in these studies (0.2% in 1993, and 0.35% in 1999), a two-fold rise in overweight subjects was noted (4% in 1993, 8% in 1999; $p < 0.05$), especially in school-aged and adolescent girls. In view of these results and the increasing incidence of coronary artery disease among young people, special attention should be paid to primary prevention.

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INTRODUCTION

Development of atherosclerosis is a process that begins in early life. Coronary artery disease (CAD) is the result of complex interactions between a variety of risk factors.^{1–3} The major risk factors promoting the development of atherosclerosis are well known nowadays.^{1,2} The great variation in the incidence of CAD in different countries, and the marked changes observed in the incidence of the disease within a single population, show that environmental factors and lifestyle in particular, must play major roles in the occurrence of CAD.^{1–5} The prevalence of major CAD risk factors was evaluated in children and adolescents in Isfahan, Iran, in 1993, and the trend was assessed in 1999.

PATIENTS AND METHODS

After performing a pilot study, the number of samples necessary was calculated and the study was carried out in 4500 children and adolescents aged 2 to 18 years, selected from different clusters in Isfahan. The importance of the study was explained to the parents of those selected, by both oral and written communication. The cooperation rate of families was approximately 85%. Each subject underwent a physical examination. Weight was measured while the subject was wearing very light clothing, and height was measured in a standing position without shoes. Blood pressure was measured by mercury sphygmomanometers with an appropriate cuff size for each subject, according to World Health Organization guidelines. A

For reprint information contact:

Roya Kelishadi, MD Tel: 98 311 46 0807 Fax: 98 311 45 9023 email: isfcarvasrc@hotmail.com
Department of Pediatrics, Isfahan Cardiovascular Research Center, P.O. Box 81465-1148, Isfahan, Iran.

fasting blood sample (at least 12 hours of fasting) was taken for analysis of blood sugar, total cholesterol, and triglycerides. Low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) were measured by an autoanalyzer (ELAN; Eppendorf AG, Cologne, Germany) using test kits (Merck, Darmstadt, Germany). The same methods and instruments were used for all measurements.

The diagnosis of diabetes mellitus in children and adolescents was based on World Health Organization criteria: fasting blood sugar more than or equal to 126 mg/dL (7 mmol·L⁻¹). Obesity in children was defined as weight for height above the 90th percentile on growth charts from the National Center of Health Statistics (NCHS, Hyattsville, MD, USA) or weight in excess of 120% of the median weight for a given height. Subjects with weight in excess of 100% but less than 120% of the median weight for a given height were considered to be overweight. For adolescents and children above 6 years, body mass index (BMI) was also used as recommended by the Committee to Develop Criteria for Evaluating the Outcomes of Approaches to Prevent and Treat Obesity.⁶

BMI was calculated as weight in kilograms divided by height in meters squared (kg·m⁻²). A child (6 to 10 years) or adolescent (11 to 18 years) with a BMI greater than the 95th percentile for age and sex, was considered obese. A child or adolescent with a BMI greater than the 85th percentile but less than the 95th percentile was considered overweight.

The source of the standard data for blood fat measurements was the *Nelson Textbook of Pediatrics*.¹ Data were from Lipid Research Clinics Population Studies.⁷ Data were analyzed by SPSS version 6 software (SPSS, Chicago, IL, USA) using regression analysis and the Student *t* test. Differences were considered significant when the *p* value was < 0.05.

RESULTS

In the samples studied in 1993 and 1999, the mean serum total cholesterol, LDL-C, and triglyceride levels were significantly higher than the standard values, but there was no significant difference between the obtained and standard values of HDL-C (Tables 1 to 4). Compared to 1993, the mean total cholesterol, LDL-C, and triglyceride

Table 1. Mean Serum Cholesterol (mmol·L⁻¹) Obtained in Iran Compared With Standard Levels

Age Group (years)	Girls			Boys		
	Obtained		Standard	Obtained		Standard
	1993	1999		1993	1999	
2-5	4.84	4.81	4.05	4.69	4.79	4.03
6-9	4.96	5.14*	4.26	4.99	5.05*	4.03
10-14	4.89	5.16*	4.16	4.90	5.15*	4.03
15-18	4.74	5.17*	4.13	4.59	5.18*	3.97

**p* value < 0.05 for 1993 versus 1999.

Table 2. Mean Low-Density Lipoprotein Cholesterol (mg/dL) Obtained in Iran Compared With Standard Levels

Age Group (years)	Girls			Boys		
	Obtained		Standard	Obtained		Standard
	1993	1999		1993	1999	
2-5	126.69	125.57	100	120.08	121.52	93
6-9	126.23	130.45*	100	127.36	131.56*	93
10-14	119.24	127.71*	97	127.36	132.42*	93
15-18	117.75	128.41*	96	127.33	131.12*	94

**p* value < 0.05 for 1993 versus 1999.

Table 3. Mean Serum Triglycerides (mmol·L⁻¹) Obtained in Iran Compared With Standard Levels

Age Group (years)	Girls			Boys		
	Obtained		Standard	Obtained		Standard
	1993	1999		1993	1999	
2-5	1.23	1.24	0.72	1.26	1.27	0.63
6-9	1.46	1.51*	0.72	1.20	1.44*	0.59
10-14	1.62	1.96*	0.82	1.54	1.67*	0.53
15-18	1.43	1.67*	0.83	1.49	1.67*	0.88

**p* value < 0.05 for 1993 versus 1999.

levels showed a significant rise in 1999 in the 6- to 18-years age group ($p < 0.05$), especially in teenagers. In 1993, 26% of girls and 27% of boys had levels of total cholesterol greater than the 95th percentile; these values were, respectively, 27.5% and 29% in 1999. In 1993, 12% of girls and 14.5% of boys had LDL-C levels above the 95th percentile; these values were, respectively, 14.2% and 16% in 1999. In 1993, 22% of girls and 31% of boys had triglyceride levels above the 95th percentile; these data were 30% and 34% in 1999. The mean HDL-C values were significantly lower than the standard values in 6- to 18-year-old boys and girls in 1993 and 1999 ($p = 0.02$), but there was no significant change in HDL-C between 1993 and 1999. In 1993, 29% of boys and 21% of girls had HDL-C levels less than the fifth percentile and these data were 29.5% and 22%, respectively, in 1999.

There was no significant increase in systolic and diastolic blood pressure between 1993 and 1999 ($p > 0.05$), as shown in Tables 5 and 6. In 1993, 6.1% of girls and 5.2% of boys had diastolic blood pressure above the 95th percentile, and 4.9% of girls and 2.5% of boys had systolic blood pressure above the 95th percentile. These values were 6.4% and 5.5%, 5% and 3.1%, respectively, in 1999 ($p > 0.05$). As shown in Table 7, there was no significant

increase in the incidence of systolic and diastolic hypertension.

A significant increase in BMI was noted in girls aged 6 to 9 and 10 to 14 years, and in 10- to 14-year-old boys ($p < 0.05$) from 1993 to 1999 (Table 8). The prevalence of obesity was only 0.2% in 1993 and approximately 0.35% in 1999, but the incidence of overweight children is increasing in our society and there was a two-fold rise from 4% in 1993 to 8% in 1999 ($p = 0.02$). Being overweight was especially more frequent in school-aged and adolescent girls.

No case of diabetes mellitus was found because diabetes in children is mainly insulin-dependent and it is not found randomly as patients become symptomatic soon after onset of the disease.

DISCUSSION

Coronary artery disease is the leading cause of mortality in the adult population and in view of its onset from an early age in recent years, specific attention has been paid to primary prevention of atherosclerosis from childhood.^{8,9} In 1993, for the first time in Iran, the prevalence of CAD risk factors was evaluated in 2- to 18-year-old children

Table 4. Mean High-Density Lipoprotein Cholesterol (mg/dL) Obtained in Iran Compared With Standard Levels

Age Group (years)	Girls			Boys		
	Obtained		Standard	Obtained		Standard
	1993	1999		1993	1999	
2-5	37.85	37.48	38	37.6	37.58	42
6-9	39.87	39.91	53	40.35	40.42	56
10-14	41.26	41.17	52	40.35	40.61	55
15-18	40.84	41.07	74	38.59	40.58	63

Table 5. Systolic Blood Pressure (mg Hg)

Age Group (years)	Girls				Boys			
	50th Percentile		95th Percentile		50th Percentile		95th Percentile	
	1993	1999	1993	1999	1993	1999	1993	1999
2-5	85	90	110	105	85	90	110	115
6-9	105	105	120	115	95	95	105	100
10-14	105	110	125	125	100	105	110	115
15-18	110	115	130	135	110	110	130	135

Table 6. Diastolic Blood Pressure (mm Hg)

Age Group (years)	Girls				Boys			
	50th Percentile		95th Percentile		50th Percentile		95th Percentile	
	1993	1999	1993	1999	1993	1999	1993	1999
2-5	65	65	80	85	60	65	75	80
6-9	65	70	80	80	60	65	75	80
10-14	70	75	85	80	65	70	80	85
15-18	70	75	90	90	70	75	90	90

Table 7. Prevalence of Systolic and Diastolic Hypertension (Adjusted for Weight and Height)

Age Group (years)	Girls				Boys			
	Systolic		Diastolic		Systolic		Diastolic	
	1993	1999	1993	1999	1993	1999	1993	1999
2-5	2.65%	2.68%	2.21%	2.3%	1.74%	1.82%	2.9%	2.9%
6-9	3.2%	3.4%	3.1%	3.5%	2.9%	3.1%	3.1%	3.5%
10-14	4.6%	4.8%	4.7%	4.9%	4.2%	4.5%	4.6%	4.8%
15-18	5.5%	5.6%	5.6%	5.8%	5.4%	5.6%	5.5%	5.7%

Table 8. Percentiles of Body Mass Index ($\text{kg}\cdot\text{m}^{-2}$)

Age Group (years)	Girls						Boys					
	50th Percentile		75th Percentile		95th Percentile		50th Percentile		75th Percentile		95th Percentile	
	1993	1999	1993	1999	1993	1999	1993	1999	1993	1999	1993	1999
2-5	15.0	15.2	16.0	16.8	18.0	19.0	16.0	16.1	17.0	17.0	19.0	19.5
6-9	15.8	16.4	17.5	18.9*	19.0	22.0*	15.6	16.2	17.4	18.1	19.1	19.15
10-14	17.2	19.1*	20.0	22.0*	23.5	25.6*	17.0	18.6*	19.8	19.9	22.1	24.6*
15-18	20.7	22.1*	22.8	24.2*	26.7	27.1	22.0	22.7	24.0	25.6*	27.2	28.1*

**p* value < 0.05 for 1993 versus 1999.

in Isfahan city. The incidence of hyperlipidemia was high in our children and adolescents (approximately a quarter of those sampled suffered from hypercholesterolemia). Blood cholesterol measured from the umbilical cord of newborns is very similar in different populations, but during the first and second years of life, blood cholesterol levels start to increase toward a level characteristic of each population. This occurs when infants begin to eat the typical food of their culture.¹⁰ In a study carried out in children of different races living in the USA, the mean cholesterol levels were 173 mg/dL in blacks, 168 mg/dL in Hispanics, 165 mg/dL in Asians, and 163 mg/dL in white Americans.¹¹ In the Isfahan studies, the mean cholesterol levels were higher at 185 mg/dL in 1993 and 190.5 mg/dL in 1999.

Various forms of health education have been given to the population via the mass media, pamphlets, and lectures, but these have been effective for only short periods of time. Families, especially the children, did not comply and change their nutritional habits as desired. As shown in this study, dyslipidemia in Iran has worsened recently and this can be attributed mainly to improper dietary habits in families and in schools, especially in respect of the quality and quantity of consumed fat. In recent years, various fried fast-foods have become easily available in cities, which are preferred to the traditional family meals by children and adolescents. Different types of snacks containing high levels of saturated fat are also consumed by children in preference to family food that is generally prepared with hydrogenated vegetable oil.

Paralleling the hyperlipidemia, the incidence of overweight children has also increased significantly, especially among girls. In addition to dietary changes, this could be due to

physical inactivity. The type and rate of physical activity has been evaluated in our society and it was found that 46% of girls and 53% of boys had regular physical activity ($p = 0.001$); unfortunately, in those who had regular physical activity, the duration of exercise was less than 20 minutes each time.¹²

Nutritional information must be provided to healthcare personnel and the importance of screening and controlling CAD risk factors from childhood, especially hyperlipidemia, should be emphasized in various phases of medical education. It is also recommended that more education be given to the population, particularly face-to-face education of children and adolescents about correct dietary habits and proper physical activity.

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