



The World Health Organization's Healthy Diet Indicator and its associated factors: A cross-sectional study in central Kinki, Japan

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ABSTRACT

The Healthy Diet Indicator (HDI), which is based on adherence to World Health Organization's (WHO) nutrition guidelines, is used worldwide. In 2015, the WHO updated the Fact Sheet for their recommended healthy diet. We investigated diet quality assessed by the updated HDI (HDI-2015) and factors related to adherence to this diet in a Japanese population. We conducted a cross-sectional study of 1370 participants from 8 workplaces, 1 college, and 2 communities. All participants completed a brief-type self-administered diet history questionnaire. The HDI-2015 assesses 7 components: fruits and vegetables, total fat, saturated fatty acid, polyunsaturated fatty acid, free sugar, dietary fiber, and potassium. Only 6.6% of subjects demonstrated high adherence to HDI-2015 (met ≥ 6 components), whereas 52.0% demonstrated moderate adherence (4–5 components), and 41.4% demonstrated low adherence (0–3 components). Male sex, older age, and regular physical activity were associated with higher adherence. The contemporary Japanese population has an overall low diet quality as evaluated by the updated HDI score. Improving adherence to healthier dietary patterns may promote better health in Japan.

1. Introduction

Dietary habits are one of the most important factors for promoting overall health and achieving longevity. Recently, increasingly comprehensive approaches have emerged to investigate diet quality, and a number of validated diet quality indexes have been developed (Gerber, 2001; Kourilaba and Panagiotakos, 2009). The Mediterranean diet score is the most well-known and widely used diet quality score (Grosso et al., 2014). However, it is not effective to apply this model to non-Mediterranean populations, who are may have low adherence to this diet for cultural reasons (Tong et al., 2016; Kanauchi and Kanauchi, 2016a, 2016b). The Healthy Eating Index-2010 (Guenther et al., 2013) and the Alternative Healthy Eating Index-2010 (Chiuve et al., 2012), 2 other comprehensive diet quality scores, measure adherence to the Dietary Guideline for Americans (U.S. department of Agriculture, 2010). This dietary pattern also does not apply to traditional diets of most Asian cultures. It is likely that using these comprehensive dietary scores would not be an effective tool to evaluate diet quality in Asian populations.

In contrast to former dietary indexes, the Healthy Diet Indicator (HDI), which is based on adherence to World Health Organization (WHO) nutrition guidelines, is designed for worldwide use and can make appropriate comparisons among different cultures (Jankovic

et al., 2014; Jankovic et al., 2015). The original HDI was developed > 20 years ago (Huijbregts et al., 1997), based on the 1990 WHO's dietary recommendations for the prevention of chronic disease (World Health Organization, 1990). The HDI was updated with the WHO's 2003 dietary recommendations (World Health Organization, 2003) using a score that consists of 8 components: protein, saturated fat, polyunsaturated fatty acid, cholesterol, free sugar, dietary fiber, sodium, and fruits and vegetables (Atkins et al., 2014; Jankovic et al., 2014; Struijk et al., 2014). This 2003 version was assessed again in recent years (Stefler et al., 2014; Berentzen et al., 2013; Mertens et al., 2018). A recent meta-analysis, including 10 cohorts from Europe and the United States, added current knowledge regarding the associations between adherence to the HDI and mortality from cardiovascular disease (Jankovic et al., 2015). However, few studies have investigated the HDI in Asians (Kim et al., 2013).

In 2015, the WHO updated the Fact Sheet for their recommended healthy diet (World Health Organization, 2015). To our knowledge, no studies have assessed the HDI using the components from the most recent Fact Sheet. The objective of this study was to investigate diet quality based on the updated HDI (HDI-2015) as well as factors associated with adherence to this diet in a Japanese population.

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2. Methods

2.1. Participants

A total of 1502 persons, aged 18 to 84, were invited to participate in this cross-sectional, community-based study. Participants were recruited from 8 workplaces, 1 local college, and 2 different areas in Nara Prefecture, central Kinki, Japan. Of these, 95 persons refused to participate. Among the remaining 1407, we excluded 9 subjects who did not complete the diet history questionnaire, 20 subjects who had implausibly low or high estimated caloric intake (< 800 or > 4500 kcal/day for men, < 700 or > 3500 kcal/day for women), and 8 subjects who had missing information for factors needed for statistical adjustment. Finally, a total of 1370 participants (746 men, 624 women) were included. Participants included 978 working professionals including industrial workers, office staff, professional caregivers, or nursing staff; 233 students; and 159 community-dwelling adults and elderly. This study was performed in accordance with the Helsinki Declaration. Study protocols were approved by the Institutional Review Board of Kio University, and written informed consent was obtained from each participant.

2.2. Dietary assessments

Details of the dietary assessment are described elsewhere (Kanauchi and Kanauchi, 2016a, 2016b). Briefly, using a brief-type self-administered diet history questionnaire (BDHQ), dietary habits over a 1-month period were evaluated. Measures of dietary intake for 58 food and beverage items were calculated using a computer algorithm for the BDHQ (Kobayashi et al., 2011), which was based on the Standard Tables of Food Composition in Japan (The Council for Science and Technology, Ministry of Education, Culture, Sports, Science and Technology, Japan, 2010).

2.3. Adapting the Healthy Diet Indicator to the updated World Health Organization Healthy Diet 2015

The updated version of the WHO Fact Sheet 2015 describes practical advice on maintaining a healthy diet (World Health Organization, 2015). We constructed a novel Healthy Diet Indicator (HDI-2015) with minor modifications from the original recommendations. Our HDI-2015 consists of 7 components as follows: ≥ 400 g of fruits and vegetables per day, < 30% fat for total energy, < 10% saturated fatty acid for total energy, 6–11% of polyunsaturated fatty acids for total energy, < 10% of free sugar for total energy, ≥ 25 g/day dietary fiber, and ≥ 3500 mg/day potassium. Because the WHO new guidelines ensure an adequate daily intake of dietary fiber but do not clearly indicate dietary fiber cutoff values, we adapted another report of a WHO/Food and Agriculture Organization (FAO) Expert Consultation, which recommended > 25 g of dietary fiber (World Health Organization, 2003). Values for adequate intake of unsaturated fat were not indicated by the new WHO guidelines; we thus adapted values from a report of an expert consultation with the FAO (Food and Agriculture Organization, 2010). Because the cutoff for potassium intakes was not indicated by the new WHO guidelines, we also adapted the older WHO guideline for potassium intake (World Health Organization, 2012) and replaced that recommendation with ≥ 3500 mg/day. On the other hand, we did not include trans fatty acids in the HDI-2015 survey because the BDHQ used in the present study could not estimate trans fatty acid intake. We also omitted the salt component because the amount of added salt during preparation of meals and at the table could not be evaluated precisely.

When an intake value was within the range recommended, a score of 1 was assigned; otherwise a recipient received a score of 0. The HDI-2015 was calculated as the sum of 7 components (range 0–7) and was classified as follows: high adherence (met 6–7 components), moderate

adherence (met 4–5 components), and low adherence (met 0–3 components).

2.4. Other variables

Current smoking status and regular exercise (≥ 30 min of sweat-inducing exercising at least 2 days a week) were assessed using a self-reported questionnaire. Alcohol consumption was classified as low (< 10 g/day for men, < 5 g/day for women), moderate (10 to 30 g/day for men, 5 to 15 g/day for women), and high (> 30 g/day for men, > 15 g/day for women).

2.5. Statistical analysis

Data are presented as means \pm standard deviations or percentages. Differences in mean values of continuous variables between groups were tested using the student *t*-test. Chi-square test was used for comparison of proportions among groups. Differences in nutrient intake, food consumption, and diet quality scores were compared among 3 or 4 groups using analysis of variance. *P* for trend values were calculated using two-sided for linear trend, treating the HDI-2015 adherence categories as a continuous variable. To identify factors associated with high adherence (meeting ≥ 6 components) to the HDI-2015, crude and adjusted (for sex, age classes, BMI levels, smoking status, alcohol intakes, and physical activity) odds ratios and 95% confidence intervals were calculated by models of logistic regression. Values of *p* < 0.05 were considered statistically significant. All statistical analyses were performed using SPSS (version 21.0; IBM Corp, Armonk, NY).

3. Results

3.1. Distributions of HDI-2015 score

The HDI-2015 score of all subjects ranged from 0 to 7; only 6.6% of subjects reported high adherence to the HDI-2015 (≥ 6 components), whereas 52.0% reported moderate adherence (4–5 components), and 41.4% reported low adherence (0–3 components). High adherence rate to HDI-2015 in men and in women were 9.0% and 3.7%, respectively (Table 1).

3.2. Characteristics of subjects and the HDI-2015

Men had significantly higher HDI-2015 scores than women, and older subjects had significantly higher scores than younger subjects. Nonsmokers also had significantly higher HDI-2015 scores than smokers. Physically active people had significantly higher scores than inactive subjects. College students had the lowest HDI-2015 scores, whereas community-dwelling adults had the highest scores (Table 2). When subjects were classified by the 3 adherence categories (low, moderate, and high), high adherence was greatest in males, older subjects, nonsmoking subjects, and those who took part in regular

Table 1
Distribution of the Healthy Diet Indicator-2015 score (N = 1370).

| Adherence | Score | All subjects n (%) | Men n (%) | Women n (%) |
|-----------|-------|-----------------------|--------------|----------------|
| Low | 0 | 5 (0.3) | 1 (0.1) | 4 (0.6) |
| | 1 | 15 (1.1) | 4 (0.5) | 11 (1.8) |
| | 2 | 122 (8.9) | 47 (6.3) | 75 (12.0) |
| | 3 | 426 (31.1) | 227 (30.4) | 199 (31.9) |
| Moderate | 4 | 437 (31.9) | 229 (30.7) | 208 (33.3) |
| | 5 | 275 (20.1) | 171 (22.9) | 104 (16.7) |
| High | 6 | 81 (5.9) | 59 (7.9) | 22 (3.5) |
| | 7 | 9 (0.7) | 8 (1.1) | 1 (0.2) |

Data are n (%).

Table 2
Factors related to the Healthy Diet Indicator (HDI)-2015 score and the prevalence of subjects among adherence categories (N = 1370).

| Factor | Class | n | HDI-2015 score | p ^{a,b} | Low adherence n = 568 | Moderate adherence n = 712 | High adherence n = 90 | p ^c |
|--------------------------|--------------------|------|----------------|--------------------|--------------------------|-------------------------------|--------------------------|----------------|
| Sex | Men | 746 | 3.97 ± 1.13 | 0.001 ^a | 279 (49.1%) ^d | 400 (56.2%) | 67 (74.4%) | 0.001 |
| | Women | 624 | 3.60 ± 1.11 | | 289 (50.9) | 312 (43.8) | 23 (25.6) | |
| Age group (years) | 18–34 | 400 | 3.65 ± 1.08 | 0.002 ^b | 178 (31.3) | 209 (29.4) | 13 (14.4) | 0.002 |
| | 35–49 | 524 | 3.82 ± 1.19 | | 227 (40.0) | 253 (35.5) | 44 (49.0) | |
| | 50–64 | 278 | 3.87 ± 1.07 | | 110 (19.4) | 146 (20.5) | 22 (24.4) | |
| | ≥65 | 168 | 4.01 ± 1.13 | | 53 (9.3) | 104 (14.6) | 11 (12.2) | |
| BMI (kg/m ²) | < 18.5 | 100 | 3.67 ± 1.08 | 0.183 ^b | 45 (7.9) | 51 (7.2) | 4 (4.4) | 0.433 |
| | 18.5–24.9 | 947 | 3.84 ± 1.12 | | 375 (66.0) | 504 (70.8) | 68 (75.6) | |
| | 25.0–29.9 | 279 | 3.70 ± 1.19 | | 129 (22.7) | 134 (18.8) | 16 (17.8) | |
| | ≥30 | 44 | 3.84 ± 1.08 | | 19 (3.4) | 23 (3.2) | 2 (2.2) | |
| Smoking | Yes | 281 | 3.60 ± 1.10 | 0.001 ^a | 150 (26.4) | 115 (16.2) | 16 (17.8) | 0.001 |
| | No | 1089 | 3.85 ± 1.14 | | 418 (73.6) | 597 (83.8) | 74 (82.2) | |
| Alcohol intake | Low | 891 | 3.79 ± 1.18 | 0.218 ^b | 356 (64.3) | 468 (65.7) | 58 (64.4) | 0.194 |
| | Moderate | 207 | 3.93 ± 1.03 | | 75 (13.2) | 116 (16.3) | 16 (17.8) | |
| | High | 272 | 3.77 ± 1.04 | | 128 (25.5) | 128 (18.0) | 16 (17.8) | |
| Regular exercise | Yes | 725 | 3.90 ± 1.13 | 0.001 ^a | 275 (48.4) | 394 (55.3) | 56 (62.2) | 0.009 |
| | No | 645 | 3.70 ± 1.11 | | 293 (51.6) | 318 (44.7) | 34 (37.8) | |
| Location | Students | 233 | 3.73 ± 1.07 | 0.044 ^b | 94 (16.5) | 130 (18.3) | 9 (10.0) | 0.002 |
| | Workers | 978 | 3.79 ± 1.15 | | 426 (75.0) | 480 (67.4) | 72 (80.0) | |
| | Community dwelling | 159 | 4.01 ± 1.11 | | 48 (8.5) | 102 (14.3) | 9 (10.0) | |

BMI, body mass index.

^a By two-sample *t*-test.

^b By analysis of variance.

^c By chi-square test.

^d Percentages calculated by columns.

exercise.

3.3. Individual HDI-2015 components in men and women separately

With respect to the individual HDI-2015 components, men were significantly more likely than women to meet guidelines for fruits and vegetables, total fat, saturated fatty acids, and potassium (Table 3).

3.4. Daily consumption of food and nutrient components and adherence to the HDI-2015

Mean daily consumption of food and nutrient components was evaluated across the HDI-2015 adherence categories (Table 4). The mean consumption of legumes, vegetables, fruits, and fish increased significantly, and those of confectionary decreased significantly from the lowest to the highest adherence groups. Higher adherence to HDI-2015 was significantly associated with diets higher in protein, polyunsaturated fatty acids, dietary fiber, and potassium, and lower in saturated fats. A significantly higher adherence to HDI-2015 was also associated with higher intakes of vitamins (Table 4).

Table 3

Percentage of subjects meeting the World Health Organization-recommended healthy diet (N = 1370).

| Components | All subjects | Men | Women | p value ^s |
|--|--------------|------|-------|----------------------|
| Fruits & vegetables ≥400 g/day | 43.9 | 46.4 | 40.9 | 0.041 |
| Total fat < 30% of total energy | 72.6 | 82.0 | 61.2 | 0.001 |
| Saturated fatty acid < 10% of total energy | 92.2 | 96.1 | 87.5 | 0.001 |
| PUFA 6–11% of total energy | 61.9 | 57.0 | 67.8 | 0.001 |
| Free sugar < 10% of total energy | 87.9 | 88.3 | 87.3 | 0.573 |
| Dietary fiber ≥25 g/day | 1.4 | 1.6 | 1.1 | 0.443 |
| Potassium ≥3500 mg/day | 20.4 | 25.3 | 14.6 | 0.001 |

PUFA, polyunsaturated fatty acids.

^s p-Values indicate difference between genders and compared using chi-square test.

3.5. Factors associated with high adherence to the HDI-2015

Multivariate logistic regression analysis revealed the following factors were associated with high adherence to the HDI-2015: male sex (OR = 2.37, *p* = 0.002) compared with female sex, age between 35 and 49 years (OR = 2.41, *p* = 0.013) and those between 50 and 64 years (OR = 2.47, *p* = 0.018) compared with those aged 18–34, and regular physical activity (OR = 1.73, *p* = 0.020) compared with inactivity (Table 5).

4. Discussion

This is the first study to investigate the updated HDI score (HDI-2015) in accordance with the new 2015 WHO Fact Sheet, comparing food and nutrient consumption and healthy lifestyle factors. The WHO made recommendations on healthy eating patterns in part to protect against malnutrition, but also to prevent the onset of diet-related diseases. Over the past few decades, the Japanese lifestyle has become more westernized, and the prevalence of unhealthy dietary habits has increased. Switching from a traditional diet to a westernized dietary pattern may play a role in an increase in obesity, metabolic diseases, and cardiovascular disease. Therefore, studying diet quality has become important in the field of nutritional epidemiology (Gerber, 2001; Kourlaba and Panagiotakos, 2009). One strength of our study was the use of the most recently updated criteria from the WHO Fact Sheet 2015 to calculate adherence to the HDI and provide a more accurate picture of overall dietary habits. Conventional HDI scores were developed as tools to assess compliance with the 1990 and 2003 WHO dietary guidelines in terms of prevention of chronic disease (World Health Organization, 1990; World Health Organization, 2003). These scores have been studied in relation to mortality, cancer risk, and cardiovascular disease risk (Knoops et al., 2006; Boylan et al., 2009; Berentzen et al., 2013; Stefler et al., 2014; Jankovic et al., 2014; Atkins et al., 2014; Struijk et al., 2014). In the present study, we constructed the new HDI in accordance with the 2015 WHO Fact Sheet (World Health Organization, 2015).

A notable finding of this study was that male sex, older age, and regular physical activity were associated with high adherence to the

Table 4
Food and nutrients by adherence levels to the Healthy Diet Indicator-2015 (N = 1370).

| Food and nutrients | Low adherence score 0–3 (n = 568) | Moderate adherence score 4–5 (n = 712) | High adherence score 6–7 (n = 90) | p-Trend [§] |
|---------------------------------|-----------------------------------|--|-----------------------------------|----------------------|
| Grains (g/1000 kcal) | 225 ± 76 | 228 ± 66 | 210 ± 50 | 0.062 |
| Legumes (g/1000 kcal) | 22 ± 16 | 30 ± 20 | 43 ± 21 | 0.001 |
| Vegetables (g/1000 kcal) | 98 ± 51 | 147 ± 68 | 211 ± 78 | 0.001 |
| Fruits (g/1000 kcal) | 36 ± 38 | 61 ± 55 | 99 ± 81 | 0.001 |
| Fish (g/1000 kcal) | 37 ± 22 | 41 ± 21 | 50 ± 29 | 0.001 |
| Meat ^a (g/1000 kcal) | 39 ± 22 | 39 ± 18 | 35 ± 15 | 0.164 |
| Poultry (g/1000 kcal) | 16 ± 12 | 16 ± 10 | 14 ± 9 | 0.140 |
| Dairy (g/1000 kcal) | 67 ± 61 | 65 ± 52 | 67 ± 49 | 0.898 |
| Eggs (g/1000 kcal) | 21 ± 15 | 23 ± 14 | 22 ± 12 | 0.195 |
| Confectionary (g/1000 kcal) | 27 ± 23 | 22 ± 16 | 16 ± 12 | 0.001 |
| Energy (kcal/day) | 1888 ± 623 | 1851 ± 554 | 1825 ± 467 | 0.420 |
| Carbohydrate (%E) | 53.5 ± 8.6 | 53.6 ± 7.5 | 53.3 ± 6.4 | 0.954 |
| Protein (%E) | 14.0 ± 2.9 | 15.0 ± 2.6 | 16.2 ± 2.5 | 0.001 |
| Total fat (%E) | 26.4 ± 7.1 | 26.6 ± 4.8 | 26.2 ± 2.5 | 0.795 |
| Saturated fat (%E) | 7.35 ± 2.45 | 6.91 ± 1.63 | 6.37 ± 0.96 | 0.001 |
| MUFA (%E) | 9.59 ± 2.77 | 9.63 ± 1.95 | 9.26 ± 1.14 | 0.356 |
| PUFA (%E) | 6.11 ± 1.64 | 6.55 ± 1.23 | 6.97 ± 0.86 | 0.001 |
| Cholesterol (mg/1000 kcal) | 207 ± 81 | 215 ± 70 | 215 ± 66 | 0.145 |
| Dietary fiber (g/1000 kcal) | 5.0 ± 1.4 | 6.4 ± 1.8 | 8.4 ± 2.1 | 0.001 |
| Potassium (mg/1000 kcal) | 1123 ± 287 | 1355 ± 365 | 1765 ± 343 | 0.001 |
| Vitamin A (µg RAE/1000 kcal) | 323 ± 215 | 380 ± 206 | 485 ± 230 | 0.001 |
| Vitamin B1 (mg/1000 kcal) | 0.37 ± 0.10 | 0.41 ± 0.11 | 0.46 ± 0.11 | 0.001 |
| Vitamin B2 (mg/1000 kcal) | 0.63 ± 0.18 | 0.68 ± 0.20 | 0.78 ± 0.19 | 0.001 |
| Niacin (mg NE/1000 kcal) | 8.6 ± 2.4 | 9.1 ± 2.6 | 10.5 ± 2.7 | 0.001 |
| Vitamin B6 (mg/1000 kcal) | 0.58 ± 0.15 | 0.66 ± 0.19 | 0.79 ± 0.19 | 0.001 |
| Vitamin B12 (µg/1000 kcal) | 4.5 ± 2.3 | 4.9 ± 2.5 | 5.8 ± 2.8 | 0.001 |
| Folic acid (µg/1000 kcal) | 144 ± 47 | 185 ± 59 | 250 ± 72 | 0.001 |
| Vitamin C (mg/1000 kcal) | 44 ± 19 | 62 ± 26 | 92 ± 35 | 0.001 |
| Vitamin D (µg/1000 kcal) | 6.2 ± 4.0 | 7.2 ± 4.3 | 8.9 ± 5.1 | 0.001 |
| Vitamin E (mg/1000 kcal) | 3.6 ± 1.0 | 4.1 ± 0.9 | 4.9 ± 0.7 | 0.001 |

Data are mean ± SD. MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; RAE, retinol activity equivalents; NE, niacin equivalent.

[§] p-Values indicate trend across the low, moderate, and high adherence categories. P for trend values were calculated using two-sided for linear trend, treating the HDI-2015 adherence categories as a continuous variable.

^a Meat includes processed meat.

new WHO-recommended dietary guidelines. Previous studies have reported an association of high diet quality with older age and more physical activity (Patino-Alonso et al., 2014; Hu et al., 2013). It has also been reported that younger people are more likely to adopt unhealthy dietary patterns than older people (Sanchez-Villegas et al., 2002). These findings are in accordance with the present study. On the other hand, several studies have reported that women are more compliant with healthy diet patterns than men (Sanchez-Villegas et al., 2002), but others reported that men had higher healthy dietary habits than women

as evaluated by the Mediterranean diet score or Healthy Eating Index (Hu et al., 2013; Previdelli et al., 2010). In the present results, we found that men had higher HDI-2015 scores than women. This association was also confirmed by multivariate logistic regression analysis, which considered other factors such as age, body mass index, smoking status, alcohol consumption, and physical activity.

In the present study, only 6.6% of subjects reported a high adherence to the dietary index. In addition, only 1.4% met requirements for dietary fiber. Because the new WHO Fact Sheet does not clearly

Table 5
Factors associated with high adherence to the Healthy Diet Indicator-2015 (met ≥ 6 components) based on logistic regression analysis (N = 1370).

| Factors | Class | Crude OR (95% CI), p ^a | Multivariate OR (95% CI) ^b , p ^a |
|-------------------|--------------------------|-----------------------------------|--|
| Sex | Women | 1 | 1 |
| | Men | 2.58 (1.59–4.19), 0.001 | 2.37 (1.38–4.09), 0.002 |
| Age | 18–34 years | 1 | 1 |
| | 35–49 years | 2.73 (1.45–5.14), 0.002 | 2.41 (1.20–4.85), 0.013 |
| | 50–64 years | 2.56 (1.27–5.17), 0.009 | 2.47 (1.17–5.21), 0.018 |
| | ≥65 years | 2.09 (0.92–4.76), 0.080 | 1.59 (0.68–3.74), 0.286 |
| BMI | < 18.5 kg/m ² | 1 | 1 |
| | 18.5–24.9 | 1.86 (0.66–5.20), 0.229 | 1.25 (0.44–3.59), 0.679 |
| | 25.0–29.9 | 1.46 (0.48–4.48), 0.508 | 0.78 (0.24–2.49), 0.672 |
| | ≥30 | 1.14 (0.20–6.48), 0.880 | 0.61 (0.10–3.58), 0.583 |
| Smoking | Smokers | 1 | 1 |
| | Nonsmokers | 1.21 (0.69–2.11), 0.507 | 1.45 (0.82–2.58), 0.201 |
| Alcohol | Low | 1 | 1 |
| | Moderate | 1.20 (0.68–2.14), 0.529 | 0.94 (0.52–1.70), 0.825 |
| | High | 0.90 (0.51–1.59), 0.711 | 0.72 (0.40–1.30), 0.278 |
| Physical activity | Inactive | 1 | 1 |
| | Active | 1.50 (0.97–2.34), 0.069 | 1.73 (1.09–2.73), 0.020 |

OR, odds ratio; CI, confidence interval; BMI, body mass index.

^a By calculated using the logistic regression model.

^b Adjusted for sex, age classes, BMI levels, smoking status, alcohol intake, and physical activity.

indicate the cutoff value for dietary fiber intake, we adopted information from a report of WHO/FAO Expert Consultation (World Health Organization, 2003). It may be difficult for Japanese people to achieve the 2003 WHO/FAO recommendations for dietary fiber (≥ 25 g/day in both men and women). Indeed, fiber-rich foods such as vegetables, legumes, and seaweeds are common in the Japanese diet (Yamori et al., 2017). However, the mean consumption level of dietary fiber in Japan is 15.1 g/day in adult men and 14.4 g/day in adult women (Ministry of Health, Labor, and Welfare of Japan, 2015). It might be speculated that almost no Japanese subjects could reach the levels recommended by the WHO/FAO.

This study has several limitations. First, as a cross-sectional study, caution must be taken when interpreting results. Second, our findings may not be generalizable to all of Japan, because results only showed associations among selected populations. Third, we could not exclude the possibility of measurement bias. The BDHQ is susceptible to potential measurement errors at recording, although these errors are thought to be smaller compared with other dietary assessment tools (Kobayashi et al., 2011). Finally, a comparison of the HDI-2015 in our study to the former HDI scores in other studies is difficult, because we calculated the scores in accordance with the most recent 2015 WHO Fact Sheet.

In conclusion, male sex, older age, and physically active persons were more likely to have healthy dietary habits as evaluated by the updated WHO 2015 Fact Sheet. However, many Japanese people did not report high adherence to the HDI-2015. Improving adherence to healthier dietary patterns may promote better health in a contemporary Japanese people.

Ethical approval and consent to participate

This study was performed in accordance with the Helsinki Declaration. Study protocols were approved by the Institutional Review Board of Kio University, and written informed consent was obtained from each participant.

Consent for publication

Not applicable.

Availability of data and materials

Data supporting the conclusions of this article are included within the manuscript. Raw data will be made available upon request addressed to the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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Author contributions

MK designed the study, performed the statistical analysis, and drafted the manuscript. KK contributed to the data collection and the discussion.

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