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Validation of a food-frequency questionnaire for cohort studies in rural Japan

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Abstract

Objectives: To examine the validity and reproducibility of a self-administered food-frequency questionnaire (FFQ) used for two cohort studies in Japan.
Design: Cross-sectional study.
Setting: Two rural towns in the Miyagi Prefecture, in north-eastern Japan.
Subjects: Fifty-five men and 58 women.
Results: A 40-item FFQ was administered twice, 1 year apart. In the mean time, four 3-day diet records (DRs) were collected in four seasons within the year. We calculated daily consumption of total energy and 15 nutrients, 40 food items and nine food groups from the FFQs and the DRs. We computed Spearman correlation coefficients between the FFQs and the DRs. With adjustment for age, total energy and deattenuation for measurement error with the DRs, the correlation coefficients for nutrient intakes ranged from 0.25 to 0.58 in men and from 0.30 to 0.69 in women, with median of 0.43 and 0.43, respectively. Median (range) of the correlation coefficients was 0.35 (−0.30 to 0.72) in men and 0.34 (−0.06 to 0.75) in women for food items and 0.60 (−0.10 to 0.76) and 0.51 (0.28–0.70) for food groups, respectively. Median (range) of the correlation coefficients for the two FFQs administered 1 year apart was 0.49 (0.31–0.71) in men and 0.50 (0.40–0.64) in women for nutrients, 0.43 (0.14–0.76) and 0.45 (0.06–0.74) respectively for food items, and 0.50 (0.30–0.70) and 0.57 (0.39–0.66) respectively for food groups. Relatively higher agreement percentages for intakes of nutrients and food groups with high validity were obtained together with lower complete disagreement percentages.
Conclusions: The FFQ has a high reproducibility and a reasonably good validity, and is useful in assessing the usual intakes of nutrients, foods and food groups among a rural Japanese population.

Keywords
Validity
Reproducibility
Food frequency questionnaire

Food-frequency questionnaires (FFQs) have been used in epidemiological studies to investigate the association between diet and chronic diseases[1]. The validity and reproducibility of FFQs in terms of consumption of nutrients has been assessed in variety of studies in Western countries[1] and Japan[2–11].

Epidemiological interest may focus on examining the associations between health and individual foods[12,13] or food groups[14–18]. There are several foods that are eaten frequently in the very localised area of Japan and are hypothesised to have health-protective effects, such as green tea[19–22] and soy products[23–26]. However, relatively few studies[11,27–29] have examined the validity and reproducibility of FFQs in terms of the consumption of foods or food groups, especially in non-Western countries.

We employed a self-administered 40-item FFQ for two population-based prospective cohort studies in Miyagi Prefecture, in north-eastern Japan, that were started in 1990[30] and in 1994[31]. In the present work, we examined the validity and reproducibility of this questionnaire for total energy and 15 nutrients, 40 food items and nine food groups, using intakes measured by 12 days of diet records as the reference standard.

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Subjects and methods

Study design and subjects

The subjects were a sub-sample of participants in one or two of the cohort studies. Fifty-nine men and 60 women were selected on a voluntary basis. Written informed consent was obtained from all subjects. We surveyed the participants with the questionnaire twice, 1 year apart, in November 1996 (FFQ1) and in November 1997 (FFQ2). In the mean time, we collected a total of 12 days of diet records, on three consecutive days (3-day DRs) four times in the year, in November 1996 and February, May and August 1997.

Food-frequency questionnaire

This FFQ was originally developed for the national collaborative cohort study of cancer in Japan[32]. The questionnaire included 40 food items and supplementary questions about the use of vitamin supplements and milk and sugar in coffee and tea. It was not originally intended to calculate the consumption of nutrients from responses on food frequencies. The questionnaire did not specify the time frame for reporting the consumption of food items and did not query specify portion size information. The questionnaire asked about the average frequency of consumption of each food. Regarding the foods consumed differently between seasons, it asked about the frequency in the season in which they are consumed most frequently within a year. Five frequency categories were used for the majority of food items (almost never, 1–2 days per month, 1–2 days per week, 3–4 days per week, almost every day). For rice and bean paste soup, the number of bowls consumed per day was asked. The frequency of alcohol consumption was asked with five frequency categories (almost never, less than once per week, 1–2 days per week, 3–4 days per week, almost every day) and the usual amount was asked with six categories. For four non-alcohol beverages, we used five categories (almost never, sometimes, 1–2 cups per day, 3–4 cups per day, more than 5 cups per day).

Diet records

The DRs were collected so as to cover both weekdays and weekends and also four different seasons of the year. We instructed the participants to record all foods and beverages consumed in a standardised booklet. We asked them to provide detailed descriptions of each food (open-ended) including the weights prepared and proportions consumed. Research dietitians checked their records in a standardised way after completion by the participants.

Statistical analysis

We excluded six subjects who failed to complete the full 12 days of diet records or the two FFQs, and used the remaining 113 subjects (55 men and 58 women) for subsequent analysis.

We calculated the daily consumption of total energy and 15 nutrient variables from the DRs using the *Standard Tables of Food Composition* published by the Science and Technology Agency of Japan[33]. Regarding alcohol, we limited the calculation to alcohol consumed as beverages and excluded alcohol used for cooking. For calculation from the FFQs, we developed a food composition table that corresponded to the items listed in the questionnaire. We determined a portion size for each food item based on the median values observed in the DRs, separately for men and women. Finally, we computed daily nutrient intakes by multiplying the consumption frequency of each food by the nutrient content of the assigned portion size and summing these values for all the foods. We did not consider nutrient intakes from vitamin supplements because the prevalence of daily users was low (20 subjects, 17.7%).

For calculating the daily consumption of the individual foods from DRs, we summed the amount of all the food codes in the DRs corresponding to the 40 items in the FFQ. We then examined the daily consumption of 40 items from the FFQ by converting the selected frequency category for each food to a daily intake. Daily intakes were calculated by multiplying an average number of daily servings by assigned portion sizes. We calculated the daily consumption of nine food groups by combining the individual food items. The nine food groups are the following: (1) total meats (consisting of four items); (2) dairy products (three items); (3) pulses (three items); (4) total fruits (three items); (5) total fruits and vegetables (nine items); (6) total fruits and vegetables excluding pickles (eight items); (7) total vegetables (six items); (8) total vegetables excluding pickles (five items); and (9) yellow & green vegetables (three items). We constructed these food group categories based on the availability of food items in the questionnaire and interest in their potential associations with health outcomes; thus the grouping was not necessarily comprehensive to cover the whole variety of food items.

To assess the validity of the FFQ, we first compared the mean daily intakes between the DRs and FFQ2. We then calculated Spearman correlation coefficients (95% confidence intervals) between the DRs and FFQ2. In addition to crude correlation coefficients, we computed coefficients with adjustment for age and total energy intake by the residual method[34] and with correction for measurement error (within-person variation) in the 12-day DRs[35]. We also calculated Spearman correlation coefficients between the two FFQs (FFQ1 and FFQ2) to assess the 1-year reproducibility.

Second, we divided the daily intakes from DRs into thirds and compared them with thirds calculated from the FFQ, expressing the results as agreement, adjacent agreement and complete disagreement percentages. We did not calculate the percentages for food items because the intakes from the FFQ were expressed as categorical variables and could not be divided into thirds.

Results

The male subjects were aged 45–77 years (mean ± standard deviation (SD), 62.1 ± 8.5 years) and the female subjects 47–76 years (mean ± SD, 61.0 ± 8.5 years). Their major occupations were farmers, self-employed and housewives. The percentage of current smokers in men was 49.1% (27 subjects). No women currently smoked.

We observed significant seasonal differences in the consumption of carotene, ascorbic acid, fruits and vegetables. The daily consumption of carotene and ascorbic acid was high in November (3971 μg for carotene and 166 mg for ascorbic acid in men; 3808 μg for carotene and 186 mg for ascorbic acid in women) and February (3418 μg and 128 mg; 3714 μg and 141 mg, respectively) and low in May (3150 μg and 100 mg; 2995 μg and 121 mg, respectively) and August (2827 μg and 100 mg; 3046 μg and 116 mg, respectively). The daily consumption of fruits was high in November (128.2 g in men and 143.0 g in women) and February (118.5 g and 150.2 g, respectively) and low in May (86.9 g and 113.7 g, respectively) and August (62.4 g and 108.1 g, respectively). Consumption of vegetables was high in November (157.0 g in men and 163.0 g in women) and February (154.9 g and 172.9 g, respectively) and low in May (131.8 g and 142.9 g, respectively) and August (121.2 g and 133.7 g, respectively). For other nutrients and food groups, we did not observe significant seasonal differences.

Table 1 presents the mean daily nutrient intakes in the DRs and FFQs, Spearman correlation coefficients between the DRs and the FFQs, and Spearman correlation coefficients between the two FFQs for both men and women. Compared with the DRs, the questionnaire underestimated the absolute amount of consumption for most of the nutrients except for retinol for both men and women. Adjusted and deattenuated Spearman correlation coefficients between the DRs and the FFQs ranged from 0.25 for protein to 0.58 for ascorbic acid in men and from 0.30 for retinol to 0.69 for phosphorus in women, with the median of 0.43 and 0.43, respectively. Median (range) of Spearman correlation coefficients between the two FFQs administered at 1-year interval was 0.43 (0.31 for niacin to 0.71 for energy) in men and 0.43 (0.40 for protein and carbohydrates to 0.64 for riboflavin and ascorbic acid) in women.

Tables 2 and 3 present the mean daily consumption of 40 food items in the DRs and the FFQs, Spearman correlation coefficients between the DRs and the FFQs, and Spearman correlation coefficients between the two FFQs for men and women, respectively. Adjusted and deattenuated Spearman correlation coefficients for food intakes ranged from −0.30 for dried fish to 0.72 for milk in men and from −0.06 for fresh juice to 0.75 for pork in women, with a median of 0.35 and 0.34, respectively. Median (range) of Spearman correlation coefficients administered at 1-year interval was 0.43 (0.14 for chicken to 0.76 for alcoholic beverages) in men and 0.45 (0.06 for deep-fried dishes to 0.74 for milk) in women.

Table 4 presents the mean daily consumption of nine food groups in the DRs and FFQs, Spearman correlation coefficients between the DRs and the FFQs, and Spearman correlation coefficients between the two FFQs for both men and women. Adjusted and deattenuated Spearman correlation coefficients for food groups intakes ranged from −0.10 for total meats to 0.76 for total fruits in men and from 0.28 for pulses to 0.70 for total fruits in women, with a median of 0.60 and 0.51, respectively. Median (range) of the Spearman correlation coefficients administered at 1-year interval was 0.50 (0.30 for pulses to 0.70 for dairy products) in men and 0.57 (0.39 for yellow & green vegetables to 0.66 for total meats) in women.

Tables 5 and 6 present agreement, adjacent agreement and complete disagreement percentages in the nutrient and food group intakes between the DRs and FFQ (crude and energy-adjusted). Median (range) of agreement percentages for energy-adjusted nutrient intakes was 43% (from 56% for ascorbic acid to 36% for sodium and riboflavin) in men and 47% (from 55% for phosphorus to 33% for retinol) in women. Median (range) of agreement percentages for energy-adjusted food group intakes was 53% (from 65% for dairy products to 33% for total meats) in men and 50% (from 59% for total fruits to 41% for total meats) in women. Median (range) of complete disagreement percentages for energy-adjusted nutrient intakes was 13% (from 15% for fat and thiamine to 4% for phosphorus) in men and 12% (from 17% for retinol to 3% for calcium and phosphorus) in women. Median (range) of complete disagreement percentages with energy-adjusted food group intakes was 9% (from 25% for total meats to 4% for total fruits and vegetables) in men and 10% (from 16% for total vegetables excluding pickles to 5% for dairy products) in women.

Discussion

In this study, we assessed the validity and reproducibility of a 40-item FFQ used for two large-scale cohort studies among a rural Japanese population. The food lists in our questionnaire were not originally intended to calculate the consumption of nutrients. They were not selected for the questionnaire according to the cumulative contribution to absolute total nutrient intakes[36] or the ability of the food items to discriminate between individual variations in nutrient intake[37]. Nevertheless, the questionnaire has a high reproducibility and a reasonably good validity for many nutrients in terms of correlation coefficients.

Median values of coefficients were almost the same between men and women in the nutrients, foods and food groups, but there were differences between sexes for several nutrients, foods and food groups. For example, regarding the validity for nutrients, there was a relatively large sex difference in correlations for energy (0.55 in men

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Table 1 Validity and reproducibility of the FFQ for the consumption of nutrients

		Mean daily intake (SD)		Spearman correlation coefficients between DRs and FFQ2		Spearman correlation coefficients between FFQ1 and FFQ2	
	Nutrient	DRs	FFQ	Crude	Age- and energy-adjusted and deattenuated	Crude	Age- and energy-adjusted
Men	Energy (kcal)	2386 (435)	2009 (469)	0.58 (0.38–0.78)	0.55 (0.35–0.76)*	0.72 (0.56–0.88)	0.71 (0.55–0.87)†
	Protein (g)	94.7 (16)	64.8 (14.7)	0.28 (0.03–0.53)	0.25 (−0.03 to 0.52)	0.62 (0.46–0.78)	0.39 (0.12–0.66)
	Fat (g)	56.3 (12.1)	35.5 (9.3)	0.25 (−0.02 to 0.52)	0.37 (0.06–0.68)	0.51 (0.31–0.71)	0.47 (0.22–0.72)
	Carbohydrate (g)	329.8 (66.1)	310.5 (77)	0.59 (0.39–0.79)	0.57 (0.35–0.79)	0.77 (0.65–0.89)	0.61 (0.41–0.81)
	Calcium (mg)	682 (185)	485 (145)	0.35 (0.08–0.62)	0.57 (0.32–0.82)	0.62 (0.44–0.80)	0.60 (0.40–0.80)
	Phosphorus (mg)	1311 (232)	911 (202)	0.32 (0.08–0.56)	0.52 (0.29–0.75)	0.68 (0.54–0.82)	0.54 (0.30–0.78)
	Iron (mg)	13.1 (2.2)	8.5 (2.1)	0.26 (−0.01 to 0.53)	0.35 (0.07–0.63)	0.51 (0.29–0.73)	0.44 (0.19–0.69)
	Sodium (mg)	6328 (1220)	2605 (694)	0.39 (0.15–0.63)	0.37 (0.11–0.62)	0.65 (0.47–0.83)	0.48 (0.24–0.72)
	Potassium (mg)	3195 (607)	2052 (545)	0.30 (0.05–0.55)	0.45 (0.17–0.72)	0.56 (0.36–0.76)	0.55 (0.35–0.75)
	Retinol (μg)	355 (298)	414 (540)	0.44 (0.22–0.66)	0.38 (0.07–0.69)	0.55 (0.37–0.73)	0.34 (0.10–0.58)
	Carotene (μg)	3367 (1375)	1465 (611)	0.37 (0.13–0.61)	0.56 (0.31–0.80)	0.49 (0.25–0.73)	0.51 (0.29–0.73)
	Thiamin (mg)	1.15 (0.20)	0.80 (0.19)	0.20 (−0.07 to 0.47)	0.33 (0.03–0.62)	0.57 (0.37–0.77)	0.52 (0.28–0.76)
	Riboflavin (mg)	1.64 (0.32)	1.23 (0.33)	0.23 (−0.02 to 0.48)	0.43 (0.18–0.69)	0.51 (0.27–0.75)	0.48 (0.24–0.72)
	Niacin (mg)	19.7 (4.6)	12.0 (3.6)	0.24 (0.00–0.48)	0.33 (0.06–0.60)	0.43 (0.19–0.67)	0.31 (0.04–0.58)
	Ascorbic acid (mg)	123 (38)	96 (34)	0.48 (0.26–0.70)	0.58 (0.34–0.83)	0.40 (0.15–0.65)	0.49 (0.27–0.71)
Women	Energy (kcal)	1857 (257)	1359 (225)	0.30 (0.06–0.54)	0.36 (0.11–0.62)*	0.58 (0.40–0.76)	0.54 (0.34–0.74)†
	Protein (g)	79.6 (12.8)	54.6 (12.0)	0.33 (0.09–0.57)	0.49 (0.26–0.73)	0.71 (0.53–0.89)	0.40 (0.16–0.64)
	Fat (g)	52.0 (10.5)	33.4 (8.5)	0.39 (0.17–0.61)	0.50 (0.25–0.74)	0.65 (0.47–0.83)	0.42 (0.20–0.64)
	Carbohydrate (g)	267.5 (41.4)	208.3 (34.2)	0.34 (0.12–0.56)	0.43 (0.21–0.66)	0.51 (0.31–0.71)	0.40 (0.16–0.64)
	Calcium (mg)	671 (174)	518 (132)	0.62 (0.46–0.78)	0.67 (0.50–0.84)	0.61 (0.41–0.81)	0.50 (0.28–0.72)
	Phosphorus (mg)	1139 (191)	817 (181)	0.45 (0.23–0.67)	0.69 (0.55–0.84)	0.70 (0.54–0.86)	0.50 (0.30–0.70)
	Iron (mg)	12.0 (2.3)	8.0 (2.0)	0.40 (0.16–0.64)	0.47 (0.24–0.71)	0.73 (0.55–0.91)	0.50 (0.26–0.74)
	Sodium (mg)	5650 (1014)	2482 (637)	0.32 (0.08–0.56)	0.33 (0.06–0.59)	0.77 (0.67–0.87)	0.55 (0.33–0.77)
	Potassium (mg)	3076 (572)	2149 (508)	0.44 (0.24–0.64)	0.45 (0.22–0.68)	0.68 (0.50–0.86)	0.49 (0.27–0.71)
	Retinol (μg)	309 (271)	335 (272)	0.30 (0.06–0.54)	0.30 (−0.05 to 0.64)	0.66 (0.46–0.86)	0.58 (0.40–0.76)
	Carotene (μg)	3399 (1313)	2089 (735)	0.37 (0.15–0.59)	0.45 (0.21–0.69)	0.55 (0.35–0.75)	0.45 (0.23–0.67)
	Thiamin (mg)	1.01 (0.17)	0.75 (0.18)	0.30 (0.06–0.54)	0.31 (0.02–0.61)	0.64 (0.46–0.82)	0.46 (0.24–0.68)
	Riboflavin (mg)	1.55 (0.30)	1.21 (0.31)	0.47 (0.27–0.67)	0.54 (0.33–0.76)	0.74 (0.60–0.88)	0.64 (0.46–0.82)
	Niacin (mg)	16.1 (3.6)	10.6 (2.9)	0.23 (−0.02 to 0.48)	0.47 (0.19–0.74)	0.68 (0.48–0.88)	0.41 (0.17–0.65)
	Ascorbic acid (mg)	141 (41)	117 (34)	0.39 (0.17–0.61)	0.43 (0.16–0.69)	0.69 (0.51–0.87)	0.64 (0.48–0.80)

FFQ – food-frequency questionnaire; SD – standard deviation; DR – diet record.
* Age-adjusted and deattenuated, using the ratio of the within-person to the between-person variance components from the data of the 12 days of diet records.
† Age-adjusted.

Table 2 Validity and reproducibility of the FFQ for the consumption of individual foods: men

	Mean daily intake in g (SD)		Spearman correlation coefficients between DRs and FFQ2		Spearman correlation coefficients between FFQ1 and FFQ2	
Food	DRs	FFQ	Crude	Age- and energy-adjusted and deattenuated	Crude	Age- and energy-adjusted
Rice	563.4 (184.7)	726.0 (236.0)	0.56 (0.34–0.78)	0.16 (−0.06 to 0.39)	0.80 (0.70–0.90)	0.44 (0.34–0.54)
Miso soup	16.2 (9.0)	24.7 (9.8)	0.49 (0.24–0.74)	0.42 (0.13–0.71)	0.75 (0.61–0.89)	0.70 (0.56–0.84)
Beef	0.8 (1.9)	3.8 (4.7)	0.40 (0.20–0.60)	0.36 (0.16–0.56)*	0.70 (0.52–0.88)	0.69 (0.51–0.87)
Pork (excluding ham, sausage)	16.4 (9.3)	10.4 (6.4)	0.05 (−0.24 to 0.34)	0.20 (−0.63 to 1.00)	0.50 (0.30–0.70)	0.43 (0.23–0.63)
Ham, sausage	6.2 (6.1)	3.1 (3.3)	0.29 (0.05–0.53)	0.37 (0.05–0.70)	0.57 (0.39–0.75)	0.59 (0.41 − 0.77)
Chicken	12.9 (14.3)	8.5 (6.5)	0.07 (−0.18 to 0.32)	0.07 (−0.37 to 0.50)	0.28 (0.03–0.53)	0.14 (−0.11 to 0.39)
Liver	0.7 (2.1)	2.0 (4.0)	0.27 (0.00–0.54)	−0.08 (−0.53 to 0.37)	0.45 (0.23–0.67)	0.27 (0.05–0.49)
Egg	44.8 (20.0)	41.4 (17.4)	0.47 (0.25–0.69)	0.53 (0.28–0.78)	0.57 (0.35–0.79)	0.56 (0.34–0.78)
Milk	110.9 (111.6)	121.8 (88.2)	0.71 (0.57–0.85)	0.72 (0.57–0.86)	0.77 (0.65–0.89)	0.72 (0.60–0.84)
Yoghurt	12.3 (26.5)	18.1 (26.6)	0.57 (0.35–0.79)	0.56 (0.33–0.79)	0.60 (0.40–0.80)	0.56 (0.36–0.76)
Cheeses	1.6 (3.6)	1.4 (3.2)	0.37 (0.12–0.62)	0.36 (0.06–0.66)	0.43 (0.19–0.67)	0.40 (0.16–0.64)
Butter	0.6 (0.9)	0.5 (0.9)	0.25 (0.00–0.25)	0.20 (−0.23 to 0.63)	0.58 (0.36–0.80)	0.50 (0.28–0.72)
Margarine	0.2 (0.9)	0.2 (0.6)	0.25 (−0.02 to 0.52)	0.28 (−0.04 to 0.60)	0.57 (0.35–0.79)	0.68 (0.46–0.90)
Deep-fried dishes, tempura	32.6 (17.3)	27.0 (20.0)	0.31 (0.06–0.56)	0.33 (0.08–0.58)*	0.39 (0.14–0.64)	0.33 (0.08–0.58)
Fried vegetables	28.3 (18.6)	32.8 (25.8)	0.30 (0.03–0.57)	0.70 (0.15–1.00)	0.39 (0.15–0.63)	0.41 (0.17–0.65)
Raw fish, fish broiled with soy, roast fish	78.4 (36.1)	54.2 (30.4)	0.23 (−0.01 to 0.47)	0.39 (0.10–0.67)	0.38 (0.16–0.60)	0.31 (0.09–0.53)
Boiled fish paste	8.9 (7.6)	5.8 (4.4)	0.32 (0.07–0.57)	0.49 (0.11–0.88)	0.19 (−0.06 to 0.44)	0.19 (−0.06 to 0.44)
Dried fish	7.0 (7.2)	2.2 (2.1)	−0.25 (−0.49 to −0.01)	−0.30 (−0.68 to 0.07)	0.50 (0.28–0.72)	0.39 (0.17–0.61)
Green vegetables	17.7 (16.9)	13.6 (7.3)	0.28 (0.03–0.53)	0.35 (0.03–0.66)	0.42 (0.17–0.67)	0.41 (0.16–0.66)
Carrot, pumpkin	22.0 (16.0)	9.6 (6.0)	0.23 (−0.02 to 0.48)	0.24 (−0.05 to 0.54)	0.38 (0.13–0.63)	0.38 (0.13–0.63)
Tomato	21.8 (19.7)	19.3 (16.5)	0.41 (0.17–0.65)	0.63 (0.28–0.99)	0.53 (0.29–0.77)	0.50 (0.26–0.74)
Cabbage, lettuce	29.2 (18.9)	23.0 (14.4)	0.31 (0.07–0.55)	0.40 (0.10–0.70)	0.34 (0.09–0.59)	0.32 (0.07–0.57)
Chinese cabbage	18.0 (15.5)	27.5 (14.0)	0.14 (−0.13 to 0.41)	0.09 (−0.32 to 0.50)	0.13 (−0.12 to 0.38)	0.15 (−0.10 to 0.40)
Wild plant	1.1 (2.1)	2.5 (3.0)	0.10 (−0.17 to 0.37)	0.26 (−0.16 to 0.69)	0.27 (0.02–0.52)	0.27 (0.02–0.52)
Mushrooms (shiitake, enokitake)	7.6 (5.9)	5.8 (4.8)	0.22 (−0.05 to 0.49)	0.32 (−0.08 to 0.72)	0.27 (0.02–0.52)	0.30 (0.05–0.55)
Potatoes	47.9 (22.8)	23.0 (15.5)	0.39 (0.19–0.59)	0.53 (0.26–0.80)	0.47 (0.25–0.69)	0.42 (0.20–0.64)
Seaweeds	12.2 (8.6)	4.8 (2.7)	0.24 (−0.01 to 0.49)	0.44 (0.02–0.85)	0.34 (0.09–0.59)	0.35 (0.10–0.60)
Pickles (radish, Chinese cabbage)	35.1 (20.8)	29.6 (14.0)	0.53 (0.33–0.73)	0.65 (0.42–0.87)	0.64 (0.42–0.86)	0.60 (0.38–0.82)
Food boiled with soy	0.7 (1.3)	1.5 (1.8)	0.09 (−0.16 to 0.34)	0.19 (−0.22 to 0.61)	0.37 (0.15–0.59)	0.39 (0.17–0.61)
Boiled beans	2.1 (4.6)	6.4 (10.3)	0.36 (0.16–0.56)	0.26 (−0.04 to 0.56)	0.50 (0.19–0.81)	0.55 (0.24–0.86)
Soybean (tofu, fermented soybeans)	88.3 (31.5)	61.6 (24.8)	−0.03 (−0.32 to 0.26)	0.02 (−0.33 to 0.38)	0.19 (−0.08 to 0.46)	0.25 (−0.02 to 0.52)
Orange	23.1 (22.2)	46.8 (28.8)	0.51 (0.31–0.71)	0.56 (0.29–0.82)	0.51 (0.27–0.75)	0.61 (0.37–0.85)
Other fruits	72.1 (53.0)	46.5 (27.7)	0.52 (0.30–0.74)	0.70 (0.43–0.98)	0.40 (0.16–0.64)	0.42 (0.18–0.66)
Fresh juice	2.4 (9.0)	26.0 (48.0)	0.15 (−0.03 to 0.33)	0.07 (0.16–0.56)*	0.46 (0.22–0.70)	0.44 (0.20–0.68)
Confectioneries	21.2 (15.6)	17.0 (14.5)	0.43 (0.19–0.67)	0.58 (0.28–0.88)	0.51 (0.31–0.71)	0.61 (0.41–0.81)
Green tea	382.4 (271.3)	510.0 (330.0)	0.73 (0.59–0.87)	0.71 (0.56–0.85)	0.62 (0.42–0.82)	0.63 (0.43–0.83)
Black tea	2.0 (7.0)	42.0 (57.0)	0.25 (0.00–0.50)	0.25 (−0.13 to 0.63)	0.55 (0.33–0.77)	0.50 (0.28–0.72)
Coffee	8.7 (36.5)	174.0 (193.5)	0.15 (−0.12 to 0.42)	0.07 (−0.21 to 0.36)	0.77 (0.63–0.91)	0.75 (0.61–0.89)
Chinese tea	18.3 (41.3)	58.5 (91.5)	0.35 (0.11–0.59)	0.20 (−0.08 to 0.48)	0.47 (0.23–0.71)	0.15 (−0.09 to 0.39)
Alcoholic beverages	23.5 (25.5)	23.4 (24.3)	0.77 (0.61–0.93)	0.70 (0.54–0.86)	0.83 (0.73–0.93)	0.76 (0.66–0.86)

FFQ – food-frequency questionnaire; SD – standard deviation; DR – diet record.
*Without deattenuation because of large within- to between-person variance in the DRs.

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Table 3 Validity and reproducibility of the FFQ for the consumption of individual foods: women

	Mean daily intake in g (SD)		Spearman correlation coefficients between DRs and FFQ2		Spearman correlation coefficients between FFQ1 and FFQ2	
Food	DRs	FFQ	Crude	Age- and energy-adjusted and deattenuated	Crude	Age- and energy-adjusted
Rice	356.4 (90.0)	399.0 (93.8)	0.55 (0.35–0.75)	0.65 (0.44–0.86)	0.39 (0.19–0.59)	0.43 (0.23–0.63)
Miso soup	13.3 (8.4)	18.7 (5.9)	0.17 (−0.10 to 0.42)	0.21 (−0.07 to 0.50)	0.66 (0.41–0.91)	0.54 (0.29–0.79)
Beef	0.8 (1.5)	2.7 (3.5)	0.31 (0.0–0.55)	0.13 (−0.11 to 0.37)*	0.63 (0.39–0.87)	0.65 (0.41–0.89)
Pork (excluding ham, sausage)	10.8 (8.6)	8.7 (6.3)	0.36 (0.11–0.61)	0.75 (0.38–1.00)	0.56 (0.31–0.81)	0.50 (0.25–0.75)
Ham, sausage	4.9 (5.4)	3.2 (3.2)	0.38 (0.13–0.63)	0.43 (0.11–0.76)	0.58 (0.33–0.83)	0.49 (0.24–0.74)
Chicken	9.8 (15.9)	9.3 (7.8)	0.12 (−0.20 to 0.39)	0.22 (−0.16 to 0.60)	0.60 (0.33–0.87)	0.49 (0.22–0.76)
Liver	0.8 (2.0)	1.2 (1.8)	0.52 (0.36–0.68)	0.21 (0.05–0.37)*	0.61 (0.45–0.77)	0.50 (0.34–0.66)
Egg	36.6 (18.1)	37.0 (17.0)	0.61 (0.43–0.79)	0.58 (0.38–0.78)	0.68 (0.50–0.86)	0.53 (0.35–0.71)
Milk	135.3 (87.5)	149.1 (77.7)	0.71 (0.57–0.85)	0.65 (0.50–0.79)	0.74 (0.60–0.88)	0.74 (0.60–0.88)
Yoghurt	21.9 (28.6)	33.3 (28.8)	0.62 (0.46–0.78)	0.60 (0.43–0.77)	0.41 (0.25–0.57)	0.45 (0.29–0.61)
Cheeses	1.3 (2.4)	1.2 (1.5)	0.32 (0.08–0.56)	0.36 (0.09–0.64)	0.47 (0.23–0.71)	0.35 (0.11–0.59)
Butter	0.8 (1.2)	0.5 (0.6)	0.10 (−0.20 to 0.37)	0.11 (−0.27 to 0.49)	0.49 (0.22–0.76)	0.56 (0.29–0.83)
Margarine	0.2 (0.6)	0.4 (0.5)	0.30 (0.03–0.57)	0.41 (0.02–0.80)	0.50 (0.23–0.77)	0.54 (0.27–0.81)
Deep-fried dishes, tempura	29.7 (20.4)	23.2 (15.4)	0.21 (0.00–0.46)	0.09 (−0.16–0.34)*	0.36 (0.11–0.61)	0.06 (−0.19 to 0.31)
Fried vegetables	32.1 (23.0)	51.3 (30.0)	0.13 (−0.10 to 0.38)	0.26 (−0.25 to 0.77)	0.46 (0.21–0.71)	0.38 (0.13–0.63)
Raw fish, fish broiled with soy, roast fish	58.6 (25.0)	48.0 (24.0)	0.30 (0.06–0.54)	0.60 (0.26–0.94)	0.50 (0.26–0.74)	0.33 (0.09–0.57)
Boiled fish paste	8.0 (6.8)	7.7 (6.1)	0.25 (0.01–0.49)	0.41 (0.08–0.73)	0.57 (0.33–0.81)	0.44 (0.20–0.68)
Dried fish	6.0 (6.7)	2.3 (2.1)	0.17 (−0.10 to 0.44)	0.35 (−0.09 to 0.79)	0.34 (0.07–0.61)	0.28 (0.01–0.55)
Green vegetables	15.9 (11.4)	14.2 (6.2)	0.18 (−0.10 to 0.43)	0.37 (−0.02 to 0.76)	0.48 (0.23–0.73)	0.40 (0.15–0.65)
Carrot, pumpkin	24.8 (17.7)	17.0 (8.3)	0.31 (0.07–0.55)	0.35 (0.08–0.62)	0.50 (0.26–0.74)	0.44 (0.20–0.68)
Tomato	34.2 (31.4)	33.6 (24.5)	0.29 (0.02–0.56)	0.33 (−0.02 to 0.67)	0.45 (0.18–0.72)	0.41 (0.14–0.68)
Cabbage, lettuce	27.9 (15.9)	25.2 (13.2)	0.17 (−0.10 to 0.42)	0.15 (−0.23 to 0.52)	0.49 (0.24–0.74)	0.40 (0.15–0.65)
Chinese cabbage	16.2 (12.0)	30.9 (14.6)	0.24 (0.00–0.49)	0.17 (−0.08 to 0.42)*	0.53 (0.28–0.78)	0.49 (0.24–0.74)
Wild plant	0.8 (2.0)	2.4 (2.4)	0.13 (−0.10 to 0.37)	0.15 (−0.24 to 0.54)	0.25 (0.01–0.49)	0.22 (−0.02 to 0.46)
Mushrooms (shiitake, enokitake)	6.7 (5.4)	3.4 (2.3)	0.27 (0.03–0.51)	0.55 (0.17–0.93)	0.46 (0.22–0.70)	0.33 (0.09–0.57)
Potatoes	44.3 (19.2)	31.5 (15.5)	0.24 (0.00–0.49)	0.08 (−0.27 to 0.43)	0.51 (0.26–0.76)	0.32 (0.07–0.57)
Seaweeds	12.1 (7.6)	6.4 (3.0)	0.09 (−0.20 to 0.36)	0.00 (−0.40 to 0.40)	0.32 (0.05–0.59)	0.13 (−0.14 to 0.40)
Pickles (radish, Chinese cabbage)	34.5 (24.3)	32.0 (16.7)	0.67 (0.51–0.83)	0.67 (0.50–0.84)	0.75 (0.59–0.91)	0.57 (0.41–0.73)
Food boiled with soy	0.4 (0.8)	1.7 (2.4)	0.11 (−0.10 to 0.36)	0.25 (0.00–0.50)*	0.48 (0.23–0.73)	0.44 (0.19–0.63)
Boiled beans	3.2 (6.1)	7.2 (8.8)	0.20 (0.00–0.44)	0.47 (0.06–0.88)	0.60 (0.36–0.84)	0.41 (0.17–0.65)
Soybean (tofu, fermented soybeans)	72.2 (28.3)	56.0 (19.3)	0.17 (−0.10 to 0.42)	0.23 (−0.08 to 0.54)	0.58 (0.33–0.83)	0.60 (0.35–0.85)
Orange	29.8 (24.0)	72.3 (31.3)	0.35 (0.10–0.60)	0.51 (0.18–0.85)	0.51 (0.26–0.76)	0.53 (0.28–0.78)
Other fruits	95.9 (50.6)	68.0 (33.0)	0.46 (0.24–0.68)	0.61 (0.35–0.87)	0.53 (0.31–0.75)	0.59 (0.37–0.81)
Fresh juice	2.4 (8.0)	22.0 (32.0)	0.01 (−0.20 to 0.26)	−0.06 (−0.43 to 0.31)	0.61 (0.36–0.86)	0.47 (0.22–0.72)
Confectioneries	39.2 (25.5)	20.0 (16.2)	0.34 (0.12–0.56)	0.27 (0.02–0.52)	0.53 (0.31–0.75)	0.41 (0.19–0.63)
Green tea	535.2 (280.9)	504.0 (240.0)	0.53 (0.33–0.73)	0.53 (0.33–0.74)	0.66 (0.46–0.86)	0.64 (0.44–0.84)
Black tea	4.6 (8.5)	40.5 (57.0)	0.31 (0.06–0.56)	0.32 (0.07–0.57)*	0.24 (−0.01 to 0.49)	0.22 (−0.03 to 0.47)
Coffee	9.6 (31.6)	120.0 (142.5)	0.41 (0.19–0.63)	0.27 (0.04–0.50)	0.66 (0.44–0.88)	0.64 (0.42–0.86)
Chinese tea	13.9 (32.1)	36.0 (60.0)	0.00 (−0.30 to 0.25)	0.03 (−0.39 to 0.46)	0.32 (0.07–0.57)	0.38 (0.13–0.63)
Alcoholic beverages	0.7 (1.5)	0.6 (1.4)	0.71 (0.53–0.89)	0.60 (0.4–0.80)	0.75 (0.57–0.93)	0.66 (0.48–0.84)

FFQ – food-frequency questionnaire; SD – standard deviation; DR – diet record.
* Without deattenuation because of large within- to between-person variance in the DRs.

Table 4 Validity and reproducibility of the FFQ for the consumption of food groups

	Food group	Mean daily intake in g (SD)		Spearman correlation coefficients between DRs and FFQ2		Spearman correlation coefficients between FFQ1 and FFQ2	
		DRs	FFQ	Crude	Age- and energy-adjusted and deattenuated	Crude	Age- and energy-adjusted
Men	Total meats	36.3 (16.9)	25.8 (15.0)	−0.06 (−0.33 to 0.21)	−0.10 (−0.51 to 0.31)*	0.53 (0.31–0.75)	0.45 (0.23–0.67)
	Dairy products	124.8 (114.1)	142.7 (100.2)	0.67 (0.49–0.85)	0.71 (0.52–0.89)	0.69 (0.53–0.85)	0.70 (0.54–0.86)
	Pulses	106.5 (31.3)	92.5 (29.8)	0.05 (−0.24 to 0.34)	0.11 (−0.25 to 0.46)	0.27 (0.00–0.54)	0.30 (0.03–0.57)
	Total fruits	97.6 (60.1)	119.6 (74.6)	0.62 (0.46–0.78)	0.76 (0.51–1.00)	0.44 (0.20–0.68)	0.50 (0.26–0.74)
	Total fruits and vegetables	241.4 (92.5)	242.2 (109.0)	0.61 (0.41–0.81)	0.75 (0.50–1.00)	0.52 (0.30–0.74)	0.54 (0.32–0.76)
	Total fruits and vegetables excluding pickles	206.3 (90.2)	212.4 (104.4)	0.61 (0.41–0.81)	0.74 (0.50–1.00)	0.49 (0.25–0.73)	0.50 (0.26–0.74)
	Total vegetables	143.8 (51.5)	122.7 (49.1)	0.50 (0.26–0.74)	0.60 (0.33–0.87)	0.49 (0.25–0.73)	0.43 (0.19–0.67)
	Total vegetables excluding pickles	108.8 (48.3)	92.9 (43.0)	0.40 (0.16–0.64)	0.49 (0.20–0.78)	0.41 (0.16–0.66)	0.37 (0.12–0.62)
	Yellow & green vegetables	61.5 (35.3)	42.5 (23.3)	0.46 (0.22–0.70)	0.54 (0.24–0.84)	0.55 (0.33–0.77)	0.53 (0.31–0.75)
Women	Total meats	26.3 (18.7)	24.0 (15.6)	0.36 (0.12–0.60)	0.51 (0.39–1.00)	0.64 (0.44–0.84)	0.66 (0.46–0.86)
	Dairy products	158.5 (94.6)	183.4 (84.1)	0.63 (0.45–0.81)	0.60 (0.45–0.82)	0.58 (0.36–0.80)	0.61 (0.39–0.83)
	Pulses	88.6 (30.9)	82.5 (23.7)	0.21 (0.00–0.46)	0.28 (0.03–0.61)	0.60 (0.40–0.80)	0.57 (0.37–0.77)
	Total fruits	128.2 (60.3)	162.9 (65.3)	0.56 (0.34–0.78)	0.70 (0.62–1.00)	0.56 (0.34–0.78)	0.58 (0.36–0.80)
	Total fruits and vegetables	281.6 (100.3)	316.2 (106.4)	0.51 (0.29–0.73)	0.57 (0.39–0.87)	0.59 (0.39–0.79)	0.59 (0.39–0.79)
	Total fruits and vegetables excluding pickles	247.1 (92.6)	284.1 (99.0)	0.44 (0.20–0.68)	0.51 (0.31–0.84)	0.57 (0.35–0.79)	0.54 (0.32–0.76)
	Total vegetables	153.4 (65.2)	153.3 (60.5)	0.47 (0.23–0.71)	0.45 (0.22–0.79)	0.66 (0.52–0.80)	0.53 (0.33–0.73)
	Total vegetables excluding pickles	119.0 (55.4)	121.2 (52.3)	0.36 (0.12–0.60)	0.35 (0.11–0.70)	0.60 (0.44–0.76)	0.46 (0.22–0.70)
	Yellow & green vegetables	74.9 (44.8)	65.1 (32.3)	0.45 (0.21–0.69)	0.44 (0.21–0.79)	0.49 (0.27–0.71)	0.39 (0.15–0.63)

FFQ – food-frequency questionnaire; SD – standard deviation; DR – diet record.
The nine food groups consist of the following: (1) total meats (four food items – beef, pork, ham and sausage, chicken); (2) dairy products (three food items – milk, yoghurt and cheeses); (3) pulses (three food items – boiled beans, soybean dishes and miso soup); (4) total fruits (three food items – orange, other fruits and fresh juice); (5) total fruits and vegetables (nine food items – orange, other fruits, fresh juice, green vegetables, carrot and pumpkin, tomato, cabbage and lettuce, Chinese cabbage and pickles): (6) total fruits and vegetables excluding pickles (eight food items – orange, other fruits, fresh juice, green vegetables, carrot and pumpkin, tomato, cabbage and lettuce, and Chinese cabbage); (7) total vegetables (six food items – green vegetables, carrot and pumpkin, tomato, cabbage and lettuce, Chinese cabbage and pickles); (8) total vegetables excluding pickles (five food items – green vegetables, carrot and pumpkin, tomato, cabbage and lettuce, and Chinese cabbage); and (9) yellow & green vegetables (three food items – green vegetables, carrot and pumpkin, and tomato).
* Deattenuation by using log-transformed intra- and inter-individual variance components.

Table 5 Percentages of agreement, adjacent agreement and complete disagreement according to tertile classification of daily nutrient intakes based on the diet records and food-frequency questionnaire

		Crude			Energy-adjusted		
	Nutrient	Agreement (%)	Adjacent agreement (%)	Complete disagreement (%)	Agreement (%)	Adjacent agreement (%)	Complete disagreement (%)
Men	Energy	56	36	7	–	–	–
	Protein	35	47	18	44	44	13
	Fat	47	36	16	42	44	15
	Carbohydrate	55	40	5	51	40	9
	Calcium	55	33	13	47	42	11
	Phosphorus	40	47	13	51	45	4
	Iron	36	47	16	40	47	13
	Sodium	42	47	11	36	53	11
	Potassium	45	44	11	44	45	11
	Retinol	42	51	7	49	38	13
	Carotene	38	51	11	42	45	13
	Thiamin	36	44	20	38	47	15
	Riboflavin	36	45	18	36	51	13
	Niacin	35	51	15	42	45	13
	Ascorbic acid	53	36	11	56	36	7
Women	Energy	40	45	16	–	–	–
	Protein	43	45	12	47	40	14
	Fat	45	41	14	50	41	9
	Carbohydrate	47	45	9	52	36	12
	Calcium	55	38	7	47	50	3
	Phosphorus	43	48	9	55	41	3
	Iron	47	45	9	48	41	10
	Sodium	41	45	14	43	43	14
	Potassium	48	41	10	40	52	9
	Retinol	36	52	12	33	50	17
	Carotene	36	48	16	43	45	12
	Thiamin	36	50	14	48	36	16
	Riboflavin	48	41	10	50	38	12
	Niacin	45	40	16	53	31	16
	Ascorbic acid	38	48	14	45	41	14

Table 6 Percentages of agreement, adjacent agreement and complete disagreement according to tertile classification of daily intakes of food groups based on the diet records and food-frequency questionnaire

		Crude			Energy-adjusted		
	Food group	Agreement (%)	Adjacent agreement (%)	Complete disagreement (%)	Agreement (%)	Adjacent agreement (%)	Complete disagreement (%)
Men	Total meats	38	33	29	33	42	25
	Dairy products	65	29	5	65	29	5
	Pulses	35	45	20	38	38	24
	Total fruits	53	44	4	56	35	9
	Total fruits and vegetables	64	31	5	60	36	4
	Total fruits and vegetables excluding pickles	58	35	7	58	35	7
	Total vegetables	60	29	11	53	38	9
	Total vegetables excluding pickles	49	36	15	51	38	11
	Yellow & green vegetables	45	45	9	47	40	13
Women	Total meats	47	38	16	41	45	14
	Dairy products	60	34	5	57	38	5
	Pulses	34	48	17	52	38	10
	Total fruits	55	33	12	59	33	9
	Total fruits and vegetables	48	45	7	50	40	10
	Total fruits and vegetables excluding pickles	53	34	12	48	34	17
	Total vegetables	59	28	14	48	40	12
	Total vegetables excluding pickles	52	33	16	48	36	16
	Yellow & green vegetables	48	41	10	52	38	10

and 0.36 in women) and protein (0.25 and 0.49, respectively).

The absolute mean levels of consumption for energy and most nutrients were lower in our questionnaire than in the diet records. This is probably due to the relatively small number of food items included in our questionnaire. A questionnaire with a larger number of food items may better estimate the absolute amount of food and nutrient consumption. In contrast, the absolute consumption levels for individual food items were not necessarily lower in our questionnaire than in the diet records, which would indicate that the validity of our questionnaire in assessing the absolute amount of intake varies by food item. However, the problem of our questionnaire estimates of absolute intake should be of less concern when they are applied to the main cohort studies, since we would use energy-adjusted values rather than absolute values, and the primary objective of analyses would be to rank individuals within the cohorts according to the relative levels of consumption.

Table 7 summarises studies conducted in Japan examining the validity and reproducibility of FFQs in assessing the consumption of multiple nutrients. Among these studies, median correlation coefficients between the DRs and the FFQs ranged from 0.36 to 0.61, and median reproducibility between the FFQs ranged from 0.32 to 0.72. Our questionnaire showed validity and reproducibility comparable with those reported in other Japanese studies.

The validity and reproducibility of individual food items[27,28] and dietary patterns[38] in the FFQ were examined for the US population. For the Japanese population, Wakai *et al.*[29] examined the validity and reproducibility of 20 food group intakes assessed by a 97-item FFQ. Median (range) of correlation coefficients with the DRs was 0.56 (0.16 for noodles to 0.83 for milk and dairy products). Median (range) of correlation coefficients for 1-year reproducibility was 0.54 (0.34 for eggs to 0.78 for breads). Tokudome *et al.*[11] also examined the validity of 15 food group intakes assessed by a 102-item FFQ. Median (range) of correlation coefficients with the DRs was 0.52 (0.17 for beverages to 0.83 for rice). Our results are similar to the findings in these studies.

Regarding the nutrients and food groups with high correlation coefficients, agreement and complete disagreement percentages according to tertile classification of daily intakes based on DRs and FFQ were generally high and low, respectively, in our study. The agreement and complete disagreement percentages of ascorbic acid in men (Spearman correlation coefficient, 0.58) were 56% and 7% (energy-adjusted), respectively. In contrast, the agreement and complete disagreement percentages of retinol in women (Spearman correlation coefficient, 0.30) were 33% and 17% (energy-adjusted), respectively. Because we cannot assume that the two variables (daily intake from DR and daily intake from FFQ) are normally distributed and their relationship is linear, we calculated

Table 7 Summary of validation studies for FFQs among the Japanese population

Author	Number of food items	Number of frequency categories	Subjects	Days of DRs	Number of nutrients	Validity: Correlation coefficients between DRs and FFQ†	Reproducibility: Correlation coefficients between FFQs†	Reproducibility: Interval between FFQs
Nakamura *et al.*, 1994[2]	21	Open-ended	19 women	7	13	0.56 (0.27–0.90)	–	1 week
Date *et al.*, 1996[3]	122	Open-ended	67 men and women	56–63	14	0.48 (0.21–0.74)	0.71 (0.28–0.78)	1 week
Katagiri *et al.*, 1998[4]	24	6	72 men and women	7	11	0.37 (0.15–0.57)	0.67 (0.59–0.90)	1 week
Sasaki *et al.*, 1998[5]	110	*	47 women	3	18	0.48 (0.19–0.75)	–	–
Egami *et al.*, 1999[6]	97	9	88 men and women	16	19	0.61 (0.42–0.83)	0.67 (0.48–0.82)	1 year
Shimizu *et al.*, 1999[7]	169	8	117 men and women	3	15	0.42 (0.10–0.56) men 0.37 (0.10–0.66) women	0.62 (0.46–0.78) men 0.57 (0.13–0.67) women	1 year
Yamaoka *et al.*, 2000[8]	65	7	71 men	7	18	0.36 (−0.10 to 0.65)	0.72 (0.59–0.81)	10 months
Tsubono *et al.*, 2001[9]	141	9	113 men and women	12	16	0.43 (0.24–0.85)	0.68 (0.47–0.91)	1 year
Tsubono *et al.*, 2001[10]	44	4	211 men and women	28	15	0.37 (0.15–0.57) men 0.39 (0.12–0.51) women	0.32 (0.06–0.58) men 0.51 (0.36–0.61) women	5 years
Tokudome *et al.*, 2001[11]	102	8	79 women	28	31	0.45 (0.23–0.71)	–	–
Present study	40	5	113 men and women	12	16	0.49 (0.27–0.65)	0.57 (0.44–0.69)	1 year

FFQ – food-frequency questionnaire; DR – diet record.
* Combination of the two questions: (1) per day, week or month, and (2) once, twice, three times or more than or equal to four times.
† Values are given as mean or median (range).

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agreement and complete disagreement percentages to ascertain the usefulness of the FFQ for dividing individuals according to their level of consumption.

For interpreting the results presented in Tables 5 and 6, we must consider what would be expected by chance alone. For example, the probability of agreement and complete disagreement expected by chance alone in tertile classification is 33% and 22%, respectively. Thus, we might have overestimated agreement percentages or underestimated complete disagreement percentages.

Some traditional Japanese foods, such as green tea and soybean products (tofu, miso, etc.), have recently drawn attention as being potentially health-protective. Although many studies have been conducted in Japan to examine the associations between consumption of green tea[19–22], soy products[23–26] and various health outcomes, most studies did not document the validity and reproducibility of questionnaires used to measure the usual consumption of these food items. In this study, the correlation between our questionnaire and the DRs was high for green tea (adjusted and deattenuated Spearman correlation coefficient of 0.71 in men and 0.53 in women), moderate for miso soup (0.42 and 0.21, respectively) and low for soybean products (0.02 and 0.23, respectively). These results suggest that the validity of FFQs for Japanese populations may vary by the food item examined.

A possible reason for the low correlation for soybean products may be the lack of variation in the questionnaire responses owing to a limited number of frequency categories, since the majority of men (65.5%) and women (75.9%) chose the highest category (almost daily). A questionnaire with a larger number of frequency categories at the high end may have improved validity for the assessment of soybean intake. Another reason may be the lack of between-person variation in our subjects in the actual consumption of soybeans. The ratio of between- to within-person variation in soybean intake, estimated from the diet record data, was 5.92 in men and 5.52 in women. These ratios are relatively higher compared with other popular foods such as rice (0.69 and 1.18, respectively), miso soup (3.50 and 3.14, respectively) and green tea (0.99 and 1.20, respectively), indicating the relatively limited between-person variation for intake of soy foods.

We have reported that consumption of green tea, as measured by another FFQ with high validity, is not associated with decreased risk of gastric cancer in a different cohort study conducted in the same area[13]. Using the two cohort studies in which the present FFQ is used, we are currently examining the associations between green tea, soybean products and various cancers. We are also beginning to examine the relationship between level of intake of food groups such as fruit and vegetables and cancer risk at several sites, because we can show that our FFQ is useful to divide individuals according to their relative level of intake.

Information regarding validity is important and indispensable in interpreting study results[1]. For example, when a calculated relative risk suggests 'no association' between diet and diseases, it may come from too small correlations between the DR and FFQ to detect differences between dietary exposures. Dietary exposures are often expressed in quintiles. Our results suggest that gross misclassification exists in several nutrients or food groups calculated by our FFQ. The attenuation of relative risks towards the null hypothesis can be caused by this non-differential misclassification[39].

In summary, we examined the validity and reproducibility of a 40-item FFQ used for two prospective cohort studies in rural Japan. Our results indicate comparable validity and reproducibility with regard to the consumption of nutrients, foods and food groups. This brief FFQ is useful to examine the association between diet and health in the Japanese population.

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