**TABLE 3**
Selected characteristics of the 1354 Japanese women according to quintiles of dietary glycemic index and load

| | Quintiles of dietary glycemic index or load | | | | | |
|---|---|---|---|---|---|---|
| | 1 ($n$ = 270) | 2 ($n$ = 271) | 3 ($n$ = 271) | 4 ($n$ = 271) | 5 ($n$ = 271) | $P$[1] |
| Dietary glycemic index[2] | 60.8 ± 2.6[3] | 64.8 ± 0.7 | 67.0 ± 0.6 | 68.9 ± 0.6 | 71.8 ± 1.4 | |
| Age (y) | 55.8 ± 11.3 | 54.7 ± 10.4 | 55.1 ± 10.4 | 55.4 ± 9.7 | 55.7 ± 9.4 | 0.89 |
| Current BMI (kg/m$^2$) | 23.9 ± 3.3 | 23.9 ± 3.1 | 23.8 ± 3.1 | 24.2 ± 3.3 | 24.2 ± 3.5 | 0.23 |
| BMI at age 20 y (kg/m$^2$) | 21.7 ± 2.8 | 21.5 ± 2.2 | 21.6 ± 2.4 | 21.8 ± 2.5 | 21.9 ± 2.8 | 0.22 |
| Premenopausal women (%) | 27 | 31 | 35 | 30 | 34 | 0.21 |
| Current smokers (%) | 6 | 3 | 3 | 1 | 4 | 0.13 |
| Dietary supplement users (%) | 37 | 30 | 31 | 26 | 24 | 0.0005 |
| Rate of eating (%) | | | | | | 0.45 |
| Fast | 37 | 36 | 33 | 39 | 33 | |
| Medium | 46 | 51 | 47 | 47 | 47 | |
| Slow | 17 | 13 | 20 | 14 | 20 | |
| Physical activity level | 1.82 ± 0.29 | 1.84 ± 0.28 | 1.83 ± 0.28 | 1.85 ± 0.28 | 1.84 ± 0.29 | 0.45 |
| Energy intake (kcal/d) | 2171 ± 559 | 2067 ± 453 | 1979 ± 467 | 1809 ± 404 | 1695 ± 440 | <0.0001 |
| Fat intake (% of energy) | 27.7 ± 5.5 | 27.0 ± 5.4 | 25.6 ± 5.2 | 24.3 ± 5.4 | 22.2 ± 5.5 | <0.0001 |
| Alcohol intake (%) | | | | | | 0.0007 |
| Nondrinkers | 57 | 57 | 62 | 67 | 66 | |
| > 0% to < 1% of energy | 20 | 21 | 21 | 19 | 20 | |
| ≥1% of energy | 23 | 22 | 17 | 14 | 15 | |
| Dietary fiber intake (g/1000 kcal) | 9.1 ± 2.3 | 7.9 ± 2.0 | 7.6 ± 1.7 | 7.2 ± 1.7 | 6.4 ± 1.6 | <0.0001 |
| Dietary glycemic load (/1000 kcal)[2] | 67.6 ± 6.7 | 79.9 ± 2.4 | 87.4 ± 2.3 | 95.4 ± 2.5 | 109.7 ± 8.4 | |
| Age (y) | 53.5 ± 12.1 | 54.4 ± 10.6 | 54.5 ± 10.1 | 56.9 ± 8.9 | 56.9 ± 9 | <0.0001 |
| Current BMI (kg/m$^2$) | 24.1 ± 3.3 | 23.8 ± 3.0 | 24.0 ± 3.4 | 24.1 ± 3.2 | 24.0 ± 3.4 | 0.70 |
| BMI at age 20 y (kg/m$^2$) | 21.6 ± 2.6 | 21.7 ± 2.4 | 21.6 ± 2.6 | 21.7 ± 2.5 | 21.9 ± 2.6 | 0.21 |
| Premenopausal women (%) | 38 | 34 | 32 | 28 | 27 | 0.002 |
| Current smokers (%) | 6 | 3 | 3 | 3 | 2 | 0.024 |
| Dietary supplement users (%) | 34 | 32 | 32 | 27 | 22 | 0.0007 |
| Rate of eating (%) | | | | | | 0.58 |
| Fast | 39 | 32 | 36 | 34 | 37 | |
| Medium | 47 | 48 | 50 | 45 | 47 | |
| Slow | 14 | 20 | 14 | 21 | 16 | |
| Physical activity level | 1.79 ± 0.27 | 1.84 ± 0.29 | 1.84 ± 0.27 | 1.86 ± 0.29 | 1.85 ± 0.30 | 0.010 |
| Energy intake (kcal/d) | 2285 ± 549 | 2106 ± 438 | 1926 ± 404 | 1808 ± 396 | 1595 ± 378 | <0.0001 |
| Fat intake (% of energy) | 31.8 ± 4.7 | 28.4 ± 3.0 | 25.6 ± 3.1 | 22.4 ± 2.8 | 18.5 ± 3.5 | <0.0001 |
| Alcohol intake (%) | | | | | | <0.0001 |
| Nondrinkers | 49 | 54 | 63 | 67 | 75 | |
| >0% to <1% of energy | 17 | 23 | 22 | 21 | 18 | |
| ≥1% of energy | 34 | 23 | 15 | 12 | 7 | |
| Dietary fiber intake (g/1000 kcal) | 8.1 ± 2.3 | 7.9 ± 2.0 | 7.6 ± 1.8 | 7.7 ± 2.1 | 6.9 ± 1.9 | <0.0001 |

[1] For continuous variables, tests for linear trend used the median value in each quintile as a continuous variable in linear regression; a Mantel-Haenszel chi-square test was used for categorical variables.
[2] Glycemic index for glucose = 100.
[3] $\bar{x}$ ± SD (all such values).

in 3 (7, 8, 10), but not in another 2 (9, 37), cross-sectional studies. Furthermore, recent randomized controlled trials have not supported the beneficial effect of a low-GI diet on HDL cholesterol in contrast with a high-GI diet (46–50). In the present study, we also found an inverse correlation between dietary GL and HDL cholesterol, but no correlation between dietary GI and HDL cholesterol.

Both dietary GI and GL were positively correlated with fasting triacylglycerol in 2 cross-sectional studies (9, 10); however, no association between dietary GI and fasting triacylglycerol was observed in a study of elderly men (37). In the present study, both dietary GI and GL were positively associated with fasting triacylglycerol. Several randomized controlled trials have also shown the beneficial effect of a low-GI diet on triacylglycerol (51), although the lack of an effect of GI has been observed in subjects with low triacylglycerol concentrations (52).

We identified a positive correlation between dietary GI and GL and fasting glucose, whereas no correlation was observed in a cross-sectional study of elderly men (37). Several prospective cohort studies (4, 5, 38), but not others (39, 40, 53), in the United States have shown a positive association between dietary GI, GL, or both and the incidence of type 2 diabetes, which is not in conflict with our finding. Recently, several (48, 49), but not all (46, 47, 50), randomized controlled trials have also shown lower fasting glucose concentrations after consumption of a low-GI diet than after a high-GI diet.

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**TABLE 4**

Metabolic risk factors according to quintiles of dietary glycemic index and load in Japanese women

| | Total *n* | Quintiles of dietary glycemic index or load | | | | | *P* for trend[1] |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Dietary glycemic index[2,3] | 1354 | 61 (46.1–63.4) | 65 (63.5–65.9) | 67 (66.0–67.9) | 69 (68.0–70.0) | 72 (70.1–76.5) | |
| BMI ($kg/m^2$)[4] | 1354 | 23.7 ± 0.2 (270)[5] | 23.9 ± 0.2 (271) | 23.8 ± 0.2 (271) | 24.2 ± 0.2 (271) | 24.4 ± 0.2 (271) | 0.017 |
| Serum total cholesterol (mg/dL)[4,6] | 1354 | 212.1 ± 2.2 (270) | 211.8 ± 2.0 (271) | 211.6 ± 2.0 (271) | 216.5 ± 2.0 (271) | 211.5 ± 2.2 (271) | 0.74 |
| Serum HDL cholesterol (mg/dL)[4,6] | 1354 | 64.7 ± 0.9 (270) | 62.5 ± 0.9 (271) | 63.0 ± 0.9 (271) | 63.8 ± 0.9 (271) | 63.6 ± 1.0 (271) | 0.58 |
| Serum LDL cholesterol (mg/dL)[4,6] | 1348 | 130.0 ± 2.1 (269) | 129.4 ± 1.9 (269) | 128.2 ± 1.9 (269) | 133.2 ± 1.9 (271) | 127.3 ± 2.1 (270) | 0.73 |
| Fasting serum triacylglycerol (mg/dL)[4,6] | 1349 | 87.1 ± 3.0 (269) | 99.1 ± 2.8 (270) | 101.7 ± 2.7 (270) | 98.0 ± 2.8 (270) | 103.1 ± 3.0 (270) | 0.001 |
| Fasting plasma glucose (mg/dL)[4,6] | 764 | 92.9 ± 2.0 (152) | 97.0 ± 1.8 (153) | 97.0 ± 1.8 (153) | 99.8 ± 1.8 (153) | 99.3 ± 1.9 (153) | 0.022 |
| Glycated hemoglobin (%)[4,6] | 845 | 5.0 ± 0.1 (169) | 5.1 ± 0.1 (169) | 5.1 ± 0.1 (169) | 5.2 ± 0.1 (169) | 5.2 ± 0.1 (169) | 0.038 |
| Dietary glycemic load (/1000 kcal)[2,7] | 1354 | 69 (31.1–75.7) | 80 (75.8–83.7) | 87 (83.8–91.2) | 95 (91.3–100.2) | 107 (100.3–148.5) | |
| BMI ($kg/m^2$)[4] | 1354 | 24.2 ± 0.3 (270) | 23.8 ± 0.2 (271) | 24.0 ± 0.2 (271) | 24.2 ± 0.2 (271) | 23.8 ± 0.3 (271) | 0.48 |
| Serum total cholesterol (mg/dL)[4,6] | 1354 | 212.6 ± 3.0 (270) | 215.1 ± 2.4 (271) | 212.1 ± 2.1 (271) | 212.2 ± 2.4 (271) | 211.6 ± 3.2 (271) | 0.87 |
| Serum HDL cholesterol (mg/dL)[4,6] | 1354 | 67.2 ± 1.3 (270) | 65.5 ± 1.0 (271) | 62.1 ± 0.9 (271) | 61.9 ± 1.0 (271) | 60.8 ± 1.4 (271) | 0.004 |
| Serum LDL cholesterol (mg/dL)[4,6] | 1348 | 127.2 ± 2.8 (267) | 130.4 ± 2.3 (271) | 130.7 ± 2.0 (270) | 130.0 ± 2.2 (270) | 129.9 ± 3.0 (270) | 0.56 |
| Fasting serum triacylglycerol (mg/dL)[4,6] | 1349 | 91.0 ± 4.1 (269) | 96.8 ± 3.3 (270) | 95.6 ± 2.9 (270) | 100.1 ± 3.2 (270) | 105.4 ± 4.4 (270) | 0.047 |
| Fasting plasma glucose (mg/dL)[4,6] | 764 | 90.9 ± 2.7 (152) | 97.0 ± 2.1 (153) | 97.5 ± 1.9 (153) | 97.2 ± 2.1 (153) | 103.4 ± 2.9 (153) | 0.012 |
| Glycated hemoglobin (%)[4,6] | 845 | 5.0 ± 0.1 (169) | 5.1 ± 0.1 (169) | 5.1 ± 0.1 (169) | 5.1 ± 0.1 (169) | 5.2 ± 0.1 (169) | 0.10 |

[1] Linear trends were tested with increasing dietary glycemic indexes and loads by assigning each participant the median value for the category and modeling this value as a continuous variable.

[2] Glycemic index for glucose = 100. Values are medians; ranges in parentheses.

[3] The median values shown are the same for BMI, triacylglycerol, and total, HDL, and LDL cholesterol but are different for glucose and glycated hemoglobin: 61, 64, 67, 69, and 71, respectively.

[4] Adjusted for residential area (5 categories), age (≤39, 40–49, 50–59, 60–69, and ≥70 y), menopausal status (premenopausal or postmenopausal), current smoking (no or yes), dietary supplement use (no or yes), rate of eating (fast, medium, or slow), physical activity level (quintiles), energy intake (quintiles), percentage of energy as fat (quintiles), alcohol intake (nondrinker, >0% to <1% of energy or ≥1% of energy), and energy-adjusted dietary fiber intake (quintiles).

[5] $\bar{x} \pm SE$; *n* in parentheses (all such values).

[6] Additionally adjusted for current BMI (quintiles) and BMI at age 20 y (quintiles).

[7] The median values shown are the same for BMI, triacylglycerol, glycated hemoglobin, and total, HDL, and LDL cholesterol but are different for glucose: 68, 79, 87, 95, and 107/1000 kcal, respectively.

We found a positive correlation between dietary GI and Hb $A_{1c}$. A positive association was also reported in cross-sectional studies conducted in patients with type 2 diabetes treated by dietary restriction alone (12) and in patients with type 1 diabetes (13). Additionally, a low-GI diet reduced Hb $A_{1c}$ more than did a high-GI diet in several randomized controlled trials (48, 49). Furthermore, a recent meta-analysis of 14 randomized controlled trials has shown the amelioration of Hb $A_{1c}$ through a low-GI diet (54).

Both total and LDL cholesterol were not correlated with dietary GI or GL in the present study, although randomized controlled trials have generally shown that low-GI diets result in lower total and LDL cholesterol concentrations (54). However, similar to our findings, no correlation between dietary GI or GL and total or LDL cholesterol was observed in several cross-sectional studies (7, 10, 37).

Our results may not be extrapolated into general Japanese populations because the subjects in the present study were selected female farmers. Additionally, our DHQ, although similar to most previous epidemiologic studies, was not designed specifically to measure dietary GI and GL; however, the satisfactory validity of this DHQ for total carbohydrate (20) provides some reassurance. Moreover, although we attempted to adjust for a wide range of potential confounding variables, we could not rule out residual confounding because of these or other unknown variables. Furthermore, because the study population consisted of generally healthy persons, the clinical relevance of our findings remains to be elucidated. However, our results should provide valuable insight from a prevention perspective.

In summary, after adjustment for a variety of confounding factors, we observed positive correlations between dietary GI and BMI, fasting serum triacylglycerol, fasting plasma glucose, and Hb $A_{1c}$ and between dietary GL and fasting serum triacylglycerol and fasting plasma glucose and negative correlations between dietary GL and serum HDL cholesterol in healthy Japanese female farmers whose dietary GI and GL were primarily determined by white rice. Because the cross-sectional nature of the present study precludes any causal inferences, more observational and experimental studies are needed before any firm conclusions can be drawn with regard to the effect of dietary GI and GL on metabolic risk factors.

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KM created a table of glycemic index, conducted the statistical analyses, and wrote the manuscript. SS was involved in the design of the dietary study and assisted in the creation of the table and the manuscript. YT assisted in the creation of the table. HO was involved in the management of the dietary dataset and data collection during the dietary study. YH was involved in the data collection for the dietary study. HH and EO were responsible for the research design, data collection, and data management. FK was responsible for the research design, data collection, and overall management. All authors provided suggestions during the preparation of the manuscript and approved

the final version submitted for publication. None of the authors had any conflict of interest to declare.

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Applied nutritional investigation

# No relation between intakes of calcium and dairy products and body mass index in Japanese women aged 18 to 20 y

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**Abstract**

**Objective:** This cross-sectional study examined possible associations of intakes of calcium and dairy products to body mass index (BMI; kilograms per square meter) in young Japanese women.
**Methods:** Subjects were 1905 female Japanese dietetic students who were 18 to 20 y of age. Dietary intake was assessed over a 1-mo period with a validated, self-administered diet history questionnaire. BMI was computed by using self-reported weight and height. BMI among quartiles of energy-adjusted intakes (per 1000 kcal) of calcium and dairy products was compared while controlling for intakes of protein, fat, and dietary fiber, self-reported rate of eating, and other non-dietary variables.
**Results:** Mean BMI ± standard deviation was 20.8 ± 2.6 kg/m$^2$. Mean estimated intakes were 268 ± 93 mg/1000 kcal for calcium and 80 ± 63 g/1000 kcal for dairy products. Intakes of calcium and dairy products were not significantly associated with BMI (adjusted means in the lowest and highest quartiles were 20.7 and 20.8 for calcium, $P$ for trend = 0.48, and 20.6 and 20.6 for dairy products, $P$ for trend = 0.81). These results were also observed after excluding 481 energy under- and over-reporters for calcium (20.4 and 20.5, respectively, $P$ for trend = 0.73) and dairy products (20.3 and 20.4, respectively, $P$ for trend = 0.73).
**Conclusions:** Intakes of calcium and dairy products may not necessarily be associated with BMI among young Japanese women who not only are relatively lean but also have a relatively low intake of calcium and dairy products. 

*Keywords:* Calcium intake; Dairy product intake; Body mass index; Japanese women; Epidemiology

## Introduction

A recently emerging body of literature suggests that the intake of calcium and/or dairy products may protect humans against the development of obesity [1–15]. A possible theory is that a low calcium intake causes high intracellular calcium concentrations, which in turn promote lipogenesis, inhibit lipolysis, and decrease thermogenesis, whereas a high calcium intake reverses these trends [3]. It seems that the effect of calcium in the form of dairy products may be greater than that of elemental calcium [16]. However, several published reports have not supported the potentially favorable effects of calcium and/or dairy products on measurements of obesity [17–22]. Thus, the relation of calcium and/or dairy product intake to obesity remains unclear. In addition, research on this issue has been conducted mainly in Western countries, whereas information is quite limited in non-Western countries including Japan, where the prevalence of obesity and dietary intakes of calcium and dairy products are relatively low [23]. Therefore, we investigated possible associations of intakes of calcium and dairy products with body mass index (BMI) in young Japanese women.

## Materials and methods

Subjects were students who entered dietetic courses at 22 colleges and technical schools in three of the four main islands of Japan in April 1997 ($n$ = 2069) [24–26].

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A total of 2063 students (2017 women and 46 men) participated in the survey (response rate 99.7%). For statistical analysis, we selected female subjects who were 18 to 20 y of age ($n = 1960$). We excluded from the 1960 women those who were currently receiving dietary counseling ($n = 33$), those with an extremely low or high reported energy intake (<775 or >3950 kcal/d, $n = 18$), and those with missing information on variables used in the present study ($n = 6$). Because some subjects were in more than one exclusion category, the final analytic sample contained 1905 subjects.

Dietary habits during the previous month were assessed by using a previously validated, self-administered diet history questionnaire (DHQ) [27–29]. Measurements of dietary intake for 147 food and beverage items, energy, protein, fat, carbohydrate, alcohol, dietary fiber, and calcium were calculated by using an ad hoc computer algorithm developed for the DHQ, which was based on the *Standard Tables of Food Composition in Japan* [30]. Although dietary supplement usage was queried in the DHQ, intake from dietary supplements was not included in this study due to the lack of a reliable composition table of dietary supplements in Japan. Dairy products consisted of full-fat, low-fat, and skimmed milk, sweetened and non-sweetened yogurt, cheese, cottage cheese, ice cream, and coffee cream [31]. Pearson's correlation coefficient between DHQ and 3-d diet records was 0.49 for calcium intake that was adjusted for energy intake by using a residual model among 47 women [27]. For dairy products (grams per 1000 kcal), Spearman's correlation coefficient between DHQ and 16-d diet records was 0.52 among 92 women (unpublished observations, S. Sasaki, 2004).

Body weight and height were self-reported as part of the DHQ. BMI was computed as weight (kilograms) divided by the square of height (meters). In the DHQ, subjects also reported their rate of eating (very slow, relatively slow, medium, relatively fast, or very fast) and intentional dietary change (no, changed within 1 y, changed within 3 y, or changed >3 y ago). In addition, a self-administered questionnaire on general lifestyle during the previous month asked about the following four variables: current smoking (yes or no), experience of dieting (≥2 kg intentional decrease in body weight within 1 mo, yes or no), residential area, and participation in sports club activities (times per month) without inquiring into the types of sports, intensity, or duration. Residential areas were categorized into 12 regional blocks according to the *National Nutrition Survey in Japan* [23]. Because relatively few subjects were categorized into three of these blocks (Hokkaido, Tohoku, and Hokuriku), they were included in their adjacent blocks, resulting in nine categories (Kanto II, Hokkaido, and Tohoku; Kanto I; Tokai and Hokuriku; Kinki I; Kinki II; Chugoku; Shikoku; Kita-kyushu; and Minami-kyushu). The residential areas were also divided into three categories according to population (city with population ≥1 million, city with population <1 million, or town and village). Subjects who participated in sports club activities at least once per week were regarded as "active" and all others as "sedentary" without consideration of other kinds of activities.

All statistical analyses were performed with SAS 8.2 (SAS Institute, Cary, NC, USA). For analyses, subjects were categorized into quartiles according to the energy-adjusted intakes (per 1000 kcal) of calcium and dairy products. Mean BMI ± standard error (SE) was calculated by quartiles of these variables while controlling for a series of covariates that could affect body weight (residential block [nine categories], size of residential area [three categories], current smoking [two categories], alcohol drinking [yes or no because of extremely low alcohol intake, mean 0.8 g/d], physical activity [two categories], experience of dieting [two categories], intentional dietary change [four categories], rate of eating [five categories], protein intake [percentage of energy intake, continuous], fat intake [percentage of energy intake, continuous], and dietary fiber intake [grams per 1000 kcal, continuous]). We did not include percentage of energy intake from carbohydrate as a covariate because of its very high correlation with percentage of energy intake from fat (Pearson's correlation coefficient −0.94). We tested for linear trends with increasing levels of intakes of calcium and dairy products by assigning each participant the median value for the category and modeling this value as a continuous variable. We also calculated the partial regression coefficient ($\beta$) and SE for intakes of calcium and dairy products by multiple regression analysis with BMI as the dependent variable, with adjustment for the potential confounding variables indicated above. All reported $P$ values are two-tailed, and $P < 0.05$ was considered statistically significant.

In a previous study [7], the size of the effect of calcium intake on BMI was $-0.26$ kg/m$^2$ per 100 mg per 1000-kcal increase in calcium intake. In our population [24], mean calcium intake ± standard deviation was 306 ± 148 mg/1000 kcal, and the standard deviation of BMI was 2.6 kg/m$^2$. Using these values, power calculations revealed that a sample of 532 women (133 women in each quartile category) was sufficient to demonstrate the expected difference ($-0.89$ kg/m$^2$) between the highest and lowest quartile categories (excepted medians 477 and 136 mg/1000 kcal, respectively), with 80% power at the $\alpha = 0.05$ significance level. Because these calculations for $t$ test (not for analysis of variance or test for linear trend) did not take into consideration the adjustment for potential confounding variables, a larger number of subjects was needed in practice. However, our sample ($n = 1905$) was much larger than the calculated sample size, indicating that its size was sufficient for detecting the difference in BMI between extreme quartiles, if the size of the effect of calcium on BMI similar to that observed in the previous study [7] was really present in our population.

## Results

Basic characteristics of the subjects are presented in Table 1. Mean BMI ± standard deviation of subjects was 20.8 ± 2.6 kg/m$^2$, and mean intakes were 268 ± 93 mg/1000 kcal for calcium and 80 ± 63 g/1000 kcal for dairy products. Potential confounding variables of the subjects are listed in Table 2 according to quartiles of intakes of calcium and dairy products. Among women in the higher quartiles of those intakes, more were defined as physically active and reported recent intentional dietary changes. Women in the higher quartiles of those intakes also had higher means of protein, fat, and dietary fiber intake. There were more subjects with dieting experience and more slower eaters in the higher quartiles of calcium intake.

As presented in Table 3, after adjustment for potential confounding variables, calcium and dairy product intakes were not significantly associated with BMI (adjusted means in the lowest and highest quartiles were 20.7 and 20.8 kg/m$^2$ for calcium, $P$ for trend = 0.48, and 20.6 and 20.6 kg/m$^2$ for dairy products, $P$ for trend = 0.81). Similar insignificant associations were observed when calcium and dairy products were treated as continuous variables in multiple regression analyses ($\beta \pm$ SE $-0.0002 \pm 0.0008$ kg/m$^2$ for calcium, $P = 0.77$, and $-0.0004 \pm 0.0001$ kg/m$^2$ for dairy products, $P = 0.71$). A repeated analysis of 1424 women with plausible reported energy intakes (ratio of energy intake to basal metabolic rate of 1.2 to 2.5) [32], conducted because of possible selective misreporting of dietary intake [33], also showed no relation between intakes of calcium and dairy products and BMI (adjusted means in the lowest and highest quartiles were 20.4 and 20.5 kg/m$^2$ for calcium, $P$ for trend = 0.73, and 20.3 and 20.4 kg/m$^2$ for dairy products, $P$ for trend = 0.73; $\beta \pm$ SE $0.0001 \pm 0.0008$ kg/m$^2$ for calcium, $P = 0.90$, and $0.0006 \pm 0.0010$ kg/m$^2$ for dairy products, $P = 0.54$).

## Discussion

Using cross-sectional data of relatively lean young Japanese women with relatively low intakes of calcium and dairy products, we found no clear association of intakes of calcium and dairy products with BMI. This finding was consistent regardless of exclusion of implausible energy reporters.

An inverse relation of intakes of calcium and/or dairy products to measurements of obesity has been indicated in a considerable number of case-control [2], cross-sectional [3,5,7–10,12], and longitudinal [1,4,6] studies and intervention trials [13–15] conducted in Western countries. In addition, the frequency of dairy consumption has been inversely associated with BMI in Iranian adults [11]. In contrast, no significant relation has been shown in two longitudinal studies [18,21] or in several intervention trials [17,19,20] in Western countries. A recent longitudinal study

Table 1
Basic characteristics of subjects ($n$ = 1905)*

| Variable | |
|---|---|
| Age (y) | 18.1 ± 0.4 |
| Body height (cm) | 157.9 ± 5.2 |
| Body weight (kg) | 51.8 ± 7.3 |
| Body mass index (kg/m$^2$) | 20.8 ± 2.6 |
| Residential block† | |
| Kanto II, Hokkaido, and Tohoku | 84 (4) |
| Kanto I | 434 (23) |
| Tokai and Hokuriku | 278 (15) |
| Kinki I | 152 (8) |
| Kinki II | 118 (6) |
| Chugoku | 294 (15) |
| Shikoku | 156 (8) |
| Kita-kyushu | 214 (11) |
| Minami-kyushu | 175 (9) |
| Size of residential area | |
| City with population ≥1 million | 318 (17) |
| City with population <1 million | 1106 (58) |
| Town and village | 481 (25) |
| Current smoking | |
| No | 1849 (97) |
| Yes | 56 (3) |
| Current alcohol drinking | |
| No | 1514 (79) |
| Yes | 391 (21) |
| Physical activity‡ | |
| Sedentary | 1647 (86) |
| Active | 258 (14) |
| Experience of dieting§ | |
| No | 1160 (61) |
| Yes | 745 (39) |
| Intentional dietary change | |
| No | 1481 (78) |
| Changed within 1 y | 213 (11) |
| Changed within 3 y | 127 (7) |
| Changed >3 y ago | 84 (4) |
| Rate of eating | |
| Very slow | 92 (5) |
| Relatively slow | 431 (23) |
| Medium | 683 (36) |
| Relatively fast | 610 (32) |
| Very fast | 89 (5) |
| Use of calcium supplement | |
| No | 1868 (98) |
| Yes | 37 (2) |
| Energy intake (kcal/d) | 1911 ± 517 |
| Protein intake (% energy) | 13.7 ± 2.2 |
| Fat intake (% energy) | 30.5 ± 6.1 |
| Carbohydrate intake (% energy) | 54.4 ± 6.8 |
| Dietary fiber intake (g/1000 kcal) | 6.3 ± 1.7 |
| Calcium intake (mg/1000 kcal) | 268 ± 93 |
| Dairy product intake (g/1000 kcal) | 80 ± 63 |

* Values are means ± standard deviations or numbers of subjects (%).

† Residential blocks were categorized into 12 blocks according to the National Nutrition Survey of Japan [23]. Because relatively few subjects were categorized into three of these blocks (Hokkaido, Tohoku, and Hokuriku), they were included in their adjacent blocks.

‡ Subjects who took part in sports club activities at least once per week were defined as "active" and others as "sedentary."

§ "Dieting" was defined as at least 2 kg of intentional decrease of body weight within 1 mo.

Table 2
Selected characteristics of subjects by quartiles of energy-adjusted intakes of calcium and dairy products ($n = 1905$)*

| Variable | Quartiles of intakes of calcium or dairy products | | | | $P^{\dagger}$ |
|---|---|---|---|---|---|
| | 1 ($n = 476$) | 2 ($n = 476$) | 3 ($n = 477$) | 4 ($n = 476$) | |
| Calcium intake (mg/1000 kcal) | 166 ± 26 | 227 ± 15 | 283 ± 17 | 394 ± 74 | |
| Current smokers (%) | 4 | 2 | 3 | 2 | 0.27 |
| Current alcohol drinkers (%) | 19 | 22 | 19 | 23 | 0.26 |
| Subjects with active lifestyle (%) | 9 | 15 | 14 | 16 | 0.0019 |
| Subjects with experience of dieting (%) | 36 | 36 | 43 | 42 | 0.0061 |
| Intentional dietary change (%) | | | | | <0.0001 |
| No | 87 | 81 | 77 | 66 | |
| Changed within 1 y | 8 | 10 | 11 | 16 | |
| Changed within 3 y | 3 | 6 | 8 | 10 | |
| Changed >3 y ago | 2 | 3 | 4 | 8 | |
| Rate of eating (%) | | | | | 0.0073 |
| Very slow | 3 | 5 | 4 | 7 | |
| Relatively slow | 21 | 22 | 23 | 24 | |
| Medium | 38 | 33 | 37 | 35 | |
| Relatively fast | 31 | 36 | 31 | 29 | |
| Very fast | 7 | 3 | 5 | 4 | |
| Protein intake (% energy) | 12.1 ± 1.9 | 13.2 ± 1.7 | 14.1 ± 1.8 | 15.2 ± 2.1 | <0.0001 |
| Fat intake (% energy) | 28.4 ± 6.9 | 31.1 ± 5.7 | 31.2 ± 5.6 | 31.1 ± 5.5 | <0.0001 |
| Dietary fiber intake (g/1000 kcal) | 5.4 ± 1.2 | 6.0 ± 1.3 | 6.7 ± 1.5 | 7.2 ± 2.0 | <0.0001 |
| Dairy product intake (g/1000 kcal) | 19 ± 8 | 49 ± 10 | 86 ± 12 | 166 ± 59 | |
| Current smokers (%) | 3 | 3 | 3 | 3 | 0.71 |
| Current alcohol drinkers (%) | 18 | 20 | 23 | 21 | 0.14 |
| Subjects with active lifestyle (%) | 10 | 14 | 14 | 16 | 0.0197 |
| Subjects with experience of dieting (%) | 40 | 37 | 38 | 42 | 0.42 |
| Intentional dietary change (%) | | | | | <0.0001 |
| No | 83 | 79 | 80 | 69 | |
| Changed within 1 y | 9 | 12 | 9 | 15 | |
| Changed within 3 y | 6 | 4 | 6 | 10 | |
| Changed >3 y ago | 3 | 5 | 4 | 6 | |
| Rate of eating (%) | | | | | 0.14 |
| Very slow | 3 | 5 | 6 | 6 | |
| Relatively slow | 22 | 24 | 21 | 23 | |
| Medium | 39 | 34 | 33 | 38 | |
| Relatively fast | 31 | 33 | 35 | 30 | |
| Very fast | 6 | 4 | 5 | 4 | |
| Protein intake (% energy) | 12.8 ± 2.1 | 13.5 ± 2.1 | 13.8 ± 2.1 | 14.6 ± 2.1 | <0.0001 |
| Fat intake (% energy) | 28.7 ± 6.6 | 30.6 ± 6.4 | 31.5 ± 5.2 | 31.1 ± 5.6 | <0.0001 |
| Dietary fiber intake (g/1000 kcal) | 6.1 ± 1.6 | 6.3 ± 1.7 | 6.4 ± 1.6 | 6.5 ± 1.8 | 0.0045 |

* Values are mean ± standard deviation unless otherwise indicated.
† For continuous variables, tests for linear trend used the median value in each quartile as a continuous variable in linear regression; a Mantel-Haenszel chi-square test was used for categorical variables.

of American adolescents has also suggested a positive association between milk intake and body weight gain [22]. These inconsistent results may be explained at least in part by the different populations examined, different methods used to assess obesity and dietary intake, and number and type of variables used as confounding factors.

A possible reason for the null association we observed may be due to the narrow BMI range of our subjects, 78% of whom were of normal weight (BMI 18.5 to 24.9 kg/m$^2$) and only 6% were overweight (BMI $\geq$ 25 kg/m$^2$); thus, our population is relatively lean compared with populations in Western countries. Alternatively, it is possible that intakes of calcium and dairy products in our population were too low to have a beneficial effect on BMI; even intake levels of the highest quartile categories were relatively low for calcium (median 373 mg/1000 kcal) and dairy products (141 g/1000 kcal).

We do not believe that our null finding is due to any inaccuracy of our data for the following reasons. First, we used a validated DHQ to assess dietary intake. Second, although we used BMI computed from self-reported rather than measured weight and height, previous research has shown that BMI derived from the former is highly correlated with measured BMI [34,35], suggesting that BMI thus calculated is a reliable measurement for use in correlation analysis. Third, we previously observed a significant association of the self-reported rate of eating and dietary fiber intake with BMI in the same population [26], which may be some evidence of the quality of our data. Fourth, we conducted analyses with and without 481 women with implau-

Table 3
Adjusted mean ± SE of BMI according to quartiles of energy-adjusted intakes of calcium and dairy products with partial regression coefficients (β) and SE expressing changes in BMI for change in energy-adjusted intakes of calcium and dairy products ($n$ = 1905)*

| Variable | Quartiles of intakes of calcium or dairy products‡ | | | | P for trend† | β ± SE | P |
|---|---|---|---|---|---|---|---|
| | 1 ($n$ = 476) | 2 ($n$ = 476) | 3 ($n$ = 477) | 4 ($n$ = 476) | | | |
| Calcium intake (mg/1000 kcal) | 170 (74–201) | 227 (202–254) | 282 (255–314) | 373 (315–728) | | | |
| BMI (kg/m$^2$) | 20.7 ± 0.1 | 20.7 ± 0.1 | 20.9 ± 0.1 | 20.8 ± 0.1 | 0.48 | −0.0002 ± 0.0008 | 0.77 |
| Dairy product intake (g/1000 kcal) | 19 (0–32) | 49 (33–65) | 86 (66–108) | 141 (109–458) | | | |
| BMI (kg/m$^2$) | 20.6 ± 0.1 | 20.8 ± 0.1 | 21.1 ± 0.1 | 20.6 ± 0.1 | 0.81 | −0.0004 ± 0.0001 | 0.71 |

BMI, body mass index; SE, standard error

* Adjusted for residential block (Kanto II, Hokkaido, and Tohoku; Kanto I; Tokai and Hokuriku; Kinki I; Kinki II; Chugoku; Shikoku; Kita-kyushu; and Minami-kyushu), size of residential area (city with population ≥ 1 million, city with population < 1 million, and town and village), current smoking (yes or no), alcohol drinking (yes or no), physical activity (sedentary or active), experience of dieting (yes or no), intentional dietary change (no, changed within 1 y, changed within 3 y, or changed >3 y ago), rate of eating (very slow, relatively slow, medium, relatively fast, or very fast), protein intake (percentage of energy, continuous), fat intake (percentage of energy, continuous), and dietary fiber intake (grams per 1000 kcal, continuous).

† Tests for linear trend used the median value in each quartile as a continuous variable in linear regression.

‡ Values are medians (ranges) or means ± SE.

sible energy intake, and these analyses provided similar results.

We could not include calcium intake from dietary supplements in the analysis because of the lack of a reliable composition table of dietary supplement in Japan. However, only 37 of 1905 women (2%) used calcium supplement in the present study. In addition, neither exclusion of calcium supplement users from analysis nor a further adjustment for calcium supplement usage as a dummy variable (yes or no) materially altered the results (data not shown). Thus, it is hardly likely that calcium supplement usage had a major effect on the findings in this study.

Our results may not be extrapolated to general Japanese populations because the subjects were selected female dietetic students who may have been highly health conscious. Other limitations regarding subject characteristics include the narrow range of age (18 to 20 y) and BMI (78% of subjects had a normal BMI, i.e., 18.5 to 24.9 kg/m$^2$) and the relatively low intakes of calcium and dairy products mentioned above. Possible seasonal changes in dietary habits were not taken into account in the present study because our DHQ assessed dietary habits during the previous month; however, seasonal variations in Japanese women seemed to be relatively minor, at least in calcium intake (7%) [36]. Although we attempted to adjust for a wide range of potential confounding variables, we can not rule out the possibility of residual confounding due to these or poorly measured variables such as physical activity, which was assessed quite roughly, and other unmeasured variables such as parental overweight or obesity, socioeconomic level, and unknown variables.

In conclusion, intakes of calcium and dairy products may not necessarily be associated with BMI among young Japanese women who not only are relatively lean but also have relatively low intakes of calcium and dairy products. However, better-designed cross-sectional studies and prospective and intervention studies should be conducted to confirm our present findings.

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## ORIGINAL ARTICLE

# Dietary intake in relation to self-reported constipation among Japanese women aged 18–20 years

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**Objective:** Information on modifiable lifestyle factors associated with constipation is limited, especially among non-Western populations. We examined associations between dietary intake and self-reported constipation in young Japanese women.
**Design:** Cross-sectional study.
**Subjects:** A total of 1705 female Japanese dietetic students aged 18–20 years and free of current disease and current dietary counseling.
**Methods:** Dietary intake was estimated over a 1-month period with a validated, self-administered, diet history questionnaire, and lifestyle variables including self-reported constipation were assessed by a second questionnaire designed for this survey.
**Results:** A total of 436 women (26%) reported themselves to be 'constipated'. A multivariate odds ratio (OR) for women in the highest quartile of rice intake was 0.47 (95% confidence interval (CI): 0.33, 0.68) compared with the lowest. Additionally, women in the highest category of coffee intake had a multivariate OR of 0.67 (0.47, 0.94) compared with women in the lowest. Conversely, women in the highest quartile of confectionery intake had a multivariate OR of 1.54 (1.12, 2.13) compared with women in the lowest. Moreover, a multivariate OR for constipation for women in the highest quartile of Japanese and Chinese tea intake was 1.49 (1.09, 2.05) compared with women in the lowest. Neither total dietary fiber intake nor other lifestyle factors examined were associated with constipation.
**Conclusions:** The consumption of rice and coffee was inversely associated with and that of confectioneries and Japanese and Chinese tea was positively associated with a prevalence of self-reported constipation.
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**Keywords:** dietary intake; constipation; Japanese women

### Introduction

Constipation is a major health problem, although the criteria for constipation remain arbitrary (Thompson *et al.*, 1999), and symptoms of constipation vary from a relatively mild bowel habit disturbance to rare serious sequelae (Talley *et al.*, 2003). The reported prevalence of constipation ranges from 2 to 30% in Western countries, depending on the definition applied (Garrigues *et al.*, 2004; Higgins and Johanson, 2004). In Japan, the prevalence of constipation, defined as ⩽3 bowel movements weekly, also seems to be relatively high (6–25%) (Hirai and Takezoe, 1997; Hirai *et al.*, 2001). As a result of its high prevalence, chronic nature and effect on quality of life (Talley, 2004), modifiable lifestyle factors associated with constipation need to be identified.

According to previous studies in the West, not only various factors including age (Everhart *et al.*, 1989; Sandler *et al.*, 1990; Campbell *et al.*, 1993; Dukas *et al.*, 2003), sex (Everhart *et al.*, 1989; Sandler *et al.*, 1990; Campbell *et al.*, 1993), smoking status (Dukas *et al.*, 2003), alcohol consumption (Dukas *et al.*, 2003; Sanjoaquin *et al.*, 2004), body mass index (BMI) (Sandler *et al.*, 1990; Dukas *et al.*, 2003; Sanjoaquin *et al.*, 2004), and physical activity (Everhart *et al.*, 1989;

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Sandler et al., 1990; Dukas et al., 2003; Sanjoaquin et al., 2004), but also several aspects of diet such as intakes of energy (Sandler et al., 1990; Towers et al., 1994), dietary fiber (Dukas et al., 2003; Sanjoaquin et al., 2004), and nonalcoholic beverages (Sandler et al., 1990; Sanjoaquin et al., 2004) have been associated with constipation. However, information on this issue is quite limited among people in Asian countries including Japan (Kunimoto et al., 1998; Wong et al., 1999; Nakaji et al., 2002; Fujiwara, 2003), where dietary habits and foods available differ considerably from those in Western countries. Moreover, quantitative assessment of diet was not performed in these Asian studies. Therefore, we investigated associations of dietary factors, which were assessed using a previously-validated self-administered diet history questionnaire (DHQ) (Sasaki et al., 1998a, b; 2000b), as well as other lifestyle factors with self-reported constipation in young Japanese women.

## Subjects and methods

*Subjects and data collection*

The subjects were students who entered dietetic courses at 22 colleges and technical schools in Japan in April 1997 ($n = 2069$) (Sasaki et al., 2002; 2000a; 2003a). A total of 2063 students (2017 women and 46 men) participated in the survey (response rate: 99.7%). The staff of each school checked the submitted questionnaires according to the survey protocol. When missing values and/or logical errors were detected, the subjects were asked to complete the questions again. The questionnaires were checked at least once by the staff at each school and by the staff at the survey center. Most surveys were completed by the end of May 1997.

*Questionnaires*

Data were collected using the following two questionnaires: DHQ and a questionnaire on general lifestyle. The DHQ is a previously validated, structured 16-page questionnaire for assessing dietary habits in the previous month, consisting of the following seven sections: overall dietary behaviors; major cooking methods; consumption frequency and amount of six alcoholic beverages; consumption frequency and semi-quantitative portion size of selected 121 food and nonalcoholic beverage items; dietary supplement; consumption frequency and amount of 19 staple foods (rice, bread and noodles) and miso-soup; and open-ended sections for foods consumed regularly ($\geqslant$once/week) but not appearing in the DHQ (Sasaki et al., 1998a, b; 2000b). The food and beverage items and their portion sizes in the DHQ were derived mainly from the data of the National Nutrition Survey of Japan (Ministry of Health and Welfare, 1994). Dietary intake, including 147 food and beverage items, energy and dietary fiber, was calculated using an *ad hoc* algorithm for the DHQ, which was based on the food composition table in Japan (Science and Technology Agency, 2000); information on dietary supplement and from the open-ended section is not used in the calculation. Dietary fiber intake was estimated by the modified Prosky method (Science and Technology Agency, 2000) from the intake of 86 fiber-containing foods in the DHQ. The food and nonalcoholic beverage items were grouped into the following 18 food groups: rice; bread; noodles; potatoes; confectioneries (including sugar and sweeteners); fat and oil; pulses (including nuts); fish and shellfish; meat; eggs; dairy products; vegetables (including mushrooms and sea vegetables); fruits; water; Japanese and Chinese tea (nonfermented type of tea (green tea) and semi-fermented type of tea (oolong tea)); black tea (fermented type of tea); coffee; other nonalcoholic beverages. A detailed description and methods of calculating dietary intake and the validity of the DHQ have been published elsewhere (Sasaki et al., 1998a). The Pearson correlation coefficient between the DHQ and 3-d dietary records was 0.48 for energy intake among 47 women (Sasaki et al., 1998a). For dietary fiber intake (g/1000 kcal), the Pearson correlation coefficient between DHQ and 16-d dietary records was 0.69 among 92 women; the mean value of the Spearman correlation coefficients for intakes of 16 food groups (g/1000 kcal) was 0.35 (range: 0.05–0.59) (unpublished observations, Sasaki, 2004).

Body weight and height were self-reported as part of the DHQ. BMI was computed as weight (kg) divided by square of height (m). We classified BMI into three categories ($<18.5$, 18.5–24.9, and $\geqslant 25$) according to the Japan Society for the Study of Obesity (Matsuzawa et al., 2000). The subjects were also asked in the DHQ whether they currently received dietary counseling.

The questionnaire on general lifestyle during the previous month is a 4-page questionnaire designed for this survey. In this questionnaire, subjects reported residential area (a place where the subject mainly lived during the previous month), participation in sports club activities (times/months), without inquiring into the types of sports, their intensity or duration, and smoking status ('never,' 'past' or 'current'). They were also asked whether or not they were currently suffering from some diseases. Residential areas were categorized into 12 blocks according to the National Nutrition Survey in Japan (Ministry of Health and Welfare, 2004). Since relatively few subjects were categorized into three of these blocks, they were included in their neighboring blocks. The residential areas were also divided into three categories according to population size (cities with population $\geqslant 1$ million, cities with population $<1$ million, and towns and villages). The subjects who participated in sport club activities at least once per week were regarded as 'active' and all others as 'sedentary'.

Constipation was assessed by the following question in the questionnaire: do you often have constipation? The possible answers were 'yes', 'sometimes', or 'no'. The subjects with an answer of *yes* to the question were considered to be 'constipated'. We examined the validity of this question in

145 female Japanese dietetic students (mean age: 21.2 years) using 14-d bowel movement diaries as the standard; 33 subjects with an answer of *yes* had significantly ($P<0.001$) fewer bowel movements (mean$\pm$s.d.: $3.4\pm1.1$ day/week) than did 60 subjects with an answer of *sometimes* ($4.5\pm1.3$ day/week) or 52 subjects with an answer of *no* ($6.2\pm1.0$ day/week).

*Statistical analysis*

For statistical analysis, we selected female subjects aged 18–20 years ($n=1960$). We excluded one woman whose residential area was not in Japan, 154 women currently having some diseases, and 33 women currently receiving dietary counseling. Also excluded were 43 women with a reported energy intake less than half the energy requirement for the lowest physical activity category (<775 ($1550\times0.5$) kcal/day) or a reported energy intake more than 1.5 times the energy requirement of the highest physical activity category (>3450 ($2300\times1.5$) kcal/day) according to the Recommended Dietary Allowance for Japanese (Ministry of Health and Welfare, 1999). We further excluded 47 women with missing values in the variables used. A total of 1705 women remained for the present analysis; some women were in more than one exclusion category.

The association between self-reported constipation (the dependent variable) and a number of variables was examined. The variables examined were six nondietary variables, that is, residential blocks (nine categories), size of residential area (three categories), physical activity (two categories), smoking status (three categories), alcohol drinking habits (two categories ('yes' or 'no') because of extremely low alcohol intake (mean: 0.7 g/day)), and BMI (three categories) and 22 dietary variables, that is, intakes of energy (kcal/day), 18 food groups mentioned above (g/1000 kcal), and total, soluble, and insoluble dietary fiber (g/1000 kcal) (quartiles except for water (four categories), black tea (four categories), and coffee (three categories) because of more than one quarter nonconsumers). We calculated both crude and multivariate odds ratios (ORs) and 95% CIs for self-reported constipation for each category of variables included using the logistic regression analysis; multivariate ORs were calculated by adjusting for six nondietary variables and energy intake. As results for the crude and multivariate analyses were similar for all variables considered, we presented only the results derived from the multivariate models. Trend of association (for only dietary variables) was assessed by a logistic regression model assigning scores to the levels of the independent variable. All statistical analyses were performed using the SPSS for Windows software program, version 11.5, (SPSS Japan Inc.) and the SAS statistical software, version 8.2 (SAS Institute Inc.). A two-sided $P$ value of $<0.05$ was considered statistically significant.

## Results

The mean ($\pm$s.d.) of selected physical characteristics was as follows: $18.1\pm0.4$ years for age, $157.9\pm5.2$ cm for height, $51.8\pm7.3$ kg for weight, and $20.8\pm2.6$ kg/m$^2$ for BMI. A total of 436 (26%) out of 1705 women reported themselves to be 'constipated'. Table 1 presents the multivariate ORs (95% CIs) for constipation in each category of selected demographic and lifestyle factors. Living in town or village was associated with a decreased prevalence of constipation compared with living in city with population $\geqslant$1 million (OR: 0.64; 95% CI: 0.43, 0.97). Residential block, physical activity, smoking status, alcohol drinking habits, and BMI were not significantly associated with constipation.

**Table 1** Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for self-reported constipation in relation to selected demographic and lifestyle factors among 1705 Japanese women aged 18–20 years

| | *n with/without constipation* | *Adjusted OR[a] (95% CI)* |
|---|---|---|
| *Residential block[b]* | | |
| Kanto II, Hokkaido, Tohoku | 21/56 | 1.00 |
| Kanto I | 97/282 | 0.75 (0.41, 1.34) |
| Tokai, Hokuriku | 74/173 | 1.06 (0.60, 1.89) |
| Kinki I | 32/103 | 0.71 (0.36, 1.37) |
| Kinki II | 31/73 | 1.07 (0.55, 2.06) |
| Chugoku | 52/219 | 0.61 (0.33, 1.10) |
| Shikoku | 27/115 | 0.59 (0.31, 1.15) |
| Kita-kyushu | 58/127 | 1.16 (0.64, 2.10) |
| Minami-kyushu | 44/121 | 0.95 (0.51, 1.76) |
| *Size of residential area* | | |
| City with population $\geqslant$1 million | 81/202 | 1.00 |
| City with population <1 million | 258/723 | 0.83 (0.59, 1.17) |
| Town and village | 97/344 | 0.64 (0.43, 0.97) |
| *Physical activity[c]* | | |
| Sedentary | 385/1113 | 1.00 |
| Active | 51/156 | 0.94 (0.66, 1.32) |
| *Smoking status* | | |
| Nonsmoker | 402/1197 | 1.00 |
| Past smoker | 15/39 | 1.18 (0.63, 2.21) |
| Currrent smoker | 19/33 | 1.79 (0.98, 3.26) |
| *Alcoholdrinking habits* | | |
| Nondrinker | 345/991 | 1.00 |
| Drinker | 91/278 | 0.87 (0.66, 1.15) |
| *Body mass index (kg/m$^2$)* | | |
| <18.5 | 69/215 | 1.00 |
| 18.5–24.9 | 351/971 | 1.15 (0.85, 1.55) |
| $\geqslant$25 | 16/83 | 0.62 (0.34, 1.13) |

[a]OR adjusted for residential block, size of residential area, physical activity, smoking status, alcohol drinking habits, body mass index, and energy intake.
[b]The residential blocks were categorized into 12 blocks according to the National Nutrition Survey of Japan (Ministry of Health and Welfare, 2004). As the subjects categorized into three of these blocks (Hokkaido, Tohoku, and Hokuriku) were relatively few, they were included in their neighboring regions.
[c]The subjects who took part in sports club activity at least once per week were defined as 'active' and others as 'sedentary'.

Table 2 shows the associations between dietary intake and constipation. Energy intake was not associated with a prevalence of constipation. There was a clear dose-response relationship between increased intake of rice and a decreased

**Table 2** Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for self-reported constipation in relation to intakes of energy, dietary fiber, and food groups among 1705 Japanese women aged 18–20 years

| | *n with/without constipation* | *Adjusted OR[a] (95% CI)* |
|---|---|---|
| *Energy intake (kcal/day)* | | |
| 1365 (777–1554)[b] | 113/313 | 1.00 |
| 1703 (1555–1833) | 105/321 | 0.94 (0.68, 1.28) |
| 1977 (1834–2154) | 100/327 | 0.87 (0.63, 1.19) |
| 2447 (2155–3339) | 118/308 | 1.12 (0.82, 1.53) |
| *P* for trend | | 0.58 |
| Food intake (g/1000 kcal) | | |
| *Rice* | | |
| 82.9 (0–104.9) | 131/295 | 1.00 |
| 124.3 (105.0–144.3) | 129/297 | 0.98 (0.72, 1.32) |
| 164.3 (144.4–186.4) | 97/330 | 0.65 (0.47, 0.90) |
| 221.0 (186.5–441.8) | 79/347 | 0.46 (0.32, 0.66) |
| *P* for trend | | <0.0001 |
| *Bread* | | |
| 8.5 (0–15.0) | 95/331 | 1.00 |
| 21.8 (15.1–27.6) | 111/315 | 1.20 (0.87, 1.65) |
| 35.3 (27.7–43.5) | 113/314 | 1.23 (0.89, 1.69) |
| 59.5 (43.6–180.5) | 117/309 | 1.27 (0.93, 1.75) |
| *P* for trend | | 0.15 |
| *Noodles* | | |
| 0 (0–13.4) | 117/309 | 1.00 |
| 22.0 (13.5–29.5) | 110/316 | 0.91 (0.67, 1.23) |
| 38.4 (29.6–50.3) | 108/319 | 0.87 (0.63, 1.18) |
| 67.4 (50.4–208.0) | 101/325 | 0.81 (0.59, 1.11) |
| *P* for trend | | 0.19 |
| *Potatoes* | | |
| 7.7 (0–10.1) | 97/329 | 1.00 |
| 12.3 (10.2–14.4) | 112/315 | 1.19 (0.87, 1.64) |
| 17.0 (14.5–21.2) | 111/315 | 1.18 (0.86, 1.63) |
| 28.1 (21.3–99.0) | 116/310 | 1.23 (0.90, 1.69) |
| *P* for trend | | 0.24 |
| *Confectioneries[c]* | | |
| 16.9 (0.6–23.3) | 95/331 | 1.00 |
| 29.5 (23.4–35.6) | 84/342 | 0.86 (0.61, 1.20) |
| 41.9 (35.7–49.3) | 127/300 | 1.47 (1.07, 2.02) |
| 60.6 (49.4–159.6) | 130/296 | 1.56 (1.13, 2.14) |
| *P* for trend | | <0.001 |
| *Fat and oil* | | |
| 6.3 (0.8–8.4) | 124/302 | 1.00 |
| 10.2 (8.5–11.8) | 109/317 | 0.83 (0.61, 1.13) |
| 13.8 (11.9–15.9) | 93/334 | 0.72 (0.52, 0.98) |
| 19.6 (16.0–68.4) | 110/316 | 0.86 (0.63, 1.17) |
| *P* for trend | | 0.23 |
| *Pulses[d]* | | |
| 8.8 (0–12.8) | 114/312 | 1.00 |
| 16.9 (12.9–21.1) | 95/331 | 0.76 (0.55, 1.05) |
| 26.2 (21.2–33.5) | 119/308 | 1.02 (0.74, 1.39) |
| 43.9 (33.6–119.6) | 108/318 | 0.93 (0.68, 1.27) |
| *P* for trend | | 0.94 |

**Table 2** *Continued*

| | *n with/without constipation* | *Adjusted OR[a] (95% CI)* |
|---|---|---|
| *Fish and shellfish* | | |
| 15.8 (0–21.7) | 111/314 | 1.00 |
| 27.2 (21.8–31.6) | 103/324 | 0.93 (0.68, 1.28) |
| 26.5 (31.7–43.0) | 107/320 | 0.97 (0.71, 1.33) |
| 55.1 (43.1–229.1) | 115/311 | 1.12 (0.81, 1.53) |
| *P* for trend | | 0.48 |
| *Meats* | | |
| 17.2 (0–22.2) | 114/311 | 1.00 |
| 26.9 (22.3–31.4) | 108/320 | 0.94 (0.69, 1.28) |
| 36.6 (31.5–42.7) | 108/318 | 0.92 (0.67, 1.26) |
| 52.9 (42.8–117.5) | 106/320 | 0.91 (0.66, 1.25) |
| *P* for trend | | 0.55 |
| *Eggs* | | |
| 3.1 (0–8.0) | 106/320 | 1.00 |
| 12.9 (8.1–17.3) | 99/327 | 0.92 (0.67, 1.27) |
| 22.9 (17.4–27.3) | 113/313 | 1.10 (0.80, 1.52) |
| 33.3 (27.4–114.3) | 118/309 | 1.24 (0.90, 1.70) |
| *P* for trend | | 0.11 |
| *Dairy products* | | |
| 18.6 (0–32.3) | 98/328 | 1.00 |
| 48.7 (32.4–65.6) | 123/303 | 1.37 (1.00, 1.88) |
| 85.3 (65.7–109.1) | 111/316 | 1.23 (0.89, 1.70) |
| 140.6 (109.2–457.7) | 104/322 | 1.05 (0.76, 1.45) |
| *P* for trend | | 0.99 |
| *Vegetables[e]* | | |
| 52.0 (2.1–69.9) | 117/309 | 1.00 |
| 84.9 (70.0–100.4) | 100/326 | 0.86 (0.63, 1.18) |
| 117.6 (100.5–139.9) | 109/318 | 0.96 (0.70, 1.31) |
| 176.8 (140.0–457.9) | 110/316 | 0.97 (0.71, 1.33) |
| *P* for trend | | 0.95 |
| *Fruits* | | |
| 14.3 (0–24.5) | 118/308 | 1.00 |
| 34.5 (24.6–44.6) | 101/325 | 0.80 (0.58, 1.09) |
| 56.8 (44.7–72.6) | 105/322 | 0.85 (0.62, 1.17) |
| 99.5 (72.7–695.7) | 112/314 | 0.95 (0.69, 1.29) |
| *P* for trend | | 0.84 |
| *Water* | | |
| 0 (0) | 160/504 | 1.00 |
| 11.5 (2.6–17.2) | 56/132 | 1.31 (0.91, 1.89) |
| 45.4 (17.3–83.0) | 109/318 | 1.11 (0.83, 1.49) |
| 181.2 (83.1–1836.0) | 111/315 | 1.12 (0.84, 1.50) |
| *P* for trend | | 0.45 |
| *Japanese and Chinese tea[f]* | | |
| 47.8 (0–86.2) | 100/326 | 1.00 |
| 141.6 (86.3–201.1) | 96/330 | 0.92 (0.66, 1.27) |
| 248.1 (201.2–313.3) | 105/322 | 1.09 (0.79, 1.50) |
| 432.9 (313.4–1471.1) | 135/291 | 1.54 (1.12, 2.11) |
| *P* for trend | | 0.004 |
| *Black tea[g]* | | |
| 0 (0) | 115/379 | 1.00 |
| 12.3 (5.4–18.9) | 83/275 | 0.98 (0.71, 1.36) |
| 31.2 (19.0–49.2) | 120/307 | 1.37 (1.01, 1.85) |
| 78.2 (49.3–871.7) | 112/314 | 1.17 (0.86, 1.61) |
| *P* for trend | | 0.11 |

**Table 2** *Continued*

| | *n with/without constipation* | *Adjusted OR[a] (95% CI)* |
|---|---|---|
| *Coffee* | | |
| 0 (0) | 240/748 | 1.00 |
| 13.1 (4.7–27.3) | 66/225 | 0.74 (0.58, 0.96) |
| 66.0 (27.4–604.7) | 130/296 | 0.66 (0.47, 0.94) |
| *P* for trend | | 0.045 |
| *Other nonalcoholic beverages* | | |
| 0 (0–4.3) | 108/318 | 1.00 |
| 14.3 (4.4–25.3) | 118/308 | 1.11 (0.81, 1.51) |
| 38.6 (25.4–55.9) | 102/325 | 0.92 (0.67, 1.27) |
| 92.7 (56.0–698.0) | 108/318 | 1.03 (0.75, 1.41) |
| *P* for trend | | 0.83 |
| *Total dietary fiber intake (g/1000 kcal)* | | |
| 4.6 (2.6–5.1) | 97/326 | 1.00 |
| 5.7 (5.2–6.1) | 110/321 | 1.14 (0.83, 1.57) |
| 6.6 (6.2–7.2) | 109/317 | 1.17 (0.85, 1.62) |
| 8.1 (7.3–14.3) | 120/305 | 1.36 (0.98, 1.87) |
| *P* for trend | | 0.07 |
| *Soluble dietary fiber intake (g/1000 kcal)* | | |
| 1.1 (0.5–1.2) | 94/332 | 1.00 |
| 1.5 (1.3–1.5) | 110/316 | 1.22 (0.89, 1.68) |
| 1.7 (1.6–1.8) | 102/325 | 1.10 (0.79, 1.52) |
| 2.1 (1.9–4.5) | 130/296 | 1.60 (1.16, 2.21) |
| *P* for trend | | 0.01 |
| *Insoluble dietary fiber intake (g/1000 kcal)* | | |
| 3.4 (1.8–3.7) | 101/325 | 1.00 |
| 4.1 (3.8–4.3) | 112/314 | 1.12 (0.82, 1.53) |
| 4.8 (4.4–5.2) | 105/322 | 1.05 (0.76, 1.45) |
| 5.9 (5.3–10.9) | 118/308 | 1.27 (0.92, 1.75) |
| *P* for trend | | 0.21 |

[a]OR adjusted for residential block, size of residential area, physical activity, smoking status, alcohol drinking habits, and body mass index. For intakes of dietary fiber and food groups, further adjusted for energy intake.
[b]Median (range).
[c]Including sugar and sweeteners.
[d]Including nuts.
[e]Including mushrooms and sea vegetables.
[f]Non- and semifermented tea.
[g]Fermented tea.

prevalence of constipation (*P* for trend <0.0001). Women in the highest quartile had a multivariate OR of 0.46 (95% CI: 0.32, 0.66) compared with women in the lowest. Other staple foods including bread and noodles were not associated with prevalence of constipation. Because only staple foods were assessed for each meal separately in DHQ, we further assessed the relationships of intakes of rice from each meal with constipation. Increased intakes of rice at breakfast, lunch, and dinner were all associated with a decreased prevalence of constipation (multivariate OR (95% CI) in the highest quartile compared with the lowest: 0.62 (0.44, 0.86) for breakfast (*P* for trend = 0.002); 0.65 (0.46, 0.91) for lunch (*P* for trend = 0.001); 0.55 (0.39, 0.78) for dinner (*P* for trend = 0.001)).

The prevalence of constipation increased with increasing intake of confectioneries (*P* for trend <0.001). In comparison with women in the lowest quartile, the multivariate OR for women in the highest was 1.56 (95% CI: 1.13, 2.14). There was also a positive association between intake of Japanese and Chinese tea and a prevalence of constipation (*P* for trend = 0.004). Women in the highest quartile of the intake had a multivariate OR of 1.54 (95% CI: 1.12, 2.11) compared with those in the lowest. On the other hand, there was an inverse association between coffee intake and a prevalence of constipation (*P* for trend = 0.045). Women in the highest category of the intake had a multivariate OR of 0.66 (95% CI: 0.47, 0.94) compared with those in the lowest. No clear associations were observed between constipation and the intake of other food groups examined. As shown in

**Table 3** Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for self-reported constipation in relation to intakes of selected food groups (further adjusted for intake of total dietary fiber) and total dietary fiber (further adjusted for intake of rice) among 1705 Japanese women aged 18–20 years

| | *n with/without constipation* | *Adjusted OR[a] (95% CI)* |
|---|---|---|
| Food intake (g/1000 kcal) | | |
| *Rice[b]* | | |
| 82.7 (0–104.6)[c] | 131/295 | 1.00 |
| 123.9 (104.7–144.1) | 129/297 | 0.99 (0.73, 1.33) |
| 163.7 (144.2–185.8) | 97/330 | 0.66 (0.48, 0.91) |
| 220.3 (185.9–440.5) | 79/347 | 0.47 (0.33, 0.68) |
| *P* for trend | | <0.0001 |
| *Confectioneries[b]* | | |
| 16.7 (0.6–23.1) | 95/331 | 1.00 |
| 29.1 (23.2–35.1) | 84/342 | 0.86 (0.61, 1.21) |
| 41.2 (35.2–48.6) | 127/300 | 1.47 (1.07, 2.03) |
| 59.9 (48.7–157.6) | 130/296 | 1.54 (1.12, 2.13) |
| *P* for trend | | 0.0005 |
| *Japanese and Chinese tea[d]* | | |
| 47.8 (0–86.2) | 100/326 | 1.00 |
| 141.6 (86.3–201.1) | 96/330 | 0.89 (0.64, 1.23) |
| 248.1 (201.2–313.3) | 105/322 | 1.05 (0.76, 1.45) |
| 432.9 (313.4–1471.1) | 135/291 | 1.49 (1.09, 2.05) |
| *P* for trend | | 0.0067 |
| *Coffee* | | |
| 0 (0) | 240/748 | 1.00 |
| 13.1 (4.7–27.3) | 66/225 | 0.75 (0.58, 0.97) |
| 66.0 (27.4–604.7) | 130/296 | 0.67 (0.47, 0.94) |
| *P* for trend | | 0.0563 |
| *Total dietary fiber intake (g/1000 kcal)* | | |
| 4.6 (2.6–5.1) | 97/326 | 1.00 |
| 5.7 (5.2–6.1) | 110/321 | 1.03 (0.75, 1.43) |
| 6.6 (6.2–7.2) | 109/317 | 1.01 (0.72, 1.40) |
| 8.1 (7.3–14.3) | 120/305 | 1.16 (0.84, 1.62) |
| *P* for trend | | 0.41 |

[a]OR adjusted for residential block, size of residential area, physical activity, smoking status, alcohol drinking habits, body mass index, and energy intake. For intakes of food groups, further adjusted for total dietary fiber intake and for total dietary fiber intake, further adjusted for intake of rice (excluding dietary fiber content).
[b]Excluding dietary fiber content.
[c]Median (range).
[d]Non- and semifermented tea.

Table 3, further adjustment for total dietary fiber, as well as soluble and insoluble dietary fiber (data not shown), did not change the results of rice (excluding dietary fiber content) ($P$ for trend $<0.0001$), confectioneries (excluding dietary fiber content) ($P$ for trend $=0.0005$), Japanese and Chinese tea ($P$ for trend $=0.0067$), and coffee ($P$ for trend $=0.0563$) materially, indicating that these observed associations are independent of dietary fiber intake.

There was a positive association of intake of total and soluble dietary fiber with a prevalence of constipation ($P$ for trend $=0.07$ and $0.01$, respectively). The association between total dietary fiber and constipation, however, disappeared when further adjusted for rice (excluding dietary fiber content) ($P$ for trend $=0.41$; Table 3), confectioneries (excluding dietary fiber content) ($P$ for trend $=0.16$), Japanese and Chinese tea ($P$ for trend $=0.09$), or coffee ($P$ for trend $=0.09$). Additionally, although the positive association between soluble dietary fiber and constipation remained when further adjusted for Japanese and Chinese tea ($P$ for trend $=0.01$) or coffee ($P$ for trend $=0.02$), the association disappeared when further adjusted for rice (excluding dietary fiber content) ($P$ for trend $=0.37$) or confectioneries (excluding dietary fiber content) ($P$ for trend $=0.08$). Thus, the positive association between dietary fiber and constipation seemed to be largely dependent on rice intake.

## Discussion

We found that increased intakes of rice and coffee were associated with a decreased risk of constipation in young Japanese women. We also found that lower intakes of confectioneries and Japanese and Chinese tea were associated with a decreased risk of constipation. While a limited number of studies on this issue conducted in Asian countries used non-validated, relatively simple questionnaires for the assessment of dietary factors (Kunimoto *et al.*, 1998; Wong *et al.*, 1999; Nakaji *et al.*, 2002; Fujiwara, 2003), we used a previously validated DHQ for quantitative assessment of dietary intake.

We found dose–response relationships of increased intake of rice with a decreased risk of constipation. Furthermore, increased intakes of rice from breakfast, lunch, and dinner were all associated with decreased risk of constipation. The protective effect of rice on constipation has also been indicated in two previous studies conducted in Asian communities (Wong *et al.*, 1999; Nakaji *et al.*, 2002) where rice is the main staple food. The reason for the association is not well known. Nakaji *et al.* (2002) hypothesized that the effect of rice is due to dietary fiber in rice because rice is the largest source of dietary fiber in Japanese people (Sasaki *et al.*, 2003b). Conversely, Wong *et al.* (1999) hypothesized that the effect of rice is explained by the increased energy intake because rice is high in energy but low in fiber. In these studies, however, quantitative assessment of dietary intake was not available because of the use of relatively simple questionnaire. Our data do not support their hypotheses since the association between rice and constipation was independent of both energy and dietary fiber intake. Rice is a staple food in Japan and a major contributor of many vitamins and minerals; some of constituents in rice and/or combinations of these constituents might exert a preventive effect on constipation. Alternatively, rice intake might merely reflect an overall healthier lifestyle that may not have been accurately captured and controlled in our analysis.

Several studies have suggested the association of breakfast-skipping and constipation (Kunimoto *et al.*, 1998; Fujiwara, 2003), but we did not assess this association because of a quite small number of women with the habit of breakfast-skipping ($n=30$). In the present study, however, 65% of the staple food intake at breakfast was derived from rice, while a decreased intake of rice at breakfast was associated with increased risk of constipation. This might suggest breakfast-skipping as a risk factor of constipation.

A positive association between confectionery intake and constipation was observed, although we are not aware of any research reporting this association. We also found an adverse effect of Japanese and Chinese tea, which is in agreement with a study of Singapore (Wong *et al.*, 1999), and a preventive effect of coffee, generally consistent with a study of the US (Dukas *et al.*, 2003). It is unclear why these foods had such effects on constipation. Although our finding regarding these foods may have been due to chance alone given the large number of statistical analyses conducted in the present study and intake of these foods may be a marker of other lifestyle factors that were not addressed, further studies examining the association between constipation and these foods would be some of interest.

Constipation seemed to be associated with intake of energy (Sandler *et al.*, 1990; Towers *et al.*, 1994), fluids (water and pure fruit juices) (Sanjoaquin *et al.*, 2004), beverages (sweetened, carbonated, and noncarbonated) (Sandler *et al.*, 1990), tea (Sandler *et al.*, 1990), meats (Sandler *et al.*, 1990; Sanjoaquin *et al.*, 2004), eggs (Nakaji *et al.*, 2002), dairy products (Sandler *et al.*, 1990), and fish (Sandler *et al.*, 1990; Sanjoaquin *et al.*, 2004) in previous studies. We, however, did not find any association of constipation with these dietary factors in the present study. These discrepancies may be, at least partially, explained by the differences in the characteristics, dietary habits, and lifestyle of the subjects examined, dietary assessment methods used, and definitions of constipation applied among studies.

The effect of dietary fiber on constipation is widely accepted, but only a few studies have found an inverse association between dietary fiber and constipation (Dukas *et al.*, 2003; Sanjoaquin *et al.*, 2004), and many other studies have failed to find this association (Everhart *et al.*, 1989; Whitehead *et al.*, 1989; Campbell *et al.*, 1993; Towers *et al.*, 1994). Unexpectedly, there seemed to be a positive association between dietary fiber intake and constipation in the present study, although the association disappeared after further adjustment for rice intake, suggesting that the association is largely due to an inverse association between rice intake and constipation. The positive association between dietary fiber and constipation may be because subjects suffering from constipation might increase their dietary fiber intake. This is particularly prevalent in the present study because the subjects are dietetic students and therefore may be highly health conscious. However, women with current dietary counseling were excluded from the present analysis. Additionally, not only was intentional dietary change, self-reported in DHQ, not significantly associated with constipation, but also the analyses, further adjusted for intentional dietary changes or after excluding the subjects who reported intentional dietary change within one year, provided identical results (data not shown). Another explanation of the positive association between dietary fiber and constipation is that dietary fiber intake was too low to have a protective effect for constipation for most women. The amount of dietary fiber estimated in the present study (mean: 12.0 g/day), however, was comparable with that observed in women aged 18–29 years in the Japanese National Nutrition Survey in 2001 (12.8 g/day) (Ministry of Health and Welfare, 2003) and 2002 (12.0 g/day) (Ministry of Health and Welfare, 2004), which has been available since 2001.

As a result of this unexpected association between dietary fiber and constipation and the possibility that subjects suffering from constipation might increase their dietary fiber intake and hence change their diet, the findings regarding foods, particularly those significantly associated with constipation in the present study (rice, confectioneries, Japanese and Chinese tea, and coffee), should be interpreted with great caution. We cannot deny that the association between these foods and constipation merely reflects dietary behaviors changed after, not before, suffering from constipation, although the findings on these foods were independent of dietary fiber intake and these foods are generally unlikely to be recognized as those having an influence of constipation. As mentioned above, however, previous studies have shown similar findings on rice (Wong *et al.*, 1999; Nakaji *et al.*, 2002), Japanese and Chinese tea (Wong *et al.*, 1999), and coffee (Dukas *et al.*, 2003). Unfortunately, these are all cross-sectional findings; prospective research on this area is required.

Findings regarding dietary factors also need to be cautiously interpreted in terms of dietary assessment methodology. First, the DHQ measures only the memory and perception of usual diet, although we used a previously-validated questionnaire (Sasaki *et al.*, 1998a, b; 2000b). Second, selective under- and/or overestimation of dietary intake, which may affect the energy-adjusted intake in a biased way, is a serious problem in many populations (Livingstone and Black, 2003) as well as the women examined here (Okubo and Sasaki, 2004). However, a repeated analysis presented in Tables 2 and 3 after excluding 400 subjects with implausible reported energy intake (women with the ratio of reported energy intake to basal metabolic rate, estimated using the FAO/WHO/UNU equation (FAO/WHO/UNU, 1985), of $<1.2$ or $>2.5$ (Black *et al.*, 1996)) provided the similar results. We thus believe that the associations in the present study are not spurious associations created by inaccurate dietary data.

Constipation has been associated with smoking status (Dukas *et al.*, 2003), alcohol drinking (Nakaji *et al.*, 2002; Dukas *et al.*, 2003; Sanjoaquin *et al.*, 2004), and BMI (Sandler *et al.*, 1990; Dukas *et al.*, 2003; Sanjoaquin *et al.*, 2004) in previous studies, but we observed no significant association of constipation with these variables. These null associations may be due to the large proportions of women without habits of smoking (94%) or alcohol drinking (78%) and with a normal BMI (78%). Physical activity has also been associated with constipation in several studies (Everhart *et al.*, 1989; Sandler *et al.*, 1990; Dukas *et al.*, 2003; Sanjoaquin *et al.*, 2004); we, however, did not find the association. This may be because of our relatively rough assessment of physical activity because we classified the subjects only into two groups according to the frequency of participating sports club activities without consideration of other kinds of activities.

In the present study, the assessment of constipation was based strictly on self-reporting, although subjects who were considered to be 'constipated' had significantly fewer bowel movements than did other subjects. The proportion of the subjects who were considered 'constipated' in the present study seemed to be relatively high (26%); some of those may not be classified as 'constipated' according to symptom-based criteria such as Rome I and Rome II criteria (Thompson *et al.*, 1999). In fact, the prevalence of self-reported constipation was much higher compared with the prevalence based on Rome I and Rome II criteria in a study of Spain (30 vs 19 and 14%) (Garrigues *et al.*, 2004). Thus, whether the same associations we observed would hold for constipation according to symptom-based criteria is not known, which should be addressed in future studies.

Although the use of medications may be associated with constipation (Wong *et al.*, 1999; Dukas *et al.*, 2003; Talley *et al.*, 2003), this variable was not assessed in the present study. We, however, analyzed only the data of apparently healthy women without any disease at the time of study to minimize the confounding by medication usage. Additionally, our results might not be representative because the subjects were selected female dietetic students.

In conclusion, intake of rice and coffee was inversely and intake of confectioneries and Japanese and Chinese tea was positively associated with self-reported constipation in a group of young Japanese women. As a result of the cross-sectional nature of the present study, which precludes any causal inferences, several limitations, particularly possibility that subjects suffering from constipation might increase their dietary fiber intake and hence change their diet and the use of self-reported constipation, and the lack of biological explanation for the associations we observed, however, further observational (favorably, prospective) and experimental studies are required to clarify these relationships.

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**BDHQ(成人版)を正しく使っていただくために(作成中原稿:06/12/26 現在[2段組版])**

第12回EBNを考える会(2006/10/25、東京/浅草)配布資料をもとに加筆修正
一部の記述に事実と合わない部分がありますことをあらかじめお許しください。

佐々木敏(ささきさとし) 連絡先:stssasak@nih.go.jp

もくじ



## 1. まえがき

食事(栄養素など)のアセスメント(調査)は、食べ物や栄養素を健康などとの関連を調べる場合、食事の改善を通して健康維持や疾病予防、疾病管理を行ううえで不可欠であると思います。それにもかかわらず、食事アセスメントを行わずに、これらが行われていることが多いようです。これは、食事アセスメントの困難さに加え、食事アセスメントへの理解の低さも原因のひとつとしてあげられるのではないかと思います。

この小冊子は、食事アセスメント法のひとつであるBDHQ(簡易型自記式食事歴法質問票: brief-type self-administered diet history questionnaire)を用いるときに、正しく活用するために知っておいてほしいことをまとめたものです。また、食事アセスメント全般に関する基礎的な事柄についても、BDHQを使う場合に知っておくべきものに限って、簡単にまとめておくことにしました。

利用の便を図って、その章または節のエッセンスを ***** にまとめました。

BDHQに続き、その類似版として、小学生高学年用のBDHQ(BDHQ10y)、中高校生用(BDHQ15y)、3歳児用(BDHQ3y)の開発も行な

っていますが、これらは BDHQ に比べるとまだ開発が遅れているため、この小冊子ではこれらには触れません。お許しください。

> この小冊子は、食事アセスメント法のひとつであるBDHQ(簡易型自記式食事歴法質問票: brief-type self-administered diet history questionnaire)を用いるときに、正しく活用することができるように知っておくべきことをまとめたものです。

2. この小冊子はだれのために書かれているのか

この小冊子は、栄養学、特に食事アセスメント(食事調査)に関する基礎知識をもっている人、主として、管理栄養士・栄養士を対象として書かれています。それ以外の読者は、栄養学の基礎知識を別の書物などで補いながら読むことをお勧めします。なお、この小冊子に書かれていることを理解するための理論は、『佐々木敏. わかりやすいEBN と栄養疫学、同文書院、2005 年(2500 円+税)』に詳しく説明されています。

> この小冊子は、栄養学、特に食事アセスメント(食事調査)に関する基礎知識をもっている人を対象に書かれています。

3. BDHQ とは何か

BDHQ は、日本に住む 18 歳以上の成人を対象として、通常の食品(サプリメント等を除く)から習慣的に摂取している栄養素量を比較的簡便に、個人を単位として調べ、個人ごとの栄養素摂取量、食品摂取量、その他、若干の定性的な食行動指標の情報を得るために設計された質問票です。その結果は、個人結果として結果説明や食事指導などに使えるものとして出力することができます。また、集団に用いた場合には、個人ごとのデータから構成される集団のデータベースが作成され、種々の目的の集計や解析に用いることができます。

しかし、摂取したものを直接に観察する方法ではありません。そのために、その精度(妥当性)を検討し、その結果を参考にして適切に用いることがたいせつです。

BDHQ とは、広義には、この質問票で得られるデータの入力、栄養価計算、結果の出力を含む、システム全体のことを指します。

> BDHQ とは、18 歳以上の成人を対象として、通常の食品(サプリメント等を除く)から習慣的に摂取している栄養素量を比較、簡便に個人を単位として調べ、個人ごとの栄養素摂取量、食品摂取量、その他、若干の定性的な食行動指標の情報を得るために設計された質問票です。広義には、この質問票を扱うためのシステム全体のことを指します。

4. BDHQ の歴史

BDHQ は、DHQ(自記式食事歴法質問票: self-administered diet history questionnaire)の簡易版として開発されました。DHQ は、栄養素などの摂取状態を定量的に、かつ、詳細に調べるための質問票を中心としたシステムです。1996 年に開発が始められ、数多くの基礎研究を経て、現在では数多くの栄養疫学研究、その他の人間栄養学研究などに活用されています。どのような研究に用いられてきたかについては、「5.DHQ」をご覧ください。BDHQ を理解するには、DHQ について、ある程度理解することが勧められます。

BDHQ は DHQ の特徴をある程度保ちつつ、構造を簡略化し、回答やデータ処理を簡便にしたものです。大規模な栄養疫学研究や、栄養が従である(他の要因が主である)研究に用いることを目的として開発されました。

DHQ については、いくつかの妥当性研究が行われ、その長所、短所がある程度、明らかにされていますが、BDHQ の妥当性は、のちほど触れますように、その精度(妥当性)に関する検討は原著論文はまだありません。その意味で、BDHQ は開発の途中段階にある質問票であるというべきでしょう。

そのため、質問票構造を含め、栄養価計算の方法(プログラム)など、BDHQ のシステムは徐々に改良されてゆきます。

また、BDHQ は成人にしか用いられないため、現在、小学生高学年用の BDHQ(BDHQ10y)、中高校生用(BDHQ15y)、3 歳児用(BDHQ3y)の開発も行なわれています。

> BDHQ は、DHQ(自記式食事歴法質問票: