Snoring & Sleep Apnea: A Population Study in Italian Women

Luigi Ferini-Strambi, Marco Zucconi, Vincenza Castronovo, Paola Garancini ,* Alessandro Oldani, and Salvatore Smirne

*Sleep Disorders Center and *Epidemiology Unit, State University and IRCCS H San Raffaele, Milan, Italy*

Abstract: The aim of this cross-sectional study was to evaluate the prevalence of sleep-disordered breathing by means of a validated portable instrument (MESAM IV) and to investigate the relationship between snoring and sleep apnea in a sample of Italian middle-aged female population. We randomly chose 750 subjects aged 40 to 65 years and 365 agreed to participate to the study. In this group, 19.7% of subjects were every-night snorers according to the questionnaire; when recorded, 54.2% snored for more than 10% of the night, and 7.1% for more than 50% of the night. Sleep apnea was also common: 10.7% of subjects had a respiratory disturbances per hour (RDI) between 5 and 9, 7.7% an RDI between 10 and 19, and 2.2% had an RDI ≥20. Snoring percentage and RDI were significantly correlated. However, 50% of subjects who snored for more than half the night had no evidence of sleep apnea. Snoring amount >50% resulted influenced by body mass index, while RDI>10 was influenced by neck diameter. We concluded that in middle-aged women, both snoring and sleep apnea are very common. A high percentage of snoring is not essential for the occurrence of sleep apnea, nor it necessarily indicates the presence of sleep apnea.
Key words: Snoring; sleep apnea; female population; epidemiology

INTRODUCTION

SNORING IS A CONSEQUENCE OF CHANGES in the configuration and properties of the upper airway that occur during sleep. About 20 years ago some authors noted that habitual snoring might be related to obstructive sleep apnea (OSA).[1] Some studies suggested that snoring and OSA might be associated with a number of forms of morbidity and, in particular, with vascular diseases.[2-5] Since snoring is invariably present in OSA patients, it is likely that the observed linkage between snoring and coronary and cerebrovascular diseases is due to OSA.[6] The 1993 community-based study by Young and colleagues[7] found that the prevalence of OSA, defined categorically as an apnea-hypopnea index (AHI) greater than five, was 9% in women and 24% in men. This prevalence result is similar to current findings in other countries.[8-11] Estimates of snoring prevalence have been usually determined from subjective reports. Only a recent epidemiologic study in Australian middle-aged men examined the relationship between snoring (objectively measured by home monitoring) and OSA.[12] These authors found that 26% of subjects had an RDI≥5, and 10% had an RDI≥10.

The aim of our cross-sectional study was to evaluate the prevalence of sleep-disordered breathing by means of home monitoring and to investigate the relationship between snoring and sleep apnea in a sample of Italian middle-aged female population.

Accepted for publication July 1999
Correspondence should be addressed to: Luigi Ferini-Strambi, MD, Sleep Disorders Center, University of Milan, H San Raffaele, Via Stamira d'Ancona 20, 20127 Milano, Italy, Phone: 39.2.26433383, Fax: 39.2.26433394, E-mail: FERINISTRAMBI.LUIGI@HSR.IT

METHODS

Population Selection

From the official records of the town of Abbiategrasso (20 km southwest of Milano; 28,000 inhabitants), we selected female subjects born and still resident in Abbiategrasso and aged between 40 and 65 years. We obtained a sample of 1,800. From these subjects, 750 were randomly chosen for the study, on the basis of power analysis considerations and refusal estimate. Each subject received a letter of explanation followed by a telephone call.

The study was done between February and April 1995. The subjects were asked to meet the research staff in the hospital of Abbiategrasso. Between 6 PM. and 8 PM, they were provided with recording equipment, the MESAM IV (Madaus Medizin-Elektronik, Freiburg, Germany).[13] Before the placement of the leads, an interview based on a symptom checklist was administered to each subject asking about life habits, medical history, and sleep habits with particular reference to snoring. The following information was requested for the analysis in this study: snoring, weight, height, neck circumference (at the level of the cricothyroid membrane). Snoring was defined on the basis of the answer to the question "Do you snore?" The possible answers were "never," "sometimes," "often," and "always."

Subjects slept at home and noted on a diary the bedtime and waking time. In the morning the devices were removed and data transferred to computer.

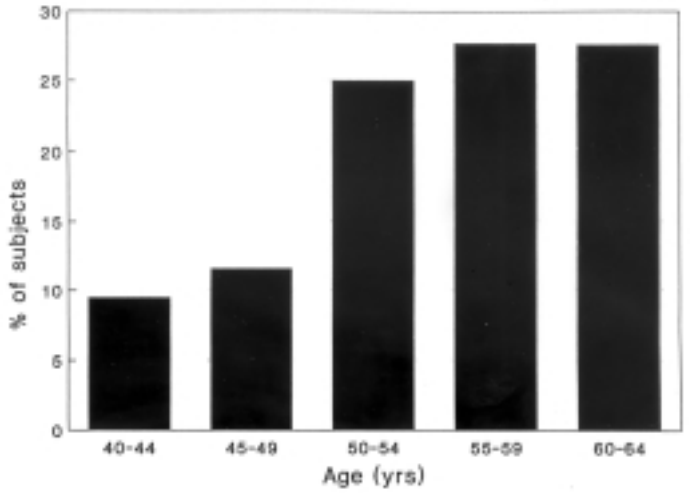

Figure 1. Histogram of rates of "Always snoring" by age

Equipment (MESAM IV)

The MESAM IV is a four-channel digital recording device for monitoring heart rate (HR), snoring sounds, oxygen saturation, and body position. The HR is monitored through a three-lead ECG and R-R intervals are measured in milliseconds. Snoring sounds are monitored through an electric subminiature microphone, type MCE 2.000, that is taped above the larynx. Oxygen saturation is measured with a flex finger probe. The body position sensor, a flat cylinder 18mm high with a diameter of 50 mm, is placed on the lower part of the sternum of the subject. Detailed descriptions of the MESAM IV device and its validity in collecting and displaying snoring, heart rate, and SaO2 data have been published.[13,14]

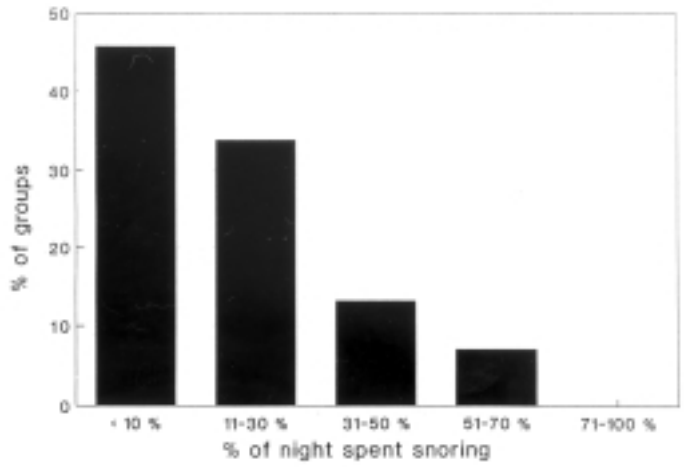

Figure 2. Histogram of the percentage of the night (from bedtime to waking time) that each subject spent snoring

MESAM IV Data Analysis

The data were printed out using the expanded version of the MESAM IV software program. An experienced scorer in the Sleep Disorder Center of University of Milano performed the analysis. Since sleep cannot be identified by MESAM IV, the time from bedtime to waking time (subject's diary) was considered sleep time. Each 5-minute epoch was scored according to Bearpark et al criteria.[12]

Respiratory disturbance index. A respiratory disturbance was scored if an episode of oxygen desaturation > 4% of the preceding baseline level, determined by visual analysis, occurred with (a) an increased HR of at least 10 beats/min, (b) a burst of snoring associated with commencement and termination of a desaturation episode, or (c) with both (a) and (b). An RDI (total number of respiratory disturbances/estimated sleep time in hours) was calculated for each subject. Before this study, 14 patients with suspected OSA were monitored simultaneously with both MESAM IV and standard polysomnography in our sleep lab. The RDI values obtained by MESAM IV and the above described scoring method showed a good agreement with those obtained by polysomnography, according to the method of Bland and Altman[15] (mean±SD=31.8±27.5vs 31.5±26.1, RDI Mesam IV minus RDI PSG = 0.08, 95 % CI=11.5 to -11.6).

Snoring percentage. A value from 0 to 9 was visually determined for each 5-min epoch to indicate the proportion of snoring: 0 indicated no snores and 9 indicated continuous repetitive snoring. An epoch of continuous repetitive respiratory disturbance with snoring terminating each episode was also scored 9. Snoring percentage was the sum of scores for all epochs/(number of epochs x 9) x 100.

Oxygen desaturation. The mean and minimum overall SaO2 percentage values were determined in each subject by visual inspection and direct measurement on the raw data collected and printed-out. In any epoch, SaO_2 data were omitted from analysis when artifact occurred.

Statistical Analysis.

Spearman correlation analysis was used to measure the relationship between snoring and RDI. ANOVA was used to assess the relationship between sleep-disordered breathing variables (RDI, snoring percentage, mean and minimum SaO_2) and potential correlates: age, body mass index (BMI), neck circumference, reported daily alcohol consumption, smoking (cigarettes/day). These potential correlates (independent variables) were analyzed as continuous variables, and the sleep-disordered breathing variables were categorized as follows: RDI (≤10 and >10), snoring percentage (≤50% and >50%), mean SaO_2 (≤97% and > 97%; on the basis of median value of our studied sample) and minimum SaO_2 (<90% and ≥90%). The relationship between the respiratory variables and the categorical vari-

Table 1—Age and BMI in randomized and studied samples

Parameters	Randomized sample (n=750)	Studied sample (n=365)	P
Age, mean (SD)	53.1 (6.3)	53.7 (6.9)	NS (Student's t test)
BMI, mean (SD)	24.2 (4.2)	24.9 (4.7)	NS (Student's t test)
"Always" snorers, %	17.7	19.7	NS (Chi-Square)

ables (menopause and current smoking status) were determined by Chi-square analysis. To examine the effects on sleep-disordered breathing (SDB) of the variables identified as significant in univariate analysis, logistic regression models were constructed using RDI, snoring percentage, mean and minimum SaO_2 (dependent variables), all categorized as just described. To facilitate interpretation of the odds-ratio, BMI was categorized as normal (<25 Kg/m²), overweight (≥25 and <30 Kg/m²) and obese (≥30 Kg/m²). The risk for age was provided for five-year increment. Neck diameter was considered as a continuous variable (by 1-cm increment).

RESULTS

Population Characteristics

Of 750 randomly selected female subjects, 365 agreed to participate (48.7%). Refusals were motivated with "being busy with work" (n=136), intercurrent illness (n=46), fear of examination (n=185), and unspecified by 18 subjects.

The mean age and distribution of the subjects studied was not significantly different from that of the initial random group, nor BMI and the percentage of subjects that reported to snore "always" (Table 1).

During the previous five years, 1.0% of the group reported having had a stroke, 1.5% a heart attack, 2.5% angina, 2.5% asthma, 4.5% bronchitis. Hypertension was reported by 23% of the subjects and diabetes by 3.5%. Smokers were 13% of the group. These prevalence rates are similar to those reported in a large Italian female population sample [16].

Prevalence of Sleep-Disordered Breathing

At the interview, the answers of the 365 subjects to the question "Do you snore during sleep?" were: "never" in 40.2% of subjects, "sometimes" in 18.9%, "often" in 21.1% and "always" in 19.7%.

Figure 1 shows the percentages of "always snoring" subject according to different age groups.

Figure 2 shows the histogram of the percentage of the night that each subject spent snoring, according to the MESAM IV results. Snoring was very common: 54.2% of the sample snored for more than 10% of the night, and 7.1% snored for more than 50% of the night.

Sleep apnea was also common: 290 subjects (79.4%) had less than 5 respiratory disturbances per hour (RDI <5), but 39 subjects (10.7%) had an RDI between 5 and 9, 28 subjects (7.7%) had an RDI between 10 and 19, and 8 subjects (2.2%) had an RDI ≥ 20.

A total of 50 subjects (13.7%) had minimum SaO2 values below 85%. In nine subjects (2.5%) the minimum SaO2 was under 80%.

Relationship between Snoring and RDI.

A total of 213 subjects responded "never" or "sometimes" to the question "Do you snore?" and only six of these, when studied, snored for at least half of the night. Spearman correlation coefficient between reported snoring and recorded snoring was 0.45 (p<.001). Reported snoring and RDI were correlated (Spearman correlation coefficient =0.34, p<.001), as well as recorded snoring and RDI (0.43, p<.001).

Table 2—Relationship between potential correlates and sleep-disordered breathing variables in the studied sample

Potential Correlate	RDI		Snoring amount		Mean SaO2		Min. SaO2	
	≤10	>10	≤50%	>50%	≤97%	>97%	<90%	≥90%
Age	53.3 ± 0.4	57.8 ± 0.9*	53.7 ± 0.4	54.0 ± 1.3	55.7 ± 0.5	52.2 ± 0.5*	56.3 ± 0.6	52.7 ± 0.4*
BMI	24.5 ± 0.2	29.1 ± 1.0*	24.5 ± 0.2	29.7 ± 1.5#	26.2 ± 0.4	23.9 ± 0.3*	27.6 ± 0.5	23.8 ± 0.2*
Neck diameter (cm)	33.9 ± 0.1	36.7 ± 0.6*	34.0 ± 0.1	36.3 ± 0.6§	34.8 ± 0.2	33.6 ± 0.2*	35.6 ± 0.3	33.5 ± 0.1*
Menopause (yes, %)	57.7	81.8 ■	60.3	53.9	70.7	50.3§	73.3	54.2#
EtOH (g/day)	9.7 ± 13.8	6.7 ± 10.5	9.3 ± 13.6	10.0 ± 12.9	8.3 ± 12.9	9.7 ± 13.9	10.2 ± 14.4	8.7 ± 13.1
Smoking (cigar./day)	2.9 ± 0.4	2.2 ± 0.8	2.8 ± 0.4	2.3 ± 1.0	3.0 ± 0.5	2.2 ± 0.4	2.0 ± 0.6	3.1 ± 0.6
Current smok .(yes, %)	13.5	6.1	12.3	19.2	13.2	11.3	19.0	10.3

* p= .0001; § p= .001; # p= .002; ■ p=.01

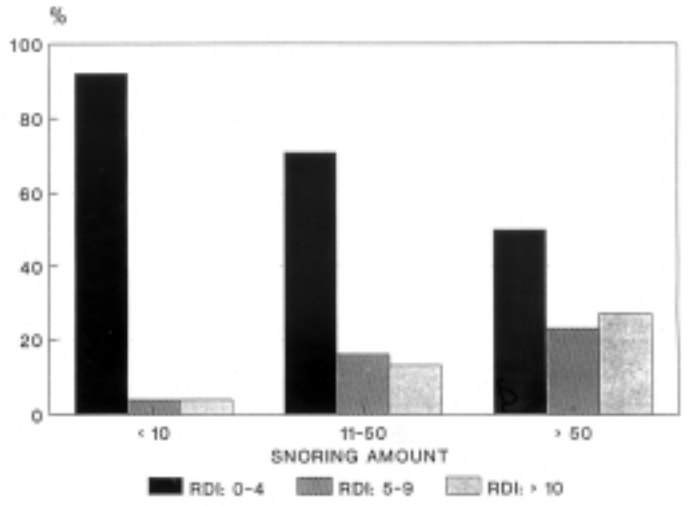

Figure 3—Histogram of subjects stratified according to the snoring amount and their RDI

However, 50% of those who snored for more than half the night had no evidence of sleep apnea (Figure 3). On the other hand, only 8% of those who snored for less than 10% of the night had an RDI>5.

Correlates of Sleep-Disordered Breathing

Medical history. Only subjects with hypertension have been considered, since the prevalence rate of other diseases reported during the previous five years were very low. In the group without hypertension, 66% snored "never" or "sometimes," while 34% snored "often" or "always." In the group with hypertension, 35% snored "never" or "sometimes", while 65% snored "often" or "always" (Chi-square, p<.001); significance was confirmed even after controlling for BMI and age (Mantel-Haenszel test). In the same group, 85% had an RDI≤10, and 15% an RDI>10 (Chi-square, p= 0.027): in this case, however, significance was not confirmed after controlling for BMI or age (Mantel-Haenszel test).

Univariate analysis. On the univariate analysis and with the sleep-disordered breathing variables dichotomized as shown (Table 2), BMI and neck diameter were significantly related to all nocturnal respiratory variables, while age was significantly related to RDI, mean and minimum SaO_2. Menopause was significantly related to RDI > 10, mean SaO_2≤97% and minimum SaO_2<90%, but not to snoring amount >50%. Neither daily alcohol consumption nor smoking consumption and current smoking status were significantly related to any sleep-disordered breathing variables.

Multiple-variable analyses. Logistic regression analyses were performed to examine the effects on RDI, snoring percentage, mean and minimum SaO_2 of the variables identified as significantly related to sleep-disordered breathing (Table 3). Neck diameter was significantly related to RDI > 10 and minimum SaO_2<90%. BMI ("obese" vs "normal") was significantly related to snoring amount > 50%, mean SaO_2≤97% and minimum SaO2<90%. The relationship between menopause and RDI>10 was not significant.

DISCUSSION

In our study we have found a high prevalence of sleep-disordered breathing in a sample of middle-aged women living in North Italy. In our group, 13.4% snored for more than 30% of the night. Sleep apnea was also common: 10.7% of subjects had an RDI between 5 and 9, 7.7% an RDI between 10 and 19, and 2.2% had an RDI>20. Reported snoring was significantly related to recorded snoring, as well as to RDI. Snoring amount (recorded snoring) was significantly related with RDI. However, 50% of the subjects who snored for more than half of the night had no evidence of sleep apnea (RDI>5).

The 1993 community-based study by Young and colleagues[7] found that the prevalence of undiagnosed sleep-disordered breathing was much higher than previously suspected among women: 9% of subjects aged 30–60 years had an apnea-hypopnea index (AHI) greater than five. In another study Jennum and Sjol[9] found an RDI>5 in 6.3% of the females aged 30–60 years. The higher prevalence rate of OSA that we found in our sample may be explained by the evaluation of subjects aged 40 to 65 years. In fact, the percentage of our females with OSA markedly increased after age 50–55, as observed by other authors.[17] Moreover, a technical factor (in our study MESAM IV has been utilized while in the other studies polysomnography or inductive plethysmography were used for evaluating nocturnal respiration) might explain the difference in the prevalence rate of OSA.

In a previous study we performed an epidemiological survey by MESAM IV in a middle-aged male population in the same town, Abbiategrasso.[10] In the male population we observed 35.2% of subjects with oxygen desaturations > 4% per hour >5. Our data show that in general population samples, the male: female ratio for OSA is approximately 2-3:1, in agreement to other studies.[7,18]

Concerning the relationship between snoring and OSA, the present study shows that snoring (both reported and recorded) and RDI were correlated in female population. Young et al[7] found that habitual snorers, both men and women, were more likely to have AHI scores of 15 or higher, and the prevalence of mild sleep-disordered breathing (AHI between 5 and 15) was higher among habitual snorers for women only. Bearpark et al.[12] found that 48% of men who snored for more than half of the night (snoring measured objectively) had no evidence of sleep apnea. A similar percentage (50%) has been found in our female sample. Therefore, although sleep apnea is associated with snoring, snoring for a large proportion of the night does not

Table 3—Multiple-variable analysis (logistic regression analysis) using RDI >10, snoring amount >50%, Mean SaO2 < 97 % and Min SaO2 <90% as dependent variables

RDI > 10	ODDS RATIO	95 % C.I.	P
Age (5-year increment)	1.5	0.9-2.4	NS
BMI (overweight vs normal)	2.2	0.7-6.2	NS
(obese vs normal)	2.2	0.6-8.7	NS
Neck diameter (1-cm increment)	1.3	1.1-1.6	0.005
Menopause (yes vs no)	1.3	0.4-5.0	NS
Snoring Amount > 50 %			
BMI (overweight vs normal)	2.3	0.7-7.3	NS
(obese vs normal)	6.2	1.5-25.0	0.01
Neck diameter (1-cm increment)	1.1	0.9-1.4	NS
Mean SaO2 ≤ 97 %			
Age (5-year increment)	1.3	1.0-1.7	0.04
BMI (overweight vs normal)	1.3	0.7-2.2	NS
(obese vs normal)	2.5	1.0-6.0	0.04
Neck diameter (1-cm increment)	1.1	1.0-1.2	NS
Menopause (yes vs no)	1.4	0.7-2.8	NS
Min. SaO2 < 90 %			
Age (5-year increment)	1.2	0.9-1.6	NS
BMI (overweight vs normal)	1.3	0.6-2.1	NS
(obese vs normal)	3.6	1.4-8.9	0.006
Neck diameter (1-cm increment)	1.2	1.1-1.4	0.001
Menopause (yes vs no)	1.5	0.7-3.3	NS

necessarily indicate that apnea is present both in male and female subjects.

Concerning the self-reported snoring, our data are consistent with other studies reporting that the prevalence of snoring in females increases with age.[5,19] The decline in habitual snoring observed in males after the age of 60 years[20,21] has not been found in the female population. Possible explanations are different changes in the distribution of body fat between elderly men and women, and gender differences in pharyngeal anatomy and function by aging. Moreover, it is also possible that snoring is perceived differently by elderly men and women.

Critical appraisal of the published studies regarding snoring and hypertension does not suggest an association between these two factors.[6] In our study female subjects that reported hypertension during the previous five years had higher prevalence of habitual snoring ("often" or "always"). The relationship between hypertension and habitual snoring was confirmed in our subjects even after controlling for BMI and age.

Our results by univariate analysis confirm previous reports that BMI and neck diameter are significantly related to SDB.[17] However, our multiple-variable analyses show that snoring amount >50% in female population is only influenced by BMI, while RDI >10 is only influenced by neck diameter. Although the etiology of snoring and sleep apnea is complex, our data indicate that some factors may preferentially affect different aspects of the spectrum of SDB. Previous investigators have shown that neck circumference is a much better index of the severity of obstructive sleep apnea than many other indices of obesity, including BMI, determination of abdominal obesity, thoraco-abdominal girth.[22,23] Our study supports this finding in women, in agreement with Guilleminault et al. study.[24] In our multiple-variable analyses, after controlling for age and BMI, menopausal status was not significantly associated with any measure of SDB examined in this study. Our results confirm the report of Kripke et al,[25] but are in contrast with other studies.[18,26] On the other hand, Millman et al.[27] evaluated body fat distribution and sleep apnea severity in women and they found that premenopausal and postmenopausal women did not differ in regards to sleep apnea severity.

In previous surveys in which snoring has been measured by self-report, a relationship between snoring and current cigarette smoking has been reported.[28,29] Our study by using objective measures of snoring does not confirm this relationship, as well as the relationship between overall consumption of tobacco and snoring. Previous studies have yielded conflicting results in the evaluation of the relationship between smoking and RDI.[8,9] We did not find that smoking (either current or the consumption measured in cigarettes/day) was related to RDI. In accord with other studies[12,30] we did not find a relationship between alcohol consumption and any measure of SDB.

In summary, we found a high prevalence of snoring and sleep apnea in a community sample of middle-aged women. Snoring percentage (objectively measured) and RDI resulted correlated, but 50% of those who snored more than half the night had no evidence of sleep apnea. This indicates that a high percentage of snoring is not essential for the occurrence of sleep apnea, nor does it necessarily

suggest that apnea is present. In our sample RDI resulted influenced only by neck diameter in the multiple-variable analyses. Menopause, smoking and alcohol consumption did not predict SDB in our female population. Longitudinal studies are now required to investigate the natural history of SDB and to identify additional factors associated with its development.

ACKNOWLEDGMENTS

The authors thank Madaus Medizin-Elektronik for the loan of MESAM IV units, Carla Taborelli and Francesca Milani for the technical assistance.

REFERENCES

1. Lugaresi E, Coccagna G, Cirignotta F. Snoring and its clinical implications. In: Guilleminault C, Dement WS, eds. Sleep apnea syndromes. New York: Alan R. Liss, 1978:13-21.
2. Koskenvuo M, Kaprio G, Partinen M, et al. Snoring as a risk for hypertension and angina pectoris. Lancet 1985;2:893-96.
3. Partinen M, Palomaki H. Snoring and cerebral infarction. Lancet 1985;2:1325-26.
4. Palomaki H, Partinen M, Juvela S, Kaste M. Snoring as a risk factor for sleep-related brain infarction. Stroke 1989;20:1311-15.
5. Gislason T, Benediktsdottir B, Bjornsson JK, Kjartansson G, Kjeld M, Kristbjarnason H. Snoring, hypertension and the sleep apnea syndrome: an epidemiologic survey of middle-aged women. Chest 1993; 103:1147-51.
6. Hoffstein V. Snoring. Chest 1996;109:201-222.
7. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med 1993;328:1230-1235.
8. Stradling JR, Crosby JH. Predictors and prevalence of obstructive sleep apnoea and snoring in 1001 middle aged men. Thorax 1991;46: 85-90.
9. Jennum P, Sjol A. Epidemiology of snoring and obstructive sleep apnea in Danish population, age 30-60. J Sleep Res 1992;1:240-44.
10. Ferini-Strambi L, Zucconi M, Palazzi S, Castronovo C, Oldani A, Della Marca G, Smirne S. Snoring and nocturnal oxygen desaturations in an Italian middle-aged male population: epidemiologic study with an ambulatory device. Chest 1994; 105:1759-64.
11. Olson LG, King MT, Hensley MJ, Saunders NA. A community study of snoring and sleep-disordered breathing: prevalence. Am J Respir Crit Care Med 1995;152:711-16.
12. Bearpark H, Elliott L, Grunstein R, Cullen S, Schneider H, Althaus W, Sullivan C. Snoring and sleep apnea: a population study in Australian men. Am J Respir Crit Care Med 1995; 151:1459-65.
13. Stoohs R, Guilleminault C. MESAM 4: an ambulatory device for the detection of patients at risk for obstructive sleep apnea syndrome (OSAS). Chest 1992;101:1221-27.
14. Penzel T, Amend G, Meinzer K, Peter JH, von Wichert P. MESAM: A heart rate and snoring recorder for detection of obstructive sleep apnea. Sleep 1990;13:176-84.
15. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986;2:307-310.
16. Consiglio Sanitario Nazionale: relazione sullo stato sanitario del paese. Vol 1 1987. Istituto Poligrafico e Zecca dello Stato, Vol 1, Roma: 1989, p. 372.
17. Strohl K, Redline S. Recognition of obstructive sleep apnea. Am J Respir Crit Care Med 1996;154:279-89.
18. Redline S, Kump PV, Tishler I, Browner I, Ferrette V. Gender differences in sleep disordered breathing in a community-based sample. Am J Respir Crit Care Med 1994;149:722-26.
19. Mondini S, Zucconi M, Cirignotta F, et al. Snoring as a risk factor for cardiac and circulatory problems: an epidemiological study. In: Guilleminault C, Lugaresi E, eds. Sleep wake disorders: natural history, epidemiology and long-term evolution. New York: Raven Press, 1983:99-105.
20. Gislason T, Aberg H, Taube A. Snoring and systemic hypertension: an epidemiological study. Acta Med Scand 1987;221:415-21.
21. Lugaresi E, Cirignotta F, Coccagna G, Piana C. Some epidemiologic data on snoring and circulatory disturbances. Sleep 1980;3:221-24.
22. Davies JRO, Ali NJ, Stradling JR. Neck circumference and other clinical features in the diagnosis of the obstructive sleep apnoea syndrome. Thorax 1992;47:101-105.
23. Hoffstein V, Mateika S. Differences in abdominal and neck circumferences in patients with and without obstructive sleep apnea. Eur Respir J 1992;5:377-81.
24. Guilleminault C, Stoohs R, do-Kim Y, Chervin R, Black J, Clerk A. Upper airway sleep-disordered breathing in women. Ann Intern Med 1995;122:493-501.
25. Kripke DF, Ancoli-Israel S, Klauber MR, Wingard DL, Mason WJ, Mullaney DJ. Prevalence of sleep-disordered breathing in ages 40-64 years: a population-based survey. Sleep 1997;20:65-76.
26. Block AJ, Wynne JW, Boysen PG. Sleep-disordered breathing and nocturnal oxygen desaturation in postmenopausal women. Am J Med 1980;69:75-9.
27. Millman RP, Carlisle CC, McGarvey ST, Eveloff SE, Levinson PD. Body fat distribution and sleep apnea severity in women. Chest 1995, 107:362-66.
28. Bloom JW, Kaltenborn W, Quan SF. Risk factors in a general population for snoring: importance of cigarette smoking and obesity. Chest 1988; 93:678-83.
29. Wetter DT, Young T, Bidwall T, Badr S, Palta M. Smoking as a risk factor for sleep disordered breathing. Arch Intern Med 1994;154: 2219-24.
30. Schmidt-Nowara WW, Coultas DB, Wiggins C, Skipper BE, Samet JM. Snoring in an hispanic-american population. J Intern Med 1990; 150:597-601.