Nutritional Characteristics of Middle-Aged Japanese Vegetarians

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Aim: Despite the possible overall health benefits of a vegetarian diet, research about the nutritional characteristics of Japanese vegetarians is small. Our objective was to investigate the nutritional characteristics of Japanese vegetarians compared with Japanese non-vegetarians.

Methods: The dietary intake, anthropometric and biochemical status of 75 middle-aged Japanese vegetarians (JV, 20 men and 55 women) were compared with those of 50 age- and sex- matched middle-aged Japanese non-vegetarians (JNV, 32 men and 18 women) in a cross-sectional study.

Results: JV men had significantly higher calcium, iron (p<0.001) and dietary fiber (p<0.01), and significantly lower vitamin B12, cholesterol, animal fat intake and percentage of energy as animal protein (p<0.01) than JNV men. In addition, JV men had significantly lower body mass index (p<0.05), diastolic blood pressure (p<0.001), systolic blood pressure (p<0.01), aspartate transaminase, alanine transaminase (p<0.05) and serum triacylglyceride (p<0.001) than JNV men. JV women had significantly lower systolic pressure and serum triacylglyceride (p<0.05) than JNV women.

Conclusions: JV men and women had better nutritional characteristics than JNV men and women from the standpoint of lifestyle-related diseases.


Key words: Dietary intake, Body mass index, Blood pressure, Triacylglyceride
menu at a SDA school or in a hospital setting, and did not calculate from actual intake, i.e., what individual vegetarians actually eat in a day. There are a few small studies of 10 healthy 30-69 year-old lacto-ovo vegetarians; however, this study calculated the dietary intake from a food frequency questionnaire not from a food record.

Therefore, in the present study we investigated the dietary intake from a food record, biochemical measurement and anthropometry of middle-aged general Japanese vegetarians compared with those of middle-aged general Japanese non-vegetarians. The aim of the present study is to clarify the advantages and disadvantages of being a Japanese vegetarian.

Subjects and Methods

Subjects

Seventy-five healthy middle-aged Japanese vegetarians (JV, 20 men and 55 women) who worked at V hospital (Tokyo, Japan), which usually offers vegetarian meals and recommends a vegetarian diet for employees and patients, and 50 age- and sex-matched healthy middle-aged Japanese non-vegetarians (JNV, 32 men and 18 women) who worked at O machinery manufacturing company (Tokyo, Japan) were recruited through advertising inside the hospital and company. The number of food records collected from JNV women was so few their dietary intake had to be dismissed in the present study. Thus, we compared only men from their dietary intake. Twenty-seven (9 men and 18 women) of 75 Japanese vegetarians reported themselves as lacto-ovo vegetarians. The rest (11 men and 37 women) were semi-vegetarians who occasionally ate meat and seafood. There were no pure vegetarians, who entirely avoid eating animal products, in this study. Non-vegetarians represented the general population and were defined as people eating food of both plant and animal origin. Informed consent was obtained from each subject before the study began. The procedures were in accord with the Helsinki Declaration of 1975, as revised in 1983.

Dietary Assessment

Subjects were asked to keep a 3-day food record with the name of the dish or food items and beverages consumed during April to June. Portion sizes of foods were described in terms of household measures, sizes of the plate, cup and bowl and standard weights of food items. After submitting the food records, each subject was interviewed by trained dietitians within 1 week to confirm the amounts and kinds of food eaten. The reported dietary intake was calculated by the dietary analysis program Eiyo-kun for Windows (version 4.0, 2005; Kenpaku-sha, Tokyo, Japan). The average one-day intake over 3 days was used.

Biochemical Measurements

Serum total cholesterol (TC), aspartate transaminase (AST), alanine transaminase (ALT) and serum triacylglyceride (TG) were obtained from an medical examination at each facility during March to July.

Anthropometric Indexes

Body weight, height and blood pressure of subjects were obtained from the medical examination at the each facility during March to July. Body mass index (BMI) was calculated as weight divided by squared height (kg/m²). Blood pressure was measured after 10-15 minutes of rest with a manual mercury manometer.

Statistical Analyses

Data are expressed as the mean ± standard deviation (SD). Differences between vegetarian and non-vegetarian groups were tested by unpaired t-test. A two-tailed p value of <0.05 was considered significant. All statistical analyses were performed with Dr. SPSS for Windows (version 10.0; SPSS, Inc. U.S.A.).

Results

Dietary Intakes

Table 1 shows that JV men had significantly higher mean intakes of calcium, magnesium, iron, copper, manganese, vitamin E, vitamin K, vitamin B₁, folate, dietary fiber, salt and vegetable fat, and significantly lower mean intakes of vitamin B₁₂, cholesterol, animal fat, including both meat and seafood fat, than JNV men. In addition, JV men had a significantly higher ratio of polyunsaturated fatty acids to saturated fatty acids (P:S) and ratio of n-6 fatty acids to n-3 fatty acids (n-6:n-3) and significantly lower % of energy as animal protein than JNV men.

The nutrients whose mean intake was below the mean intake of the National Health and Nutrition Survey in Japan, 2004 (JNHNS) were energy, protein, fat, zinc, vitamin D, vitamin B₂, niacin, vitamin B₆, vitamin B₁₂, cholesterol, salt and % of energy as animal protein in JV men, and all nutrients except zinc, vitamin A, vitamin B₁₂, folate, panthotenic acid and % of energy as animal protein in JNV men.

The % of subjects whose dietary intakes met their own individual requirements based on the Dietary Reference Intakes for Japanese, 2005 (JDR, Table 1) is shown in Fig. 1A, B and C. The nutrients for which the percentage of subjects meeting the JDRI was below...
Table 1. Dietary intakes of vegetarian and non-vegetarian men*, the National Health and Nutrition Survey in Japan, 2004 (JNHNS) and Dietary Reference Intakes for Japanese, 2005 (JDRI) (Mean ± SD)

|                        | Vegetarian men (n=20) | Non-vegetarian men (n=32) | JNHNS men | Vegetarian women (n=50) | JDRI women | JDRI 
|------------------------|-----------------------|---------------------------|-----------|-------------------------|------------|-------
| Age (y)                | 45.2 ± 8.3            | 44.2 ± 5.2                | 30-49     | 45.9 ± 8.8              | 30-49      | 30-49 | JDRI
| Energy and macronutrients |                       |                           |           |                         |            |       |
| Energy (kcal)          | 1,983 ± 558           | 1,843 ± 439               | 2,171     | 1,675 ± 515             | 2,650      | 2,000 | EER
| Protein (g)            | 65.4 ± 20.5           | 69.5 ± 16.7               | 77.3      | 61.3 ± 23.2             | 50         | 40    | EAR
| Fat (g)                | 54.9 ± 23.0           | 51.4 ± 20.1               | 61.3      | 52.5 ± 24.0             | 20-25%     | 20-25% | DG
| Carbohydrate (g)       | 305.4 ± 98.2          | 265.7 ± 71.4              | 292.9     | 244.8 ± 86.6            | 50-70%     | 50-70% | DG

Minerals

|                       |                      |                           |           |                         |            |       |
| Potassium (mg)        | 2,782 ± 1,493        | 2,061 ± 861               | 2,226     | 2,719 ± 1,019           | 2,000      | 1,600 | AI
| Calcium (mg)          | 630 ± 268            | 381 ± 217***              | 462       | 555 ± 233               | 600        | 600   | DG
| Magnesium (mg)        | 381 ± 160            | 217 ± 68***               | 254       | 306 ± 110               | 310        | 240   | EAR
| Phosphorus (mg)       | 1,076 ± 378          | 971 ± 257                 | 1,049     | 992 ± 360               | 1,050      | 900   | AI
| Iron (mg)             | 10.9 ± 4.0           | 6.3 ± 2.6***              | 7.8       | 9.5 ± 3.6               | 6.5        | 9     | EAR
| Zinc (mg)             | 8.1 ± 3.0            | 9.2 ± 3.8                 | 9.2       | 7.0 ± 2.5               | 8          | 6     | EAR
| Copper (mg)           | 1.50 ± 0.64          | 1.21 ± 0.38*              | 1.25      | 1.20 ± 0.41             | 0.6        | 0.6   | EER
| Manganese (mg)        | 4.19 ± 1.88          | 2.54 ± 0.71***            | 1.25      | 3.00 ± 1.10             | 4          | 3.5   | AI

Vitamins

|                       |                      |                           |           |                         |            |       |
| Vitamin A (μgRE)*     | 966 ± 667            | 877 ± 858                 | 823       | 876 ± 500               | 550        | 450   | EAR
| Vitamin D (μg)        | 3.6 ± 8.2            | 6.3 ± 7.1                 | 7.7       | 5 ± 11                  | 5          | 5     | AI
| Vitamin E (mg)f       | 11.0 ± 4.9           | 8.0 ± 3.1*                | 8.8       | 9.1 ± 4.2               | 8          | 8     | AI
| Vitamin K (μg)        | 355 ± 289            | 204 ± 187*                | 228       | 296 ± 219               | 75         | 65    | AI
| Vitamin B1 (mg)       | 1.27 ± 0.74          | 0.88 ± 0.37*              | 1.12      | 1.04 ± 0.39             | 1.2        | 0.9   | EAR
| Vitamin B2 (mg)       | 1.25 ± 0.90          | 0.96 ± 0.42               | 1.36      | 1.11 ± 0.44             | 1.3        | 1.0   | EAR
| Niacin (mg) 8         | 13.4 ± 6.6           | 14.6 ± 6.5                | 17.3      | 12.5 ± 6.8              | 13         | 10    | EER
| Vitamin B6 (mg)       | 1.18 ± 0.54          | 1.09 ± 0.51               | 1.43      | 1.17 ± 0.46             | 1.1        | 1.0   | EER
| Vitamin B12 (μg)      | 1.9 ± 2.3            | 11.3 ± 11.8***            | 7.1       | 3.7 ± 7.9               | 2.0        | 2.0   | EAR
| Folate (μg)           | 455 ± 297            | 276 ± 151*                | 275       | 365 ± 151               | 200        | 200   | EER
| Panthotenic acid (mg) | 5.70 ± 2.21          | 5.68 ± 2.24               | 5.61      | 5.56 ± 1.78             | 6          | 5     | AI
| Vitamin C (mg)        | 105 ± 61             | 87 ± 58                   | 89        | 119 ± 65                | 85         | 85    | EAR

50% were energy, fat, zinc, vitamin A, vitamin D, vitamin B3, vitamin B12, vitamin C, dietary fiber, salt, saturated fatty acids (SFA) and n-3 fatty acids (n-3) in JV men (Fig.1A), and energy, fat, calcium, magnesium, vitamin D, vitamin E, dietary fiber, salt, SFA and n-3 in JV women (Fig. 1B), and energy, fat, calcium, magnesium, phosphorus, iron, manganese, vitamin A, vitamin D, vitamin E, vitamin B1, vitamin B2, vitamin B6, panthotenic acids, vitamin C, dietary fiber, SFA and n-3 in JNV men (Fig. 1C).

Biochemical Measurements and Anthropometric Indexes

JV men had significantly lower BMI and blood pressure than JNV men. In addition, JV men had lower mean values of BMI and both diastolic and systolic blood pressure than those in JNHNS (Table 2). JV men had significantly lower AST, ALT and TG than JNV men. JV men also had lower mean values of TC and TG than those in JNHNS (Table 2). JV women had significantly lower systolic pressure (Table 2) and TG (Table 2) than JNV women.

Discussion

Cholesterol, animal fat intake and percentage of energy as animal protein in JV men were significantly lower than in JNV men. These results show that JV
men had better nutritional characteristics in the prevention of lifestyle-related diseases than JNV men. However, vitamin B12 intake of JV men was significantly lower than that of JNV men. The percentage of JV who met their own individual requirement of vitamin B12 intake based on JDRI was 35% for men and 50% for women. Since the main foods supplying vitamin B12 are of animal origin\textsuperscript{1,32,33}, vegetarians, especially those who avoid all animal foods (pure vegetarians) are at a higher risk for vitamin B12 deficiency. Low intake of vitamin B12 is associated with increased blood homocysteine, which is a risk factor for cardiovascular diseases\textsuperscript{34,35}. Vegetarians may need to take vitamin B12 fortified foods or/and supplements.

Vitamin D and n-3 fatty acid were at risk for deficiency in JV since 1) the % of subjects who met the JDRI of vitamin D and n-3 fatty acids was below 50% in both JV men and women, 2) the mean vita-
Fig. 1. Percentage of subjects whose dietary intakes met their own requirements based on the Dietary Reference Intakes for Japanese\textsuperscript{a,b}.

A: Vegetarian men, B: Vegetarian women, C: Non-vegetarian men.

\textsuperscript{a}JDRI= Dietary Reference Intakes for Japanese, 2005. The JDRI of 30-49-year-old men, activity level II (shown in Table 1) is taken as 100% for A and C, and the JDRI of 30-49-year-old women, activity level II (reference 31) is taken as 100% for B.

\textsuperscript{b}SFA=saturated fatty acids, n-6=n-6 fatty acids, n-3=n-3 fatty acids.
Table 2. Anthropometric indexes and biochemical measurements of vegetarians and non-vegetarians and the National Health and Nutrition Survey in Japan, 2004 (JNHNS) (Mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropometric indexes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>45.2 ± 8.3</td>
<td>45.9 ± 8.9</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>58.1 ± 7.2</td>
<td>66.3 ± 7.1***</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>164.5 ± 6.9</td>
<td>169.2 ± 5.2**</td>
</tr>
<tr>
<td>Body mass index (kg/cm²)</td>
<td>21.4 ± 2.1</td>
<td>23.2 ± 2.4*</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>71.7 ± 9.1</td>
<td>83.3 ± 11.4***</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>118.3 ± 13.2</td>
<td>129.4 ± 14.7**</td>
</tr>
<tr>
<td>Biochemical measurements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC (mg/dL)</td>
<td>189.4 ± 47.2</td>
<td>213.0 ± 34.3</td>
</tr>
<tr>
<td>AST (IU/L)</td>
<td>16.2 ± 4.9</td>
<td>22.3 ± 9.7*</td>
</tr>
<tr>
<td>ALT (IU/L)</td>
<td>14.3 ± 9.0</td>
<td>22.4 ± 12.7*</td>
</tr>
<tr>
<td>TG (mg/dL)</td>
<td>119.6 ± 63.3</td>
<td>228.8 ± 93.2***</td>
</tr>
</tbody>
</table>

a All values of vegetarians and non-vegetarians are average 1 day intake of the 3 days recorded ± standard deviation (SD).
Unpaired Student’s t-tests were used for statistical comparisons between same sex vegetarians and non-vegetarians. Significant difference: *p < 0.05, **p < 0.01, ***p < 0.001.

b Mean value of 30-49-year-old men and women in the National Health and Nutrition Survey in Japan, 2004 (JNHNS) (reference 30).
c TC: total cholesterol.
d AST: aspartate transaminase.
e ALT: alanine transaminase.
f TG: triacylglyceride.

In the present study, JV men had a tendency toward lower TC (p = 0.065) and significantly lower cholesterol intake and a higher ratio of polyunsaturated fatty acids to saturated fatty acids (P:S ratio), and intake of dietary fiber and beans (not shown in the table; JV 177 ± 137, JNV 41 ± 62, p < 0.01) than JNV men. Studies in not only the western world but also China and Africa showed that vegetarians had lower serum total cholesterol values than non-vegetarians as well as studies in Japan.

A study showed that serum total cholesterol values were increased by dietary cholesterol, and decreased by unsaturated fatty acids, soluble dietary fiber, phytosterol, tococholenol and nuts, soybeans as food that contain abundant unsaturated fatty acids. The P:S ratio, and intake of cholesterol, dietary fiber and beans may relate to the lower total cholesterol in JV men.

Serum triacylglyceride values in JV men were significantly lower than in JNV men. JV men had a significantly lower ratio of starchy food intake (total intake of cereals and starchy vegetables to total food intake, not shown in the table; JV 38.7 ± 10.0, JNV 48.4 ±
11.1, \( p < 0.01 \) and significantly higher dietary fiber intake than JNV men. Some studies showed that low carbohydrate intake\(^{39, 60}\) and a low glycemic index diet (40% carbohydrates, 35% fat)\(^{41}\) decreased serum triacylglyceride values. A lower ratio of starchy food intake to total food intake and significantly higher dietary fiber intake may relate to significantly lower serum triacylglyceride values in JV men in the present study.

In conclusion, these results showed that JV men had better anthropometric and biochemical measurements than JNV men; however, they also indicated that JV are at risk for vitamin D, vitamin B\(_2\) and n-3 fatty acid deficiency, and may be at risk for calcium, vitamin A and vitamin B\(_2\) deficiency.

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**References**


3) Fraser GE: Associations between diet and cancer, ischemic heart disease, and all-cause mortality in non-Hispanic white California Seventh-day Adventists. Am J Clin Nutr, 1999; 70(suppl):532S-538S


10) Marmot MG and Smith GD: Why are the Japanese living longer? BMJ, 1989; 299:1547-1551


25) Yurino F and Umezawa M: Nutrient Intakes on Lacto-ovo-vegetarian Diet in Junior High School Students [in Japanese]. Bulletin of Koshien University, A, Faculty of...
34) SatoY, Kaji M, Kondo I, YoshidaH, Satoh K, and Metoki N: Hyperhomocysteinemia in Japanese patients with con-