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【 ORIGINAL ARTICLE 】

Relationship between Snoring and Lifestyle-related Diseases among a Japanese Occupational Population

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Abstract:

Objective Snoring is a common physical condition in active workers. However, the link between snoring and health problems is poorly understood. Therefore, the prevalence of snoring in Japanese workers and the relationships between snoring and lifestyle-related diseases were investigated.

Methods This was a retrospective, single-center, cross-sectional study. The results of a single year's medical examinations were investigated for 25,141 Japanese active office workers 20 to 59 years old. The presence and duration of snoring were investigated using a personal computer at a medical interview before the medical checkup. The snoring frequency was investigated for each gender. In addition, the relationships between snoring and hypertension, diabetes, and dyslipidemia were also analyzed.

Results Men (21,774) were a mean 46±6 years old with a snoring prevalence of 43%. Women (3,367) were a mean 46±6 years old with a snoring prevalence of 20%. In men, snoring was an independent comorbid factor of hypertension and dyslipidemia. In particular, a long snoring vintage (multiple years) was an independent comorbid factor for hypertension [odds ratio (OR), 1.14; 95% confidence interval (CI), 1.05-1.24; p=0.002; and OR, 1.20; 95% CI, 1.07-1.34; p=0.001]. In women, snoring was not an independent comorbid factor for lifestyle-related diseases when adjusted for the age and body mass index.

Conclusion Snoring was shown to be a frequent pathophysiology in active workers. It was a health indicator for active workers, and especially in men, intervention for snoring may reduce the risk of developing lifestyle-related diseases.

Key words: snores, hypertension, dyslipidemia, medical checkup, office worker

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Introduction

The frequency of snoring in Japanese adults 35 to 79 years old has been reported to be 24% for men and 10% for women (1). The prevalence of snoring depends on the ethnicity, age of the subject, and degree of obesity, but some reports indicate that the rate is ≥50% for both men and women (2). In general, it can be said that this is a frequent physical condition.

Snoring is a "common" physical condition according to medical interviews during health examinations for the working class, and links between snoring and health problems have not been strongly recognized. Snoring is considered an independent factor influencing the development of lifestyle-related diseases in young people (3, 4). If snoring can be recognized early in working age and intervention or prevention of snoring can be provided, the quality of life and life prognosis of workers with lifestyle-related diseases may be improved.

Therefore, in the present study, the frequency of snoring prevalence was investigated in active workers by gender, age, and body mass index (BMI), and then the associations between snoring and lifestyle-related diseases were studied. This was a retrospective, single-center, cross-sectional study.

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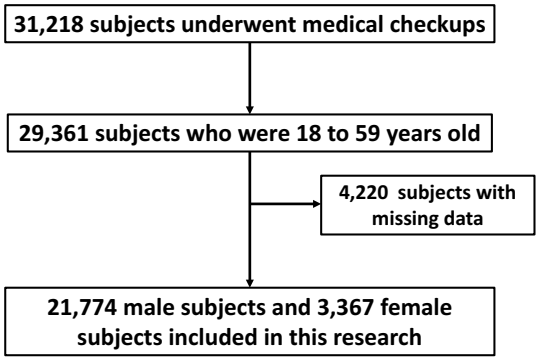

Figure 1. **Flowchart for inclusion criteria.**

Materials and Methods

Subjects

A medical checkup was conducted in 25,141 company staff members of FUJITSU Limited or affiliated companies between April 1, 2015, and March 31, 2016, at the Health Examination Center, FUJITSU Ltd. Of these staff members, 21,774 men and 3,367 women who were 20 to 59 years old and had no missing items in this survey were included as subjects in the analysis (Fig. 1).

Information regarding gender, age, height, weight, BMI, use or non-use of antihypertensive agents, use of diabetes drugs (including insulin), and use of lipid metabolism disorder drugs was collected at the health examination. Blood tests were performed by fasting blood sampling after a fast of ≥10 hours. Plasma glucose was measured by the enzymatic method (Hexokinase-UV method). Glycosylated hemoglobin (HbA1c) was measured by high-performance liquid chromatography. Total cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), and triglyceride (TG) levels were measured by enzymatic methods. LDL-C was calculated by the Friedewald equation, and a direct LDL-C method was used when TG was ≥400 mg/dL.

Hypertension was defined as systolic blood pressure (BP) ≥140 mmHg, diastolic BP ≥90 mmHg, and/or the current use of antihypertensive medications. Diabetes mellitus was defined as a glucose level ≥126 mg dL^{-1} in the fasting state or as HbA1c ≥6.5%, according to the National Glycohemoglobin Standardization Program, and/or current use of diabetes drugs. Patients with LDL-C ≥140 mg dL^{-1}, HDL-C <40 mg dL^{-1}, TG ≥150 mg dL^{-1}, or non-HDL-C (TC - HDL-C) ≥ 170 mg dL^{-1}, as well as patients who were receiving lipid metabolism disorder treatment, were defined as having dyslipidemia.

Blood pressure measurement in the waiting area

Each person sat in a backed chair in a waiting area without crossing their legs for a few minutes under supervision by staff. Each of them then measured their BP via the brachial artery on their own with an automatic electronic manometer (HBP-9021, Omron Healthcare, Kyoto, Japan). The BP was measured between 9 AM and 11 AM after adjusting the height of the measurement table in order to keep the position of the cuff at the heart level; the tourniquet cuff tightened around the upper arm automatically (width, 13 cm). The BP was measured once, but a second measurement was performed if the first measurement indicated BP ≥140/90 mmHg. If two measurements were recorded, the second one was used in the present analysis.

Questionnaires about snoring and lifestyle

Lifestyle habits in the most recent two to three months were investigated using a personal computer at a medical interview before the medical checkup.

Snorers were defined as subjects who responded with "Yes" to the following question: "Do you snore or has anyone pointed out that you snore?" When the subjects answered "Yes", they were asked about the snoring period with the following three options: "Short-term snorer" defined as starting to snore only in the recent few months; "Long-term snorer" defined as having snored for a few years; and "Persistent snorer", defined as having snored for more than a few years. If the answer was not applicable, the closest answer was chosen from the three options.

A smoking habit was defined as a current smoker with a regular smoking habit. A drinking habit was defined as consuming alcohol once a week or more frequently. An exercise habit was defined as regular exercise of once a week or more frequently.

Statistical analyses

Since the frequency of snoring varies with gender, age, and BMI (3, 4), the prevalence of snoring was investigated by gender, age, and BMI. Men were classified into the following four groups according to their age quartiles: age-quartile (Q)1, 21-43 years old; Q2, 44-47 years old; Q3, 48-51 years old; and Q4, 52-59 years old. They were also classified into the following four groups according to their BMI quartiles: BMI-Q1, 12.1-21.6 kg/m^2; Q2, 21.7-23.5 kg/m^2; Q3, 23.6-25.8 kg/m^2; and Q4, 25.9-60.8 kg/m^2. Women were classified into the following four groups according to their age quartiles: age-Q1, 24-42 years old; Q2, 43-46 years old; Q3, 47-50 years old; and Q4, 51-59 years old. They were also classified into the following four groups according to their BMI quartiles: BMI-Q1, 11.0-19.3 kg/m^2; Q2, 19.4-21.1 kg/m^2; Q3, 21.2-23.7 kg/m^2; and Q4, 23.8-44.9 kg/m^2. Pearson's χ^2 test was used to compare the prevalence of snoring among the four groups (Q1-4) by gender, age, and BMI.

The data are expressed as the means ± standard deviation. All patients were classified into the following four groups: nonsnorers, short-term snorers, long-term snorers, and persistent snorers. Tukey's honest significance test and Pearson's χ^2 test were used to compare parameters among the four groups for each sex. The associations between snoring

duration and hypertension, diabetes mellitus, and dyslipidemia were analyzed using univariable (unadjusted in model 1) and multivariable logistic regression after adjusting for covariates (age and BMI in model 2; age, BMI, current smoker, alcohol consumption, and exercise habit in model 3) in each snoring group. Odds ratios (ORs) are presented versus nonsnorers with 95% confidence intervals (CIs). Statistical analyses were conducted using the JMP software program for Windows (version 10.0; SAS Institute, Cary, USA). Significant differences were defined at a p value for the hazard ratio of <0.05.

Ethics

This research was conducted in accordance with the Helsinki Declaration. In conducting the research, we anonymized all information that could identify individuals and conducted the study under strict control with reference to the "Guidelines for Proper Handling of Personal Information by Medical Care/Nursing Care Service Providers" and "Things to Keep in Mind for Proper Handling of Personal Health Information on Employment Management" of the Ministry of Health, Labour and Welfare of Japan. The use of health information so that individuals cannot be identified was clearly stated in each patient's questionnaire and a poster was posted at the Health Examination Center, FUJITSU. The posters explained that questions about the handling of health information management would be answered, and opting out was allowed. The FUJITSU Clinic Ethics Committee reviewed this study, and we obtained the approval of the Committee before conducting this study.

Results

Background characteristics of the subjects

The average age and BMI of the entire subject group (n= 25,141) were 47 years old and 24 kg/m^2. Men (n=21,774) had an average age of 46±6 years old and an average BMI of 24±4 kg/m^2. Women (n=3,367) had an average age of 46 ±6 years old and an average BMI of 22±4 kg/m^2.

For both men and women, there were significant differences in the age, BMI, blood pressure, glucose tolerance, and lipid profiles among the four groups of non-snorers, short-term snorers, long-term snorers, and persistent snorers. Furthermore, the longer the snoring period, the higher the incidence of hypertension, diabetes, and dyslipidemia. As for lifestyle habits, the non-snorers, short-term snorers, long-term snorers and persistent snorers showed significant differences in the frequency of smoking, drinking habits, and exercise habits in men (p <0.001, p <0.001, and p <0.001, respectively), whereas no significant differences were noted in women (p=0.068, p=0.105, and p=0.099, respectively).

Relationships of snoring prevalence with age and BMI

The prevalence of snoring was 43% in men and 20% in women (Table 1). The prevalence of snoring increased with both age and BMI in both men and women (Fig. 2). The correlation between the age and BMI was r=0.028 (p < 0.001) for men and r=0.079 (p <0.001) for women, indicating no correlation.

Relationships between lifestyle-related diseases and comorbid snoring in male workers

For hypertension, the snorer, long-term snorer, and persistent snorer groups were independent comorbid factors, even in model 3 (OR, 1.15; 95% CI, 1.07-1.24; p <0.001, OR, 1.14; 95% CI, 1.05-1.24; p=0.002, and OR; 1.20; 95% CI, 1.07-1.34; p=0.001). For diabetes, the short-term snorer group was a significant comorbid factor in model 3 (OR, 0.60; 95% CI, 0.37-0.92; p=0.018). For dyslipidemia, the any-snorer and long-term snorer groups were independent comorbid factors, even in model 3 (OR, 1.08; 95% CI, 1.02-1.15; p=0.008, and OR, 1.09; 95% CI, 1.02-1.17; p=0.007; Table 2).

Relationships between lifestyle-related diseases and comorbid snoring in female workers

In all cases of hypertension (OR, 1.92; 95% CI, 1.47-2.49; p <0.001), diabetes (OR, 2.21; 95% CI, 1.45-3.33; p < 0.001), and dyslipidemia (OR, 1.65; 95%CI, 1.38-1.97; p < 0.001), snoring was a significant comorbid factor only in model 1 (Table 3). In addition, among long-term snorers and persistent snorers, snoring was a significant comorbid factor of hypertension, diabetes, and dyslipidemia in model 1 (Table 3).

Discussion

The incidence of snoring among active Japanese workers 20 to 59 years old was 43% for men and 20% for women. As previously reported (5, 6), the incidence of snoring is high in people of advanced age and high BMI. In men, snoring was still an independent co-factor of hypertension and dyslipidemia even after adjusting for the age, BMI, smoking habit, alcohol consumption, and exercise habit. In particular, snoring was an independent comorbid factor for hypertension among active workers who had been snoring for a few years or for more than a few years. However, snoring was not an independent comorbid factor for lifestyle-related diseases after adjusting for age and BMI in women.

The strength of this investigation was that the medical checkups were performed under the same conditions, as they were conducted at a single facility, and the number of subjects was large. There have been a number of reports on the relationship between snoring and lifestyle-related diseases to date (1, 6-11). Many of these reports evaluated the snoring frequency and intensity, but there have been only few reports that considered the snoring period, as in this study (3). Thus, new findings were obtained through this study in which the snoring period was used as a survey item.

Table 1. Backgrounds of the Subjects.

	Total subjects	Male (n=21,774)					Female (n=3,367)				
			Snorers (n=9,417)			p value		Snorers (n=682)			p value
		Nonsnorers	Short-term	Long-term	Persistent		Nonsnorers	Short-term	Long-term	Persis-tent	
Number of subject (%)	25,141	12,357 (57)	459 (2)	6,359 (29)	2,599 (12)	/	2,685 (80)	109 (3)	447 (13)	126 (4)	/
Age (years)	47±6	46±7	46±6	48±6 ab	47±6 abc	<0.001	46±6	46±6	47±6 d	46±5	0.004
BMI (kg/m^2)	24±4	23±4	24±3 a	25±4 a	25±4 abe	<0.001	22±4	23±4 a	23±4 a	24±4 a	<0.001
Systolic blood pressure (mmHg)	119±13	119±13	119±13	121±13 af	122±13 abc	<0.001	112±14	113±14	116±15 a	113±13	<0.001
Diastolic blood pressure (mmHg)	76±10	76±10	75±10	77±10 ab	78±10 abc	<0.001	70±10	71±10	73±11 a	71±10	<0.001
FPG (mg/dL)	102±17	102±16	101±11	105±19 ab	106±21 abc	<0.001	95±11	97±11	97±15 a	98±14 d	<0.001
HbA1c (%)	5.6±0.6	5.6±0.6	5.6±0.4	5.7±0. 7 ab	5.8±0.7 abc	<0.001	5.5±0.4	5.5±0.3	5.6±0.6 a	5.6±0.5 a	<0.001
LDL-C (mg/dL)	123±30	123±30	127±29 g	125±30 d	125±30	<0.001	115±31	120±33	121±32 a	124±30 g	<0.001
HDL-C (mg/dL)	58±15	57±14	55±13 d	56±14 a	55±13 ac	<0.001	71±16	71±17	68±15 d	67±17 g	<0.001
TG (mg/dL)	124±103	124±103	136±102	139±114 a	147±113 ah	<0.001	73±41	86±48 g	85±50 a	97±71 ac	<0.001
Non-HDL-C (mg/dL)	147±34	147±34	153±34 d	150±34 a	151±34 a	<0.001	134±33	140±37	141±34 a	144±33 d	<0.001
Comorbidity (%)											
Hypertension	4,717 (19)	2,078 (17)	75 (16)	1,558 (25)	709 (27)	<0.001	204 (8)	10 (9)	64 (14)	19 (15)	<0.001
Antihypertensive agents	2,888 (11)	1,195 (10)	36 (8)	1,015 (16)	474 (18)	<0.001	112 (4)	5 (5)	40 (9)	11 (9)	<0.001
Diabetes mellitus	1,915 (8)	849 (7)	22 (5)	643 (10)	299 (12)	<0.001	66 (2)	3 (3)	25 (6)	8 (6)	<0.001
Diabetes drugs	943 (4)	418 (3)	9 (2)	317 (5)	150 (6)	<0.001	31 (1)	0 (0)	12 (3)	6 (5)	0.004
Dyslipidemia	12,450 (50)	6,056 (49)	253 (55)	3,641 (57)	1,552 (60)	<0.001	698 (26)	40 (37)	159 (36)	51 (40)	<0.001
Hypolipidemic agents	2,042 (8)	906 (7)	32 (7)	675 (11)	315 (12)	<0.001	75 (3)	5 (5)	23 (5)	11 (9)	<0.001
Lifestyle (%)											
Current smoker	6,041 (24)	3,065 (25)	114 (25)	1,758 (28)	869 (33)	<0.001	180 (7)	6 (6)	33 (7)	16 (13)	0.068
Alcohol consumption	19,003 (76)	9,310 (75)	363 (79)	5,199 (82)	2,086 (80)	<0.001	1,614 (60)	75 (69)	285 (64)	71 (56)	0.105
Exercise habits	9,928 (39)	5,091 (41)	170 (37)	2,611 (41)	912 (35)	<0.001	935 (34)	33 (30)	144 (32)	32 (25)	0.099

BMI: body mass index, FPG: fasting plasma glucose, HbA1c: glycosylated hemoglobin, LDL-C: low-density lipoprotein cholesterol, HDL-C: high-density lipoprotein cholesterol, and TG: triglyceride

Values are presented as the mean±standard deviation.

[a]p<0.001 vs. Nonsnorers by the analysis of Tukey's honestly significant difference test.

[b]p<0.001 vs. Short-term snorers by the analysis of Tukey's honestly significant difference test.

[c]p<0.05 vs. Long-term snorers by the analysis of Tukey's honestly significant difference test.

[d]p<0.01 vs. Nonsnorers by the analysis of Tukey's honestly significant difference test.

[e]p<0.001 vs. Long-term snorers by the analysis of Tukey's honestly significant difference test.

[f]p<0.01 vs. Short-term snorers by the analysis of Tukey's honestly significant difference test.

[g]p<0.05 vs. Nonsnorers by the analysis of Tukey's honestly significant difference test.

[h]p<0.01 vs. Long-term snorers by the analysis of Tukey's honestly significant difference test.

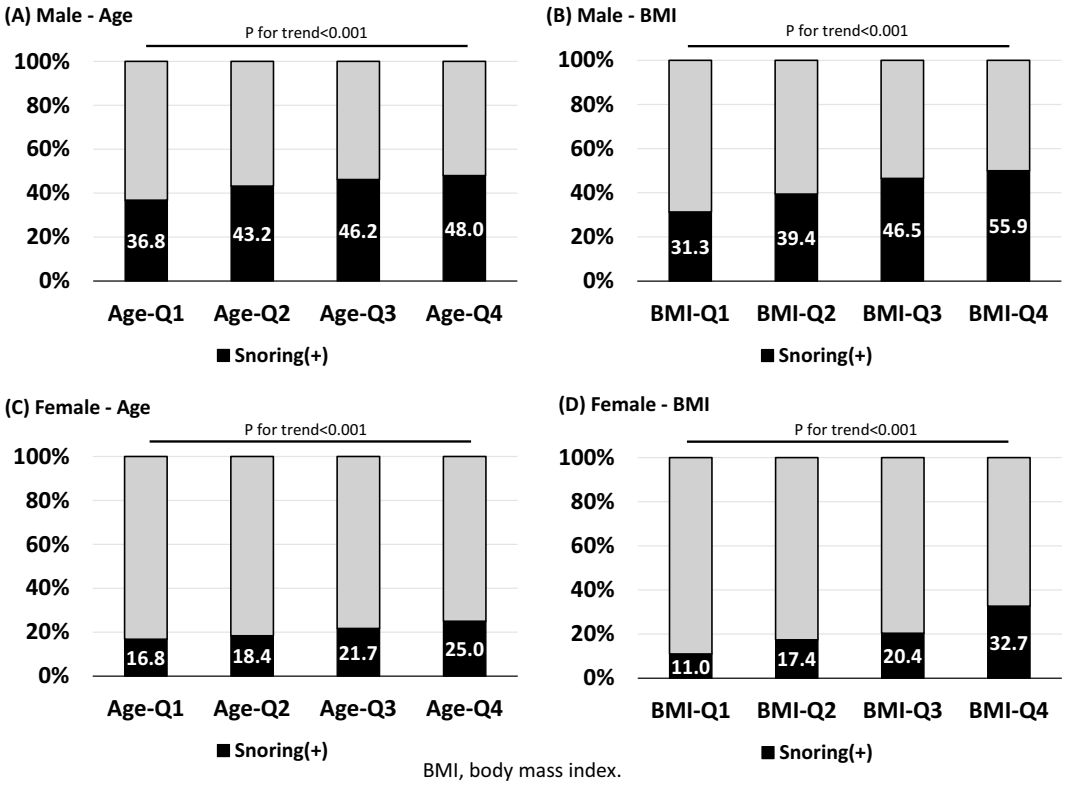

Figure 2. **Prevalence of subjects with snoring according to age and body mass index. (A) Men: The subjects were divided into quartiles by age (Age-Q1 to Q4). (B) Men: The subjects were divided into quartiles by body mass index (BMI; BMI-Q1 to Q4). (C) Women: The subjects were divided into quartiles by age (Age-Q1 to Q4). (B) Women: The subjects were divided into quartiles by BMI (BMI; BMI-Q1 to Q4). The proportion of subjects with snoring significantly increased with advancing age and BMI according to the analysis of Pearson's χ^2 test.**

Self-reported snoring

In the survey, 43% of men and 20% of women reported a snoring habit. It has been said that the prevalence of snoring is gender-dependent and increases with advancing age and BMI (1, 2, 7). It has also been reported that the snoring frequency increases in both male and female Asian subjects up to 59 years of age (8). Similar results were obtained in this study.

In addition, a report on the investigation of sleep status in five areas of Latin America (2) also surveyed the prevalence of snoring with a simple question, "Do you snore all or most nights?" The results of that study revealed that the prevalence of habitual snoring was 61.7% to 72.6% for men and 49.6% to 62.5% for women. Thus, a simple question like that used in this study might result in a high prevalence.

Self-reported snoring as determined in this study cannot be used to evaluate snoring without a bed partner, but recently, apps have been developed for smartphones and other devices that can detect snoring, raising awareness of snoring and aiding in the diagnosis. It has been reported that the reliability of self-reported snoring and snoring reported by roommates can be assured compared with all-night sleep recording (9, 10), and the data from the present survey was considered to be worthy of evaluation.

Snoring and sleep-disordered breathing

The prevalence of habitual snoring in patients with sleep-disordered breathing (SDB) is considered to reach about 80%. However, about 30% of men with habitual snoring and 20% of women with habitual snoring have SDB (12). In other words, snoring and SDB are not synonymous. It is considered that simple soring and SDB are associated with lifestyle-related diseases (13) and are risk factors for developing cardiovascular disease (14, 15). Therefore, snoring is important as a risk factor for health problems.

Snoring and lifestyle-related diseases among a male occupational population

In this study, snoring was an independent comorbid factor of hypertension and dyslipidemia, independent of smoking habits, drinking habits, and poor activity, which are factors other than advanced age and high BMI.

It has been reported that snoring may be directly involved in increasing blood pressure (16, 17). Even in simple snoring without apnea, hypopnea, or desaturation, it is said that increased inspiratory effort due to snoring results in negative intrathoracic pressure, decreased baroreceptor sensitivity, and blood pressure fluctuation (16). The results of this study indicated that the longer the snoring period, the higher the

Table 2. **Results of Logistic Regression Analyses to Determine Lifestyle-related Diseases in Males.**

Snorers	Model 1		Model 2		Model 3	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Hypertension	1.63 (1.53-1.75)	<0.001	1.17 (1.09-1.26)	<0.001	1.15 (1.07-1.24)	<0.001
Diabetes mellitus	1.55 (1.40-1.70)	<0.001	1.04 (0.94-1.16)	0.414	1.05 (0.94-1.16)	0.393
Dyslipidemia	1.43 (1.35-1.51)	<0.001	1.09 (1.03-1.16)	0.003	1.08 (1.02-1.15)	0.008

Short-term snores	Model 1		Model 2		Model 3	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Hypertension	0.97 (0.75-1.24)	0.788	0.87 (0.66-1.14)	0.316	0.86 (0.65-1.12)	0.267
Diabetes mellitus	0.68 (0.43-1.03)	0.068	0.60 (0.37-0.92)	0.017	0.60 (0.37-0.92)	0.018
Dyslipidemia	1.28 (1.06-1.54)	0.010	1.11 (0.91-1.35)	0.317	1.10 (0.90-1.35)	0.342

Long-term snores	Model 1		Model 2		Model 3	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Hypertension	1.60 (1.49-1.73)	<0.001	1.16 (1.07-1.26)	<0.001	1.14 (1.05-1.24)	0.002
Diabetes mellitus	1.52 (1.37-1.70)	<0.001	1.06 (0.95-1.19)	0.294	1.07 (0.95-1.20)	0.246
Dyslipidemia	1.39 (1.31-1.48)	<0.001	1.10 (1.03-1.17)	0.006	1.09 (1.02-1.17)	0.007

Persistent snores	Model 1		Model 2		Model 3	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Hypertension	1.85 (1.68-2.05)	<0.001	1.21 (1.08-1.35)	<0.001	1.20 (1.07-1.34)	0.001
Diabetes mellitus	1.76 (1.53-2.02)	<0.001	1.04 (0.89-1.21)	0.587	1.02 (0.88-1.19)	0.755
Dyslipidemia	1.54 (1.42-1.68)	<0.001	1.08 (0.99-1.19)	0.088	1.02 (0.93-1.12)	0.641

OR: odds ratio, CI: confidence interval

Model 1: unadjusted. Model 2: adjusted for age and body mass index (BMI).

Model 3: adjusted for age, BMI, current smoker, alcohol consumption, and exercise habit.

risk of comorbidity for hypertension. Furthermore, it has been reported that the impact of snoring on hypertension depends on the age and weight (3, 18). There is a strong association between snoring and hypertension in younger people (3, 4, 19) and those near normal weight (4) and less of an association in older people. In particular, there are reports that snoring at a young age causes health problems (15, 16, 20). In other words, it was considered that the evaluation of snoring at regular health checkups for the working generation was important as a health index.

Although the relationship between snoring and diabetes has been previously reported (18), no obvious relationship between snoring and diabetes was identified based on the results of this study.

Some associations between snoring and lipid abnormalities have also been reported (21, 22). There is a report indicating that the intermittent hypoxia-mediated pathology of obstructive sleep apnea affects lipid metabolism and that snoring can cause inflammation, affecting lipid metabolism disorders (22); however, the direct mechanism underlying the involvement of snoring in lipid metabolism is unknown at this time.

Snoring and lifestyle-related diseases among a female occupational population

In women, a univariate analysis showed that all comorbid diseases of snoring, i.e. hypertension, diabetes, and dyslipidemia, were associated with a high OR (1.65-2.21). However, the risk of comorbidity for lifestyle-related diseases was significantly higher in long-term snorers and persistent snorers than in others (OR: 1.39-1.85). This suggests that snoring for several years or longer may be an important health disorder indicator, although there was no significant association between snoring and lifestyle-related diseases after adjusting for advanced age and high BMI. This result indicates that snoring, which increases with advanced age and high BMI, is a strong comorbid factor for lifestyle-related diseases.

Clinical implications of the results of this study

Based on the results of this study, it should be strongly recognized that snoring is a comorbid factor of lifestyle-related diseases for active workers, in whom primary prevention of cardiovascular diseases is particularly important. For both men and women, snoring for a few years or longer tended to increase the risk of comorbid lifestyle-related diseases. In particular, men may be able to be provided lifestyle guidance using their snoring status as a health indicator. Snoring and sleep apnea can be improved by improving obesity and increasing physical activity (23, 24). Smoking is also recognized as a risk factor for developing snoring (7); therefore, smoking cessation guidance may also be neces-

Table 3. Results of Logistic Regression Analyses to Determine Lifestyle-related Diseases in Females.

Snorers	Model 1		Model 2		Model 3	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Hypertension	1.92 (1.47-2.49)	<0.001	1.16 (0.87-1.56)	0.310	1.17 (0.89-1.56)	0.300
Diabetes mellitus	2.21 (1.45-3.33)	<0.001	1.25 (0.79-1.95)	0.329	1.27 (0.80-1.98)	0.312
Dyslipidemia	1.65 (1.38-1.97)	<0.001	1.11 (0.91-1.35)	0.317	1.12 (0.92-1.36)	0.270

Short-term snores	Model 1		Model 2		Model 3	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Hypertension	1.23 (0.59-2.28)	0.555	0.80 (0.37-1.58)	0.542	0.81 (0.37-1.60)	0.553
Diabetes mellitus	1.12 (0.27-3.09)	0.849	0.70 (0.16-2.07)	0.554	0.70 (0.16-2.08)	0.554
Dyslipidemia	1.65 (1.10-2.45)	0.016	1.24 (0.79-1.91)	0.341	1.28 (0.82-1.98)	0.269

Long-term snores	Model 1		Model 2		Model 3	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Hypertension	2.03 (1.50-2.73)	<0.001	1.19 (0.84-1.67)	0.314	1.20 (0.85-1.67)	0.300
Diabetes mellitus	2.35 (1.44-3.72)	<0.001	1.28 (0.75-2.12)	0.351	1.31 (0.77-2.16)	0.312
Dyslipidemia	1.57 (1.27-1.94)	<0.001	1.03 (0.81-1.30)	0.804	1.04 (0.82-1.32)	0.737

Persistent snores	Model 1		Model 2		Model 3	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Hypertension	2.16 (1.26-3.51)	0.006	1.38 (0.77-2.36)	0.268	1.34 (0.74-2.29)	0.322
Diabetes mellitus	2.69 (1.17-5.42)	0.022	1.65 (0.69-3.50)	0.245	1.53 (0.63-3.31)	0.328
Dyslipidemia	1.94 (1.34-2.78)	<0.001	1.26 (0.84-1.87)	0.266	1.24 (0.82-1.85)	0.306

OR: odds ratio, CI: confidence interval

Model 1: unadjusted. Model 2: adjusted for age and body mass index (BMI).

Model 3: adjusted for age, BMI, current smoker, alcohol consumption, and exercise habit.

sary to improve snoring.

In addition, it is also said that snoring without obstructive sleep apnea increases the probability of complaining of daytime sleepiness (25, 26); therefore, the snoring pathophysiology may be important from the viewpoint of improving work efficiency in labor and preventing industrial accidents.

Study limitations

Whether or not the results of the present study can be applied to general workers is unclear. This study was also unable to distinguish between cause and effect. The background of the subjects was based on their own answers, so it might be inaccurate.

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

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