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Association between Vegetable Intake and Dietary Quality in Japanese Adults: A Secondary Analysis from the National Health and Nutrition Survey, 2003

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Summary Objective: To investigate dietary quality among Japanese adults with a high vegetable diet, to consider dietary recommendation for vegetable intake. Design and setting: In the cross-sectional study of the National Health and Nutrition Survey 2003, we conducted the secondary analyses. The food-weighing method in one-day assessed the dietary intake. From 11,630 subjects, 2,305 men and 2,312 non-pregnant/lactating women, aged 20–69 y, and with an energy intake between 1,500 and 3,712 kcal were selected. Associations between vegetable, nutrient-density, and food intake were analyzed according to tertile cutoff: low vegetable diet (LVD), medium vegetable diet (MVD), or high vegetable diet (HVD). Differences across subgroups were tested after age adjustment. Results: Mean vegetable intakes were 309 g for men and 318 g for women. Only 35% of Japanese met the vegetable intake (VI) recommendation of ≧350 g/d. VI had a positive association with age. Men 20–29 y-old and women 30–39 y-old were the subjects with the lowest VI. HVD subjects had higher intake for most food groups, whereas wheat in men; and wheat, sweets, and alcohol in women were negatively associated with VI. Main sources of energy for men and women with HVD were rice, wheat, and meat. HVD also had higher micronutrient-density. Conclusion: These analyses demonstrated the beneficial effects of HVD on dietary quality in the population studied. We concluded recommendations for adequate vegetable intake are expected to improve diet quality among Japanese adults, especially for the group aged 20–39.

Key Words Japanese, vegetable, dietary quality, recommendations

Unbalanced diet has been known for many years to play a key role as a risk factor for chronic diseases. What is apparent at the global level is that great changes have extended in the world since the second half of the 20th century, inducing major modifications in diet, first in industrial regions and more recently in developing countries. Traditional, largely plant origin food has been swiftly replaced by a high energy-dense diet with a substantial content of animal-based foods, fat, and sugar. According to the World Health Report 2002 (*1*), low fruit and vegetable intakes were estimated to cause about 31% of ischemic heart disease and 11% of strokes worldwide. Overall, it is estimated that up to 2.7 million lives could potentially be saved each year if fruit and vegetable consumption, which are sources of minerals and vitamins (*2*), were sufficiently increased (*3*). Vegetable consumption was associated with higher bone mineral density in the elderly (*4*, *5*), reduction of cardiovascular disease risks (*6*, *7*), cancer prevention and a decrease in all mortality (*1*, *3*).

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According to WHO, life expectancy in Japan is the highest in the world (*8*). One of the most important factors for increasing longevity could be their proper food habits with plant origin foods and fish. Furthermore, the "Japanese diet" is characterized by a large intake of diverse fresh vegetables, fish, and soy, and a low intake of red meat, in addition to the wide variety of foods in each meal (*9*, *10*); thus, it may be related with the low prevalence of cardiovascular diseases (CVD), and obesity compared to countries such as the US (*11–16*).

In the year 2000, the Ministry of Health and Welfare Japan started "Health Japan 21," an initiative to promote health status in the 21st century (*17*). Focus areas that the Ministry had considered were the following: nutrition, physical exercise, smoking, alcohol, cardiovascular diseases, and cancer. The Ministry of Health set the levels of target values for those items to be achieved to the year 2010. One of the nutritional goals for Japanese adults is to increase the average of vegetable and green-yellow vegetable intakes reaching 350 and 120 g a day, respectively. However, recent data showed that vegetable intakes were below the recommendations, especially in the group aged 20 to 39 y. To

improve such undesirable dietary conditions in Japanese, the Food Guide Study Group (a tentative name) developed the Food Guide Spinning Top to eat a balanced diet by choosing large enough servings of vegetables dishes, among other measures (*18*).

Because people eat a mix of foods, this study focuses on the dietary patterns of Japanese who had a high vegetable diet using the National Health and Nutrition Survey 2003 data (*19*). We therefore described and analyzed dietary patterns in detail to explain the complex relationships between diet and health and to design educational programs in the future for promoting vegetable consumption among Japanese adults with considerations of dietary recommendation for vegetable intake.

METHODS

NHNS data. The National Health and Nutrition Survey 2003 (NHNS 2003) is a cross-sectional survey on a nationally representative sample of the non-institutionalized population of Japan (*19*). It includes (a) physical examination (anthropometry measurements, blood pressure, blood test, a questionnaire on medication, smoking status, alcohol intake, exercise, and number of steps measured by a pedometer), (b) dietary survey that involves weighing the amount of food consumed over one day by a household and individual household members, and (c) questionnaire on health-related behaviors, habits, and knowledge factors (*20*).

Subjects. We performed a secondary analysis of the dataset from NHNS 2003 with the permission of the Japanese government authority. From 11,630 subjects, 2,305 men and 2,312 non-pregnant/lactating women were selected with the following inclusion criteria: age between 20 and 69 y, and energy intakes between 1,500 and 3,712 kcal. The criteria for energy were determined between those values to exclude confounding data for the analyses.

Food classifications data. All food recorded in the survey was grouped into 32 food groups: rice, wheat, other cereals, potatoes, other starches, sugar, soy beans, other beans, nuts and seeds, green-yellow vegetables, other vegetables, pickles made from vegetables, vegetable juice, fruit, fruit juice, mushrooms, seaweed (algae), fish and shellfish, processed fish, meat, poultry, organs, eggs, dairy products, oil, sweets, alcoholic beverages, beverages, condiments, spices, and dietary supplements. Macronutrients, micronutrients and fiber were calculated per 1,000 kcal of energy consumed (*21*). Energy density values were calculated based on food intake, excluding all beverages such as milk, juice, and tea.

Statistical analysis. All analyses were performed using the Statistical Package for Social Science (version 11; SPSS Inc, Chicago, IL) (*22*). All data were expressed as mean and standard error (SE). The participants were categorized as having a low vegetable diet (LVD), medium vegetable diet (MVD), or high vegetable diet (HVD) using sex-specific tertile cutoff points. We determined age-adjusted means for dietary variables across tertile of vegetable intake using a general linear model (GLM). Age, energy intake (kcal/d), energy density excluding beverages such as milk and juice (kcal/g), nutrient density (per 1,000 kcal) and groups of food were included as covariance for continuous variables. p values <0.05 were considered significant.

RESULTS

Food intake

From a total of 11,630 Japanese, we selected 4,617 subjects for the analyses (2,305 men and 2,312 women). Mean vegetable intake was 309.2 g for men and 317.7 g for women. For men, proportions of green-yellow vegetables (G-YV), other vegetables (OV), vegetable juice, and pickles were 33% (102.0 g), 59% (181.0 g), 2% (5.0 g), and 7% (21.2 g), respectively. For women, G-YV, OV, vegetable juice, and pickles contributed 35% (109.9 g), 57% (182.1 g), 2% (6.0 g) and 6% (19.7 g), respectively (Table 1). Only 35% of Japanese met the vegetable intake recommendation of ≧350 g per day on the selected survey day. Total vegetable intakes were associated with age, and subjects above the recommendation were significantly older than those below the recommendation (50.2 vs. 46.0 y-old for men and 52.5 vs. 46.9 y-old for women) (Table 2). Men and women between 20 and 39 y old were the subjects with the lowest vegetable intake (Table 1).

Based on the tertile cutoff points, the low vegetable diet (LVD), medium vegetable diet (MVD), and high vegetable diet (HVD) were defined as follows: for men, vegetable intake less than 209.7 g, from 209.7 to 361.1 g and more than 361.1 g, respectively, and for women, less than 224.0 g, from 224.0 to 360.2 g, and more than 360.2 g, of vegetable, respectively.

Table 3 shows the average intake of each food group. Comparing men with HVD and those with LVD, the former ate a larger amount of rice (486.1 vs. 436.1 g), potatoes (72.6 vs. 47.4 g), soy beans (80.5 vs. 59.8 g), fruit (105.0 vs. 64.7 g), mushrooms (24.1 vs. 12.3 g), algae (24.1 vs. 12.9 g), processed fish (42.6 vs. 33.1 g), meat (83.1 vs. 58.7 g), and dairy products (98.0 vs. 79.0 g). In contrast, wheat was 30% lower in HVD than in LVD (97.9 vs. 127.9 g). Alcohol intake did not show a statistically significant trend among the three groups, but when the mean intakes were compared between HVD and LVD, the association with vegetables was negative ($p<0.05$) (224.5 vs. 257.7 g). Main sources of energy for the LVD diet were rice (34%), wheat (12%), alcoholic beverages (7%), meat (7%), condiments (5%), fish and shellfish (4%), soy beans (3%), sweets (3%), dairy products (3%), and eggs (3%). For HVD, major sources were rice (33%), wheat (8%), meat (8%), condiments (6%), alcoholic beverages (5%), fish and shellfish (4%), soy beans (4%), dairy products (3%), processed fish (3%), and eggs (3%).

Comparing women with HVD and those with LVD, those with HVD had a 32% higher intake of potatoes (74.6 vs. 50.9 g), 18% of sugar (9.6 vs. 7.9 g), 19% of soy beans (71.9 vs. 58.4 g), 26% of fruit (151.5 vs. 112.8 g), 45% of mushrooms (22.2 vs. 12.3 g), 37% of

Table 1. Vegetable consumption in Japanese adults according to age groups.

	Total Japanese		20–39 y-old		40–59 y-old		60–69 y-old	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Male *n*	2,305		731		1,002		572	
Total vegetables (g)	309.2	3.7	276.7	6.5	302.7	5.5	362.0	7.3
G-Y vegetables (g)	102.0	1.9	90.9	3.3	96.6	2.8	125.7	3.7
Other vegetables (g)	181.0	2.6	166.2	4.7	177.6	4.0	205.7	5.3
Vegetable juice (g)	5.0	0.8	5.8	1.4	5.3	1.2	3.2	1.5
Pickles (g)	21.2	0.7	13.7	1.3	23.2	1.1	27.3	1.4
Female *n*	2,312		623		1,067		622	
Total vegetables (g)	317.7	3.6	267.0	6.8	322.0	5.2	361.1	6.8
G-Y vegetables (g)	109.9	2.0	90.0	3.8	106.3	2.9	136.0	3.8
Other vegetables (g)	182.1	2.6	159.7	4.9	187.8	3.8	194.8	4.9
Vegetable juice (g)	6.0	0.8	6.2	1.5	7.5	1.2	3.2	1.5
Pickles (g)	19.7	0.7	11.2	1.3	20.4	1.0	27.1	1.3

Means with SE.
G-Y vegetables: green and yellow vegetables.

Table 2. Vegetable consumption according to Japanese vegetable recommendation.

	<350 g		≧350 g		
	Mean	SE	Mean	SE	*p* value
Male	*n*= 1,490		*n*=815		
Age	46.0	0.4	50.2	0.5	0.00
Total vegetables (g)	205.5	2.8	498.7	3.8	0.00
G-Y vegetables (g)	67.1	2.0	165.8	2.7	0.00
Other vegetables (g)	120.4	2.5	291.7	3.4	0.00
Vegetable juices (g)	1.1	0.9	11.9	1.3	0.00
Pickles (g)	16.8	0.9	29.3	1.2	0.00
Female	*n*=1,493		*n*=819		
Age	46.9	0.3	52.5	0.5	0.00
Total vegetables (g)	218.2	2.8	499.1	3.8	0.00
G-Y vegetables (g)	74.9	2.1	173.8	2.9	0.00
Other vegetables (g)	126.8	2.6	283.0	3.5	0.00
Vegetable juices (g)	0.8	1.0	15.4	1.3	0.00
Pickles (g)	15.8	0.8	26.9	1.2	0.00

Means with SE. Mean adjusted for age by general linear model (GLM).

algae (19.0 vs. 12.1 g), 25% of meat (60.5 vs. 45.6 g), 32% of poultry (24.1 vs. 17.1 g), and 10% of beverages (647.4 vs. 585.6 g). HVD had 41, 27 and 60% lower intake of wheat (87.4 vs. 123.1 g), sweets (31.4 vs. 40.0 g) and alcoholic beverages (42.8 vs. 68.4 g), respectively. The principle sources of energy in LVD were rice (28%), wheat (14%), sweets (7%), meat (6%), condiments (5%), dairy products (5%), fish and shellfish (4%), soy beans (4%), fruit (4%), and eggs (3%), while for HVD they were rice (27%), wheat (9%), meat (7%), condiments (6%), sweets (5%), dairy products (5%), soy beans (4%), fruit (4%), fish and shellfish (4%), and processed fish (3%) (Table 4).

Micronutrients

In men and women, the intake of energy and selected nutrients also differed by vegetable intakes category. Men with HVD had higher intakes of energy, protein density, fat density, and polyunsaturated fat density than LVD ($p<0.05$). Energy density was 23% lower (1.2 vs. 1.5 g/kcal) (Table 5). Cholesterol density, unsaturated fat density, and monounsaturated fat density were not associated with vegetable intake ($p>0.05$). Fiber was 63% higher in this group of men than in LVD (7.8 vs. 5.6 g/1,000 kcal). For micronutrients, HVD had 36, 30, 19, 87, 53, and 81% higher intake of potassium density (1,323.7 vs. 972.7 mg/1,000 kcal), calcium density (273.7 vs. 209.4 mg/1,000 kcal), magnesium density (141.2 vs. 117.8 mg/1,000 kcal), vitamin A density (558.5 vs. 298.9 μgRE/1,000 kcal), folic acid density (184.3 vs. 120.6 μg/1,000 kcal), and vitamin C density (57.0 vs. 31.5 mg/1,000 kcal), respectively than the LVD.

In women, those with HVD had significantly higher consumptions of energy, protein density, fiber density, and polyunsaturated fat density (Table 6). However, energy density and cholesterol density had a negative association with vegetable intake ($p<0.05$). Micronutrient intakes were also higher in HVD than in LVD. Those nutrient were potassium density (1,584.9 vs. 1,122.4 g/1,000 kcal), calcium density (330.9 vs. 263.5 mg/1,000 kcal), magnesium density (160.3 vs. 128.1 mg/1,000 kcal), vitamin A density (699.8 μgRE/1,000 kcal), folic acid density (225.3 vs. 141.6 μg/1,000 kcal), and vitamin C density (79.2 vs. 47.3 mg/1,000 kcal). HVD had 41, 29, 25, 89, 59, 67, and 58% higher intake of the micronutrients mentioned above. Density of carbohydrates, fats, saturated fats and monounsaturated fats were not associated with vegetable intake.

DISCUSSION

In order to develop practical measures to increase

Table 3. Percentage of subjects and mean of food intake according to vegetables in men.

	LVD (n=768)				MVD (n=769)				HVD (n=768)				p value
	% of consumers	Mean intake (g)	SE	% of energy source	% of consumers	Mean intake (g)	SE	% of energy source	% of consumers	Mean intake (g)	SE	% of energy source	
Rice	97.9	436.1	7.2	33.9	99.6	461.8	7.1	33.5	99.6	486.1	7.2	33.4	0.00
Wheat	85.8	127.9	4.4	12.2	84.7	102.7	4.4	9.5	84.7	97.9	4.4	8.0	0.00
Other cereals	6.3	12.6	2.1	0.9	6.6	11.6	2.0	0.7	6.6	14.8	2.1	0.8	0.53
Potatoes	58.4	47.4	2.7	1.4	68.8	63.4	2.7	1.6	68.8	72.5	2.7	1.7	0.00
Other starches	21.9	1.8	0.4	0.2	22.0	1.8	0.4	0.2	22.0	2.4	0.4	0.2	0.53
Sugar	76.4	7.7	0.3	1.3	81.7	7.9	0.3	1.3	81.7	8.3	0.3	1.3	0.42
Soy beans	70.5	59.8	2.9	3.2	79.1	59.6	2.9	3.1	79.1	80.5	2.9	3.8	0.00
Other beans	3.2	1.5	0.3	0.1	3.7	0.8	0.3	0.1	3.7	1.6	0.3	0.2	0.19
Nuts and seeds	18.5	1.9	0.4	0.4	24.9	2.4	0.4	0.6	24.9	2.9	0.4	0.6	0.18
G-Y vegetables	89.0	44.3	2.7	0.6	96.3	93.6	2.7	1.2	96.3	168.3	2.7	1.9	0.00
Other vegetables	96.8	78.0	3.2	0.8	99.9	166.9	3.2	1.6	99.9	298.1	3.2	2.5	0.00
Vegetable juice	0.4	−0.1	1.3	0.0	2.0	2.4	1.3	0.0	2.0	12.6	1.3	0.1	0.00
Pickles	55.6	13.6	1.2	0.2	63.9	20.3	1.2	0.3	63.9	29.7	1.2	0.4	0.00
Fruit	39.0	64.7	4.2	1.8	53.7	85.2	4.2	2.2	53.7	105.0	4.2	2.5	0.00
Jam	5.7	1.0	0.2	0.1	7.2	1.0	0.2	0.1	7.2	0.8	0.2	0.1	0.80
Fruit juice	8.0	11.9	1.8	0.2	11.7	11.2	1.8	0.2	11.7	8.2	1.8	0.1	0.34
Mushrooms	46.2	12.3	1.1	0.1	55.8	17.2	1.1	0.1	55.8	24.1	1.1	0.2	0.00
Algae	63.6	12.9	1.1	0.2	62.3	14.3	1.1	0.1	62.3	17.8	1.1	0.2	0.00
Fish	67.2	68.4	2.9	4.3	68.8	71.9	2.9	4.4	68.8	69.6	2.9	3.9	0.68
Processed fish	64.4	33.1	1.9	2.5	68.7	35.8	1.8	2.7	68.7	42.6	1.9	3.0	0.00
Meat	79.5	58.8	2.3	6.6	84.0	70.5	2.3	7.1	84.0	83.1	2.3	7.8	0.00
Poultry	34.7	22.8	1.7	1.6	35.5	24.0	1.6	1.6	35.5	25.3	1.7	1.6	0.57
Organs	4.8	2.6	0.5	0.1	2.6	1.7	0.5	0.1	2.6	2.6	0.5	0.1	0.38
Eggs	83.0	39.9	1.4	2.8	83.1	42.4	1.4	2.8	83.1	43.1	1.4	2.7	0.25
Dairy products	55.7	79.0	4.9	2.8	58.7	98.5	4.8	3.2	58.7	98.0	4.9	3.0	0.01
Oil	88.5	12.0	0.4	4.9	91.9	12.6	0.4	4.8	91.9	12.8	0.4	4.7	0.26
Sweets	28.5	20.2	1.6	3.0	30.1	20.4	1.6	2.8	30.1	19.8	1.6	2.6	0.96
Alcoholic drinks	60.6	257.7	14.5	6.7	65.3	268.6	14.4	6.8	65.3	224.5	14.5	5.2	0.08
Beverages	88.0	566.9	15.4	1.8	92.4	590.0	15.3	1.5	92.4	595.3	15.4	1.3	0.39
Condiments	100.0	121.6	4.0	4.6	100.0	120.5	4.0	5.5	100.0	123.4	4.0	5.8	0.88
Spices	28.4	0.3	0.1	0.0	29.6	0.4	0.1	0.0	29.6	0.3	0.1	0.0	0.57
Dietary supplements	11.5	8.9	1.6	0.3	15.6	13.3	1.6	0.5	15.6	10.7	1.6	0.4	0.14

Means with SE. Mean adjusted for age by GLM.
LVD: low vegetable diet, MVD: medium vegetable diet, HVD: high vegetable diet.
LVD: 133.8 g (<209.5 g), MVD: 283.3 g (209.5–361.1 g), HVD: 510.4 g (361.1–1,416.1 g).

vegetable consumption, the characteristics of vegetable intake among the general population should be considered. The dietary Guideline for Japanese recommended consuming an average of ≧350 g/d of vegetables (*17*) to ensure appropriate intake of such nutrients as vitamins, potassium, and dietary fiber. However, reports in detail on food patterns and vegetable intake among a representative Japanese population are scanty.

We found that the average intake of vegetables for Japanese was 313 g. Although it is lower than the Japanese minimum recommendation (≧350 g/d), it is approaching the recommended value. The mean intake of vegetables estimated in this study is relatively higher than the 277 g of vegetable intake reported by the NHNS 2003 (*19*), due to the inclusion criteria used to select Japanese for analysis.

The average of vegetable intake in men was 309 g, and in women, it was 318 g. We found that only 35% of the population had ≧350 g of vegetable intake. Those subjects with the lowest intake of vegetables were in the same age group as reported by the NHNS 2003 (*19*).

We observed that vegetable intake was associated positively with age. Older Japanese were likely to eat more vegetables than the youths. This pattern could be a consequence of the food behaviors developed before the nutritional transition, such as the increased intake of animal-based food (*19*). However, this nutritional transition has a not entirely negative consequence due to animal-based food being a source of such nutrients as calcium and high-quality protein, and also, the finding that eggs, diary products, and fish may protect against intracerebral haemorrhage (*23*).

To support the conclusion that HVD group had a better dietary quality than LVD, we examined some nutrients that are considered determinants of a healthy diet. We found that in men with HVD, rice, potatoes, soy

Table 4. Percentage of subjects and mean of food intake according to vegetables in women.

	LVD (n=774)				MVD (n=767)				HVD (n=771)				p value
	% of consumers	Mean intake (g)	SE	% of energy source	% of consumers	Mean intake (g)	SE	% of energy source	% of consumers	Mean intake (g)	SE	% of energy source	
Rice	97.8	319.2	5.5	28.0	97.9	330.9	5.5	28.7	98.6	327.4	7.2	26.8	0.31
Wheat	86.7	123.1	3.8	13.7	83.2	98.0	3.8	10.7	79.0	87.4	4.4	9.0	0.00
Other cereals	5.3	8.8	1.6	0.6	5.6	6.4	1.6	0.5	5.8	10.3	2.1	0.7	0.23
Potatoes	64.6	50.9	2.5	1.8	71.9	60.5	2.5	2.0	73.1	74.6	2.7	2.3	0.00
Other starches	18.7	1.6	0.4	0.2	21.1	1.9	0.4	0.2	19.9	2.4	0.4	0.2	0.27
Sugar	81.1	7.9	0.4	1.6	81.9	8.3	0.4	1.6	88.6	9.6	0.3	1.7	0.00
Soy beans	71.4	58.4	2.8	3.7	76.2	62.4	2.7	3.8	84.0	71.9	2.9	4.4	0.00
Other beans	4.0	2.1	0.4	0.2	4.9	1.4	0.4	0.2	7.8	2.8	0.3	0.3	0.10
Nuts and seeds	24.7	2.8	0.4	0.7	34.0	2.3	0.4	0.6	41.0	3.6	0.4	0.9	0.07
G-Y vegetables	90.1	50.9	2.9	0.8	96.5	101.8	2.8	1.5	99.1	177.2	2.7	2.5	0.00
Other vegetables	97.9	88.7	3.3	1.0	99.7	169.0	3.3	1.9	99.5	289.0	3.2	3.0	0.00
Vegetable juice	0.8	0.0	1.4	0.0	1.7	2.1	1.4	0.0	7.3	15.9	1.3	0.2	0.00
Pickles	45.3	12.8	1.2	0.2	56.4	19.2	1.2	0.4	58.7	27.3	1.2	0.5	0.00
Fruit	60.1	112.8	4.7	3.5	72.9	131.6	4.7	3.9	80.4	151.5	4.2	4.3	0.00
Jam	9.4	1.6	0.2	0.2	7.7	1.0	0.2	0.1	12.6	1.7	0.2	0.2	0.03
Fruit juice	11.2	11.8	1.7	0.3	10.4	7.2	1.7	0.2	12.5	11.3	1.8	0.2	0.11
Mushrooms	49.1	12.3	1.0	0.1	56.3	16.7	1.0	0.2	59.1	22.2	1.1	0.2	0.00
Algae	57.6	12.1	1.1	0.1	60.8	14.7	1.1	0.2	65.7	19.0	1.1	0.2	0.00
Fish	64.2	56.7	2.4	4.3	64.3	58.6	2.4	4.3	64.4	57.6	2.9	4.0	0.85
Processed fish	64.6	32.0	1.7	2.8	71.1	34.9	1.7	3.1	76.8	37.6	1.9	3.2	0.06
Meat	76.6	45.6	1.9	5.8	81.8	55.6	1.9	6.6	79.2	60.5	2.3	6.8	0.00
Poultry	33.3	17.1	1.5	1.3	31.1	18.9	1.5	1.4	32.5	24.1	1.7	1.8	0.00
Organs	3.1	1.5	0.4	0.1	2.9	1.0	0.4	0.1	3.2	2.3	0.5	0.1	0.10
Eggs	81.3	38.5	1.2	3.1	79.8	36.1	1.2	2.8	76.6	34.7	1.4	2.6	0.09
Dairy products	72.4	121.0	5.0	4.8	73.7	125.8	4.9	4.9	73.8	129.2	4.9	4.5	0.51
Oil	90.2	10.6	0.3	4.8	91.0	11.2	0.3	5.0	87.4	11.1	0.4	4.8	0.37
Sweets	53.1	40.0	2.0	7.0	51.6	34.8	2.0	5.9	49.7	31.4	1.6	5.2	0.01
Alcoholic drinks	45.2	68.4	5.8	1.8	48.0	51.1	5.8	1.5	49.5	42.8	14.5	1.3	0.01
Beverages	94.3	585.6	14.9	1.3	94.8	601.7	14.8	1.1	94.8	647.4	15.4	1.1	0.01
Condiments	99.9	95.7	3.1	5.3	100.0	97.1	3.1	6.1	100.0	103.7	4.0	6.4	0.17
Spices	26.5	0.3	0.0	0.0	25.3	0.3	0.0	0.0	27.3	0.3	0.1	0.0	0.89
Dietary supplements	18.1	14.6	2.2	0.6	21.9	18.7	2.2	0.6	23.6	14.3	1.6	0.7	0.30

Means with SE. Mean adjusted for age by GLM.
LVD: 150.7 g (<224.0 g), MVD: 291.9 g (224.0–360.2 g), HVD: 511.0 g (360.2–1,388.9 g).

beans, fruit, mushrooms, algae, processed fish, and meat had a positive association with vegetable intake. Most of those foods (that increase directly with vegetable intake) were low in energy density. Exceptions were for processed fish and meat. On the other hand, women with HVD ate more potatoes, sugar, soy beans, fruit, jam, mushrooms, algae, meat, poultry and beverages. Although sugar was higher in HVD, the intake was less than 10% of the total calories (*23*). In addition, women with HVD had less wheat, sweets and alcoholic beverages, of which the latter two groups are rich in energy.

Furthermore, we also observed that mushrooms and potatoes had the highest correlation with vegetable intake in men and women (data not shown). The positive correlation of mushrooms and potatoes with vegetable intake could be related with the season in which the survey was carried out. In November, autumn in Japan, it is very popular to have hot-pot meals, as well as braised meat with potatoes and other meals which are made by seasoning food and combining those meals with foods typically used in Japan, such as tofu (bean curds). Natto (fermented soybeans) was another traditional food with higher intake among this group of subjects than in the LVD. It has been reported that consumption of soy might reduce risk of prostate and breast cancer because of the high amount of isoflavones (*25*, *26*). In addition, it was suggested that natto might prevent the development of osteoporosis (*27*).

Processed fish also was associated positively with vegetable intake. It could be because Japanese add canned fish in salad or use bonito flakes as topping in various dishes, and also, to make Japanese soup (miso soup). Furthermore, in men and women, the percentage of Japanese that ate each group of food was higher in most of the subjects with HVD than LVD, suggesting that HVD had not only larger amounts of food by weight, but also a wider variety of it, and thus, a higher intake of nutrients in the diet. Foote et al. and Torheim et al.

Table 5. Nutrient density intake according to vegetable intake in men.

Men	LVD (n=768)		MVD (n=769)		HVD (n=768)		p value
	Mean intake (g)	SE	Mean intake (g)	SE	Mean intake (g)	SE	
Total vegetables (g)	135.7	3.21	283.2	3.18	508.7	3.20	0.00
Energy (kcal)	2,162	16.9	2,314	16.7	2,452	16.9	0.00
Energy without beverages (kcal)	1,911	16.0	2,040	15.9	2,214	16.0	0.00
Total food weight (g)	2,227	23.9	2,495	23.7	2,783	23.8	0.00
Food weight without beverages (g)	1,312	12.3	1,524	12.2	1,844	12.3	0.00
Total energy density (kcal/g)	1.03	0.01	0.96	0.01	0.91	0.01	0.00
Energy density without beverages (kcal/g)	1.49	0.01	1.35	0.01	1.22	0.01	0.00
Protein (g/1,000 kcal)	35.6	0.3	36.5	0.3	37.6	0.26	0.00
Fat (g/1,000 kcal)	26.0	0.3	26.6	0.3	27.0	0.28	0.04
Carbohydrate (g/1,000 kcal)	138.4	0.8	136.8	0.8	138.6	0.81	0.21
Salt (g)	5.41	0.07	5.76	0.07	6.18	0.07	0.00
Sodium (mg/1,000 kcal)	2,130	27.3	2,266	27.0	2,432	27.2	0.00
Potassium (mg/1,000 kcal)	972.7	10.2	1,130.0	10.1	1,323.7	10.2	0.00
Sodium/potassium (mg/1,000 kcal)	2.30	0.03	2.07	0.03	1.90	0.03	0.00
Calcium (mg/1,000 kcal)	209.4	3.51	237.9	3.48	273.7	3.51	0.00
Magnesium (mg/1,000 kcal)	117.7	1.14	126.1	1.13	141.2	1.14	0.00
Vitamin A (μgRE/1,000 kcal)	298.9	13.6	397.5	13.4	558.5	13.5	0.00
Folate (μg/1,000 kcal)	120.6	2.1	145.5	2.1	184.3	2.12	0.00
Vitamin C (mg/1,000 kcal)	31.5	0.97	43.9	0.97	57.0	0.97	0.00
Fiber (g/1,000 kcal)	5.21	0.08	6.60	0.08	8.51	0.08	0.00
Saturated fat (g/1,000 kcal)	6.56	0.09	6.69	0.09	6.61	0.09	0.61
Monounsaturated fat (g/1,000 kcal)	8.85	0.11	9.07	0.11	9.22	0.11	0.07
Polyunsaturated fat (g/1,000 kcal)	6.10	0.08	6.20	0.08	6.50	0.08	0.00
Cholesterol (g/1,000 kcal)	167.4	3.13	165.6	3.10	163.2	3.13	0.63

Means with SE. Mean adjusted for age by GLM.

found that dietary diversity would contribute to nutrient adequacy (*28–30*). We clearly demonstrated that men and women in HVD also had greater density of fiber, potassium, magnesium, calcium, vitamin A, folic acid and vitamin C. Moreover, those nutrients were taken mainly from vegetables, except for calcium and magnesium. Because of that, we suggest that people who had higher vegetable intakes were likely to have a diet with a better dietary quality. The nutrients selected for these analyses are well known for improving health, and preventing cardiovascular diseases and osteoporosis (*23*).

Although HVD had higher dietary quality, we found that the average intake of salt in HVD was 6.2 g/1,000 kcal and 6.6 g/1,000 kcal, in men and women, respectively. These values are as much as 38 and 47% higher than the maximum recommendation of 4.5 g/1,000 kcal for Japanese aged between 1 and 69 y (*31*). The sources were related with ingredients and foods that are typically present in Japanese meals, such as soy sauce, miso, and pickles as was shown in the NHNS 2003 (*19*). Thus, although the Japanese diet is characterized as "healthy" (*9, 10*), the high salt intake in Japan (*19, 33*) has also been an issue to be overcome in public heath programs. The large amount of salt consumed in the Japanese diet was related to an increase of stroke risk (*33*). Shimazu et al. found that although subjects with high consumption of sodium were related with higher prevalence of hypertension, the Japanese dietary pattern was associated with lower cardiovascular mortality (*34*). Those results could be explained by other components in the diet that compensated for the high sodium intake, such as soybeans, seaweed, and green tea. Our study also showed a higher consumption of those foods in the HVD. Although we did not have information about urine excretion of sodium and potassium, we calculated the ratio of sodium/potassium intake. In the HVD, this ratio was the lowest because of the high potassium intake among those Japanese.

Energy density (kcal/g) was negatively associated with vegetable intake. On the other hand, we observed that men with HVD showed a higher intake of protein density and fat density than those with LVD. Higher fat density intake in the HVD than LVD could be explained by the high amount of meat and milk consumed by this group of subjects. Nevertheless, density of saturated fat and cholesterol were not associated with vegetable intake, which are factors that increase risks of cardiovascular diseases. In women with HVD, we found that protein density intake was higher than LVD, but energy density and cholesterol intake were the lowest, suggesting that those were women concerned with health care.

We selected subjects who consumed between 1,500 and 3,712 kcal of energy to exclude confounding data for the analyses. On the other hand, energy density was calculated based only on food intake excluding all bev-

Table 6. Nutrient density intake according to vegetable intake in women.

Men	LVD (n=774)		MVD (n=767)		HVD (n=771)		p value
	Mean intake (g)	SE	Mean intake (g)	SE	Mean intake (g)	SE	
Total vegetables (g)	152.2	3.28	292.1	3.26	509.3	3.29	0.00
Energy (kcal)	1,907	12.95	1,949	12.88	2,058	13.01	0.00
Energy without beverages (kcal)	1,749	12.69	1,800	12.63	1,910	12.75	0.00
Total food weight (g)	2,005	19.11	2,181	19.00	2,502	19.19	0.00
Food weight without beverages (g)	1,219	10.47	1,393	10.41	1,655	10.52	0.00
Total energy density (kcal/g)	1.00	0.01	0.93	0.01	0.85	0.01	0.00
Energy density without beverages (kcal/g)	1.48	0.01	1.31	0.01	1.17	0.01	0.00
Protein (g/1,000 kcal)	36.9	0.26	38.3	0.26	39.5	0.26	0.00
Fat (g/1,000 kcal)	29.0	0.27	29.6	0.27	29.3	0.27	0.33
Carbohydrate (g/1,000 kcal)	141.3	11.7	139.9	11.7	141.1	11.8	0.31
Salt (g)	5.62	0.07	6.13	0.07	6.62	0.07	0.00
Sodium (mg/1,000 kcal)	2,213	28.7	2,413	28.6	2,607	28.9	0.00
Potassium (mg/1,000 kcal)	1,122	4.43	1,323	4.40	1,585	4.44	0.00
Sodium/potassium (mg/1,000 kcal)	2.08	0.02	1.88	0.02	1.71	0.02	0.00
Calcium (mg/1,000 kcal)	263.5	1.27	291.9	1.26	339.6	1.27	0.00
Magnesium (mg/1,000 kcal)	128.1	14.8	141.1	14.8	160.3	14.9	0.00
Vitamin A (μgRE/1,000 kcal)	370.7	2.34	490.8	2.33	699.8	2.35	0.00
Folate (μg/1,000 kcal)	141.6	1.67	176.2	1.67	225.3	1.68	0.00
Vitamin C (mg/1,000 kcal)	47.3	0.09	63.2	0.09	79.2	0.09	0.00
Fiber (g/1,000 kcal)	6.60	0.09	8.08	0.09	10.44	0.09	0.00
Saturated fat (g/1,000 kcal)	7.68	0.10	7.71	0.10	7.45	0.10	0.13
Monounsaturated fat (g/1,000 kcal)	9.76	0.12	10.02	0.12	9.83	0.12	0.25
Polyunsaturated fat (g/1,000 kcal)	6.63	0.09	6.85	0.08	6.97	0.09	0.02
Cholesterol (g/1,000 kcal)	180.5	3.24	174.2	3.22	167.7	3.25	0.02

Means with SE. Mean adjusted for age by GLM.

erages (35). Although this study has the advantage of a large number of Japanese adults from a representative sample, the food weighing method for one day in November may not be a fair representation of the typical dietary consumption because of the under—or over—reporting of food. Therefore, we are not able to generalize these patterns for all Japanese who had high vegetable diet because of the day-to-day food intake variations and the change of food intake in different seasons. Further studies are needed to examine the association of vegetable intake and socioeconomic, lifestyle, and other factors.

CONCLUSION

These analyses demonstrated the beneficial effects of HVD on dietary quality in the population because the subjects with HVD had higher intakes of fiber and several vitamins and minerals. Therefore, we conclude that recommendations for adequate vegetable intake are expected to improve diet quality among Japanese adults, especially for the group between 20 to 39 y of age.

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