Prevalence of Sleep Disordered Breathing Symptoms and Their Relation with Concomitant Diseases in Afyon, Turkey: A Population Based Study

Afyon İlinde Uykuda Solunum Bozukluğu Semptom Prevalansı ve Bu Semptomların Eşlik Eden Hastalıklarla İlişkisi: Toplum Temelli Çalışma

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ABSTRACT Objective: To estimate the prevalence of symptoms of sleep-disordered breathing (SDB) and to evaluate the relationship between these symptoms and concomitant systemic disorders in Turkish adults. **Material and Methods:** A sample group representing whole Afyon city filled, a questionnaire consisting of questions about demographic features, SDB symptoms and concomitant diseases. Body mass indices of the subjects were calculated. **Results:** There was no significant difference for snoring between males and females, whereas witnessed apnea and excessive daytime sleepiness were significantly higher in females. Obesity was more prevalent among females. SDB symptoms were more common among obese subjects. Diabetes (DM), hypertension (HT), hyperlipidemia and congestive heart failure (CHF) were significantly more prevalent among snorers. There was a 1.7 folds increase in HT risk and a 1.4 folds increase in DM risk in snorers. We also found a 1.4 folds increased risk for hyperlipidemia and 2.1 folds increased risk for CHF in our snorer population. Snoring and witnessed apnea were found as risk factors for hypertension independently from smoking status, BMI and age. **Conclusion:** The frequency of SDB symptoms were high in Afyon city, with a greater than expected rate for females. Snoring and witnessed apnea were found as independent risk factors for hypertension.

Key Words: Diabetes mellitus; hypertension; prevalence; sleep apnea syndromes; snoring

ÖZET Amaç: Türk erişkinlerde uykuda solunum bozukluğu semptom prevalansını saptamak ve bu semptomlar ile eşlik eden sistemik hastalıklar arasındaki ilişkiyi incelemek. **Gereç ve Yöntemler:** Tüm Afyon ilini temsil edecek şekilde seçilmiş örneklem grubundaki kişilere demografik özellikleri, uyku ile ilişkili solunum semptomları ve eşlik eden hastalıkların sorgulandığı bir anket doldurduldu. Katılımcıların beden kitle indeksleri hesaplandı. **Bulgular:** Erkek ve kadınlar arasında horlama sıklığı açısından istatistiksel olarak anlamlı fark saptanmazken, tanıklı apne ve gündüz aşırı uykululuk sıklığı kadınlarda daha sık olarak bulundu. Obezite kadınlarda daha sık idi. Obez hastalarda uykuda solunum bozukluğu semptomları daha yaygın idi. Diabet (DM), hipertansiyon (HT), hiperlipidemi ve konjestif kalp yetmezliği (KKY) horlaması olanlarda anlamlı olarak daha sık saptandı. Horlaması olanlarda HT riski 1.7 kat, DM riski 1.4 kat artmış olarak bulundu. Yine horlaması olan popülasyonda hiperlipidemi riski 1.4 kat ve KKY riski 2.1 kat artmış olarak bulundu. Horlama ve tanıklı apne, hipertansiyon için; sigara içme durumu, beden kitle indeksi ve yaştan bağımsız risk faktörleri olarak tespit edildi. **Sonuç:** Uykuda solunum bozukluğu semptomları sıklığı Afyon ilinde yüksektir ve bu sıklık kadınlarda beklenenden de yüksek olarak tespit edilmiştir. Horlama ve tanıklı apne hipertansiyon için bağımsız risk faktörleri olarak tespit edilmiştir.

Anahtar Kelimeler: Diabetes mellitus; hipertansiyon; prevalans; uykuda solunum bozukluğu; horlama

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Sleep disordered breathing (SDB) is a common syndrome.[1,2] It is associated with various medical problems[3–5] that have impact on morbidity and mortality. It also causes an additional burden of the public health

service.[6–8] There have been many epidemiologic studies to establish the prevalence of SDB and obstructive sleep apnea syndrome (OSAS) in Western countries,[1,2,9] with limited data having been published in Asian countries.[10–12] Previous studies reported that the prevalence of SDB ranged from 3 to 28% in Western countries, depending on the definition of SDB and the methodology of the studies. Recently, among Asians, the prevalence of SDB was estimated to be 8.8% in Chinese office men[11] and 19.5% in normal Indian men.[12] Obstructive sleep apnea has long been observed in clinical practice to be more common in men,[13,14] although it has been documented in population studies[1,9,15] that the male dominance of sleep-disordered breathing (SDB) may not be as high, suggesting an underpresentation and/or underrecognition of this problem in women in the clinic population. SDB may also have different prevalence and risk factors in different communities and ethnic groups. The Wisconsin sleep cohort study observed a three times higher prevalence of sleep disordered breathing (SDB) in men (24%) than in women (9%).[1] This gender difference in the prevalence of SDB has not been adequately explained but suggests that the risk factors and mechanisms for OSA may differ between men and women. It is commonly thought that hormonal factors may be one of the reasons accounting for these differences.

Hypertension and type 2 diabetes are two components of the metabolic syndrome. Apart from well-known risk factors, such as obesity, physical inactivity and excessive alcohol intake, there are also data indicating that both disorders are related to the OSAS.[3,16–18] The underlying pathophysiologic mechanisms are not fully understood, but it can be speculated that hypoxemia, hypercapnia and/or arousal from sleep, followed by the chronic activation of the sympathetic nervous system[19] negatively influence the metabolic and cardiovascular system. Snoring is one of the cardinal symptoms of OSAS. Several studies have found that snoring is positively associated with both hypertension[20-22] and diabetes.[23,24] It seems reasonable that snoring increases the risk of hypertension and diabetes through OSAS.[25]

The purpose of this study was to estimate the prevalence of symptoms related with sleep disordered breathing and to evaluate the relationship between snoring and systemic disorders in Turkish adults of 19-90 years age.

MATERIAL AND METHODS

The study was conducted between November 2005 and February 2006, in Afyonkarahisar, a city located in middle Anatolia in Turkey, 350 km from the capital Ankara and has a population of approximately 817000. The study was approved by the Afyon Kocatepe University Faculty of Medicine Clinical Research Ethics Committee and written, informed concent was obtained from all participiants.

A total of 7000 km. roadway drived for the research by a team of 15 physicians, one nurse and a driver. A total of 2035 people, from 75 different screening regions (18 urban, 57 villages) of our city were detected with stratified sampling method, according to the population records of the year 2000, which represent the population of the area appropriately. Regions and subjects were selected regarding to represent minimum %80 of population of that village. In every research point, minimum 20 people were included to the study. The records of the regional health institutions were used in order to determine the subjects. The study group was selected randomly from the "Family Cards" of the primary health centers, regarding the gender and ages. Only one person was selected from every house. According to population distribution of year 2000, we determined the minimum number of people as 1990 (when d=0.02, 5% error and 95% confidence interval) and at the end of the study we reached a number of 2035 people.

The subjects were informed about the study by telephone interviews one night before, their approvals were obtained and their transport to the health institutions, where the study would be conducted, was provided. The data were collected by a questionnaire in which face to face survey method was performed by the physicians. For questions regarding symptoms related to sleep disturbances, the subjects were asked for presence of snoring, witnessed apnea and excessive day-time

sleepiness. Example questions: "Have your bedpartner or spouse ever told you that you were snoring in your sleep?", "Have your bedpartner or spouse ever told you that you stopped breathing for some time during your sleep?".

Body mass index was calculated according to the formula: weight/square of height. Participants with a BMI ≥ 30 were classified as obese, and those with a BMI < 30 were classified as non-obese. Participants were asked for physician diagnosed diabetes mellitus (DM), hypertension (HT), hyperlipidemia, congestive heart failure (CHF), cerebrovascular accidents (CVA) and erectile dysfunction.

STATISTICAL ANALYSIS

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version. 12.0. The results were presented as the means ± SD. The Chi-square test was used to compare the differences between proportions. When the comparison involved continuous variables, the t-test was used. Multiple logistic regression analysis was performed for simultaneous evaluations of more than two variables and the results were expressed as odds ratios (OR) with 95% confidence intervals (CI). To analyze the independent influence of snoring on the somatic diseases, multivariate models were used, with adjustment for age, BMI, alcohol addiction and smoking status. Age was categorized into intervals (18-24, 25-44, 45-64, 65-74, >75) in the multiple analysis, while BMI was categorized into four intervals (<25: normal, 25.0-29.9: overweight, 30.0-39.9: obese, >40: morbid obese).

RESULTS

Of the 2035 participants, 58.7% were females and 41.3% were males. Demographic features and major symptoms related to SDB according to gender were shown in Table 1. There was no significant difference between males and females for mean age. BMI was significantly higher in females than in males (p= 0.000). Men were smoking significantly more than women (p= 0.000).

Evaluation of major symptoms related to SDB revealed that there was no significant difference for snoring between males and females (p= 0.541), whereas witnessed apnea and excessive daytime sleepiness were significantly higher in females (p= 0.000). Mean age of obese subjects was significantly higher than non-obese ones (p= 0.000) and obesity was more prevalent among females (p= 0.000). Snoring, witnessed apnea and excessive daytime sleepiness were also more frequent among obese subjects (Table 2). Mean age of snorers was 49.7 ± 11.3 years and that of non-snorers was 46.9 ± 13.9 years. The difference was statistically significant

TABLE 2: Demographic features and major SDB symptoms with regard to obesity.

	Non-obese BMI<30 (n=1390)	Obese BMI ≥ 30 (n=645)	P value
Age, years (Mean±SD)	46.8±14.0	49.7±10.4	<0.001
Female/Male (%)	50.7/49.3	72.3/27.7	<0.001
Snoring (%)	27.1	48.8	<0.001
Witnessed apnea (%)	9.7	14.2	0.003
Excessive daytime sleepiness (%)	25.4	30.4	0.021

TABLE 1: Demographic features and major SDB symptoms with regard to gender.

	Female (n=1194)	Male (n=841)	Total (2035)	P value
Age, years, (Mean ± SD)	47.9 ± 12.8	47.8 ± 13.6	47.9 ± 13.1	0.881
BMI, kg/m2, (Mean ± SD)	28.9 ± 6.1	26.5 ± 4.5	27.9 ± 5.6	<0.001
Smoking status				
Never (%)	91.3	25.6	64.0	
Former (%)	1.4	25.3	11.3	<0.001
Current (%)	7.2	49.1	24.6	
Alcohol consumption (%)	5.2	7.3	5.9	0.058
Snoring (%)	33.4	34.7	34.0	0.541
Witnessed apnea (%)	13.7	7.8	11.2	<0.001
Excessive daytime sleepiness (%)	30.8	21.9	27.1	<0.001

TABLE 3: Prevalence of concomitant diseases of snorers and non-snorers.

	Snorers (n= 691)	Non-snorers (n= 1344)	p value
Diabetes mellitus (%)	15.5	11.7	0.016
Hypertension (%)	31.1	20.7	<0.001
Hyperlipidemia (%)	41.0	33.3	0.001
Congestive heart failure (%)	2.9	1.4	0.021
Cerebrovascular event (%)	1.7	1.2	0.317
Erectile dysfunction (%)	6.1	4.6	0.155

(p< 0.001). Of the snorers 57.7% were females and 42.3% were males. There was no statistically significant difference between snorers and non-snorers according to gender (p= 0.541). Prevalence of concomitant diseases of snorers and non-snorers were shown in Table 3. DM (1.4 times, p= 0.016), HT (1.7 times, p< 0.001), hyperlipidemia (1.4 times, p= 0.001) and CHF (2.1 times, p= 0.024) were significantly more prevalent among snorers. CVA and erectile dysfunction were also more prevalent among snorers but the difference was not statistically significant. Risk factors for hypertension and diabetes in the multiple logistic regression analysis is shown in Table 4.

Comparison of major symptoms related to SDB according to age groups revealed that snoring was most prevalent in 45-64 years age group, wit-

TABLE 4: Risk factors for hypertension and diabetes in the multiple logistic regression analysis.

	OR (95% CI) for Hypertension		OR (95% CI) for Diabetes	
	Univariate analysis	Multivariate analysis	Univariate analysis	Multivariate analysis
Age, years				
18-24	1	1	1	1
25-44	5.12 (1.27-20.70) (p=0.022) (B:1.634)	2.90 (0.69-12.19) (B:1.063)*	5.27 (0.73-38.24) (p=0.100) (B:1.663)	3.93 (0.53-28.89) (B:1.368)
45-64	17.96 (4.51-71.56) (p=0.000) (B:2.888)	8.54 (2.05-35.52) (B:2.145)†	18.62 (2.62-132.53) (p=0.003) (B:2.924)	12.53 (1.73-90.78) (B:2.528)‡
65-74	41.88 (10.28-170.66) (p=0.000) (B:3.735)	22.58 (5.31-96.03) (B:3.117)†	25.45 (3.50-185.28) (p=0.001) (B:3.237)	17.92 (2.42-132.76) (B:2.886)†
>75	48.37 (10.84-215.77) (p=0.000) (B:3.879)	27.35 (5.72-130.72) (B:3.309)†	13.48 (1.59-114.13) (p=0.017) (B:2.601)	10.96 (1.26-94.91) (B:2.394)‡
BMI, kg/m^2				
<25.0	1	1	1	1
25.0-29.9	1.43 (1.07-1.90) (p=0.015) (B:0.356)	1.18 (0.85-1.62) (B:0.161)	1.59 (1.22-2.26) (p=0.009) (B:0.465)	1.31 (0.90-1.92) (B:0.272)
30.0-39.9	2.99 (2.27-3.96) (p=0.000) (B:1.097)	2.09 (1.51-2.90) (B:0.739)†	1.97 (1.38-2.80) (p=0.000) (B:0.675)	1.44 (0.97-2.14) (B:0.364)
>40.0	12.62 (6.47-24.62) (p=0.000) (B:2.535)	7.27 (3.56-14.86) (B:1.984)†	2.93 (1.38-6.23) (p=0.005) (B:1.074)	1.62 (0.72-3.66) (B:0.481)
Smoking status				
Non-smoker	1	1	1	1
Ex-smoker	3.58 (2.62-4.90) (p=0.000) (B:1.275)	2.36 (1.64-3.38) (B:0.857)†	1.84 (1.28-2.63) (p=0.001) (B:0.608)	1.20 (0.81-1.79) (B:0.183)
Current smoking	3.18 (2.11-4.80) (B:1.157)	1.89 (1.19-3.01) (B:0.638)†	2.64 (1.66-4.20) (p=0.000) (B:0.972)	1.54 (0.92-2.56) (B:0.431)
Alcohol consumption				
No	1	1	1	1
Yes	2.88 (1.57-5.28) (B:1.058)	1.54 (0.78-3.06) (B:0.434)	3.46 (1.40-8.54) (p=0.007) (B:1.240)	3.2 (1.14-9.08) (B:1.169)
Major SDB symptoms				
No symptoms	1	1		1
Snoring (only)	1.73 (1.41-2.13) (p=0.000) (B:0.326)	1.41 (1.10-1.81) (B:0.347)*	1.39 (1.06-1.81) (p=0.016) (B:0.549)	1.06 (0.79-1.43) (B:0.059)
Witnessed apnea (only)	1.68 (1.24-2.26) (p=0.001) (B:0.383)	1.70 (1.20-2.41) (B:0.530)*	1.47 (1.00-2.14) (p=0.047) (B:0.516)	1.32 (0.87-1.99) (B:0.275)
Excessive day-time sleepiness (only)	1.07 (0.85-1.34) (B:0.343)	1.12 (0.87-1.47) (B:0.116)	1.41 (1.07-1.86) (p=0.016) (B:0.067)	1.50 (1.11-2.04) (B:0.408)†

The data are presented as adjusted odds ratios (95% confidence interval)
SDB: Sleep disordered breathing
*p< 0.010, †p< 0.001, ‡p< 0.050

nessed apnea was most prevalent in 25-44 years age group and excessive daytime sleeping was most prevalent in >75 years age group (Figure 1). When the subjects were classified according to BMI, it was seen that all major symptoms related to SDB significantly increase as BMI increases (Figure 2).

DISCUSSION

The importance of this study is that it is the first population based study representing a city in Turkey. Although there are studies investigating SDB symptoms in truck, bus and taxi drivers in Turkey,[26,27] to our knowledge, there are no studies investigating a sample population representing the whole city.

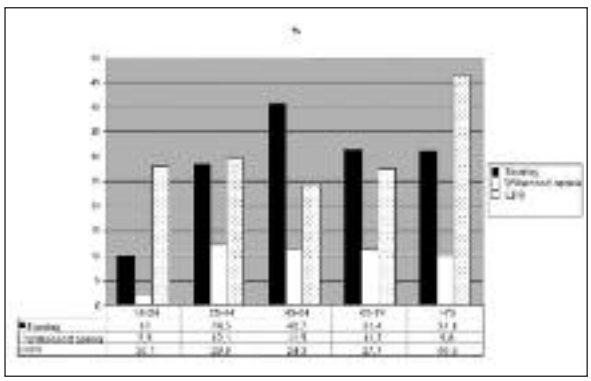

FIGURE 1: Major SDB symptoms according to age.
*In the comparison of the age groups p values for snoring, witnessed apnea and excessive daytime sleeping were p< 0.001, p< 0.001 and p= 0.006, respectively. EDS: Excessive daytime sleepiness.

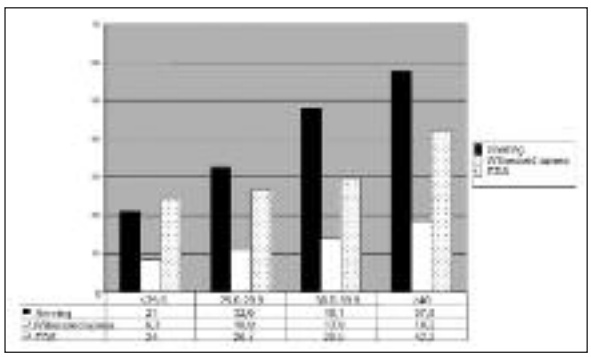

FIGURE 2: Major SDB symptoms according to BMI.
*In the comparison of the age BMI groups p values for snoring, witnessed apnea and excessive daytime slleping were pz 0.001, p= 0.010 and p= 0.020, respectively. EDS: Excessive daytime sleepiness.

Prevalances of symptoms related with SDB varies in different studies. In a recent study from Greece, prevalence of habitual snoring was found 29.5% in males and 24.1% in females.[28] Mehra et al[29] found an overall prevalence of snoring as 29.9%. The rates in a Brazilian study by Pires et al[30] were 40% for males and 24% for females. Our results are similar to these studies. However, in a study from Spain, Marin et al[31] reported a prevalence of loud snoring as 64% in males and 36% in females. They highlighted that using subjective reports, the prevalence of habitual snoring, may previously have been underestimated, as it was said to range from 30 to 45% in men. When comparing self and spouse reports of snoring, were compared poor agreement was found[32] and hence in epidemiological studies on sleep disturbances, the bed-partner questionnaire or a direct measurement during sleep is mandatory. Using these approaches habitual snoring was detected in 64-81% of subjects in community studies.[1,2,15]

In patients with OSAS, obesity is responsible for an increase in neck size; this so-called 'neck obesity' has been implicated in the pathophysiology of upper airway obstruction during sleep due to fat compression of the pharynx.[33,34] In our study, all major symptoms related with SDB were significantly higher in the obese population. The high prevalences of witnessed apnea and excessive daytime sleepiness in women in our study was considered to be due to their obesity, since the women were more obese than men in our sample. On the other hand, some studies like Wisconsin Sleep Cohort Study[35] reported that white women with SDB had similar symptoms as those of men.

In this study, we also evaluated the relation of SDB symptoms with the concomitant diseases. DM, HT, hyperlipidemia and CHF were more prevalent among snorers. In epidemiologic studies, there is a growing consensus that SDB is an important risk factor for hypertension regardless of the excessive weight and other potentially confounding factors. Lindberg et al[20] reported that persistant snoring was an independent risk factor for the development of hypertension among males aged <50 years. Gislason et al[21] showed that there was almost a three-

fold increase in the predicted prevalence of hypertension among intermittant and habitual snorer womenwhen compared to nonsnorer women in the 40 to 49 years old age group and a 60 percent increase in the 50 to 59- year-old age group. Carlson et al[36] reported that age, BMI, and sleep apnea were all found to be independent predictors of hypertension. Obesity combined with sleep apnea turned out to result in a 3.9-fold increase in the prevalence of hypertension. In this study, we found a 1.7 folds increased HT risk in snorers.

Shin et al[37] reported that habitual snorers had significantly higher glucose and insulin levels at 2nd h of oral glucose tolerance test as compared to nonhabitual snorers, while fasting glucose or insulin levels did not differ significantly between the groups. In a population-based sample of hypertensive men, the prevalence of obstructive sleep apnea was significantly higher in diabetic patients than in normoglycemic subjects, independent of central obesity.[17] In contrast, in an Italian study of obese patients, snoring was associated with diabetes in a univariate analysis, however in a multivariate analysis, an independent effect of snoring was only observed for hypertension.[38]

Elmasry et al[23] showed that in males aged 30-69 years, habitual snoring was associated with an increased incidence of diabetes within 10 years. They say that although obesity is the main risk factor for developing diabetes, coexistent habitual snoring may add to this hazard. Meslier et al[18] reported a significant relationship between sleep-disordered breathing and impaired glucose–insulin metabolism that was independent of obesity and age. Al-Delaimy et al[24] also showed that snoring is independently associated with elevated risk of type II diabetes. Similar to these studies, we found a 1.4 folds increased DM risk in snorers.

The pathophysiology of hypertension and diabetes in sleep-disordered breathing is not fully understood. In a review of the pathophysiology of hypertension in obstructive sleep apnea, Richert et al[39] stated that there were three components of importance: (1) large negative intrathoracic pressure, (2) intermittent hypoxemia and (3) arousal from sleep. As the severity of sleep apnea, as indicated by the maximum intraeosophageal pressure, decreases with age,[40] this might be a possible explanation of why younger patients with sleep apnea are more prone to develop hypertension. When it comes to diabetes and impaired glucose metabolism, it is known that sleep deprivation reduces insulin sensitivity[41] and has a harmful impact on carbohydrate metabolism similar to that seen in normal aging.[42,43] The frequent arousals seen in patients with OSAS might have negative consequences on carbohydrate metabolism through similar pathophysiologic mechanisms, such as sleep deprivation or sleep disruption with other causes.

We also found a 1.4 folds increased risk for hyperlipidemia and 2.1 folds increased risk for CHF in our snorer population.

Snoring and witnessed apnea were found as risk factors for hypertension independently from smoking status, BMI or age. Excessive daytime sleepiness was an independent risk factor for diabetes mellitus.

A limitation for this study can be that it was a self-reported study which has the possibility of exageration or recall bias. To overcome this problem, we tried to investigate the medical reports and previous prescriptions of the subjects to verify the presence of the physician diagnosed diseases.

As a conclusion, the frequency of SDB symptoms were high in Afyon city, with a greater than expected rate for females. The risk for HT and DM were found to be higher in snorers. Snoring and witnessed apnea were found as risk factors for hypertension independently from smoking status, BMI or age, whereas excessive daytime sleepiness was an independent risk factor for diabetes mellitus.

REFERENCES

1. 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(17):1230-5.
2. Bearpark H, Elliott L, Grunstein R, Cullen S, Schneider H, Althaus W, et al. Snoring and sleep apnea. A population study in Australian men. Am J Respir Crit Care Med 1995;151(5):1459-65.
3. Peppard PE, Young T, Palta M, Skatrud J. Prospective study of the association between sleep-disordered breathing and hypertension. N Engl J Med 2000;342(19):1378-84.
4. Nieto FJ, Young TB, Lind BK, Shahar E, Samet JM, Redline S, et al. Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. Sleep Heart Health Study. JAMA 2000;283(14):1829-36.
5. Jennum P, Sjøl A. Snoring, sleep apnoea and cardiovascular risk factors: the MONICA II Study. Int J Epidemiol 1993;22(3):439-44.
6. Wright J, Sheldon T. Sleep apnoea and its impact on public health. Thorax 1998;53(5):410-3.
7. Strohl KP, Redline S. Recognition of obstructive sleep apnea. Am J Respir Crit Care Med 1996;154(2 Pt 1):279-89.
8. Young T, Finn L. Epidemiological insights into the public health burden of sleep disordered breathing: sex differences in survival among sleep clinic patients. Thorax 1998;53(Suppl 3):S16-9.
9. 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(2):711-6.
10. Ng TP, Seow A, Tan WC. Prevalence of snoring and sleep breathing-related disorders in Chinese, Malay and Indian adults in Singapore. Eur Respir J 199812(1):198-203.
11. Ip MS, Lam B, Lauder IJ, Tsang KW, Chung KF, Mok YW, et al. A community study of sleep-disordered breathing in middle-aged Chinese men in Hong Kong. Chest 2001;119(1):62-9.
12. Udwadia ZF, Doshi AV, Lonkar SG, Singh CI. Prevalence of sleep-disordered breathing and sleep apnea in middle-aged urban Indian men. Am J Respir Crit Care Med 2004;169(2):168-73.
13. Guilleminault C, Quera-Salva MA, Partinen M, Jamieson A. Women and the obstructive sleep apnea syndrome. Chest 1988;93(1):104-9.
14. Vgontzas AN, Tan TL, Bixler EO, Martin LF, Shubert D, Kales A. Sleep apnea and sleep disruption in obese patients. Arch Intern Med 1994;154(15):1705-11.
15. Redline S, Kump K, Tishler PV, Browner I, Ferrette V. Gender differences in sleep disordered breathing in a community-based sample. Am J Respir Crit Care Med 1994;149(3 Pt 1):722-6.
16. Pepperell JC, Ramdassingh-Dow S, Crosthwaite N, Mullins R, Jenkinson C, Stradling JR, et al. Ambulatory blood pressure after therapeutic and subtherapeutic nasal continuous positive airway pressure for obstructive sleep apnoea: a randomised parallel trial. Lancet 2002;359(9302):204-10.
17. Elmasry A, Lindberg E, Berne C, Janson C, Gislason T, Awad Tageldin M, et al. Sleep-disordered breathing and glucose metabolism in hypertensive men: a population-based study. J Intern Med 2001;249(2):153-61.
18. Meslier N, Gagnadoux F, Giraud P, Person C, Ouksel H, Urban T, et al. Impaired glucose-insulin metabolism in males with obstructive sleep apnoea syndrome. Eur Respir J 2003;22(1):156-60.
19. Carlson JT, Hedner J, Elam M, Ejnell H, Sellgren J, Wallin BG. Augmented resting sympathetic activity in awake patients with obstructive sleep apnea. Chest 1993;103(6):1763-8.
20. Lindberg E, Janson C, Gislason T, Svärdsudd K, Hetta J, Boman G. Snoring and hypertension: a 10 year follow-up. Eur Respir J 1998;11(4):884-9.
21. Gislason T, Benediktsdóttir B, Björnsson JK, Kjartansson G, Kjeld M, Kristbjarnarson H. Snoring, hypertension, and the sleep apnea syndrome. An epidemiologic survey of middle-aged women. Chest 1993;103(4):1147-51.
22. Hu FB, Willett WC, Colditz GA, Ascherio A, Speizer FE, Rosner B, et al. Prospective study of snoring and risk of hypertension in women. Am J Epidemiol 1999;150(8):806-16.
23. Elmasry A, Janson C, Lindberg E, Gislason T, Tageldin MA, Boman G. The role of habitual snoring and obesity in the development of diabetes: a 10-year follow-up study in a male population. J Intern Med 2000;248(1):13-20.
24. Al-Delaimy WK, Manson JE, Willett WC, Stampfer MJ, Hu FB. Snoring as a risk factor for type II diabetes mellitus: a prospective study. Am J Epidemiol 2002;155(5):387-93.
25. Gislason T, Taube A. Prevalence of sleep apnea syndrome--estimation by two stage sampling. Ups J Med Sci 1987;92(2):193-203.
26. Fidan F, Ünlü M, Sezer M, Kara Z. [Relation between traffic accidents and sleep apnea syndrome in truck drivers]. Tuberk Toraks 2007;55(3):278-84.
27. Doğan ÖT, Dal U, Özşahin SL, Akkurt İ, Seyfikli Z. [The prevalence of sleep related disorders among the drivers and it's relation with traffic accidents]. Tuberk Toraks 2006;54(4):315-21.
28. Karachaliou F, Kostikas K, Pastaka C, Bagiatis V, Gourgoulianis KI. Prevalence of sleep-related symptoms in a primary care population - their relation to asthma and COPD. Prim Care Respir J 2007;16(4):222-8.
29. Mehra R, Stone KL, Blackwell T, Ancoli Israel S, Dam TT, Stefanick ML, et al. Prevalence and correlates of sleep-disordered breathing in older men: osteoporotic fractures in men sleep study. J Am Geriatr Soc 2007;55(9):1356-64.
30. Pires ML, Benedito-Silva AA, Mello MT, Pompeia Sdel G, Tufik S. Sleep habits and complaints of adults in the city of São Paulo, Brazil, in 1987 and 1995. Braz J Med Biol Res 2007;40(11):1505-15.
31. Marin JM, Gascon JM, Carrizo S, Gispert J. Prevalence of sleep apnoea syndrome in the Spanish adult population. Int J Epidemiol 1997;26(2):381-6.
32. Wiggins CL, Schmidt-Nowara WW, Coultas DB, Samet JM. Comparison of self- and spouse reports of snoring and other symptoms associated with sleep apnea syndrome. Sleep 1990;13(3):245-52.
33. Davies RJ, Stradling JR. The relationship between neck circumference, radiographic pharyngeal anatomy, and the obstructive sleep apnoea syndrome. Eur Respir J 1990;3(5):509-14.
34. Koenig JS, Thach BT. Effects of mass loading on the upper airway. J Appl Physiol 1988;64(6):2294-9.
35. Young T, Hutton R, Finn L, Badr S, Palta M. The gender bias in sleep apnea diagnosis. Are women missed because they have different symptoms? Arch Intern Med 1996;156(21):2445-51.
36. Carlson JT, Hedner JA, Ejnell H, Peterson LE. High prevalence of hypertension in sleep apnea patients independent of obesity. Am J Respir Crit Care Med 1994;150(1):72-7.
37. Shin C, Kim J, Kim J, Lee S, Shim J, In K, et al. Association of habitual snoring with glucose and insulin metabolism in nonobese Korean adult men. Am J Respir Crit Care Med 2005;171(3):287-91.
38. Marchesini G, Pontiroli A, Salvioli G, Novi RF, Vitacolonna E, Taboga C, et al.; QUOVADIS Study Group. Snoring, hypertension and Type 2 diabetes in obesity. Protection by physical activity. J Endocrinol Invest 2004;27(2):150-7.
39. Richert A, Ansarin K, Baran AS. Sleep apnea and hypertension: pathophysiologic mechanisms. Semin Nephrol 2002;22(1):71-7.
40. Krieger J, Sforza E, Boudewijns A, Zamagni M, Petiau C. Respiratory effort during obstructive sleep apnea: role of age and sleep state. Chest 1997;112(4):875-84.
41. González-Ortiz M, Martínez-Abundis E, Balcázar-Muñoz BR, Pascoe-González S. Effect of sleep deprivation on insulin sensitivity and cortisol concentration in healthy subjects. Diabetes Nutr Metab 2000;13(2):80-3.
42. Scheen AJ, Byrne MM, Plat L, Leproult R, Van Cauter E. Relationships between sleep quality and glucose regulation in normal humans. Am J Physiol 1996;271(2 Pt 1):E261-70.
43. Spiegel K, Leproult R, Van Cauter E. Impact of sleep debt on metabolic and endocrine function. Lancet 1999;354(9188):1435-9.