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Variation in Men's Dietary Intake Between Occupations, Based on Data From the Japan Environment and Children's Study

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Abstract

There has been increasing interest in dietary health promotion in the workplace. Although many previous studies have focused on dietary habits in specific occupations, variation between occupational groups requires clarification. The present study aimed to examine differences in food and nutrient intake between occupational groups, using detailed classification. A cross-sectional study was conducted using data from the Japan Environment and Children's Study. The study included 38,721 employed Japanese expectant fathers aged between 20 and 65 years. Dietary intake was assessed using a food frequency questionnaire. Occupations were categorized into 11 categories according to the Japan Standard Occupational Classification. Analysis of variance and analysis of covariance were performed to compare dietary intake of occupational groups. Logistic regression analysis was performed to examine the differences in adherence to dietary recommendations across occupations. Dietary intake differed significantly between occupations. Specific dietary intake was observed in security and agricultural workers, who tended to exhibit higher consumption levels for numerous foods and nutrients. In addition, relative to other workers, security workers showed higher intake of dairy products and calcium, and agricultural workers consumed larger amounts of pickles and salt. The study categorized occupations into detailed categories using the Japan Standard Occupational Classification, which facilitated the clarification of overall dietary trends across occupations and identification of specific dietary characteristics in individual occupations. The findings could aid in workplace health promotion.

Keywords

occupation, dietary intake, food intake, nutrient intake

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From an occupational health perspective, an understanding of dietary intake plays a key role in promoting workers' health. There is strong evidence for the association between diet and health, such as sodium intake and blood pressure (Aburto et al., 2013), fruit and vegetable consumption and stroke (He, Nowson, & MacGregor, 2006) and cardiovascular diseases (Wang et al., 2014). To prevent such diseases related to diet, working people should pay attention to their daily eating style and food choices. The workplace is a suitable place to improve dietary behaviors and intake because workers spend a long time at their workplace.

The diet of workers has been shown to be associated with working conditions including shift work (Balieiro et al., 2014; de Assis, Nahas, Bellisle, & Kupek, 2003; Hemio et al., 2015; Morikawa et al., 2008; Sudo & Ohtsuka, 2001), working hours (Escoto, Laska, Larson, Neumark-Sztainer, & Hannan, 2012), physical or mental strain (Lallukka et al., 2004), and control at work (Raberg Kjollesdal, Holmboe-Ottesen, & Wandel, 2010). Particularly, in men, such work-related factors may strongly influence their daily eating style and food choices, as well as their health condition. Some studies have reported an association between work-related factors and diet in men: job demand/job control and unhealthy diet in relation to waist circumference (Jaaskelainen et al., 2015) and job stress and eating behaviors related to obesity (Nishitani, Sakakibara, & Akiyama, 2009).

Given the associations between work-related factors and diet as already mentioned, dietary habits are thought to differ between occupations. Occupations have been shown to be associated with dietary intake as a socioeconomic factor (Galobardes, Morabia, & Bernstein, 2001; Raberg Kjollesdal et al., 2010; Si Hassen et al., 2016). Many previous studies examining differences in dietary intake between occupations have focused on particular groups, such as "professionals" or "manual workers" (Si Hassen et al., 2016), or reclassified several groups into two or three categories. Several reports have focused on specific workers, such as nurses (Han, Choi-Kwon, & Kim, 2016), physicians (Mota et al., 2013), bus drivers (Balieiro et al., 2014), airline employees (Hemio et al., 2015), hotel staff (Seibt, Susse, Spitzer, Hunger, & Rudolf, 2015), factory workers (Morikawa et al., 2008), and garbage collectors (de Assis et al., 2003), who work night shifts. A few studies have examined dietary behaviors or intake according to several occupational groups (Fukuda, Nakamura, & Takano, 2005; Mishra et al., 2005). However, only a few studies have examined the variation in dietary intakes across multiple occupations and compared them to each other.

Dietary variation between multiple occupational groups requires clarification. To develop the appropriate approach for healthy diets according to occupational setting, it is necessary to identify the characteristics of the dietary intake of each occupational group. It was hypothesized that there would be considerable variation in food and nutrient intake between 11 occupational categories. The aim of this study was to examine differences in food and nutrient intake between occupations, using detailed classification.

Method

Design

The study used data from the Japan Environment and Children's Study (JECS), a prospective observational cohort designed to investigate the effect of environmental factors on children's health. The study was initiated in January 2011, and the recruitment period ended in March 2014; more than 100,000 pregnant women were recruited as participants, with optional participation for their partners, with their children to be followed up until they became 13 years of age. Participants were recruited from 15 regional centers located in Japan. Details of the study protocol have been described in a previous article (Kawamoto et al., 2014). The present study is based on the data set "jecs-ag-ai-20160424," which was released in June 2016 (Michikawa et al., 2018). The JECS protocol was approved by the review board on epidemiological studies of the Ministry of the Environment, and the ethics committees of all participating institutions (Kawamoto et al., 2014). The study was conducted in accordance with the principles of the Declaration of Helsinki and the other nationally valid regulations. Written informed consent was obtained from all participants.

Sample

The study was based on the analysis of data from pregnant women's partners' self-administered questionnaires, which were collected during the first trimester and second/third trimester of pregnancy. Data regarding household income and educational level were based on data from the pregnant women's responses in self-administered questionnaires completed during the second or third trimester. The male participants (fathers) included individuals aged 20 years or older. Fathers who reported their occupations as "student," "househusband," "unemployed," or "workers not classifiable by occupation" (as it is written) were excluded from the study. Questionnaires with missing information regarding age, occupation, educational level, household income, or body mass index (BMI) were also excluded. With respect to energy intake, participants who reported consuming fewer than 1,150 kcal per day or equal to or more than 4,575 kcal per day (less than half the energy requirement for the lowest physical activity category according to the Dietary Reference Intakes for Japanese, 2015, or equal to or more than 1.5 times the energy requirement for the highest

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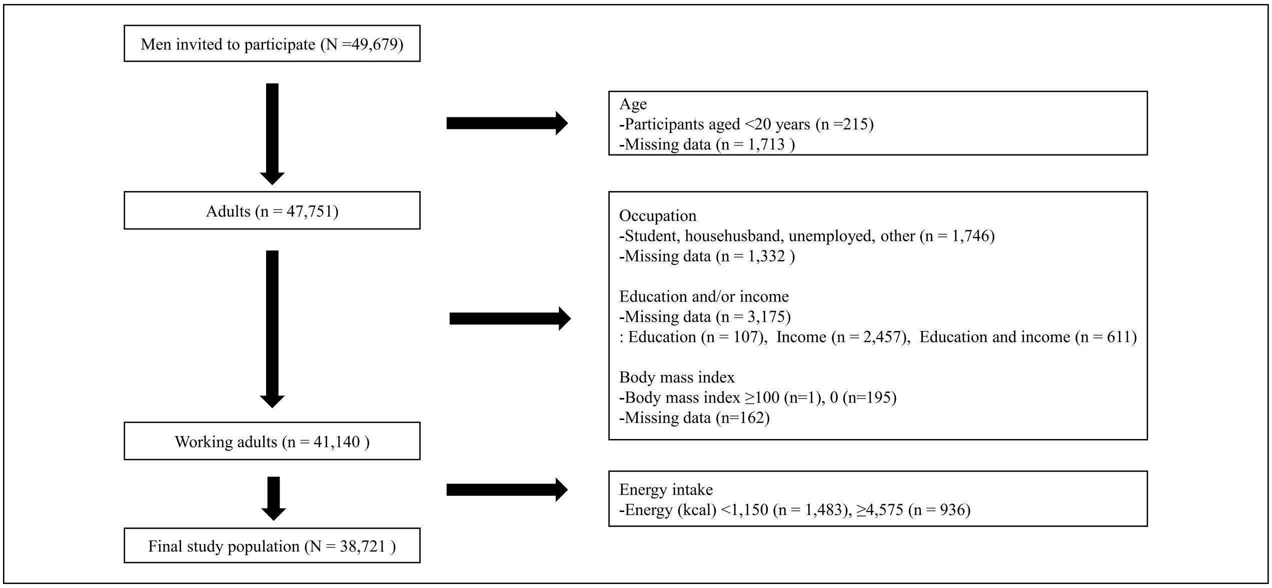

Figure 1. Participant inclusion flowchart.

physical activity category among men aged 18–49 years; Kobayashi, Asakura, Suga, & Sasaki, 2017; Ministry of Health) were excluded. Ultimately, data for 38,721 participants were included in the analysis. The details of the screening process are described in Figure 1.

Dietary Intake

Food and nutrient intake was assessed using the food frequency questionnaire (FFQ) used in the Japan Public Health Center-Based Prospective Study for the Next Generation (Michikawa et al., 2015). The FFQ was previously validated against 12-day weighed food records (Yokoyama et al., 2016). Participants (fathers) were asked how often, on average, they had consumed certain types of food and drink, during the preceding year. The FFQ included Japanese pickled vegetables, such as yellow pickled radish, pickled plum, cucumber, and so on. There were nine possible responses for each item, ranging from "never or less than once per month" to "at least seven times per day." Portion sizes were specified using pictures of standard serving size or standard amount, with three possible responses for each item such as "less than half," "same," and "more than one and a half times." Food consumption data were converted into data regarding energy and nutrients. To evaluate nutrient intake, this study used reference values such as estimated average requirements (EARs) and tentative dietary goals for preventing lifestyle-related diseases (DGs) from the Dietary Reference Intakes for Japanese (2015; Ministry of Health). In this study, "healthy food" or "healthy eating" would be defined as the diet that adheres to the dietary reference values of nutrition in Japan (Ministry of Health).

Socioeconomic Factors

Educational level was assessed using the following categories: junior high school, high school, higher professional school, professional school, junior college, university, and graduate school. Income was assessed using the following categories: <US$20,000, US$20,000–39,000, US$40,000–59,000,US$60,000–79,000,US$80,000–99,000,US$100,000–119,000, US$120,000–149,000, US$150,000–199,000, and ≥US$200,000 (conversion formula; US$1 = 100 yen). Occupations were classified according to the Japanese Standard Occupational Classification (Communications), which contains 12 major groups: administrative and managerial workers ("administrative"); professional and engineering workers ("professional"); clerical workers ("clerical"); sales workers ("sales"); service workers ("service"); security workers ("security"); agricultural, forestry, and fishery workers ("agricultural"); manufacturing process workers ("manufacturing"); transport and machine operation workers ("transport"); construction and mining workers ("construction"); carrying, cleaning packaging, and related workers ("carrying"); and workers not classifiable by occupation (which was not included in the present analysis).

Statistical Analysis

Nutrient intake was measured using energy-adjusted nutrient intake values, which were compared with Dietary

Table 1. Characteristics of the Male Participants (N = 38,721).

	n	%
Occupation		
Administrative and managerial workers	1,680	4.3
Professional and engineering workers	12,315	31.8
Clerical workers	3,818	9.9
Sales workers	4,315	11.1
Service workers	4,228	10.9
Security workers	1,727	4.5
Agricultural, forestry, and fishery workers	656	1.7
Manufacturing process workers	5,216	13.5
Transport and machine operation workers	1,628	4.2
Construction and mining workers	2,598	6.7
Carrying, cleaning packaging, and related workers	540	1.4
Educational level		
Junior high school	1,880	4.9
High school	13,656	35.3
Higher professional school	806	2.1
Professional school	7,546	19.5
Junior college	837	2.2
University	11,952	30.9
Graduate school	2,044	5.3
Household income[a]		
<US$20,000	1,546	4.0
US$20,000–39,000	12,937	33.4
US$40,000–59,000	13,301	34.4
US$60,000–79,000	6,529	16.9
US$80,000–99,000	2,736	7.1
US$100,000–119,000	990	2.6
US$120,000–149,000	366	1.0
US$150,000–199,000	215	0.6
≥US$200,000	101	0.3

Note. [a]1US$ = 100 yen.

Reference Intake values, as follows: energy-adjusted nutrient intake (amount/day) = [reported nutrient intake (amount/day) × estimated energy requirement (EER; kcal/day)/observed energy intake (kcal/day)]. The EER was set at 2,650 kcal (EER for men aged 18–49 years with moderate physical activity levels; Ministry of Health) due to the absence of quantitative data for physical activity. Energy intake from protein, fat, and carbohydrates was calculated as follows: protein (% energy) = protein (g) × 4 (kcal/g)/total energy (kcal) ×100; fat (% energy) = fat (g) × 9 (kcal/g)/total energy (kcal) × 100; carbohydrate (% energy) = carbohydrate (g) × 4 (kcal/g)/total energy (kcal) × 100. Analysis of variance (ANOVA) and analysis of covariance (ANCOVA), with age (categorized into five groups: 20s, 30s, 40s, 50s, and 60s), BMI (categorized into three groups: less than 18,5kg/m^2, 18.5–24.9 kg/m^2, equal to or more than 25 kg/m^2), household income, and educational level adjusted for, were performed to examine the differences in food and nutrient intake between 11 occupational categories.

Twelve micronutrients (vitamin B2, niacin, vitamin B6, vitamin B12, folic acid, magnesium, iron, zinc, copper, iodine, selenium, and molybdenum) were excluded from analysis because the EARs or DGs were adhered to for all occupations and more than 50% of the study participants. Natural logarithmic transformation was used in the analyses because of the non-normally distributed residuals (e.g., calcium, retinol equivalent, vitamin C). After the ANOVA and ANCOVA were performed, post hoc multiple comparisons were performed using Tukey's test. For clinically more important nutrients, a logistic regression analysis was performed to investigate the prevalence of adherence to the dietary recommendations across occupations, using administrative and managerial workers as the reference category, unadjusted or adjusted for age, BMI, household income, and educational level. Diagnostics for logistic regression were performed using Stata's linktest and the Hosmer–Lemeshow test. Levels of significance are represented by *p* values; two-sided, $p < .05$ was considered statistically significant. The statistical analysis was performed using Stata/IC 14.0.

Results

Participant Characteristics

The participants' characteristics are described in Table 1. Their mean age was 33.0 (standard deviation 5.7) years, and their median BMI was 23.0 kg/m^2 (interquartile range 4.1). About one third of the participants were professionals and engineers (n = 12,315; 32%). Two peaks in the educational level were observed for high school (n = 13,656; 35%) and university (n = 11,952; 31%). Most participants (n = 34,313; 89%) reported household incomes of <US$80,000. Regarding energy intake from protein, saturated fatty acid, dietary fiber, retinol equivalent, vitamin B1, vitamin C, salt, potassium, and calcium, adherence to the EARs or DGs was less than 50%. Particularly for dietary fiber intake, only 6% of the participants adhered to the DGs (Table 2).

Food Intake

Median daily consumption rates for food groups according to occupation are shown in Table 3. Focusing on the main food groups (i.e., from pulses column to the dairy products column in Table 3), food intake varied widely

Table 2. Prevalence of Meeting Guidelines ($N = 38,721$).

Adherence to Dietary Reference Intake for Japanese (2015)	n	%
Proteins 13-20% energy[a]	14,734	38.1
Protein ≥50 g[b]	38,351	99.0
Fatty acid 20-30% energy[a]	21,163	54.7
Saturated fatty acid ≤7% energy[a]	15,475	40.0
Carbohydrate 50-65% energy[a]	23,795	61.5
Dietary fiber ≥20 g[a]	2,354	6.1
Retinol equivalent ≥600 μg[b]	14,775	38.2
Vitamin B1 ≥1.1 mg[b]	16,141	41.7
Vitamin B2 ≥1.2 mg[b]	25,567	66.0
Niacin ≥12 mg[b]	38,150	98.5
Vitamin B6 ≥1.2 mg[b]	30,356	78.4
Vitamin B12 ≥2.0 μg[b]	38,701	100.0
Folic acid≥200 μg[b]	34,403	88.9
Vitamin C ≥85 mg[b]	16,933	43.7
Sodium≥600 mg[b]	38,702	100.0
Salt < 8 g[a]	8,406	21.7
Potassium ≥3,000 mg[a]	13,665	35.3
Calcium ≥550 mg[b]	16,737	43.2
Magnesium≥ 280 mg[b]	27,519	71.1
Iron≥ 6 mg[b]	37,646	97.2
Zinc ≥8 mg[b]	37,342	96.4
Copper ≥0.7 mg[b]	38,615	99.7
Iodine ≥95 μg[b]	25,517	65.9
Selenium ≥25 μg[b]	38,285	98.9
Molybdenum ≥20 μg[b]	38,721	100.0

Note. [a]Tentative dietary goals for preventing lifestyle-related diseases (DGs). [b]Lowest value among estimated average requirements (EARs) for men aged 18 to 69 years.

between occupations, as follows: dairy products (50.8% between the highest and lowest values), fruits (47.4%), green and yellow vegetables (39.5%), and pulses (30.1%). Occupational categories were ranked according to intake values for these foods (except dairy products) as follows (from highest to lowest): (1) security; (2) agricultural and administrative, professional, and clerical; (3) sales and service; and (4) manufacturing, transport, construction, or carrying. In particular, intake of dairy products in the security category was significantly higher relative to that observed for the other occupations. The association remained significant after adjusting for the potential confounders.

With respect to the other food groups, the widest variation in the intake of pickles (53%) was observed between the agricultural and service categories. In particular, the agricultural category exhibited a significantly higher intake value for pickles relative to that observed for the other occupations. The association remained significant after adjusting for the potential confounders. In addition, seasoning consumption was highest in the agricultural, security, and construction categories.

Nutrient Intake

With regard to nutrient intake (Table 4), the administrative, professional, clerical, sales, and service occupational categories tended to exhibit higher energy intake values for protein and fat and lower energy intake values for carbohydrates. In contrast, the other occupational categories (except the security category) exhibited lower energy intake values for protein and fat and higher energy intake values for carbohydrates. Wide variation in nutrient intake between occupational categories was observed for dietary fiber (16%) and energy from saturated fat (11%), which were inconsistent with dietary goals for any occupations. The agricultural occupational category showed significantly higher intake of dietary fiber and lower intake of saturated fat, relative to that observed for other occupational categories, while the construction occupational category showed significantly lower intake of dietary fiber relative to that observed for other occupational categories.

As shown in Table 5, occupational categories were ranked according to intake values for most micronutrients (except retinol equivalent, calcium, and sodium), as follows (from highest to lowest): (1) security, agricultural, administrative, professional, and clerical; (2) sales and service; and (3) manufacturing, transport, construction, and carrying. Variation of more than 10% was observed between the highest and lowest intake values for some nutrients, as follows: retinol equivalent (17%), folate (14%), vitamin C (22%), sodium (salt; 10%), potassium (13%), and calcium (16%). After adjusting for the potential confounders, the security occupational category exhibited significantly higher intake values for calcium relative to those observed for other occupational categories, and the agricultural occupational category exhibited a significantly higher intake value for salt relative to that observed for other occupational categories.

Table 6 describes the adherence to the dietary recommendations for saturated fatty acid, dietary fiber, and salt intake according to occupations. After adjusting for the potential confounders, agriculture workers showed higher odds of adherence to the DGs for saturated fatty acid (OR 1.68, 95% CI 1.40, 2.03, $p < .001$) and dietary fiber (OR 2.02, 95% CI 1.50, 2.72, $p < .001$) compared with administrative and managerial workers.

Overall, the results showed higher food and nutrient intake values for the security and agricultural occupational categories relative to those observed for the other occupational categories; in particular, dairy products and calcium intake was the highest in the security occupational category, and pickles and salt intake was the highest in the agricultural occupational category. From the view of adherence to the dietary recommendations, relatively higher adherence for saturated fatty acid and

Table 3. Daily Intake for Food Groups (g) According to Occupation (*N* = 38,721).

	Main food groups (g)																												Other food groups (g)							
	Pulses				Vegetables				Green and yellow vegetables				Other vegetables				Fruits				Fish and shellfish				Dairy products				Pickles				Seasoning			
Occupation	Median	IQR	Model 1[b]	Model 2[c]	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1[b]	Model 2[b]	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2
Administrative (*n* = 1,680)	35.2	48.5	EF	DE	138.5	143.9	D	BC	56.8	82.1	DE	DEF	71.1	70.5	CD	ABC	67.0	136.2	EFG	ABC	41.3	42.6	C	C	116.9	193.4	D	BC	6.3	13.4	ABC	A	17.6	15.6	ABCD	AB
Professional (*n* = 12,315)	32.5	42.2	CD	BCD	136.7	128.4	D	C	56.7	75.0	D	CEF	71.0	65.0	D	C	68.1	126.8	F	BC	37.3	39.0	BC	BC	117.1	192.1	D	C	5.6	12.0	A	A	17.8	15.2	C	B
Clerical (*n* = 3,818)	33.3	43.1	CDE	CDE	137.9	126.2	D	C	54.7	76.1	D	EF	71.7	63.2	D	BC	69.3	126.8	FG	BC	38.1	37.7	BC	BC	121.0	194.2	D	C	6.0	11.7	AB	A	17.6	14.6	BC	AB
Sales (*n* = 4,315)	32.1	42.0	BC	ABCD	126.5	121.4	C	AB	52.4	68.9	C	BCDE	67.1	61.8	BC	AB	60.0	127.3	CDE	AB	37.3	40.0	BC	BC	100.0	176.3	C	AB	5.7	11.8	AB	A	17.1	14.4	AB	A
Service (*n* = 4,228)	29.3	41.8	A	A	122.6	126.0	BC	ABC	47.5	67.4	B	BCD	68.1	67.2	BC	ABC	52.9	127.6	BCD	ABC	34.7	42.7	ABC	ABC	90.0	173.3	BC	BC	5.2	11.9	A	A	16.9	15.4	A	A
Security (*n* = 1,727)	39.9	53.6	F	F	151.4	130.3	E	D	65.8	80.1	E	G	77.9	64.4	E	DE	85.7	143.0	G	D	38.7	39.8	C	C	141.4	208.2	E	D	6.5	12.2	AB	AB	20.3	17.5	E	C
Agricultural (*n* = 656)	36.8	45.0	DEF	EF	145.3	150.0	DE	D	54.1	76.5	CD	FG	83.6	82.5	E	E	72.8	145.7	DEFG	CD	39.0	42.1	C	C	84.6	165.6	BC	ABC	8.9	21.8	D	C	20.3	18.2	E	C
Manufacturing (*n* = 5,216)	30.0	39.2	A	AB	115.4	120.7	A	A	42.6	62.7	A	A	63.5	64.0	A	A	48.9	120.6	AB	A	32.3	38.7	A	A	85.6	164.6	B	AB	5.6	11.9	AB	A	18.1	16.4	C	B
Transport (*n* = 1,628)	29.9	42.4	AB	ABC	120.6	121.6	AB	ABC	44.6	64.0	AB	ABD	67.1	66.3	AB	ABC	48.0	122.6	ABC	ABC	35.2	40.7	ABC	ABC	78.6	157.6	AB	AB	6.1	12.3	BC	AB	17.1	15.5	ABC	AB
Construction (*n* = 2,598)	31.2	41.3	AB	ABCD	117.4	124.8	A	ABC	43.5	65.2	A	ABCD	63.3	67.3	AB	ABC	46.5	123.2	A	AB	34.8	43.5	C	C	69.5	143.5	A	A	7.2	14.9	C	B	18.8	16.1	DE	C
Carrying (*n* = 540)	27.9	39.6	AB	ABC	117.7	120.0	ABC	ABC	39.8	61.4	AB	ABC	66.1	68.3	ABCD	ABCD	45.1	112.4	ABC	ABC	31.1	44.8	AB	AB	79.5	163.4	ABC	ABC	5.3	14.4	ABC	AB	16.5	15.4	ABC	AB
p value[a]			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001
Total	31.6	42.3			129.8	127.3			51.8	71.3			69.1	65.2			60.6	127.9			36.4	39.9			103.5	182.5			5.8	12.4			17.8	15.6		

Note. Administrative = administrative and managerial workers; Agricultural = agricultural, forestry, and fishery workers; ANOVA = analysis of variance; ANCOVA = analysis of covariance, adjusted for age, body mass index, household income, and educational level; Carrying = carrying, cleaning, packaging, and related workers; Clerical = clerical workers; Construction = construction and mining workers; IQR = interquartile range; Manufacturing = manufacturing process workers; Professional = professional and engineering workers; Sales = sales workers; Security = security workers; Service = service workers; Transport = transport and machine operation workers.

[a] The *p* value shows the results of the ANOVA (unadjusted) or ANCOVA (adjusted for household income, educational level, age, and body mass index). [b] Model 1: Turkey's test was performed after ANOVA (unadjusted). The same letter designated that the mean yields for these occupations are not different at 5% level. [c] Model 2: Tukey's test was performed after ANCOVA (adjusted for household income, educational level, age, and body mass index). The same letter designated that the mean yields for these occupations are not different at 5% level.

Table 4. Daily Intake of Macronutrients According to Occupation (*N* = 38,721).

	Energy				Protein (%energy)				Fatty acid (%energy)				Saturated fatty acid (%energy)				Carbohydrate (%energy)				Fiber (g)			
Occupation	Median	IQR	Model 1[b]	Model 2[c]	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2
Administrative (*n* = 1,680)	2092.5	847.5	ABCD	ABC	12.8	2.5	DE	DE	25.6	8.8	EF	BCD	7.7	3.2	DEF	CD	54.9	11.8	A	AB	12.6	5.8	D	CDE
Professional (*n* = 12,315	2082.0	818.0	AB	AB	12.6	2.5	CD	CD	25.8	8.8	F	CD	7.8	3.2	F	D	55.9	11.0	C	CD	12.5	5.5	D	DE
Clerical (*n* = 3,818)	2047.0	783.0	A	A	12.8	2.5	E	E	25.8	8.4	F	CD	7.8	3.1	F	D	56.0	10.8	BC	BCDE	12.8	5.3	D	E
Sales (*n* = 4,315)	2118.0	833.0	BCD	ABC	12.5	2.6	C	CDE	25.7	9.1	F	D	7.8	3.2	EF	D	55.4	11.6	AB	A	11.9	5.2	C	B
Service (*n* = 4,228)	2148.0	919.5	CD	BC	12.3	2.7	B	BC	25.3	9.6	DE	CD	7.5	3.4	DE	D	56.1	12.4	BCD	ABC	11.7	5.3	BC	BC
Security (*n* = 1,727)	2254.0	894.0	E	D	12.6	2.4	CDE	DE	25.3	8.5	CDE	ABC	7.7	3.1	CDE	BCD	56.9	10.9	EF	FG	12.8	5.2	D	F
Agricultural (*n* = 656)	2255.0	940.5	E	D	12.2	2.6	AB	ABC	23.8	9.4	AB	A	6.7	3.3	A	A	57.3	12.0	EF	FG	12.5	7.1	D	F
Manufacturing (*n* = 5,216)	2108.5	874.0	BC	ABC	12.1	2.6	A	ABC	24.4	9.4	BC	AB	7.3	3.3	BC	CD	57.5	12.0	F	G	11.4	5.2	B	B
Transport (*n* = 1,628)	2241.5	946.5	E	D	12.0	2.7	A	AB	23.8	9.5	AB	A	7.1	3.3	AB	ABC	57.4	12.3	EF	EFG	11.4	5.2	AB	AB
Construction (*n* = 2,598)	2278.5	964.0	E	D	12.0	2.7	A	A	23.9	9.3	A	A	7.1	3.1	A	AB	56.8	12.6	DE	CDEF	10.9	5.1	A	A
Carrying (*n* = 540)	2164.0	972.5	DE	CD	12.0	2.6	AB	ABC	24.9	9.4	ABCD	ABCD	7.4	3.3	ABCD	BCD	56.9	12.7	EF	DEFG	11.2	5.5	AB	ABCD
p value[a]			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001
Total	2126.0	865.0			12.4	2.6			25.3	9.0			7.6	3.2			56.2	11.6			12.1	5.4		

Note. Administrative = administrative and managerial workers; Agricultural = agricultural, forestry, and fishery workers; ANCOVA = analysis of covariance, adjusted for age, body mass index, household income, and educational level; ANOVA = analysis of variance; Carrying = carrying, cleaning, packaging, and related workers; Clerical = clerical workers; Construction = construction and mining workers; IQR = interquartile range; Manufacturing = manufacturing process workers; Professional = professional and engineering workers; Sales = sales workers; Security = security workers; Service = service workers; Transport = Transport and machine operation workers.

[a] The *p* value shows the results of the ANOVA (unadjusted) or ANCOVA (adjusted for household income, educational level, age, and body mass index). [b] Model 1: Turkey's test was performed after ANOVA (unadjusted). The same letter designated that the mean yields for these occupations are not different at 5% level. [c] Model 2: Tukey's test was performed after ANCOVA (adjusted for household income, educational level, age, and body mass index). The same letter designated that the mean yields for these occupations are not different at 5% level.

Table 5. Daily Intake of Micronutrients According to Occupation (*N* = 38,721).

	Salt (g)				Potassium (mg)				Calcium (mg)				Retinol equivalent (μg)				Vitamin B1 (mg)				Vitamin C (mg)			
Occupation	Median	IQR	Model 1[b]	Model 2[c]	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2	Median	IQR	Model 1	Model 2
Administrative (*n* = 1,680)	10.4	3.9	DE	BCD	2919.8	1002.0	E	D	552.7	301.3	D	BC	527.9	497.0	CD	DE	1.08	0.31	F	DE	85.2	67.5	D	BC
Professional (*n* = 12,315	10.1	3.8	CD	BCD	2820.9	955.9	D	C	536.8	292.0	D	C	514.4	482.6	CD	D	1.08	0.29	F	E	83.1	61.5	D	C
Clerical (*n* = 3,818)	10.4	3.8	D	CD	2862.7	946.5	DE	CD	544.4	295.3	D	C	515.7	473.9	CD	DE	1.08	0.28	F	E	84.4	59.3	D	C
Sales (*n* = 4,315)	10.2	3.8	BCD	BCD	2731.7	927.6	C	B	513.4	271.1	C	AB	493.8	500.6	C	CD	1.05	0.28	DE	BCD	77.9	58.8	C	AB
Service (*n* = 4,228)	9.8	4.1	A	A	2612.3	937.8	B	AB	482.9	261.8	AB	A	459.7	474.4	B	BCD	1.04	0.31	CDE	BCD	72.5	59.5	B	A
Security (*n* = 1,727)	10.4	3.6	D	D	2811.0	892.1	DE	D	558.1	294.7	D	D	532.7	512.5	D	E	1.08	0.28	F	E	82.0	57.8	D	C
Agricultural (*n* = 656)	10.8	4.7	E	E	2748.7	1025.7	CD	CD	499.4	270.5	ABC	ABC	465.4	435.4	AB	ABCD	1.05	0.32	EF	CDE	84.1	66.6	CD	C
Manufacturing (*n* = 5,216)	9.9	4.2	AB	ABC	2570.3	928.1	AB	A	484.4	268.9	B	AB	423.2	435.0	A	A	1.02	0.29	BC	ABC	69.0	55.2	AB	A
Transport (*n* = 1,628)	9.9	4.1	AB	AB	2562.6	885.1	AB	A	482.1	260.6	AB	AB	436.8	466.8	A	AB	1.00	0.29	AB	AB	69.4	54.2	AB	A
Construction (*n* = 2,598)	10.1	4.1	CD	D	2530.9	872.1	A	A	470.9	241.5	A	A	438.2	485.8	A	ABC	1.00	0.29	A	A	67.2	56.5	A	A
Carrying (*n* = 540)	9.9	4.2	ABC	ABC	2489.3	903.1	A	A	473.1	261.2	AB	ABC	394.4	486.8	A	AB	1.02	0.29	ABCD	ABCDE	65.0	58.6	A	A
p value[a]			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001			<.001	<.001
Total	10.1	3.9			2725.0	957.7			514.2	279.6			484.1	484.0			1.05	0.29			77.9	60.0		

Note. Administrative = administrative and managerial workers; Agricultural = agricultural, forestry, and fishery workers; ANCOVA = analysis of covariance, adjusted for age, body mass index, household income, and educational level; ANOVA = analysis of variance; Carrying = carrying, cleaning, packaging, and related workers; Clerical = clerical workers; Construction = construction and mining workers; IQR = interquartile range; Manufacturing = manufacturing process workers; Professional = professional and engineering workers; Sales = sales workers; Security = security workers; Service = service workers; Transport = Transport and machine operation workers.

[a] The *p* value shows the results of the ANOVA (unadjusted) or ANCOVA (adjusted for household income, educational level, age, and body mass index). [b] Model 1: Turkey's test was performed after ANOVA (unadjusted). The same letter designated that the mean yields for these occupations are not different at 5% level. [c] Model 2: Tukey's test was performed after ANCOVA (adjusted for household income, educational level, age, and body mass index). The same letter designated that the mean yields for these occupations are not different at 5% level.

Table 6. Adherence to the Dietary Recommendations According to Occupations (*N* = 38,721)

	Saturated fatty acid					Dietary fiber					Salt				
	Prevalence of meeting guidelines[a] (%)	Model 1[b]		Model 2[c]		Prevalence of meeting guidelines[a] (%)	Model 1[b]		Model 2[c]		Prevalence of meeting guidelines[a] (%)	Model 1[b]		Model 2[c]	
Occupation		OR (95 CI)	*p* value	OR (95 CI)	*p* value		OR (95 CI)	*p* value	OR (95 CI)	*p* value		OR (95 CI)	*p* value	OR (95 CI)	*p* value
Administrative (*n* = 1,680)	38.0	1.00		1.00		8.0	1.00		1.00		19.7	1.00		1.00	
Professional (*n* = 12,315)	36.3	0.93 (0.84, 1.03)	.178	0.97 (0.87, 1.07)	.514	7.0	0.86 (0.71, 1.04)	.125	0.93 (0.77, 1.13)	.469	20.4	1.04 (0.92, 1.19)	.516	0.98 (0.86, 1.11)	.738
Clerical (*n* = 3,818)	36.4	0.94 (0.83, 1.05)	.267	0.97 (0.86, 1.09)	.621	7.5	0.92 (0.75, 1.14)	.463	1.00 (0.80, 1.24)	.985	18.5	0.93 (0.80, 1.07)	.301	0.90 (0.78, 1.04)	.160
Sales (*n* = 4,315)	37.3	0.97 (0.87, 1.09)	.633	0.95 (0.84, 1.07)	.396	5.1	0.62 (0.49, 0.77)	<.001	0.71 (0.57, 0.89)	.003	20.7	1.06 (0.92, 1.22)	.403	0.96 (0.83, 1.11)	.574
Service (*n* = 4,228)	41.8	1.17 (1.04, 1.32)	.007	1.05 (0.93, 1.19)	.400	5.2	0.63 (0.50, 0.78)	<.001	0.78 (0.62, 0.98)	.034	25.7	1.41 (1.23, 1.62)	<.001	1.15 (1.00, 1.33)	.051
Security (*n* = 1,727)	38.2	1.01 (0.88, 1.16)	.913	0.99 (0.86, 1.14)	.869	7.4	0.91 (0.71, 1.17)	.455	1.19 (0.92, 1.54)	.175	18.2	0.91 (0.76, 1.08)	.257	0.77 (0.65, 0.92)	.004
Agricultural (*n* = 656)	53.7	1.89 (1.58, 2.27)	<.001	1.68 (1.40, 2.03)	<.001	12.3	1.61 (1.20, 2.16)	.001	2.02 (1.50, 2.72)	<.001	19.4	0.98 (0.78, 1.23)	.851	0.80 (0.63, 1.01)	.055
Manufacturing (*n* = 5,216)	44.4	1.30 (1.17, 1.46)	<.001	1.11 (0.99, 1.24)	.085	4.5	0.54 (0.43, 0.67)	<.001	0.73 (0.58, 0.92)	.007	25.0	1.36 (1.19, 1.56)	<.001	1.08 (0.94, 1.24)	.286
Transport (*n* = 1,628)	48.0	1.51 (1.31, 1.73)	<.001	1.23 (1.06, 1.41)	.005	4.2	0.51 (0.38, 0.68)	<.001	0.61 (0.50, 0.92)	.013	25.3	1.38 (1.17, 1.63)	<.001	1.10 (0.93, 1.30)	.259
Construction (*n* = 2,598)	48.8	1.56 (1.38, 1.77)	<.001	1.25 (1.10, 1.42)	.001	3.5	0.41 (0.31, 0.54)	<.001	0.86 (0.46, 0.80)	.001	21.9	1.14 (0.98, 1.33)	.09	0.85 (0.73, 1.00)	.047
Carrying (*n* = 540)	41.3	1.15 (0.94, 1.40)	.169	0.93 (0.76, 1.13)	.460	5.2	0.63 (0.41, 0.95)	.028	0.86 (0.56, 1.32)	.493	28.3	1.61 (1.29, 2.01)	<.001	1.25 (1.00, 1.57)	.053
Total (*n* = 38,721)	40.0					6.1					21.7				

Note. Administrative = administrative and managerial workers; Agricultural = agricultural, forestry, and fishery workers; ANOVA = analysis of variance; ANCOVA = analysis of covariance, adjusted for age, body mass index, household income, and educational level; Carrying = carrying, cleaning, packaging, and related workers; Clerical = clerical workers; Construction = construction and mining workers; IQR = interquartile range; Manufacturing = manufacturing process workers; OR = odds ratio; Professional = professional and engineering workers; Sales = sales workers; Security = security workers; Service = service workers; Transport = Transport and machine operation workers; Construction = construction and mining workers; 95 CI = 95% confidential interval.

[a] Adherence to the dietary recommendations: saturated fatty acid ≤7% energy, dietary fiber ≥20 g/day, salt < 8g/day. [b] Model 1: unadjusted. [c] Model 2: adjusted for household income, educational level, age and body mass index.

dietary fiber intake was observed among agriculture workers.

Discussion

The present study clarified the variation in dietary intakes across occupations. The finding that the highest intake of dairy products and calcium was observed in the security occupational category and the highest intake of pickles was observed in the agricultural occupational category is of particular note. These two occupational categories were likely to exhibit high consumption levels for vegetables and fruit. Agricultural workers showed higher adherence to the recommendations for energy intake from saturated fatty acid and dietary fiber.

The associations between occupation and diet could be explained by several pathways. One possible explanation is that individual or organizational work-related factors are characterized by occupation itself. For example, shift workers tend to have irregular eating habits (Lowden, Moreno, Holmback, Lennernas, & Tucker, 2010), which can increase cardio-metabolic risk (Pot, Hardy, & Stephen, 2014). Besides, Raulio et al. (2008) reported the association between diet and working conditions such as physical strain, mental strain, job strain, and support (Raulio, Roos, Mukala, & Prattala, 2008). The presence of a cafeteria and fewer vending machines (Almeida et al., 2014) or coworkers' healthy behaviors at workplace (Tabak, Hipp, Marx, & Brownson, 2015) are shown to be associated with workers' healthy diet. Another explanation is that occupation may reflect specific socioeconomic background, which has been shown to be associated with diet (Galobardes et al., 2001; Si Hassen et al., 2016). The results of this study could be interpreted by such explanations as follows.

The security occupational category included individuals such as self-defense officials; judicial police staff; other public security workers who engaged in firefighting; and security and other public security workers (Communications). The agricultural occupational category included individuals such as agriculture workers, forestry workers, and fishery workers (Communications). Both security and agriculture workers could be expected to engage in physically demanding work and therefore show high EERs. They could have had more opportunities to consume healthy food relative to other occupational categories. For example, the security occupational category's work environments could have included a cafeteria, cooking facilities, or the provision of meals, which could have contributed to healthy eating habits. In addition, agriculture workers could have consumed vegetables because they were grown (Umezawa, 2012).

This study focused on dietary behavior and style in security and agriculture workers. The security occupational category exhibited higher consumption levels for dairy products and calcium relative to those observed for the other occupational categories. This could be explained by dietary behavior such as eating breakfast, as a previous study reported a positive association between eating breakfast and dairy product and calcium intake (Peters, Verly, Marchioni, Fisberg, & Martini, 2012). Their dietary behaviors could have been influenced by environmental factors in the workplace, as mentioned earlier. In contrast, the characteristics of dietary intake in agriculture workers could partially reflect the traditional Japanese dietary pattern, which is characterized by specific foods including pickles (Nanri et al., 2012). The finding that they were more likely to consume pickles and salt relative to the other occupational categories is notable. Research conducted in Japan has shown that daily salt intake was associated with Japanese pickle intake (Wakasugi, James Kazama, & Narita, 2015). The high salt intake in this occupational category could be explained by high pickle consumption. This occupational category also consumed more vegetables and exhibited higher fiber intake and lower energy intake from saturated fat relative to most other occupational categories. These findings should be considered from various perspectives. It would be interesting to examine dietary characteristics, including culinary factors, involving Japanese food. Adaptation of the good aspects of the traditional Japanese diet could be useful in the development of health promotion programs.

The remaining occupational categories showed certain tendencies in dietary intake. In particular, it is important to consider differences in the consumption of vegetables, fruit, and dietary fiber between occupations, because previous research has provided evidence of an association between the consumption of these foods and health (He et al., 2006; Park, Subar, Hollenbeck, & Schatzkin, 2011; Wang et al., 2014). The findings of the current study in this regard are described in the following text.

Administrative, professional, and clerical workers tended to exhibit high fruit and vegetable intake, which is consistent with some previous studies (Kachan et al., 2012; Mishra et al., 2005). These occupational categories differed from the agricultural category, in that they exhibited lower levels of energy intake from carbohydrate and higher energy intake from protein and fat. This could be partially explained by socioeconomic differences between occupational categories, as individuals on lower incomes exhibited higher levels of grain consumption and energy intake from carbohydrate and lower energy intake from protein and fat, relative to those on higher incomes, according to the National Health and Nutrition Survey in Japan (Ministry of Health, 2014). In the current study, less than 65% of participants in the administrative, professional, and clerical occupational categories reported household incomes of <US$60,000 (US$1 = 100 yen; data not shown). In contrast, 78% of the agricultural occupational category reported household incomes of <US$60,000 (US$1 = 100 yen; data not shown).

Moreover, manual and physical workers, such as those in the manufacturing, transport, construction, and carrying occupational categories, tended to show lower levels of vegetable, fruit, and dietary fiber intake relative to those in other occupational categories. These findings were partially consistent with those of previous studies (Galobardes et al., 2001; Kachan et al., 2012). Furthermore, it is possible that socioeconomic background affected the findings. Of the manual and physical occupational workers, less than 15% had graduated from university (data not shown), and more than 79% reported household incomes of <US$60,000 (US$1 = 100 yen; data not shown). Therefore, occupational health staff should support these workers and provide dietary guidance and nutritional education via interviews. If possible, the introduction of catering services or workplace cafeterias that provide healthy food could improve their dietary habits (Raulio, Roos, & Prattala, 2010; Roos, Sarlio-Lahteenkorva, & Lallukka, 2004).

Overall, to interpret the findings appropriately, it is necessary to consider the characteristics of the occupation itself, including various work-related factors such as physical work, stress, shift work, working hours, work environment, and welfare facilities, in addition to socioeconomic factors when examining workers' dietary behavior. Although it is important to consider the reasons for poor dietary habits, we should also focus on good dietary habits and identify those that could be adapted to other occupations. The findings could be helpful in the development of appropriate dietary health promotion in individual occupational settings.

This study is unique in that participants' occupations were classified into 11 groups according to the major groups of the Japan Standard Occupation Classification (version 2009), with the exception of workers who were not classifiable by occupation. Previous studies classified occupations into two or three groups because of small sample sizes. However, classification into 11 groups could be performed in the current study, as the sample size was large (N = 38,721) and the number of participants in the smallest group was more than 500. With the detailed classifications, the results showed remarkable dietary intake, such as dairy products in the security and pickles in agriculture occupational groups, which have not been reported previously.

Strengths and Limitations

This study has several strengths and limitations. The study subjects were limited to expectant fathers. The fact that family composition was similar among the participants was a notable strength, given that it clearly illustrates how their partners' pregnancy could offer a chance for men to reconsider their health behaviors, for example, quitting smoking, as was previously reported (Yin et al., 2016). Men's eating behaviors may also be influenced by their wives' pregnancy. However, the family structure similarity was also a limitation in that information regarding single men was not included in the results. Such information should be considered in order for us to fully understand the results.

The sample was not representative of the overall working population. According to Japanese statistics, the most common occupation was clerical workers (20%) followed by professional and engineering workers (17%; Japan). In the present study, approximately 32% of the participants were professional and engineering workers. Although this study did not include participants who reported their occupations as "student," "househusband," or "unemployed," it would be interesting to include participants with diverse social backgrounds in the analysis and examine if there is sufficient information about them. Given that the official unemployment rate in this age group was 4.6% to 7.0% (January 2011 to March 2014; 25–34 years old; Statistics Bureau), studies focusing on unemployed persons might be important.

The effect of the missing data on the results should be acknowledged. Particularly, there are many participants with missing data on income. We also observed several differences in dietary intake between participants with missing data and those with complete data; participants with missing data showed lower intakes of most foods and nutrients than those with completed data did (data not shown). According to these findings, it might be necessary to interpret the results as somewhat overestimated.

The analysis included data collected via self-report questionnaires including an FFQ; therefore, overreporting or underreporting could have occurred. The participants could have been interested in health or possessed some health-related knowledge, which could have influenced their self-reporting.

This study assessed nutrient intake using only one EER (for moderate physical activity level) due to the lack of quantitative information about physical activity level. Although the level of energy intake was expected to differ between occupations, such as clerical workers and construction workers, in this study, the difference in mean daily intake across occupations was about 200 kcal (between the highest and lowest values). It could be suggested that several small occupational groups with high or low energy intake be included in the same occupational category. Future studies might be needed to assess occupations classified in more detail with quantitative information of physical activity level. Additionally, due to changes in health status and socioeconomic status with age, people are likely to experience substantial changes in certain dietary intakes across their life span. Stratifying by age group would be helpful for developing suitable methods of improving health practice.

The results of this cross-sectional study showed an association between the level of dietary intake and occupations. The causal relationship of the findings is still unknown. Although some potential mechanisms were supposed, further longitudinal studies might be helpful to clarify them.

Conclusion

Dietary intake characteristics of 38,721 individuals were examined according to occupation. Variation in dietary intakes across occupations was clarified; the results showed particularly high intake values for dairy products and calcium in security workers and pickles and salt in agriculture workers. The findings suggest that considering the unique characteristics of occupations and their related background factors, including working condition and workplace environment as factors would be helpful to design further studies and developing health promotion program at the workplace.

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Authorship

RT, MT, KA, and TK contributed to the study conception and design. MT and TK collected the data. RT and MT analyzed the data. RT wrote the article, and MT, KA, and TK critically reviewed the manuscript and supervised the study process. All authors read and approved the final manuscript.

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Supplemental Material

The supplementary material for this article is available online.

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