Discussion

Thyroid dysfunction is associated with body weight and adiposity (1, 2). However, it is controversial whether different levels of the thyroid function within the normal range affect body weight and adiposity. In several previous population-based studies, the TSH level was found to be associated with BMI (3, 5, 6, 11, 19-21); yet, four of the six studies reported a lack of association between the serum TSH level and waist circumference (15, 22-24). These results support our findings in men that the serum TSH level is associated with body weight and BMI, but not waist circumference. Waist circumference is more closely associated with visceral fat than BMI (25), and another study reported that the TSH concentration is associated with the amount of subcutaneous, but not preperitoneal fat (22), indicating that the serum TSH concentration may have a more marked effect on total body fat than on visceral fat.

We found a gender difference in the association between the serum TSH concentration and BMI; a significant association was found in men only. In most previous reports, this association was evaluated in men and women together (4, 12, 19, 21, 23). Among previous studies that evaluated the association between the serum TSH concentration and obesity in men and women separately, three showed no gender differences in the association (3, 6, 26), while one found a significant association exclusively in women (11). The gender differences may have resulted from variations in sex hormones, the TSH concentration, fat distribution or the degree of obesity between men and women. Similarly, the differences between our results and those of previous studies may have resulted from differences in ethnicity. Interestingly, all previous studies from Asian countries showed no significant associations between the serum TSH concentration and BMI in either women only (15, 16) or in both men and women (8, 9). In contrast, the association between the TSH concentration and BMI is stronger in severely obese participants than in mildly obese participants (27). Because the mean BMI values are lower in Asian populations, particularly in Asian women, the degree of obesity, as well as ethnicity, may have affected the differences in the associations found between the genders and between Asian and Western populations.

Although the smoking status is associated with the thyroid function (12) and body weight (13), the interaction between the smoking status and the TSH level on indices of obesity is also controversial. Similar to our results, two studies reported a positive association between BMI and the serum TSH level among nonsmokers only (3, 4). One study indicated that this association was somewhat stronger in female nonsmokers than in female smokers (6). In contrast, another study found the association to be stronger among current smokers than nonsmokers (5). Smokers are reported to have lower serum TSH concentrations (12) and lower BMI measurements (13) than nonsmokers. Since the association between smoking and BMI is strong (3), smoking may mask a potential relationship between the TSH level and BMI.

The mechanisms underlying the association between the TSH level and adiposity have been discussed. A high TSH concentration may be the result of a lower thyroid function, even when the TSH level is within the normal range, which may lead to a lower basal metabolic rate (19) and obesity. Some reports have indicated that the direct action of TSH in stimulating adipogenesis causes body fat accumulation (28, 29). Another hypothesis is that adipose tissue influences the thyroid function, possibly through the effects of leptin (30). Obesity itself may also affect the serum TSH concentration independent of the thyroid function (31). The thyroid function and obesity may affect each other; thus, a prospective study is needed to evaluate whether a lower TSH concentration, even within the normal range, causes obesity and increases cardiovascular risks.

The strengths of this study include the relatively large sample size. Several studies evaluating the association between the serum TSH level and obesity did not fully evaluate the effects of gender, age or smoking status on the association. We evaluated the association both adjusted for these possible confounders and separately according to gender and the smoking status. There are some limitations to this study. First, we evaluated only the serum TSH concentrations. Because we did not evaluate other thyroid hormones, thyroid autoantibodies or thyroid ultrasonography findings, we were unable to exclude patients with latent thyroid disorders and a normal TSH concentration. However, participants with self-reported thyroid disorders and those with an abnormal serum TSH concentration were excluded; thus, almost all participants were considered to be healthy euthyroid participants. Second, the sample included only subjects who were employed. Poor health may exclude some individuals from working; hence, the prevalence of obesity may be lower in our sample than in the general Japanese population. Third, the number of female smokers was so small that we were unable to evaluate the association between the serum TSH level and indices of obesity in women separately according to the smoking status. Similarly, the number of ex-smokers was so small that we were unable to evaluate the effects of smoking cessation on the TSH-obesity association. Fourth, this was a cross-sectional study, and the use of a prospective design may provide additional information regarding the causal relationship between the serum TSH level and obesity.

In conclusion, significant positive associations were observed between the serum TSH concentration and body weight and BMI in men only. In addition, the association between the serum TSH concentration and body weight was influenced by the smoking status. Further prospective studies are needed to evaluate whether a subclinically low thyroid function, even that within the normal serum TSH concentration range, causes obesity and increases cardiovascular risks.

The authors state that they have no Conflict of Interest (COI).

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Associations between Rice, Noodle, and Bread Intake and Sleep Quality in Japanese Men and Women

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Abstract

Background: Previous studies have shown that a diet with a high-glycemic index is associated with good sleep quality. Therefore, we investigated the association of sleep quality with the intake of 3 common starchy foods with different glycemic indexes–rice, bread, and noodles–as well as the dietary glycemic index in a Japanese population.

Methods: The participants were 1,848 men and women between 20 and 60 years of age. Rice, bread, and noodle consumption was evaluated using a self-administered diet history questionnaire. Sleep quality was evaluated by using the Japanese version of the Pittsburgh Sleep Quality Index, and a global score >5.5 was considered to indicate poor sleep.

Results: Multivariate-adjusted odds ratios (95% confidence intervals) for poor sleep across the quintiles of rice consumption were 1.00 (reference), 0.68 (0.49–0.93), 0.61 (0.43–0.85), 0.59 (0.42–0.85), and 0.54 (0.37–0.81) (p for trend = 0.015); those for the quintiles of noodle consumption were 1.00 (reference), 1.25 (0.90–1.74), 1.05 (0.75–1.47), 1.31 (0.94–1.82), and 1.82 (1.31–2.51) (p for trend = 0.002). Bread intake was not associated with sleep quality. A higher dietary glycemic index was significantly associated with a lower risk of poor sleep (p for trend = 0.020).

Conclusion: A high dietary glycemic index and high rice consumption are significantly associated with good sleep in Japanese men and women, whereas bread intake is not associated with sleep quality and noodle consumption is associated with poor sleep. The different associations of these starchy foods with sleep quality might be attributable to the different glycemic index of each food.

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Introduction

Sleep quality is known to be a function of sleep duration and latency [1]. Epidemiological studies have shown that short sleep duration is associated with increased mortality [2,3], poor mood [2,4], chronic health conditions (e.g., obesity and metabolic syndrome) [2,5], cardiovascular disease and diabetes [2,6], hypertension [2,7], and poor self-related health and quality of life [2,8]. Moreover, previous studies have shown that dietary factors affect sleep quality. A cross-sectional study of children younger than 2 years of age showed that the consumption of a meal with a high-glycemic index (GI) in the evening was associated with longer sleep duration [9]. In addition a clinical trial showed that sleep onset latency is reduced by approximately 10 minutes after the consumption of a carbohydrate-rich evening meal with a high-GI compared with an evening meal with a low-GI [10]. These data suggest that sleep quality is influenced by the carbohydrate-based GI of the meals.

The dietary GI of the general Japanese population is approximately 70 [11–13], this is considerably higher than the dietary GI in predominantly Western populations (i.e., European, Australian, and North American), which ranges from 48 to 60 [14–16]. This difference may be due to disparities in the average intakes of different foods that contribute to the GI. Rice is a common starchy food in the Japanese diet, as approximately 70% of the cereals consumed are rice [17], and rice accounts for 59% of the dietary GI [11–13]. However, no studies have evaluated the

associations of rice or other common staple foods such as bread and noodles with sleep quality in a Japanese population.

This study investigated the associations between sleep quality and intake of carbohydrate-based staple foods (i.e., rice, bread, and noodles) as well as the dietary GI and glycemic load (GL) in a Japanese population.

Methods

Participants

The study population comprised 7,306 employees of a factory that produces zippers and aluminum sashes in Toyama Prefecture, Japan. The Industrial Health and Safety Law in Japan requires that employers offer annual health examinations to all of their employees. The present study included data on 2,255 white-collar daytime workers between 20 and 60 years of age. White-collar workers were studied because many blue-collar workers are involved in shift work, making it difficult to evaluate sleep quality.

A questionnaire about diet was completed by 1,977 (88%) of the white-collar daytime workers in 2003, and a questionnaire about sleep was completed by 2003 (94%) of the worker in 2004. In total, 1,858 (82%) of the workers provided complete data on both questionnaires. Ten participants with extremely low or high energy intake (i.e., <500 or >4,000 kcal/day) were excluded from the study. Thus, data on 1,848 white-collar daytime workers (1,164 men and 684 women) were included in the analysis.

Data collection

The annual health examination included a medical history, physical examination, and anthropometric measurements. Body mass index was calculated as weight divided by height squared (kg/m^2). A questionnaire was used to identify health-related behaviors including smoking status (i.e., current, previous, or never), and habitual exercise; habitual exercise was assessed as hours per week spent on leisure time physical activities and was expressed as metabolic equivalent hours per week (MET-h/week).

Dietary assessment and calculation of the dietary GI and GL

A self-administered diet history questionnaire (DHQ) was used to assess dietary habits during the preceding month. [18,19]. The DHQ was developed to estimate the respondents' dietary intake of macronutrients and micronutrients for use in epidemiological studies in Japan. Detailed descriptions of the methods used to calculate dietary intakes and the validity of the DHQ have been reported previously [18,19]. Estimates of dietary intake for 147 food and beverage items, energy, protein, fat, total carbohydrate, and alcohol in 2003 were calculated using an ad hoc computer algorithm developed for the DHQ that was based on the Standard Tables of Food Composition in Japan [20]. The DHQ evaluates the consumption of 19 staple foods (i.e., rice, noodles, and other wheat foods). The intake frequency of each staple food for breakfast, lunch, dinner, and snack/midnight snack in 1 week was evaluated. For rice, the type of rice (i.e., white rice, white rice mixed with barley, white rice with germ, 50% polished rice, 70% polished rice, or brown rice) and serving size (i.e., number and size; cups for children, women, and men, and small and large bowls were defined as 110, 140, 170, 220, and 250 g, respectively) were evaluated. Similarly, the types of bread and noodles were evaluated. Bread was classified as white bread, buttered bread, cake bread, bread containing cream and sweet bean paste, pizza, *okonomiyaki* (Japanese "pizza," which contains shredded cabbage and dough cooked in a frying pan), or Japanese-style pancakes (small pancakes containing flour, sugar, and egg, cooked in a frying pan). Noodles were classified as Japanese noodles (i.e., buckwheat and Japanese white noodles), instant noodles, Chinese noodles, or pasta [12]. The DHQ also includes the frequencies of skipping breakfast, lunch, dinner per week. Of the 147 food and beverage items included in the DHQ, 6 (4.1%) are alcoholic beverages, 8 (5.4%) contain no available carbohydrates, and 63 (42.9%) contain less than 3.5 g available carbohydrate per serving. Therefore, the dietary GI and GL were calculated on the basis of the remaining 70 items [11,21]. The GI databases used were an international table of GI [22], a report on the GI values of Japanese foods [23], a report on GI values published after the publication of the international GI tables [24], and an online database provided by the Sydney University Glycemic Index Research Service [25]. The GIs of all foods in the DHQ have been published elsewhere [11]. Although there are concerns regarding the utility of the GI for mixed meals (i.e., overall diet) [26,27], many studies have shown that the GI of mixed meals can be predicted on the basis of the GI value of each of the component foods [28]. We calculated the dietary GI as the sum of the percentage contribution of each food multiplied by their respective GI values. Dietary GL was calculated by multiplying the dietary GI by the total daily carbohydrate intake and dividing by 100. We used energy-adjusted values calculated using the density method (per 1,000 kcal) for GL [21]. The reproducibility and relative validity of the dietary GI and GL assessed using the DHQ have been reported elsewhere [21].

Sleep assessment

Sleep quality in the previous month was assessed by using the Japanese version of the Pittsburgh Sleep Quality Index questionnaire (PSQI-J) [29], which was developed from the original questionnaire, the PSQI [1]. In brief, the PSQI-J is a standardized self-administered questionnaire for assessing sleep quality that includes the following 7 components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is weighted equally on a scale of 0 to 3, and the scores for each component are then summed to yield a PSQI-J global score ranging from 0 to 21, higher scores indicate poorer sleep quality. Participants completed the PSQI-J at home in 5–10 minutes, and the responses were then reviewed by a well-trained nurse.

Statistical analysis

When the PSQI-J component scores of the male and female participants were compared, sleep duration was significantly shorter in men than in women ($p = 0.011$); however, there were no significant differences in the other component scores including the PSQI-J global score between sexes. Therefore, all analyses were performed in the whole population, (i.e., not stratified by sex). In this study, we used energy density values for macronutrients and alcohol (% of energy [% energy]) and for food intakes (weight per 1000 kcal [g/1000 kcal]).

"Poor sleep," was defined as a PSQI-J global score >5.5 [29]. In a previous study, using a cut-off of 5.5 for the PSQI-J global score provided estimates with a sensitivity and specificity of 85.7% and 86.6% for primary insomnia, 80.0% and 86.6% for major depression, and 83.3% and 86.6% for schizophrenia, respectively [29]. Rice, bread, and noodle intake as well as the GI and GL were categorized into quintiles. Analysis of covariance was used to evaluate the means of each PSQI-J component score adjusted for age, sex and total energy intake. The prevalence of poor sleep in each quintile was compared using the χ^2 test. Odds ratios (ORs) with 95% confidence intervals (95% CIs) for poor sleep were

Table 1. Characteristics of study participants by quintiles of dietary rice, bread, and noodle intake as well as dietary glycemic index and glycemic load ($N = 1,848$).

	Q1 (lowest)	Q2	Q3 (middle)	Q4	Q5 (highest)	p value[a]
Rice (range, g/1,000 kcal)	<132.7	132.7–168.4	168.5–202.2	202.3–249.1	≥249.2	
Male (%)	48.0	54.5	61.7	74.1	76.7	<0.001
Age (years)	37.6 ± 10.1	39.2 ± 9.5	39.9 ± 9.8	39.9 ± 9.9	41.7 ± 10.2	0.001
Body mass index (kg/m^2)	22.4 ± 3.1	22.5 ± 3.0	23.1 ± 3.2	22.9 ± 3.2	23.0 ± 3.0	0.060
Habitual exercise level (METs/week)	1.0 ± 12.1	1.1 ± 8.7	0.6 ± 4.0	0.8 ± 9.5	1.2 ± 8.5	0.823
Current smokers (%)	28.0	26.6	30.4	32.8	37.5	0.026
Skip breakfast (%)	64.5	42.1	35.9	18.3	11.7	<0.001
Total energy intake (kcal/day)	2012 ± 582	2034 ± 491	1942 ± 452	1870 ± 410	1731 ± 414	<0.001
Protein intake (%kcal)	17.9 ± 2.9	17.8 ± 2.6	17.2 ± 2.5	16.5 ± 2.4	15.5 ± 2.4	<0.001
Fat intake (%kcal)	31.8 ± 6.4	29.7 ± 5.4	26.9 ± 5.4	23.8 ± 5.0	19.8 ± 4.9	<0.001
Carbohydrate intake (%kcal)	52.0 ± 7.1	54.5 ± 5.6	57.3 ± 5.4	60.3 ± 5.6	65.3 ± 5.9	<0.001
Alcohol consumption (%kcal)	5.0 ± 7.5	4.4 ± 6.4	4.5 ± 6.6	4.7 ± 5.8	4.1 ± 6.1	0.603
Bread intake (g/1,000 kcal)	44.9 ± 32.2	35.4 ± 24.5	30.2 ± 24.0	20.9 ± 21.8	12.9 ± 18.9	<0.001
Noodle intake (g/1,000 kcal)	47.9 ± 38.1	37.7 ± 30.4	34.4 ± 29.6	37.3 ± 35.7	27.0 ± 29.0	<0.001
Dietary GI	63.8 ± 4.1	66.6 ± 2.7	68.1 ± 2.9	69.7 ± 2.5	71.6 ± 3.0	<0.001
Dietary GL (/1,000 kcal)	141 ± 46	157 ± 40	163 ± 42	171 ± 39	179 ± 44	<0.001
Bread (range, g/1,000 kcal)	0	0.1–14.8	14.9–30.1	30.2–47.2	≥47.3	
Male (%)	73.9	66.1	58.0	58.0	58.5	<0.001
Age (years)	41.1 ± 10.0	39.9 ± 9.8	39.7 ± 9.9	39.5 ± 10.2	38.9 ± 9.8	0.045
Body mass index (kg/m^2)	23.1 ± 3.0	23.0 ± 3.3	22.8 ± 3.2	22.6 ± 3.2	22.5 ± 2.9	0.082
Habitual exercise level (METs/week)	1.3 ± 10.7	0.5 ± 2.4	1.3 ± 10.5	0.7 ± 5.1	0.9 ± 10.3	0.610
Current smokers (%)	40.7	29.5	29.2	26.0	29.2	0.284
Skip breakfast (%)	17.3	10.7	20.6	50.9	72.4	<0.001
Total energy intake (kcal/day)	1811 ± 445	2031 ± 508	1995 ± 508	1927 ± 405	1803 ± 472	<0.001
Protein intake (%kcal)	16.3 ± 3.0	17.0 ± 2.7	17.2 ± 2.7	17.3 ± 2.4	16.8 ± 2.3	<0.001
Fat intake (%kcal)	22.5 ± 7.1	25.7 ± 6.5	27.3 ± 6.5	27.8 ± 6.2	26.6 ± 6.2	<0.001
Carbohydrate intake (%kcal)	59.0 ± 8.6	57.8 ± 7.5	58.2 ± 7.0	57.4 ± 6.5	59.2 ± 6.9	0.003
Alcohol consumption (%kcal)	7.43 ± 8.36	5.15 ± 6.80	3.12 ± 4.61	3.40 ± 4.86	3.28 ± 5.38	<0.001
Rice intake (g/1,000 kcal)	239.1 ± 71.4	206.3 ± 62.9	185.6 ± 61.3	165.1 ± 52.7	154.8 ± 59.5	<0.001
Noodle intake (g/1,000 kcal)	35.3 ± 39.6	35.6 ± 27.5	37.9 ± 29.8	36.1 ± 32.1	34.7 ± 33.0	0.733
Dietary GI	70.1 ± 4.2	68.9 ± 3.6	67.9 ± 3.6	67.3 ± 3.6	67.2 ± 3.6	<0.001
Dietary GL (/1,000 kcal)	160 ± 44	172 ± 45	170 ± 46	161 ± 39	157 ± 42	<0.001
Noodles (range, g/1,000 kcal)	<7.4	7.4–23.3	23.4–36.5	36.6–57.4	≥57.5	
Male (%)	66.0	56.5	62.8	63.3	66.4	0.330
Age (years)	40.9 ± 10.2	39.9 ± 10.0	40.2 ± 9.5	38.6 ± 10.0	39.7 ± 9.9	0.037

Table 1. Cont.

	Q1 (lowest)	Q2	Q3 (middle)	Q4	Q5 (highest)	p value[a]
Body mass index (kg/m^2)	22.9 ± 3.1	22.9 ± 3.1	22.6 ± 2.9	22.7 ± 3.1	23.0 ± 3.4	0.498
Habitual exercise level (METs/week)	0.6 ± 7.2	1.2 ± 10.9	0.8 ± 5.4	1.2 ± 8.7	0.8 ± 9.8	0.864
Current smokers (%)	26.2	27.3	32.2	33.0	27.9	0.801
Skip breakfast (%)	39.5	37.8	28.8	33.4	32.8	0.584
Total energy intake (kcal/day)	1833 ± 455	1945 ± 470	1997 ± 421	1917 ± 509	1861 ± 509	<0.001
Protein intake (%kcal)	16.6 ± 2.9	17.3 ± 2.6	17.0 ± 2.6	16.9 ± 2.8	16.8 ± 2.4	0.006
Fat intake (%kcal)	25.5 ± 6.9	27.4 ± 6.5	26.9 ± 6.6	26.0 ± 6.7	23.9 ± 6.5	<0.001
Carbohydrate intake (%kcal)	58.8 ± 7.6	57.8 ± 6.9	57.1 ± 6.8	58.3 ± 7.3	59.8 ± 7.9	<0.001
Alcohol consumption (%kcal)	4.72 ± 6.90	3.48 ± 5.39	4.86 ± 6.77	4.52 ± 6.38	4.95 ± 6.40	0.012
Rice intake (g/1,000 kcal)	220.1 ± 72.8	188.8 ± 66.3	185.1 ± 64.0	184.3 ± 64.5	174.7 ± 69.0	<0.001
Bread intake (g/1,000 kcal)	25.9 ± 28.2	31.9 ± 27.9	25.6 ± 22.1	27.0 ± 25.0	27.4 ± 26.7	0.008
Dietary GI	70.5 ± 4.0	68.9 ± 3.5	68.5 ± 3.4	67.6 ± 3.4	66.0 ± 3.7	<0.001
Dietary GL (/1,000 kcal)	163 ± 41	166 ± 43	168 ± 41	163 ± 44	159 ± 50	0.094
Dietary GI (range)	<65.3	65.3–67.7	67.8–69.5	69.6–71.6	≥71.7	
Male (%)	52.4	53.5	62.3	69.2	77.5	0.011
Age (years)	38.7 ± 10.3	40.2 ± 9.6	39.1 ± 9.6	39.6 ± 10.0	41.6 ± 9.9	<0.001
Body mass index (kg/m^2)	22.6 ± 3.3	22.7 ± 3.2	22.7 ± 2.9	23.0 ± 3.3	23.1 ± 2.8	0.172
Habitual exercise level (METs/week)	1.3 ± 12.7	0.4 ± 1.9	1.1 ± 10.6	0.6 ± 3.8	1.2 ± 8.9	0.466
Current smokers (%)	27.5	24.9	33.7	31.5	38.3	0.605
Skip breakfast (%)	50.8	39.2	35.5	28.4	18.4	<0.001
Total energy intake (kcal/day)	2017 ± 560	1977 ± 469	1896 ± 449	1858 ± 426	1804 ± 439	<0.001
Protein intake (%kcal)	17.7 ± 2.7	17.9 ± 2.5	16.8 ± 2.3	16.5 ± 2.5	15.7 ± 2.6	<0.001
Fat intake (%kcal)	28.7 ± 6.6	27.9 ± 6.2	26.4 ± 6.4	24.5 ± 6.2	22.3 ± 6.4	<0.001
Carbohydrate intake (%kcal)	56.0 ± 7.4	56.9 ± 6.9	58.8 ± 7.1	59.0 ± 6.9	61.1 ± 7.4	<0.001
Alcohol consumption (%kcal)	4.1 ± 6.3	3.6 ± 5.3	3.6 ± 5.2	5.5 ± 7.5	5.7 ± 7.1	<0.001
Rice intake (g/1,000 kcal)	128.9 ± 55.5	160.4 ± 44.0	187.3 ± 50.2	214.9 ± 46.8	261.7 ± 61.5	<0.001
Bread intake (g/1,000 kcal)	35.5 ± 29.2	32.6 ± 24.8	30.6 ± 26.0	24.5 ± 24.1	14.6 ± 20.6	<0.001
Noodle intake (g/1,000 kcal)	53.9 ± 40.2	46.5 ± 34.0	34.5 ± 28.8	27.3 ± 23.7	17.4 ± 19.3	<0.001
Dietary GL (range,/1,000 kcal)	<128	128–149	150–169	170–194	≥195	
Male (%)	47.8	48.1	64.8	70.3	84.0	<0.001
Age (years)	37.7 ± 9.7	39.4 ± 9.7	40.4 ± 9.6	41.3 ± 10.1	40.4 ± 10.2	<0.001
Body mass index (kg/m^2)	22.0 ± 3.1	22.5 ± 3.1	23.1 ± 3.3	23.1 ± 3.0	23.4 ± 2.9	<0.001
Habitual exercise level (METs/week)	0.4 ± 2.6	0.8 ± 7.7	0.3 ± 1.1	1.3 ± 12.4	2.0 ± 12.3	<0.001
Current smokers (%)	33.7	27.4	27.7	33.9	33.2	0.301
Skip breakfast (%)	58.9	36.8	31.7	24.1	20.9	<0.001

Table 1. Cont.

	Q1 (lowest)	Q2	Q3 (middle)	Q4	Q5 (highest)	p value[a]
Total energy intake (kcal/day)	1472 ± 305	1695 ± 272	1870 ± 302.9	2052 ± 331	2465 ± 450	<0.001
Protein intake (%kcal)	17.5 ± 3.0	17.2 ± 2.6	17.1 ± 2.6	16.8 ± 2.5	15.9 ± 2.4	<0.001
Fat intake (%kcal)	28.2 ± 7.1	26.6 ± 6.4	25.9 ± 6.6	25.1 ± 6.6	24.0 ± 6.4	<0.001
Carbohydrate intake (%kcal)	53.8 ± 7.4	57.6 ± 6.5	58.5 ± 6.8	59.8 ± 6.8	62.1 ± 6.7	<0.001
Alcohol consumption (%kcal)	6.5 ± 8.8	4.3 ± 5.7	4.2 ± 6.1	4.0 ± 5.2	3.5 ± 5.0	<0.001
Rice intake (g/1,000 kcal)	154.3 ± 64.4	189.4 ± 64.3	197.1 ± 66.5	203.4 ± 65.0	208.9 ± 71.6	<0.001
Bread intake (g/1,000 kcal)	30.7 ± 28.5	27.1 ± 24.7	29.8 ± 28.1	24.4 ± 23.5	25.9 ± 25.2	0.004
Noodle intake (g/1,000 kcal)	41.8 ± 35.7	36.3 ± 30.9	31.1 ± 30.9	34.3 ± 31.1	36.1 ± 34.4	<0.001

GI: glycemic index, GL: glycemic load, METs/week: metabolic equivalent hours per week; Q: quintile.
[a]The χ^2 test was used to analyze categorical variables, and linear regression analysis was used to calculate *p*-values for trends for continuous variables.
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calculated using multiple logistic regression analyses. ORs were first adjusted for age (years; continuous) and sex (age- and sex-adjusted model) and then for body mass index (kg/m^2; continuous), smoking status (i.e., current, previous, or never; dummy variable), habitual exercise (MET-h/week; continuous), alcohol consumption (percentage of energy; continuous), frequency of breakfast consumption per week (i.e., 0–3, 4–6, or 7 days/week; dummy variable), rice intake (for the multivariate analyses of bread and noodle intake; continuous), bread intake (for the multivariate analyses of rice and noodle intake; continuous), and noodle intake (for the multivariate analyses of rice and bread intake; continuous). The *p*-values for linear trends were calculated by using the median value of each quintile. Furthermore, each food, dietary GI, and dietary GL was included in the logistic regression analyses as continuous variables, and the ORs for an increment of 1 standard deviation in these variables were calculated. Statistical analyses were performed with Statistical Analysis System version 9.3 (SAS Institute Inc., Cary, NC, USA). The level of significance was set at $p<0.05$.

Ethical considerations

Written informed consent was not obtained from the participants. The design of the present study was approved by the occupational safety and health committee of the subject company, which consisted of employee representatives. Employees were informed of the study design and of the right to refuse to participate in the study in the study documents. Participants who answered the questionnaire were regarded as having consented to the survey. Linkable anonymized data were provided by the company to ensure that individuals would not be identifiable by the researchers. This study was approved by the Institutional Review Committee of Kanazawa Medical University for Ethical Issues.

Results

Table 1 shows the characteristics of the 1,848 study participants stratified by rice, bread, and noodle consumption quintiles as well as dietary GI and GL quintiles. Higher rice intake was significantly associated with older age ($p=0.001$), higher carbohydrate intake ($p<0.001$), higher dietary GI ($p<0.001$), higher GL ($p<0.001$), lower bread intake ($p<0.001$), lower noodle intake ($p<0.001$), lower frequency of breakfast consumption ($p<0.001$), and a lower probability of being a current smoker ($p=0.026$). Body mass index, alcohol consumption, and habitual exercise were not significantly associated with rice intake. Higher bread intake was significantly associated with a higher frequency of breakfast consumption ($p<0.001$), female sex ($p<0.001$), younger age ($p=0.045$), lower alcohol consumption ($p<0.001$), lower rice intake ($p<0.001$), lower dietary GI ($p<0.001$), and lower dietary GL ($p<0.001$). Habitual exercise and smoking status were not significantly associated with bread intake. Higher noodle intake was significantly associated with higher carbohydrate intake ($p<0.001$), higher bread intake ($p=0.008$), higher alcohol consumption ($p=0.012$), lower rice intake ($p<0.001$), and lower dietary GI ($p<0.001$). Sex, smoking status, and frequency of breakfast consumption were not significantly associated with noodle intake. Increasing GI quintiles were significantly associated with older age ($p<0.001$), alcohol consumption ($p<0.001$), higher carbohydrate intake ($p<0.001$), higher rice intake ($p<0.001$), lower bread intake ($p<0.001$), lower noodle intake ($p<0.001$), and lower frequency of breakfast consumption ($p<0.001$). Habitual exercise and smoking status were not significantly associated with the dietary GI.

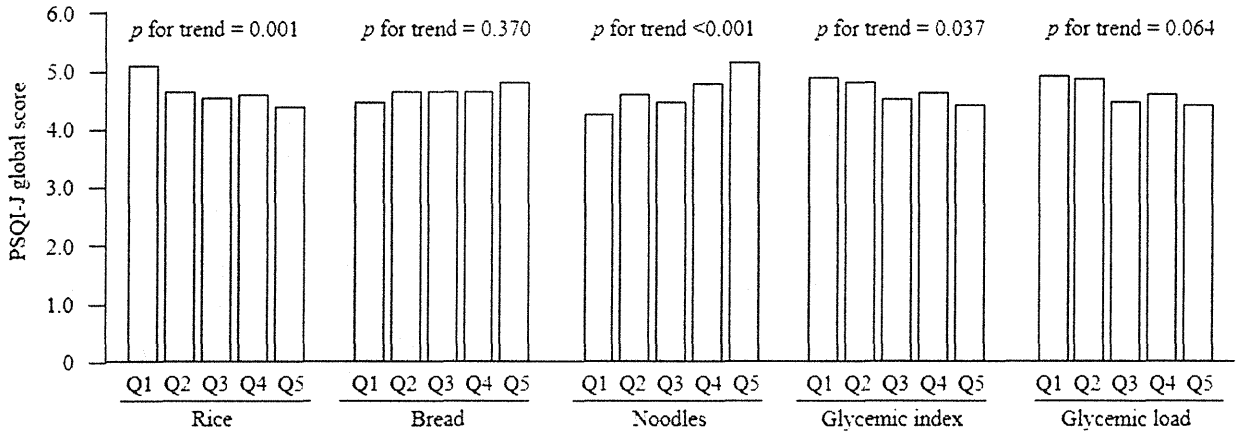

Figure 1. PSQI-J global scores for quintiles of starchy food intake, dietary glycemic index, and glycemic load. Mean PSQI-J global scores were adjusted for age, sex, and total energy intake (kcal/day, continuous), by using the analysis of covariance model. PSQI-J: Japanese version of the Pittsburgh Quality Index; Q: quintile.
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Figure 1 shows the mean PSQI-J global score according to rice, bread, and noodle consumption quintile as well as dietary GI and GL quintiles adjusted for age, sex and total energy intake. Higher rice intake and higher GI were significantly associated with a lower PSQI-J global score ($p = 0.001$ and $p = 0.037$, respectively), and higher noodle intake was significantly associated with a higher PSQI-J global score ($p<0.001$). Table 2 shows sleep duration and PSQI-J component scores according to rice, bread, and noodle consumption quintile as well as dietary GI and GL quintile. Higher rice intake was significantly associated with lower scores for poor sleep duration ($p = 0.003$) but was not associated with any other component of sleep quality. Higher noodle intake was significantly associated with a higher frequency of sleep disturbance ($p<0.001$), higher levels of daytime dysfunction ($p = 0.005$), increased use of sleep medication ($p = 0.008$), poorer subjective sleep quality ($p = 0.021$), and longer sleep latency ($p = 0.049$). A higher dietary GI was significantly associated with lower scores for poor sleep duration ($p = 0.013$) but not with other PSQI-J components. These associations remained even after adjusting for age, sex, and total energy intake (data not tabulated).

The multivariate-adjusted ORs (quintile, 95%CI) for the prevalence of poor sleep across the quintiles of rice intake were 1.00 (reference), 0.68 (0.49–0.93), 0.61 (0.43–0.85), 0.59 (0.42–0.85), and 0.54 (0.37–0.81), respectively, indicating that rice intake had a significant positive association with better sleep (p for linear trend = 0.015) (Table 3). In contrast, the multivariate-adjusted ORs across the quintiles of noodle intake were 1.00 (reference), 1.25 (0.90–1.74), 1.05 (0.75–1.47), 1.31 (0.94–1.82), and 1.82 (1.31–2.51), respectively, indicating that noodle consumption was significantly associated with poor sleep (p for linear trend = 0.002) (Table 3). These associations did not change even after further adjusting for vegetable, meat, and fish intake (data not shown). Dietary GI was also associated with good sleep (p for trend = 0.020), whereas dietary GL was not (p for trend = 0.092).

Discussion

This study evaluated the association between sleep quality and the intake of common starchy foods (i.e., rice, bread, and noodles) as well as the dietary GI and GL in a Japanese population. Rice consumption was positively associated with sleep quality. In contrast, noodle consumption had a significant inverse association with sleep quality. Furthermore, a significant positive relationship between dietary GI and sleep quality was observed. Because rice is a major contributor to the dietary GI among Japanese people, differences between the GI values of rice, bread, and noodles may influence their sleep quality.

The present results show that higher consumption of rice, which is the main contributor to the dietary GI in Japanese foods, and the dietary GI itself are closely associated with a lower PSQI-J global score, i.e., good sleep. In a previous cross-sectional study of children younger than 2 years of age, the consumption of an evening meal with a high-GI was associated with longer sleep duration compared with the consumption of an evening meal with a low-GI [9]. The present results are consistent with these previous findings, because rice intake and the dietary GI were associated with sleep duration but not sleep latency in the present study. In contrast, in a clinical trial of 12 healthy young men, a carbohydrate-based meal with a high-GI was significantly associated with a shortening of sleep onset latency compared with a meal with a low-GI and was most effective when consumed 4 hours before going to sleep [10]. We assessed daily rice consumption and the dietary GI, but not rice consumption or the GI of evening meals, which may have affected the present results.

A high dietary GI may affect sleep quality via the effects of tryptophan (TRP) and melatonin [30–36]. A previous study showed that both carbohydrate intake and a meal with a high-GI increase the ratio of TRP to other large neutral amino acids (TRP/LNAA) after the meal, compared with a meal with a low-GI [37]. LNAA and TRP are competitively transported across the blood–brain barrier, and a higher TRP/LNAA ratio would result in more TRP being transported into the brain. In the brain, TRP is converted into serotonin and then to melatonin, which induces sleep [30–36].

Similar to the dietary GI, rice consumption was significantly associated with a low PSQI-J global score in the present study. Rice, especially white rice, is a common starchy food eaten by Japanese people; it accounts for approximately 28% of the daily energy intake and 70% of cereal intake [17]. Furthermore, white rice accounts for 59% of the dietary GI for in the Japanese diet [11–13]. Therefore, rice intake would affect sleep quality via the effect of the GI. In addition, rice contains high levels of melatonin [38], which may also favor good sleep.

Table 2. PSQI-J component scores by quintiles of rice, bread, and noodle intake as well as dietary glycemic index and glycemic load.

	Q1 (lowest)	Q2	Q3 (middle)	Q4	Q5 (highest)	P value[a]
Rice						
Sleep duration (hours)	6.2 ± 0.9	6.3 ± 0.8	6.4 ± 0.8	6.4 ± 0.9	6.4 ± 0.8	0.008
PSQI-J						
Subjective sleep quality	1.26 ± 0.69	1.16 ± 0.64	1.18 ± 0.68	1.15 ± 0.64	1.08 ± 0.63	0.063
Sleep latency	0.72 ± 0.77	0.70 ± 0.74	0.70 ± 0.77	0.67 ± 0.74	0.67 ± 0.75	0.630
Sleep duration	1.04 ± 0.84	0.91 ± 0.74	0.81 ± 0.70	0.84 ± 0.75	0.79 ± 0.73	0.003
Habitual sleep efficiency	0.13 ± 0.50	0.06 ± 0.25	0.07 ± 0.31	0.08 ± 0.34	0.09 ± 0.40	0.787
Sleep disturbances	0.93 ± 0.51	0.94 ± 0.51	0.90 ± 0.50	0.89 ± 0.49	0.86 ± 0.51	0.290
Use of sleep medication	0.08 ± 0.40	0.04 ± 0.26	0.05 ± 0.33	0.06 ± 0.36	0.03 ± 0.29	0.773
Daytime dysfunction	0.99 ± 0.73	0.91 ± 0.67	0.87 ± 0.74	0.96 ± 0.72	0.86 ± 0.71	0.211
Bread						
Sleep duration (hours)	6.4 ± 0.8	6.4 ± 0.8	6.3 ± 0.8	6.3 ± 0.8	6.2 ± 0.8	0.007
PSQI-J						
Subjective sleep quality	1.13 ± 0.69	1.17 ± 0.60	1.14 ± 0.64	1.17 ± 0.65	1.22 ± 0.69	0.407
Sleep latency	0.71 ± 0.76	0.71 ± 0.75	0.64 ± 0.73	0.69 ± 0.73	0.72 ± 0.78	0.570
Sleep duration	0.77 ± 0.75	0.83 ± 0.74	0.90 ± 0.74	0.92 ± 0.78	0.97 ± 0.78	0.003
Habitual sleep efficiency	0.07 ± 0.30	0.10 ± 0.39	0.10 ± 0.37	0.09 ± 0.41	0.08 ± 0.37	0.706
Sleep disturbances	0.88 ± 0.50	0.94 ± 0.52	0.93 ± 0.50	0.89 ± 0.50	0.90 ± 0.51	0.383
Use of sleep medication	0.05 ± 0.33	0.05 ± 0.32	0.05 ± 0.33	0.04 ± 0.29	0.06 ± 0.38	0.905
Daytime dysfunction	0.89 ± 0.72	0.94 ± 0.71	0.97 ± 0.73	0.91 ± 0.71	0.89 ± 0.69	0.491
Noodles						
Sleep duration (hours)	6.38 ± 0.83	6.32 ± 0.81	6.37 ± 0.80	6.30 ± 0.86	6.27 ± 0.82	0.275
PSQI-J						
Subjective sleep quality	1.11 ± 0.66	1.14 ± 0.66	1.13 ± 0.63	1.22 ± 0.68	1.23 ± 0.65	0.021
Sleep latency	0.64 ± 0.72	0.65 ± 0.70	0.67 ± 0.75	0.72 ± 0.79	0.79 ± 0.78	0.049
Sleep duration	0.82 ± 0.75	0.91 ± 0.76	0.82 ± 0.73	0.90 ± 0.77	0.94 ± 0.78	0.114
Habitual sleep efficiency	0.05 ± 0.28	0.07 ± 0.37	0.10 ± 0.39	0.09 ± 0.39	0.12 ± 0.40	0.069
Sleep disturbances	0.81 ± 0.52	0.94 ± 0.51	0.87 ± 0.50	0.95 ± 0.49	0.96 ± 0.50	<0.001
Use of sleep medication	0.02 ± 0.23	0.03 ± 0.27	0.03 ± 0.28	0.06 ± 0.36	0.10 ± 0.46	0.008
Daytime dysfunction	0.83 ± 0.72	0.91 ± 0.70	0.92 ± 0.72	0.90 ± 0.71	1.03 ± 0.70	0.005
Dietary GI						
Sleep duration (hours)	6.3 ± 0.8	6.3 ± 0.8	6.3 ± 0.8	6.4 ± 0.8	6.4 ± 0.8	0.025
PSQI-J						
Subjective sleep quality	1.21 ± 0.68	1.17 ± 0.62	1.16 ± 0.65	1.17 ± 0.70	1.11 ± 0.63	0.279
Sleep latency	0.73 ± 0.76	0.74 ± 0.76	0.64 ± 0.76	0.66 ± 0.74	0.69 ± 0.72	0.382

Table 2. Cont.

	Q1 (lowest)	Q2	Q3 (middle)	Q4	Q5 (highest)	P value[a]
Sleep duration	0.98 ± 0.78	0.91 ± 0.78	0.88 ± 0.74	0.84 ± 0.76	0.79 ± 0.73	0.013
Habitual sleep efficiency	0.09 ± 0.38	0.10 ± 0.42	0.09 ± 0.36	0.08 ± 0.34	0.07 ± 0.36	0.923
Sleep disturbances	0.93 ± 0.51	0.94 ± 0.50	0.88 ± 0.51	0.91 ± 0.50	0.87 ± 0.50	0.204
Use of sleep medication	0.06 ± 0.32	0.09 ± 0.45	0.03 ± 0.29	0.05 ± 0.35	0.02 ± 0.21	0.065
Daytime dysfunction	0.96 ± 0.71	0.91 ± 0.71	0.88 ± 0.71	0.94 ± 0.72	0.89 ± 0.71	0.561
Dietary GL						
Sleep duration (hours)	6.3 ± 0.8	6.3 ± 0.8	6.3 ± 0.8	6.4 ± 0.8	6.4 ± 0.8	0.067
PSQI-J						
Subjective sleep quality	1.15 ± 0.66	1.19 ± 0.66	1.13 ± 0.62	1.15 ± 0.64	1.20 ± 0.71	0.515
Sleep latency	0.71 ± 0.75	0.76 ± 0.77	0.62 ± 0.74	0.67 ± 0.73	0.71 ± 0.77	0.159
Sleep duration	0.94 ± 0.81	0.91 ± 0.74	0.87 ± 0.72	0.82 ± 0.76	0.85 ± 0.77	0.241
Habitual sleep efficiency	0.12 ± 0.46	0.09 ± 0.39	0.07 ± 0.34	0.09 ± 0.35	0.07 ± 0.30	0.370
Sleep disturbances	0.87 ± 0.50	0.92 ± 0.48	0.86 ± 0.52	0.96 ± 0.48	0.91 ± 0.53	0.041
Use of sleep medication	0.04 ± 0.33	0.07 ± 0.37	0.05 ± 0.32	0.06 ± 0.40	0.02 ± 0.20	0.388
Daytime dysfunction	0.94 ± 0.72	0.88 ± 0.70	0.89 ± 0.71	0.92 ± 0.71	0.96 ± 0.73	0.537

PSQI-J, the Japanese version of the Pittsburgh Sleep Quality Index; GI, glycemic index; GL, glycemic load; Q: quintile.

[a]Linear regression analyses were used to assess the linear trends between sleep duration and each PSQI-J component score across the quintiles of starchy food intake, dietary GI, and dietary GL by using the median value of each quintile.

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Table 3. ORs for the prevalence of poor sleep[a] in each quintile of dietary rice, bread, and noodle intake as well as dietary glycemic index and glycemic load.

	Q1 (lowest)	Q2	Q3 (middle)	Q4	Q5 (highest)	p^b value	Continuous[c] (1 SD increment)	*P* value
Rice								
Prevalence of poor sleep (%)	39.0	30.7	28.0	28.0	26.0	<0.001		
Age-, sex-adjusted OR	1	0.69	0.60	0.59	0.54	0.001	0.85	0.010
(95%CI)	(reference)	(0.51, 0.94)	(0.44, 0.82)	(0.43, 0.81)	(0.39, 0.74)		(0.76, 0.96)	
Multivariate-adjusted OR[d]	1	0.68	0.61	0.59	0.54	0.015	0.87	0.045
(95%CI)	(reference)	(0.49, 0.93)	(0.43, 0.85)	(0.42, 0.85)	(0.37, 0.81)		(0.76, 1.00)	
Bread								
Prevalence of poor sleep (%)	27.7	30.1	29.5	31.3	33.3	0.284		
Age-, sex-adjusted OR	1	1.13	1.10	1.19	1.31	0.545	1.06	0.312
(95%CI)	(reference)	(0.82, 1.55)	(0.80, 1.51)	(0.87, 1.63)	(0.96, 1.78)		(0.95, 1.19)	
Multivariate-adjusted OR[d]	1	1.14	1.04	1.05	1.14	0.921	1.01	0.885
(95%CI)	(reference)	(0.81, 1.60)	(0.74, 1.47)	(0.74, 1.50)	(0.79, 1.63)		(0.89, 1.14)	
Noodle								
Prevalence of poor sleep (%)	24.6	30.5	26.4	31.3	39.0	<0.001		
Age-, sex-adjusted OR	1	1.35	1.10	1.38	1.95	<0.001	1.21	0.001
(95%CI)	(reference)	(0.97, 1.87)	(0.79, 1.53)	(1.00, 1.91)	(1.42, 2.67)		(1.09, 1.35)	
Multivariate-adjusted OR[d]	1	1.25	1.05	1.31	1.82	0.002	1.21	<0.001
95%CI)	(reference)	(0.90, 1.74)	(0.75, 1.47)	(0.94, 1.82)	(1.31, 2.51)		(1.09, 1.35)	
Dietary GI								
Prevalence of poor sleep (%)	35.4	34.3	24.7	28.9	28.5	0.016		
Age-, sex-adjusted OR	1	0.96	0.59	0.73	0.72	0.006	0.82	<0.001
(95%CI)	(reference)	(0.71, 1.30)	(0.43, 0.81)	(0.54, 1.00)	(0.52, 0.99)		(0.74, 0.91)	
Multivariate-adjusted OR[d]	1	0.96	0.60	0.77	0.77	0.020	0.85	0.006
(95%CI)	(reference)	(0.71, 1.31)	(0.44, 0.84)	(0.56, 1.07)	(0.55, 1.07)		(0.76, 0.95)	
Dietary GL								
Prevalence of poor sleep (%)	31.1	30.0	25.8	31.1	33.9	0.379		
Age-, sex-adjusted OR	1	0.96	0.78	1.02	1.14	0.215	1.02	0.721
(95%CI)	(reference)	(0.70, 1.32)	(0.56, 1.08)	(0.74, 1.40)	(0.83, 1.57)		(0.91, 1.14)	
Multivariate-adjusted OR[d]	1	0.98	0.79	1.09	1.27	0.092	1.07	0.284
(95%CI)	(reference)	(0.71, 1.35)	(0.56, 1.11)	(0.77, 1.54)	(0.88, 1.82)		(0.95, 1.21)	

GI, glycemic index; GL, glycemic load, CI, confidence interval; SD, standard deviation; OR: odds ratio; PSQI-J: Japanese version of the Pittsburgh Sleep Quality Index; Q: quintile;

[a]A PSQI-J global score >5.5 indicate poor sleep.

[b]The χ^2 test was used to analyze the prevalence of poor sleep, and logistic regression analysis was used to assess the linear trends of ORs by using the median value of each quintile.

[c]Differences of SD for rice, bread, noodles, dietary GI, and dietary GL were 69.1 g/1,000 kcal, 26.2 g/1,000 kcal, 32.8 g/1,000 kcal, 3.9, and 43.8/1,000 kcal, respectively.

[d]Multivariate models included age (continuous), sex (continuous), Body mass index (kg/m^2; continuous), smoking status (i.e., current, previous, or never; dummy variable), habitual exercise (MET-h/week; continuous), alcohol consumption (percentage of energy; continuous), frequency of breakfast consumption (i.e., 0–3, 4–6, or 7 days/week; dummy variable), rice intake (for the multivariate analyses of bread and noodles; continuous), bread intake (for the multivariate analyses of rice and noodles; continuous), and noodle intake (for the multivariate analyses of rice and bread; continuous).

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In contrast, bread intake was not significantly associated with sleep quality, whereas noodle intake was significantly associated with poor sleep. The GIs of the breads and noodles used in the analyses ranged from 51 to 74 and 46 to 47, respectively; these values are lower than 77, which is the GI of Japanese white rice [11]. In a previous study, the TRP/LNAA ratio increased by 17% after a mixed-macronutrient meal with a high-GI (GI = 70) and was higher than that after a mixed-macronutrient meal with a low-GI (GI of 50; 8% increase), even though the amount of carbohydrates was the same in both meals (66.5% energy) [37]. Although noodles are major starchy foods, the GI of noodles is too low to increase the postprandial TRP/LNAA ratio. Furthermore, noodle intake was inversely associated with rice intake. In the present study, higher noodle intake was associated with poor sleep even after adjusting for rice intake. However, it is possible that the adjustment using statistical models is insufficient; thus, the low sleep quality of subjects with higher noodle intake may be due to a lower rice intake. An interventional study is required to investigate the differences in the associations of starchy foods with sleep quality.

Shorter sleep duration is associated with a relative increase and decrease in calories derived from fat and carbohydrates, respectively [39]. In Japan, breakfast often consists of foods low in fat but high in carbohydrates and fiber. Japanese people who eat breakfast generally consume more rice [40]. People with good sleep quality tend to eat breakfast, which may affect the association between rice intake and sleep quality. However, in the present study, lower rice intake was significantly associated with poor sleep even after adjusting for the frequency of breakfast consumption.

In this study, diets with high rice intake and a high GI were significantly associated with good sleep; however, such diets are also reported to be associated with several health problems including obesity, diabetes mellitus, cardiovascular disease, and some cancers [11–16,41–43]. Furthermore, obesity induced by the long-term consumption of a diet with a high-GI may cause sleep apnea syndrome, which may also affect sleep quality. Accordingly, the association between the long-term consumption of meals with a high-GI and sleep quality should be analyzed in greater detail.

One of the strengths of the present study is that we examined rice consumption in a large Japanese population. Japanese people consume approximately 10 times more rice than European and North American people [44]. Thus, it is important to evaluate the association between rice and sleep in people with high rice consumption. Further, this is the first study to investigate the association between rice, bread, and noodle consumption and sleep quality. In addition, the GI and GL were calculated by using responses to a validated questionnaire [21]. Nevertheless, the present study also has several limitations. First, we restricted the final study population to white-collar workers; white-collar work is reported to be strongly correlated with poor sleep quality [45]. Compared with the general Japanese population, the study participants had a similar mean PSQI-J global score but shorter mean sleep duration [46]. Therefore, the results of this study cannot necessarily be generalized to the overall Japanese population. Second, sleep quality is reported to be related to physiological actions and eating behaviors such as skipping meals, eating speed, and watching television during meals [47]; we did not have data on these variables. Third, the DHQ and PSQI-J were evaluated approximately 1 year apart. However, lifestyle factors such as dietary habits and sleep quality are unlikely to change much in 1 year among steadily employed middle-aged people. Fourth, women are reported to have difficulty sleeping at the beginning and end of their menstrual cycle [48,49]; in the present study, we did not obtain data on the menstrual cycles of the female participants. However, when we compared the PSQI-J component and global scores of men and women, nearly identical trends were observed (data not shown). Fifth, the dietary GI and rice consumption data used in this study were daily values, not evening values. As mentioned in the preceding text, the consumption of a meal with a high-GI within 4 hours of going to bed may be an effective way of facilitating sleep [10]. In the present study, the dietary GI and rice intake were significantly associated with sleep duration but not sleep latency. However, dietary intake at dinner may be more closely associated with sleep quality.

In conclusion, the present study indicate that high consumption of rice and a high dietary GI are associated with good sleep, especially good sleep duration. Meanwhile, higher noodle consumption is associated with poor sleep quality. The effects of starchy foods on sleep may differ according to their GI values. Diets with a high-GI, especially those with high rice intake, may contribute to good sleep. Nevertheless, further interventional studies are required to determine appropriate carbohydrate intake during the evening meal to facilitate good sleep.

Author Contributions

Conceived and designed the experiments: SY MS K. Nakamura YM KM MN HN. Performed the experiments: MS K. Nakamura YM KM MN KY MI TK YN HN. Analyzed the data: SY. Contributed reagents/materials/analysis tools: SY MS K. Nakamura YM KM MN KY MI TK YN K. Nogawa YS SS HN. Wrote the paper: SY MS.

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The Effect of Age on the Relationships between Work-related Factors and Heavy Drinking

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Abstract: The Effect of Age on the Relationships between Work-related Factors and Heavy Drinking: Yuko MORIKAWA, *et al.* Department of Epidemiology and Public Health, Kanazawa Medical University—Aims: The aim of this study was to investigate age-related differences in the relationship between work-related factors and heavy drinking. **Methods:** This study in 3,398 male workers at a factory in Japan examined data on heavy drinking, defined as an alcohol consumption >40 g/day, and work-related factors including occupation, shift work, and job stress evaluated using the Japanese version of the Karasek's Job Content Questionnaire (JCQ). In the present cross-sectional study, alcohol consumption was assessed using a self-administered diet history questionnaire (DHQ). **Results:** The prevalence of heavy drinkers in the study population was 15.5% and rose with increasing age. An increase in the odds ratio (OR) for heavy drinking was observed consistently in blue-collar workers compared with white-collar workers in all age groups. In subjects aged 20–29 years, shift work had also increased the OR for heavy drinking. In subjects aged 40–49 years, the two groups with a lower decision latitude had an increased OR compared with the highest group. In subjects aged 20–29 years, the age adjusted OR for individuals who received the lowest level of social support in the workplace was increased significantly compared with the highest group (4.22 [95%CI, 1.07–16.62]). On the other hand, social support showed a positive association with heavy drinking in subjects aged 40–49 and 50–59 years. Job demand was not related to heavy drinking in any of the age groups. **Conclusions:** Our findings suggest that occupation and work schedule are related to alcohol use more apparently in a younger age group and that psychosocial factors are related to enhancement or prevention of alcohol use.
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Key words: Alcohol drinking, Age group, Stress, Workplace

Excessive intake of alcohol has been linked to major morbidities, including neuropsychiatric disorders, gastrointestinal illness, cancer, and cardiovascular disease, as well as both intentional and unintentional injury[1]. The WHO[2] warned that alcohol is the leading risk factor for death in males aged 15–59 years, which represents the working population. Numerous studies have investigated the factors related to excessive drinking or problematic drinking and have shown that socioeconomic status such as educational attainment, family history of alcohol dependence, anxiety traits and cultural norms for alcohol use may contribute to drinking problems[3–9].

For work-related factors, heavy drinking or problem drinking behavior was more prevalent in manual workers and lower occupational classes[6, 10–12]. Although the effects of shift work on alcohol consumption have not been established, we have reported previously that shift work increased the prevalence of heavy drinking in middle-aged male workers when accompanied by sleep problems[13]. Studies that have examined the relationship between psychosocial work characteristics and alcohol consumption have generally produced

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equivocal findings. Some studies investigated the risk of high job demands or high-strain work on heavy drinking[14], whereas others examined whether passive work was a risk factor for heavy drinking[15]. Several studies failed to show a significant relationship between job stress and heavy drinking[16–18]. Social support in the workplace may both encourage and supress heavy drinking[19]. The effects of effort-reward imbalance have also been shown to be equivocal[16, 17].

Such inconsistencies may be caused by differences in the age distribution of the study populations, as it is known that drinking patterns change with increasing age[20]. Some studies have reported that younger adults show higher enhancement, social and coping tendencies associated with anxiety motives for drinking compared with older adults[21, 22]. To date, however, only a few relevant cross-sectional studies, one from Japan and the other from Finland, have reported age-related differences in the effects of work characteristics on alcohol consumption[17, 23]. Although the measures evaluating work characteristics and the relationships between job stress and heavy drinking were different between two studies, both studies concluded that job stressors were not consistently associated with heavy drinking.

For epidemiological study, alcohol consumption must be determined as accurately as possible. However, it is suggested that people drink more alcohol than indicated by self-reported survey[24, 25]. Underestimation of alcohol consumption may affect the association of heavy drinking and work-related factors. To minimize the bias, it is important to use questionnaires that have been validated with respect to measurement of alcohol intake. However, no studies on age-related differences in the effects of work characteristics on alcohol consumption have used such validated questionnaires.

In the present cross-sectional study, alcohol consumption was assessed using a self-administered diet history questionnaire (DHQ)[26], which has been validated with respect to the accuracy of measurement of alcohol consumption[27]. We investigated the associations of work-related factors including occupation, work schedule and job strain on heavy drinking in male factory workers in Japan stratified according to age. We investigated only male subjects, as the prevalence of heavy drinking in female workers was too small for the purposes of the study. Job strain was evaluated using the Japanese version of the Karasek's Job Content Questionnaire (JCQ)[28].

Methods

The study was approved by the Ethics Committee for Epidemiologic Research at the Kanazawa Medical University (Ishikawa, Japan).

Study subjects

The study population consisted of male workers employed at a factory that produces light-metal products. In 2002, a self-administered survey on job stress, depressive score, occupational category and work schedule was carried out on 7,271 employees (4,703 males, 2,568 females). One year later, a self-administered survey on alcohol consumption, other health-related behaviors, and history of medical treatment was also carried out. The data of both surveys were merged and used for analysis. Of the 4,703 subjects, 3,398 (72.3%) provided valid responses in the two surveys. The mean age (SD) of these 3,398 subjects was 41.8 (10.6) years. After excluding 610 nondrinkers, 2,788 subjects were included in the analysis. Subjects who did not drink were excluded because they may have had specific reasons for not consuming alcohol, such as severe illness or constitutional factors.

Occupation, work schedule, psychosocial work characteristics and other social variables

Occupational status was categorized into three groups: white-collar, blue-collar engaged in fixed-day work, and blue-collar engaged in shift work. White-collar workers included administrators, managers, clerical workers and professional workers, while blue-collar work included operation of machinery, processing or construction of aluminium products, and other manual work. Shift work included two- and three-shift rosters.

Individual work characteristics including job demands, job control, and worksite support were determined using the Japanese version of the Karasek's JCQ which is based on a job demand-control model[26]. The depression score was assessed using a self-rated scale, the Center for Epidemiological Studies Depression Scale (CESD)[29].

Marital status was divided into "married" and "not married".

Alcohol consumption, smoking, and medical treatment

In accordance with the Japanese Ministry of Health, Labor, and Welfare guidelines, "21st Century Measures for National Health Promotion (2nd)", heavy drinking was defined as an alcohol intake exceeding 40 g/day[30]. Alcohol intake during the preceding month was assessed using DHQ[26]. The DHQ was developed originally to estimate the dietary intakes of macronutrients and micronutrients in epidemiological studies in Japan. The DHQ includes questions about the nature of alcohol intake, including weekly or monthly frequency, and the amount and type of alcohol consumed on each occasion. The mean alcohol intake per day was calculated over a one-month

period using an ad hoc computer algorithm developed for the DHQ, which was based on the Standard Tables of Food Composition in Japan. The validity of alcohol consumption derived from the DHQ was confirmed using 16-day semi-weighed dietary records as a reference[27]. The subjects were classified as current-smokers, non-smokers or ex-smokers based on their smoking habits. Medical treatment history for hypertension, dyslipidemia and diabetes mellitus was also recorded.

Statistical analysis

The data of the four age groups (20–29, 30–39, 40–49 and 50–59 years) were analyzed separately. A multiple logistic regression model was used to evaluate the effects of work-related factors on heavy drinking. The factors included in the model were occupational category (white-collar work/blue-collar work engaged in fixed-day work/blue-collar work engaged in shift work) and psychosocial work characteristics (job demand, decision latitude, and social support in the workplace). Potential confounding factors in the model included age (continuous variable), marital status (single/married), current smoking (no/yes), depression score, and the use of medication for hypertension, diabetes or dyslipidemia (no/yes). Analysis of the data of subjects aged 20–29 years did not include the use of medication in the model, as only four workers were taking these drugs. The data on work characteristics, job demand, decision latitude, social support in the workplace and depression scores were grouped into tertiles.

Statistical analyses were performed using IBM SPSS 19.0 (IBM Corp., Armonk, NY, USA). All probability values were two-tailed with the level of statistical significance defined as $p<0.05$.

Results

Table 1 summarizes the distribution of sociodemographic factors, work-related factors, and the amount of alcohol consumed, grouped according to age. The prevalence of heavy drinkers was 15.5% (n=525) in the study population and rose with increasing age: 20–29 years, 4.9% (n=29); 30–39 years, 10.4% (n=80); 40–49 years, 19.5% (n=197); 50–59 years, 21.3% (n=219).

Table 2-1 and Table 2-2 present the findings of a multiple logistic regression analysis that assessed the correlation between heavy drinking and sociodemographic factors, depression score and work-related factors after adjustment for age. Current smoking was related significantly to heavy drinking in all the age groups. Medical treatment, marital status and depression scale (CESD) were not related to heavy drinking in any of the age groups. Compared with the white-collar group, the OR for heavy drinking was increased in the two blue-collar groups in all age groups. In the group aged 20–29 years, the OR ratio for blue-collar workers engaged in shift work was increased significantly (OR 4.79 [95%CI, 1.49–15.44]) compared with white-collar workers. Among the other three age groups, there were significant differences in ORs between white-collar and blue-collar groups, although shift work did not influence heavy drinking.

The relationship between psychosocial work characteristics and heavy drinking was different in the four age groups. In subjects aged 40–49 years, lower decision latitude increased the frequency of heavy drinking, with the OR of the intermediate group (OR 1.90 [95%CI, 1.24–2.92]) and the lowest group (OR 1.82 [95%CI, 1.17–2.84]) being increased significantly. In subjects aged 20–29 years, low social support in the workplace was related to heavy drinking (OR 5.91 [95%CI, 1.28–27.32]). On the other hand, social support encouraged heavy drinking in subjects aged 50–59 years.

Table 3 summarizes the relationships between occupational factors and heavy drinking after adjustment for age, marital status, medical treatment, smoking, and all the variables listed in the table. An increased OR was observed consistently in blue-collar workers compared with white-collar workers in all age groups. In subjects aged 20–29, shift work showed an additional relationship with heavy drinking. For psychosocial work characteristics, decision latitude correlated significantly with heavy drinking in subjects aged 30–39 or 40–49 years, although these two age groups showed opposite direction. In subjects aged 30–39 years, the two groups with lower decision latitude had decreased ORs compared with the highest group. In contrast, in subjects aged 40–49 years, the two groups with lower decision latitude had increased ORs compared with the highest group. The association between social support and heavy drinking changed from a negative to a positive relationship with increasing age. In subjects aged 20–29 years, the OR of the group receiving the lowest level of social support in the workplace was increased significantly (OR 4.70 [95%CI, 1.15–19.28]) compared with the highest group. On the other hand, social support showed a positive association with heavy drinking in subjects aged 40–49 or 50–59 years. Job demand was not related with heavy drinking in any of the age groups.

Discussion

We carried out a cross-sectional study to investigate the effect of age on the association between work-related factors and alcohol consumption, and found age-related differences in the relationship between work-related factors and heavy drinking. Occupation

Table 1. Distribution of sociodemographic factors, work-related factors and amount of alcohol consumed according to age in 2003

	All	20–29 years	30–39 years	40–49 years	50–59 years
Number	3,398	592	768	1,011	1,027
Age in years, (mean ± sd)	41.8 ± 10.6	25.6 ± 2.8	34.4 ± 2.9	44.7 ± 2.7	54.0 ± 2.6
Occupation[a)], n (%)					
White-collar	1,274 (37.5)	186 (31.4)	344 (44.8)	391 (38.7)	362 (35.2)
Blue-collar	2,115 (62.2)	406 (68.6)	424 (55.2)	620 (61.3)	665 (64.8)
Shift work[a)], n (%)					
Day work	2,554 (75.2)	374 (63.2)	575 (74.9)	787 (77.8)	818 (79.6)
Shift work	844 (24.8)	218 (36.8)	193 (25.1)	224 (22.2)	209 (20.4)
Score of JCQ[a)], (mean ± sd)					
Decision latitude	65.9 ± 9.9	65.3 ± 10.4	67.3 ± 9.3	65.6 ± 9.7	65.4 ± 10.3
Job demand	33.0 ± 5.1	33.3 ± 5.5	34.3 ± 5.4	33.0 ± 4.8	31.8 ± 4.7
Social support	22.6 ± 3.3	23.9 ± 3.5	22.7 ± 3.3	22.1 ± 3.2	22.3 ± 3.1
Depression score (0–51)[a)], (mean ± sd)	14.9 ± 7.7	15.0 ± 7.7	14.9 ± 8.5	15.2 ± 7.7	14.4 ± 7.0
Marital status, n (%)					
Single	29 (29.0)	468 (79.1)	256 (33.3)	162 (16.0)	100 (9.7)
Married	986 (71.0)	124 (20.9)	512 (66.7)	849 (84.0)	927 (90.3)
Smoking, n (%)					
Never	1,152 (33.9)	255 (43.1)	300 (39.1)	295 (29.2)	302 (29.4)
Current smoker	1,751 (51.5)	298 (50.3)	380 (49.5)	559 (55.3)	514 (50.0)
Ex-smoker	495 (14.6)	39 (6.6)	88 (11.5)	157 (15.5)	211 (20.5)
Medical treatment, n (%)					
No	3,057 (90.0)	588 (99.3)	737 (96.0)	920 (91.0)	812 (79.1)
Yes	341 (10.0)	4 (0.7)	31 (4.0)	91 (9.0)	215 (20.9)
Alcohol consumption per day, n (%)					
0 g/day	610 (18.0)	137 (23.1)	136 (17.7)	165 (16.3)	172 (16.7)
<20 g/day	1,612 (47.4)	371 (62.7)	419 (54.6)	436 (43.1)	386 (37.6)
<40 g/day	651 (19.2)	55 (9.3)	133 (17.3)	213 (21.1)	250 (24.3)
≥40 g/day (heavy drinking)	525 (15.5)	29 (4.9)	80 (10.4)	197 (19.5)	219 (21.3)

Nondrinkers were included. Medical treatment: the use of medication for hypertension, diabetes or dyslipidemia. [a)]: Data of job stress, depressive score, occupational category and work schedule were collecte in 2002.

was related to alcohol use in all age groups, particularly in the younger age group, and shift work was related to alcohol use more apparently in the younger age group. However, work-related psychosocial factors were related to either encouragement or prevention of alcohol use, and the directions of the relationships were different according to age.

The frequency of heavy drinking among the all subjects, 15.5%, was similar to the 19.7% calculated from the data for the same year of the National Health and Nutrition Survey in Japan[31)], although the questionnaire used for estimation of alcohol intake was different from that used by us. Our study showed that the frequency of heavy drinking increased with age. An international comparative study reported that Japanese men consumed more alcohol and had a higher proportion of middle-aged men were heavy drinkers, whereas men in many European populations and in the US population reduced their alcohol consumption as they got older[20)]. It is possible these different trends are a consequence of the social drinking norms in Japan including high alcohol consumption in job-related drinking, permissive attitudes towards drinking by middle-aged men and the relatively greater expense of alcoholic beverages for young men.

We found an increased OR for heavy drinking in blue-collar workers compared with white-collar workers in all age groups, particularly in the younger age group. This finding is in agreement with those of former studies. A cross-sectional study from the US by Harford *et al.*[6)] showed that the percentage of drinkers in white-collar occupations in men was higher than in blue-collar occupations, while the men in blue-collar who drink have a higher average daily consumption than drinkers in white-collar

Table 2-1. Age-adjusted odds ratios for heavy drinking related to sociodemographic factors, work-related factors, and depression score in workers aged 20–39 years

		20–29 years						30–39 years					
Variables	(Range)	n	Cases	(%)	OR	95%CI		n	Cases	(%)	OR	95%CI	
Marital status													
Single		351	19	(5.4)	1.00			207	20	(9.7)	1.00		
Married		104	10	(9.6)	1.50	(0.58–3.87)		425	60	(14.1)	1.36	(0.80–2.30)	
Current smoking													
No		209	7	(3.3)	1.00			320	32	(10.0)	1.00		
Yes		246	22	(8.9)	2.92	(1.13–7.46)	*	312	48	(15.4)	1.64	(1.02–2.62)	*
Medical treatment													
No		452	29	(6.4)	—	— —		608	74	(12.2)	1.00		
Yes		3	0	(0.0)	—	— —		24	6	(25.0)	2.24	(0.85–5.89)	
CESD													
Low	(0–11)	170	14	(8.2)	1.00			255	29	(11.4)	1.00		
Intermediate	(12–17)	147	10	(6.8)	0.99	(0.36–2.48)		189	22	(11.6)	1.01	(0.56–1.79)	
High	(18–51)	138	5	(3.6)	0.43	(0.13–1.38)		188	29	(15.4)	1.32	(0.76–2.28)	
Type of occupation													
White collar		150	5	(3.3)	1.00			296	24	(8.1)	1.00		
Blue collar, day work		145	7	(4.8)	1.99	(0.54–7.35)		190	31	(16.3)	2.14	(1.21–3.79)	**
Blue collar, shift work		160	17	(10.6)	4.79	(1.49–15.44)	**	146	25	(17.1)	2.61	(1.45–4.70)	**
Job demand													
Low	(12–31)	172	11	(6.4)	1.00			184	23	(12.5)	1.00		
Intermediate	(32–35)	120	9	(7.5)	1.32	(0.49–3.54)		163	29	(17.8)	1.32	(0.74–2.38)	
High	(36–48)	163	9	(5.5)	0.73	(0.26–2.03)		285	28	(9.8)	0.71	(0.40–1.26)	
Decision latitude													
High	(71–96)	135	6	(4.4)	1.00			223	28	(12.6)	1.00		
Intermediate	(63–70)	155	8	(5.2)	0.90	(0.26–3.20)		241	35	(14.5)	1.19	(0.70–2.02)	
Low	(24–62)	165	15	(9.1)	2.76	(0.96–8.00)		168	17	(10.1)	0.77	(0.41–1.45)	
Social support													
High	(25–32)	140	3	(2.1)	1.00			95	10	(10.5)	1.00		
Intermediate	(23–24)	183	13	(7.1)	4.12	(0.90–18.96)		321	41	(12.8)	1.24	(0.59–2.58)	
Low	(8–22)	132	13	(9.8)	5.91	(1.28–27.32)	*	216	29	(13.4)	1.31	(0.61–2.81)	

Nondrinkers were excluded. Definition of heavy drinking: (≥40 g/day). Medical treatment: the use of medication for hypertension, diabetes or dyslipidemia. OR (95% confidence interval (CI)): age-adjusted odds ratios calculated using a logistic regression model. Age and each variable were included in the model. * $p<0.05$; ** $p<0.001$. CESD: Center for Epidemiological Studies Depression Scale.

occupations. We also reported a cross-sectional study of male workers in smaller sized enterprises that showed that the frequency of heavy drinkers was higher in manual workers and transportation workers compared with white-collar workers[11]. Some studies have also reported that highly hazardous physical working conditions are associated positively with heavy and binge drinking[18, 23]. A higher frequency of alcohol dependence in blue-collar workers compared with white-collar workers has also been reported[10, 12]. These differences in drinking habits between occupational groups may reflect differences in cultural norms for drinking and other socioeconomic factors including educational attainment.

This study showed that shift work was associated with a higher likelihood of heavy drinking in subjects aged 20–29 years. To date, the effects of shift work on alcohol consumption or heavy drinking have not been established. We have reported previously that shift work increased the prevalence of heavy drinking in middle-aged male workers when accompanied by sleep problems, and suggested that shift workers may try to cope with sleep problems by using alcohol[13]. Shift workers in a young age group may also use

Table 2-2. Age-adjusted odds ratios for heavy drinking related to sociodemographic factors, work-related factors, and depression score in workers aged 40–59 years

		40–49 years						50–59 years					
Variables	(Range)	n	Cases	(%)	OR	95%CI		n	Cases	(%)	OR	95%CI	
Marital status													
Single		117	31	(26.5)	1.00			73	22	(30.1)	1.00		
Married		729	166	(22.8)	0.77	(0.49–1.20)		782	197	(25.2)	0.77	(0.45–1.29)	
Current smoking													
No		371	72	(19.4)	1.00			433	86	(19.9)	1.00		
Yes		475	125	(26.3)	1.56	(1.12–2.17)	**	422	133	(31.5)	1.86	(1.36–2.54)	*
Medical treatment													
No		769	179	(23.3)	1.00			681	173	(25.4)	1.00		
Yes		77	18	(23.4)	1.04	(0.59–1.82)		174	46	(26.4)	1.02	(0.70–1.48)	
CESD													
Low	(0–11)	300	61	(20.3)	1.00			322	92	(28.6)	1.00		
Intermediate	(12–17)	287	71	(24.7)	1.25	(0.85–1.85)		299	65	(21.7)	0.70	(0.48–1.00)	
High	(18–51)	259	65	(25.1)	1.30	(0.87–1.94)		234	62	(26.5)	0.91	(0.63–1.33)	
Type of occupation													
White collar		350	61	(17.4)	1.00			322	64	(19.9)	1.00		
Blue collar, day work		315	88	(27.9)	1.82	(1.25–2.63)	**	369	105	(28.5)	1.61	(1.13–2.29)	**
Blue collar, shift work		181	48	(26.5)	1.73	(1.12–2.66)	*	164	50	(30.5)	1.80	(1.17–2.77)	**
Job demand													
Low	(12–31)	307	77	(25.1)	1.00			398	105	(26.4)	1.00		
Intermediate	(32–35)	252	63	(25.0)	0.95	(0.64–1.40)		258	62	(24.0)	0.94	(0.66–1.35)	
High	(36–48)	287	57	(19.9)	0.76	(0.52–1.13)		199	52	(26.1)	0.99	(0.67–1.54)	
Decision latitude													
High	(71–96)	243	38	(15.6)	1.00			234	60	(25.6)	1.00		
Intermediate	(63–70)	325	87	(26.8)	1.90	(1.24–2.92)	**	313	74	(23.6)	0.95	(0.65–1.41)	
Low	(24–62)	278	72	(25.9)	1.82	(1.17–2.84)	**	308	85	(27.6)	1.13	(0.77–1.66)	
Social support													
High	(25–32)	86	19	(22.1)	1.00			75	27	(36.0)	1.00		
Intermediate	(23–24)	383	87	(22.7)	1.12	(0.64–1.97)		427	104	(24.4)	0.56	(0.33–0.93)	*
Low	(8–22)	377	91	(24.1)	1.16	(0.66–2.04)		353	88	(24.9)	0.58	(0.34–0.97)	*

Nondrinkers were excluded. Definition of heavy drinking: (≥40 g/day). Medical treatment: the use of medication for hypertension, diabetes or dyslipidemia. OR (95% confidence interval (CI)): age-adjusted odds ratios calculated using a logistic regression model. Age and each variable were included in the model. * $p<0.05$; ** $p<0.001$. CESD: Center for Epidemiological Studies Depression Scale.

alcohol for adaptation to irregular working schedules.

We found that a decrease in decision latitude increased the frequency of heavy drinking in subjects aged 40–49 years. However, the opposite relationship was found in subjects aged 30–39 years. The positive relationship between decision latitude and heavy drinking in subjects aged 30–39 years was also observed in the same age group in the study by Hiro *et al.*[23]. These different associations between decision latitude and drinking habits according to age may be explained by the motivational model of alcohol use proposed by Cox *et al.*[32]. According to the model, the motives for drinking are categorized into four groups: social (external, positive reinforcement), enhancement (internal, positive enhancement), conformity (external, negative reinforcement) and coping (internal, negative reinforcement). Subjects aged 40–49 years with a lower decision latitude may use alcohol to cope with job stress (negative reinforcement). However, subjects aged 30–39 years with higher decision latitude may use alcohol for social motives (positive reinforcement).

In the youngest age group, a decrease in social support in the workplace increased the frequency of

Table 3. Relationship between work-related factors and heavy drinking in 2,788 subjects excluding 610 abstainers after adjustment for all confounding factors determined by multiple logistic regression

	20–29		30–39		40–49		50–59	
Variables	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Type of occupation								
White collar	1.00		1.00		1.00		1.00	
Blue collar, day work	1.57	(0.43–5.66)	2.27	(1.23–4.19) **	1.60	(1.07–2.39) *	1.62	(1.09–2.40) *
Blue collar, shift work	4.68	(1.36–16.04) *	2.80	(1.44–5.48) **	1.48	(0.91–2.40)	1.95	(1.19–3.18) **
Job demand								
Low	1.00		1.00		1.00		1.00	
Intermediate	1.14	(0.41–3.12)	1.40	(0.75–2.61)	1.01	(0.68–1.50)	0.93	(0.64–1.35)
High	0.93	(0.32–2.69)	0.72	(0.38–1.34)	0.79	(0.53–1.19)	1.04	(0.70–1.56)
Decision latitude								
High	1.00		1.00		1.00		1.00	
Intermediate	0.54	(0.15–1.88)	0.83	(0.46–0.15)	1.70	(1.07–2.69) *	0.88	(0.57–1.36)
Low	1.23	(0.36–4.25)	0.42	(0.20–0.90) *	1.47	(0.87–2.49)	0.93	(0.58–1.47)
Social support								
High	1.00		1.00		1.00		1.00	
Intermediate	2.66	(0.68–10.35)	1.32	(0.61–2.87)	0.80	(0.44–1.44)	0.62	(0.35–1.08)
Low	4.70	(1.15–19.28) *	1.49	(0.64–3.46)	0.80	(0.43–1.48)	0.61	(0.34–1.08)

Nondrinkers were excluded. Definition of heavy drinking: (≥40 g/day). Medical treatment: the use of medication for hypertension, diabetes, or dyslipidemia. OR (95% confidence interval (CI)) calculated using logistic regression after adjustment for variables including age, marital status, smoking, medical treatment (the use of medication for hypertension, diabetes or dyslipidemia) and all the items listed in the table. * $p<0.05$; ** $p<0.001$.

heavy drinking, whereas a positive association was found in subjects aged 40 years or older. These findings suggested that this young age group may have used alcohol to cope with job stress, whereas older age group may have used alcohol according to social positive enhancement. However, in the population investigated by Hiro *et al.*[23], social support increased the likelihood of heavy drinking in both the younger and older age groups. Social support therefore appears to have disparate effects of either enhancing or preventing heavy drinking, particularly in a young age group. However, the prevalence of heavy drinking in each age group of subjects in that study was half that of our study subjects. The differences of prevalence in heavy drinking may contribute to the differences in the association of heavy drinking and work-related factors between the two studies.

While the strength of the present study was its investigation of the relationship between work-related factors and heavy drinking according to age by using a validated questionnaire for measurement of alcohol consumption, it also had several limitations. First, the study was conducted in a single factory in Japan, with the majority of subjects living in the district around the factory. This means that they shared similar drinking norms, which may have influenced them to acquire drinking habits[9, 33]. Generalization of our results should therefore be carried out with caution. Second, due to the cross-sectional design of the study, we were unable to determine causal relationships. There is evidence that socioeconomic status (SES) in early adolescence affects drinking habits[34]. SES may also affect the selection of jobs in youth. As we did not collect information about educational attainment, which is a better indicator of SES in adolescents, we were unable to exclude the effects of selection bias. Third, there was a one-year time lag between investigating work characteristics and depression score and evaluating alcohol consumption. It is therefore possible that work characteristics and depression score may have changed over this one-year period.

In conclusion, our findings suggest that there are age-related differences in the relationship between work-related factors and heavy drinking. Occupation and work schedule related to alcohol use more apparently in the younger age group. Psychosocial factors were related to either enhancement or prevention of alcohol use, and the directions of the relationships were different according to age. Therefore, approaches in consideration of age-specific characteristics in the relationships between work-related factors and drinking behavior would be necessary for prevention