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Associations between alcohol consumption and sleep-disordered breathing among Japanese women

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Background: The associations between alcohol consumption and sleep-disordered breathing in women are uncertain.

Methods: We conducted a cross-sectional study of 3,113 women aged 30-69 years. The 3% oxygen desaturation index (3%ODI), based on overnight pulse oximetry findings, was selected as an indicator of sleep-disordered breathing.

Results: 3%ODI frequencies of ≥5 were higher for drinking women with ethanol intakes of ≥23.0g/d than for never drinkers: the respective multivariable odds ratios and 95% confidence intervals was 1.8(1.0-3.4). The corresponding odds ratio was 3.0(1.6-5.8) for habitual snoring. The associations of ethanol intakes of ≥23.0g/d with 3%ODI ≥5 was more evident among women with BMI <23.0 kg/m^2 (median) than those with higher BMI but did not vary by habitual snoring. The multivariable odds ratios of 3%ODI ≥5 for women with ethanol intakes of ≥23.0g/d versus never drinkers were 2.7(1.0-6.7) for lower BMI and 1.5(0.6-3.3) for higher BMI and the corresponding odds ratio were 2.8(1.6-7.2) and 3.2(1.3-7.9) for habitual snoring, respectively.

Conclusion: Alcohol consumption was associated with higher prevalence of sleep-disordered breathing among Japanese women.

Keywords: Alcohol consumption, women, sleep-disordered breathing, epidemiology

Introduction

Sleep-disordered breathing (SDB) is associated with risk of hypertension[1] and cardiovascular disease[2] as well as with all causes of mortality.[2,3] Alcohol consumption is associated with elevated morning blood pressure levels[4] and risk of mortality from cardiovascular disease.[5] Previous clinical studies reported that alcohol consumption prior to bedtime was associated with an increase in the number and duration of hypopnea and apnea occurrences in snorers or sleep-disordered breathing patients,[6-8] and required higher levels of continuous positive airway pressure (CPAP) to prevent apnea and hypopnea.[9] However, it is not yet clear to what extent alcohol consumption by women is associated with risk of SDB. Several previous epidemiological studies found that alcohol consumption was associated with snoring for men[10,11] and for men and women combined.[12] However, such an association with SDB was observed only in men,[13-15] but not in women[15] or in men and women combined.[16,17] Further, a previous study of Japanese men showed that this association was more evident in men with low BMI than in those with high BMI.[14]

To examine the associations between alcohol consumption and sleep-disordered breathing specifically among Japanese women, we conducted a large community-based study.

Methods

Study population

The Circulatory Risk in Communities Study (CIRCS) is a dynamic community cohort study of Japanese covering five communities in Japan.[18] The CIRCS underwent sleep investigation in three communities: Yao City, Osaka Prefecture; Ikawa town, Akita Prefecture; and Kyowa town, Ibaraki Prefecture from 2001 to 2005. The participants of 981 women from the district of Yao (recruitment rate among the cardiovascular survey participants = 78% for women), 608 women from Ikawa (85%), and 1,559 women from Kyowa (78%) were available for the present sleep study with satisfactory recording by a pulse-oximeter. Also, women with self-reported history of stroke or coronary heart disease (n=35) were excluded because they were likely to change their lifestyles. The data for 3,113 women aged 30-69 years were used for the analysis. The study protocol was approved by the Medical Ethics Committees of the University of Tsukuba, Osaka University and the Osaka Medical Center for Health Science and Promotion. Informed consent was obtained from the community representatives to conduct an epidemiological study based on guidelines of the Council for International Organizations of Medical Science.[19]

Measurement of cardiovascular risk factors

Height in stocking feet and weight in light clothing were also measured, and body mass index (BMI) was calculated as weight (kg)/height (m^2). Interviews were conducted to ascertain the frequency of snoring (often, sometimes, never, unknown), number of cigarettes smoked per day, ethanol intake per day, and past histories of sleep apnea, stroke and coronary heart disease.

Persons who replied “often” for snoring over the previous three months were labeled as suffering from habitual snoring. Persons who smoked one or more cigarettes per day were defined as current smokers and those who had not smoked for 3 months or more were defined as former smokers, while both never smokers and occasional smokers were regarded as non-smokers because the latter are very rare in Japan. The usual weekly alcohol intake was assessed in units of “*go*”, a Japanese unit of volume corresponding to 23 g ethanol, which was then converted to grams of ethanol per day.[4,14] One “*go*” is equivalent to 180 ml of sake and corresponds to one bottle (633 ml) of beer, two single shots (75 ml) of whiskey, or two glasses (180 ml) of wine. Subjects who drank >8g of ethanol per week were considered to be current drinkers and those who had not drunk for 3 months or more were defined as former drinkers.

Assessment of sleep-disordered breathing

Arterial oxygen saturation during one night of sleep at home was measured with a pulse-oximeter (PULSOX-3Si; Minolta Co., Osaka, Japan). The device stores values of peripheral blood oxygen saturation by performing a moving average for the last 5 seconds, updated every second. This sampling time was short enough to avoid the underestimation of oxygen desaturation.[20] The stored data were downloaded to a personal computer via an interface (PULSOX IF-3; Minolta) and analyzed using proprietary software supplied with the equipment (DS-3 version. 2.0a; Minolta) and the records reviewed by trained physicians. The oxygen desaturation index (ODI) was calculated based on frequency of ≥3% reductions in arterial oxygen saturation during sleep. The 3%ODI as an indicator of sleep-disordered breathing described in previous studies[14,21] was also used for this study. It represents the number of events per hour of adjusted measurement time in which blood oxygen decreases by ≥3%. The individuals filled out a sleep diary in order to exclude waking time from the analysis to minimize the potential overestimation of sleep duration. All data were reviewed by trained physicians and total recording time less than 4 h or the artifact likely due to frequent body movement or inadequate fitting of the probe were excluded. Overall 3%ODI was established as the mean value of 3%ODIs over at least a 4-hour period of sleep as measured by pulse oximetry. The sleep-disordered breathing was defined in terms of 3% ODI level as ≥5 events per hour and the 3%ODI <5 was used as the reference category. A previous validity study reported that sensitivity was 80% and specificity 95% for 3%ODI ≥5 to detect an apnea-hypopnea index (AHI) of ≥5 by full polysomnography.[22]

Statistical analysis

Age-adjusted population characteristics according to categories of drinking status (never, former, and ethanol intakes of <23.0 and ≥23.0 g/day) were calculated by using analysis of covariance and the chi-square test. Logistic regression analysis was used to estimate the odds ratio of the prevalence of 3%ODI ≥5 and habitual snoring according to categories of ethanol intake. The potentially confounding variables were age (year), BMI (kg/m^2), smoking status (never, ex- and current smoking), and communities (Yao, Ikawa, and Kyowa). The associations of alcohol consumption with 3%ODI ≥5 and habitual snoring were examined and stratified by using the median BMI (<23.0 and ≥23.0 kg/m^2). The significance for interactions by body mass index was tested by using the cross-product terms of ethanol intake and body mass index categories in multivariable models.

All statistical analyses were performed with SAS version 9.1.3 software (SAS Institute Inc., Cary, NC). All probability values for statistical tests were two-tailed, and values of $p < 0.05$ were regarded as statistically significant.

Results

The proportion of sleep-disordered breathing equivalent to 3%ODI ≥5 were 17.4% for total subjects aged 30-69 years, 17.5% for never-drinkers, and 23.9% for women with ethanol intake of ≥23.0 g/d. The respective proportion of habitual snoring was 10.5%, 10.1 % and 23.5%. Compared with never-drinking women, women with ethanol intake of ≥23.0 g/d were younger, showed higher mean values of 3%ODI and were more likely to smoke. Mean body mass index did not differ between women with ethanol intake of ≥23.0 g/d and never-drinking women (Table 1).

The proportions of sleep-disordered breathing and habitual snoring were higher for women with ethanol intake of ≥23.0g/d compared with never drinkers (Table 2). The multivariable odds ratios of these outcomes were 1.8(1.0-3.4) and 3.0(1.5-5.8), respectively.

We also examined the association of drinking status with sleep-disordered breathing and habitual snoring, stratified by median BMI (BMI <23.0 versus ≥23.0 kg/m^2) (Table 3). The association between ethanol intake and sleep-disordered breathing were more evident among women with lower BMI than those with higher BMI although the interaction by BMI did not reach the levels of statistical significance (p=0.23).

The multivariable odds ratios of 3%ODI ≥5 for ethanol intakes of ≥23.0 g/d versus never drinking were 2.7(1.0-6.7) for lower BMI and 1.5(0.6-3.3) for higher BMI. The association between ethanol intake and sleep-disordered breathing did not vary by habitual snoring.

Discussion

In our study of a general population of 3,113 Japanese women, we found that ethanol intakes of ≥23.0 g/d were associated with approximately 2.0-fold higher prevalence of sleep-disordered breathing equivalent to 3%ODI ≥5.

To the best of our knowledge, this is the first study to show an association between alcohol consumption and higher prevalence of sleep-disordered breathing among a general population of Japanese women. Our findings are in agreement with the results of clinical experimental studies, which demonstrated an increase in mean AHI,[6] increased frequency of arterial oxygen desaturation[7,8] and the need for higher continuous positive airway pressure to eliminate snoring[9] after the ingestion of alcohol prior to bedtime. The adverse effects of alcohol on SDB are narrowing of the pharyngeal airways and an increase in nasal resistance,[23] selective reduction in hypoglossal motor nerve activities,[24] and diminished arousal response.[7]

Our study showed that the association of alcohol consumption with sleep-disordered breathing equivalent to 3%ODI ≥5 was more evident among women with lower BMI (<23.0 kg/m^2) than those with higher BMI. The Wisconsin Sleep Cohort Study find no association between alcohol consumption and SDB among 645 women.[15] In that study, however, they did not conduct a stratified analysis by BMI, whose mean BMI was much higher (31 kg/m^2) than that in our present population (23.0 kg/m^2). This suggests that the strong effect of excess weight on sleep-disordered breathing may mask a moderate effect of alcohol consumption. Further, compared with whites, Asians tend to have a lower position of the hyoid bone and shorter dimension of the posterior airway space,[25] Japanese may have a higher risk of sleep-disordered breathing than whites when they drink habitually. Moreover, the positional sleep apnea occurs more commonly in the less obese subjects.[26] In addition, we previously reported a positive association between alcohol consumption and sleep-disordered breathing among Japanese men: the multivariable OR of 3%ODI ≥5 was 1.95(1.15-3.31) for ethanol intake ≥1.0 g/d per kg for men aged 40-69 years.[14]

A major strength of our study is the use of a large general population sample, which has the advantage of providing a more realistic estimation for the association between alcohol consumption and sleep-disordered breathing than can be attained with hospital or laboratory studies, because the subjects can maintain regular daily habits such as sleeping or alcohol consumption. Also, SDB[14] and cardiovascular risk factors[27-29] were measured with standardized methods with proven satisfactory reliability and precision.

The limitation of our study is that since we used pulse oximetry to evaluate sleep-disordered breathing, we could not accurately ascertain the severity of SDB, sleep architecture changes, relationships with REM sleep, sleep fragmentation and positional nature of hypoxia, while the sensitivity was 80% and specificity 95% for 3%ODI ≥5 to detect an AHI ≥5 by full PSG.[22] Second, pulse oximetry inherently underestimates respiratory disturbance events during sleep compared with measurements obtained with full PSG, particularly for non-obese subjects such as those studied here (mean BMI=23.6 kg/m^2). In fact, one study found that, for the 3% ODI of ≥5 to screen for AHI ≥5/h by PSG, the sensitivity was 68% for subjects with BMI ≤27.0 kg/m^2 and 94% for those with BMI >27.0 kg/m^2.[22] Third, we conducted the multivariable analysis to examine relationships between alcohol consumption and sleep-disordered breathing, but we have no data on potential confounding factors such as income, pulmonary disease, psychiatric disease, allergies, and use of benzodiazepines, narcotics, antidepressants and illicit drugs. Fourth, the number of drinkers was still small due to the low prevalence in drinkers among Japanese women.[5] A larger study is of value to confirm our findings.

In conclusion, habitual alcohol consumption was found to be associated with higher prevalence of sleep-disordered breathing among Japanese women.

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Competing interests

Authors Renzhe Cui, Takeshi Tanigawa, Susumu Sakurai, Kazumasa Yamagishi, Isao Muraki, Hironori Imano, Tetsuya Ohira, Masahiko Kiyama, Akihiko Kitamura, Yoshinori Ishikawa, Hiroyasu Iso does not have competing financial interest.

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Table 1 Age-adjusted mean and prevalence of selected cardiovascular risk factors among 3,113 Japanese women aged 30-69 years

	Total subjects	Never drinkers	Ex-drinkers	Ethanol intake, g/day	
				<23.0	≥23.0
No.	3,113	2,368	174	492	79
Age, years	55.5	56.1	54.3†	53.0‡	52.7‡
3%ODI, episodes/h	3.0	3.0	2.8	2.9	3.9*
Subjects with 3%ODI≥5, %	17.4	17.5	17.7	16.0	23.9
Habitual snoring, %	10.5	10.1	10.4	10.7	23.5‡
Body mass index, kg/m^2	23.3	23.4	23.3	22.8†	23.1
Current smokers, %	5.8	3.5	19.2‡	7.6‡	34.6‡

*p<0.05, †p<0.01, ‡p<0.001, are compared with never drinkers.
Habitual snoring: snoring “often” over the last three months.

Table 2 Multivariable odds ratios and 95% confidence intervals of sleep-disordered breathing and habitual snoring according to alcohol consumption

	Never drinkers	Ex- drinkers	Ethanol intake, g/day	
			<23.0	≥23.0
Total number	2,368	174	492	79
3%ODI ≥5, No.	428	29	68	17
Age-adjusted OR	1.0	1.0 (0.7-1.5)	0.9 (0.7-1.2)	1.6 (0.9-2.8)
Multivariable OR	1.0	1.0 (0.6-1.6)	1.0 (0.8-1.4)	1.8 (1.0-3.4)*
Habitual snoring, No.	205	15	46	15
Age-adjusted OR	1.0	1.0 (0.6-1.8)	1.1 (0.8-1.5)	2.7 (1.5-5.0)‡
Multivariable OR	1.0	1.0 (0.5-1.7)	1.1 (0.8-1.6)	3.0 (1.6-5.8)*

*p<0.05, †p<0.01, ‡p<0.001 compared with never drinkers.

Multivariable adjustment: age (year), body mass index (kg/m^2), smoking status (never, ex- and current smoking), and community.

Table 3 Multivariable odds ratios and 95% confidence intervals of 3%ODI ≥5 according to alcohol consumption by median BMI subgroups

	Never drinkers	Ex- drinkers	Ethanol intake, g/day	
			<23.0	≥23.0
Total number	2,368	174	492	79
BMI <23.0 kg/m^2	1,150	84	285	40
3%ODI ≥5, No.	118	7	18	7
Multivariable OR	1.0	0.9 (0.4-2.1)	0.7 (0.4-1.2)	2.7 (1.0-6.7)*
Habitual snoring, No.	62	5	15	7
Multivariable OR	1.0	1.0 (0.4-2.7)	0.9 (0.5-1.6)	2.8 (1.1-7.2)†
BMI ≥23.0 kg/m^2	1,218	90	207	39
3%ODI ≥5, No.	310	22	50	10
Multivariable OR	1.0	1.0 (0.6-1.7)	1.2 (0.8-1.9)	1.5 (0.6-3.3)
Habitual snoring, No.	143	10	31	8
Multivariable OR	1.0	0.9 (0.5-1.9)	1.4 (0.9-2.1)	3.2 (1.3-7.9)†

*p<0.05, †p<0.01 compared with never drinkers.

Multivariable adjustment variables are similar as shown in Table 2.