

ORIGINAL ARTICLE

Demographics, health-related behaviors, eating habits and knowledge associated with vegetable intake in Japanese adults

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Objectives: To analyze demographic, health-related behaviors, eating habit and knowledge associated with vegetable intake.

Methods: Secondary analyses using the dataset from the National Health and Nutrition Survey 2003. Food intake data measured by the food-weighing method in one-day and a questionnaire assessed the dietary intake and health-related behaviors, eating habit and knowledge. This study was made in Japan. The data of 1742 men and 2519 nonpregnant/nonlactating women, aged 20–69 years, energy intake between percentiles 1 and 99 were included. Vegetable intake was analyzed according to the Japanese vegetable recommendation (≥ 350 g/day) after age adjustment.

Results: Average of VI was 307 g/day in men and 297 g/day in women. Only 35% of men and 31% of women met the recommended amount of vegetable intake. Japanese from city areas, aged 60–69 years, had the highest vegetable intake and subjects from metropolitan areas had the lowest vegetable intake. Depending on the age groups, risks for low vegetable intake in Japanese were found in subjects with skipping meals, alcohol intake and history of smoking.

Conclusions: To increase vegetable intake, it is necessary to provide more nutritional education and lifestyle-related diseases education.

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Introduction

There is strong and consistent epidemiological evidence that vegetable intake (VI) is beneficial to health, decreasing the risk for a range of chronic diseases and many cancers (Mozaffarian *et al.*, 2003; Sauvaget *et al.*, 2003; World Health Organization, 2004; Pomerleau *et al.*, 2006). As a consequence, in many countries, dietary guidelines include recommendations for vegetable consumption. In Japan, a VI of ≥ 350 g/day is recommended. However, most Japanese

consume less than this amount. The National Health and Nutrition Survey of 2003 (NHNS, 2003) showed that the average daily VI was 278 g. The highest intake was among the Japanese aged between 60 and 69 years, though it was still below the recommended amount (Ministry of Health, Labour and Welfare, 2005). Therefore, health authorities are making an effort to develop dietary programs, such as the Food Guide Spinning Top (Yoshiike *et al.*, 2007), to encourage people to eat a balanced diet by choosing enough servings of vegetable dishes. Many research studies have been carried out in a number of countries to ascertain the determinants of fruit and vegetable consumption. The majority of the studies have focused on household income (Kirkpatrick and Tarasuk, 2003; Laaksonen *et al.*, 2003), regional differences (Pollard *et al.*, 2001; Papadaki and Scott, 2002) and understanding the psychosocial and sociodemographic determinants of fruit and VI. These include knowledge, perception of benefits and barriers, food preparation skills, gender and social status (Satia *et al.*, 2002; Friel *et al.*, 2004;

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Larson *et al.*, 2006). Furthermore, a higher VI is associated with eating homegrown vegetables (Billson *et al.*, 1999), eating vegetables at lunch or dinner, eating salads (Satia *et al.*, 2002) and skill in preparing vegetables (Larson *et al.*, 2006; Crawford *et al.*, 2007). In addition, other studies showed that distress was associated with unhealthy habits, such as low VI (Unusan, 2006). In Japan, very little research has been conducted on these topics. In terms of initiatives to promote increased consumption, a more thorough understanding of the behavioral correlates of VI is likely to be important; thus, the aim of this paper is to analyze demographics, health-related behaviors, eating habits and the knowledge associated with VI among Japanese adults, because such information could be beneficial for developing effective dietary interventions.

Methods

NHNS 2003 data

NHNS 2003 data is a cross-sectional survey of a nationally representative sample of the noninstitutionalized population of Japan. It includes (1) 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), (2) a dietary survey that involves weighing the amount of food consumed over a day by a household and individual household members and (3) a questionnaire on health-related behaviors, eating habits and knowledge (Iwaoka *et al.*, 2001).

The design and protocol of the national survey conducted by the Ministry of Health, Labour and Welfare of Japan (MHLWJ) were thoroughly reviewed by the technical committee on the survey in the ministry, and also approved by the Ministry of Internal Affairs and Communications in the government office, including the ethical issues. Detailed explanation was made to the households selected as the survey sample by the dietitians of the local public health centers and informed consent was obtained from the households participating in the survey.

Subjects

We performed a secondary analysis of the dataset from NHNS 2003 with the permission of the MHLWJ. From 11 105 subjects, 1742 men and 2519 women were selected according to the following inclusion criteria: age (between 20 and 69 years), energy intake (between percentiles 1 and 99 according to sex cutoff (910–4015 kcal for men and 726–3079 kcal for women)) and those who completed the health-related behaviors, eating habits and knowledge questionnaire. The inclusion criteria for energy were restricted to percentiles 1–99 to exclude outlying data for the analyses. The exclusion criteria were pregnant/lactating women.

Vegetable classification

Green-yellow vegetables, light color vegetables, pickles made from vegetables, vegetable juice. Mushrooms, seaweeds and plants foods that contain variable amounts of starch, such as potato, were not included in vegetable groups.

Demographics, health-related behaviors, eating habits and knowledge

A questionnaire about demographic factors, health-related behaviors, eating habits and knowledge were carried out. It was assessed as follow:

- Demographic factors: age, sex, region of residence (12 regions: Hokkaido, Tohoku, Kanto I, Kanto II, Hokuriku, Tokai, Kinki I, Kinki II, Chugoku, Shikoku, Northern Kyushu and Southern Kyushu), area of residence (metropolitan: more than 150 000 people, city: between 50 000 and 150 000 people and town/rural: less than 50 000 people).
- Health-related behaviors: exercise habit (yes, no), perception of overall health status (very good, good, not good), average hours of sleep (less than 6 h or more than 9 h, 7–9 h), feeling dissatisfaction, distress or burden and others (very often, sometimes, never), history of smoking (yes, no), frequency of alcohol intake (every day, 6 days/week to 1 day/month, gave up/rarely).
- Eating habits: skipping meals (yes, no), eating snacks (yes, no).
- Knowledge: knowledge about 'Health Japan 21' (yes, no), 'lifestyle-related diseases (LSRD)' (I know the content, I have heard about it, I do not know what it is), attendance at health-related education programs (yes, no).

Statistical analysis

All analyses were performed using the Statistical Package for Social Science (version 11; SPSS Inc., Chicago, IL, USA). Data were expressed as mean and 95% confidence interval (CI) according to sex and age groups (20–39, 40–59 and 60–69 years).

Two approaches were used to assess the relationship between vegetable consumption and other factors. First, we used a general linear model (GLM) with VI as the dependent variable, and all other independent factors as categorical variables: demographics, health-related behaviors, eating habits and knowledge factors. We determined age-adjusted means of VI across factors and correlations with *P* values <0.05 to be significant.

In the second approach, we computed the proportion of subjects who ate a total of ≥ 350 g/day of vegetables, the intake recommended for adults by 'Health Japan 21'. Factors correlated with meeting the recommendation of VI were assessed the odd ratio (OR), with 95% CI, estimated from a multiple logistic regression after age adjustment.

Results

All the analyses were carried out in the subset of 4261 subjects, 1742 men and 2519 women, who met all the inclusion criteria.

In Table 1 the body mass index (BMI) and nutrient intakes among Japanese adults is shown. BMI was slightly higher in men aged 40–59 years, and in women aged 60–69 years.

Energy intake was significantly higher in women aged 40–59 years. For both men and women, protein intake tends to increase with age whereas fat intake decreases. Mean VI was 307 g for men and 297 g for women. The proportion of those who met the recommendation of ≥ 350 g of VI per day was 35% in men and 31% in women (Table 2).

For men and women aged 20–39 years, mean of VI was 265 and 243 g, respectively. For those aged 30–49 years, it was 299 and 302 g, and for the oldest group, it was 359 and 343 g, indicating a trend for VI to increase with age.

By region of residence, the regions with the highest VI were Hokuriku (central northeast Japan) for men and Kanto II (central Japan) for women. The lowest VI was in Shikoku for both men and women ($P < 0.05$; Table 2).

Table 1 BMI and macronutrient intake according to group of age

Sex	Group of age (years)	Mean	s.e.	*P value
Male				
BMI	20–39	23.1	0.2	0.00
	40–59	23.9	0.1	
	60–69	23.7	0.1	
Energy	20–39	2291	26.7	0.17
	40–59	2296	20.2	
	60–69	2238	24.2	
Protein	20–39	80	1.1	0.01
	40–59	83	0.9	
	60–69	85	1.1	
Fat	20–39	66	1.2	0.00
	40–59	58	0.8	
	60–69	53	1.0	
Carbohydrate	20–39	315	4.1	0.44
	40–59	315	3.4	
	60–69	321	3.9	
Female				
BMI	20–39	21.4	0.1	0.00
	40–59	22.9	0.1	
	60–69	23.5	0.1	
Energy	20–39	1741	16.7	0.00
	40–59	1815	12.5	
	60–69	1806	15.5	
Protein	20–39	64	0.7	0.00
	40–59	70	0.6	
	60–69	71	0.8	
Fat	20–39	55	0.9	0.00
	40–59	52	0.6	
	60–69	46	0.7	
Carbohydrate	20–39	236	2.4	0.00
	40–59	256	2.0	
	60–69	271	2.6	

Abbreviations: BMI, body mass index; s.e., standard error. Mean values by ANOVA: * $P < 0.05$.

Men and women from the city areas aged 60–69 years had the highest VI, whereas men and women from metropolitan areas trend to the lowest intake. For young men, VI was higher when the number of family was 3. For middle-aged and elderly men, VI was higher when the number of family members was 2. On the other hand, men living alone had the lowest intake of vegetables ($P < 0.05$; Table 2).

When health-related behaviors, eating habits and knowledge were analyzed (Tables 3 and 4), we found that in men and women who had breakfast and lunch at home had a higher VI.

In men aged 20–39 years, those who did not skip meals, drink alcohol everyday, and attended health education groups had a higher VI. Men aged 40–59 years who did not skip meals, did not feel dissatisfaction, distress or burden, drank alcohol 6 days/week to 1 day/month and had never smoked consumed more vegetables. In the oldest age group, people who perceived their status as good, did not skip meals, did not feel dissatisfaction, distress or burden and

Table 2 Vegetable intake in Japanese adults

	N	Mean (g)	s.e.
Men	1742	307	4.3
Women	2519	297	3.4
<i>Group of age (years)</i>			
<i>Men</i>			
20–39	492	265	7.1
40–59	742	299	6.4
60–69	508	359	8.8
<i>Women</i>			
20–39	696	243	5.5
40–59	1155	302	5.0
60–69	668	343	6.8
<i>Recommended amount (g)^a</i>			
<i>Men</i>			
< 350	1127	203	3.3
≥ 350	615	497	4.4
<i>Women</i>			
< 350	1734	208	2.5
≥ 350	785	492	3.8
<i>Highest area of VI^a</i>			
<i>Men</i>			
Hokuriku	152	368	14.2
<i>Women</i>			
Kanto II	232	351	10.7
<i>Lowest area of VI^a</i>			
<i>Men</i>			
Shikoku	97	262	17.8
<i>Women</i>			
Shikoku	126	251	14.6

Abbreviations: s.e., standard error; VI, vegetable intake. ^aMean and s.e. adjusted for age.

Table 3 Vegetable consumption according to the health and lifestyle behaviors

	20–39 years old				40–59 years old				60–69 years old			
	N	Mean (g)	s.e.	P value	N	Mean (g)	s.e.	P value	N	Mean (g)	s.e.	P value
<i>Demographic factors</i>												
<i>Area of residence</i>												
<i>Men</i>												
Metropolitan	77	248	17.9		100	284	17.3		59	306	25.7	
City	233	273	10.3		293	311	10.1		243	380	12.7	
Town-rural	182	261	11.7	0.47	349	292	9.3	0.28	206	350	13.8	0.03
<i>Women</i>												
Metropolitan	146	241	12.1		165	286	13.2		111	305	16.7	
City	303	241	8.4		500	311	7.6		297	363	10.2	
Town-rural	247	247	9.3	0.87	490	298	7.7	0.20	260	336	10.9	0.01
<i>Household size</i>												
<i>Men</i>												
Living alone	57	193	21.0		50	227	24.4		31	262	35.1	
2	53	265	21.4		125	325	15.7		233	384	12.9	
3	125	283	13.9		180	298	13.0		123	377	17.7	
4 or people	257	271	9.7	0.00	387	300	9.0	0.01	121	319	17.8	0.00
<i>Women</i>												
Living alone	44	213	22.1		54	306	23.2		88	342	18.8	
2	79	242	16.4		260	320	10.8		326	356	9.8	
3	156	268	11.7		302	311	9.8		127	341	15.7	
4 or more people	417	237	7.1	0.07	539	288	7.6	0.10	127	311	15.6	0.11
<i>Health-related behaviors</i>												
<i>Breakfast</i>												
<i>Men</i>												
Skip	72	207	18.1		54	227	23.2		5	287	87.9	
Meal out	105	230	15.0		84	217	18.5		28	242	37.2	
Home meal	315	289	8.7	0.05	604	316	6.9	0.05	475	367	9.0	0.02
<i>Women</i>												
Skip	54	191	19.7		30	213	30.8		8	232	62.0	
Meal out	115	202	13.5		88	248	18.0		37	269	28.8	
Home meal	527	257	6.3	0.03	1037	309	5.2	0.02	623	349	7.0	0.02
<i>Lunch</i>												
<i>Men</i>												
Skip	9	173	52.2		11	217	52.1		8	255	69.4	
Meal out	264	251	9.6		333	291	9.5		133	308	17.0	
Home meal	219	285	10.6	0.02	398	307	8.7	0.01	367	380	10.2	0.03
<i>Women</i>												
Skip	12	220	42.0		10	207	53.4		4	180	87.0	
Meal out	276	226	8.8		327	280	9.3		125	281	15.6	
Home meal	408	255	7.2	0.01	818	312	5.9	0.01	539	358	7.5	0.03
<i>Exercise habit</i>												
<i>Men</i>												
No	387	260	8.0		581	297	7.2		296	350	11.5	
Yes	105	280	15.3	0.25	161	306	13.7	0.56	212	372	13.6	0.22
<i>Women</i>												
No	601	240	5.9		890	295	5.7		429	336	8.5	
Yes	95	262	15.0	0.16	265	327	10.5	0.01	239	355	11.4	0.18

Abbreviations: GLM, general linear model; s.e. standard error.

Values of vegetable intake are mean and s.e. calculated by GLM adjusted for age at $P < 0.05$.

Table 4 Vegetable consumption according to health-related behaviors, eating habits and knowledge factors

	20–39 years old				40–59 years old				60–69 years old			
	N	Mean (g)	s.e.	P value	N	Mean (g)	s.e.	P value	N	Mean (g)	s.e.	P value
<i>How is your health status at the present?</i>												
<i>Men</i>												
Not good	57	233	20.8		113	275	16.3		93	345	20.5	
Good	387	267	8.0		592	303	7.1		382	370	10.1	
Very good	48	285	22.9	0.21	37	306	28.5	0.29	33	271	34.4	0.02
<i>Women</i>												
Not good	87	239	15.7		157	278	13.5		120	331	16.1	
Good	543	242	6.3		938	303	5.5		523	347	7.7	
Very good	66	251	18.0	0.87	60	349	21.8	0.02	25	310	35.4	0.43
<i>Do you frequently skip meals?</i>												
<i>Men</i>												
Yes	195	239	11.2		160	230	13.5		45	301	29.5	
No	297	281	9.1	0.00	582	317	7.0	0.00	463	365	9.2	0.04
<i>Women</i>												
Yes	195	221	10.5		158	266	13.5		64	297	22.0	
No	501	251	6.5	0.02	997	308	5.4	0.00	604	348	7.2	0.03
<i>Do you usually eat snack?</i>												
<i>Men</i>												
Yes	307	258	9.0		396	292	8.7		241	356	12.8	
No	185	275	11.5	0.27	346	306	9.3	0.25	267	362	12.1	0.77
<i>Women</i>												
Yes	571	238	6.1		904	304	5.6		453	348	8.3	
No	125	266	13.0	0.05	251	298	10.7	0.63	215	333	12.0	0.32
<i>During the last month, have you felt dissatisfaction, distress, burden, etc?</i>												
<i>Men</i>												
Very often	88	272	16.4		111	272	16.4		39	285	31.7	
Sometimes	364	298	7.3		562	298	7.3		374	361	10.2	
Never	40	344	20.8	0.91	69	344	20.8	0.02	95	381	20.3	0.04
<i>Women</i>												
Very often	135	227	12.6		183	286	12.6		67	336	21.6	
Sometimes	527	245	6.4		914	305	5.6		525	344	7.7	
Never	34	272	25.0	0.21	58	305	22.3	0.35	76	340	20.3	0.94
<i>How often per week do you drink alcohol?</i>												
<i>Men</i>												
Everyday	123	295	14.3		326	295	9.5		238	336	12.8	
6 days/week to 1 day/month	231	252	10.3		237	322	11.2		144	399	16.4	
Gave up/rarely	138	260	13.4	0.05	179	273	12.9	0.01	126	358	17.6	0.01
<i>Women</i>												
Everyday	52	255	20.3		90	265	17.9		25	353	35.4	
6 days/week to 1 day/month	291	232	8.6		371	299	8.8		141	335	15.0	
Gave up/rarely	353	250	7.8	0.27	694	309	6.4	0.07	502	345	7.9	0.82
<i>Do you know what Health Japan 21 is?</i>												
<i>Men</i>												
No	482	265	7.2		719	296	6.4		493	355	8.9	
Yes	10	244	49.9	0.68	23	386	36.0	0.01	15	498	50.9	0.01
<i>Women</i>												
No	668	241	5.6		1107	300	5.1		644	343	7.0	
Yes	28	283	27.6	0.14	48	354	24.4	0.03	24	343	36.1	0.99
<i>Do you know what lifestyle-related diseases are?</i>												
<i>Men</i>												
I do not know what it is	58	273	20.7		95	280	17.8		57	344	26.2	
I heard about it	184	263	11.6		294	286	10.1		208	343	13.7	
Yes, I know the content	250	264	10.0	0.90	353	314	9.2	0.07	243	377	12.7	0.17

Table 4 Continued

	20–39 years old				40–59 years old				60–69 years old			
	N	Mean (g)	s.e.	P value	N	Mean (g)	s.e.	P value	N	Mean (g)	s.e.	P value
<i>Women</i>												
I do not know what it is	36	302	24.1		54	267	23.0		76	314	20.4	
I heard about it	256	222	9.0		378	277	8.7		232	335	11.6	
Yes, I know the content	404	251	7.2	0.00	723	318	6.3	0.00	360	354	9.3	0.14
<i>Do you go to attend health-education groups?</i>												
<i>Men</i>												
No	446	259	7.4		635	297	6.9		413	355	9.8	
Yes	46	318	23.0	0.01	107	311	16.7	0.43	95	377	20.4	0.34
<i>Women</i>												
No	598	242	6.0		852	293	5.8		443	332	8.4	
Yes	98	251	14.7	0.56	303	328	9.7	0.00	225	364	11.7	0.03
<i>Have you ever smoked?</i>												
<i>Men</i>												
Yes	355	257	8.4		627	292	6.9		378	351	10.2	
No	137	285	13.6	0.08	115	335	16.1	0.02	130	383	17.4	0.12
<i>Women</i>												
Yes	256	227	9.1		231	277	11.3		60	284	22.7	
No	440	252	6.9	0.03	924	309	5.6	0.01	608	349	7.1	0.01

Abbreviations: GLM, general linear model; s.e., standard error.

Values of vegetable intake are mean and s.e. calculated by GLM adjusted for age at $P < 0.05$.

drank alcohol 6 days/week to 1 day/month had a higher intake of vegetables.

For the youngest women, those who did not skip meals, did not eat snacks, had a lack of knowledge of LSRD and had never smoked had a higher VI. In women aged 40–59 years, those who had exercise habit, perceived their health status as very good, did not skip meals, had knowledge of LSRD, attended health education groups and had never smoked had a higher VI. Women aged 60–69 years, who did not skip meals, attended health education groups and had never smoked had the highest VI.

In logistic regression, men aged 20–39 years who skipped breakfast, had breakfast away from home, perceived their status as good, skipped meals and had snacks were associated with lower VI (Table 5). In subjects aged 40–59 years who skipped breakfast, had breakfast away from home, did not perceive their health status as good, skipped meals, felt distress or dissatisfaction very often or often and had ever smoked showed association with low VI (Table 6), whereas those drinking alcohol 6 days/week to 1 day/month had a higher VI. In men aged 60–69 years who had breakfast and lunch away from home and perceived their health status as good, the VI were higher.

Women aged 20–39 years who had breakfast away from home, heard about LSRD, but did not know what LSRD is had a higher risk for low VI. Women who did not know about LSRD had a higher VI. Women aged 40–59 years who skipped breakfast, had breakfast and lunch away from home,

did not do exercise, skipped meals, drank alcohol every day, had heard about LSRD and had a history of smoking were related to a low VI. In women aged between 60–69 years who ate breakfast or lunch away from home, did not exercise, did not know and/or had not heard about LSRD, did not attend health-education group and had ever smoked, the risk for low VI was higher.

Discussion

Most of the associations analyzed in this study have been reported previously in Western countries; however, there are no nationally representative data from Japan. Our aim was to examine the relationships of demographic factors, health-related behaviors, eating habits and knowledge of VI among Japanese adults.

In this study, a large number of subjects did not meet the current 'Health Japan 21' recommendation for VI, and this finding was positively correlated with age (MHLWJ, 2005). We found that about 65% of men and 69% of women ate less than 350 g of vegetables in a selected typical day. However, the average amount of VI in both men and women approached the recommended dietary target for vegetables of ≥ 350 g in a day.

We demonstrated that household size was related to VI as previously reported by (Papadaki and Scott, 2002). Men living with someone had a higher intake than those living

Table 5 Risk for low vegetable intake in Japanese adults according to exercise habits and place for breakfast, lunch and dinner

	20–39 years old				40–59 years old				60–69 years old			
	N	OR	95% CI		N	OR	95% CI		N	OR	95% CI	
Breakfast												
Men												
Skip	72	3.80	1.82	7.94*	54	2.23	1.09	4.54*	5	3.55	0.39	32.04
Meal out	105	1.94	1.16	3.25*	84	4.14	2.09	8.19*	28	4.08	1.52	10.92*
Home meal	315		Reference		604		Reference		475		Reference	
Women												
Skip	54	2.18	0.91	5.26	30	13.17	1.78	97.42*	8	2.45	0.49	12.23
Meal out	115	2.13	1.15	3.96*	88	2.36	1.35	4.13*	37	2.20	1.05	4.63*
Home meal	527		Reference		1037		Reference		623		Reference	
Lunch												
Men												
Skip	9	1.62	0.33	8.00	11	2.35	0.50	11.10	8	1.84	0.43	7.84
Meal out	264	1.28	0.87	1.90	333	1.12	0.82	1.54	133	2.24	1.47	3.41*
Home meal	219		Reference		398		Reference		367		Reference	
Women												
Skip	12	0.78	0.21	2.94	10	4.32	0.54	34.50	4	2.81	0.29	27.21
Meal out	276	1.40	0.94	2.11	327	1.59	1.18	2.12*	125	2.57	1.67	3.97*
Home meal	408		Reference		818		Reference		539		Reference	
Exercise habits												
Men												
No	387	1.30	0.82	2.06	581	1.16	0.80	1.68	296	1.14	0.80	1.63
Yes	105		Reference		161		Reference		212		Reference	
Women												
No	601	1.10	0.64	1.90	890	1.40	1.04	1.87*	429	1.40	1.01	1.92*
Yes	95		Reference		265		Reference		239		Reference	

Abbreviations: 95% CI, 95% confidence interval; OR, odds ratio.

Values of OR and 95% CI are calculated by logistic model. Significance level compared with vegetable intake (< 350 and ≥ 350 g) within the same group of age and sex: * $P < 0.05$.

alone. We also found that residence regions and area were associated with VI: low intake was particularly marked in those regions separated from the main Japanese island (Honshu), that is, Shikoku and southern Kyushu. This finding could be related to higher vegetable prices because of the natural conditions, such as low temperature and snowfall damaging agricultural crops. The Annual Report on Food, Agriculture and Rural Areas in Japan, Fiscal Year 2003 reported that the total field crop damage from low temperatures for vegetables nationwide was 7%. The field crops regions damage from low temperature was 15% for Hokkaido and 8% for Kyushu (The Ministry of Agriculture, Forestry and Fisheries of Japan, 2003).

On the other hand, subjects from city areas had a higher VI compared with those living in metropolitan or town-rural areas. Furthermore, men and women from metropolitan areas had the lowest consumption, indicating that transportation of vegetables to markets, availability and price could be the main factors for their low intake.

When we analyzed the mean intake using GLM, we divided total VI into green and yellow vegetables, light color

vegetables, vegetable juice and pickles (data not shown). After dividing vegetables into these groups, we found that vegetable juice was consumed in large quantities by young men living alone, men aged 40–59 years who had never smoked and women aged 20–39 years who had knowledge of LSRD. Furthermore, women aged 40–59 years who perceived their health status as very good and women aged 60–69 years living alone had a high consumption of vegetable juice. The results suggest that these subjects with healthier behaviors or those living alone have more vegetable juice intake. In addition, young women aged 20–39 years who had breakfast out also had high intakes of vegetable juice. This may be attributable to subjects being aware of their low VI and attempting to compensate for this by consuming vegetable juice. This finding is interesting because there are no previous Japanese studies identifying factors to explain vegetable juice intake.

In men and women aged 60–69 years, having snacks was associated with pickle intake (data not shown). In Japanese culture, many old people have snacks before going to bed,

Table 6 Risk for low vegetable intake in Japanese adults, according to health-related behaviors, eating habits and knowledge factors

	20–39 years old				40–59 years old				60–69 years old			
	N	OR	95% CI		N	OR	95% CI		N	OR	95% CI	
How is your health status at the present?												
Men												
Not good	57	2.06	0.90	4.71	113	2.39	1.08	5.26*	93	0.48	0.19	1.18
Good	387	1.91	1.02	3.56*	592	1.48	0.75	2.92	382	0.35	0.15	0.79*
Very good	48		Reference		37		Reference		33		Reference	
Women												
Not good	87	1.20	0.54	2.67	157	1.74	0.93	3.27	120	0.67	0.26	1.73
Good	543	1.19	0.64	2.24	938	1.53	0.89	2.63	523	0.45	0.19	1.11
Very good	66		Reference		60		Reference		25		Reference	
Do you frequently skip meals?												
Men												
Yes	195	1.57	1.04	2.38*	160	2.26	1.46	3.50*	45	1.45	0.77	2.73
No	297		Reference		582		Reference		463		Reference	
Women												
Yes	195	1.18	0.76	1.83	158	2.21	1.44	3.39*	64	1.54	0.90	2.65
No	501		Reference		997		Reference		604		Reference	
Do you usually eat snack?												
Men												
Yes	307	1.53	1.03	2.27*	396	1.13	0.83	1.54	241	0.91	0.64	1.29
No	185		Reference		346		Reference		267		Reference	
Women												
Yes	571	1.49	0.94	2.37	904	1.08	0.80	1.46	453	0.82	0.59	1.14
No	125		Reference		251		Reference		215		Reference	
Men												
Yes	359	1.30	0.85	2.00	501	1.40	1.01	1.94*	273	0.83	0.59	1.19
No	133		Reference		241		Reference		235		Reference	
Women												
Yes	517	1.03	0.67	1.59	918	1.07	0.79	1.45	462	0.97	0.70	1.35
No	179		Reference		237		Reference		206		Reference	
During the last month, have you felt dissatisfaction, distress, burden, etc?												
Men												
Very often	88	0.85	0.36	2.00	111	2.79	1.45	5.37*	39	1.93	0.89	4.22
Sometimes	364	0.79	0.37	1.68	562	1.81	1.09	3.00*	374	1.16	0.74	1.82
Never	40		Reference		69		Reference		95		Reference	
Women												
Very often	135	1.95	0.80	4.77	183	1.52	0.80	2.88	67	1.07	0.55	2.08
Sometimes	527	1.54	0.70	3.40	914	1.09	0.62	1.93	525	0.98	0.60	1.59
Never	34		Reference		58		Reference		76		Reference	
How often per week do you drink alcohol?												
Men												
Everyday	123	0.68	0.39	1.17	326	0.85	0.57	1.28	238	1.19	0.77	1.84
6 days/week to 1 day/month	231	0.90	0.56	1.45	237	0.65	0.43	0.99*	144	0.76	0.47	1.22
Gave up/rarely	138		Reference		179		Reference		126		Reference	
Women												
Everyday	52	0.92	0.45	1.89	90	1.50	0.90	2.53*	25	0.73	0.32	1.63
6 days/week to 1 day/month	291	1.22	0.82	1.83	371	1.12	0.85	1.47	141	1.13	0.77	1.65
Gave up/rarely	353		Reference		694		Reference		502		Reference	
Do you know what lifestyle-related diseases are?												
Men												
I do not know what it is	58	0.61	0.33	1.11	95	1.36	0.83	2.24	57	1.25	0.70	2.24
I heard about it	184	0.92	0.60	1.40	294	1.21	0.86	1.69	208	1.39	0.96	2.02
Yes, I know the content	250		Reference		353		Reference		243		Reference	

Table 6 Continued

	20–39 years old				40–59 years old				60–69 years old			
	N	OR	95% CI		N	OR	95% CI		N	OR	95% CI	
<i>Women</i>												
I do not know what it is	36	0.30	0.15	0.61*	54	1.61	0.86	3.00	76	1.92	1.14	3.23*
I heard about it	256	1.54	1.00	2.37	378	1.62	1.22	2.14*	232	1.65	1.18	2.31*
Yes, I know the content	404		Reference		723		Reference		360		Reference	
<i>Do you go to attend health-education groups?</i>												
<i>Men</i>												
No	446	1.65	0.88	3.09	635	1.35	0.88	2.07	413	1.35	0.86	2.11
Yes	46		Reference		107		Reference		95		Reference	
<i>Women</i>												
No	598	1.41	0.84	2.35	852	1.26	0.96	1.67	443	1.41	1.02	1.95*
Yes	98		Reference		303		Reference		225		Reference	
<i>Have you ever smoked?</i>												
<i>Men</i>												
Yes	355	1.52	0.99	2.33	627	1.77	1.17	2.68*	378	1.30	0.87	1.94
No	137		Reference		115		Reference		130		Reference	
<i>Women</i>												
Yes	256	1.27	0.85	1.91	231	1.66	1.17	2.35*	60	2.78	1.50	5.18*
No	440		Reference		924		Reference		608		Reference	

Abbreviations: 95% CI, 95% confidence interval; OR, odds ratio.

Values of OR and 95% CI are calculated by logistic model. Significance level compared with vegetable intake (<350 and ≥350 g) within the same group of age and sex: * $P < 0.05$.

particularly pickles, even though there is a campaign to reduce salt intake (MHLWJ, 2002).

Logistic regression analyses showed that risk factors associated with low VI were different by age group in both men and women. Our findings suggest that in the youngest and oldest age groups, especially for women, educational initiatives that aim to increase VI should include such strategies as increasing availability of vegetables in cafeterias and restaurants where they usually have lunch, furthermore, food price must be taken into consideration. Other authors found that subjects in their twenties reported low VI because of lack of time to cook vegetables or living alone for the first time and not having the skills to prepare vegetables dishes (Papadaki and Scott, 2002; Larson *et al.*, 2006). We also found other unhealthy behaviors that were negatively correlated with VI in each age group. For example, more health-related behaviors and eating habits factors affecting VI, such as eating snacks, were observed among the youngest group, whereas behaviors related to distress, such as drinking alcohol and a history of smoking, were common in the middle-aged group. In the oldest age group, lack of health-related knowledge and not attending health-education groups were factors negatively associated with VI, especially in women. Our finding is consistent with previous studies showing that unhealthier behaviors, such as drinking alcohol, are associated not only with distress (Hiro *et al.*, 2007) but also with low VI (Agudo *et al.*, 1999; Unusan, 2006). Women in the middle and in the oldest age groups,

lack of knowledge or having only heard about LSRD was associated with lower VI, indicating that merely having heard about LSRD has no effect on behavior; therefore, women need to learn the content of LSRD to improve VI. The differences in health-related behaviors and eating habits across age groups could be because the subjects in the youngest group are likely to live alone and eat out, whereas middle-aged Japanese (aged 40–59 years) may be busy with work and have family obligations.

After analyzing the responses to the question ‘during the last month, on average, how many hours did you sleep’ it was found that this factor was not significant either when the mean intake were calculated using GLM or in the logistical regression analysis ($P > 0.05$; data not shown). As the number of subjects skipping dinner was small, we could not analyze the relation between dinner and VI. On the other hand, number of subjects who had knowledge of Health Japan 21 was few, however, they clearly trended to have higher intake of vegetable (Table 4). Thus, we suggest that it is important to spread more information of Health Japan 21 among Japanese to raise awareness about healthy lifestyle to carry out more effective dietary interventions.

Finally, this study had a large number of subjects and the data considered to be representative for Japanese adults. Although the consumption of energy and nutrient were closed to other surveys done in Japan adults (Nakamura *et al.*, 2002; Zhou *et al.*, 2003), this study has several limitations. First, the dietary intake was assessed for one day in

November; thus, it may not be a fair representation of the typical dietary consumption of individual subjects and, not only because of under/over reporting of VI, but also because the day-to-day food intake may vary and there may be seasonal variations as well. Second, some portion of the findings could likely be due to chance because we dealt with many variables in statistical models to cover important groups of vegetables and various indicators for lifestyles. Third, we were not able to access information on household income or educational level to analyze whether those factors are also associated with VI as has been reported in previous studies (Agudo *et al.*, 1999; Kirkpatrick and Tarasuk, 2003; Laaksonen *et al.*, 2003); and fourth, due to the cross-sectional design, causal hypotheses cannot be supported.

Conclusions

These analyses clearly demonstrate that VI among Japanese adults is associated with demographic factors such as area of residence, healthier behaviors and eating habits such as having meals away from home. We concluded that to increase VI, it is necessary to provide more nutritional education, such as how to cook vegetables, for Japanese aged 20–39 years and to focus on education about LSRD for subjects aged 40–69 years.

Conflict of interest

The authors declare no conflict of interest.

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