Dietary Intake and Serum Total Cholesterol Level: Their Relationship to Different Lifestyles in Several Japanese Populations

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SUMMARY Serum total cholesterol level and dietary intake were surveyed 1975–1977 in six Japanese population groups with different lifestyles, including groups in both rural (Akita and Kochi) and urban (Osaka) areas. Clerical workers in Osaka, who had the most westernized lifestyle of all the study groups, had the highest mean serum total cholesterol level (202 mg/dl for men ages 40–49 and 50–59 years), while farmers in Akita had the lowest mean serum total cholesterol level (163 mg/dl for men 40–49 years old, 159 mg/dl for men 50–59 years old, 165 mg/dl for men 60–69 years old). Nutrient intake data for men ages 40–59 years showed 23% of calories from fat for clerical workers in Osaka, the highest among the study groups, whereas farmers in Akita showed a low level of 14%. The ratio of dietary polyunsaturated to saturated fatty acids was over 1.1 for all groups. Cholesterol intake was 339–487 mg/day. Total carbohydrate as a percentage of calories was 53–65%; 75–80% of carbohydrate energy was ingested from cereals. Sugar accounted for less than 3.5% of total calories.

In the cross-group correlation analysis between dietary lipid intake and serum total cholesterol, a significant strong positive correlation was found between the dietary lipid factor (Φ) of Keys et al. and the mean serum total cholesterol level. A weak but significant correlation was observed between the dietary lipid factor and serum total cholesterol for individual inhabitants of Osaka.

FOR MORE THAN 10 years, our research group has been carrying out epidemiologic surveys on several Japanese populations with different lifestyles, including farmers in Akita, clerical and manual workers and other residents of Osaka, and farmers in Kochi.

Despite their homogeneous racial and cultural background, these groups have different mean cholesterol levels. In 1965, farmers in Akita showed a very low mean serum total cholesterol (155 mg/dl), whereas clerical workers and other inhabitants of Osaka showed much higher levels, 201 and 179 mg/dl, respectively. However, westernization of lifestyles has brought about a change of diet, notably an increase in fat intake, even among the farmers in Akita. Serum total cholesterol level has increased, and among the farmers in Akita has approached that of the Osaka residents. The mean serum total cholesterol level of clerical workers in Osaka has not increased in this 10-year period, and remains approximately 200 mg/dl.

In this paper, we present data on serum total cholesterol and nutrient intake in several Japanese popula-
tions with different lifestyles, and analyze the relationship between dietary intake and serum total cholesterol level.

Materials and Methods

We studied men from six population groups: three in Osaka, clerical workers, manual workers and residents engaged in various types of work; residents, mostly farmers, in Kochi prefecture, Shikoku; and two groups of residents, also mostly farmers, in Akita prefecture in northeastern Japan (Akita A and B). Akita A is a farming village located in a flat field, but Akita B is on a mountain side. Figure 1 shows the survey districts. The epidemiologic surveys on nutritional intake and cardiovascular conditions were carried out in the spring and autumn, 1975–1977.

We surveyed all adults ages 40–69 years who lived in Akita or Kochi, and all adults in a small region of Akita B. Osaka residents who were volunteers living in the area of the former survey were newly recruited from the viewpoint of primary prevention of cerebro- and cardiovascular diseases. Clerical and manual workers are employees of two companies in Osaka. All employees 40–59 years old were surveyed. Because of retirement, few persons in their sixties were available, so we did not include them. Numbers of men and response rates are shown in Table 1. Response rates ranged from 67% to 95% for persons ages 40–69 years.

Blood samples were drawn from an antecubital vein into a vacuum tube. Serum was separated within 30 minutes and frozen at −20°C until analysis. Serum cholesterol was determined within 1 month, by the Liebermann-Burchard method, using the Technicon Autoanalyzer II procedure. Cholesterol analysis was standardized by the Center for Disease Control (CDC) according to the Cooperative Cholesterol and Triglyceride Standardization Program sponsored by CDC and the World Health Organization. The coefficient of variation has consistently been less than 3%.

The nutrition survey was carried out on males 40–69 years old by the 24-hour recall method, using wax food models, measurement instruments, genuine foods, and a bowl and plate during the dietitian’s interview. Nutritional intakes were calculated by Standard Tables of Food Composition in Japan, except cholesterol and saturated and polyunsaturated fatty acids, which were calculated according to other published data. The data here are for males 40–59 years old, to correspond to the serum cholesterol data. The relationship between dietary lipid intake and serum cholesterol level was assessed using the dietary lipid factor (φ) of Keys et al. φ = (S − ½P) × 2430/E = 1.5 (1000C/E)², where S = saturated fatty acid intake (g/day), P = polyunsaturated fatty acid intake (g/day), E = energy intake (kcal/day), and C = cholesterol intake (mg/day).

Men for nutrition surveys were selected by random sampling after stratifying the examinees by age; numbers and selection ratios are shown in Table 2.

The F test was used for the analysis of variance to compare the differences of mean levels in the population groups; the H test of Kruskal-Wallis was used to compare differences in the distributions.

Results

Serum Total Cholesterol Level

The mean levels and standard deviations of serum total cholesterol are shown in Table 3. Little difference was found among age groups within each population, but the differences between population groups were significant: age 40–49 years, F = 29.12 (p < 0.001); age 50–59 years, F = 19.44 (p < 0.001); age 60–69 years, F = 10.20 (p < 0.001).

The mean level of serum total cholesterol for middle-aged clerical workers was 202 mg/dl, the highest level of all our study groups. In contrast, farmers in Akita B had mean levels of 159–165 mg/dl.

For ages 40–49 years, the difference of serum cholesterol was significant between clerical and manual workers (p < 0.05), between clerical workers and inhabitants in Osaka (p < 0.01), and between Akita A and Akita B (p < 0.01). The distribution curves also clearly show the difference (H = 318.18, p < 0.001) (fig. 2).

Table 4 shows proportions of men with high and low levels of serum cholesterol; the differences are significant, as can also be seen in the distribution curves (fig. 2). The proportion of men with serum cholesterol level of 260 mg/dl and above was considerably higher for clerical workers in Osaka (5.8%) than for any of the other groups (0.0–3.4%). The findings were similar for men with a level of 220 mg/dl and above. Corre-

![Figure 1. Survey districts of six Japanese population groups with different lifestyles: Akita A, Akita B, Osaka and Kochi.](http://circ.ahajournals.org/figure/1)
respondingly, the proportion of men with a serum total cholesterol level below 160 mg/dl was low for the three groups in Osaka and considerably higher for the inhabitants of Kochi, Akita A and Akita B.

Nutrient and Food Intake

Tables 5 and 6 show nutrient and food intake per capita per day, in grams and proportions, for men ages 40–59 years in each population group.

![Figure 2. Distribution of serum total cholesterol in six groups of men ages 40–59 years, 1975–1977.](http://circ.ahajournals.org/Downloaded from http://circ.ahajournals.org)
TABLE 4. Proportion of Men Ages 40–59 Years with High and Low Levels of Serum Total Cholesterol, 1975–1977

<table>
<thead>
<tr>
<th>Serum total cholesterol (mg/dl)</th>
<th>Clerical workers, Osaka (n = 313)</th>
<th>Manual workers, Osaka (n = 377)</th>
<th>Inhabitants, Osaka (n = 300)</th>
<th>Inhabitants, Kochi (n = 246)</th>
<th>Inhabitants, Akita A (n = 296)</th>
<th>Inhabitants, Akita B (n = 134)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 260</td>
<td>5.8%</td>
<td>3.4%</td>
<td>1.3%</td>
<td>0.4%</td>
<td>1.4%</td>
<td>0%</td>
</tr>
<tr>
<td>≥ 230</td>
<td>17.9%</td>
<td>13.5%</td>
<td>10.7%</td>
<td>4.9%</td>
<td>3.7%</td>
<td>1.5%</td>
</tr>
<tr>
<td>≥ 220</td>
<td>25.9%</td>
<td>18.6%</td>
<td>16.0%</td>
<td>7.3%</td>
<td>5.4%</td>
<td>4.5%</td>
</tr>
<tr>
<td>&lt; 180</td>
<td>25.6%</td>
<td>32.1%</td>
<td>39.3%</td>
<td>51.2%</td>
<td>56.4%</td>
<td>75.4%</td>
</tr>
<tr>
<td>&lt; 160</td>
<td>7.7%</td>
<td>12.7%</td>
<td>18.7%</td>
<td>28.5%</td>
<td>31.8%</td>
<td>53.0%</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Population group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clerical workers, Osaka (n = 114)</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>2038</td>
</tr>
<tr>
<td>Protein</td>
<td></td>
</tr>
<tr>
<td>Total (g)</td>
<td>72.9</td>
</tr>
<tr>
<td>Animal (g)</td>
<td>40.8</td>
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<tr>
<td>Animal (% of total protein)</td>
<td>56.0</td>
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<tr>
<td>Fat</td>
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</tr>
<tr>
<td>Total (g)</td>
<td>51.8</td>
</tr>
<tr>
<td>Animal (g)</td>
<td>28.4</td>
</tr>
<tr>
<td>Animal (% of total fat)</td>
<td>54.8</td>
</tr>
<tr>
<td>Polyunsaturated fatty acid (g)</td>
<td>14.0</td>
</tr>
<tr>
<td>Saturated fatty acid (g)</td>
<td>13.3</td>
</tr>
<tr>
<td>P/S ratio</td>
<td>1.1</td>
</tr>
<tr>
<td>Cholesterol (mg)</td>
<td>487</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>268.4</td>
</tr>
<tr>
<td>Protein (% of total calories)</td>
<td>14.3</td>
</tr>
<tr>
<td>Fat (% of total calories)</td>
<td>22.9</td>
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<tr>
<td>Polyunsaturated fatty acid (% of total calories)</td>
<td>6.2</td>
</tr>
<tr>
<td>Saturated fatty acid (% of total calories)</td>
<td>5.9</td>
</tr>
<tr>
<td>Carbohydrate (% of total calories)</td>
<td>52.7</td>
</tr>
<tr>
<td>Alcohol (% of total calories)</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Abbreviation: P/S = ratio of polyunsaturated to saturated fat.


<table>
<thead>
<tr>
<th>Population group</th>
<th>Clerical workers, Osaka (n = 114)</th>
<th>Manual workers, Osaka (n = 117)</th>
<th>Inhabitants, Osaka (n = 166)</th>
<th>Inhabitants, Kochi (n = 157)</th>
<th>Inhabitants, Akita A (n = 174)</th>
<th>Inhabitants, Akita B (n = 62)</th>
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</thead>
<tbody>
<tr>
<td>Milk (ml)</td>
<td>80.7</td>
<td>79.7</td>
<td>42.2</td>
<td>43.5</td>
<td>40.6</td>
<td>53.5</td>
</tr>
<tr>
<td>Dairy products+ (g)</td>
<td>10.7</td>
<td>2.1</td>
<td>3.2</td>
<td>4.7</td>
<td>1.9</td>
<td>3.6</td>
</tr>
<tr>
<td>Eggs (g)</td>
<td>37.2</td>
<td>39.8</td>
<td>33.3</td>
<td>21.5</td>
<td>26.1</td>
<td>23.5</td>
</tr>
<tr>
<td>Meat (g)</td>
<td>80.8</td>
<td>71.2</td>
<td>49.7</td>
<td>33.8</td>
<td>61.8</td>
<td>32.2</td>
</tr>
<tr>
<td>Fish and shellfish (g)</td>
<td>86.9</td>
<td>68.3</td>
<td>95.9</td>
<td>146.0</td>
<td>130.1</td>
<td>132.0</td>
</tr>
<tr>
<td>Miso+ (g)</td>
<td>8.4</td>
<td>8.6</td>
<td>4.9</td>
<td>11.5</td>
<td>45.1</td>
<td>60.5</td>
</tr>
<tr>
<td>Pickles (g)</td>
<td>19.7</td>
<td>42.7</td>
<td>41.1</td>
<td>46.2</td>
<td>45.9</td>
<td>72.6</td>
</tr>
</tbody>
</table>

All weights are for wet, uncooked foods.
+Cheese, ice cream, sour milk beverages, milk powder, condensed milk, and raw cream.
†Fermented soybean paste.
Energy Intake

There was a difference in energy intake among the groups (F = 11.47, p < 0.001). Men in Kochi, Akita A and B, mostly farmers, showed higher energy intake levels than manual workers and general inhabitants in Osaka. Clerical workers in Osaka had the lowest energy intake of all groups.

Protein Intake

Protein intake in grams was significantly different in the various groups (F = 10.20, p < 0.001). Men in Kochi, Akita A and B had a higher protein intake than manual workers and inhabitants in Osaka. However, protein intake as a percentage of calories was about the same in all groups (14%). Animal protein intake was the highest among the men in Kochi.

Fat Intake

In contrast to protein intake, the level of fat intake was highest for clerical workers in Osaka (52 g) and lowest for inhabitants of Kochi (31 g). Fat ranged from 23% of total calories for Osaka clerical workers to 11% in Kochi. Figures for animal fat intake paralleled those for total fat intake; clerical workers in Osaka showed the highest level (28 g) and inhabitants of Kochi the lowest (15 g) (F = 16.43, p < 0.001).

Intake of Polyunsaturated Fatty Acids, Saturated Fatty Acids, and Cholesterol

Intake of polyunsaturated fatty acids was different in the various groups (F = 12.17, p < 0.001). Clerical workers in Osaka had the highest intake (14 g), inhabitants of Kochi the lowest (10 g). Intake of polyunsaturated fatty acids constituted 3.5-6.2% of calories.

Intake of saturated fatty acids was similar to that of polyunsaturated fatty acids, but the intake of saturated fatty acids was significantly different between the groups (F = 25.33, p < 0.001). Clerical workers showed the highest intake (13 g), inhabitants of Kochi the lowest (7 g). As a percentage of calories, all groups showed levels under 6%; inhabitants of Kochi had the lowest level (2.5%).

In the groups with the higher levels of polyunsaturated fatty acids, intake of saturated fatty acids was also higher. In all groups, the intake of polyunsaturated fatty acids was higher than the intake of saturated fatty acids. Kochi and Akita had the highest polyunsaturated to saturated fat (P/S) ratios (1.4 and 1.6, respectively).

Cholesterol intake also varied significantly between the groups (F = 3.66, p < 0.01). The three groups in Osaka each had cholesterol intake levels greater than 400 mg. In contrast, the inhabitants of Kochi, Akita A and B all had levels less than 400 mg. Men in Akita B had the lowest level (339 mg).

Carbohydrate Intake

Carbohydrate intake varied significantly between the groups (F = 22.90, p < 0.001). Clerical workers in Osaka had the lowest level (268 g) and inhabitants of Kochi the highest (406 g). The Osaka general residents group had higher carbohydrate intake (339 g) than the clerical or manual workers in Osaka and about the same as residents of Akita A (334 g), who had the lowest level among the rural groups. Clerical workers in Osaka had the lowest percentage of calories from carbohydrate (53%, compared with 56-65% in all other groups).

Percentage of Calories from Cereals, Sugar and Alcohol

For each group, 75-80% of the carbohydrate intake was ingested from cereals. The percentage of total calories from cereals among the clerical workers, lowest of all groups, was 46%; the levels for Osaka inhabitants and the Kochi group were higher, 59% and 57%, respectively.

Sugar intake was estimated by totaling the refined sugar added to foods and beverages such as tea and coffee, plus the total carbohydrate intake from sources such as cakes, cookies and soft drinks, yielding a percentage of total calories from sugar somewhat higher than the true value. Nevertheless, it was still less than 3.5% in all groups.

Alcohol as percentage of total calories was highest among the Akita A and B men, 14% and 17%, respectively. Figures for other groups were 10-11% (table 5).

Intake by Food Groups

Table 6 shows the individual daily consumption of certain foods, separated according to food group. The consumption of milk and dairy products varied significantly among the groups (F = 4.42, p < 0.001). Dairy products were usually ingested in the form of milk; clerical workers in Osaka consumed more milk than the other groups (81 ml).

The three groups in Osaka ate significantly more eggs than the three rural groups (F = 3.34, p < 0.001), an average of almost one egg per day in contrast to half an egg per day. Clerical workers also had the highest level of meat consumption (81 g), in contrast to the low levels of 34 g in Kochi and 32 g in Akita B.

Consumption of fish and shellfish followed a different pattern: Inhabitants of rural areas had a higher level than those in Osaka. Inhabitants of Kochi consumed the most fish (146 g) and manual workers in Osaka the least (68 g). In clerical and manual workers in Osaka, the ratio of intake of meat to fish and shellfish was 1:1; among the other groups it was much less (1:2 or 1:4).

The intake of miso (fermented soybean paste), consumed in soup, was much higher in Akita A and B (45 g and 61 g) than among the other groups (under 12 g) (F = 8.78, p < 0.001). Men in these groups averaged four to five cups of miso soup per day, in contrast to the men in Kochi and the three groups in Osaka, who averaged one cup or less.

Men in Akita B consumed 73 g of pickles, the highest figure for all the groups; the lowest figure was 20 g, among clerical workers in Osaka, which was half the amount eaten by manual workers in Osaka.
Relationship Between Dietary Intake and Serum Cholesterol Level

Intergroup Correlations

Figure 3 shows the relationship between the mean level of the dietary lipid factor of Keys et al. and the mean level of serum total cholesterol for men ages 40–59 years. A strong positive correlation was found ($r = 0.901$, $p < 0.05$).

Interindividual Correlations

Correlation analysis of data from individuals was also carried out on the dietary lipid factor and serum total cholesterol for all populations combined and for each separately. For all six populations combined, this resulted in a significant positive correlation ($r = 0.229$, $p < 0.001$). For the correlation between the dietary lipid factor and the serum total cholesterol level for individuals within each group, the Osaka general residents group showed a weak positive correlation ($r = 0.164$, $p < 0.05$), but the other groups showed no significant correlation.

Discussion

Our group reported earlier on the differences in serum total cholesterol level between population groups with different lifestyles. This paper is a 10-year follow-up study.

For serum total cholesterol level, past and present results can be compared. The Osaka clerical workers, who had the highest serum total cholesterol level in this study, showed no significant difference from the previous study (201 mg/dl vs 202 mg/dl). But for the manual workers and general inhabitants in Osaka, the recent mean level was higher (195 vs 186 mg/dl and 188 vs 179, respectively). The difference in both these groups was 9 mg/dl (5%). Men in Akita A and B also showed an increase: 173 vs 155 mg/dl (12%) and 163 vs 155 (5%), respectively. Thus, the group with the highest serum total cholesterol level in the previous study showed no significant difference, but the groups with earlier levels below 200 mg/dl showed an increase of 5% or more. Isomura et al. reported similar findings, i.e., an increase of 4% over the last 8 years among the residents of a mountain village.

Based on available U.S. data also standardized by the CDC, the means for the Japanese groups are significantly lower, by 20–60 mg/dl, than the recent 211–226 mg/dl serum total cholesterol level of white, middle-aged American males. Even though this recent level is lower for Americans than mean levels a decade or two ago, the Japanese levels are still much lower.

The data presented here can be generalized for all Japanese people who have shown a change in lifestyle, particularly in dietary intake. However, health statistics in Japan do not show any increase in the mortality rate for ischemic heart disease; rather, the age-adjusted mortality decreased during 1968–1978. The mortality rate for cerebral stroke, the leading cause of death in Japan, has also started to decline. In the follow-up study of men in Akita A and B, the incidence of stroke has declined to five persons per thousand per year, almost the former high figure. These and other findings led us to hypothesize that in Japan, in contrast to America, low rather than high levels of serum total cholesterol represent a stroke risk factor, especially for cerebral hemorrhage. Kagan et al. reported that serum cholesterol level was negatively associated with risk of intracranial hemorrhage for Japanese-Americans in Hawaii.

Japanese company executives and physicians, who had higher mean levels of serum total cholesterol (210–220 mg/dl), exhibited a higher incidence rate of ischemic heart disease than other groups studied. There remains a need to alert people with high cholesterol levels to the dangers of this condition and to promote primary prevention of ischemic heart disease.

Recent westernization of lifestyles in Japan brought with it an increase in fat intake. The national nutrition survey, involving people ranging from infants to the aged, showed an increase in the percentage of calories from fat — from 14.8% in 1965 to 21.4% in 1975. This finding indicates the overall national trend, but does not necessarily hold true for men ages 40–59 years.

The present data may be compared with the results of our nutrition survey conducted 5–7 years ago, using the measurement method, for men averaging 50 years of age. The percentage of calories from protein in the past survey was 13–15%, the same as the present figure. The percentage of calories from fat, however, was higher by 2–3% in the latest survey: i.e., for manual workers in Osaka, 19.3% of calories compared with 16.5% in the earlier survey, and for Akita A, 14.4% and 12.2%. Ozawa also surveyed trends in

![Figure 3. Correlation between mean level of dietary lipid factor and mean level of serum total cholesterol for men ages 40–59 years in each population. The dietary factor ($\phi$) was calculated by the equation of Keys et al.](http://circ.ahajournals.org/Download/524/1/524.jpg)
dietary intake of farmers in Akita and Osaka, and compared 1965 statistics with data from 1935. He reported that the farmers in Akita showed an increase of 50–100% in meat consumption over this 30-year period, and also continued high intake of rice and salty foods, such as pickles and miso.

The data for fat intake in the present study can be compared with similar figures for America and England. In those countries, the percentage of calories from fat is 40% and the P/S ratio 0.2–0.5; the cholesterol intake of Americans is 500–600 mg/day. In contrast, our study showed that even among clerical workers in Osaka, who had the most westernized diet of all our study groups, fat was 23% of calories, the P/S ratio 1.1 and cholesterol intake 490 mg.

In the Ni-Hon-San Study, Japanese in Japan had a lower level of fat intake (17%) than did Japanese-Americans (35–40%). Also, the cholesterol intake level for Japanese in Japan was 450–500 mg.

Another Japanese characteristic shown in our study is the level and type of carbohydrate ingested — 53–65% of calories, 75–80% derived from cereals; refined sugar constituted at most 3.5% of calories in our study groups. In contrast, studies in Europe and America show a lower proportion of total calories from carbohydrates (46%), but a higher proportion from sugar (23%).

Protein level was similar for Japanese, Americans, and English, about 14% of calories, although intake of animal protein was higher for Americans and English than for Japanese.

We also found a positive correlation between the dietary lipid factor of Keys et al. and serum total cholesterol level not only across the six population groups, but also in the analysis for individuals.

Many animal experiments and controlled clinical studies indicate the relationship between dietary fat intake, especially polyunsaturated and saturated fatty acids and cholesterol, and serum cholesterol level. Epidemiologic surveys show that immigration, with its concomitant dietary changes, has a drastic impact on serum cholesterol. Also, vegetarians and people with primitive lifestyles have a low serum cholesterol level. In international surveys, such as the Seven Countries Study, Keys et al. found a positive correlation across population groups between the percentage of calories from saturated fat and serum total cholesterol and between the combined lipid score for saturated and polyunsaturated fat and serum total cholesterol. (Dietary cholesterol was not measured.) For individuals, the Ni-Hon-San Study also showed a positive correlation between serum total cholesterol and the intake of saturated fatty acid, animal protein and cholesterol for Japanese in Japan, Hawaii and California. The Western Electric Study showed a positive association between the dietary lipid factor and serum cholesterol concentration for individuals. However, the Framingham and the Tecumseh studies failed to disclose any relationship between serum total cholesterol and dietary factors.

Keys pointed out the difficulty of attempting to characterize individuals within a culturally homogenous population when the intraindividual variability is large compared with the interindividual variability. Jacobs et al. reported that the zero correlations found by various cross-sectional observational studies actually do not negate the evidence that diet affects serum cholesterol. Liu et al. also reported that the sample must be followed long enough to allow reliable estimation of mean dietary intake and other factors, i.e., to overcome the problems of intraindividual variation. Also, factitious inverse correlations may even result between dietary cholesterol–saturated fat and serum cholesterol when sizable numbers of individuals in a population reduce their intake of these lipids when they learn they have a high serum cholesterol level. The Western Electric Study affords an example of an early unbiased dietary survey to characterize each man in detail in regard to his eating habits; a significant correlation between diet score and serum cholesterol was demonstrated in the analysis of individuals.

In our study, it is perhaps due to difficulties such as the foregoing that only a weak, although significant, correlation between dietary lipid score and serum total cholesterol was recorded for individuals, and in the Japanese populations reported on here, overall and for the inhabitants of Osaka. In contrast, with large differences between groups in both dietary intake and serum total cholesterol and ability to characterize groups accurately using a 24-hour dietary recall, a high-order relationship for groups was found between the dietary lipid score and serum total cholesterol level. Therefore, we conclude that dietary lipid intake was a major determinant of the difference in serum cholesterol levels in Japanese population groups with different lifestyles.

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