Gender-Related Differences in Symptoms of Patients With Suspected Breathing Disorders in Sleep: A Clinical Population Study Using the Sleep Disorders Questionnaire

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Background: Gender-related differences in the symptom profile of patients with suspected sleep disordered breathing (SDB) may be one explanation of the clinical underrecognition of SDB in women.

Study Objectives: The aim of this study was to prospectively assess gender-related differences in presenting symptoms in a clinical sample of patients with suspected sleep disordered breathing.

Design: Administration of the Sleep Disorders Questionnaire prior to clinical and polysomnographic evaluation. Responses obtained from the questionnaire were used to construct 4 independent symptom scales: sleep apnea (SA), periodic limb movement syndrome (PLM), psychiatric sleep disorder (PSY), and narcolepsy (NAR). Analyses of variance were used to examine the effect of gender, AHI, and age on the symptom scales. Associations between gender and each diagnostic scale of the questionnaire were determined by multiple analyses of covariance.

Setting: Tertiary pulmonary referral center.

Participants: 2739 men and 782 women with suspected SDB. All patients who were referred to the sleep laboratory underwent full-night polysomnography, irrespective of the likelihood of SDB.

Interventions: N/A

Measurements and Results: Overall, men scored significantly higher on items related to worsening of snoring/breathing with alcohol (P <0.001) and smoking history (P <0.01) than women. Complaints such as witnessed apneas (P <0.001) and worsening of snoring in supine position (P <0.05), however, were more frequently reported by men with an apnea-hypopnea index (AHI) <5/hr, compared with AHI-matched women. There were no significant differences in these items in patients with an AHI >15/hr. In contrast, women complained significantly more often of insomnia, restless legs, depression, nightmares, palpitations at night, and hallucinations than men. As a result, women had significantly higher scores on the PLM, PSY, and NAR scales of the Sleep Disorders Questionnaire (P <0.001, for all). After adjustments for age, body mass index, AHI, arousal index, oxygen saturation data, and smoking history, by means of multiple analyses of covariances, gender differences remained significant (P <0.001, for all scales).

Conclusions: We observed significant gender-related differences in presenting symptoms of patients with sleep disordered breathing at a tertiary level. These differences should be taken into consideration in clinical evaluation of women with suspected sleep disordered breathing.

Keywords: Sleep disordered breathing, gender differences, signs and symptoms, periodic limb movement disorder, psychiatric sleep disorder

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INTRODUCTION

THE PREVALENCE OF OBSTRUCTIVE SLEEP APNEA SYNDROME (OSAS) IN THE GENERAL POPULATION HAS BEEN ESTIMATED IN SEVERAL LARGE STUDIES.[1-3] Common to all reports is a higher prevalence of OSAS in men compared with women, with male-to-female ratios of 2-4:1. The ratio of men to women in clinical populations, however, appears to be considerably higher than in the community and is typically 6:1 or greater.[4,5] The reason for the discrepancy between clinical and population-based studies is not fully understood. A possible explanation for the underrecognition of OSAS in women in clinical studies is that the syndrome is manifested by a different cluster of symptoms in women than in men, or that women underreport the characteristic symptoms that have become the hallmark of the syndrome such as excessive daytime sleepiness, chronic fatigue, habitual snoring, and witnessed apneas.[6]

In a recent retrospective chart review analysis, Shepertycky and coworkers[7] reported that women with OSAS (mean AHI 36/hr) reported witnessed apnea less often than men. Interestingly, women in that report described their main presenting symptom as insomnia and were more likely to have a history of depression. Supporting these observations, both Chervin[8] and Lavie[9] reported that women were more likely to suffer from "atypical" OSAS symptoms, such as fatigue and lack of energy.

The possibility that sleep apnea has different presentations in women and men may have 2 important clinical implications. First, reliance on snoring or self-reported apnea may result in more men being referred for sleep laboratory evaluation than women. Second, the presentation of women with more atypical symptoms could make physicians turn to other diagnostic possibilities such as depression or insomnia, rather than OSAS.

In view of the importance of these practical implications, we prospectively studied the influence of gender on symptom reports

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using the Sleep Disorders Questionnaire (SDQ) in a clinical population of patients with suspected sleep disordered breathing. The SDQ is a comprehensive questionnaire including multiple symptoms related to sleep apnea, restless legs, narcolepsy, insomnia, depression, and other symptoms of psychiatric sleep disorder.[10] Responses obtained from the SDQ were used to construct 4 independent symptom scales prior to full night polysomnography. We hypothesized that there are significant differences in the symptom scales of the SDQ between men and women with suspected sleep disordered breathing.

METHODS

This study was undertaken in Vienna, Austria, between 1996 and 2004. The study population included consecutive patients undergoing full night polysomnography (PSG) in the Lainz Hospital sleep laboratory, the first sleep referral center in Vienna. All patients were residents with free access to government-funded health care services, including physician visits and hospitalizations. All patients who had been referred for snoring and/or witnessed apneas were included in this study and underwent full assessment. Referral for a PSG did not require the presence of excessive daytime sleepiness. Referral to PSG occurred through family practitioners (40%), chest physicians (22%), and through the departments outpatient clinic (13%). Approximately 25% of the patients were self-referred.

Subjects were initially contacted by the sleep laboratory staff via telephone. Name and address of each patient was recorded and a PSG was scheduled within 4 weeks, irrespective of age, symptoms, profession, insurance, or referral type. The SDQ was sent to each patient via mail. Patients were asked to fill in the questionnaire prior to clinical and polysomnographic evaluation. Subjects were excluded from this study for the following reasons: age <18 years, recent upper airway surgery, history of alcohol abuse, history of neuromuscular disease, severe daytime hypoxemia, unstable coronary artery disease, night terrors, history of psychiatric conditions requiring the use of tranquilizers, or language barrier. We further excluded patients who were referred for the investigation of chronic insomnia or those with predominant restless legs syndrome without symptoms of snoring or apnea. The study protocol was approved by the institutional review board.

Measures

The SDQ is derived from the Sleep Questionnaire and Assessment of Wakefulness, a general clinical questionnaire about sleep habits and symptoms.[11] It has a high completion rate and has been validated against polysomnography and multiple sleep latency testing.[10] Previous reports have shown that it is a useful instrument in the detection and differentiation of a variety of sleep disorders.[10,12,13] It asks key questions pertaining to snoring, apneas, self-reported awakenings, and daytime sleepiness, and, in addition, asks specifically about insomnia, restless legs, depression, accidental sleep, as well as other psychiatric and narcolepsy-related symptoms.

Responses obtained from the SDQ were used to construct 4 independent symptom scales: SA for sleep apnea (12 items, including questions on "current weight" and "age"), PLM for periodic limb movement disorder (9 items), PSY for psychiatric sleep disorder (9 items), and NAR for narcolepsy (15 items). The remaining 19 items, which are not reported here, include questions concerning the subject's profession, use of hypnotic-sedatives, and questions related to physical fitness. Subjects filled out the SDQ at home and brought in the completed forms. Patients marked their responses on a 5-point Likert scale ranging from "never" = 1 to "all the time" = 5. For numeric items, such as age, body mass index (BMI), and sleep data, empirical distributions of quintiles were formed and incorporated into the SDQ, so that the response set for the entire questionnaire was transformed to numeric form. Finally, individual scores were summed up for every patient to provide a total-scale score. Douglas et al.[10,14] demonstrated that the SDQ had good test-retest reliability and was used successfully to support diagnosis in patients suspected of having a sleep disorder. In addition to the 64 SDQ items, subjects were asked to check if they "felt excessively sleepy" in several everyday situations such as driving a car, reading a book/newspaper, after a light meal, on the phone, or sitting quietly in a cinema/theatre. Subjects were asked to rate their complaint on a 5-point scale (SS = Sleepiness Score), with 1 indicating "no excessive daytime sleepiness at all" and 5 indicating "excessive daytime sleepiness most of the time." We found a strong relationship between the SS and the Epworth Sleepiness Scale ($r = 0.857$, $n = 50$, $P < 0.001$, unpublished observation).

Subjects chosen for this analysis include all patients who had PSG of acceptable quality and who completed the SDQ. At least one overnight diagnostic PSG was performed in the same sleep laboratory. A second PSG was performed if there were technical difficulties in interpreting the results of the PSG or if the patient had <4 hours of sleep on first PSG. PSG included a 4-channel electroencephalogram (EEG; C4/A1, C3/A2), a 2-channel electro-oculogram, a 2-channel submental electromyogram (EMG), and an electrocardiogram. Nasal and oral airflow were detected by thermistors. Thoracic and abdominal respiratory effort was monitored with piezoelectric strain gauges placed around the chest and abdomen. Mean (SpO_2mean) and minimum oxygen saturation (SpO_2min) was recorded by pulse oximetry. Height and weight were assessed on the evening of the study.

Obstructive apnea was defined as the absence of airflow for >10 seconds in the presence of continued respiratory effort. Hypopnea was defined as >10 s reduction in the amplitude of respiratory effort to between 10% and 50% of the baseline level during sleep, associated with a 4% reduction in SpO_2. Each PSG was manually scored by a sleep technician according to standard criteria[15] and validated by a sleep specialist. Arousals were defined as episodes lasting 3 s to 15 s, in which there was a return to alpha activity or theta activity from a slower background frequency on the EEG associated with increased EMG activity. Sleep stages and arousals were scored independently of mechanical events and without knowledge of the data from the questionnaires. For each patient, an apnea-hypopnea index (AHI) and an arousal index (AI) were calculated by dividing the total number of apneas/hypopneas or arousals, respectively, by the total sleep time in hours (TST). For categorical analysis, cut-off points of 0 to <5, 5 to <15, 15 to <30, and ≥30 were used.

Sample

A total of 5576 patients underwent overnight PSG at the Lainz Hospital sleep laboratory during the study period. There were 1850 subjects excluded because of diagnoses other than sleep disordered breathing, and an additional 205 subjects were excluded

Table 1—Differences between men and women in frequency distribution of anthropometric, clinical and polysomnographic variables

	AHI < 5		AHI 5-15		AHI 15-30		AHI > 30	
	Men n = 1341	Women n = 512	Men n = 540	Women n = 132	Men n = 309	Women n = 55	Men n = 549	Women n = 83
Age, yr	48 ± 11	50 ± 11***	52 ± 11	56 ± 8***	54 ± 10	58 ± 10**	53 ± 10	56 ± 11*
BMI, kg/m^2	29 ± 5	30 ± 7**	29 ± 5	30 ± 7**	30 ± 5	33 ± 7**	32 ± 6	35 ± 7**
SpO_2 minimum, %	85 ± 8	86 ± 8**	83 ± 7	81 ± 8**	79 ± 9	74 ± 10**	68 ± 12	64 ± 12*
SpO_2 mean,%	93 ± 4	94 ± 3**	93 ± 2	93 ± 3	93 ± 3	92 ± 3	90 ± 4	89 ± 5*
TST, hrs	5.6 ± 0.8	5.5 ± 0.9	5.4 ± 0.8	5.3 ± 1.0	5.5 ± 0.8	5.4 ± 1.1	5.4 ± 1.0	5.5 ± 1.0
AI, events/hr	2.3 ± 6.0	1.1 ± 4.4***	3.8 ± 5.3	2.8 ± 2.9	8.9 ± 6.6	7.0 ± 6.2*	33.8 ± 25.2	27.2 ± 23.5*
REM sleep, % TST	17 ± 6	16 ± 6***	16 ± 7	15 ± 7	15 ± 7	13 ± 8*	14 ± 7	13 ± 6
SWS, % TST	18 ± 9	20 ± 9***	17 ± 10	20 ± 9**	15 ± 9	18 ± 10*	8 ± 8	9 ± 10
Sleep efficiency, %	86 ± 9	85 ± 10***	83 ± 10	82 ± 11	83 ± 10	80 ± 13	79 ± 13	81 ± 12
AHI, events/hr	2.1 ± 1.4	1.8 ±1.4***	8.8 ± 2.9	8.8 ± 3.0	21.2 ± 4.4	20.8 ± 3.6	58 ± 20	58 ± 22
SS	2.5 ± 1.2	2.9 ± 1.3***	2.6 ± 1.2	2.7 ± 1.3	2.5 ± 1.2	2.9 ± 1.3**	2.8 ± 1.3	3.3 ± 1.4**

*** indicates P <0 .001; ** indicates P < 0.01; * indicates P < 0.05
Data are presented as mean ± standard deviation.
BMI refers to body mass index; TST to total sleep time; AI to arousal index; SWS to slow wave sleep; AHI to apnea-hypopnea-index; and SS to sleepiness score

Table 2—Two-way analyses of variance for the diagnostic scales of the SDQ: effects of sex and AHI

	Men AHI group				Women AHI group				P-value Main Effects		Interaction
	<5	5-15	15-30	>30	<5	5-15	15-30	>30	Sex	AHI	
SA	38 ± 7	39 ± 6	40 ± 6	43 ± 7	36 ± 7	36 ± 6	38 ± 6	42 ± 8	<0.001	<0.001	0.386
PLM	19 ± 6	20 ± 5	20 ± 6	21 ± 6	22 ± 7	23 ± 6	23 ± 6	24 ± 6	<0.001	<0.001	0.987
PSY	15 ± 5	15 ± 5	15 ± 6	15 ± 5	18 ± 6	17 ± 5	18 ± 5	18 ± 6	<0.001	0.441	0.737
NAR	22 ± 7	22 ± 7	23 ± 7	24 ± 8	23 ± 8	22 ± 7	24 ± 7	26 ± 9	<0.002	<0.001	0.107

Data are presented as mean ± standard deviation.
SA refers to the sleep apnea scale; PLM to periodic limb movement; PSY to psychiatric sleep disorder; and NAR to narcolepsy

due to missing questionnaire data. The remaining 3521 patients completed the questionnaire and were eligible for the present study. There were no significant differences between genders in response trends.

Statistical Analyses

For quantitative data, the mean ± standard deviation was calculated for responses to questionnaire items of subjects who underwent polysomnography and completed the SDQ. First, we examined the effect of gender, AHI group, and the interaction of gender and AHI group by analyses of variance (ANOVA) with 2 independent factors—Gender and AHI group. The clinical relevance of changes was estimated by calculating Cohen's d effect sizes (ES); d is defined as the difference between 2 means divided by the pooled standard deviation for those means. An effect size of 0.2 is indicative of a small effect, 0.5 indicates a medium effect size, and 0.8 indicates a large effect size.[16] Second, we examined the effect of age, AHI group, and the interaction of age and AHI group by analyses of variance (ANOVA) with 2 independent factors—Age and AHI group—separate for the sexes. The aim was to identify possible effects of the hormonal status on OSAS, especially in women. Consequently, we chose the age of 50 years as the cut-off point for the 2 age groups.[17] Third, unpaired student t-tests were performed for each study characteristic for comparisons according to gender separately for each AHI group. Fourth, we assessed associations between each diagnostic scale of the SDQ as the dependent variable and gender as the independent variable by means of multiple analyses of covariance, using – and thereby controlling for – age, BMI, AHI, AI, mean and minimum SpO_2, and smoking history as covariates.

RESULTS

Gender Differences in Clinical Data and Polysomnographic Variables

Differences in clinical characteristics and sleep data among male and female patients are provided in Table 1. Overall, women were heavier and older than men. Among patients with an AHI <5/hr, women appeared to have a slightly lower sleep efficiency than men. There were, however, no significant gender-related differences in total sleep time or sleep efficiency in patients with an AHI of ≥5. There were significant differences in sleep architecture. While men spent slightly more time in REM sleep and had significantly more arousals, women spent significantly more time in slow wave sleep. Female patients with an AHI >5/hr had a lower minimum overnight SpO_2 than men. Women had a significantly higher SS than men, in patients both with (AHI > 15/hr) and without sleep apnea (AHI < 5/hr).

Table 2 presents the results of the 2-way ANOVAs for the 4 scale scores of the SDQ in which AHI group and gender were factors. These results indicate that both main effects were statistically significant for the investigated scales (except for the effect of AHI on PSY), but the interactions were not. Hence, any effects seen between the different AHI groups were mirrored in their male

Table 3—Cohen's *d* effect sizes for gender-related differences in SDQ scale scores by AHI

	AHI group			
Scale	< 5	5-15	15-30	> 30
SA	0.29	0.39	0.37	0.11
PLM	0.50	0.56	0.50	0.51
PSY	0.45	0.42	0.57	0.53
NAR	0.20	0.04	0.23	0.24

SA refers to the sleep apnea scale; PLM to periodic limb movement; PSY to psychiatric sleep disorder; and NAR to narcolepsy
An effect size of 0.2 indicates a small effect; 0.5 indicates a medium effect; and 0.8 indicates a large effect size.

and female counterparts. Women scored higher on PLM, PSY, and NAR, and lower in SA than men (P <0.001, for all). Patients with OSAS (AHI > 15/hr) scored higher on SA, PLM, and NAR than subjects without OSAS (AHI <5/hr) (P < 0.001, for all). These patterns were consistent irrespective of AHI group and sex.

To estimate the clinical importance of gender-related differences, effect sizes were computed for the diagnostic scale scores of the SDQ according to the different AHI groups. As Table 3 shows, gender was associated with a moderate effect for symptoms in the PLM and PSY scale (0.45 to 0.57), low to moderate effect sizes for SA (0.11 to 0.39), and considerably lower effect sizes for the NAR scale score (0.04 to 0.24).

To account for the potential effect of menopause on symptom expression, we further analyzed the effect of age on the 4 scale scores in women separated into 2 age groups (Table 4). Women under the age of 50 scored higher on NAR than women older than 50; however, there were no significant differences in the other scale scores. There was no interaction between age and AHI group, except for the SA scale. Women who were older than 50 years and had an AHI <5/hr, reported symptoms in the SA scale more frequently than younger AHI matched women. It is noteworthy, however, that we observed a similar interaction between age and AHI (<5/hr) in men (data not shown).

We further investigated for differences between sexes on the level of single items, or single symptoms, separately for each of the AHI groups (Tables 5a-d).

SDQ Responses by Gender and AHI

The highest values were observed on the "snoring that bothers others" and "snore/breathing worse if on back" items, indicating that snoring was the predominant symptom in the investigated sample. For both men and women, items such as "stop breathing in sleep," "sweat at night," and "high blood pressure" increased with higher AHI. There were, however, no statistically significant gender-related differences for these symptoms in patients with an AHI >15/hr. In contrast, we observed significant differences between men and women for most of the SA scale items among subjects with an AHI <5/hr. Of note, there was a significant gender difference on examination of smoking history irrespective of AHI category.

For the other sleep problems, women were more likely than men to report symptoms of restless legs, depression, and insomnia. Women in all AHI groups more frequently reported to "wake up often during the night" compared with men. Likewise, there was a general trend for women to have higher item scores in the NAR scale of the SDQ at the lower AHI cut-off.

Table 6 shows that, after correcting for confounding factors, there were significant gender-related differences in all the SDQ scales, suggesting that women and men differed with regard to the symptom scales scores, irrespective of age, BMI, smoking history, and severity of sleep disordered breathing (as measured by AHI, AI, mean and minimum overnight SpO_2). Total SA score was independently associated with age, BMI, AHI, SpO_2mean, SpO_2min, and smoking history, accounting for 35.2% of the total variability. PLM was associated with age, BMI, and smoking history, but not AHI, accounting for 17.5% of the variability. Similarly, there was no independent relationship between AHI and total PSY score, but there was a significant association with the covariates BMI and smoking history, accounting for 5.6% of the variability. In addition to BMI and SpO_2min, age, smoking history, and arousal index were significantly associated with NAR, accounting for 7.0% of the variability.

The 4 SDQ scales were significantly inter-correlated on a low to medium level, with Pearson coefficients for SA-PLM = 0.408, SA-PSY = 0.195, SA-NAR = 0.280, PLM-PSY = 0.619, PSY-NAR = 0.446, and PLM-NAR = 0.438 (N = 3521, P <0.001, for all).

DISCUSSION

The aim of this study was to assess gender-related differences in presenting symptoms of patients with suspected sleep disordered breathing using the Sleep Disorders Questionnaire. Using a relatively large clinical sample with significant heterogeneity in disordered breathing severity, we were able to systematically examine the independent effect of gender on symptom expression. Our results indicate that there are significant gender-related differences in the symptom profile of patients with suspected OSAS.

The validity of our results is strengthened by the large sample studied and by the high response rate in a validated questionnaire.

Table 4—Two-way analyses of variance for the diagnostic scales of the SDQ in women: effects of age group and AHI

	Age < 50yrs AHI group				Age ≥ 50yrs AHI group				P-value Main Effects		Interaction
	<5	5-15	15-30	>30	<5	5-15	15-30	>30	Age	AHI	
SA	34 ± 7	35 ± 6	40 ± 5	43 ± 5	37 ± 7	37 ± 6	38 ± 6	42 ± 9	0.908	<0.001	0.021
PLM	21 ± 6	22 ± 6	23 ± 5	24 ± 5	23 ± 7	23 ± 6	23 ± 6	25 ± 6	0.165	0.144	0.856
PSY	18 ± 6	17 ± 5	18 ± 3	18 ± 5	18 ± 7	17 ± 6	18 ± 5	18 ± 6	0.825	0.737	0.984
NAR	24 ± 8	23 ± 6	28 ± 9	30 ± 9	23 ± 8	22 ± 7	23 ± 7	25 ± 8	<0.001	<0.001	0.098

Data are presented as mean ± standard deviation.
SA refers to the sleep apnea scale; PLM to periodic limb movement; PSY to psychiatric sleep disorder; and NAR to narcolepsy

Table 5a—Responses to single items of the sleep apnea scale of the SDQ by AHI

	AHI < 5		AHI 5-15		AHI 15-30		AHI > 30	
	Men n = 1341	Women n = 512	Men n = 540	Women n = 132	Men n = 309	Women n = 55	Men n = 549	Women n = 83
Snore that bothers others	4.4 ± 1.0	4.3 ± 1.1	4.3 ± 1.0	4.4 ± 1.1	4.5 ± 0.9	4.4 ± 1.2	4.6 ± 0.8	4.7 ± 0.9
Stop breathing in sleep	3.3 ± 1.5	3.0 ± 1.7**	3.4 ± 1.5	2.9 ± 1.7**	3.9 ± 1.3	3.5 ± 1.6	4.1 ± 1.2	4.0 ± 1.4
Awake unable to breathe	1.9 ± 1.2	2.2 ± 1.3**	2.0 ± 1.3	2.2 ± 1.4	2.1 ± 1.3	2.5 ± 1.4	2.5 ± 1.4	2.7 ± 1.4
Sweat at night	2.8 ± 1.3	2.8 ± 1.4	2.7 ± 1.3	2.8 ± 1.3	2.8 ± 1.3	2.9 ± 1.4	3.0 ± 1.4	3.1 ± 1.4
High blood pressure (history)	2.4 ± 1.6	2.7 ± 1.6*	2.6 ± 1.6	2.8 ± 1.7	2.8 ± 1.6	3.0 ± 1.7	3.2 ± 1.7	3.4 ± 1.5
Nose blocks up while trying to sleep	2.6 ± 1.4	2.6 ± 1.5	2.6 ± 1.4	2.4 ± 1.4	2.5 ± 1.4	2.6 ± 1.5	2.7 ± 1.5	2.7 ± 1.6
Snore/breathing worse if on back	4.0 ± 1.3	3.8 ± 1.5*	4.1 ± 1.4	3.8 ± 1.6	4.2 ± 1.3	4.3 ± 1.2	4.2 ± 1.2	3.8 ± 1.6*
Snore/breathing worse with alcohol	3.2 ± 1.6	1.9 ± 1.4**	3.1 ± 1.7	1.9 ± 1.5**	3.1 ± 1.7	1.6 ± 1.3**	3.3 ± 1.7	1.9 ± 1.5**
Number of years as a smoker	2.4 ± 1.7	2.2 ± 1.6**	2.4 ± 1.7	1.7 ± 1.4**	2.4 ± 1.7	1.4 ± 1.1**	2.4 ± 1.7	2.1 ± 1.7

** indicates P <0.01; * indicates P < 0.05
Data are presented as mean ± standard deviation.

Table 5b—Responses to items of the periodic limb movement scale of the SDQ by AHI

	AHI < 5		AHI 5-15		AHI 15-30		AHI > 30	
	Men n = 1341	Women n = 512	Men n = 540	Women n = 132	Men n = 309	Women n = 55	Men n = 549	Women n = 83
Wake up often during night	2.8 ± 1.3	3.3 ± 1.3**	3.0 ± 1.3	3.5 ± 1.2**	3.0 ± 1.3	3.4 ± 1.3*	3.3 ± 1.4	3.6 ± 1.4*
Restless legs as falling asleep	1.7 ± 1.1	2.0 ± 1.3**	1.6 ± 1.0	2.3 ± 1.4**	1.7 ± 1.2	2.0 ± 1.2	1.8 ± 1.2	2.4 ± 1.4**
Palpitations at night	1.9 ± 1.1	2.3 ± 1.3**	1.9 ± 1.1	2.3 ± 1.3**	2.0 ± 1.1	2.3 ± 1.3	2.1 ± 1.2	2.7 ± 1.3**
Restless legs disturb sleep	1.6 ± 1.0	1.9 ± 1.2**	1.6 ± 1.0	2.0 ± 1.3**	1.7 ± 1.1	1.8 ± 1.1	1.7 ± 1.2	2.3 ± 1.3**
Insomnia	1.4 ± 0.8	1.7 ± 1.1**	1.5 ± 1.0	1.7 ± 1.0*	1.3 ± 0.8	1.6 ± 1.0	1.4 ± 1.0	1.7 ± 1.1
Lessening of sexual interest	2.3 ± 1.3	3.0 ± 1.5**	2.5 ± 1.4	3.1 ± 1.6**	2.6 ± 1.5	3.4 ± 1.5**	2.7 ± 1.5	2.9 ± 1.6
Smoking two hours before bedtime	2.2 ± 1.7	2.1 ± 1.6	2.1 ± 1.7	1.5 ± 1.3**	2.1 ± 1.7	1.4 ± 1.3**	2.1 ± 1.7	2.0 ± 1.7
Wake up period at night	2.0 ± 1.1	2.3 ± 1.2**	2.1 ± 1.0	2.6 ± 1.3**	2.1 ± 1.1	2.4 ± 1.3	2.0 ± 1.1	2.2 ± 1.2
Night urination (number of times)	1.9 ± 0.9	2.2 ± 1.1**	2.1 ± 1.0	2.6 ± 1.0**	2.1 ± 1.0	2.6 ± 1.1**	2.6 ± 1.1	2.9 ± 1.1**

** indicates P < 0.01; * indicates P < 0.05
Data are presented as mean ± standard deviation.

An important strength of our study lies in the use of attended, laboratory-based polysomnography, the diagnostic standard for assessment of SDB. In addition, we controlled our findings for potentially confounding factors such as BMI, age, smoking history, and objective measures of SDB such as apnea severity, oxygen saturation data, and arousal index.

Gender-Related Differences in Symptoms of Sleep Disordered Breathing

Previous studies performed in the general population suggested that men experienced SDB 2 to 3 times more frequently than women.[1-3] In the sleep laboratory sample, the male/female ratio was even higher. The reason for the apparent gender discrepancy between clinic and community populations is not clear. A potential explanation for the clinical underrecognition of sleep apnea in women might be that women have different symptoms, different severity of symptoms, or that women underreport their symptoms.

In the present study we found no significant gender-related differences in the "snoring that bothers others" item; however, men reported worsening of snoring in association with alcohol or supine position more frequently than women. We have also found significant gender-related differences in a variety of other symptoms associated with sleep disorders. Women were more likely to complain of substantial symptoms associated with PLM disorder compared with men who had overall lower total PLM scale scores. Symptoms in the PLM scale included restless legs, awakenings during the night, palpitations, and insomnia. Furthermore, we observed higher female item scores on questions related to depression, difficulties falling asleep, suicidal thoughts, nightmares, or sleep paralysis. The magnitude of the gender-effect on the diagnostic subscales of the SDQ was computed by performing both effect sizes and multi-variate analyses. While effect sizes detected for PLM and PSY were moderate, lower effect sizes were calculated for SA and NAR. These findings confirm that clinically relevant gender-related differences were particularly present for the atypical sleep apnea symptoms, rather than for typical sleep apnea symptoms. After adjusting for potentially confounding factors by means of multiple analyses of covariances, the gender differences for the SDQ scales remained significant.

Our findings are supported by other clinical population studies.[7,9,18,19] Shepertycky and coworkers[7] studied the clinical presentation of 130 randomly selected women with OSAS (AHI 36 ± 3/hr) matched individually with 130 men with OSAS for age, BMI, and AHI. While there were no significant gender differences in self-reported snoring, women in that report presented more often with insomnia or depression than men did. Similarly, Pillar and Lavie[18] have shown that depression and anxiety scores (using the

Table 5c—Responses to items of the psychiatric sleep disorder scale of the SDQ by AHI

	AHI < 5		AHI 5-15		AHI 15-30		AHI > 30	
	Men n = 1341	Women n = 512	Men n = 540	Women n = 132	Men n = 309	Women n = 55	Men n = 549	Women n = 83
Trouble getting to sleep	1.9 ± 1.1	2.3 ± 1.3**	1.9 ± 1.1	2.4 ± 1.3**	1.8 ± 1.0	2.4 ± 1.1**	1.8 ± 1.2	2.1 ± 1.1**
Racing thoughts at bedtime	2.5 ± 1.2	2.7 ± 1.3**	2.4 ± 1.2	2.7 ± 1.3*	2.4 ± 1.3	2.7 ± 1.3	2.3 ± 1.3	2.6 ± 1.4
Sad/depressed at bedtime	1.8 ± 1.0	2.1 ± 1.1**	1.7 ± 1.0	2.0 ± 1.1**	1.8 ± 1.0	2.1 ± 1.0*	1.7 ± 1.1	2.3 ± 1.3**
Sadness/depression disturbs sleep	1.5 ± 0.8	1.9 ± 1.1**	1.5 ± 0.8	1.7 ± 1.0*	1.6 ± 0.9	1.7 ± 0.9	1.5 ± 0.9	2.0 ± 1.1**
A lot of nightmares	1.7 ± 0.9	2.1 ± 1.1**	1.7 ± 0.9	2.0 ± 1.0**	1.8 ± 1.0	2.1 ± 1.0	1.8 ± 1.1	2.1 ± 1.2**
Unable to sleep for days	1.3 ± 0.7	1.6 ± 0.9**	1.3 ± 0.7	1.5 ± 0.9**	1.2 ± 0.6	1.7 ± 1.0**	1.4 ± 0.9	1.7 ± 1.1*
Unhappy with loving relationships	1.7 ± 1.1	2.1 ± 1.3**	1.8 ± 1.1	2.0 ± 1.4	1.7 ± 1.1	2.3 ± 1.5**	1.8 ± 1.2	1.8 ± 1.1
Considered/attempted suicide	1.3 ± 0.7	1.5 ± 1.0**	1.3 ± 0.7	1.4 ± 1.0	1.3 ± 0.8	1.6 ± 1.0	1.2 ± 0.6	1.6 ± 1.1**
Family: psychiatric hospitalization	1.4 ± 1.1	1.5 ± 1.3	1.3 ± 1.0	1.4 ± 1.1	1.2 ± 0.9	1.4 ± 1.2	1.4 ± 1.1	1.5 ± 1.3

** indicates P < 0.01; * indicates P < 0.05
Data are presented as mean ± standard deviation.

Table 5d—Responses to items of the Narcolepsy Scale of the SDQ by AHI

	AHI < 5		AHI 5-15		AHI 15-30		AHI > 30	
	Men n = 1341	Women n = 512	Men n = 540	Women n = 132	Men n = 309	Women n = 55	Men n = 549	Women n = 83
Feel paralyzed as falling asleep	1.2 ± 0.6	1.3 ± 0.8*	1.3 ± 0.7	1.4 ± 0.9	1.3 ± 0.7	1.5 ± 1.0	1.3 ± 0.7	1.5 ± 0.9*
Paralyzed after a nap	1.7 ± 1.0	1.8 ± 1.1*	1.7 ± 1.0	1.6 ± 1.1	1.7 ± 1.1	1.9 ± 1.4	1.8 ± 1.2	1.8 ± 1.3
Hallucinations upon awakening	1.2 ± 0.6	1.4 ± 0.8**	1.3 ± 0.6	1.4 ± 0.8	1.3 ± 0.7	1.6 ± 1.0*	1.3 ± 0.8	1.5 ± 0.9*
Slept for several days	1.8 ± 1.1	2.1 ± 1.3**	1.8 ± 1.2	1.7 ± 1.2	1.7 ± 1.1	2.0 ± 1.4	2.1 ± 1.4	2.3 ± 1.5
Sleepy during the day	2.4 ± 1.1	2.6 ± 1.2**	2.4 ± 1.2	2.4 ± 1.3	2.4 ± 1.2	2.7 ± 1.3	3.0 ± 1.4	3.0 ± 1.4
Accidental sleep	1.9 ± 1.2	2.0 ± 1.4	2.1 ± 1.3	2.0 ± 1.5	2.3 ± 1.4	2.3 ± 1.5	2.7 ± 1.6	3.0 ± 1.6
Bad grades due to sleepiness	1.3 ± 0.7	1.2 ± 0.7	1.3 ± 0.8	1.2 ± 0.6	1.2 ± 0.6	1.3 ± 0.8	1.2 ± 0.7	1.2 ± 0.7
Trouble on job due to sleepiness	1.6 ± 1.0	1.7 ± 1.1	1.5 ± 1.0	1.5 ± 1.0	1.6 ± 1.0	1.4 ± 0.9	1.7 ± 1.2	2.0 ± 1.5
Too sleepy to drive	1.2 ± 0.6	1.3 ± 0.8	1.2 ± 0.7	1.1 ± 0.7	1.3 ± 0.7	1.2 ± 0.8	1.5 ± 1.0	1.6 ± 1.1
Hallucinations after napping	1.2 ± 0.5	1.2 ± 0.6	1.1 ± 0.5	1.2 ± 0.6	1.2 ± 0.6	1.3 ± 0.8	1.2 ± 0.7	1.4 ± 0.8
Paralyzed upon morning awakening	1.8 ± 1.1	2.0 ± 1.2**	1.8 ± 1.1	1.9 ± 1.2	1.8 ± 1.1	2.2 ± 1.3*	1.8 ± 1.2	2.2 ± 1.4**
Failure to remember driving	1.3 ± 0.7	1.4 ± 0.8*	1.3 ± 0.6	1.3 ± 0.7	1.4 ± 0.7	1.3 ± 0.8	1.3 ± 0.7	1.3 ± 0.8
Weak knees when laughing	1.0 ± 0.4	1.1 ± 0.5*	1.1 ± 0.4	1.0 ± 0.3	1.1 ± 0.4	1.2 ± 0.7	1.1 ± 0.5	1.2 ± 0.5
Muscular weakness if strong emotion	1.2 ± 0.6	1.4 ± 0.8**	1.2 ± 0.6	1.2 ± 0.6	1.2 ± 0.6	1.2 ± 0.6	1.2 ± 0.6	1.4 ± 0.9
Work accidents due to sleepiness	1.1 ± 0.5	1.1 ± 0.4	1.1 ± 0.5	1.1 ± 0.4	1.2 ± 0.5	1.1 ± 0.5	1.2 ± 0.6	1.2 ± 0.6

** indicates P < 0.01; * indicates P < 0.05
Data are presented as mean ± standard deviation.

SCL-90) were significantly higher in women than in men with SDB.

Only few population-based studies have systematically investigated gender-related differences in sleep disordered breathing symptoms.[1,20,21] Using data from the Wisconsin Sleep Cohort Study, Young et al.[20] did not observe significant gender-related differences in snoring, self-reported breathing pauses, depression, restless legs, or nightmares in subjects with an AHI of ≥15. It should be acknowledged, however, that this study may have been underpowered to detect a gender-specific difference in these symptoms, since only 17 female subjects with an AHI >15 were included. In contrast to the latter findings, Redline and coworkers[1] noted that the "classic" symptoms of sleep apnea, such as snoring and witnessed apnea were reported two- to three-fold more likely in males. The best available evidence from the community sample, however, comes from the Sleep Heart Health Study.[21] Baldwin and colleagues[21] demonstrated that women were significantly more likely to report insomnia, difficulties falling asleep, and awakening with leg cramps than men. Hence, the findings from both clinical and population-based studies suggest that women suffer from a number of atypical symptoms of sleep apnea.

The distinction between the more traditional symptoms of OSAS and the "atypical" OSAS symptoms is important, as clinicians rely on self-reported apnea and the quantitative aspects of snoring, which have been associated with OSAS in predominantly male populations.[5] Thus, when evaluating the symptoms of women, the attending physician may misinterpret symptoms as insomnia, depression, or restless legs syndrome rather than sleep apnea.

The higher rates of insomnia and depression scores in women in our report, however, may also arise from basic gender personality characteristic differences and may be unrelated to SDB. In fact, the 2-way ANOVA has shown that AHI had no effect on total PSY score in our report. These findings confirm those of Lindberg et al.,[22] who previously suggested that insomnia is more frequent in women than in men. In this respect, insomnia resembles other psychiatric disorders that occur more frequently in women, such as anxiety and depressive disorders.[23]

There were also substantial gender-related differences in excessive daytime sleepiness. Consistent with previous studies, women with SDB are more likely to report sleepiness than men with SDB.[8,20,22,24] Curiously, in our clinical sample men had a sig-

Table 6—Confounding Variables of Symptom Scale Scores

	SA	PLM	PSY	NAR
Men (Mean ± SD), N = 2739	39.5 ± 6.8	19.8 ± 5.9	15.1 ± 5.2	22.7 ± 7.2
Women (Mean ± SD), N = 782	36.9 ± 7.3	22.8 ± 6.6	17.8 ± 6.2	23.7 ± 7.9
Sex	P < 0.001	P < 0.001	P < 0.001	P < 0.001
Smoking history	P < 0.001	P < 0.001	P = 0.001	P = 0.001
Age	P < 0.001	P < 0.001	P = 0.798	P < 0.001
BMI	P < 0.001	P < 0.001	P < 0.001	P < 0.001
SpO_2min	P < 0.001	P = 0.641	P = 0.053	P = 0.031
SpO_2mean	P = 0.006	P = 0.101	P = 0.638	P = 0.055
AI	P = 0.575	P = 0.687	P = 0.190	P = 0.007
AHI	P = 0.003	P = 0.120	P = 0.990	P = 0.750
Total explained variance	35.2%	17.5%	5.6%	7.0%

nificantly higher arousal index than women irrespective of AHI category. These observations may either suggest gender-related differences in the perception of sleepiness or a discrepancy between polysomnographic parameters of sleep fragmentation and subjective sleepiness reports. In fact, Kingshott and coworkers[25,26] found no significant relationship between arousal frequency and subjective (Epworth Sleepiness Scale) or objective measures of sleepiness (MSLT, MWT). Chervin[8] has previously shown that female gender was independently associated with increased sleepiness. It has to be noted, however, that there is a strong relationship between excessive daytime sleepiness and complaints such as fatigue, depression or insomnia, symptoms which are also more commonly reported by women.[8,22]

The higher prevalence of hypersomnolence in women with an AHI <5/hr may have also been due to a higher prevalence of upper airway resistance syndrome in women. However, because neither population studies nor clinical diagnostic studies use invasive manometry necessary to detect this syndrome, undetected upper airway resistance syndrome in women is unlikely to explain the gender disparity shown in conventional polysomnography.

Finally, we also attempted to account for the potential effect of menopause in women. Menopause is considered to be a risk factor for sleep disordered breathing.[27,28] Since we did not obtain any information on the hormone status in this report, our analysis was based on dichotomizing the sample according to recommended age cut-offs.[17] Based on this analysis we were not able to identify differences in SA, PLM, or PSY scales between women who were younger and those who were older than 50 years of age. However, we can not entirely rule out that gender-related differences in presenting symptoms may have been a result of hormonal effects.

Implications of the Study and Referral Bias

The population studied represents subjects who had been referred to a sleep laboratory and therefore does not represent the general population. There is an inevitable referral bias in primary care that may have prevented the assessment of true gender-related differences in symptoms associated with SDB. A number of factors, however, may strengthen our findings. First, administration of the SDQ occurred prior to clinical and polysomnographic evaluation. Second, free access to the sleep laboratory minimized the confounding effect of possible "prescreening" since the majority of patients were either self-referred or were referred by family practitioners who would have had no particular knowledge of sleep disordered breathing.[29] Third, every patient who had been referred underwent a full sleep study, even if the likelihood of significant sleep disordered breathing was considered low from the SDQ response. An additional important strength of our study lies in the use of attended, laboratory-based polysomnography, the diagnostic standard for assessment of SDB. Although the above mentioned approach may have reduced a noteworthy proportion of the clinical referral bias, the majority of patients were filtered through different stages of the Austrian healthcare system and were therefore subject to referral bias.

CONCLUSION

Using the Sleep Disorders Questionnaire we found significant gender-related differences in presenting symptoms of patients with sleep disordered breathing at a tertiary level. These differences should be taken into consideration in the clinical evaluation of women referred for suspected sleep disordered breathing.

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