Current State of and Recent Trends in Serum Lipid Levels in the General Japanese Population

Research Committee on Serum Lipid Level Survey 1990 in Japan

(Investigators are listed in the appendix.)

To determine the recent serum lipid levels in the general Japanese population and trends in their changes over the past 30 years, a nationwide survey of serum lipid levels was conducted in 39 institutes from various districts around Japan. The total number of subjects was 34,815, consisting of 20,279 men and 14,536 women aged 4 through 99 years. All the serum samples were collected and analyzed within one week at the Special Research Laboratory (Tokyo, Japan). In males, the mean serum cholesterol level showed a gradually increase from 170 mg/dl in the 0- to 9-year-old age group to 198 mg/dl in the 50- to 59-year-old age group. There was a slight decrease after age 60 years. In females, the mean cholesterol level gradually rose with age from 173 mg/dl in the 0- to 9-year-old age group to 210 mg/dl in the 60- to 69-year-old age group, and fell to 207 mg/dl after 80 years of age. The mean HDL-cholesterol level in men gradually decreased with age from 60 mg/dl in the 0- to 9-year-old age group to 51 mg/dl in the 30- to 39-year-old age group, remained at this level up to 69 years of age, and then increased to 54 mg/dl for the above 80 years old group. The mean HDL-cholesterol level in women increased from 57 mg/dl in the 0- to 9-year-old age group to 62 mg/dl for the 20- to 29-year-old age group: then gradually decreased with age to 54 mg/dl in the 60- to 79-year-old age group. The mean LDL-cholesterol level in men gradually increased with age from 98 mg/dl in the 0- to 19-year-old age group to 122 mg/dl at 70-79 years of age. The mean LDL-cholesterol level in women was low at 101-103 mg/dl up to 29 years of age, then it increased with age to 135 mg/dl in the 60- to 69-year-old age group. The serum cholesterol levels in 1970 and 1980 were higher than that in 1960, but in 1990 values similar to those in 1960 were observed in both men and women. The present results will become the standard serum lipid level data for the Japanese people, and succeeding 10-year surveys will clarify the trends of lipid levels in this country. *J Atheroscler Thromb*, 1996; 2: 122-132.

Key words : Serum lipid levels, Recent trends, General Japanese population

Comparisons among various populations throughout the world have revealed a direct correlation between serum cholesterol level and coronary heart disease (CHD) rate. The Seven Countries Study (1) showed that regions such as Finland and the USA which have the highest average dietary fat and cholesterol intakes also have the highest serum cholesterol values and incidence of CHD. On the other hand, Japan which has lower dietary fat and lower chole-

sterol intake was found to have lower serum cholesterol values and a correspondingly lower incidence of CHD. Japanese in the 1960s consumed very little dietary fat, 36 g per day in 1965, and both cholesterol levels and the incidence of CHD were low (1). Japanese who migrated to Hawaii and California showed higher levels of serum cholesterol and a higher incidence of CHD than people in Japan (2). Thus, dietary habits and other environmental factors rather than genetic background affect serum cholesterol levels and CHD mortality in the population. In the United States, during the period of 1960 through 1991, many changes in nutritional lifestyle, and medical therapeutic factors may have decreased serum total cholesterol levels among American adults (3). On the other hand, Japanese have adopted

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mixed dietary habits of a traditionally low fat and low cholesterol diet and a western style diet of relatively high fat and high cholesterol, and the serum cholesterol levels in the Japanese populations were found to have gradually increased over the 20 years from 1960 to 1980 by the 10-year-interval national surveys of serum cholesterol levels conducted in 1960 (4), 1970 (5) and 1980 (6). This study is the fourth survey and reveals the most recent serum lipid levels in the Japanese general population and the trends of serum lipid levels over the 30 years from 1960 to 1990.

Method

Design and Data Collection

The Research Committee on Serum Lipid Level Survey 1990 in Japan organized the members of 39 institutes from various areas around Japan. The project was designed to produce representative data of serum lipid and apolipoprotein levels in the civilian Japanese population. The subjects were people receiving annual health examinations in general community, companies and schools, and not patients visiting hospitals. The total number of subjects was 34,815, consisting of 20,279 men and 14,536 women.

Fig. 1. Serum cholesterol for Japanese males, mean and percentile values for 10-year age groups.

Laboratory Methods

All serum samples were obtained in the fasting state. All lipid and lipoprotein analyses were conducted on venous blood samples within one week of collection at the Special Research Laboratory (SRL, Tokyo). Serum cholesterol (7) and triglyceride levels (8) were measured enzymatically. HDL-cholesterol was measured in supernatants following precipitation of apo B-containing lipoproteins with heparin-calcium chloride (9). LDL-cholesterol was calculated for samples with triglyceride levels of 400 mg/dl or less using the equation reported by Friedewald *et al.* (10). The results of lipid analyses in the four surveys were indirectly standardized according to the criteria of the CDC Lipid Standardization Program (11). There were no differences between the data obtained by Zak-Henly's method in 1960 (3) and 1970 (4), and those by the enzymatic methods used in 1980 (5) and 1990. Thus, the cholesterol levels in these four surveys appear to be comparable. In the present survey, apolipoproteins A1, B and E and Lp (a) measurements were performed in 2,000 randomized samples, and these results will be reported in separate papers.

Data Analyses

The statistical analyses of the present data were performed by SAS statistical package in the Information Processing Center, Aichi Medical University. The mean and standard deviation (SD) were obtained excluding extreme cases outside two SDs after the initial calculation. One of the reasons for the operation was comparability with the previous data in 1960 to 1980.

Results

Table 1 and Fig. 1 show the age-specific means, standard deviations, medians and percentiles of serum total cholesterol levels by age group in males, and Table 2 and Fig. 2 those in females.

In the males, the age-specific mean serum cholesterol levels gradually increased from 170 mg/dl in the 0- to 9-year-old age group to 198 mg/dl in the 50- to 59-year-old age group. There was a slight decrease after age 60. The ninety-fifth percentile was 216 mg/dl in the 0- to 9-year-old

Table 1. Serum total cholesterol (mg/dl) for normal Japanese men.

Age (years)	n	Mean	SD	Percentile					
				5	10	25	50	75	95
0-9	517	170	25	132	140	152	167	186	216
10-19	1463	170	26	132	138	151	168	188	217
20-29	755	180	30	135	144	159	177	197	237
30-39	2318	191	32	142	150	167	188	214	248
40-49	6606	196	31	146	156	174	195	218	252
50-59	4708	198	31	146	157	176	198	221	252
60-69	2409	194	31	144	153	171	194	216	247
70-79	568	194	30	146	154	172	192	214	249
80+	60	191	30	132	152	172	195	215	233

Table 2. Serum total cholesterol (mg/dl) for normal Japanese women.

Age (years)	n	Mean	SD	Percentile						
				5	10	25	50	75	90	95
0-9	473	173	24	135	143	155	173	188	206	217
10-19	1440	177	27	137	144	159	175	194	213	225
20-29	480	177	29	135	142	155	176	197	216	231
30-39	1395	179	28	137	144	159	176	196	216	229
40-49	3432	191	30	143	153	169	189	211	233	245
50-59	3386	208	31	156	168	187	209	231	250	259
60-69	2535	210	30	159	170	189	211	233	251	260
70-79	618	209	31	159	168	189	210	232	250	259
80+	71	207	37	138	156	172	217	239	251	262

Fig. 2. Serum cholesterol for Japanese females, mean and percentile values for 10-year age groups.

age group, increased to 252 mg/dl in the 40- to 59-year-old age group, and slightly decreased after age 60.

In females, the mean cholesterol levels gradually rose from 173 mg/dl in the 0- to 9-year-old age group to 210 mg/dl in the 60- to 69-year-old age group, and fell to 207 mg/dl after age 80. The 95th percentile rose from 217 mg/dl in the 0- to 9-year-old age group to 231 mg/dl in the 20- to 29-year-old age group, dipped slightly in the 30- to 39-year-old age group, and thereafter increased to 262 mg/dl in the above 80-year-old age group.

Table 3 and Fig. 3 show the age-specific means, standard deviations, medians and percentiles of serum triglyceride levels in males, and Table 4 and Fig. 4 those in females. The age-specific mean triglyceride values in men increased from 55 mg/dl in the 0- to 9-year-old age group to 109 mg/dl in the 30- to 39-year-old age group, and remained unchanged up to 69 years of age, followed by a decline to 88 mg/dl above 80 years old. In females, the age-specific mean triglyceride levels increased gradually from 56 mg/dl in the 0- to 9-year-old age group to 105 mg/dl in the 60- to

Fig. 3. Serum triglyceride for Japanese males, mean and percentile values for 10-year age groups.**Table 3.** Serum triglyceride (mg/dl) for normal Japanese men.

Age (years)	n	Mean	SD	Percentile						
				5	10	25	50	75	90	95
0-9	528	55	31	27	28	36	48	64	90	109
10-19	1495	61	34	26	30	39	52	73	102	129
20-29	763	94	47	39	45	59	81	119	159	193
30-39	2234	109	52	44	51	69	95	138	187	214
40-49	6489	109	51	45	53	71	98	138	186	214
50-59	4613	110	51	47	54	72	99	139	184	217
60-69	2391	105	47	47	55	71	95	130	172	201
70-79	579	95	40	47	51	66	87	119	151	177
80+	65	88	37	37	48	63	83	107	135	147

Table 4. Serum triglyceride (mg/dl) for normal Japanese women.

Age (years)	n	Mean	SD	Percentile						
				5	10	25	50	75	90	95
0-9	481	56	25	27	31	39	50	70	90	107
10-19	1459	63	31	30	34	43	56	74	99	121
20-29	494	63	29	31	34	43	57	76	96	117
30-39	1417	69	34	33	37	46	60	80	107	138
40-49	3490	77	37	37	42	52	69	92	122	154
50-59	3535	96	45	44	50	63	85	119	158	186
60-69	2637	105	46	48	55	71	95	129	171	197
70-79	639	102	44	48	56	71	92	124	159	196
80+	74	99	41	51	57	70	90	117	157	183

Fig. 4. Serum triglyceride for Japanese females, mean and percentile values for 10-year age groups.

69-year-old age group, and then declined to 99 mg/dl above 80 years of age.

Table 5 and Fig. 5 show the age-specific means, standard deviations, medians and percentiles in serum HDL-cholesterol levels in males, and Table 6 and Fig. 6 those in females. The age-specific mean HDL-cholesterol levels in men gradually decreased from 60 mg/dl in the 0- to 9-year-old age group to 51 mg/dl in the 30- to 39-year-old age group, and remained at this level up to 69 years of age, and then increased to 54 mg/dl in the above 80-year-old age

group. The mean HDL-cholesterol levels in women increased from 57 mg/dl in the 0- to 9-year-old age group to 62 mg/dl in the 20- to 29-year-old age group, and gradually decreased to 54 mg/dl in the 60- to 79-year-old age group.

Table 7 and Fig. 7 show the age-specific means, standard deviations, medians and percentiles in serum LDL-cholesterol levels in males, and Table 8 and Fig. 8 those in females. The age-specific mean LDL-cholesterol levels for men gradually increased from 98 mg/dl in the 0- to 19-year-old age group to 122 mg/dl in the 70- to 79-year-old age

Fig. 5. Serum HDL-cholesterol for Japanese males, mean and percentile values for 10-year age groups.**Table 5.** Serum HDL-cholesterol (mg/dl) for normal Japanese men.

Age (years)	n	Mean	SD	Percentile						
				5	10	25	50	75	90	95
0-9	503	60	12	40	44	51	59	69	76	79
10-19	1462	59	12	40	44	50	58	67	75	80
20-29	764	53	12	35	39	45	52	60	68	74
30-39	2328	51	13	32	36	42	50	59	69	74
40-49	6633	51	13	32	35	42	50	59	69	74
50-59	4683	51	13	32	35	42	50	59	70	76
60-69	2389	51	13	32	36	42	50	59	69	75
70-79	551	52	14	31	36	42	51	63	73	77
80+	64	54	15	33	36	42	52	65	74	80

Table 6. Serum HDL-cholesterol (mg/dl) for normal Japanese women.

Age (years)	n	Mean	SD	Percentile						
				5	10	25	50	75	90	95
0-9	466	57	12	37	43	49	57	65	72	78
10-19	1410	60	12	41	45	52	59	67	75	79
20-29	476	62	12	44	48	54	62	70	78	82
30-39	1363	58	12	40	43	51	58	67	74	78
40-49	3342	58	12	37	42	49	57	66	74	79
50-59	3438	56	13	36	40	47	55	65	73	78
60-69	2582	54	12	35	38	45	53	62	71	76
70-79	625	54	13	33	37	45	53	62	71	76
80+	75	56	14	33	39	46	55	64	77	81

Fig. 6. Serum HDL-cholesterol for Japanese females, mean and percentile values for 10-year age groups. **Fig. 7.** Serum LDL-cholesterol for Japanese males, mean and percentile values for 10-year age groups.

group. The age-specific mean LDL-cholesterol level for women increased from 103 mg/dl in the 0- to 19-year-old age group to 135 mg/dl in the 60- to 69-year-old age group, and then decreased slightly thereafter.

Table 9 shows the prevalence of each blood cholesterol level in Japanese men and women. The age-adjusted proportions of adults 20 through 79 years of age with serum total cholesterol levels of 220 mg/dl and higher were 20.1% for men and 24.6% for women. Those with serum total cholesterol levels of 240 mg/dl and higher were 8.2% for

men and 11.3% for women.

Table 10 shows the prevalence of each blood triglyceride level. The age-adjusted proportions of adults from 20 through 79 years of age with serum triglyceride levels of 200 mg/dl and higher were 5.7% for men and 2.7% for women.

Table 11 shows the prevalence of high and low HDL-cholesterol. The age-adjusted proportions of adults from 20 through 79 years of age with a low HDL-cholesterol level of less than 35 mg/dl were 8.4% for men and 3.6% for women. Those with high HDL-cholesterol levels higher

Table 7. Serum LDL-cholesterol (mg/dl) for normal Japanese men.

Age (years)	n	Mean	SD	Percentile						
				5	10	25	50	75	90	95
0-9	522	98	23	62	70	83	96	111	127	145
10-19	1489	98	24	63	70	82	95	112	130	141
20-29	765	107	28	67	73	87	103	125	146	159
30-39	2323	116	30	69	78	94	113	136	159	169
40-49	6598	121	30	74	83	100	120	142	163	174
50-59	4699	122	30	73	82	101	122	144	164	174
60-69	2401	121	30	74	82	99	120	142	162	173
70-79	573	122	29	77	87	101	121	143	160	170
80+	63	120	30	70	77	101	122	144	154	159

Table 8. Serum LDL-cholesterol (mg/dl) for normal Japanese women.

Age (years)	n	Mean	SD	Percentile						
				5	10	25	50	75	90	95
0-9	477	103	22	67	77	88	101	117	133	140
10-19	1451	103	24	68	76	86	102	117	134	146
20-29	491	101	27	61	69	84	99	115	137	156
30-39	1408	105	26	68	74	87	103	122	141	155
40-49	3439	117	29	75	82	97	115	136	156	171
50-59	3395	133	29	85	94	112	133	154	172	181
60-69	2536	135	29	87	97	115	135	156	174	183
70-79	618	134	28	87	97	115	134	153	171	182
80+	75	133	33	73	82	108	141	162	171	178

Fig. 8. Serum LDL-cholesterol for Japanese females, mean and percentile values for 10-year age groups.

than 60 mg/dl were 25.0% for men and 39.6% for women.

Table 12 shows the prevalence of hyper-LDL-cholesterolemia in men and women. The age-adjusted proportions of adults from 20 through 79 years of age with a high LDL-cholesterol higher than 130 and 160 mg/dl were 34.0% and 9.8% for men and 37.9% and 12.1% for women, respectively.

The trends in mean serum cholesterol level in the Japanese population in the previous four surveys were compared. The serum cholesterol levels in 1970 and 1980

were higher than that in 1960, but that in 1990 was similar to the value in 1960 in both men and women (Table 13). The serum triglyceride level in men increased in 1980, but decreased in 1990 (Table 14). However, in women the triglyceride level gradually decreased with time.

The mean age-adjusted serum cholesterol level in Japan increased gradually from 1970 to 1980 with no further increase seen in 1990, while the levels in USA gradually decreased during this 30 year period (3), with the difference between the two countries becoming smaller (Table 15).

Discussion

Various factors influence serum cholesterol levels in the populations, especially intakes of saturated fat and cholesterol (1). The extent to which trends in the composition of dietary fat and cholesterol in the US adult population are consistent with the decline in serum cholesterol levels is unclear (3). Continuing surveys of food intake by individuals will provide updated dietary information to explore this issue. Due to westernization, especially changes in dietary habits, the serum cholesterol levels in the Japanese populations rose from 1960-1980, but after 1980, dietary fat intake, particularly animal fat intake reached a plateau, as did serum cholesterol levels (12, 13).

Table 16 shows the changes in dietary intake of nutrients in the Japanese population (12). Compared with the data

Table 9. Prevalence (%) of each cholesterol level (mg/dl) in Japanese men and women.

Age (years)	Men										Women									
	n	160<	180<	200<	220<	230<	240<	250<	260<		n	160<	180<	200<	220<	230<	240<	250<	260<	
0-9	517	63.2	30.6	11.2	4.1	2.7	1.4	1.0	0.1		473	66.2	34.7	13.9	4.2	2.1	0.8	0	0	
10-19	1463	61.4	33.2	14.0	4.3	2.1	1.0	0.2	0.0		1440	71.9	42.2	19.7	6.3	3.5	1.5	0.8	0.5	
20-29	755	73.0	43.3	23.6	11.6	6.9	4.4	2.8	0.3		480	66.5	43.5	21.8	8.3	5.2	2.9	1.7	0.4	
30-39	2318	81.9	59.0	38.3	20.1	13.9	8.4	4.4	1.8		1395	72.9	43.8	21.0	8.2	4.7	2.6	1.7	0.7	
40-49	6606	86.8	67.4	44.8	23.7	16.1	10.0	5.9	2.3		3432	84.5	61.9	37.7	17.0	11.8	6.8	3.8	1.2	
50-59	4708	88.1	70.4	47.0	26.0	17.2	11.3	6.0	2.4		3386	93.4	80.2	60.7	37.5	26.6	17.4	10.4	4.4	
60-69	2409	85.1	65.0	42.6	21.8	13.7	7.8	4.2	1.7		2535	94.4	83.0	64.0	38.6	30.0	19.1	11.2	5.0	
70-79	568	84.7	65.5	41.4	20.3	12.9	7.4	4.8	1.2		618	94.0	81.7	62.9	37.1	27.0	19.1	10.0	4.3	
80+	60	86.7	61.7	48.2	16.6	5.0	3.3	1.7	0.0		71	88.7	73.2	63.3	43.6	28.2	21.1	12.7	5.6	
20-79	17364	83.3	61.8	39.6	20.6	13.5	8.2	4.7	1.6		11846	84.3	65.7	44.7	24.6	17.6	11.3	6.5	2.7	

Table 10. Prevalence (%) of hypertriglyceridemia (mg/dl) in Japanese men and women.

Age (years)	Men					Women				
	n	150<	170<	200<	250<	n	150<	170<	200<	250<
0-9	528	1.4	1.1	0.9	0.3	481	0.2	0.0	0.0	0.0
10-19	1495	3.2	2.3	0.9	0.0	1459	2.1	1.2	0.6	0.0
20-29	763	13.3	8.8	4.7	0.1	494	2.0	1.4	0.6	0.0
30-39	2234	20.5	14.5	7.4	1.6	1417	3.7	2.6	1.1	0.2
40-49	6489	20.3	14.2	7.5	1.4	3490	5.4	3.3	1.5	0.1
50-59	4613	20.2	13.4	7.2	1.4	3535	12.4	7.9	3.6	0.5
60-69	2391	16.4	10.4	5.4	1.1	2637	15.7	10.3	4.6	0.7
70-79	579	10.4	6.2	1.9	0.3	639	13.5	7.4	4.5	0.4
80+	65	4.6	4.6	1.5	0.0	74	10.8	5.4	4.1	0.0
20-79	17069	16.9	11.3	5.7	1.0	12212	8.8	5.5	2.7	0.3

Table 11. Prevalence (%) of low- and high-HDL-cholesterolemia (mg/dl) in Japanese men and women.

Age (years)	Men							Women						
	n	<30	<35	<40	50<	60<	70<	n	<30	<35	<40	50<	60<	70<
0-9	503	0.0	2.0	5.5	22.5	47.9	21.3	468	0.4	2.4	7.2	27.8	40.8	13.9
10-19	1462	0.2	1.1	4.8	25.0	41.5	18.7	1410	0.1	1.1	3.7	20.1	47.9	19.1
20-29	764	0.9	5.5	12.1	42.0	24.9	8.5	476	0.2	1.1	3.1	14.9	56.3	23.9
30-39	2328	3.0	8.7	19.4	49.6	23.2	8.3	1363	0.5	1.7	4.6	23.0	44.1	17.2
40-49	6633	2.7	9.3	20.3	51.2	23.7	8.7	3342	0.7	3.3	7.2	26.7	41.5	16.2
50-59	4683	3.0	9.7	20.5	50.2	24.9	9.4	3438	0.9	3.9	9.9	34.6	36.0	15.2
60-69	2389	2.8	8.6	19.5	49.8	23.6	9.3	2582	1.2	5.1	12.0	40.2	30.3	11.3
70-79	551	3.4	8.7	19.1	47.7	29.9	13.4	625	1.4	6.7	14.0	40.3	29.6	10.2
80+	64	4.6	6.3	18.6	46.9	32.8	18.8	75	2.6	6.7	10.6	33.3	41.3	16.0
20-79	17348	2.6	8.4	18.5	48.4	25.0	9.6	11826	0.8	3.6	8.5	30.0	39.6	15.7

Table 12. Prevalence (%) of hyper-LDL-cholesterolemia (mg/dl) in Japanese men and women.

Age (years)	Men						Women					
	n	130<	150<	160<	190<	220<	n	130<	150<	160<	190<	220<
0-9	522	8.6	3.0	1.7	0.0	0.0	477	11.7	3.1	1.5	0.0	0.0
10-19	1489	9.8	2.8	1.2	0.1	0.0	1451	12.6	3.3	1.6	0.1	0.0
20-29	766	20.1	8.4	5.0	0.0	0.1	491	13.4	5.7	4.3	0.4	0.0
30-39	2323	30.8	14.5	9.1	0.6	0.0	1408	17.2	6.6	3.5	0.2	0.0
40-49	6598	37.2	17.9	11.5	0.8	0.0	3439	31.4	13.9	8.4	0.8	0.0
50-59	4699	40.3	19.1	11.9	0.7	0.0	3395	53.6	29.1	18.3	1.5	0.0
60-69	2401	37.0	17.9	11.0	0.9	0.0	2536	56.6	31.3	20.7	2.1	0.0
70-79	573	38.7	20.0	10.5	0.5	0.0	618	55.0	28.3	17.3	1.8	0.0
80+	63	41.3	19.0	4.8	0.0	0.0	75	60.0	34.6	25.3	0.0	0.0
20-79	17360	34.0	16.3	9.8	0.6	0.0	11887	37.9	19.2	12.1	1.1	0.0

obtained just after World War II, the total fat and animal fat intake increased 3-fold from 18g in 1950 to 36g in 1965 and to 55.6 g per day in 1980, and remained almost unchanged at 56.9 g per day in 1990. In Japan, the proportion of calories consumed as fat increased from 7.7% in 1950 to 14.8% in 1965 and to 23.6% in 1982, and 25.3% in 1990. The total calories consumed increased from 2,096 Kilocalories in 1960 to 2,210 Kilocalories in 1970, and decreased to 2,026 Kilocalories in 1990. Concomitantly, the mean serum cholesterol levels increased by 8 mg/dl in men (from 184 to 192 mg/dl) and 10 mg/dl in women (from 186 to 196 mg/dl) in all

age groups from 1960 to 1980, and remained unchanged during the subsequent 10-year period (4-6). CHD morbidity per 100,000 persons gradually increased by 3-fold from 34 in 1960 to 106 in 1980, but remained almost unchanged at 112 in 1990 (15). In Tanushimaru, the serum cholesterol level was 150 mg/dl in 1958 (1) and increased to 190 mg/dl in 1990 (15) due to changes in eating habits and lifestyle (15). Thus, the westernization of dietary habits prevailed in Japan from 1960 to 1980, with this trend plateauing from 1980 though 1990. The use of lipid-lowering drugs or of sex hormones, obesity, physical activity, and other dietary factors may have

Table 13. Serum cholesterol levels (mg/dl) in the Japanese population.

Sex/Age (yrs)		1960			1970			1980			1990		
		n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Men	0-9	7	163					357	173	27	528	170	25
	10-19	135	149		2	176	30	779	160	28	1495	170	26
	20-29	372	170		103	182	36	509	185	37	763	180	30
	30-39	250	182		239	188	33	892	193	35	2234	191	32
	40-49	374	181		1043	194	45	1522	198	37	6489	196	31
	50-59	233	188		623	181	45	1065	201	38	4613	198	31
	60-69	141	191		334	169	43	588	199	40	2391	194	31
	70-79	29	193		97	157	40	282	190	38	579	194	30
	80+	8	202					114	183	39	65	191	30
Women	0-9	4	173					313	178	29	481	173	24
	10-19	205	167		9	198	15	761	170	28	1459	177	27
	20-29	327	174		96	185	39	516	174	34	494	177	29
	30-39	97	178		184	184	42	588	178	32	1417	179	28
	40-49	103	175		377	179	36	697	192	36	3490	191	30
	50-59	62	211		273	194	44	718	212	39	3535	208	31
	60-69	57	194		142	199	46	589	213	37	2637	210	30
	70-79	8	183		33	189	44	388	209	40	639	209	31
	80+	3	205					214	195	40	74	207	37

Table 14. Serum triglyceride levels (mg/dl) in the Japanese population.

Sex/Age (yrs)		1960			1970			1980			1990		
		n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Men	0-9							354	65	22	528	55	31
	10-19				2	84	37	781	78	36	1495	61	34
	20-29				103	98	45	512	100	50	763	94	47
	30-39				239	112	69	895	116	63	2234	109	52
	40-49				1043	106	58	1528	119	63	6489	109	51
	50-59				623	98	54	1074	120	62	4613	110	51
	60-69				334	96	72	591	117	64	2391	105	47
	70-79				97	74	31	280	117	52	579	95	40
	80+							114	109	44	65	88	37
Women	0-9							314	69	24	481	56	25
	10-19				9	105	29	762	86	34	1459	63	31
	20-29				96	89	42	513	85	36	494	63	29
	30-39				184	98	48	588	79	34	1417	69	34
	40-49				377	104	54	705	91	44	3490	77	37
	50-59				273	118	60	731	107	51	3535	96	45
	60-69				142	132	77	591	126	64	2637	105	46
	70-79				33	109	54	396	122	54	639	102	44
	80+							217	106	40	74	99	42

Serum triglyceride levels were not measured in 1960.

contributed to the observed lack of change in serum total cholesterol levels.

Although the reliability with which trends in lipid measurements can be assessed depends on knowledge of comparability of the measurements in the four surveys, the methods for cholesterol measurement were different in each survey. However, the accuracy of the measurements was indirectly monitored through the CDC Lipid Laboratory Standardization Program (11), and the cholesterol levels measured by the methods in two consequent surveys were comparable.

There have been many studies of nationwide reference values of serum cholesterol and triglyceride. In the present survey as well as the earlier surveys in Japan (4-6) and the US (3, 14), higher cholesterol levels were observed in men than in women from 20 to 50 years of age. The higher levels in men compared with women and the tendency in women towards higher levels in the older age groups have been reported repeatedly, similarly to our findings.

Physiological effects, especially female sex hormones might have reduced both serum cholesterol and triglyceride

Table 15. Serum cholesterol levels (mg/dl) in Japan and USA from 1960 through 1990.

Sex/Age		1960			1970			1980			1990		
		Japan	USA	Difference	Japan	USA	Difference	Japan	USA	Difference	Japan	USA	Difference
Male	20-29	170	198	−28	182	194	−12	177	192	−15	180	189	−9
	30-39	182	227	−45	188	221	−33	192	217	−25	191	207	−16
	40-49	181	231	−50	194	229	−35	197	227	−30	196	218	−22
	50-59	188	233	−45	181	229	−48	199	229	−30	198	221	−23
	60-69	191	230	−39	169	226	−57	193	221	−28	194	218	−24
	70-79	193			157			192			194	205	−11
Female	20-29	174	194	−20	185	191	−6	173	189	−16	177	185	−8
	30-39	178	214	−36	184	207	−23	178	207	−29	179	195	−16
	40-49	175	237	−62	179	232	−53	191	232	−41	191	217	−26
	50-59	211	262	−51	194	245	−51	211	249	−38	208	237	−29
	60-69	194	266	−72	199	250	−51	214	246	−32	210	234	−24
	70-79	184			189			211			209	230	−21

Table 16. Intake of nutrients in the Japanese population.

	1960		1970		1980		1990	
		%		%		%		%
Total Kilocalories	2096	100.0	2210	100.0	2119	100.0	2026	100.0
Carbohydrate (g)	399.0	76.1	368.0	66.6	309.0	61.5	287.0	59.2
Protein (g)	69.7	13.3	77.6	14.0	78.7	14.9	78.7	15.5
Total fat (g)	24.7	10.6	46.5	18.9	55.6	23.6	56.9	25.3
Animal fat (g)			20.9		26.9		27.5	

levels in the females from 20 to 50 years of age, although most Japanese women have not received estrogen replacement therapy since its use for contraceptive purposes is not permitted in Japan. HDL-cholesterol levels were higher in females than in males above 10 years of age. Therefore, the LDL-cholesterol levels in the females were lower than those in the males at 20 to 49 years of age and higher in those 0 to 19 years of age and over 50 years. The drop in serum cholesterol levels in the teenage years reported in the US (16) and earlier Japan surveys (3, 5) was not observed in the present study.

The National Health and Nutrition Examination Surveys (NHANES) (3) provide periodic information on the health and nutritional status of the civilian non-institutionalized population of the United States. The mean serum total cholesterol levels in US adults from 20 through 74 years of age have consistently declined over time from 1991 (3, 17). This decline occurred across the entire distribution of serum cholesterol levels and in all age and sex groups. These findings suggest that public health programs designed to reduce serum cholesterol levels are proving successful in the United States (18). The observed downward trend in serum cholesterol levels has coincided with a continuing decline in coronary heart disease mortality (19).

In 1980 and 1989, the National Survey on Circulatory Disorders was conducted in Japan to determine the prevalence of risk factors for cardiovascular diseases in the same population as the annual Japanese Nutrition Survey (20). Between 1980 and 1989, age-adjusted serum cholesterol

levels increased from 186 to 201 mg/dl for men and from 189 to 202 mg/dl for women. The increase in serum cholesterol levels is contrary to the downward trends seen in mortality from coronary heart disease (21). Energy supply from dietary fat increased from 23.4% to 25.1%, but the expected change in serum cholesterol levels from Keys' equation (22) was 2.6 mg/dl, which could account for only 20% of the weighted mean of the difference for both sexes (13.5 mg/dl). Moreover, blood samples in the survey were not necessarily obtained under fasting conditions (20), making serum lipid levels higher than those in the present study. Regional heterogeneity of serum lipid concentration such as low serum cholesterol levels in the Tohoku area (northern Japan) might have produced the discrepancy between the National Survey on Circulatory Disorders (20) and the present study.

Tracking of national, regional, and occupational cholesterol levels and coronary disease rates may be instructive in Asia, particularly where urbanization has become associated with adoption of a sedentary lifestyle. In the earlier surveys in Japan, serum lipid determinations were carried out at various institutions (4-6), and thus, there is evidence of considerable interclinic variation. However, in the present survey, measurements of lipid level were performed at a single laboratory. The observed interclinic differences may be attributed in part to the distribution of lipid influencing factors such as genetic, dietary, and other environmental factors.

Attention to standardized national, international, migrant, and demonstration projects in addition to clinical trials of

lipid-lowering regimens will be particularly helpful in tracking and controlling the course of heart disease in the future. The present results will represent the standard lipid level data for the Japanese population, and subsequent 10-year surveys will clarify the trends of lipid levels and CHD rates in this country.

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