J Occup Health 2014; 56: 359–368

Journal of Occupational Health

Low Intake of Vegetables, High Intake of Confectionary, and Unhealthy Eating Habits are Associated with Poor Sleep Quality among Middle-aged Female Japanese Workers

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Abstract: Low Intake of Vegetables, High Intake of Confectionary, and Unhealthy Eating Habits are Associated with Poor Sleep Quality among Middle-aged Female Japanese Workers: Ryoko KATAGIRI, *et al.* Department of Social and Preventive Epidemiology, Graduate School of Medicine, the University of Tokyo—Objectives: Although workers with poor sleep quality are reported to have problems with work performance, few studies have assessed the association between dietary factors and sleep quality using validated indexes. Here, we examined this association using information acquired from validated questionnaires. **Methods:** A total of 3,129 female workers aged 34 to 65 years were analyzed. Dietary intake was assessed using a self-administered diet history questionnaire (DHQ), and subjective sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). The relationship between the intake of several food groups and nutrients and sleep quality was examined using multivariable logistic regression models. The effect of eating habits on sleep quality was also examined. **Results:** Poor sleep quality was associated with low intake of vegetables (p for trend 0.002) and fish (p for trend 0.04) and high intake of confectionary (p for trend 0.004) and noodles (p for trend 0.03) after adjustment for potential confounding factors (age, body mass index, physical activity, depression score, employment status, alcohol intake and smoking status). Poor sleep quality was also significantly and positively associated with consumption of energy drinks and sugar-sweetened beverages, skipping breakfast, and eating irregularly. In addition, poor sleep quality was significantly associated with high carbohydrate intake (p for trend 0.03). **Conclusions:** A low intake of vegetables and fish, high intake of confectionary and noodles and unhealthy eating habits were independently associated with poor sleep quality. Poor sleep quality was also associated with high carbohydrate intake in free-living Japanese middle-aged female workers.
(J Occup Health 2014; 56: 359–368)

Key words: Eating habits, Food intake, Japanese female workers, Sleep quality

Received Mar 10, 2014; Accepted Jun 10, 2014
Published online in J-STAGE Aug 28, 2014
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Inadequate sleep is prevalent in modern societies[1]. Mean sleep duration has decreased in many countries, including Japan[2], and attention has focused on the associations of inadequate sleep and health outcomes. Associations with inadequate, particularly short, sleep duration have been reported for obesity[3] and total mortality[4]. In the workplace too, shift work[5] and high work demands[6] have been associated with sleep disturbances, and people with poor sleep quality take more sick leave or have problems in occupational activities[7]. Thus, a reduction in sleep disturbance will positively impact both general and working populations.

Sleep can be evaluated from two aspects, quantity (sleep duration) and quality. Although adequate methods of evaluating sleep quality have not been rigorously established[8], Buysse and his group developed the "Pittsburgh Sleep Quality Index (PSQI)" to evaluate total sleep quality[9]. This questionnaire assesses seven aspects of sleep (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medications and daytime dysfunction), and their sum yields a global score for sleep quality. A high global score indicates poor sleep quality and has been associated with metabolic syndrome[10].

Assessing the association between sleep quality and food intake is important because while dietary factors that affect sleep quality can be easily improved, altering sleep quality autonomously cannot. Some lifestyle behaviors such as exercise may improve sleep quality[11]. However, one Japanese survey showed that middle-aged female workers spend approximately 4 hours per day on housework, including cooking, but only 20 minutes per day on sports and hobbies[12], while another showed that increasing physical activity requires more self-regulatory capacity for schedule adjustment than dietary change, which could be easily achieved due to the obligatory nature of eating[13]. Thus, altering dietary habits is more feasible than altering lifestyle behaviors in female workers. Evidence supporting the relationship between sleep quality and diet has been scarce, however, and of those available, two studies, one each from Japan[14] and the US[15], utilized non-validated questionnaires. The relationship between dietary intake and sleep quality would be better understood by studies utilizing validated questionnaires. Further, studies focusing on food groups and eating habits are also necessary, as they would provide an approachable benchmark for alternations in food choice and lifestyle.

Here, we attempted to identify the relationship between dietary habits (dietary intake and eating habits) and sleep quality among Japanese middle-aged female workers with validated questionnaires.

Methods

Study participants

The study was based on a multicenter survey entitled "Three-generation Study of Women on Diets and Health", which was described in detail elsewhere[16]. Briefly, the survey was conducted from April to May in 2011 and 2012 in Japan. Since a large earthquake (Tohoku Region Pacific Coast Earthquake) occurred in March 2011 in the northeastern part of Japan, the survey was conducted from April to May in 2011 in Hokkaido and the southwestern part of Japan. The same survey was then conducted from April to May in 2012 in the northeastern part of Japan. Surveys were conducted at participating institutions according to the survey protocol, which was approved by the ethics committee of the Faculty of Medicine, University of Tokyo (No. 3249). The participants in the survey consisted of first-year students taking dietetic courses at universities, colleges and technical schools, as well as their mothers and grandmothers. In total, 85 teaching institutions participated, and 7,016 first-year students were provided with questionnaires. Students were required to distribute questionnaires directly to their mothers and grandmothers, and those who were unable to do so were excluded from participation, except in the case that grandmothers were unavailable (65- to 89-year-old female acquaintances were allowed instead of grandmothers). The purpose and outline of the survey were explained to the students by collaborators, and written informed consent was acquired from all participants, including mothers and grandmothers.

The subjects of the present study were the mothers (middle-aged women). Questionnaires for mothers were composed of two booklets, one for dietary habits and one for lifestyle, including basic characteristics and sleep. Of the 7,016 mothers who obtained questionnaires, 4,044 answered both booklets (response rate=57.6%). The exclusion criteria for participants in this analysis were as follows: over 65 years of age (n=10), living in the Eastern Japan at the time of the survey in 2011 because of the influence of the earthquake (n=63), data from an institution where the response rate was only 2% (n=2), low (<500 kcal/day) or high (>4,000 kcal/day) energy intake (n=20), missing data for height, weight or age (n=4), failure to answer Question 2, 4, 5a or 6 (regarding sleep latency, sleep efficiency and subjective sleep quality) and more than two missing answers for Question 5b to 5j (regarding causes of sleep disturbance) in the PSQI. Of the remaining 3,900 participants, those who answered that they were employed (full time or part time) were included in the analysis. Ultimately, 3,129 female workers aged 34 to 65 years were included in the study.

Measurements

Sleep quality was assessed using the PSQI[9]. Questions from the Japanese version of the PSQI were included in the lifestyle questionnaire booklet in this study. The PSQI is described in detail elsewhere[9]. Briefly, participants answered nine questions concerning their sleep quality in the previous month, which generated a score (range 0–3, 0=good and 3=poor) for seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medication and daytime dysfunction. The sum of these seven scores yielded a global score for sleep quality (range 0–21), with a lower score indicating better sleep quality.

Self-administered diet history questionnaires (DHQs) were used to assess the dietary habits of participants for the previous month. Details of the DHQ and its validity are reported elsewhere[17, 18]. Briefly, the DHQ is a validated questionnaire that includes questions concerning the frequency of consumption and semiquantitative portion size consumed for 151 food and beverage items, general eating habits including skipping meals and eating irregularly, use of dietary supplements and major cooking methods. An *ad hoc* algorithm for the DHQ based on the Standard Tables of Food Composition in Japan[19] was then used to calculate the estimated dietary intake of energy, food groups, food items and nutrients.

Age, body height and body weight were self-reported in the DHQ. Body mass index (BMI) was calculated as body weight (kilograms) divided by the square of body height (meters). The lifestyle questionnaire also included questions about the residential area and smoking history of the mother, whereas questions about the education level of the mother were included in the lifestyle questionnaire of the student. Alcohol consumption was assessed in the DHQ. Physical activity measured by metabolic equivalents hour (METs*hour) was calculated from the time spent for the five types of physical activity (walking, bicycle riding, running, standing and playing sports). These questions were included in the lifestyle questionnaire. Sleep duration and the duration of the five physical activities were summed and then subtracted from 24 hours, and the remaining time was recognized as time spent "sitting". MET values for each activity were as follows: walking (3.5 MET), bicycle riding (7.5 MET), standing (3.2 MET), running (7.0 MET), playing sports (8.0 MET), sleeping (1.0 MET) and sitting (1.3 MET)[20]. These METs were multiplied by the time spent for each activity, and the sum of these yielded the extent of physical activity, which was expressed as METs*hour per day.

To assess depression, the lifestyle questionnaire included the Center for Epidemiologic Studies Depression (CES-D) scale[21]. The CES-D scale includes 20 questions marked between 0 and 3, with higher scores indicating that the situation or condition appears more frequently (score 0=never and score 3=always), except for question 4, 8, 12 and 16, which were scored in reverse order (score 3=never and score 0=always). A total score of 16 or more was considered to indicate the presence of depression[21]. Although subjective stress in daily life was evaluated by another short question in the questionnaire, psychological status in this study population was evaluated with the CES-D scale, which has already been validated.

Statistical analysis

The global score of PSQI was divided into three categories (good, score of 0–3; middle, score of 4 and 5; and poor, score of 6 or more) to analyze the relationship with dietary intake. Although global score ranges from 0 to 21, the score yielded was a whole number, and the distribution of the global score was skewed (median score of 4 with 91.4% of participants having a score ≤7). Thus, the classification shown above divided the analyzed population into approximate tertiles in which the trend of the relationships between sleep quality and diet could be examined.

First, the mean ± standard deviation (SD) for intake of each food group and macronutrients was described. Food group intake was energy adjusted using the density method and presented as grams per 1,000 kcal of energy, and macronutrients and alcohol were presented as percent energy. The frequency of participants who answered "Yes" for several eating habits (consuming energy drinks, consuming sugar sweetened beverages, skipping breakfast and eating irregularly) in each category of the PSQI global score was also described. Consumption of energy drinks and sugar-sweetened beverages was included in eating habits, as 75.9% of the participants did not consume the former, while 74.0% of the participants consumed the latter less than once a week in the previous month. Differences in basic characteristics and food group intake among the three groups with different PSQI scores were tested by analysis of variance (ANOVA) and the *ad hoc* Dunnett's test for continuous variables and the Chi-square test for categorical variables.

Multivariable logistic regression analysis was then conducted to adjust for confounding factors. For logistic regression, the global score of the PSQI was classified into two groups at the PSQI cut-off value: "poor sleep quality group" (global score ≥5.5, including those in the poor group in ANOVA) and "middle and good sleep quality group" (global score <5.5, including those in the good and middle groups in ANOVA). The cut-off value for good sleep quality was reported to be a score of 5.5 in the Japanese population[22]. Macronutrients, food groups and eating habits that showed a significant or marginally significant relationship with sleep quality category in ANOVA and the *ad hoc* Dunnett's test were selected. Continuous values of macronutrients and food groups were divided into quintiles (Q1 was lowest and Q5 was highest). Eating habits were divided into two groups based on whether participants consumed energy drinks once or more per month (Yes) or never (No); consumed sugar-sweetened beverages once or more per week (Yes) or less (No); skipped breakfast once or more per week (Yes) or never (No); or ate outside of the three regular meal times (eat irregularly) once or more per week (Yes) or never (No). Multivariate adjusted odds ratios and 95% confidence intervals for the poor sleep quality group against the good and middle sleep quality groups were calculated. The reference was Q1 for macronutrients and food groups, and the group that did not have these habits ("No" group) was the reference for eating habits.

Adjustments were made for physical activity level (continuous), CES-D score (continuous), employment status (binominal), current smoking status (binominal) and BMI (continuous) selected from the results of ANOVA and the Student's *t*-test, which was used to compare the good and poor sleep quality groups as in the case of the logistic regression (the results were not shown). In addition, age (continuous) and the amount of alcohol intake (continuous) were also included as established confounding factors based on the findings in previous papers[7, 23]. All statistical procedures were conducted using SAS 9.3 (SAS Institute, Cary, NC, USA). *p*-values were two-tailed and considered statistically significant when <0.05.

Results

Basic characteristics of the participants in this analysis are shown in Table 1. Poor sleep quality was significantly associated with a high CES-D score, employment status (poor quality in full-time workers) and high prevalence of smoking. Although physical activity level was significantly different between the three groups by ANOVA, the relationship with sleep quality was not linear. No significant association was observed between sleep quality and education level, menopause and alcohol consumption.

Dietary intake by food groups and eating habits in each group with different PSQI global scores is shown in Table 2. There were significant differences in the mean intake of protein and fat among the categories of sleep quality, but these results were not dose dependent. Regarding intake classified by food group, a high intake of vegetables had a significant association with good sleep quality, while that of confectionary was significantly related to poor sleep quality. Concerning eating habits, a high frequency of energy drink or sugar-sweetened beverage consumption, skipping breakfast and irregular eating were significantly associated with worse sleep quality.

The results of multivariable logistic regression analysis are shown in Table 3. After adjustment for potential confounding factors (age, BMI, physical activity, CES-D score, employment status, alcohol intake and smoking status), high intakes of vegetables and fish were significantly related to good sleep quality (*p* for trend 0.002 and 0.04, respectively) and high consumptions of confectionary and noodles were related to poor sleep quality (*p* for trend 0.004 and 0.02, respectively). Regarding macronutrients, high carbohydrate intake was significantly associated with poor sleep quality (*p* for trend 0.03). Four eating habits (consumption of energy drinks or sugar-sweetened beverages, skipping breakfast and eating irregularly) were also significantly associated with poor sleep quality after adjustment.

Discussion

In this study, we found that a low intake of vegetables and fish and high intake of confectionary and noodles were associated with poor sleep quality. Poor sleep quality was also associated with the consumption of beverages containing sugar or caffeine, such as energy drinks or sugar-sweetened beverages, as well as unhealthy eating habits, such as skipping breakfast and eating irregularly. Regarding macronutrients, high carbohydrate intake was significantly associated with poor sleep quality. To our knowledge, this is the first study to investigate the association of dietary habits (quantitative intake of food groups and aspects of eating habits) with sleep quality using validated questionnaires.

Regarding previously known factors associated with sleep quality, we did not observe a linear trend between physical activity level and sleep quality. A Japanese report on sleep quality among employees showed that a high frequency of exercise was associated with good sleep quality[7]. In our study, however, physical activity was calculated by including all activity such as walking for commuting or housekeeping work in daily life and was not focused on exercise such as sports or fun activities which may have favorable effects on sleep. Moreover, 67% of the participants in our study were not in the habit of getting exercise, such as through sports, and the time spent on exercise (running or playing sports) was less than 36 minutes per week in 97% of them. This low prevalence of exercise habits is another issue in this generation. In addition, although excess alcohol consumption has been known to be associated with poor sleep quality, it was not associated with sleep quality in our study. The number of individuals who drink to excess might be too small to examine the relationship statistically in Japanese female workers. This result was consistent with a past Japanese report[7], but another report showed a significant negative effect of alcohol intake on sleep quality[23].

Among the findings, our results suggest that the relationship of dietary intake with sleep quality is similar to that with sleep duration. In cross-sectional studies, reduced sleep duration was associated with inadequate dietary intake, such as a high intake of snacks[24] and low intake of vegetables[24], as well as undesirable eating habits, including skipping breakfast and irregular eating[24, 25]. It was also reported that fewer adolescents in a short sleep group ate adequate amounts of fish and vegetables[26]. Sleep duration is one of seven components of sleep quality in the PSQI global score; here, the correlation between PSQI global score and sleep duration was significant ($r=-0.404$ $p<0.0001$, data are not shown) and consistent with

Table 1. Basic characteristics of the subjects

	Total (n=3,129)	Pittsburgh Sleep Quality Index score			
		Good Score ≤3 (n=1,195)	Middle Score 4 or 5 (n=1,103)	Poor Score ≥6 (n=831)	*p* value[3)]
PSQI global score	4.41 ± 2.17	2.39 ± 0.78	4.45 ± 0.50	7.26 ± 1.60	
Age (years)	47.6 ± 4.0	47.6 ± 4.0	47.8 ± 3.9	47.4 ± 4.1	0.12
Body height (cm)	157.3 ± 5.0	157.5 ± 5.0	157.1 ± 5.0	157.3 ± 5.1	0.35
Body weight (kg)	54.2 ± 7.8	54.0 ± 7.4	54.0 ± 7.9	54.6 ± 8.4	0.14
BMI (kg/m^2)	21.9 ± 3.0	21.8 ± 2.8	21.9 ± 3.0	22.1 ± 3.2	0.08
Physical activity (METS*hour/day)	41.0 ± 5.6	40.7 ± 5.4	41.3 ± 5.7	41.1 ± 5.6	0.02
CES-D score	12.6 ± 5.7	10.8 ± 4.7	12.2 ± 5.0	15.8 ± 6.6	<0.0001
Sleep duration (hours)	6.09 ± 0.91	6.52 ± 0.86	6.01 ± 0.76	5.62 ± 0.89	<0.0001
Current smoker (number [%])					
Yes	259 (8.28)	87 (7.28)	70 (6.35)	102 (12.3)	<0.0001
No	2,870 (91.7)	1,108 (92.7)	1,033 (93.6)	729 (87.7)	
Current drinker (number [%])					
Yes	1,628 (52.0)	605 (50.6)	592 (53.7)	431 (51.9)	0.34
No	1,501 (47.9)	590 (49.4)	511 (46.3)	400 (48.1)	
Menopause[1)]					
Yes	658 (21.1)	252 (21.1)	227 (20.6)	179 (21.6)	0.87
No	2,466 (78.9)	941 (78.9)	874 (79.4)	651 (78.4)	
Education[2)] (number [%])					
Junior high school	36 (1.18)	18 (1.53)	9 (0.84)	9 (1.11)	0.29
High school	1,405 (45.9)	525 (44.7)	491 (45.6)	389 (48.1)	
Junior college	1,134 (37.1)	454 (38.7)	394 (36.6)	286 (35.4)	
University and higher	444 (14.5)	161 (13.7)	171 (15.9)	112 (13.8)	
Unknown	41 (1.34)	16 (1.36)	12 (1.11)	13 (1.61)	
Employment status (numbers %)					
Full time	1,401 (44.8)	510 (42.7)	489 (44.3)	402 (48.4)	0.04
Part time	1,728 (55.2)	685 (57.3)	614 (55.7)	429 (51.6)	

PSQI, Pittsburgh Sleep Quality Index; CES-D, Center for Epidemiologic Studies Depression Scale. Continuous values are presented as the mean ± standard deviation. Percentages indicate the proportion of participants who answered "Yes" divided by the numbers of total participants and each category of sleep quality. [1)]Menopause n=3,124. [2)]The daughter's questionnaire asked about the mother's highest educational level (graduate institution). *p*-value was calculated using the chi-square test after exclusion of participants who answered "Unknown". n=3,060. [3)]*p*-values were calculated by analysis of variance (ANOVA) for continuous values and the chi-squared test for categorical values.

a previous study in US college students (r=–0.31)[27)]. Although several studies have reported that sleep quality and quantity might be different aspects of sleep[28)], we found that the two relationships (dietary intake and sleep duration and dietary intake and sleep quality) might partially overlap each other.

Regarding macronutrients, a study of Japanese workers showed a marginally significant association between low carbohydrate intake and difficulty in maintaining sleep[14)], and our results for carbohydrate were inconsistent with this paper. On the other hand, there are other past studies showing opposite results that were consistent with ours[29)]. In our study, the participants with poor sleep quality in the category for the highest carbohydrate intake consumed more confectionary and less rice than the participants with good sleep quality in the same category (data are not shown). Therefore, not only the total amount of carbohydrates but also the components of the carbohydrates or glycemic index might affect sleep quality, and further studies about the effect of macronutrients on sleep quality are required to confirm the associations.

Regarding eating habits, energy drink consump-

Table 2. Food group intake and frequency of unhealthy eating habits by the Pittsburgh Sleep Quality Index score

	Total (n=3,129)	Pittsburgh Sleep Quality Index			p value[3)]
		Good Score≤3 (n=1,195)	Middle Score4 or 5 (n=1,103)	Poor Score≤6 (n=831)	
Energy intake (kcal/day)	1,837 ± 493	1,809 ± 466	1,854 ± 485	1,856 ± 539	0.04
Macronutrients (% energy)					
Carbohydrate	54.3 ± 7.1	54.5 ± 7.1	53.8 ± 7.0†	54.5 ± 7.3	0.05
Protein	13.6 ± 2.0	13.6 ± 2.0	13.7 ± 1.9	13.4 ± 2.1†	0.003
Fat	29.1 ± 5.9	28.8 ± 6.0	29.5 ± 5.7†	29.0 ± 6.1	0.02
Alcohol	1.92 ± 4.13	1.94 ± 4.18	1.87 ± 3.95	1.96 ± 4.29	0.88
Food groups (g/1,000 kcal)[1)]					
Cereals	208 ± 62	213 ± 63	205 ± 59†	205 ± 62†	0.004
Rice	152 ± 63	157 ± 66	149 ± 62†	148 ± 62†	0.003
Noodles	31.8 ± 28.7	31.1 ± 28.6	31.4 ± 28.9	33.2 ± 28.6†	0.24
Bread	26.9 ± 22.2	27.1 ± 23.2	26.2 ± 20.6	27.4 ± 22.6	0.46
Nuts and pulses	34.5 ± 29.4	34.6 ± 27.6	35.2 ± 30.3	33.4 ± 30.7	0.39
Potatoes	16.4 ± 12.6	16.7 ± 13.3	16.4 ± 12.5	15.9 ± 11.8	0.29
Fish	30.3 ± 15.7	30.4 ± 16.1	30.9 ± 15.5	29.2 ± 15.2	0.06
Meat	36.3 ± 17.9	35.9 ± 18.0	37.1 ± 17.4	35.5 ± 18.5	0.11
Fruits	42.6 ± 44.0	42.8 ± 44.9	43.2 ± 44.8	41.5 ± 41.5	0.68
Total vegetables	128.4 ± 65.9	132.8 ± 70.1	129.6 ± 62.8†	121.7 ± 63.0†	0.0009
Green and yellow vegetables	51.6 ± 36.3	54.3 ± 39.0	50.8 ± 33.8†	48.7 ± 35.2†	0.0019
Other vegetables	62.0 ± 32.9	63.3 ± 34.3	62.7 ± 32.3	59.2 ± 31.5†	0.015
Confectionary	40.9 ± 22.7	39.3 ± 22.3	41.0 ± 22.3	43.3 ± 23.7†	0.0005
Eggs	18.4 ± 12.3	18.8 ± 12.4	18.2 ± 11.4	18.2 ± 13.4	0.38
Dairy products	68.3 ± 63.6	66.2 ± 62.2	69.7 ± 62.0	69.6 ± 67.5	0.34
Tea	26.3 ± 67.9	27.5 ± 70.0	26.5 ± 67.1	24.2 ± 66.0	0.56
Coffee	176 ± 163	173 ± 157	181 ± 169	173 ± 166	0.43
Green tea	255 ± 228	259 ± 235	246 ± 210	263 ± 242	0.26
Eating habits (number [%])					
Energy drink consumption					
Never	2,373 (75.9)	961 (80.6)	834 (75.6)	578 (69.6)	<0.0001
1−3 times /mo	508 (16.3)	167 (14.0)	182 (16.5)	159 (19.1)	
≥Once /wk	246 (7.87)	65 (5.45)	87 (7.89)	94 (11.3)	
Sugar-sweetened beverages consumption					
≤ once /wk	2,314 (74.0)	907 (76.0)	831 (75.4)	576 (69.3)	0.003
1−6 times/wk	730 (23.4)	264 (22.1)	243 (22.1)	223 (26.8)	
≥Once /day	83 (2.65)	23 (1.93)	28 (2.54)	32 (3.85)	
Breakfast skipping					
Never	2,469 (79.7)	999 (84.5)	881 (80.5)	589 (71.7)	<0.0001
Skip 1−2 times /wk	262 (8.46)	69 (5.84)	91 (8.32)	102 (12.4)	
Skip ≥3 times /wk	367 (11.9)	114 (9.64)	122 (11.2)	131 (15.9)	
Eat irregularly[2)]					
Never	1,998 (63.9)	814 (68.1)	699 (63.4)	485 (58.4)	<0.0001
≥Once /wk	1,131 (36.2)	381 (31.9)	404 (36.6)	346 (41.6)	

Continuous values were presented as the mean ± standard deviation. Frequency was the proportion of participants who answered "Yes" divided by numbers of each PSQI class. [1)]Cereals include rice, noodles and bread (bread includes four kinds of bread and other wheat products). Total vegetables include green and yellow vegetables, other white vegetables, mushrooms and seaweeds. [2)]Eat either rice, bread, noodles or miso soup irregularly (at times other than three regular meal times). [3)]*p*-values were calculated by analysis of variance (ANOVA) for continuous variables and by the chi-square test for eating habits. †p<0.05 with Dunnett's test (reference: good sleep quality group).

Table 3. Multivariable adjusted odds ratios and 95% confidence intervals for poor sleep quality among 3,129 middle-aged Japanese female workers

	Q1 (n=625)	Q2 (n=626)	Q3 (n=626)	Q4 (n=626)	Q5 (n=626)	*p* for trend[3]
Macronutrients[1]						
Carbohydrates (% energy)	≤48.8	48.8–52.6	52.6–55.9	55.9–59.9	60.0≤	
Adjusted ORs (95% CI)	1.0	0.95 (0.72–1.25)	1.02 (0.77–1.35)	1.20 (0.90–1.59)	1.26 (0.95–1.67)	0.03
Protein (% energy)	≤12.0	12.0–13.1	13.1–14.0	14.0–15.1	15.1≤	
Adjusted ORs (95% CI)	1.0	0.79 (0.60–1.03)	0.85 (0.66–1.11)	0.63 (0.47–0.82)	0.85 (0.65–1.11)	0.08
Fat (% energy)	≤24.2	24.2–27.8	27.8–30.5	30.5–33.7	33.7≤	
Adjusted ORs (95% CI)	1.0	1.08 (0.82–1.41)	1.09 (0.83–1.43)	0.76 (0.58–1.01)	0.92 (0.70–1.21)	0.10
Food group[1]						
Cereals (g/1,000 kcal)	≤158.3	158.3–190.3	190.3–219.1	219.1–254.5	254.5≤	
Adjusted ORs (95% CI)	1.0	1.01 (0.78–1.32)	0.98 (0.75–1.28)	0.98 (0.74–1.28)	0.90 (0.68–1.18)	0.42
Rice (g/1,000kcal)	≤99.0	99.0–130.5	130.5–161.0	161.0–199.7	199.7≤	
Adjusted ORs (95% CI)	1.0	0.96 (0.74–1.25)	0.98 (0.75–1.27)	0.86 (0.65–1.13)	0.83 (0.63–1.10)	0.13
Noodle (g/1,000 kcal)	≤10.3	10.3–19.3	19.3–32.6	32.6–49.9	50.0≤	
Adjusted ORs (95% CI)	1.0	0.76 (0.57–1.01)	1.10 (0.84–1.44)	1.21 (0.92–1.59)	1.13 (0.86–1.48)	0.02
Total vegetables (g/1,000 kcal)	≤76.7	76.7–103.7	103.7–131.6	131.6–172.9	172.9≤	
Adjusted ORs (95% CI)	1.0	0.68 (0.52–0.88)	0.63 (0.48–0.82)	0.70 (0.53–0.90)	0.62 (0.48–0.82)	0.002
Green and yellow vegetables (g/1,000 kcal)	≤24.4	24.4–36.3	36.3–50.9	50.9–72.7	72.7≤	
Adjusted ORs (95% CI)	1.0	0.92 (0.71–1.19)	0.74 (0.57–0.97)	0.68 (0.52–0.90)	0.81 (0.62–1.06)	0.02
Other vegetables (g/1,000 kcal)	≤35.8	35.8–50.1	50.1–63.7	63.7–83.3	83.3≤	
Adjusted ORs (95% CI)	1.0	0.93 (0.72–1.21)	0.72 (0.55–0.94)	0.66 (0.51–0.87)	0.80 (0.61–1.04)	0.009
Fish (g/1,000 kcal)	≤17.8	17.9–24.4	24.4–31.1	31.1–41.1	41.1≤	
Adjusted ORs (95% CI)	1.0	0.76 (0.59–1.0)	0.87 (0.67–1.13)	0.80 (0.61–1.04)	0.72 (0.55–0.94)	0.04
Confectionary (g/1,000 kcal)	≤22.1	22.1–32.7	32.7–42.9	42.9–57.3	57.3≤	
Adjusted ORs (95% CI)	1.0	1.03 (0.78–1.37)	1.06 (0.80–1.41)	1.33 (1.01–1.75)	1.39 (1.05–1.83)	0.004
Adjusted ORs (95% CI) for eating habits[2]	No	Yes				*p* value
Energy drink consumption	1.0	1.40 (1.16–1.70)				0.0005
Sugar-sweetened beverage consumption	1.0	1.23 (1.01–1.49)				0.01
Breakfast skipping	1.0	1.59 (1.30–1.96)				<0.0001
Irregular eating	1.0	1.35 (1.13–1.61)				0.0003

OR, odds ratio; CI, confidence interval. Values of odds ratios were adjusted for age (continuous), BMI (continuous), physical activity level (continuous), CES-D score (continuous), employment status (binominal), alcohol intake (continuous) and current smoking status (binominal). [1]Macronutrients and food groups were divided into quintiles (Q1 was lowest and Q5 highest). The range of each macronutrient and food group is described. The number of participants in each quintile were as follows: n=625 for Q1 and n=626 each for Q2 to Q5. [2]Eating habits were divided into two groups based on whether participants consumed energy drinks once or more per month (Yes) or never (No), consumed sugar-sweetened beverages once or more per week (Yes) or less (No), skipped breakfast once or more per week (Yes) or never (No) or ate outside of regular meal times (irregular eating) once or more per week (Yes) or never (No). [3]Trends of association were examined using a logistic regression model that assigned scores to the level of the independent variable.

tion was highly correlated with sleep quality. Energy drinks contain a wide range of caffeine (50–500 mg per can or bottle), as well as various stimulant substances such as taurine and herbal derivatives. Caffeine disturbs sleep in a dose-dependent manner[30]. The association of caffeinated beverages, including energy drinks, with the PSQI score has been investigated in college students[31]. Consistent with these studies, our results showed that a high frequency of energy drink consumption significantly correlated with low sleep quality. Although coffee and tea also contain high amounts of caffeine as in the case of energy drinks[32], most of the participants drank them, and this may have been one cause of no association between these drinks and sleep quality. Poor sleep quality may have been caused by additional caffeine intake from energy drink and/or sugar-sweetened beverages or by confounding of an unhealthy lifestyle, which people with high intake of energy drinks or sugar-sweetened beverages are likely to have. In addition, higher intake of noodles was significantly associated with poor sleep quality, and it might be an indicator of unhealthy eating habits. This is because the mean intake of noodles was significantly higher in the subjects who skipped breakfast or ate irregularly compared with the subjects who did not have these habits (data are not shown).

Our results can be interpreted in several ways. Causality of the association between sleep quality and diet could be considered both ways. People with busy lifestyles may not have sufficient time to sleep satisfactorily or eat meals of good nutritional quality. They may also frequently skip breakfast, eat fewer vegetables and eat more snacks instead of regular meals. This notion is partially supported by our present finding of a high prevalence of full-time workers categorized with poor sleep quality. In other words, a busy lifestyle can result in both insufficient sleep quality and unhealthy dietary habits. Although both insufficient sleep and unhealthy dietary habits co-exist and sleep quality can affect dietary habits, sleep quality itself cannot be changed autonomously within a busy lifestyle, whereas dietary habits can be changed, to some extent at least. Another possibility is that people who have inappropriate eating habits cannot establish a normal rhythm in daily life and have irregular (i.e., not robust) circadian rhythms. Lifestyle regularity is correlated with sleep quality, examined by the PSQI[33], and resetting the circadian rhythm is a non-pharmacological treatment for insomnia. Accordingly, improvement of unhealthy and irregular dietary habits might be a suitable circadian pacemaker-directed approach to the treatment of poor sleep quality.

There were several limitations to this study. First, its cross-sectional design cannot reveal the direction of causality. Sleep restriction is known to increase the secretion of ghrelin, an appetite-stimulating hormone, and increase hunger and appetite[34], but the strength of this possible causation in our study is weakened by the relatively minor difference in energy intake among sleep quality groups. Estimates of energy intake made using the DHQ lack accuracy[35], and BMI is a more appropriate indicator of the balance of energy intake and expenditure[36]. Although the difference in energy intake among groups in Table 2 showed only marginal significance, BMI did not significantly differ between the three sleep quality groups, and energy intake might not differ largely between the groups. Second, regarding generalizability, the participants included mothers of dietetic students. Although selected from various areas throughout Japan, they may have had healthier habits than other Japanese populations. Nevertheless, the nutritional intake and anthropometry data for this population were not particularly different from those in the Japanese National Health and Nutrition Survey[37]. Third, the response rate was relatively low (57.6%). Although this might be caused by selection bias and healthy people tending to participate in the survey, there is a possibility that this response rate was influenced by the study design, in which the study was not explained to the mothers directly by study's collaborators. Their daughters (students) explained the aim and procedure of the study to them and distributed the questionnaires. This recruitment method might not work correctly in an institution where the response rate is extraordinarily low (2%). Fourth, working situation, including shift work, work demands (working time, burden or stress related to work), and occupational class were not assessed. Although these factors might affect sleep quality or diet, the prevalence of poor sleep quality of 26.6% in our study and was close to that of the general Japanese population (25.9–30.6% in 40- to 59-year-old women, as assessed with the PSQI)[38]. Thus, the results of this study can be generalized to middle-aged female Japanese workers. Finally, sleep quality, body height, body weight and diet were self-reported, raising the possibility of misreporting[39]. In addition, the definition of poor or good sleep quality has not been standardized[8], despite the PSQI being a validated questionnaire. For the dietary questionnaire, we minimized the possible influence of underreporting, which is likely in obese populations[40], by using energy-adjusted values. For PSQI, although the possibility of misreporting, particularly overreporting of insomnia patients due to memory distortion[39], has been known, this misreporting would be independent of the dietary intake assessment using the DHQ, and it should not have biased our results. Although such misreporting is more likely to weaken associations, we still observed an association, suggesting that if present, it had no major influence on our results.

In conclusion, an unhealthy dietary intake (low intake of vegetables and high intake of confectionary) and unhealthy eating habits (more frequent energy drinks and/or sugar-sweetened beverage consumption, breakfast skipping, and irregular eating) were associated with poor sleep quality in Japanese middle-aged female workers. Although more studies are needed to clarify causality, dietary intervention might be a preventive strategy for sleep disturbance.

Acknowledgments: This study was funded by a Grant-in-Aid for Scientific Research (KAKENHI grant no. 22240077) from the Japan Society for the Promotion of Science. We thank the members of the Three-generation Study of Women on Diets and Health Study Group. The members are listed in Kobayashi S, Asakura K, Suga H, Sasaki S, Three-generation Study of Women on Diets and Health Study Group. High protein intake is associated with low prevalence of frailty among old Japanese women: a multicenter cross-sectional study. Nutr J 2013;12:164 (doi: 10.1186/1475-2891-12-164).

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