ORIGINAL

Dietary diversity and characteristics of lifestyle and awareness of health in Japanese workers : a cross-sectional study

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Abstract : The aim of this study was to clarify the characteristics of lifestyle and health awareness according to dietary diversity in a Japanese worksite population. The participants were 1,312 men and women aged 20 to 63 years who were living in Tokushima Prefecture, Japan during the period 2012-2013. We obtained anthropometric data and information on lifestyle characteristics using a self-administered questionnaire. Dietary intake was assessed using a food frequency questionnaire, and dietary diversity was determined using the Quantitative Index for Dietary Diversity (QUANTIDD). The characteristics of lifestyle and health awareness according to quartiles of the QUANTIDD score were assessed using the chi-square test and a general linear model. The higher the QUANTIDD score was, the larger were the proportions of participants who knew the appropriate amount of dietary intake and participants who referred to nutritional component information when choosing and / or buying food. Among participants with higher QUANTIDD scores, the proportion of participants who considered their current diet was good was high in women, whereas the proportion of participants who wanted to improve their diet in the future was high in men. Those results indicate that higher dietary diversity was related to better characteristics of lifestyle and awareness of health. J. Med. Invest. 67 : 255-264, August, 2020

Keywords **:** *dietary diversity, lifestyle, healthy conscious, Japanese workers, cross-sectional study*

INTRODUCTION

Poor eating habits including undereating or overeating have become public health problems in Japan. According to the National Health and Nutrition Survey, consumption of healthy food groups (such as fish and shellfish, beans, vegetables and fruits) by Japanese, especially young Japanese aged 20-30 years (1), has been decreasing. Dietary guidelines for Japanese recommend eating a variety of foods (2). Dietary guidelines for other countries also indicate the importance of eating a variety of foods at all ages (3, 4).

Research on dietary diversity has mainly focused on 1) whether sociological factors affect the diversity of ingested food (5-7) and 2) whether intake of various foods affects human health (8-11), particularly in older people and infants, though there has been no study conducted in workers. In a study on the relationships between sociological factors and diversity of food intake, various sociological factors including access to food, social support and the degree of involvement in cooking at home were shown to affect dietary diversity in older people (5). Motives for food selection (6) and household income level (7) have also been shown to affect dietary diversity. In a study on the relationship between health and dietary diversity, it was shown that dietary diversity predicts the nutritional status and health status of infants in developing countries (8). In older people, higher dietary diversity has been shown to decrease the risks of cognitive decline (9), mortality (10), obesity and / or metabolic syndrome (7, 11). Those previous studies showed that dietary diversity was not only influenced by sociological factors but was also related to some diseases. However, there are few reports about the characteristics of lifestyle and awareness of health according to dietary diversity.

Thus, we aimed to clarify the associations of dietary diversity with characteristics of lifestyle and awareness of health in Japanese workers.

PATIENTS AND METHODS / MATERIALS AND METHODS

Study population

This cohort study is a population-based annual examination of a dynamic cohort established in Tokushima Prefecture, which is located in Shikoku Island of Japan. Details of the number of participants have been previously reported (12).

Abbreviations used :
BMI, Body mass index ; FFQg, Food Frequency Questionnaire Based on Food Groups ; GLM, general linear model ; QUANTIDD, Quantitative Index for Dietary Diversity ; SD, standard deviation ; SE, standard error

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The present study population consisted of 1,399 men and women aged 20-63 years in Tokushima Prefecture. Participants with missing data for lifestyle and awareness of health (n = 8) and potential confounders (n = 54) including drinking habits, education and physical activity were excluded. Subjects with a medical history of cancer, heart disease or stroke (n = 13) were also excluded from analysis. Twelve participants whose daily total energy intake was extremely high (mean + 3 standard deviations (SDs) : 3176.2 kcal/day in men and 2807.8 kcal/day in women) or extremely low (mean - 3 SDs : 515.4 kcal/day in men and 496.4 kcal/day in women) were also excluded. Finally, data for the remaining 1,312 participants (969 men and 343 women) were analyzed in this study (Figure 1). The study protocol was approved by the institutional review boards of Tokushima University Hospital (ethical approval number : 2868).

Assessment of eating behavior and dietary awareness

Information on eating behavior and dietary awareness was obtained from self-reported questionnaires.

Regarding eating behavior, we obtained information on the weekly frequency (times/week) for skipping meals, eating snacks, eating bedtime snacks, eating out and takeaway food consumption. We also obtained information on dinner starting time, bedtime, and duration (number of hours) between dinner time and bedtime.

We assessed seven categorical variables for dietary awareness (knowledge about the appropriate amount of food intake, evaluation and recognition of own meal contents and/or consumption, evaluation of present dietary consumption, desire to improve present dietary habits, eating speed, reference to nutrient indications, and use of supplements) with the following questions. 1) Knowledge about the appropriate amount of food intake was estimated using the question 'Do you know the appropriate amount of food intake?'. The participants answered 'yes' or 'no'. 2) Evaluation and recognition of own meal contents and/or consumption were estimated using the question 'Do you think your amount of food intake is appropriate?'. The participants answered 'yes' or 'no'. 3) Evaluation of present dietary consumption was estimated using the question 'What do you think about your present dietary habits?'. The participants answered 'good', 'neither good nor bad' or 'bad'. 4) Desire to improve present dietary habits was estimated using the question 'Do you want to improve your present dietary habits in the future?'. The participants answered 'yes', 'no' or 'nothing in mind'. 5) Eating speed was estimated using the question 'What do you think about your eating speed?'. The participants answered 'fast', 'normal' or 'slow'. 6) Reference to nutrition facts was estimated using the question 'Do you refer to nutrition facts when you eat out or purchase food?'. The participants answered 'every time', 'sometimes' or 'never'. 7) Use of supplements was estimated using the question 'Have you used supplements more than once a week over the past year or more?'. The participants answered 'yes' or 'no'.

Dietary assessment

The participants were requested to complete a questionnaire to obtain data on their dietary intake.

Regarding the amounts of intake for food groups and energy, the participants were asked about meals taken in the past month using "Food Frequency Questionnaire Based on Food Groups (FFQg) ver. 2.0" (Kenpakusha Inc.) as a food frequency questionnaire method for determining the frequency and amount of food intake. Food intake was estimated using questionnaires about both the amounts and frequencies of intake of 29 food items and 10 cooked meals. Amounts of food intake were finally calculated for 17 food groups (cereals, potatoes, deep yellow vegetables, mushrooms and other vegetables, seaweed, beans, fish and shellfish, meat, eggs, milk, fruits, sweets, beverages, sugar and sweeteners, nuts and seeds, fat and oil, and seasonings and spices). The validity of FFQg was verified by Takahashi *et al.* by comparing food intake amounts using the weighting method for seven consecutive days (13). The participants were asked about the frequency and amount of all foods consumed at each meal (how many times and how much consumed per week). The amount of each food consumed per week was calculated by summing the product of the frequency of intake and the amount consumed at each meal.

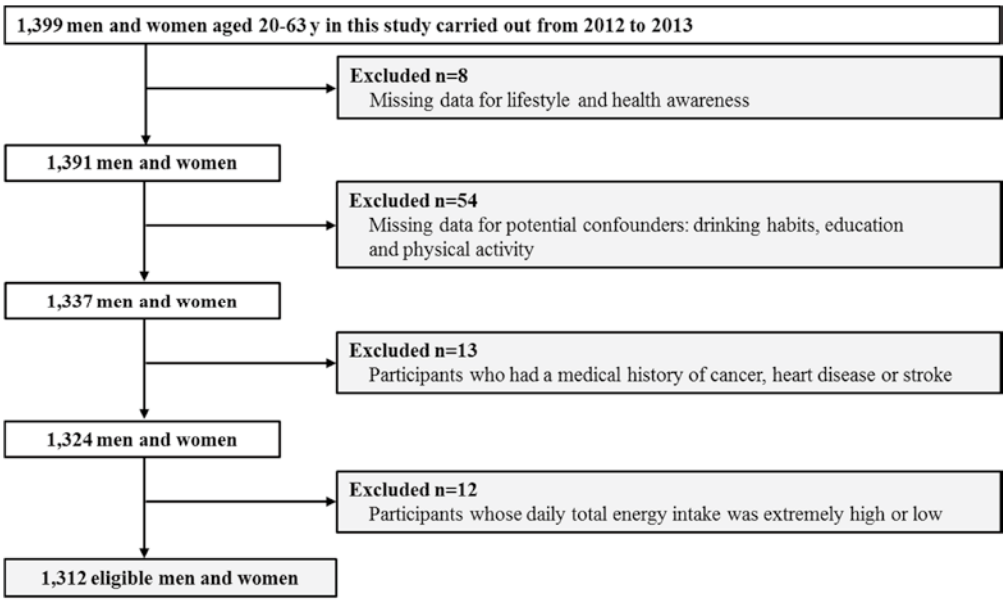

Figure 1. Overview of the participants.
Of the 1,399 participants aged 19-63 years, we excluded participants for whom some data were missing. Next, we excluded 13 subjects with a medical history of cancer, heart disease or stroke. We also excluded 12 participants whose daily total energy intake was extremely high or low. Data for the remaining 1,312 participants (969 men and 343 women) were used for analysis in this study.

Dietary diversity was determined using the Quantitative Index for Dietary Diversity (QUANTIDD) developed by Katanoda *et al*. (14) The QUANTIDD score is calculated by the proportion of foods that contribute to total energy or the amount of foods and the number of food groups using the following formula : QUANTIDD = (1-summation operation prop $[j]^2$)/(1-1/n), where prop (j) is the proportion of food group (s) j that contributes to total energy or nutrient intake, n is the number of food groups, and j = 1, 2, . ., n. The possible score ranges from 0 to 1. A higher score reflects equal distributions of food groups, and a lower score reflects an unbalanced diet. We calculated the score based on the amounts of 16 food groups excluding beverages (9, 12).

Other measurements

The participants were requested not to eat overnight and they underwent a medical health check-up the following day in each worksite. Body height was measured to the nearest 0.1 cm with participants standing without shoes, and body weight was measured to the nearest 0.1 kg with participants wearing lightweight clothing. Body mass index (BMI) was calculated by weight (kg)/the square of height (m^2). Daily values of physical activity (MET-hours/week) were calculated using the International Physical Activity Questionnaire (15). Data for medical history (binary ; yes or no), education (categorical ; elementary and junior high schools, high school and junior college, college and graduate school, other), drinking habits (binary ; current or former/never) and smoking habits (categorical ; current, former or never) were obtained by a self-administered questionnaire. The questionnaire was completed by subjects before the physical examination day, and then it was checked and collected.

Statistical analysis

At first, comparisons of the basic characteristics and dietary awareness characteristics of the participants according to the QUANTIDD score were performed. Continuous variables were expressed as mean ± SD or the median (25 percentile, 75 percentile), and simple comparisons of the means of the data were performed using analysis of variance or the Kruskal-Wallis test. Categorical variables were expressed as numbers (percentages, %), and comparisons of proportions were performed using the chi-square test. If the results of the chi-square test were significant for categorical variables regarding eating behavior and dietary awareness, Bonferroni's method was performed as a multiple-comparison method. The Jonckheere-Terpstra test for continuous variables and the Mantel-Haenszel test for categorical variables were used to calculate the p for trend.

Next, general linear models (GLMs) were used to estimate the adjusted means ± standard error (SE) of intake of food groups or weekly frequencies of dietary skipping, snacking, bedtime snacking, eating out and use of home-meal replacement according to the QUANTIDD score after controlling for age, energy intake, physical activity, smoking habits, drinking habits and education level. When we used those analyses to assess the associations of intake of food groups and the eight continuous variables for eating behavior with the QUANTIDD score, we controlled the following variables as potential confounders : age (continuous, years) and energy intake (continuous, kcal/day) for an age- and energy-adjusted model and 2) age- and energy-adjusted model + physical activity (continuous, MET-hours/week), smoking habits (categorical ; current, former or never), drinking habits (categorical ; current, former or never) and education level (categorical ; elementary, junior high and high schools, tertiary college, career college and junior college, college and graduate school or other) for a multivariate-adjusted model. For comparison of continuous variables according to 4 groups based on the QUANTIDD score, the least significant difference test was used as a post hoc test if the results of analysis using the GLM were significant.

To consider the possibility of exclusion of individuals with a high energy intake having affected the results, we performed reanalysis for the population including men who had an intake of 3176.2 kcal/day and women who had an intake of 2807.8 kcal/day, who had been excluded in our study.

All statistical tests were performed after stratification by sex for the following reasons : 1) the male-female ratio of our study population was 3 : 1, 2) there were difference in basic attributes between men and women, and 3) lifestyle and awareness of health differ in men and women (16, 17). All statistical tests were based on two-sided probabilities and were performed using SPSS version 18.0 J for Windows (SPSS Inc., Japan, Tokyo Japan). All p values < 0.05 were considered statistically significant.

RESULTS

Characteristics of the participants

Table 1 shows the characteristics of participants according to quartiles of the QUANTIDD score. The participants who had higher QUANTIDD scores were older and were higher energy consumers in both men and women. The proportion of current drinkers was higher in participants with higher QUANTIDD scores in both sexes. In men with higher QUANTIDD scores, the frequency of physical activity and the proportion of participants with a higher education level were higher, while the proportion of participants who were current smokers was lower.

Characteristics of participants with dietary awareness according to quartiles of the dietary diversity score

Table 2 shows the characteristics of participants with dietary awareness according to quartiles of the QUANTIDD score.

In both men and women, there were higher proportions of participants according to quartiles of the QUANTIDD score who always or sometimes refer to nutrition facts when eating out or purchasing food (p for trend < 0.001 in both men and women). In addition, the proportion of participants who understood the appropriate content and/or amount of meals was higher according to quartiles of the QUANTIDD score (p for trend = 0.022 in men and p for trend = 0.012 in women). In only women, the proportion of participants who evaluated their current diet as good was higher according to quartiles of the QUANTIDD score. On the other hand, there was a higher proportion of participants who wanted to improve their meals in the future only in men.

However, the significance for the proportion of participants who understood the appropriate content according to quartiles of the QUANTIDD score in women disappeared after Bonferroni's method as a multiple-comparison method.

Characteristics of eating behaviors according to quartiles of the dietary diversity score

Table 3 shows multivariate-adjusted means ± SE for each of the eating behaviors according to quartiles of the QUANTIDD score. In the age-energy adjustment model, no linear association was found with the QUANTIDD score for any eating behavior. In the multivariate adjustment model, a significant association between the frequency of dietary skipping and the QUANTIDD score was found (p = 0.049).

Intake of food groups according to quartiles of the dietary diversity score

Intake of food groups according to quartiles of the QUANTIDD score by sex is shown in Table 4. In the age-and energy-adjusted model, cereal intake decreased with increase in the QUANTIDD score in both sexes. In addition, consumption of all food groups

Table 1. Characteristics of participants according to quartiles of the dietary diversity score in this study by sex

	QUANTIDD score §§				p-value	p for trend
	Q1 (lowest)	Q2	Q3	Q4 (highest)		
Men (n=969)						
Number of subjects	242 (25.0)	243 (25.1)	242 (25.0)	242 (25.0)		
Age (years) †, ¶	39.9 ± 9.8	40.7 ± 9.4	41.4 ± 10.0	42.8 ± 10.3	0.012	0.002
BMI (kg/m^2) †, ¶	23.9 ± 3.4	23.9 ± 3.4	23.8 ± 3.4	23.8 ± 3.2	0.960	0.652
Physical activity (MET-hours/week) §, ††	7.4 (0.8, 22.4)	8.6 (1.3, 25.3)	12.4 (4.0, 29.8)	16.8 (5.9, 37.8)	<0.001	<0.001
Energy intake (kcal/day) †, ¶	1704.9 ± 418.6	1798.9 ± 372.2	1815.6 ± 393.6	2009.2 ± 10.3	<0.001	<0.001
Smoking habits ‡, ‡‡					0.001	<0.001
Current	109 (45.0)	88 (36.2)	69 (28.5)	75 (31.0)		
Former or never	133 (54.9)	155 (63.8)	173 (71.4)	167 (69.0)		
Drinking habits ‡, ‡‡					0.115	0.019
Current	135 (55.8)	149 (61.3)	150 (62.0)	161 (66.5)		
Former or never	107 (44.2)	94 (38.6)	92 (38.1)	81 (33.4)		
Education level ‡, ‡‡					<0.001	<0.001
Elementary, junior high schools and high school	80 (33.1)	54 (22.2)	60 (24.8)	46 (19.0)		
Tertiary college, career college and junior college	59 (24.4)	63 (25.9)	44 (18.2)	43 (17.8)		
College and graduate school	103 (42.6)	126 (51.9)	137 (56.6)	153 (63.2)		
Other	0 (0.0)	0 (0.0)	1 (0.4)	0 (0.0)		
Women (n=343)						
Number of subjects	85 (24.8)	86 (25.1)	87 (25.4)	85 (24.8)		
Age (years) †, ¶	36.1 ± 8.6	38.8 ± 8.7	41.2 ± 9.6	41.9 ± 10.6	<0.001	<0.001
BMI (kg/m^2) †, ¶	20.7 ± 2.9	21.3 ± 3.0	21.6 ± 3.3	21.5 ± 3.1	0.289	0.093
Physical activity (MET-hours/week) §, ††	6.6 (0.9, 16.0)	6.3 (2.0, 14.6)	8.1 (1.3, 23.0)	8 (3.6, 20.7)	0.326	0.078
Energy intake (kcal/day) †, ¶	1418.1 ± 278.7	1603.4 ± 276.8	1730.5 ± 329.3	1792.0 ± 405.0	<0.001	<0.001
Smoking habits ‡, ‡‡					0.254	0.182
Current	10 (11.8)	4 (4.7)	5 (5.7)	5 (5.9)		
Former or never	75 (88.2)	82 (95.3)	82 (94.2)	80 (94.1)		
Drinking habits ‡, ‡‡					0.092	0.013
Current	20 (23.5)	25 (29.1)	28 (32.2)	35 (41.2)		
Former or never	65 (76.5)	61 (71.0)	59 (67.8)	50 (58.8)		
Education level ‡, ‡‡					0.542	0.460
Elementary, junior high schools and high school	22 (25.9)	22 (25.8)	25 (28.7)	23 (27.1)		
Tertiary college, career college and junior college	23 (27.1)	19 (22.1)	17 (19.5)	22 (25.9)		
College and graduate school	40 (47.1)	45 (52.3)	45 (51.7)	40 (47.1)		
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		

† Mean ± SD ‡ Number (%) § Median (25 percentile, 75 percentile)

¶ Analysis of variance was used to calculate the p value and the Jonckheere-Terpstra test was used to calculate the p for trend.

†† The Kruskal-Wallis test was used to calculate the p value and the Jonckheere-Terpstra test was used to calculate the p for trend.

‡‡ The chi-square test was used to calculate the p value and the Mantel-Haenszel test was used to calculate the p for trend.

§§ QUANTIDD score: Q1: 0-0.7725, Q2: 0.7726-0.8303, Q3: 0.8304-0.8719, Q4: 0.8720-1.00 for men, Q1: 0-0.8364, Q2: 0.8365-0.8798, Q3: 0.8799-0.9053, Q4: 0.9054-1.00 for women.

Table 2. Characteristics of dietary awareness according to quartiles of the dietary diversity score by sex [†,‡,§]

	QUANTIDD score [¶]				*p*- value	*p* for trend
	Q1 (lowest)	Q2	Q3	Q4 (highest)		
Men (n=969)						
Number of subjects	242	243	242	242		
Do you know the appropriate amount of food intake?					0.095	0.022
Yes	110 (45.5) [a]	116 (47.7) [a, b]	117 (48.3) [a, b]	136 (56.2) [b]		
No	132 (54.5)	127 (52.3)	125 (51.7)	106 (43.8)		
Do you think your amount of food intake is appropriate?					0.708	0.537
Yes	154 (63.6)	154 (63.4)	150 (62.0)	162 (66.9)		
No	88 (36.4)	89 (36.6)	92 (38.0)	80 (33.1)		
What do you think about your present dietary habits?					0.537	0.161
Good	16 (6.6)	12 (4.9)	15 (6.2)	21 (8.7)		
Neither good nor bad	138 (57.0)	155 (63.8)	147 (60.7)	147 (60.7)		
Bad	88 (36.4)	76 (31.3)	80 (33.1)	74 (30.6)		
Do you want to improve your present dietary habits in the future?					0.005	0.001
Yes	124 (51.2) [a]	122 (50.2) [a, b]	134 (55.4) [a, b]	143 (59.1) [b]		
No	49 (20.2)	66 (27.2)	63 (26.0)	65 (26.9)		
Nothing in mind	69 (28.5)	55 (22.6)	45 (18.6)	34 (14.0)		
What do you think about your eating speed?					0.273	0.100
Fast	118 (48.8)	115 (47.3)	111 (45.9)	103 (42.6)		
Normal	101 (41.7)	115 (47.3)	108 (44.6)	111 (45.9)		
Slow	23 (9.5)	13 (5.3)	23 (9.5)	28 (11.6)		
Do you refer to nutrient indications when you eat out or purchase food?					<0.001	<0.001
Every time	9 (3.7) [a]	9 (3.7) [a]	12 (5.0) [a]	34 (14.0) [b]		
Sometimes	69 (28.5)	84 (34.6)	95 (39.3)	103 (42.6)		
Never	164 (67.8)	150 (61.7)	135 (55.8)	105 (43.4)		
Have you used supplements more than once a week over the past year or more?					0.437	0.173
Yes	14 (5.8)	21 (8.6)	23 (9.5)	22 (9.1)		
No	228 (94.2)	222 (91.4)	219 (90.5)	220 (90.9)		
Women (n=343)						
Number of subjects	85	86	87	85		
Do you know the appropriate amount of food intake?					0.035	0.012
Yes	46 (54.1)	50 (58.1)	50 (57.5)	63 (74.1)		
No	39 (45.9)	36 (41.9)	37 (42.5)	22 (25.9)		
Do you think your amount of food intake is appropriate?					0.272	0.290
Yes	49 (57.6)	52 (60.5)	47 (54.0)	58 (68.2)		
No	36 (42.4)	34 (39.5)	40 (46.0)	27 (31.8)		
What do you think about your present dietary habits?					0.376	0.021
Good	1 (1.2)	2 (2.3)	3 (3.4)	5 (5.9)		
Neither good nor bad	41 (48.2)	47 (54.7)	47 (54.0)	50 (58.8)		
Bad	43 (50.6)	37 (43.0)	37 (42.5)	30 (35.3)		
Do you want to improve your present dietary habits in the future?					0.272	0.131
Yes	57 (67.1)	57 (66.3)	67 (77.0)	59 (69.4)		
No	12 (14.1)	15 (17.4)	14 (16.1)	17 (20.0)		
Nothing in mind	16 (18.8)	14 (16.3)	6 (6.9)	9 (10.6)		
What do you think about your eating speed?					0.267	0.071
Fast	33 (38.8)	32 (37.2)	34 (39.1)	42 (49.4)		
Normal	39 (45.9)	48 (55.8)	45 (51.7)	37 (43.5)		
Slow	13 (15.3)	6 (7.0)	8 (9.2)	6 (7.1)		
Do you refer to nutrient indications when you eat out or purchase food?					0.003	<0.001
Everytime	8 (9.4) [a]	9 (10.5) [a, b]	17 (19.5) [a, b]	24 (28.2) [b]		
Sometimes	40 (47.1)	53 (61.6)	42 (48.3)	41 (48.2)		
Never	37 (43.5)	24 (27.9)	28 (32.2)	20 (23.5)		
Have you used supplements more than once a week over the past year or more?					0.820	0.822
Yes	13 (15.3)	9 (10.5)	12 (13.8)	11 (12.9)		
No	72 (84.7)	77 (89.5)	75 (86.2)	74 (87.1)		

† Number (%)

‡ The chi-square test was used to calculate the *p* value and the Mantel-Haenszel test was used to calculate the *p* for trend.

§ Different letters indicate significant differences between groups after Bonferroni's method.

¶ QUANTIDD score: Q1: 0-0.7725, Q2: 0.7726-0.8303, Q3: 0.8304-0.8719, Q4: 0.8720-1.00 for men, Q1: 0-0.8364, Q2: 0.8365-0.8798, Q3: 0.8799-0.9053, Q4: 0.9054-1.00 for women.

Table 3. Characteristics of eating behaviors according to quartiles of the dietary diversity score by sex †,‡,††,‡‡

	Age and energy adjusted model §				*p*-value	Multivariate adjusted model ¶				*p*-value
	Q1 (lowest)	Q2	Q3	Q4 (highest)		Q1 (lowest)	Q2	Q3	Q4 (highest)	
Men (n=969)										
Number of subjects	242	243	242	242		242	243	242	242	
Dietary skipping (times/week)	1.99 ± 0.17	1.80 ± 0.17	1.97 ± 0.17	1.83 ± 0.17	0.799	1.89 ± 0.17	1.77 ± 0.16	2.03 ± 0.16	1.89 ± 0.17	0.745
Snacking (times/week)	2.83 ± 0.17	3.17 ± 0.17	3.36 ± 0.17	3.00 ± 0.17	0.126	2.82 ± 0.17	3.19 ± 0.17	3.34 ± 0.17	3.01 ± 0.17	0.133
Bedtime snacking (times/week)	0.83 ± 0.10	0.76 ± 0.10	0.74 ± 0.10	0.86 ± 0.10	0.787	0.75 ± 0.10	0.75 ± 0.10	0.76 ± 0.10	0.92 ± 0.10	0.583
Eating out (times/week)	3.27 ± 0.18	3.58 ± 0.18	3.54 ± 0.18	3.72 ± 0.18	0.375	3.39 ± 0.18	3.60 ± 0.17	3.51 ± 0.17	3.60 ± 0.18	0.825
Home-meal replacement (times/week)	1.91 ± 0.14	1.66 ± 0.13	1.87 ± 0.13	1.63 ± 0.14	0.354	1.85 ± 0.14	1.66 ± 0.13	1.89 ± 0.13	1.67 ± 0.14	0.504
Dinner time (o'clock)	20.36 ± 0.08	20.25 ± 0.08	20.26 ± 0.08	20.24 ± 0.08	0.697	20.38 ± 0.08	20.25 ± 0.08	20.28 ± 0.08	20.20 ± 0.08	0.461
Bedtime (o'clock)	23.79 ± 0.07	23.81 ± 0.07	23.79 ± 0.07	23.80 ± 0.07	0.996	23.80 ± 0.07	23.81 ± 0.07	23.79 ± 0.07	23.79 ± 0.07	0.994
Duration between dinner time and bedtime (hours)	3.43 ± 0.08	3.55 ± 0.08	3.51 ± 0.08	3.53 ± 0.08	0.727	3.41 ± 0.08	3.56 ± 0.08	3.49 ± 0.08	3.55 ± 0.08	0.515
Women (n=343)										
Number of subjects	85	86	87	85		85	86	87	85	
Dietary skipping (times/week)	0.76 ± 0.25	1.34 ± 0.24	0.95 ± 0.24	1.65 ± 0.25	0.055	0.70 ± 0.25[a]	1.40 ± 0.23[b]	1.01 ± 0.23[a, b]	1.60 ± 0.24[b]	0.049
Snacking (times/week)	5.51 ± 0.39	5.33 ± 0.37	5.33 ± 0.37	5.92 ± 0.38	0.648	5.42 ± 0.39	5.29 ± 0.36	5.28 ± 0.37	6.10 ± 0.38	0.357
Bedtime snacking (times/week)	0.41 ± 0.16	0.79 ± 0.15	0.54 ± 0.15	0.73 ± 0.15	0.261	0.38 ± 0.16	0.79 ± 0.15	0.55 ± 0.15	0.75 ± 0.15	0.205
Eating out (times/week)	2.17 ± 0.29	2.24 ± 0.27	2.92 ± 0.27	2.37 ± 0.28	0.203	2.21 ± 0.29	2.22 ± 0.27	2.92 ± 0.27	2.35 ± 0.28	0.206
Home-meal replacement (times/week)	1.92 ± 0.24	1.92 ± 0.22	1.62 ± 0.22	1.73 ± 0.23	0.763	1.88 ± 0.24	1.92 ± 0.22	1.63 ± 0.22	1.77 ± 0.23	0.818
Dinner time (o'clock)	19.55 ± 0.12	19.54 ± 0.11	19.49 ± 0.11	19.63 ± 0.11	0.812	19.57 ± 0.12	19.53 ± 0.11	19.48 ± 0.11	19.63 ± 0.11	0.785
Bedtime (o'clock)	23.87 ± 0.12	23.69 ± 0.12	23.56 ± 0.12	23.83 ± 0.12	0.241	23.84 ± 0.12	23.69 ± 0.12	23.57 ± 0.12	23.85 ± 0.12	0.269
Duration between dinner time and bedtime (hours)	4.32 ± 0.14	4.16 ± 0.13	4.06 ± 0.13	4.17 ± 0.13	0.617	4.28 ± 0.14	4.17 ± 0.13	4.07 ± 0.13	4.19 ± 0.13	0.767

† Adjusted mean ± standard error

‡ A general linear model was used to calculate the adjusted means and *p* value.

§ Age- and energy- adjusted model: Adjusted for age (continuous, years) and energy intake (continuous, kcal/day).

¶ Multivariate- adjusted model: Adjusted for age, energy intake, physical activity (continuous, MET-hours/week), smoking habits (categorical; current, former or never), drinking habits (categorical; current, former or never) and education level (categorical; elementary, junior high schools and high school, tertiary college, career college and junior college, college and graduate school or other).

†† Different letters indicate significant differences between groups after using the least significant difference test as a post hoc test.

‡‡ QUANTIDD score: Q1: 0-0.7725, Q2: 0.7726-0.8303, Q3: 0.8304-0.8719, Q4: 0.8720-1.00 for men, Q1: 0-0.8364, Q2: 0.8365-0.8798, Q3: 0.8799-0.9053, Q4: 0.9054-1.00 for women.

Table 4. Intake of food groups according to quartiles of the dietary diversity score by sex †, ‡, ††, ‡‡

	Age and energy adjusted model §				*p*-value	Multivariate adjusted model ¶				*p*-value
	Q1 (lowest)	Q2	Q3	Q4 (highest)		Q1 (lowest)	Q2	Q3	Q4 (highest)	
Men (n=969)										
Number of subjects	242	243	242	242		242	243	242	242	
Cereals (g/day)	500.5 ± 4.6 [a]	417.5 ± 4.5 [b]	374.6 ± 4.6 [c]	304.1 ± 4.7 [d]	<0.001	502.0 ± 4.6 [a]	418.3 ± 4.5 [b]	373.3 ± 4.5 [c]	303.1 ± 4.6 [d]	<0.001
Potatoes and starches (g/day)	11.7 ± 1.1 [a]	16.8 ± 1.1 [b]	19.1 ± 1.1 [b]	29.2 ± 1.1 [c]	<0.001	12.0 ± 1.1 [a]	17.0 ± 1.1 [b]	18.9 ± 1.1 [b]	29.0 ± 1.1 [c]	<0.001
Deep yellow vegetables (g/day)	31.0 ± 1.8 [a]	41.3 ± 1.8 [b]	47.3 ± 1.8 [c]	65.4 ± 1.8 [d]	<0.001	32.0 ± 1.8 [a]	41.3 ± 1.8 [b]	47.1 ± 1.8 [c]	64.7 ± 1.8 [d]	<0.001
Mushrooms and other vegetables (g/day)	50.1 ± 2.7 [a]	67.1 ± 2.6 [b]	84.6 ± 2.6 [c]	108.7 ± 2.7 [d]	<0.001	50.9 ± 2.7 [a]	67.1 ± 2.6 [b]	84.2 ± 2.6 [c]	108.3 ± 2.7 [d]	<0.001
Seaweed (g/day)	2.0 ± 0.1 [a]	2.5 ± 0.1 [b]	2.8 ± 0.1 [b]	4.2 ± 0.1 [c]	<0.001	2.0 ± 0.1 [a]	2.4 ± 0.1 [b]	2.8 ± 0.1 [b]	4.1 ± 0.1 [c]	<0.001
Beans (g/day)	26.8 ± 1.7 [a]	33.8 ± 1.7 [b]	41.3 ± 1.7 [c]	56.3 ± 1.7 [d]	<0.001	27.1 ± 1.7 [a]	33.9 ± 1.7 [b]	41.0 ± 1.7 [c]	56.3 ± 1.8 [d]	<0.001
Fish and shellfish (g/day)	38.6 ± 1.9 [a]	45.7 ± 1.9 [b]	51.0 ± 1.9 [c]	62.2 ± 1.9 [d]	<0.001	39.5 ± 1.9 [a]	45.7 ± 1.9 [b]	50.6 ± 1.9 [b]	61.7 ± 1.9 [c]	<0.001
Meat (g/day)	74.2 ± 2.3 [a]	81.9 ± 2.3 [b]	90.1 ± 2.3 [c]	90.2 ± 2.3 [c]	<0.001	74.4 ± 2.3 [a]	82.2 ± 2.2 [b]	89.8 ± 2.2 [c]	90.1 ± 2.3 [c]	<0.001
Eggs (g/day)	25.1 ± 1.1 [a]	26.4 ± 1.1 [a]	31.2 ± 1.1 [b]	32.2 ± 1.1 [b]	<0.001	25.0 ± 1.1 [a]	26.5 ± 1.1 [a]	31.2 ± 1.1 [b]	32.1 ± 1.1 [b]	<0.001
Milk and dairy products (g/day)	55.0 ± 5.9 [a]	87.0 ± 5.8 [b]	107.2 ± 5.8 [c]	128.5 ± 6.0 [d]	<0.001	55.7 ± 5.9 [a]	87.3 ± 5.8 [b]	106.9 ± 5.8 [c]	127.8 ± 6.0 [d]	<0.001
Fruits (g/day)	21.2 ± 2.7 [a]	27.1 ± 2.7 [a]	41.0 ± 2.7 [b]	67.4 ± 2.8 [c]	<0.001	21.4 ± 2.7 [a]	27.4 ± 2.6 [a]	40.6 ± 2.7 [b]	67.4 ± 2.7 [c]	<0.001
Confectioneries (g/day)	52.2 ± 2.5 [a]	60.0 ± 2.5 [b]	63.9 ± 2.5 [b]	64.9 ± 2.5 [b]	0.001	51.0 ± 2.5 [a]	59.9 ± 2.4 [b]	64.3 ± 2.4 [b]	65.8 ± 2.5 [b]	<0.001
Beverages (g/day)	318.2 ± 15.1 [a]	312.2 ± 14.9 [a]	261.2 ± 14.9 [b]	274.6 ± 15.3 [a, b]	0.017	314.4 ± 14.3	307.3 ± 13.9	267.3 ± 13.9	277.2 ± 14.4	0.055
Sugar and sweeteners (g/day)	3.6 ± 0.2 [a]	4.0 ± 0.2 [a, b]	4.5 ± 0.2 [b]	6.3 ± 0.2 [c]	<0.001	3.6 ± 0.2 [a]	4.0 ± 0.2 [a, b]	4.5 ± 0.2 [b]	6.3 ± 0.2 [c]	<0.001
Nuts and seeds (g/day)	1.3 ± 0.2 [a]	1.6 ± 0.2 [a]	1.6 ± 0.2 [a]	2.4 ± 0.2 [b]	<0.001	1.3 ± 0.2 [a]	1.6 ± 0.2 [a]	1.6 ± 0.2 [a]	2.4 ± 0.2 [b]	<0.001
Fat and oil (g/day)	10.6 ± 0.4 [a]	12.9 ± 0.4 [b]	13.5 ± 0.4 [b]	14.8 ± 0.4 [c]	<0.001	10.6 ± 0.4 [a]	12.9 ± 0.4 [b]	13.5 ± 0.4 [b]	14.8 ± 0.4 [c]	<0.001
Seasonings and spices (g/day)	21.3 ± 0.6 [a]	22.8 ± 0.6 [a, b]	24.5 ± 0.6 [b]	24.9 ± 0.7 [c]	<0.001	21.3 ± 0.7 [a]	22.8 ± 0.6 [a, b]	24.5 ± 0.6 [b]	24.8 ± 0.7 [c]	0.001
Women (n=343)										
Number of subjects	85	86	87	85		85	86	87	85	
Cereals (g/day)	382.2 ± 6.3 [a]	337.5 ± 5.9 [b]	320.0 ± 6.0 [c]	244.7 ± 6.1 [d]	<0.001	381.3 ± 6.2 [a]	336.8 ± 5.8 [b]	319.0 ± 5.8 [c]	247.3 ± 6.0 [d]	<0.001
Potatoes and starches (g/day)	16.8 ± 2.3 [a]	23.7 ± 2.1 [b]	33.1 ± 2.2 [c]	33.2 ± 2.2 [c]	<0.001	16.8 ± 2.3 [a]	23.6 ± 2.1 [b]	33.0 ± 2.2 [c]	33.5 ± 2.2 [c]	<0.001
Deep yellow vegetables (g/day)	37.2 ± 3.7 [a]	48.3 ± 3.5 [b]	71.7 ± 3.5 [c]	79.7 ± 3.6 [c]	<0.001	37.5 ± 3.6 [a]	48.2 ± 3.4 [b]	71.6 ± 3.4 [c]	79.6 ± 3.5 [c]	<0.001
Mushrooms and other vegetables (g/day)	67.1 ± 5.8 [a]	83.6 ± 5.4 [b]	116.6 ± 5.4 [c]	120.9 ± 5.6 [c]	<0.001	67.9 ± 5.7 [a]	83.5 ± 5.3 [b]	116.7 ± 5.3 [c]	120.1 ± 5.5 [c]	<0.001
Seaweed (g/day)	2.3 ± 0.3 [a]	2.1 ± 0.2 [a]	3.6 ± 0.2 [b]	3.2 ± 0.2 [b]	<0.001	2.2 ± 0.3 [a]	2.0 ± 0.2 [a]	3.6 ± 0.2 [b]	3.3 ± 0.2 [b]	<0.001
Beans (g/day)	30.4 ± 3.0 [a]	34.7 ± 2.8 [a]	42.1 ± 2.8 [b]	44.6 ± 2.9 [b]	0.005	30.3 ± 3.0 [a]	34.5 ± 2.8 [a]	41.9 ± 2.9 [b]	45.0 ± 3.0 [b]	0.004
Fish and shellfish (g/day)	31.8 ± 2.9 [a]	43.9 ± 2.7 [b]	52.2 ± 2.7 [c]	56.4 ± 2.8 [c]	<0.001	31.8 ± 2.9 [a]	43.8 ± 2.7 [b]	52.2 ± 2.7 [c]	56.5 ± 2.8 [c]	<0.001
Meat (g/day)	65.7 ± 3.9 [a]	75.1 ± 3.6 [a, b]	78.2 ± 3.6 [b]	82.8 ± 3.7 [b]	0.023	66.3 ± 3.8 [a]	75.0 ± 3.6 [a, b]	78.3 ± 3.6 [b]	82.2 ± 3.7 [b]	0.038
Eggs (g/day)	24.4 ± 1.7	24.3 ± 1.6	26.9 ± 1.6	28.1 ± 1.6	0.323	24.5 ± 1.7	24.1 ± 1.6	26.7 ± 1.6	28.4 ± 1.6	0.253
Milk and dairy products (g/day)	103.8 ± 10.0	112.8 ± 9.3	111.3 ± 9.3	99.4 ± 9.6	0.706	104.1 ± 10.0	112.8 ± 9.3	110.9 ± 9.4	99.6 ± 9.8	0.740
Fruits (g/day)	37.7 ± 6.4 [a]	42.9 ± 6.0 [a]	69.4 ± 6.0 [b]	85.7 ± 6.2 [b]	<0.001	36.7 ± 6.4 [a]	42.8 ± 5.9 [b]	69.1 ± 6.0 [a, b]	87.1 ± 6.2 [a, b]	<0.001
Confectioneries (g/day)	71.1 ± 4.5	70.6 ± 4.2	66.1 ± 4.3	80.1 ± 4.4	0.128	70.0 ± 4.4	70.8 ± 4.1	65.9 ± 4.1	81.1 ± 4.3	0.072
Beverages (g/day)	101.2 ± 14.0	92.1 ± 13.1	79.3 ± 13.2	116.4 ± 13.6	0.234	106.8 ± 12.5	95.3 ± 11.6	84.9 ± 11.7	101.8 ± 12.1	0.598
Sugar and sweeteners (g/day)	5.2 ± 0.5 [a]	5.7 ± 0.4 [a]	6.4 ± 0.4 [a, b]	7.3 ± 0.4 [b]	0.012	5.1 ± 0.4 [a]	5.8 ± 0.4 [a, b]	6.4 ± 0.4 [b, c]	7.3 ± 0.4 [c]	0.007
Nuts and seeds (g/day)	1.0 ± 0.4 [a]	1.6 ± 0.3 [a]	1.9 ± 0.3 [a, b]	2.6 ± 0.4 [b]	0.028	0.9 ± 0.4 [a]	1.5 ± 0.3 [a]	1.9 ± 0.3 [a, b]	2.7 ± 0.4 [b]	0.013
Fat and oil (g/day)	11.8 ± 0.7	12.6 ± 0.6	12.9 ± 0.6	13.1 ± 0.6	0.577	11.8 ± 0.7	12.6 ± 0.6	12.8 ± 0.6	13.1 ± 0.6	0.615
Seasonings and spices (g/day)	19.6 ± 1.0	18.7 ± 0.9	19.4 ± 0.9	18.5 ± 0.9	0.812	19.6 ± 1.0	18.7 ± 0.9	19.4 ± 0.9	18.5 ± 0.9	0.822

† Adjusted mean ± standard error

‡ A general linear model was used to calculate the adjusted means and p value.

§ Age- and energy- adjusted model: Adjusted for age and energy intake.

¶ Multivariate- adjusted model: Adjusted for age, energy intake, physical activity (continuous, MET-hours/week), smoking habits (categorical; current, former or never), drinking habits (categorical; current, former or never) and education level (categorical; elementary, junior high schools and high school, tertiary college, career college and junior college, college and graduate school or other).

†† Different letters indicate significant differences between groups after using the least significant difference test as a post hoc test.

‡‡ QUANTIDD score: Q1: 0-0.7725, Q2: 0.7726-0.8303, Q3: 0.8304-0.8719, Q4: 0.8720-1.00 for men, Q1: 0-0.8364, Q2: 0.8365-0.8798, Q3: 0.8799-0.9053, Q4: 0.9054-1.00 for women.

except cereals and beverages increased with increase in the QUANTIDD score in men. In women, intake of potatoes, deep yellow vegetables, mushrooms and other vegetables, seaweed, beans, fish and shellfish, meat, fruits, sugar and sweeteners, and nuts and seeds increased with increase in the QUANTIDD score. In the multivariate-adjusted model, the results were similar to those in the age-and energy-adjusted model.

Reanalysis including those excluded due to high energy intake

The results were not substantially changed by the inclusion of men with an intake of 3176.2 kcal/day and women with an intake of 2807.8 kcal/day, who had been excluded in our study.

DISCUSSION

In our study, a higher QUANTIDD score was associated with a higher proportion of participants who referred to nutrition labeling when eating out or purchasing food. Furthermore, there were gender differences in amounts of intake of food groups and/or awareness of their meals. These results did not change substantially when including men and women who had been excluded due to a high energy intake, and our results are considered to be robust.

A positive association between dietary diversity and better dietary awareness such as referring to nutrition labeling when eating out or purchasing food was found in both men and women. A possible reason for our results is that higher dietary diversity reflects healthy dietary habits. It has been shown that dietary diversity directly affects food quality in older people (18), though there is no evidence for this in workers. Actually, regardless of the age group, both male and female participants who had a higher QUANTIDD score tended to consume more healthy food groups such as vegetables, fruits, fish and beans. Although the male participants who had a higher QUANTIDD score tended to consume more unhealthy food groups including sugar and sweeteners, fat and oil, seasonings and spices, and confectioneries in addition to healthy food groups, the contribution of unhealthy food groups to the QUANTIDD score was low, and the influence of these food groups might be small : contribution rate of healthy food groups of 25.0% v.s. contribution rate of unhealthy food groups of 10.7%. In middle-aged Japanese people, it has been reported that better dietary awareness/attitude (e.g., self-efficacy in consuming 5 or more vegetable dishes per day), dietary knowledge (e.g., being able to understand the appropriate volume or obesity prevention effectiveness) and/or dietary behavior (e.g., frequency of cooking meals) were major factors for higher vegetable consumption, which is a healthy eating behavior (19). Therefore, from results of previous studies and our results, it is expected that Japanese with a high dietary diversity have a high level of awareness about health. Another possible reason for the present results may be a difference for men and women. The possible reason is related to increasing age with increase in the QUANTIDD score in women. Since Japanese women in their 20s and 30s are in charge of both housework and childcare after marriage and childbirth (20), it has been reported that the time spent doing housework including cooking becomes longer with advance of age for women (21). In a previous study, the existence of family members and child rearing were shown to be important as motivative factors for women to be cooking (22). Monsivais *et al*. also reported that spending time for preparing meals at home is essential for healthy eating habits (23). On the other hand, another reason for men is related to increasing education level with increase in the QUANTIDD score. In men with higher QUANTIDD scores, the frequency of physical activity and the proportions of participants with a higher education level were higher, while the proportion of participants who were current smokers was lower in the present study. With regard to educational background, it has been reported that the higher the educational background is, the better is the understanding of various health and medical information, and that educational background has a positive effect on health knowledge (24). Thus, both men and women with higher QUANTIDD scores might have better dietary awareness such as referring to nutrition labeling.

In our study, there were gender differences in the amounts of intake of food groups and/or degree of consciousness regarding meals. Claudia *et al*. reported that women tend to make healthy food choices and/or have healthier dietary behavior compared to those for men (17). In addition, according to the Awareness Survey Report on Food Education in 2018, the proportions of respondents who answered "I am keeping a healthy dietary lifestyle in mind" were about 68.3% for men and 83.9% for women (25). Regarding the question about "whether nutritional balance is taken into consideration in daily eating habits", the proportions of respondents who responded "taking into consideration almost daily" were 54.6% for men and 61.0% for women (25). Those results mean that women make more efforts that men do to improve their current dietary lifestyle. Thus, women might have been more conscious than men of their current diet in our study, though the significant difference in the proportion of participants who understood the appropriate content according to quartiles of the QUANTIDD score in women disappeared after Bonferroni's method. Additionally, men might have been conscious about trying to change their dietary habits to better ones in the future.

This study is the first study on the characteristics of lifestyle and awareness of health according to dietary diversity among Japanese workers, though the study area is a limited region. However, our study has some limitations. First, because of the cross-sectional approach, the temporal relationships of dietary diversity with characteristics of lifestyle and health awareness remain obscure. Second, the sample size of this study, especially for women, was small. Third, the findings might not be generalizable to other populations because the study participants were only Japanese workers. We could not obtain information on the kind of occupation for each of the participants, though the kind of occupation is important information for workers. Fourth, dietary diversity using the QUANTIDD score was calculated from FFQ data in this study. FFQ is an advanced form of the checklist in the dietary history method that asks respondents how often and how much food they ate over a specific period (26, 27). Therefore, since the answer depends on the memory of participants, there might be a deviation from the actual food intake. However, the validity and reproducibility of the FFQ used in our study were confirmed through comparison with the 7-day recording method among residents in Tokushima Prefecture (13). Fifth, information on eating behavior and eating consciousness was based on self-reporting. Since answers were obtained according to the judgment of each participant, there is a possibility that cognitive bias and recall bias occurred. In addition, it is difficult to comprehensively evaluate food consciousness and eating behavior only by the questions in the questionnaire used in this study. Sixth, we could not obtain information on social factors such as differences in family composition (e.g., household composition, marital status, and presence of children) and employment patterns, though information on social factors is important information for dietary lifestyle. It has been reported that married people have more vegetable intake than unmarried people do and that unmarried men select easy-to-prepare meals more than do married men (28). It has also been reported that the existence of a spouse and family social support are important factors for increasing vegetable consumption (29). In addition, factors such as working style and working hours have been reported to affect eating habits (30). However, because such information could not be considered in our study, it will be necessary to conduct research with consideration of social factors such as differences in family composition and employment patterns.

In conclusion, our results indicate the possibility that dietary diversity reflects intake of healthy food groups and/or healthy dietary awareness such as referring to nutrition labeling when eating out or purchasing food. Further large studies on the characteristics of lifestyle and health awareness according to dietary diversity are needed.

CONFLICT OF INTEREST

All authors state that they have no conflicts of interest.

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