Infrequent home-cooked meal consumption is related to the inadequacy of dietary fibre and minerals intake among Japanese adults aged 18-64 years: analysis from the 2015 National Health and Nutrition Survey

Mai Matsumoto  
Kokuritsu Kenkyu Kaihatsu Hojin Iyaku Kiban Kenko Eiyo Kenkyujo

Aki Saito  
Kokuritsu Kenkyu Kaihatsu Hojin Iyaku Kiban Kenko Eiyo Kenkyujo

Chika Okada  
Kokuritsu Kenkyu Kaihatsu Hojin Iyaku Kiban Kenko Eiyo Kenkyujo

Emiko Okada  
Kokuritsu Kenkyu Kaihatsu Hojin Iyaku Kiban Kenko Eiyo Kenkyujo

Hidemi Takimoto (thidemi@nibiohn.go.jp)  
https://orcid.org/0000-0002-2751-8710

Research

Keywords: home-cooked meal, nutrition inadequacy, mineral, Japanese, NHNS

DOI: https://doi.org/10.21203/rs.3.rs-31265/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License
Abstract

Background: Consumption of home-cooked meals may lead to better nutritional intake. Few studies have examined the effect of frequency of home-cooked meal consumption on inadequacy of nutritional intake based on nutritional standards. We therefore aimed to examine the association between the frequency of home-cooked meal consumption and nutrient intake inadequacy among Japanese adults.

Methods: This study was a secondary analysis of the 2015 National Health and Nutrition survey in Japan, involving 921 men and 1300 women aged 18–64 years, a cross-sectional survey. The frequency of home-cooked meal consumption was determined using two questions enquiring about the frequency of eating out and take-away meals. Data on dietary intake were collected using a one-day semi-weighed household dietary record. The inadequacy of each nutrient intake was assessed by comparing estimated average requirement (EAR) level for 14 nutrients and the range of the dietary goal (DG) for seven nutrients according to the 2015 version of the Dietary Reference Intake for Japanese. Participants were stratified into three groups based on the frequency of consuming home-cooked meals. Group differences in EAR and DG were assessed using the covariate and logistic regression analysis, respectively.

Results: Among men and women, the proportion of participants who consumed home-cooked meals almost every day and meals prepared out of home at least once a day were 34.9% and 46.8%, and 14.7% and 6.3%, respectively. A higher frequency of consumption of home-cooked meals was associated with higher intake and adequacy of dietary fiber and minerals (iron, calcium, potassium etc.), and with higher intake of vegetables and lower intake of oils.

Conclusions: Low frequency of home-cooked meal consumption was associated with insufficient intake of dietary fiber and multiple mineral intakes among Japanese adults. Dietary fiber and mineral intake may need to the focus of interventions aimed at improving nutrient intake in individuals who predominantly eat food prepared away from home.

Background

The frequency of consuming meals prepared away from home has been reported to influence the quality of dietary intake.[1] Consuming meals prepared away from home is associated with higher intake of energy, fat, and sodium, and with lower intake of dietary fiber, vitamin C, and several minerals such as iron and calcium.[2–11] Additionally, meals prepared away from home has been linked to reduced consumption of healthy foods such as vegetables, fruit and dairy products. [12–16] Moreover, increased frequency of eating out and take-away meals was reported to be associated with an increase in body weight, body mass index (BMI), and waist circumference[12, 16–18], and increased risk of obesity[19–21], insulin resistance, diabetes mellitus[14, 21, 22], and depression.[9, 23, 24] These findings suggest that a higher frequency of eating meals prepared away from home can affect not only the quality of diet, but also physical health.
A shift from food prepared at home convenient/easy-to-prepare and away-from-home foods has been reported in the United States.[25] Additionally, high frequency of consuming food prepared away from home has been reported in high income countries such as United Kingdom, and Japan.[16, 26] Thus, it is crucial to examine the association between frequency of eating out or take-away meal consumption and overall dietary quality Few studies have examined the association between home-cooked meal intake and overall dietary quality. For example, a UK study observed better dietary intake indicators among those who had more home-cooked meals.[16] Fewer studies have analyzed nutritional adequacy (focusing on each nutrient or food) according to frequency of home-cooked meal consumption. It is important to describe how home-cooked meal consumption is associated with specific characteristics within overall dietary intake quality to identify effective public health nutritional interventions. Thus, we aimed to examine the relationship between the frequency of consuming home-cooked meals and inadequate nutrient intake among adult Japanese aged 18–64 years using data from the 2015 National Health and Nutrition Survey in Japan (NHNS).

**Methods**

**Data source and study population**

The NHNS is a nationally representative cross-sectional annual survey conducted by local public health centers under the supervision of the Ministry of Health, Labour, and Welfare. The present study was based on data from the 2015 NHNS conducted between November 1 to 30, 2015. Details of the 2015 NHNS has been described elsewhere.[29, 30] Briefly, the participants, who included households and family members (aged ≥1 year as of November 1, 2015) in 300 areas, were stratified and randomly extracted from the general census areas in the Comprehensive Survey of Living Conditions in 2015. The 2015 NHNS consisted of physical examination, dietary survey, and lifestyle questionnaire. A total of 3,507 out of 5,327 eligible households (65.8%) and 8,583 people participated in the survey. This current study included 5,048 adults aged 18–64 years. We excluded participants with missing data required for analysis in the present study, such as dietary information (n = 1,127), body weight (n = 592), smoking status or/and habitual alcohol consumption (n = 270). Moreover, we excluded those with missing data on the frequency of eating out and take-away meals (n = 5). We also excluded those who skipped breakfast, lunch, or/and dinner (n = 749), because meal skipping may affect nutrient and food intakes[31, 32], and lactating or pregnant women who may have changed their usual dietary habits (n = 84).[33] Thus, the final participants consisted of 2,221 Japanese adults aged 18–64 years (921 men and 1,300 women).

The permission to use the 2015 NHNS data was obtained from the Ministry of Health, Labour, and Welfare, and only anonymised information was availed for this study. As this survey was conducted according to the Health Promotion Act, all participants gave informed consent to the local government, and approval from Institutional Review Board was not required.

**Dietary assessment**
Dietary intake data was collected using a one-day semi-weighed household dietary record administered in November 2015, excluding Sundays and public holidays. Prior to completing the survey, trained fieldworkers (mainly registered dieticians) provided an outline of the survey and explained to the participants how to complete the dietary record. The main record-keepers in the household (members who are usually responsible for preparing meals) were instructed to weigh all foods and beverages consumed by the household members and the amount of food waste and leftovers and record their names and weights on recording forms. Additionally, the main record-keepers recorded the approximate proportions of the food consumed by each household member when members shared foods from the same dish to enable estimation of individual intake. If weighing was not possible because of eating out, the portion size consumed, or quantity of foods and details of any leftovers was recorded. Trained fieldworkers visited each household and checked for any missing information and errors. In accordance with the survey manual of the NHNS, the trained fieldworkers converted these estimates of portion sizes or quantity of foods into weights of foods and coded each food item, according to the NHNS food number lists based on the Standard Tables of Food Composition in Japan[34] to calculate the intake of energy and nutrients. The trained fieldworkers inputted collected dietary intake data using software specifically developed for the NHNS.

Energy and nutrients were calculated based on the 2010 Standard Tables of Food Composition in Japan, and foods were classified into 17 groups based on its food group table.[34] In this study, we adjusted the reported dietary intake based on the assumption that each participant reported the estimated energy requirement (EER) when their physical activity level was at the second level, to render the comparison between the reported nutrient intake and the Dietary Reference Intake for Japanese (DRIs)[28] values practically possible. The following calculation was used: dietary intake (unit/day) = reported dietary intake (unit/day)/reported energy intake (kcal/day) × EER (kcal/day). For protein, total fat, saturated fat, and carbohydrate, %energy for each nutrient was also calculated. Additionally, food intake values were energy-adjusted using the density method (i.e. their amounts per EER for food groups) to minimise the influence of dietary misreporting.

**Frequency of home-cooked meals**

The frequency of home-cooked meal consumption was assessed by the combination of two questions asking about the frequency of eating out and take-away meals. Participants reported the frequency of eating out and take-away meals (twice a day or more, once a day, 4–6 times per week, 2–3 times per week, once a week, less than once a week, seldom) in the lifestyle questionnaire. The classification of participants into three groups according to the frequency of home-cooked meals consumption is shown in Figure 1. Participants who answered, “twice a day or more” to either question and those who answered, “once a day,” “4–6 times a week” or “2–3 times a week” to both questions were classified into the Low group (low frequency of home-cooked meal consumption). Participants who responded to both questions “once a week,” “less than once a week,” “seldom” were classified in the High group (high frequency of
home-cooked meal consumption). If none of the above applies to those, participants were classified into the Middle group.

**Determination of inadequate nutrient intake**

Inadequate intake of each nutrient was determined by comparing consumed nutrient levels with the relevant dietary reference value according to the Japanese DRIs, using a previously reported method.[35–37] In the Japanese DRIs, different types of dietary reference values were established according to their purpose. The estimated average requirement (EAR) is set to prevent insufficient intake of nutrients, whereas the tentative dietary goal to prevent lifestyle-related diseases (DG) is set to prevent non-communicable diseases.

Nutrient inadequacy was defined as follows: intake level below EAR was considered as inadequate using the cut-point method for the following 14 nutrients with known EARs: protein, vitamin A (as retinol activity equivalents), vitamin B1, vitamin B2, niacin (as niacin equivalent), vitamin B6, vitamin B12, folate, vitamin C, calcium, magnesium, iron, zinc, and copper. Regarding iron intake in menstruating women, we applied the value <9.3 mg/day as recommended by the World Health Organisation (WHO) (bioavailability of iron as 15%, probability of inadequacy as 50%)[38] for women aged 20–49 years because the cut-point method is less applicable to these populations.[39, 40] For the following seven nutrients, the intake level outside the range of DG values was considered as inadequate: protein (as % energy), total fat (as % energy), saturated fat (as % energy), carbohydrate (as % energy), total dietary fiber, sodium (as salt-equivalent), and potassium.

**Other variables**

Body height (to the nearest 0.1 cm) and weight (to the nearest 0.1 kg) were measured for approximately 90% of the participants by trained field workers according to standardised procedures. For the remaining participants, height and weight were measured either by other household members at home or were self-reported. BMI was calculated as weight (kg) divided by height (m) squared. Smoking status and alcohol drinking habits during the preceding month were assessed by a self-administered questionnaire.

**Statistical analysis**

All statistical analyses were stratified by sex. The differences in characteristics among three groups according to the frequency of the home-cooked meal consumption were compared using the chi-square test for categorical variables and analysis of variance (ANOVA) for continuous variables. Differences in daily nutrients and food intake among the three groups according to the frequency of home-cooked meal consumption were assessed by ANOVA in the crude model and a covariate analysis (ANCOVA) in the adjusted model. Dunnett test, with the high group as reference, was performed in the post-test. The nutritional inadequacy of each nutrient intake was represented as the proportion of participants whose
intake was above the EAR or in the range of the DG in each group. Logistic regression analysis was used to examine the difference in the prevalence of meeting DRIs based on the Low and Middle groups according to the frequency of the home-cooked meal consumption compared with the High group in the crude and adjusted model. Confounding factors considered in the adjusted model were age category (18–34, 35–50, and 51–64 years), occupation (professional/manager, sales/service/clerical, security/transportation/labour, student, housekeeper, and not in paid employment), living alone or not (yes or no), region (Hokkaido/Tohoku, Kanto, Hokuriku/Tokai, Kinki, Shikoku/Chugoku, Kyusyu), current smoker (yes or no) and habitual alcohol drinker (yes or no), which was reported as a factor affecting the frequency of consumption of meals prepared away from home[8, 27]. All statistical analyses were performed with SAS statistical software, version 9.4 (SAS Institute Inc., Cary, NC, USA). All reported P values were two-tailed, with a P-value <0.05 considered statistically significant.

Results

The basic characteristics of participants according to frequency of home-cooked meal consumption are shown in Table 1. The proportion of participants classified into the High, Middle, and Low groups were 34.9%, 50.5%, and 14.7% for men, and 46.8%, 46.9%, and 6.3% for women, respectively. There were significantly fewer young men and women in the high frequency of home-cooked meal consumption group. Additionally, men and women living alone had significantly less home-cooked meal consumption (p <0.001). The region significantly differed in women, with more women in the Low group living in the urban Kanto area (p = 0.002). In the Low group, the proportion of people eating out or having take-away meals were approximately 90% of men and 70% of women, which was significantly higher both among men and women than in other groups. There were no differences in mean BMI, type of occupation, current smoking and consumption of snacks both among men and women.
Table 1
Characteristics of 2221 Japanese adults aged 18-64 years according to frequency of home-cooked meal consumption [Mean (SD) or n (%)]

|           | Men | Women |
|-----------|-----|-------|
|           | Hi  | Middl| Lo  | p*  | Hi  | Middl| Low (n=82) | p* |
| n         | 321 | 465  | 135 |     | 608 | 61  | 82         |    |
| Age (years) |     |       |     |     |     |     |           |    |
| Mean (S D) | 49.6 | 47.5 | 44.8 |     | 48.8 | 47.5 | 44.7 |    |
| Age category, n (%) |     |       |     |     |     |     |           |    |
| 18-34 years | 4 (  | 4 (  | 4 (  | 0   | 4 (  | 4 (  | 4 (1  | 0.0 |
|            | 9    | 1    | 1    | 1    | 8    | 1.0  | 7.4    | 0.04|
|            | 6.5  | 5.7  | 7.5  |     | 4.5  | 4.7  | 4.7    |    |
| 35-50 years | 2 (  | 1 (  | 3 (  | 1    | 7 (1 | 1    | 5.5    |    |
|            | 3.5  | 4.5  | 3.5  |     | 1.0  | 4.7  | 5.5    |    |
|            | 7.8  | 5.8  | 4.5  |     | 5.8  | 4.5  | 5.5    |    |
| 51-64 years | 5 (  | 2 (  | 2 (  | 2    | 5 (  | 2 (  | 3 (19 |    |
|            | 7.8  | 7.2  | 7.2  |     | 4.5  | 4.5  | 4.5    |    |
|            | 8.5  | 8.5  | 8.5  |     | 8.5  | 8.5  | 8.5    |    |

*Significant at p < 0.05.
| Years | 5 | 1 | 7 | 5 | 2 | 4 | 0 | 3 | 2 | 4 | 9 | 8.9 | 2 | 4 | 7 | 4.9 | 2 | 7 | 32 | .9 |
|-------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

| Body mass index (kg/m²) | Mean (SD) | Body mass index category, n (%) | Underweight |  |
|-------------------------|-----------|---------------------------------|--------------|---|
|                         | 2 (3.3)   | 2 (3.3)                          | 0 (2.9)      |   |
|                         | 3 (4.4)   | 4 (3.4)                          | 1 (2.7)      |   |
|                         | 8 (5.4)   | 5 (4.3)                          | 0 (2.6)      |   |
|                         |           |                                 | 1 (3.2)      |   |
|                         |           |                                 | 0 (1.9)      |   |
|                         |           |                                 | 1 (15.9)     |   |
|                         |           |                                 | 6 (13.4)     |   |
|                         |           |                                 | 3 (13.4)     |   |
|                         |           |                                 | 7 (3.4)      |   |
|                         |           |                                 | 7 (3.4)      |   |
|                         |           |                                 | 3 (13.4)     |   |
|                         |           |                                 | 1 (3.4)      |   |


\[
\begin{array}{cccccccc}
\text{No.} & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\
\text{Overweight} & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
\text{Normal} & 0 & 6 & 0 & 6 & 0 & 5 & 4 & 3.9 \\
\text{Normal} & 2 & 2 & 2 & 5 & 9 & 4 & 9 & 6.5 \\
\text{Normal} & 9 & 0 & 3 & 9 & 0 & 3 & 4 & 9.5 \\
\end{array}
\]
|                             | 1   | 1   | 2   | 6   | 4   | 6   |
|-----------------------------|-----|-----|-----|-----|-----|-----|
| Security/transportation/lab  | 3   | 2   | 9   | 6   | 5   | 7   |
|                             | 7   | 5   |    | 0   |    |    |
|                             | 1   | 0   | 5   | 9   |    |    |
|                             |    |    |    |    |    |    |
| Sales/manager/secretarial   | 6   | 1   | 3   | 2   | 2   | 3   |
|                             | 5   | 2   | 1   | 2   | 3   | 6   |
|                             | 0   | 7   | 5   | 6   | 2   | 3   |
|                             | 3   | 2   | 7   | 2   | 1   | 3   |
|                             |     |     |     |     |     |     |
| S t u d e n t | 3 | 1 | 4 | 7 | 1 | 2 |
|-------------|---|---|---|---|---|---|
|             | 0 | 0 | 2 | 3 | 1 | 4 |
|             | 9 | 2 | 0 | 2 | 3 | 4 |

| H o u s e k e e p e r | 3 | 6 | 2 | 1 | 1 | 9 |
|---------------------|---|---|---|---|---|---|
|                     | 0 | 1 | 1 | 3 | 1 | 4 |
|                     | 9 | 3 | 5 | 7 | 8 | 7 |

| N o t i n p a i d e m p l o y m e n t | 2 | 3 | 9 | 1 | 1 | 1 |
|----------------------------------|---|---|---|---|---|---|
|                                  | 6 | 8 | 5 | 7 | 1 | 0 |
|                                  | 1 | 1 | 5 | 7 | 8 | 6 |

| L i v i n g a l o n e | 1 | 4 | 2 | < 3 | 4 | 1 |
|---------------------|---|---|---|---|---|---|
|                     | 1 | 3 | 4 | 9 | 2 | 1 |
|                     | . | 4 | 5 | . | 3 | 0 |

| R e g i o n | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|------------|---|---|---|---|---|---|---|---|
|            | 9 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| Hokuaido and Tohoku |  |
|---------------------|---|
| Hokkaido            | 1 |
| 1                   | 4 |
| 2                   | 0 |
| 8                   | 1 |
| )                   |  |
| )                   |  |
| )                   |  |

| Kanto               |  |
|---------------------|---|
| Kantō               | 2 |
| 7                   | 0 |
| 7                   | 7 |
| 9                   | 1 |
| )                   |  |
| )                   |  |
| )                   |  |

| Hikokura and Tokai |  |
|--------------------|---|
| Hokkaido           | 1 |
| 0                   | 6 |
| 8                   | 1 |
| 7                   | 1 |
| 7                   | 1 |
| )                   |  |
| )                   |  |
| )                   |  |

| Kinki               |  |
|--------------------|---|
| Kinki              | 3 |
| 1                   | 5 |
| 6                   | 0 |
| 5                   | 6 |
| )                   |  |
| )                   |  |
| )                   |  |

| Shikoku and C |  |
|---------------|---|
| Shikoku       | 3 |
| 3             | 6 |
| 9             | 5 |
| 2             | 1 |
| )             |  |
| )             |  |
| )             |  |
|        | 3 ( | 4 ( | 1 ( | 7 ( | 6 ( | 5 ( |
|--------|-----|-----|-----|-----|-----|-----|
| K y u  | 9   | 5   | 9   | 1   | 9   | 1   |
|        | 2   | .   | 1   | 3   | .   | 0   |
|        | .   | 7   | .   | .   | .   | 1   |
| Ky u   | 2   | .   | 1   | 0   | 0   | )   |

|        | 1 ( | 4 ( | 5 ( | 0   | 4   | 5   | 7   | 0   |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|
| C u r r e n t s m o k e r, n (%) | 0   | 3   | 4   | 4   | 0   | 7   | 5   | 9   |
|        | 2   | 1   | 0   | 0   | 0   | 7   | .   | 7   |
|        | .   | .   | 9   | 7   | 0   | 5   | 2   |     |

|        | 1 ( | 4 ( | 5 ( | 0   | 4   | 7   | 1   | 0   |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|
| H a b i t u a l a l c o h o l d r i n k e r, n (%) | 1   | 3   | 7   | 5   | 3   | 7   | 2   | 2   |
|        | 7   | 6   | 2   | 7   | 3   | 7   | 1   | 0   |
|        | .   | 3   | .   | 1   | .   | 2   |     |     |
|        | 5   | 0   | .   | 3   | 6   | .   | 2   | 9   |

|        | <   | <0.00 |
|--------|-----|-------|
| F r q u e n c y o f h o m e - c o o k e d m e a l c o n s u m p t i | 0   | 0    |
|        | 0   | 1    |
|   | 1 ( | 1 ( | 1 ( | 1 ( | 1 ( | 1 ( | 1 ( | 1 ( |
|---|-----|-----|-----|-----|-----|-----|-----|-----|
| t | 8 | 5 | 7 | 1 | 2 | 3 | 4 | 2 |
| i |   | 8 |   |   |   | 8 |
| m | 6 |   |   |   |   | 3 | 0 |   |
| e |   | 4 | 5 |   |   |   |   |   |
| o |   |   |   |   |   |   |   |   |
| r |   |   |   |   |   |   |   |   |
| l |   |   |   |   |   |   |   |   |
| e |   |   |   |   |   |   |   |   |
| s |   |   |   |   |   |   |   |   |
| n |   |   |   |   |   |   |   |   |
| n |   |   |   |   |   |   |   |   |
| 2 | 1 ( | 2 ( | 1 ( | 4 ( | 1 ( | 2 ( | 4 ( | 1 ( |
| t | 0 | 3 | 1 | 4 | 8 | 5 | 2 | 2 |
| i | 6 | 3 | 9 | 7 | 0 | 8 | 1 | 3 |
| m | 0 | 1 | 4 | 1 | 2 | 0 |
| e |   |   |   |   |   |   |   |   |
| s |   |   |   |   |   |   |   |   |
| n |   |   |   |   |   |   |   |   |
| 3 | 1 ( | 1 ( | 1 ( | 4 ( | 3 ( | 2 ( | 0 ( | 0 ( |
| t | 9 | 6 | 7 | 3 | 5 | 1 | 6 | 7 |
| i | 7 | 1 | 9 | 8 | 5 | 1 | 6 | 6 |
| m | 4 | 5 | 1 | 6 | 8 | 7 |
| e |   |   |   |   |   |   |   |   |
| s |   |   |   |   |   |   |   |   |
| n |   |   |   |   |   |   |   |   |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| C | 1 ( | 1 ( | 8 ( | 0 | 4 ( | 4 ( | 5 ( | 0.0 |
| on | 1 | 3 | 7 | 3 | 2 | 6 | 7 | 7 |
| su | 8 | 6 | 2 | 7 | 0 | 8 | 6 | 8 |
| m |   |   |   |   |   |   |   |   |
|   |   |   |   |   |   |   |   |   |
Table 2 shows the nutrient intakes on the dietary recording day according to the frequency of home-cooked meal consumption. Among men, the intake of protein, calcium, iron, copper, dietary fiber and potassium was significantly lower in the Low group than in the High group (p = 0.020, 0.044, 0.008, 0.027, 0.002 and 0.004, respectively). While in women, the intake of folate, calcium, magnesium, iron and potassium in the Middle group was significantly lower than in the High group (p = 0.046, 0.036, 0.014, 0.001 and 0.026, respectively). Dietary fiber intake was higher in the High group compared the Middle and Low groups (p = 0.005).
Table 2
Nutrient intakes on the dietary recording day among 2221 Japanese adults aged 18-64 years according to frequency of home-cooked meal consumption [Mean (SD)]†

|                | Men          |        | P  |        | Women         |        | P  |        |
|----------------|--------------|--------|----|--------|----------------|--------|----|--------|
|                | High (n=49)  | Middle (n=29) | Low (n=13) |        | High (n=49)  | Middle (n=29) | Low (n=13) |        |
| Energy, kcal/d| 2 (3, 5)     | 2 (3, 5) | 2 (3, 5) | 0 (0)  | 1 (1)        | 1 (1) | 0 (0) |        |
| Nutrients with EAR | 9 (1) | 1 (1) | 1 (1) | 0 (0)  | 7 (3)        | 7 (3) | 0 (0) |        |
| Protein, g/d  | 8 (7)        | 7 (6)  | 9 (8) | 0 (0)  | 3 (2)        | 3 (2) | 1 (0) |        |
| Vitamin A, μg/d | 6 (5) | 6 (5) | 2 (3) | 0 (0)  | 6 (5)        | 4 (0) | 0 (0) |        |
| Vitamin E, μg/d | 1 (1) | 1 (1) | 0 (0) | 0 (0)  | 0 (0)        | 0 (0) | 0 (0) |        |

*Statistically significant difference (P < 0.05)
|   | n  | 1 | 2 | 4 |   | 1 | 0 | 4 |
|---|----|---|---|---|---|---|---|---|
| B | 1  |   |   |   |   |   |   |   |
| m | g / d |   |   |   |   |   |   |   |
| V | 1 ( | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| it | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| a | 4 | 4 | 4 | 4 | 5 | 4 | 3 | 2 |
| m | 6 | 8 | 1 | 4 | 3 | 6 | 9 | 8 |
| in | B | 2 |   |   |   |   |   |   |
| m | g / d |   |   |   |   |   |   |   |
| N | 3 ( | 3 | 3 | 0 | 0 | 2 | 2 | 0 |
| i | 5 | 9 | 6 | 1 | 3 | 1 | 8 | 8 |
| a | 1 | 0 | 0 | 0 | . | . | 9 | 9 |
| c | 8 | . | . | 5 | 7 | 6 | 5 | 5 |
| in | B | 3 |   |   |   |   |   |   |
| m | g / d |   |   |   |   |   |   |   |
| V | 1 ( | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| it | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| a | 4 | 4 | 3 | 1 | 2 | 2 | 1 | 5 |
| m | 6 | 9 | 5 | 1 | 8 | 7 | 7 | 9 |
| in | B | 6 |   |   |   |   |   |   |
| m | g / d |   |   |   |   |   |   |   |
| V | 7 ( | 7 | 6 | 0 | 0 | 6 | 5 | 0 |
| it | 7 | 7 | 6 | 0 | 6 | 5 | 6 | 5 |
| a | 7 | 8 | 5 | 1 | 3 | 0 | 8 | 2 |
| m | 7 | 7 | 8 | 3 | 1 | 1 | 5 | 5 |
| in | B | 1 |   |   |   |   |   |   |
| m | g / d |   |   |   |   |   |   |   |
| 1 |   | 2 |   |   |   |   |   |   |
| Nutrients with DG | % energy | % energy | % energy | % energy |
|------------------|----------|----------|----------|----------|
|                  |          |          |          |          |
| m g / d          |          |          |          |          |
| Zn (mg/d)        | 1 (0.063) | 1 (0.02) | 1 (0.039) | 8 (0.088) |
| Ni (mg/d)        | 2 (0.2)  | 2 (0.2)  | 2 (0.2)  | 6 (0.066) |
| Cu (mg/d)        | 7 (0.58) | 5 (0.39) | 5 (0.39) | 3 (0.036) |
| Co (mg/d)        | 10.7 (1.0) | 10.8 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
| Fe (mg/d)        | 10.8 (1.0) | 10.8 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
| % energy         | 10.6 (1.0) | 10.6 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
| % energy         | 10.6 (1.0) | 10.6 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
| % energy         | 10.6 (1.0) | 10.6 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
| % energy         | 10.6 (1.0) | 10.6 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
| % energy         | 10.6 (1.0) | 10.6 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
| % energy         | 10.6 (1.0) | 10.6 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
| % energy         | 10.6 (1.0) | 10.6 (1.0) | 10.5 (1.0) | 10.5 (1.0) |
|   |     |     |     |     |     |     |     |     |     |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|   | 4   | 4   | 7   | 1   | 7   | 6   | 8   | 8   | 6   |
|   |     |     |     |     |     |     |     |     |     |
| u r a t e d fat, % energy |   |     |     |     |     |     |     |     |     |
| C  | 6   | (   | 5   | (   | 0   | 0   | 5   | (   | 0   |
| a r b o lhydrate, % energy |     | 8  | 9  | 9  | 7  | .  | 7  | 8  | 6  |
|     | .  | .  | .  | .  | 1  | 2  | .  | .  | .  |
|     | 5  | 0  | 5  | 1  | 7  | 2  | 7  | 8  | 0  |
|     |     |     |     |     |     |     |     |     |     |
| D i e t ary fibre, g/day |   |     |     |     |     |     |     |     |     |
| D  | 1   | (   | 1   | (   | 0   | 0   | 1   | (   | 0   |
|   | 8   | 6   | 7   | 6   | 5   | 5   | 6   | 6   | 5   |
|     | .  | .  | .  | .  | 0  | 0  | .  | .  | .  |
|     | 1  | 8  | 9  | 6  | 9  | 5  | 0  | 0  | 5  |
|     |     |     |     |     |     |     |     |     |     |
| S o d i u m |   |     |     |     |     |     |     |     |     |
| S  | 1   | (   | 1   | (   | 0   | 0   | 1   | (   | 0   |
|   | 3   | 4   | 3   | 4   | 3   | 3   | 0   | 3   | 0   |
|     | .  | .  | .  | .  | 6  | 7  | .  | .  | .  |
|     | 0  | 1  | 1  | 2  | 4  | 9  | 0  | 6  | 3  |
|     |     |     |     |     |     |     |     |     |     |
|   |     |     |     |     |     |     |     |     |     |
|   | 3   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|   | 1  | 6  | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
|   |   |     |     |     |     |     |     |     |     |
|   | 8  | 9  | 8  | 9  | 8  | 9  | 8  | 9  | 8  |
|   | 1  | 0  | 1  | 0  | 1  | 0  | 1  | 0  | 1  |
The multivariate-adjusted odds ratios (ORs) for nutrient intake adequacy according to the frequency of home-cooked meal consumption are shown in Table 3. Only few men and women had inadequate intake
of protein, niacin and copper compared with EAR. Among men, the proportion of those having inadequate intake of iron, protein %energy, dietary fiber, and potassium in the Low group was significantly higher than in the High group. The multivariate-adjusted ORs [95% confidence interval (CI)] in the Low group compared with the High group (reference) were 2.03 [1.03—4.01], 1.58 [1.03—2.40], 1.91 [1.17—3.12], and 2.17 [1.33—3.55], respectively. Women in the Low group significantly took inadequate Vitamin C compared to women in the High group (OR [95% CI]; 1.72 [1.05–2.80]). For magnesium and dietary fiber, the ORs were significantly higher in the Middle group than in the High group (ORs [95% CI]; 1.31 [1.03–1.65] and 1.32 [1.03–1.69]).
Table 3
Multivariate-adjusted ORs for the presence of inadequate nutrient intake (based on EAR and DG) compared with the meeting EAR and DG for frequency of home-cooked meal consumption among 2221 Japanese adults aged 18-64 years.

| Men | | | | Women | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | High | Middle | Low | High | Middle | Low |
| | (n=492) | (n=294) | (n=135) | (n=900) | (n=318) | (n=82) |
| Nutrients with EAR | | | | | | | |
| Protein, n, % | 3 | 0 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| | 9 | 4 | 2 | | | |
| Crude OR (95% CI) | - | - | - | - | - | - | - | - | - | - |
| Adjusted OR (95% CI) | - | - | - | - | - | - | - | - | - | - |
| Vitamins | | | | | | | |
| Vitamin A, n, % | 2 | 6 | 2 | 6 | 1 | 7 | 3 | 5 | 3 | 5 | 4 | 5 |
| | 1 | 7 | 8 | 2 | 0 | 4 | 2 | 3 | 2 | 3 | 8 | 8 |
| | 6 | 3 | 9 | 1 | 2 | 0 | 5 | 5 | 5 | 3 | 5 | 5 |
| Crude OR | 1.00 (Reference) | 0.80 (0.59) | 1.39 (0.89) | 1.00 (Reference) | 0.99 (0.79) | 1.23 (0.77) |
| Adjusted OR | 1.08 | 2.18 | | | | | 1.24 | 1.96 | | |
| Vitamin B₁, n | 5% CI | Adjusted OR (95% CI) | Crude OR (95% CI) | Adj u |
|--------------|-------|----------------------|------------------|-------|
|              | 1.00  | 0.81 (0.60 - 1.00)  | 1.00 (Reference) | 1.00  |
|              | 1.41  | 1.10 (0.88 - 1.41)  | 1.00 (Reference) | 0.97  |
|              | 1.00  | 2.24 (1.22 - 2.24)  | 1.00 (Reference) | 1.18  |
|              | 1.41  | 0.88 (0.73 - 1.00)  | 0.97 (Reference) | 0.77  |
|              | 1.00  | 2.24 (1.22 - 2.24)  | 0.97 (Reference) | 0.77  |
|              | 1.41  | 1.22 (1.00 - 1.41)  | 1.00 (Reference) | 1.18  |
|              | 1.00  | 2.24 (1.22 - 2.24)  | 0.97 (Reference) | 0.77  |
|              | 1.41  | 1.22 (1.00 - 1.41)  | 1.00 (Reference) | 1.18  |
|              | 1.00  | 2.24 (1.22 - 2.24)  | 0.97 (Reference) | 0.77  |
|              | 1.41  | 1.22 (1.00 - 1.41)  | 1.00 (Reference) | 1.18  |
| Vitamin B2, % | Vitamin B2, n | Vitamin B2, % | Vitamin B2, n | Vitamin B2, % | Vitamin B2, n |
|--------------|--------------|--------------|--------------|--------------|--------------|
| Vitamin B2, % | 1.00 (Reference) | 0.86 (0.64) | 1.46 (0.96) | 1.00 (Reference) | 0.92 (0.71) | 1.00 (0.60) |
| Vitamin B2, n | 1.16) | 2.22) | 1.18) | 1.66) |
| Vitamin B2, % | 1.47 (0.98) | 2.19) | | | |
| Vitamin B2, n | 1.17) | | | | |
| Vitamin B2, % | 1.00 (Reference) | | | | |
|            | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Niacin, n  | 3     |       |       |       |       |       |       |       |       |       |
|            |       |       |       |       |       |       |       |       |       |       |
| Crude OR (95% CI) | -     | -     | -     | -     | -     | -     |       |       |       |       |
| Adjusted OR (95% CI) | -     | -     | -     | -     | -     | -     |       |       |       |       |
| Vitamin B6 | 1     | 3     | 1     | 3     | 5     | 3     | 9     | 3     | 2     | 3     |
|            | 0     | 7     | .     | 4     | .     | 3     | 1     | 7     | 2     | 9     |
|            |       | 3     |       | 1     |       | 7     |       |       | 2     | 0     |
| n | % |
|---|---|
| Crude OR (95% CI) | 1.00 | 0.99 | 1.55 | 1.00 | 1.06 | 1.20 |
| (Reference) | (0.73) | (1.03) | (2.34) | (Reference) | (0.84) | (0.74) |
| Adjusted OR (95% CI) | 1.00 | 0.95 | 1.36 | 1.00 | 1.04 | 1.17 |
| (Reference) | (0.70) | (0.88) | (2.09) | (Reference) | (0.82) | (0.72) |
| Vitamin B12 | 4 | 1 | 5 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 |
| n | 6 | 4 | 3 | 1 | 8 | 3 | 3 | 2 | 2 | 0 | 7 | 0 |

| Vitamin B12, n | 1.00 | 0.77 | 0.92 | 1.00 | 0.89 |
| Crude OR | (Reference) | (0.50) | (0.51) | (Reference) | (0.51) |
|  | 1.17 | 1.65 | 1.57 |
## Table

|          | 1.00 (Reference) | 0.75 (0.49, 1.15) | 0.85 (0.46, 1.56) | 1.00 (Reference) | 0.82 (0.62, 1.07) | 0.76 (0.43, 1.36) |
|----------|------------------|------------------|------------------|------------------|------------------|------------------|
| **Adjusted OR (95% CI)** |                  |                  |                  |                  |                  |                  |
| Folate, n, % | 2.8 | 4.9 | 2.1 | 7.1 | 8.1 | 1.2 | 6.1 |
|            | 1.9 | 0.4 | 8.2 | 5.3 | 8.2 |     | 8.9 |
|            | 2.0 |     | 8.0 |     |     | 0.0 | 2.0 |
| **Crude OR (95% CI)** | 1.00 (Reference) | 1.25 (0.75, 2.06) | 1.97 (1.06, 3.67) | 1.00 (Reference) | 1.10 (0.79, 1.53) | 1.91 (1.08, 3.39) |
| Ad        | 1.65 (0.69, 1.07) | 1.00 (Reference) | 1.00 (Reference) | 1.03 (0.74, 1.40) | 1.80 (1.00, 3.07) |
|                | Reference |   |   |   |   |   |   |   |   |
|----------------|-----------|---|---|---|---|---|---|---|---|
|                | 1.93)     | 3.16) | 1.45) | 3.27) |
|             |           |       |       |       |
| **Vitamin C, %** | 1.00 (Reference) | 0.96 (0.72) | 1.55 (1.03) | 1.00 (Reference) | 1.28 (1.02) | 1.92 (1.20) |
|                | 1.28) | 2.33) |
| **Crude OR (95% CI)** |           |       |       |       |
|                | 1.00 (Reference) | 0.87 (0.65) | 1.25 (0.82) | 1.00 (Reference) | 1.20 (0.95) | 1.72 (1.05) |
|                | 1.17) | 1.92) |
| **Adjusted OR (95% CI)** |           |       |       |       |
|                | 1.00 (Reference) | - | - | 1.00 (Reference) | - | - |
|                | 1.52) | 2.80) |
| Minerals | Calcium, n/\% | |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 1 | 8 | 2 | 5 | 9 | 6 | | |
| | 8 | 9 | 6 | 7 | 1 | 7 | | |
| | 9 | 7 | 4 | 4 | | | | |
| | 1895 | 2048 | 3725 | 4463 | 5205 | 5453 | 5664 | 6345 |

| Crude OR (95\% CI) | 1.00 | 0.94 | 1.44 | 1.00 | 1.27 | 1.49 | 1.00 | 1.27 | 1.49 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (Reference) | (0.70) | (0.95) | (0.95) | (0.70) | (1.01) | (0.93) | (0.95) | (0.98) | (0.93) |
|   | 1.26) | 2.21) |   | 1.60) | 2.40) |   |   |   |   |

| Adjusted OR (95\% CI) | 1.00 | 0.93 | 1.42 | 1.00 | 1.24 | 1.44 | 1.00 | 1.24 | 1.44 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (Reference) | (0.69) | (0.91) | (0.91) | (0.69) | (0.98) | (0.88) | (0.91) | (0.98) | (0.88) |
|   | 1.26) | 2.20) |   | 1.56) | 2.35) |   |   |   |   |

| Magnesium | 1 | 4 | 2 | 4 | 7 | 5 | 2 | 3 | 2 | 4 | 3 | 4 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | 5 | 8 | 2 | 8 | 6 | 6 | 2 | 6 | 6 | 3 | 4 | 1 |
|   | 6 | 5 | 4 | 3 | 5 | 1 |   |   |   |   |   |
| Iron, n, % | Crude OR (95% CI) | Adjusted OR (95% CI) | Iron, n, % | Crude OR (95% CI) |
|-----------|-------------------|----------------------|-----------|-------------------|
| 2.7       | 1.00 (Reference) | 1.00 (Reference)    | 2.4       | 1.00 (Reference) |
| 3.2       | 0.99 (0.74)      | 0.77 (0.43)         | 3.1       | 1.00 (Reference) |
| 6.6       | 1.27 (0.83)      | 1.24 (0.99)         | 6.7       | 1.00 (Reference) |
| 9.1       | 1.36 (0.91)      | 1.22 (0.75)         | 9.4       | 2.12 (1.11)       |
| 1.1       | 1.00 (Reference) | 1.24 (0.99)         | 1.1       | 1.00 (Reference) |
| 2.3       | 1.31 (1.03)      | 1.81 (1.14)         | 2.4       | 1.00 (Reference) |
| 3.3       | 1.32 (1.05)      | 1.56 (1.16)         | 4.4       | 1.00 (Reference) |
| 4.3       | 1.23 (0.77)      | 2.88 (1.48)         | 5.3       | 1.00 (Reference) |
| Zinc, % | 2 | 4 | 4 | 1 | 3 | 2 | 7 | 4 |
|---------|---|---|---|---|---|---|---|---|
|         | 7 | 9 | 0 | 1 | 5 | 4 | 9 | 3 |
|         | 9 | 5 | 0 | 0 | 4 | 3 | 4 | 9 |
|         | 8 | 7 | 8 | 8 | 8 | 8 | 8 | 8 |

| Crude OR (95% CI) | 1.00 | 1.23 | 1.43 | 1.00 | 0.71 | 1.48 |
|-------------------|------|------|------|------|------|------|
| (Reference)       | (0.73) | (0.72) | (Reference) | (0.42) | (0.64) | |
|                   | 2.07) | 2.86) | (Reference) | 1.19) | 3.45) | |

| Adjusted OR (95% CI) | 1.00 | 0.75 | 2.03 | 1.00 | 1.13 | 1.35 |
|----------------------|------|------|------|------|------|------|
| (Reference)          | (0.41) | (1.03) | (Reference) | (0.84) | (0.74) | |
|                     | 1.36) | 4.01) | (Reference) | 1.51) | 2.46) | |

| Adjusted OR (95% CI) | 1.00 | 1.24 | 1.57 | 1.00 | 0.63 | 1.22 |
|----------------------|------|------|------|------|------|------|
| (Reference)          | (0.72) | (0.75) | (Reference) | (0.37) | (0.50) | |
|                      | 2.13) | 3.29) | (Reference) | 1.08) | 2.99) | |
| Nutrients with DG | P  | 1  | 3  | 1  | 3  | 6  | 4  | 1  | 2  | 1  | 3  | 3  | 3  |
|------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Copper, %        |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Crude OR (95% CI)|    |    |    |    |    |    |    |    |    |    |    |    |    |
| Adjusted OR (95% CI) |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Protein, n, % | Crude OR (95% CI) | Adjusted OR (95% CI) | Fat, n, % | Crude OR |
|--------------|-------------------|----------------------|----------|---------|
|              |                   |                      |          |         |
| 1.00         | 1.00              | 1.00                 | 1.00     | 1.00    |
| (Reference)  | (0.74, 1.12)     | (0.74, 1.35)         | (Reference) | (0.78, 1.28) |
| 1.68         | 1.35              | 2.53                 | 1.58     | 1.32    |
| (Reference)  | (1.12, 2.53)     | (1.35, 2.30)         | (Reference) | (1.28) |
| 1.03         | 1.31              |                      | 1.29     |         |
| (Reference)  | (0.80, 2.30)     | (0.80, 2.11)         | (Reference) | (0.81) |
| 1.42         | 2.30              |                      |          |         |
|                | Adjusted OR (95% CI) |                |                |                |                |                |
|----------------|----------------------|----------------|----------------|----------------|----------------|----------------|
|                | 1.00 (Reference)     | 1.28 (0.96 - 1.71) | 1.12 (0.74 - 1.71) | 1.00 (Reference) | 1.00 (0.80 - 1.26) | 1.31 (0.81 - 2.11) |
| Saturated fat, % | 1 2 3 4 5 6 7 8 1 | 2 4 5 9 3 5 1 | 0 0 7 6 2 1 | 4 5 6 6 | | |
|                | 1.00 (Reference)     | 1.25 (0.93 - 1.67) | 1.28 (0.85 - 1.93) | 1.00 (Reference) | 1.16 (0.92 - 1.45) | 1.02 (0.64 - 1.62) |
| Adj usted OR (95% CI) | 1.00 (Reference) | 1.23 (Reference) | 1.18 (Reference) | 1.00 (Reference) | 1.15 (Reference) | 1.01 (Reference) |
|-----------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Carb hydr ate, n, %    | 1 3 2 1 1 1      | 3 3 5 3 3 3      | 4 3 6 3 3 3      | 2 3 2 3 2 3      | 3 3 2 3 2 9      | 3 3 9 4 4 0      |
| Crude OR (95% CI)     | 1.00 (Reference) | 0.93 (Reference) | 0.70 (Reference) | 1.00 (Reference) | 0.89 (Reference) | 1.14 (Reference) |
|                       | 1.24 (Reference) | 1.18 (Reference) | 1.11 (Reference) | 1.13 (Reference) | 1.83 (Reference) |                   |
| Adjusted              | 1.00 (Reference) | 0.95 (Reference) | 0.80 (Reference) | 1.00 (Reference) | 0.88 (Reference) | 1.22 (Reference) |
|                       | 1.28 (Reference) | 1.25 (Reference) | 1.25 (Reference) | 1.11 (Reference) | 1.98 (Reference) |                   |
|                         | Dietary Fiber, % |                         |                         |                         |
|-------------------------|------------------|-------------------------|-------------------------|-------------------------|
|                         | 1.00 (Reference) | 1.14 (0.84 - 1.56)    | 1.99 (1.24 - 3.21)    | 1.00 (Reference)       |
|                         | 1.54            | 3.21                    |                         | 1.73                    |
|                         |                 |                         |                         |                         |
| Crude OR (95% CI)       |                  |                         |                         |                         |
|                         | 1.00 (Reference) | 1.14                    | 1.91                    | 1.00 (Reference)      |
|                         | 1.56            | 3.12                    |                         | 1.69                    |
|                         |                 |                         |                         |                         |
| Adjusted OR (95% CI)    |                  |                         |                         |                         |
|                         | 1.00 (Reference) | 1.14                    | 1.91                    | 1.00 (Reference)      |
|                         | 1.56            | 3.12                    |                         | 1.69                    |
|                         |                 |                         |                         |                         |
| Sodium (salt-equivalent), n, % | Crude OR (95% CI) | Adjusted OR (95% CI) |
|-------------------------------|-------------------|---------------------|
|                               | 1.00 (Reference)  | 1.00 (Reference)   |
|                               | 0.95 (Reference)  | 1.11 (Reference)   |
|                               | 0.91 (Reference)  | 0.87 (Reference)   |
|                               | 1.74 (Reference)  | 1.00 (Reference)   |
|                               | 1.88 (Reference)  | 1.00 (Reference)   |
|                               | 1.55 (Reference)  | 1.56 (Reference)   |
|                               | 4.35 (Reference)  | 1.65 (Reference)   |
### Potassium, n, %

|          | Crude OR (95% CI) | Adjusted OR (95% CI) |
|----------|-------------------|----------------------|
|          | 1.00 (Reference)  | 1.00 (Reference)     |
|          | 1.12 (0.84 - 1.51) | 1.13 (0.83 - 1.53)   |
|          | 2.25 (1.40 - 3.62) | 2.17 (1.33 - 3.55)   |
|          | 1.00 (Reference)  | 1.00 (Reference)     |
|          | 1.26 (1.00 - 1.59) | 1.23 (0.97 - 1.56)   |
|          | 0.88 (0.55 - 1.41) | 1.01 (0.62 - 1.65)   |

CI, confidence interval; DG, tentative dietary goal for preventing lifestyle-related disease; DRI, Dietary Reference Intakes; EAR, estimated average requirement; OR, odd ratio.

Percentage of subjects whose intake was in the range of DG or above the EAR. Each energy-
adjusted nutrient intake (unit/d) was compared with each DRI value (unit/d), using the cut-point method.
The probability of inadequacy >50% for menstruating women whose bioavailability of iron is 15% (<9.3 mg/d) was considered inadequate for women aged 20-49 y.
* Adjusted for confounding variables of age category (18-34, 35-50, and 51-64 years), occupation (professional / manager, sales / service / clerical, security / transportation / labour, student, housekeeper, and not in paid employment), living alone (yes or no), region (Hokkaido and Tohoku, Kanto, Hokuriku and Tokai, Kinki, Shikoku and Chugoku and Kyusyu), current smoker (yes or no) and habitual alcohol drinker (yes or no).

Table 4 shows food group intakes according to the frequency of home-cooked meal consumption. For both men and women, vegetable intake in the High groups was higher than that of the Low group (p = 0.004 and p = 0.012, respectively). Fat and oil intake in the High group was lower than the Middle and Low groups among men (p = 0.002); significant difference was observed only between the High and Middle groups in women. Among men, a higher intake of mushrooms was observed in the High group than in the Low group (p = 0.015). Among women, a higher intake of potatoes and lower intake of meat and poultry were observed in the High group than in the Middle group (p = 0.002 and p = 0.032, respectively).
| Food groups (g/1000 kcal) | Men | | | | Women | | | |
|--------------------------|-----|-----|-----|-----|-------|-----|-----|-----|
|                          | High (n=492) | Mid (n=294) | Low (n=135) | p‡ | p§ | High (n=900) | Mid (n=318) | Low (n=82) | p‡ | p§ |
| Grains                   | 637.8 (178.1) | 636.2 (181.8) | 668.0 (196.3) | 0.18 | 7 | 431.9 (143.5) | 434.7 (143.4) | 468.6 (171.2) | 0.09 | 9 |
| Potatoes                 | 665.7 (79.7) | 568.6 (66.6) | 527.0 (67.7) | 0.08 | 6 | 593.9 (75.8) | 445.4 (56.0)* | 526.7 (74.1) | 0.00 | 1 |
| Sugars                   | 7.9 (11.0) | 7.1 (8.9) | 7.7 (8.2) | 0.50 | 7 | 7.1 (8.3) | 7.1 (8.9) | 5.5 (6.3) | 0.22 | 6 |
| Pulses                   | 79.9 (101.3) | 76.4 (83.3) | 67.9 (92.8) | 0.44 | 1 | 75.4 (91.6) | 64.8 (74.7) | 65.6 (90.3) | 0.07 | 9 |
| Sesame and nuts          | 2.2 (5.7) | 3.3 (12.2) | 1.7 (5.2) | 0.11 | 9 | 2.4 (5.4) | 2.8 (8.3) | 1.9 (4.8) | 0.37 | 8 |
| Vegetables               | 354.3 (186.5) | 362.4 (204.3) | 294.2 (171.8)* | 0.00 | 1 | 322.2 (171.6) | 312.0 (161.7) | 262.1 (160.8)* | 0.00 | 9 |
| Fruits                   | 94.6 (149.3) | 84.0 (114.6) | 56.4 (125.3) | 0.01 | 6 | 109.8 (120.0) | 104.8 (130.6) | 95.1 (123.3) | 0.54 | 6 |
| Mushrooms                | 22.9 (37.9) | 18.6 (30.4) | 13.1 (23.0)* | 0.01 | 0 | 20.2 (28.7) | 18.7 (30.3) | 16.1 (25.7) | 0.42 | 3 |
| Seaweeds                 | 15.5 (25.8) | 12.0 (19.8) | 11.9 (20.1) | 0.06 | 8 | 11.4 (21.2) | 10.1 (19.5) | 11.0 (22.2) | 0.54 | 1 |
| Fish and shellfishes     | 88.5 (84.6) | 87.7 (77.2) | 71.7 (78.8) | 0.09 | 1 | 67.7 (64.0) | 66.1 (68.2) | 67.1 (66.9) | 0.91 | 3 |

*Significantly different from high consumption group at p<0.05

†Mean (SD)
| Food Group | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
|------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Meat and poultry | 131.1 (87.3) | 134.8 (96.3) | 38.2 (100.8) | 0.73 (9.8) | 0.98 (8.9) | 91.5 (64.9) |
| Eggs | 48.8 (46.7) | 45.4 (41.3) | 43.3 (41.2) | 0.39 (1.3) | 0.41 (9) | 41.4 (38.0) |
| Dairy products | 100.9 (143.8) | 104.3 (139.9) | 97.0 (163.1) | 0.86 (3.4) | 0.74 (4) | 124.5 (140.1) |
| Fat and oils | 13.4 (10.2) | 15.9 (11.0)* | 17.5 (10.8)* | <0.0 (0) | 0.00 (2) | 11.0 (9.0) |
| Confectionaries | 19.5 (42.0) | 21.6 (43.2) | 22.6 (54.1) | 0.72 (8) | 0.80 (6) | 32.9 (47.6) |
| Beverages | 112.4 (684.1) | 114.6 (755.8) | 120.7 (748.5) | 0.54 (1) | 0.51 (3) | 939.4 (544.3) |
| Seafoodings | 115.5 (108.0) | 135.7 (125.0) | 147.4 (144.0) | 0.01 (6) | 0.08 (4) | 84.9 (77.4) |

† Food groups expressed as amount per day were energy-adjusted by using the following equation: energy-adjusted intake (g/d) = observed intake (g/d) × Estimated Energy Requirement (EER, kcal/d) / observed energy intake (kcal/d).
‡ The p values are shown for an analysis of variance to analyze differences of nutrient intake between three groups.
§ The p values are shown for covariate analysis to analyze difference of nutrient intake between three groups adjusted for confounding variables of age category (18-34, 35-50, and 51-64 years), occupation (professional / manager, sales / service / clerical, security / transportation / labour, student, housekeeper, and not in paid employment), living alone (yes or no), region (Hokkaido and Tohoku, Kanto, Hokuriku and Tokai, Kinki, Shikoku and Chugoku and Kyusyu), current smoker (yes or no) and habitual alcohol drinker (yes or no).
* There is significant difference by Dunnett test compared with High group in the adjusted model.

### Discussion

The present study examined the association between the frequency of home-cooked meal consumption and nutrient inadequacy among Japanese adults aged 18–64 years. We found that inadequate intake of dietary fiber and several minerals was associated with a higher frequency of eating out or take-away meal. To the best of our knowledge, this study is the first to examine the relationship between the
frequency of home-cooked meal consumption and nutrient inadequacy, based on dietary reference values among Japanese adults.

In this study, participants were classified into three groups (Low group, Moderate group, and High group according to the frequency of the home-cooked meal consumption) based on the response to questions about the frequency of eating out and take-away meals. The results by the questionnaire on the frequency of habitual eating out and take-away meals assessed was comparable to results in the dietary survey, despite being based on one-day dietary record method.

Several factors increased the likelihood of eating food prepared away from home. Men and younger people had a lower frequency of consuming home-cooked meal. These results were consistent with those from previous studies that showed a higher frequency of eating out among men and younger adults when compared with that among older adults\[13, 41\], or higher proportion of eating out in men than women\[13\]. Similar to a previous study among Japanese university students \[36\], living alone was associated with a higher frequency of eating meals prepared away from home. In addition, women living in urban areas had less home-cooked meal consumption, which is consistent with the result of a Vietnamese study.\[42\] Thus, the current results may indicate that younger adults, especially men, are more likely to consume meals prepared away from home in Japan as well as other countries.

The association between the frequency of consuming home-cooked meals and nutrients intake has been reported in several studies. An Australian study that used a 24-hour dietary recall reported that adults with a higher frequency of consuming foods prepared outside the home has lower iron and calcium intakes\[2\], which is similar to the results of iron and calcium intakes in the present study. However, inadequate intake of these nutrients based on dietary reference values was not observed except for iron among men in the present study. According to a previous Japanese study, approximately more than 50% of Japanese adults had inadequate intake of calcium.\[43\] Also, another study showed that the proportion of Japanese women who met the standard value of iron intake was low, whereas a large percentage of Japanese men met the standard.\[44\] Japanese usual insufficient intake status may reflect to the present results, regardless of the frequency of home-cooked meal consumption. In contrast, Japanese people rarely lack copper and protein\[43\], which may explain the no difference in inadequacy of these nutrients according to the frequency of home-cooked meal consumption. Of note, EAR is set by the perspective of avoiding insufficient intake, whereas DG is set for the prevention of non-communicable diseases, which may have determined differently the definition of inadequacy of each nutrient intake.

Dietary fiber was the only nutrient that significant differed depending on the frequency of home-cooked meal consumption. This finding was largely consistent with the previous studies that reported the association the frequency of eating out with dietary fiber intake.\[2, 8\] Lower dietary fiber intake was observed in the Low group in men, and the Middle group in women; this trend was similar for other nutrients. It has been reported that women in Japan and elsewhere cook more often than men.\[27, 45\] Higher income is associated with a higher frequency of eating out and take-away meals.\[41\] Additionally, better diets are seen in women compared with men \[46\] and high educated individuals have greater
dietary fiber and healthy food intake despite more frequent eating out and take-away. These reports may partly explain our present finding that lower frequency of home-cooked meals is associated with lower nutrients intakes and inadequacy of nutrient intake compared with that in the High group. Socioeconomic factor may be one of the important factors associated to home-cooked meals consumption. Unfortunately, other than occupation, we did not consider other socioeconomic indicators. While the proportion of professional, manager, sales, service, and clerics differed among men and women, and was higher in the Low group, there was no significant different in occupation among the groups. Thus, future studies should consider socioeconomic factors such as educational background and income level.

The frequency of eating out and take-away meals has been associated with a lower intake of vegetable and a higher intake of fat and oils. These results are consistent with the present study. Low intake of vegetables may partly explain the inadequate intake of potassium among men, and inadequate intake of magnesium and vitamin C among women. There has been no report on potassium and magnesium intake and inadequacy based on frequency of home-cooked meals consumption. These results highlights the need for health promotion for people with a higher frequency of eating out or take-away meals, as well as for food industry.

In this study, approximately 45% of men and 30% of women regularly ate out or had take-away meal consumption. In Japan, the government has called for voluntary efforts among food industry to improve the food environment so that people can eat well-balanced meals, whether they eat out or prepare for themselves. Example of such effort include “Increase in number of corporation in food industry that supply food products low in salt and fat.” However, the current recommendation focuses on preventing excess intake. Further efforts by the government is needed to increase the population intake of dietary fiber and minerals.

The study had some limitations. First, the participants were randomly selected from nationally representative households in Japan; therefore, the individual level response rate was unknown. This might have introduced some bias in the estimation of average intake in Japanese adults. Second, a dietary intake derived from one-day weighed dietary record is unlikely to represent the usual intake. Therefore, the variability in the dietary intake of individuals over a period of several days might have influenced the findings. It is noted that the one-day household-based dietary record method used in NHNS has been compared with individual dietary records among Japanese participants, and the correlation coefficients of the intakes of total energy and macronutrients, such as protein, fat, and carbohydrates were high (0.89 to 0.91). Thus, this method is fairly valid for the estimation of individual intake. Third, it could have been difficult for participants to accurately weigh food consumption in the case of eating out, take-away, or ready-meal use, unlike when they consumed home-cooked meals and could weigh all the foods and beverages, including the amounts of food waste and leftovers. Therefore, nutrient and food intakes may not have been accurately assessed. Fourth, we limited the participants to those who had three meals a day in the present analysis, because we wanted to assess nutrient intake and nutrition adequacy by the difference in the frequency of home-cooked meals consumption. This might have induced some bias in
the nutrient intakes. Finally, factors other than the frequency of home-cooked meals consumption may also affect the adequacy of nutrient intake. Future studies should examine the causes of nutrient intake inadequacy.

**Conclusions**

This cross-sectional study indicated that Japanese adults aged 18–64 years with lower frequency of home-cooked meal consumption were less likely to meet the standard values of dietary fiber and mineral intake. Our findings suggest that dietary fiber and mineral intake may be the focus of an interventional approach to improve the nutrient intake status of those with low home-cooked meal consumption among Japanese adults. Further studies targeting food environment, including the food industry, are needed to improve nutritional adequacy for those with higher frequency of eating out or consuming take-away meals.

**Abbreviations**

ANCOVA, covariate analysis; ANOVA, analysis of variance; BMI, body mass index; DG, tentative dietary goal to prevent lifestyle-related diseases; DRIs, Dietary Reference Intake for Japanese; EAR, estimated average requirements; EER, estimated energy requirements; NHNS, National Health and Nutrition Survey in Japan; OR, odd ratio; 95% CI, 95% confidence interval.

**Declarations**

**Ethics approval and consent to participate**

Not applicable.

**Consent for publication**

Not applicable.

**Availability of data and materials**

This study was a secondary analysis of the 2015 National Health and Nutrition Survey in Japan and was conducted with the permission of the Ministry of Health, Labour and Welfare, in Japan.

**Competing interests**

The authors declare that they have no competing interests.
Funding

This study is part of the Health Japan 21 (the second term) Analysis and Assessment Project, funded by Ministry of Health, Labour, and Welfare. Ministry of Health, Labour, and Welfare had no role in the design, analysis or writing of this article.

Authors’ contributions

All authors designed research. M. M. and A. S. analyzed the data. M. M. wrote the first draft. A. S., C. O. and E. O. took part in the interpretation of the data and provided critical revisions of the manuscript for important intellectual content. H. T. had primary responsibility for final content. All authors read and approved the final manuscript.

Acknowledgments

Not applicable.

References

1. Beydoun MA, Powell LM, Wang Y: Reduced away-from-home food expenditure and better nutrition knowledge and belief can improve quality of dietary intake among US adults. Public Health Nutr 2009, 12:369-381.
2. Burns C, Jackson M, Gibbons C, Stoney RM: Foods prepared outside the home: association with selected nutrients and body mass index in adult Australians. Public Health Nutr 2002, 5:441-448.
3. Goffe L, Rushton S, White M, Adamson A, Adams J: Relationship between mean daily energy intake and frequency of consumption of out-of-home meals in the UK National Diet and Nutrition Survey. Int J Behav Nutr Phys Act 2017, 14:131.
4. Ma Y, Bertone ER, Stanek EJ, 3rd, Reed GW, Hebert JR, Cohen NL, Merriam PA, Ockene IS: Association between eating patterns and obesity in a free-living US adult population. Am J Epidemiol 2003, 158:85-92.
5. Haines PS, Hungerford DW, Popkin BM, Guilkey DK: Eating patterns and energy and nutrient intakes of US women. J Am Diet Assoc 1992, 92:698-704, 707.
6. Kearney JM, Hulshof KF, Gibney MJ: Eating patterns—temporal distribution, converging and diverging foods, meals eaten inside and outside of the home—implications for developing FBDG. Public Health Nutr 2001, 4:693-698.
7. Mattes RD, Donnelly D: Relative contributions of dietary sodium sources. J Am Coll Nutr 1991, 10:383-393.
8. Ljubicic M, Saric MM, Baric IC, Rumbak I, Komes D, Satalic Z, Guine RPF: Consumer knowledge and attitudes toward healthy eating in Croatia: a cross-sectional study. Arh Hig Rada Toksikol 2017,
9. Seguin RA, Aggarwal A, Vermeylen F, Drewnowski A: Consumption Frequency of Foods Away from Home Linked with Higher Body Mass Index and Lower Fruit and Vegetable Intake among Adults: A Cross-Sectional Study. *J Environ Public Health* 2016, **2016**:3074241.

10. Guthrie JF, Lin BH, Frazao E: Role of food prepared away from home in the American diet, 1977-78 versus 1994-96: changes and consequences. *J Nutr Educ Behav* 2002, **34**:140-150.

11. Larson NI, Perry CL, Story M, Neumark-Sztainer D: Food preparation by young adults is associated with better diet quality. *J Am Diet Assoc* 2006, **106**:2001-2007.

12. Satia JA, Galanko JA, Siega-Riz AM: Eating at fast-food restaurants is associated with dietary intake, demographic, psychosocial and behavioural factors among African Americans in North Carolina. *Public Health Nutr* 2004, **7**:1089-1096.

13. Smith KJ, McNaughton SA, Gall SL, Blizzard L, Dwyer T, Venn AJ: Takeaway food consumption and its associations with diet quality and abdominal obesity: a cross-sectional study of young adults. *Int J Behav Nutr Phys Act* 2009, **6**:29.

14. Pereira MA, Kartashov AI, Ebbeling CB, Van Horn L, Slattery ML, Jacobs DR, Jr., Ludwig DS: Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet* 2005, **365**:36-42.

15. Paeratakul S, Ferdinand DP, Champagne CM, Ryan DH, Bray GA: Fast-food consumption among US adults and children: dietary and nutrient intake profile. *J Am Diet Assoc* 2003, **103**:1332-1338.

16. Mills S, Brown H, Wrieden W, White M, Adams J: Frequency of eating home cooked meals and potential benefits for diet and health: cross-sectional analysis of a population-based cohort study. *Int J Behav Nutr Phys Act* 2017, **14**:109.

17. Prentice AM, Jebb SA: Fast foods, energy density and obesity: a possible mechanistic link. *Obes Rev* 2003, **4**:187-194.

18. Schroder H, Fito M, Covas MI: Association of fast food consumption with energy intake, diet quality, body mass index and the risk of obesity in a representative Mediterranean population. *Br J Nutr* 2007, **98**:1274-1280.

19. van der Horst K, Brunner TA, Siegrist M: Ready-meal consumption: associations with weight status and cooking skills. *Public Health Nutr* 2011, **14**:239-245.

20. Dominguez LJ, Martinez-Gonzalez MA, Basterra-Gortari FJ, Gea A, Barbagallo M, Bes-Rastrollo M: Fast food consumption and gestational diabetes incidence in the SUN project. *PLoS One* 2014, **9**:e106627.

21. Krishnan S, Coogan PF, Boggs DA, Rosenberg L, Palmer JR: Consumption of restaurant foods and incidence of type 2 diabetes in African American women. *Am J Clin Nutr* 2010, **91**:465-471.

22. Zong G, Eisenberg DM, Hu FB, Sun Q: Consumption of Meals Prepared at Home and Risk of Type 2 Diabetes: An Analysis of Two Prospective Cohort Studies. *PLoS Med* 2016, **13**:e1002052.

23. Sanchez-Villegas A, Toledo E, de Irala J, Ruiz-Canela M, Pla-Vidal J, Martinez-Gonzalez MA: Fast-food and commercial baked goods consumption and the risk of depression. *Public Health Nutr* 2012,
24. Duffey KJ, Gordon-Larsen P, Jacobs DR, Jr., Williams OD, Popkin BM: *Differential associations of fast food and restaurant food consumption with 3-y change in body mass index: the Coronary Artery Risk Development in Young Adults Study*. *Am J Clin Nutr* 2007, 85:201-208.

25. Smith LP, Ng SW, Popkin BM: *Trends in US home food preparation and consumption: analysis of national nutrition surveys and time use studies from 1965-1966 to 2007-2008*. *Nutr J* 2013, 12:45.

26. Ministry of Health, Labour and Welfare: *The National Health and Nutrition Survey in Japan, 2015. 2017.*

27. Wolfson JA, Bleich SN: *Is cooking at home associated with better diet quality or weight-loss intention?* *Public Health Nutr* 2015, 18:1397-1406.

28. Ministry of Health, Labour and Welfare: *Dietary Reference Intakes for Japanese (2015 Edition).* 2015.

29. Ministry of Health, Labour and Welfare: *The National Health and Nutrition Survey in Japan, 2016.* 2017.

30. Saito A, Imai S, Htun NC, Okada E, Yoshita K, Yoshiike N, Takimoto H: *The trends in total energy, macronutrients and sodium intake among Japanese: findings from the 1995-2016 National Health and Nutrition Survey*. *Br J Nutr* 2018, 120:424-434.

31. Leech RM, Livingstone KM, Worsley A, Timperio A, McNaughton SA: *Meal Frequency but Not Snack Frequency Is Associated with Micronutrient Intakes and Overall Diet Quality in Australian Men and Women*. *J Nutr* 2016, 146:2027-2034.

32. Zhang L, Cordeiro LS, Liu J, Ma Y: *The Association between Breakfast Skipping and Body Weight, Nutrient Intake, and Metabolic Measures among Participants with Metabolic Syndrome*. *Nutrients* 2017, 9.

33. Murakami K, Miyake Y, Sasaki S, Tanaka K, Arakawa M: *Dietary glycemic index and glycemic load in relation to risk of overweight in Japanese children and adolescents: the Ryukyus Child Health Study*. *Int J Obes (Lond)* 2011, 35:925-936.

34. Science and Technology Agency: *Standard Tables of Food Composition in Japan, 2010*. Tokyo Ministry of Education, Culture, Sports, Science and Technology; 2010.

35. Okubo H, Sasaki S, Murakami K, Takahashi Y: *Nutritional adequacy of four dietary patterns defined by cluster analysis in Japanese women aged 18-20 years*. *Asia Pac J Clin Nutr* 2010, 19:555-563.

36. Kobayashi S, Asakura K, Suga H, Sasaki S: *Living status and frequency of eating out-of-home foods in relation to nutritional adequacy in 4,017 Japanese female dietetic students aged 18-20 years: A multicenter cross-sectional study*. *J Epidemiol* 2017.

37. Kohri T, Kaba N, Itoh T, Sasaki S: *Effects of the National School Lunch Program on Bone Growth in Japanese Elementary School Children*. *J Nutr Sci Vitaminol (Tokyo)* 2016, 62:303-309.

38. WHO/FAO: *Guidelines on Food Fortification With Micronutrients*. Geneva. 2006.

39. FAO/WHO: *Requirements of vitamin A, iron, folate and vitamin B12*. Roma1988.
40. Board. IoMFaN: Dietary Reference Intakes: Applications in Dietary Assessment. Washington, D.C.2000.

41. Huang YH, Lin CC, Lin CI, Lin SH: Association of eating out with bone density in Taiwan. Public Health Nutr 2017, 20:3151-3155.

42. Lachat C, Khanh le NB, Khan NC, Dung NQ, Nguyen do VA, Roberfroid D, Kolsteren P: Eating out of home in Vietnamese adolescents: socioeconomic factors and dietary associations. Am J Clin Nutr 2009, 90:1648-1655.

43. Saito A, Okada E, Tarui I, Matsumoto M, Takimoto H: The Association between Milk and Dairy Products Consumption and Nutrient Intake Adequacy among Japanese Adults: Analysis of the 2016 National Health and Nutrition Survey. Nutrients 2019, 11.

44. Zhang W, Iso H, Ohira T, Date OC, Tanabe N, Kikuchi S, Tamakoshi A: Associations of dietary iron intake with mortality from cardiovascular disease: the JACC study. J Epidemiol 2012, 22:484-493.

45. Saito A, Matsumoto M, Hyakutake A, Saito M, Okamoto N, Tsuji M: The frequency of cooking dinner at home and its association with nutrient intake adequacy among married young-to-middle-aged Japanese women: the POTATO Study. J Nutr Sci 2019, 8:e14.

46. Imamura F, Micha R, Khatibzadeh S, Fahimi S, Shi P, Powles J, Mozaffarian D: Dietary quality among men and women in 187 countries in 1990 and 2010: a systematic assessment. Lancet Glob Health 2015, 3:e132-142.

47. Ministry of Health, Labour and Welfare: Health Japan 21 (the Second Term). 2012.

48. Iwaoka F, Yoshiike N, Date C, Shimada T, Tanaka H: A validation study on a method to estimate nutrient intake by family members through a household-based food-weighing survey. J Nutr Sci Vitaminol (Tokyo) 2001, 47:222-227.

Figures
Figure 1

Classification of study participants based on frequency of consuming home cooked meals

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Stobenuttakimoto.docx