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Serum Cholesterol Levels in Children from Urban and Rural Communities

The Shimane Heart Study

(cholesterol/local difference/dietary habits)

TOSHIKAZU NISHIO, CHUZO MORI, KATSUTOSHI ABE, MASAKAZU SAITO, YUTAKA TOMITA, NORIYUKI HANEDA, and YASUJI NAKAO

Department of Pediatrics, Shimane Medical University, Izumo 693, Japan

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Serum cholesterol levels were determined in 358 Japanese school children aged from 12−15 years. The subjects belonged to three different schools located in an urban area (A), a fishing village (B), and a mountain village (C), respectively.

Cholesterol levels in urban area A were significantly higher than the levels in rural areas B and C ($p<0.01$). Mean values±SD were ; for boys, 165.2±22.4 mg/dl in A, 137.6±16.4 in B, 138.8±30.0 in C, and for girls, 169.5±23.6 in A, 152.0±25.8 in B, 142.6±21.8 in C.

Frequency of hypercholesterolemic children (<200 mg/dl) was significantly higher in the urban area (6.9% in A) than in rural areas (1.9% in B and 2.0% in C). Eight percent of children in a mountain village were hypocholesterolemic (<110 mg/dl), thereby reflecting an inadequate diet.

Serum cholesterol is one of the risk factors in atherosclerotic vascular diseases such as coronary infarct and cerebral apoplexy (1−4). Concerning the adult population, epidemiological studies on serum cholesterol and atherosclerosis have been extensively performed in various countries and communities (5−12). Few such studies on children have been reported, particularly regarding differences in cholesterol levels among different communities of the same ethnic origin.

The Shimane Heart Study of vascular diseases in adults was initiated in 1978 in an attempt to clarify risk factors which may already be present in children (13). The cholesterol levels of Japanese children in three different communities were compared, and our findings are reported herein.

MATERIALS AND METHODS

Study Population

The subjects included in this study were 358 apparently healthy Japanese children aged from 12−15 years. They were all students at three Junior

High Schools in Izumo City, Oki and Daiwa, located in an urban area, a fishing village of solitary island and a mountain village, respectively, as shown in Fig. 1. All these areas are in Shimane Prefecture. The details are shown in Table I.

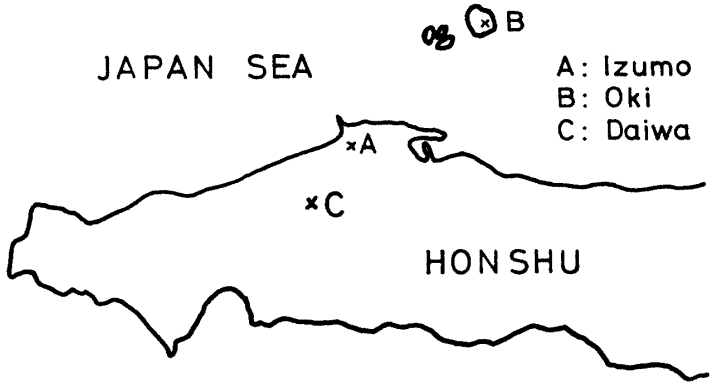

Fig. 1. Geographical distribution of the communities studied.

Examination

The family history of hypertension, apoplexy, coronary infarct, diabetes mellitus and obesity was obtained by questionnaire. The following examinations were performed on the children : anthropometric measurements (body weight, height, chest circumference, upper arm circumference, skinfold thickness), physical examinations, blood pressure measurements, hemoglobin, determinations of serum total and HDL cholesterol, urinalyses, ECG, VCG, and UCG.

Serum Cholesterol Determination

Blood samples were collected by left antecubital venipuncture (sitting position) at 11 : 30 a. m. after a 4 hour fast. The blood was allowed to clot at room temperature for about 2 hours and then centrifuged at 2,500 r. p. m. for 10 minutes using Sure-Sep II (General Diagnostics Co.), as a serum separator. The serum was preserved at −20°C until tested.

The serum total cholesterol levels were measured by a modified Zurkowski-Shibata method. The serum, sulfosalicylic acid, acetate acid and sulfuric acid were mixed and incubated at 37°C for 15 minutes. The absorbance of the mixture was measured at 578 nm against the blank containing a similar mixture but omitting the serum.

To evaluate the reproducibility of the method, 105 sera were measured twice on separate days, and the correlation coefficient between the values of two measurements was 0.94. The reproducibility was considered to be within allowable limits.

In addition, each measurement was checked by standard serum and the data were discarded if the error was over 5 per cent.

RESULTS

Differences of Cholesterol Levels among Three Communities

The mean values of cholesterol in children of three communities are shown in Table I. In both sexes, significant differences of cholesterol levels were observed between the children of Izumo and of Oki or Daiwa ($p<0.01$), but differences between Oki and Daiwa were not significant at the 1% level. To clarify the differences, the cumulative frequency distributions of cholesterol levels were determined, as shown in Fig.2. These curves indicate that, in both sexes, there are more children with low cholesterol levels in Oki and Daiwa than in Izumo, and also are more subjects with high levels in Izumo than in Oki and Daiwa.

TABLE I. *Serum Cholesterol Levels (mg/dl) in Children of Three Communities*

	Boys		Girls	
	No.	Mean±SD	No.	Mean±SD
Izumo	84	165.2±22.4	73	169.5±23.6
Oki	55	137.6±16.4	48	152.0±25.8
Daiwa	48	138.8±30.0	50	142.6±21.8

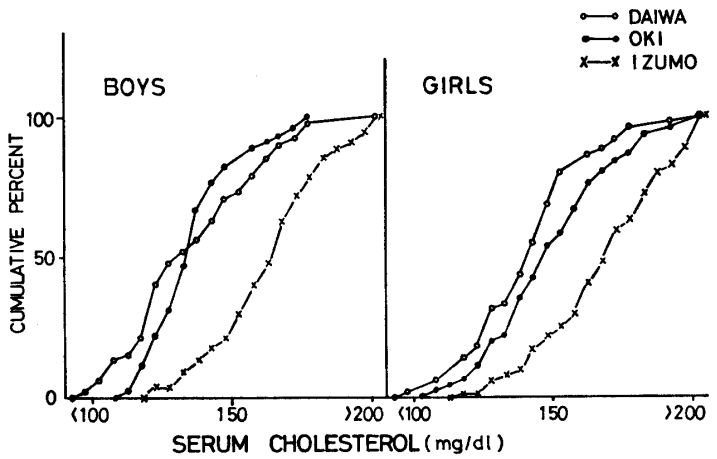

Fig. 2. Cumulative frequency distribution of cholesterol levels in boys and girls of three communities.

The cumulative frequency distributions of cholesterol of both sexes in each community are shown in Fig. 3. The cholesterol levels tended to be higher in girls than in boys in the three communities, although the differences of mean values between both sexes were significant, exclusively in the children from Oki ($p<0.01$).

Frequency of Children with Abnormal Cholesterol Levels among Different Communities

Children with high cholesterol levels (>200 mg/dl) were more numerous

in Izumo than in other areas, as shown in Table II ($p<0.01$). On the contrary, children with a low cholesterol level (<110 mg/dl) were more

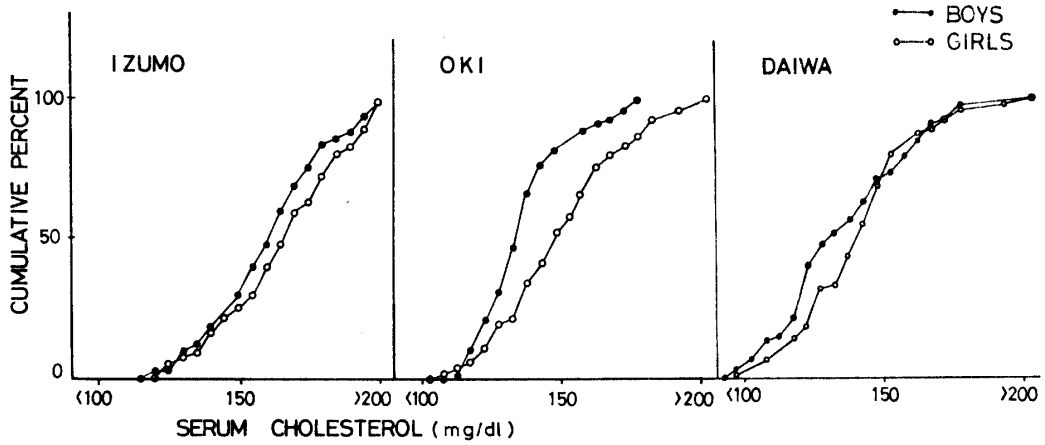

Fig. 3. Cumulative frequency distribution of cholesterol levels in boys and girls of three cummunities.

TABLE II. *Numbers of Hypercholesterolemic and Hypocholesterolemic Children among Three Communities*

	Cholesterol levels	
	>200 mg/dl	<110 mg/dl
Izumo	11 (6.9%)	0
Oki	2 (1.9%)	1 (1.0%)
Daiwa	2 (2.0%)	8 (8.2%)

frequent in other areas than in Izumo. In Daiwa, approximately 8% of all the children were hypocholesterolemic.

DISCUSSION

Epidemiological studies in various countries have revealed differences in serum cholesterol levels among different communities, ethnic groups and ages (5—12).

Factors such as age, sex, heredity, socioeconomic state, race, and dietary habits are all assumed to play a role. We have already reported differences in cholesterol levels among various ages of boys and girls (5).

An extensive survey performed in U. S. A. showed apparent racial differences in serum cholesterol levels (6). Black children had significantly higher mean levels than white children ; 170 mg/dl vs. 162 mg/dl, $p<0.0001$. These results suggest that serum cholesterol levels may be influenced by heredity or dietary habits.

However, a precise explanation for the differences is not feasible by making comparisons between different races, because the hereditary factor has also to be considered. To exclude this factor, it is important to perform comparative

studies among different communities of the same ethnical background.

For this purpose, we measured serum cholesterol levels in Japanese children of the same age who lived in different communities. This is the first such report of findings in Japanese children living in various communities.

We found that the cholesterol levels were different among the three communities. In general, there was a Daiwa<Oki<Izumo gradient, with relatively smaller differences between Daiwa and Oki than between Oki and Izumo. Izumo is an urban area, and the usual diet has become westernized, in other words, of high calories and high fats. On the contrary, Oki and Daiwa are rural areas and the inhabitants ingest the usual traditional Japanese diet of low fats and high carbohydrates. We assume that the contents of fat in diet are responsible for the difference in serum cholesterol levels among these different communities.

Similar observations have been reported in comparative studies of serum cholesterol levels of Japanese men living in different countries (7, 14, 15). Serum cholesterol levels among Japanese immigrants to Hawaii and California were significantly higher than the levels of Japanese living in Japan, that is, the mean cholesterol levels in California, Hawaii, and Japan were 228.2, 218.3, and 181.1 mg/dl, respectively. Serum cholesterol showed a positive regression with dietary intake of saturated fat, animal protein and dietary cholesterol. These results suggest that dietary habits may be responsible for the difference in serum cholesterol levels (14). A close relationship between serum cholesterol and fat content in diets was observed by some investigators (16−18).

High serum cholesterol levels are considered to be an important risk factor in atherosclerotic vascular diseases (1−4). The 95 percentile values of cholesterol in normal children of various ages were 190−200 mg/dl, as reported previously (5). Therefore, we considered cholesterol levels higher than 200 mg/dl to be a risk factor for a potential atherosclerosis. Frequency of hypercholesterolemic children selected by the upper-mentioned criteria was different among the three communities, that is, higher in urban than in rural areas.

The values of Izumo City (6.9%) are similar to those of Tokyo, the most "westernized" industrialized district in Japan (19). Therefore, the preventive measures for hypercholesterolemia and atherosclerotic vascular diseases, for example, low-fat diet, are urgently needed during childhood even in Izumo City, the less "westernized" industrialized area in Japan.

A most interesting observation in the present study was prevalence of children with low cholesterol levels (<110 mg/dl) in Daiwa village (8.2% of the subjects). The village is located in a mountain area, where dietary habits are less "westernized", so the intake of fat is presumed to be lower than in other areas. These circumstances may influence the cholesterol levels in children of the community.

The analogous trends in serum cholesterol levels and dietary habits were observed among American Indians living in primitive conditions (8, 20).

Their serum cholesterol levels were reported to be less than half that of Caucasians. Schwart and Hill reported the differences of cholesterol levels between urban and rural areas (21). The levels in rural areas were 10—30 mg/dl lower than that in urban regions.

Relationships between serum lipids and atherosclerotic vascular diseases are most difficult to determine. Nevertheless, these relationships must be given increasing attention as atherosclerotic vascular diseases are on the increase in Japan as the result of rapid "westernization" in dietary habits and life style since the 1950s. As a part of Shimane Heart Study, we have already commenced investigation on causative factors for the difference in cholesterol levels of children among different communities, and on the potential effects on the occurrence of atherosclerosis.

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