Title:

Prevalence of sleep-disordered breathing among women working in the aged care services in Japan

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Abstract

Objectives

The aim of this study was to examine the prevalence of sleep-disordered breathing (SDB) in women working in the field of aged care in Japan.

Methods

A cross-sectional study was conducted for female employees aged 18–60 years in aged care facilities in Japan. The analyzed set consisted of 712 participants with complete data. SDB was determined by respiratory disturbance index (RDI), measured using an ambulatory airflow monitor with a polyvinylidene fluoride film sensor to detect nasal and oral airflow overnight at home. Based on the findings of previous studies, RDI 10 was considered equivalent to apnea-hypopnea index (AHI) 15.

Results

The prevalence of moderate to severe SDB (RDI ≥ 10) was 22.8%. The mean age was 38.1 years, and mean sleeping time of participants was 6.1 hours. The median body mass index (BMI) was 22.0. Women with moderate to severe SDB (RDI ≥ 10) had a higher age, neck circumference, neck-height ratio, BMI, systolic blood pressure, and increased prevalence of hypertension, short sleepers (amount of sleep on the SDB testing day < 6 hours), and habitual snorers, compared to women with no or mild SDB (RDI < 10).

Conclusions

Our study found that women working in the aged care services in Japan were heavily burdened by SDB even though they were relatively young and slim. To prevent CVD from developing in the future, programs through which workplaces can help their employees improve their lifestyle, and early diagnosis and treatment of SDB are highly recommended. (246 words)

Key Terms

industrial health, nursing staff, shift work, sleep, sleep apnea

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Author contributions:

Study concept and design: YS, AI, HW, KM, NM, and TT. Acquisition of data: YS, AI, HW, KM, NM, RF, YS, SI, YH, and TT. Statistical analysis and drafting of the manuscript: YS. Analysis, interpretation of data, and critical revision of the manuscript for important intellectual content: All authors.

Conflict of Interest

Takeshi Tanigawa is a part-time occupational physician of Koyama Healthcare Group. The other authors declare no conflict of interest.

Introduction

The rate of aging in Japan is the most pronounced worldwide; in 2015, 26.6% of the population was over 64 years old (National Institute of Population and Social Security Research). According to an estimate, Japanese society will continue to age, and people over 64 years old will comprise 37.7% of the national population by 2050, while people of working age (15−64 years old) will account for only 51.8% (National Institute of Population and Social Security Research). The demand for aged care services increases with an aging population, and the health maintenance of workers in this field becomes increasingly important.

Aged care services largely rely on the female labor force. According to a nationwide survey of the working conditions of aged care staff, women make up 79.8% of all employees of aged care facilities (Care Work Foundation). The 2016 labor force survey in Japan further reported that a total of 1.2 million women were engaged in aged care services, three times the number of men working in the same field (0.4 million) (Statistics Bureau 2017). Aged care staff is more likely to engage in shift work to provide a 24-h service, which potentially results in adverse health impacts (Brown et al. 2009). Furthermore, due to the persisting traditional social norms indicating that women should stay at home and perform household chores, women working in Japan face the burden of playing multiple roles as a worker and as a family member (Honjo et al. 2016; Ikeda et al. 2009). Thus, they experience various psychological stresses, and have difficulties in achieving an optimal work-life balance (Chandola et al. 2004; Makabe et al. 2015; Sekine et al. 2006).

Overly long, short, or poor quality sleep generally increases the risk of premature death and cardiovascular diseases (CVDs), and impairs cognitive function in both men and women (Meisinger et al. 2007; Patel et al. 2004; Tanno et al. 2017). Working women in Japan sleep 17 minutes less (Statistics Bureau 2012) and have poorer sleep quality than working men (Sekine et al. 2006). An international comparison by the Economic Co-operation and Development (OECD) further emphasizes the poor status of sleep quality in Japanese women, showing that women in Japan have the shortest sleep duration among both men and women of 26 OECD countries (OECD Social Policy Division Directorate of Employment 2016).

Sleep-disordered breathing (SDB) is one factor that can impair sleep quality through disturbed breathing and occasional arousal during sleep (Malhotra and White 2002). SDB increases blood pressure, leading to increased future risk of CVDs and cerebrovascular diseases (Malhotra and White 2002). Therefore, SDB is an important public health issue. A previous study of community-dwelling women in Japan reported prevalence of SDB (defined by 3% oxygen desaturation index (ODI) $\geq$ 10) at 6.4%; however, the study participants were relatively old (mean age 54 years) and 70.5% were post-menopausal, which is a risk factor of SDB (Cui et al. 2008). Studies of SDB in working women are rare, and to our knowledge only one report exists, where SDB prevalence (apnea-hypopnea index (AHI) $\geq$ 15, measured by the full polysomnography (PSG)) in working women in the United States was found to be at 4.0% (Young et al. 1993). SDB prevalence in working women in Asia has not yet been reported.

While working in the aged care services is physically and psychologically demanding for women, studies regarding women's health in this field are scarce and mostly focus on lower back pain, fatigue, and stress, instead of SDB (Fujii et al. 2007; Harano et al. 2012; Mitoku 2010). Therefore, this study aimed to examine the prevalence of SDB in women working in the field of aged care.

Methods

Study sample

Our study participants consisted of employees in aged care facilities in Japan. Women aged 18−60 years were eligible for this study regardless of their job category or working time status; however, those already diagnosed with or receiving treatment for SDB were excluded. A total of 745 women registered, of which 17 women declined to participate in the study, or could not attend due to work schedule conflicts or sickness (response rate = 97.7%), and 16 women failed to monitor SDB during their participation. Overall, 712 women were eligible for data analysis. The protocol of this study was approved by the ethical review board of the Juntendo University Faculty of Medicine, Tokyo, Japan, in 2014 (authorization number: 2014057). Written informed consent was obtained from each participant.

Outcome measurements

SDB was determined using the respiratory disturbance index (RDI), which is the number of respiratory disturbance events per hour. RDI was measured using a single-channel airflow monitor (NGK Spark Plug, Nagoya, Japan) with a polyvinylidene fluoride film sensor, which detects both nasal and oral airflow. The participants were asked to wear the monitor overnight at home when they slept, and to keep a record of their sleep time. The collected data were analyzed automatically using a computer program (Institute of Sleep Health Promotion, Tokyo, Japan) that calculated RDI. This method has been used in previous studies, including a cultural comparison between countries (Nakano et al. 2007; Yamagishi et al. 2010), and the comparability of this method to the AHI of full polysomnography has previously been validated (Nakano et al. 2008). In brief, RDI 5.3, RDI 11.4, and RDI 19.6 obtained by this method is equivalent to AHI 5, AHI 15, and AHI 30, respectively. The reproducibility of the two tests performed at home, calculated as the interclass correlation coefficients, was 0.92, and the sensitivity of using RDI 11.4 to detect AHI 15 was 0.91, while specificity was 0.82 (Nakano et al. 2008). We defined RDI < 5 as no SDB, 5 ≤ RDI < 10 as mild SDB, 10 ≤ RDI < 20 as moderate SDB, and RDI ≥ 20 as severe SDB. Due to the small number of participants with severe SDB (n = 29), we combined severe SDB with moderate SDB in our analyses and classified them as cases of RDI ≥ 10.

Covariates

Height (cm) and weight (kg) were measured in stockings and light clothes. Body mass index (BMI) was calculated by dividing weight (kg) by height (m) squared. Neck circumference (NC) was horizontally measured at the level of the cricothyroid membrane (Davies and Stradling 1990). Neck-height ratio (NHR) was calculated by dividing NC by height to adjust for the increase in neck circumference with height (Dancey et al. 2003).

Blood pressure was measured twice on the right arm after a 5-minute rest, and mean values were used for analysis. Hypertension was determined as systolic blood pressure ≥ 140, or diastolic blood pressure ≥ 90, or antihypertensive medication use. Using a self-administered questionnaire, we collected data regarding age, habitual snoring, current alcohol intake, current smoking habits, work category, shift work, menopause, and medical history, and obtained values for the Japanese version of the Epworth Sleepiness Scale (JESS) (Takegami et al. 2009), the Athens Insomnia Scale (AIS) (Okajima et al. 2013), the Perceived Stress Scale (PSS-4) (Cohen et al. 1983), and the Center for Epidemiologic Studies Depression scale (CES-D) (Li et al. 2011).

Statistical analysis

The age-adjusted mean values and prevalence in the three RDI groups (< 5.0, 5−9.9, and ≥ 10) were calculated using the χ^2-test, one-way analysis of variance, and analysis of covariance. Additionally, we stratified the data based on median BMI (< 22.0 or ≥ 22.0) for further analysis. All statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC, USA). All statistical tests were two-tailed, and differences with $p < 0.05$ were considered statistically significant.

Results

The mean age of the 712 female participants (38.1 years) and other basic characteristics are presented in Table 1. Thirty-five percent of women worked night shifts, 12.2% were clerks, 40.4% were aged care staff, and 18.9% were nurses.

The prevalence of no SDB (RDI < 5), mild SDB (5 ≤ RDI < 10), and moderate to severe SDB (RDI ≥ 10) was 39.2%, 38.1%, and 22.8%, respectively. Women with moderate to severe SDB had a higher age, NC, NHR, BMI, systolic blood pressure, and increased prevalence of hypertension, short sleepers (amount of sleep on the SDB testing day < 6 hours), and habitual snorers, compared to women with no or mild SDB (RDI < 10).

We found significant differences in age-adjusted SDB prevalence when the data was stratified by BMI group (i.e., above or below median BMI). SDB prevalence at RDI ≥ 5 was 59.7% in the BMI < 22.0 group, and 67.7% in the BMI ≥ 22.0 group (p = 0.03); at RDI ≥ 10, SDB prevalence was 22.3% in the BMI < 22.0 group, and 31.5% in the BMI ≥ 22.0 group (p = 0.003; Figure 1). In the group with lower BMI, age, BMI, and the proportion of habitual snorers were higher, whereas the proportion of insomnia was lower among women with moderate to severe SDB, compared to women with no or mild SDB. In the group with higher BMI, the age, NC, NHR, BMI, systolic blood pressure, and the proportion of short sleepers were higher among women with moderate to severe SDB, compared to women with no or mild SDB (Table 2).

Analysis of data stratified by job category showed significant differences (20.2% and 28.7% for nurses and non-nurses respectively; p = 0.04) in the prevalence of moderate to severe SDB (RDI ≥ 10), but did not show any difference in the prevalence of mild SDB (5 ≤ RDI < 10).

Discussion

The prevalence of moderate to severe SDB (RDI ≥ 10, equivalent to AHI ≥ 15 (Nakano et al. 2008)) among women working in the aged care services was 22.8%. Mean sleeping time in study participants was 6.1 hours, which was shorter than the ideal 7 hours associated with the least relative risk of all-cause mortality (Wingard and Berkman 1983).

Compared to previous studies in women (Cui et al. 2008; Young et al. 1993), the SDB prevalences obtained in our study seem relatively high; however, a recent study from Switzerland on community-dwelling women over 40 years old reported SDB prevalences of 60.8% and 23.4% for AHI ≥ 5 and AHI ≥ 15, respectively, which is similar to our findings (Heinzer et al. 2015). Another recent study of working men in Japan also reported similar SDB prevalences (RDI 5−14.9: 37.4%, RDI 15−29.9: 15.7%, RDI ≥ 30: 6.6%) (Nakayama-Ashida et al. 2008). Reasons for the relatively high SDB prevalence in recent studies include increasing obesity (World Health Organization), improvement of the technology used to detect SDB, and changes in SDB criteria for determining hypopnea; e.g., Young, et al. (1993) defined hypopnea as a 4% decrease in oxyhemoglobin saturation, whereas Franklin et al. (2013) lowered this threshold to 3% desaturation (BaHammam et al. 2014; Franklin et al. 2013; Heinzer et al. 2016; Peppard et al. 2013; Ruehland et al. 2009; Senaratna et al. 2016; Young et al. 1993).

Using RDI instead of ODI as a home-test SDB indicator is a strength of our study. Results obtained by ODI are known to be affected by body size, and there is a possibility that ODI might not detect SDB accurately in people with BMI below 25.0, whereas RDI can be used for any BMI range (Nakano et al. 2008). Thus, we were able to identify

SDB without the influence of body size using RDI, even among Japanese women, who have a low prevalence of overweight individuals (Ministry of Health 2016).

Similar to the results of previous studies (Cui et al. 2008), BMI and SDB were positively associated in our study. The mean BMI of our study participants was 23.0, which was higher than the average BMI (21.8) of the general population of Japanese women in a similar age range (20–59 years old) (Ministry of Health 2016). This higher BMI is likely one of the reasons for the high SDB prevalence in our sample population. NC and NHR were also positively associated with SDB, which is consistent with previous study findings (Dancey et al. 2003).

Our study participants showed a relatively high percentage of short sleepers, shift workers with night shifts, and individuals with low socio-economic statuses such as low education (education ≤ 12 years), which have been reported as risk factors of increased BMI (Anzai et al. 2000; Gangwisch et al. 2005; Karlsson et al. 2001). Night shift workers and individuals of low socio-economic status have been found to have poor health-related behaviors, including high dietary intake, and less exercise, which can be associated with increased BMI, and high smoking rates (Anzai et al. 2000; Honjo et al. 2008; Wang et al. 2012). We found that 24.9% were current smokers, and 23.3% were overweight (BMI ≥ 25). These proportions are remarkably high compared to the national representative values for women in the same age range (9.7% current smokers and 15.7% overweight individuals) (Ministry of Health 2016). Higher BMI (Wetter et al. 1994) and smoking (Newman et al. 2001) have been identified as risk factors of SDB, and one study has shown a possible relationship between job-related stress, including high job demands, and SDB (Nakata et al. 2007). These factors in particular are strongly represented in our sample, given the population's socioeconomic background and the nature of their jobs, potentially increasing the prevalence of SDB in the present study.

Another study has also reported that when night shift work and SDB were combined, the severity of SDB worsened (Verde-Tinoco et al. 2017). This indicates the possibility that night shift work, which is inevitable for aged care service providers, may have also increased our sample population's SDB prevalence. Furthermore, previous studies have found that sleep deprivation is a predisposition to SDB (White et al. 1983); our sample population generally sleeps shorter than the average Japanese (OECD Social Policy Division Directorate of Employment 2016). Effort Reward Imbalance is associated with short sleep among Japanese working women (Utsugi et al. 2005); aged care services, a physically and psychologically demanding but low-waged job (Ministry of Health 2018), might contribute to the comparably high SDB prevalence.

Our study enrolled a large sample population, and is the first to examine SDB prevalence among women working in the aged care services. Our study used RDI, which can be applied to investigate SBD in populations regardless of their BMI range, to detect SDB among Japanese women, who are known to be relatively slim (Ministry of Health 2016).

In this study, RDI was measured using a single-channel airflow monitor with a polyvinylidene fluoride film sensor to detect SDB. Although this single-channel equipment is an ambulatory home test (i.e., it does not use PSG as a standard to measure AHI), its comparability to AHI has been validated; namely, RDI ≥ 11.4 was equivalent to AHI ≥ 15, which demonstrates moderate SDB (Nakano et al. 2008).

Concluding Remarks

Our study found that women working in the aged care services in Japan had a relatively high SDB prevalence despite their relatively low age (mean = 38.1 years) and low BMI (median = 22.0). The mean sleeping time in study participants was 6.1 hours, which was shorter than the ideal 7 hours associated with the least relative risk of all-cause mortality (Wingard and Berkman 1983). Women working in aged care services experience severe health burdens as they are exposed to shift work and have relatively high smoking rates. The mean BMI = 23.0 in our study participants was higher than the Japanese national average of 21.8 (Ministry of Health 2016), but was lower than the BMI reported in Western countries (World Health Organization). Nevertheless, BMI was associated with SDB even when we stratified our results by the median BMI. This shows that the situation regarding SDB in Japan is similar to that reported in Western countries. Due to the socioeconomic background and nature of the job for women working in aged care services, the smoking rate and proportion of shift work and short sleepers were high, all of which are known to be CVD risk factors, together with SDB. To prevent CVD from developing in the future, programs through which workplaces can help their employees improve their lifestyle, such as those providing guidance for smoking secession, the development of healthier eating and sleeping habits, and early diagnosis and treatment of SDB, are highly recommended.

Figure legends

Fig. 1

Age-adjusted prevalence of SDB (RDI $\geq$ 5, RDI $\geq$ 10) among women aged 18–60 stratified by BMI (BMI < 22 vs. BMI $\geq$ 22). SDB = sleep-disordered breathing, BMI = body mass index, RDI = respiratory disturbance index

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Table 1. Basic characteristics according to RDI among 712 Women.

	RDI								
	All		<5.0		5-9.9		≥10		*p*-for difference
Median RDI	6.0		3.1		7.0		14.1		
Number	712		279 (39.2%)		271 (38.1%)		162 (22.8%)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age, years	38.1	11.5	34.8	10.6	37.9	11.1	44.2	11.4	<.0001
NC, cm	32.6	2.5	32.3	2.2	32.5	2.4	33.5	2.8	<.0001
NHR	0.206	0.02	0.205	0.01	0.206	0.01	0.212	0.02	<.0001
NC≥32.0 (Median), %	55.4		53.1		56.3		65.5		0.06
BMI, kg/m^2	23.0	4.2	22.5	3.5	22.8	4.0	24.9	5.1	<.0001
Systolic blood pressure, mmHg	113.0	16.4	111.6	14.1	113.2	15.3	116.7	19.9	0.01
Diastolic blood pressure, mmHg	68.0	11.2	67.6	9.8	68.2	10.9	69.9	13.2	0.11
Antihypertensive medication use, %	4.6		4.90		5.09		8.82		0.15

Hypertension, %	11.5		10.0		12.7		18.6		0.03
Alcohol intake, %	37.1		34.0		34.6		41.3		0.33
Current smoker, %	24.9		22.2		25.4		24.2		0.71
Amount of sleep on the testing day <6 h, %	57.5		53.3		55.8		68.8		0.03
Excessive daytime sleepiness, %	29.2		31.8		29.4		26.7		0.57
Insomnia, %	33.5		32.4		39.5		32.0		0.15
Habitual snoring (≥3 times per week), %	13.8		8.7		11.6		22.2		0.001
Post menopause, %	18.8		23.8		25.0		21.2		0.20
Shift work, %	35.0		32.0		39.0		35.2		0.24
Depression, %	24.1		21.0		25.1		22.2		0.53
Stress (PSS-4 score)	5.9	2.0	5.8	2.0	5.9	2.0	5.8	2.0	0.70

SD: Standard Deviation, RDI: Respiratory disturbance index (times/hour), BMI: Body mass index, NC: Neck circumference, NHR: Neck-height ratio (neck/height), Hypertension: systolic blood pressure≥140, or diastolic blood pressure≥90, or antihypertensive medication use, Excessive daytime sleepiness: Epworth sleepiness scale≥11, Insomnia: Athens Insomnia Scale≥6, Depression: Center for Epidemiologic Studies Depression Scale≥11 and/or depression medication, PSS: Perceived Stress Scale

Fig 1.

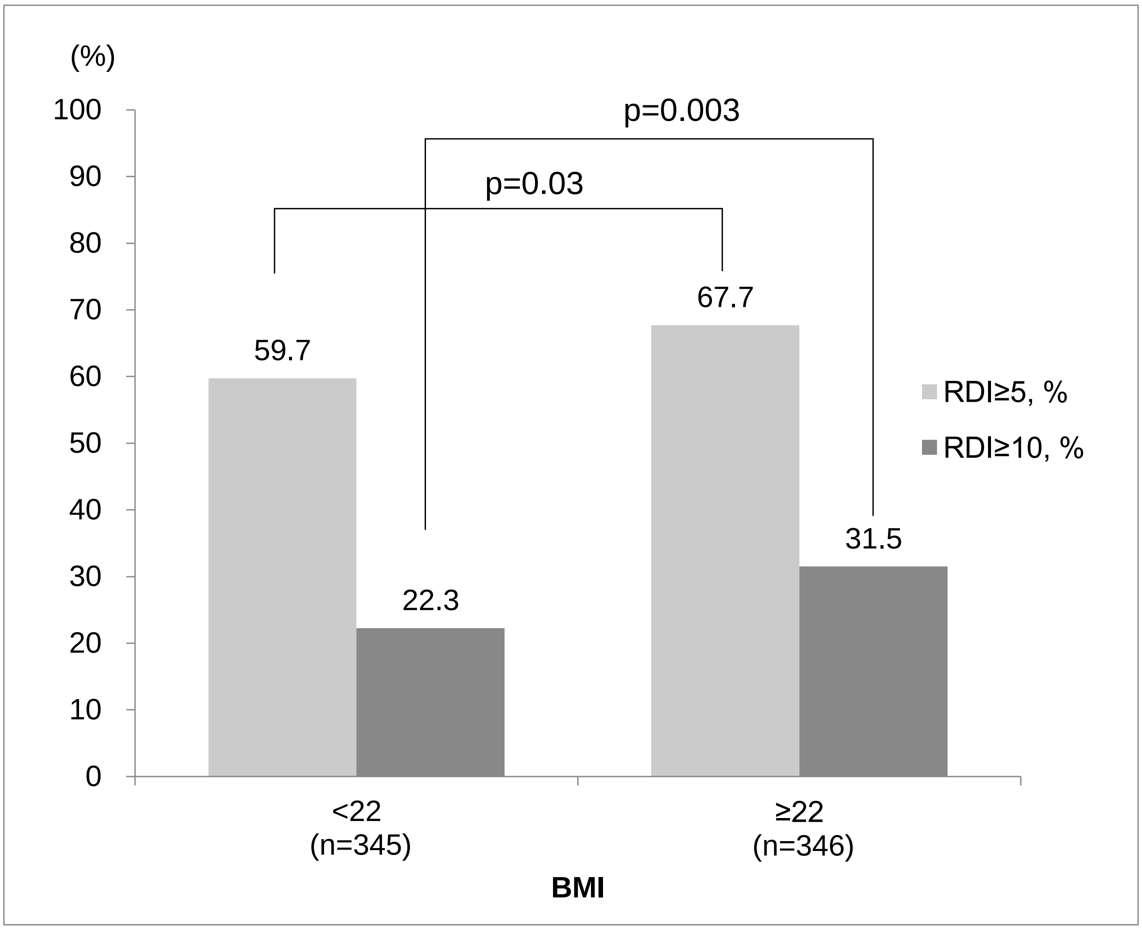
(%)
100
90
80
70
60
50
40
30
20
10
0
p=0.003
p=0.03
67.7
59.7
RDI≥5, %
RDI≥10, %
31.5
22.3
<22
(n=345)
≥22
(n=346)
BMI

Table 2. Age-Adjusted Means by RDI, Stratified by BMI.

BMI<22.0, Median BMI

	RDI						
	<5.0		5-9.9		>10		*p*-for difference
Median RDI	3.1		6.8		13.1		
Number (Total 345)	154		131		60		
	Mean	SE	Mean	SE	Mean	SE	
Age, years	34.2	9.9	38.2	11.1	43.6	12.0	<.0001
NC, cm	31.1	1.2	31.0	1.4	31.4	1.3	0.314
NHR	0.197	0.01	0.196	0.01	0.198	0.01	0.57
NC≥32.0(Median), %	28.5		30.1		29.6		0.96
BMI, kg/m^2	20.1	1.3	19.7	1.5	20.3	1.3	0.037
Systolic blood pressure, mmHg	105.9	12.0	107.7	13.9	108.6	15.0	0.84
Diastolic blood pressure, mmHg	63.7	8.5	65.0	9.0	66.0	11.2	0.97
Antihypertensive medication use, %	0.3		1.2		4.6		0.08
Hypertension, %	2.4		4.9		5.4		0.42
Diabetes medication use, %	-		-		-		-

Alcohol intake, %	37.4		34.5		47.9		0.25
Current smoker, %	26.4		25.5		27.1		0.97
Amount of sleep on the testing day <6 h, %	48.1		53.6		56.1		0.57
Excessive daytime sleepiness, %	34.0		27.8		25.5		0.43
Insomnia, %	31.4		42.1		23.7		0.040
Habitual snoring (≥3 times per week), %	6.1		6.0		19.7		0.01
Post menopause, %	25.6		26.0		21.4		0.28
Shift work, %	29.2		38.0		27.0		0.20
Depression, %	22.1		23.7		18.2		0.73
Stress (PSS-4 score)	5.7	2.0	5.9	2.2	6.2	1.9	0.89

SE: Standard error, RDI: Respiratory disturbance index (times/hour), BMI: Body mass index, NC: Neck circumference, NHR: Neck-height ratio (neck/height), Hypertension: systolic blood pressure ≥ 140, or diastolic blood pressure ≥ 90, or antihypertensive medication use, Excessive daytime sleepiness: Epworth sleepiness scale ≥ 11, Insomnia: Athens Insomnia Scale ≥ 6, Depression: Center for Epidemiologic Studies Depression Scale ≥ 11 and/or depression medication, PSS: Perceived Stress Scale

Cont. Table 2. Age-Adjusted Means by RDI, Stratified by BMI.

BMI≥22.0, Median BMI

	RDI						
	<5.0		5-9.9		≥10		*p*-for difference
Median RDI	3.1		7.0		14.6		
Number (Total 346)	118		130		98		
	Mean	SE	Mean	SE	Mean	SE	
Age, years	35.8	11.4	37.6	11.1	44.3	10.9	<.0001
NC, cm	33.6	2.3	33.9	2.3	34.8	2.7	0.012
NHR	0.213	0.02	0.214	0.01	0.221	0.02	0.016
NC≥32.0(Median), %	82.6		80.7		84.9		0.76
BMI, kg/m^2	25.2	3.3	25.7	3.5	27.5	4.6	0.0003
Systolic blood pressure, mmHg	115.5	14.9	117.6	15.1	125.0	20.1	0.039
Diastolic blood pressure, mmHg	69.4	10.4	70.5	11.8	74.8	13.3	0.29
Antihypertensive medication use, %	8.4		7.2		12.5		0.35
Hypertension, %	16.5		18.4		27.9		0.10
Diabetes medication use, %	3.1		2.8		6.0		0.20

Alcohol intake, %	29.3		35.9		38.1		0.42
Current smoker, %	20.4		25.7		20.7		0.60
Amount of sleep on the testing day <6 h, %	58.4		60.2		76.3		0.047
Excessive daytime sleepiness, %	29.7		30.6		22.7		0.44
Insomnia, %	30.9		39.5		32.1		0.34
Habitual snoring (≥3 times per week), %	12.6		15.7		23.0		0.21
Post menopause, %	23.4		25.6		20.5		0.31
Shift work, %	32.6		38.3		43.5		0.32
Depression, %	21.5		28.4		20.0		0.30
Stress (PSS-4 score)	5.7	2.0	6.0	1.8	5.9	2.1	0.37

SE: Standard error, RDI: Respiratory disturbance index (times/hour), BMI: Body mass index, NC: Neck circumference, NHR: Neck-height ratio (neck/height), Hypertension: systolic blood pressure ≥ 140, or diastolic blood pressure ≥ 90, or antihypertensive medication use, Excessive daytime sleepiness: Epworth sleepiness scale ≥ 11, Insomnia: Athens Insomnia Scale ≥ 6, Depression: Center for Epidemiologic Studies Depression Scale ≥ 11 and/or depression medication, PSS: Perceived Stress Scale