The Gender Bias in Sleep Apnea Diagnosis

Are Women Missed Because They Have Different Symptoms?

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Background: Population-based studies have shown that sleep apnea is underdiagnosed in women, relative to men. One hypothesis for this gender bias is that women with sleep apnea are missed because clinical guidelines for the evaluation and diagnosis of sleep apnea, established primarily on men, are not valid for women. In this investigation, data from the Wisconsin Sleep Cohort Study, a community-based study of the natural history of sleep apnea, were used to determine whether women with sleep apnea have unique symptoms or complaints.

Methods: The sample comprised 551 men and 388 women, none of whom had ever been given a diagnosis of sleep apnea. Data on typical sleep apnea symptoms and other factors were obtained by interview and survey. Sleep apnea status was determined from the frequency of apneic and hypopneic events during sleep as recorded by in-laboratory, whole-night polysomnography. The sensitivity and relative predictive power of each symptom or factor for sleep apnea at different severity levels were calculated and compared by gender.

Results: Regardless of severity level, women with sleep apnea did not report symptoms that differed significantly from those of men with the same level of sleep apnea. For men and women, snoring was the most sensitive and strongest predictor of sleep apnea.

Conclusions: Current clinical indications for sleep apnea evaluation are as appropriate for women as they are for men. Other reasons for the gender disparity in sleep apnea diagnosis, including the possibility that health care providers disregard typical symptoms in women, should be pursued.

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IN RECENT YEARS, research findings[1-4] and special reports[5-14] have underscored the need to identify and to reduce current barriers to optimal health care for women. One potential cause of gender-based inequities in evaluation and diagnoses is that clinical guidelines that were established primarily from research on men may not be valid for women. We investigated whether the recently recognized underrepresentation of women among patients with diagnosed sleep apnea[15-18] can be explained by gender-biased guidelines. We used data from a population-based study of sleep-disordered breathing to test the hypothesis that women have symptoms of sleep apnea that differ from the current clinical indications for sleep apnea evaluation, namely, habitual snoring, loud snoring, breathing pauses during sleep, and excessive daytime somnolence.[19]

Sleep apnea has been considered to be a disease predominantly of men.[20,21] The basis for evaluation and treatment was developed almost entirely from clinical observations of and research on male patients.[15] In clinical populations, the male-female ratio for diagnosed sleep apnea is typically 8:1 or greater.[22-25] The few population studies that have included women, however, show that undiagnosed sleep apnea is prevalent in women as well as men and estimate the male-female ratio for this condition to be only 2:1 or 3:1.[16,17,26,27] One possible explanation for the gender ratio disparity between clinical and general populations is that women with sleep apnea have different manifestations, and current indications for evaluation will selectively fail to evaluate and diagnose their disorders.

Although the gender disparity in sleep apnea diagnoses has caused concern, its cause has not yet been investigated. A few studies offer limited data suggesting that symptom differences may exist. Results of a study of acquaintances and relatives of patients with sleep apnea indicated that

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STUDY PARTICIPANTS AND METHODS

SAMPLE

The 388 women and 551 men enrolled in the Sleep Cohort Study, a longitudinal study of the natural history of sleep-disordered breathing as assessed by laboratory polysomnography, constitute our sample. Details of the construction of the Sleep Cohort Study sample have been reported previously.[16] A 2-stage sampling scheme designed to optimize study power by enrolling more subjects who were more likely to have sleep-disordered breathing was used to construct a cohort with a wide spectrum of sleep-disordered breathing severity. In the first stage, 6947 men and women, 30 to 60 years of age, employed at 1 of 5 large state agencies in south central Wisconsin, were surveyed about their sleep patterns and other characteristics by mailed questionnaire. Completed questionnaires were returned by 5029 subjects, resulting in a response rate of 72.4%. A comparison of respondents and nonrespondents with respect to personnel data, including sex, age, and job category, revealed no significant differences ($P>.10$ for all).

In the second stage of sampling, responses to 6 survey questions, answered with a 5-point frequency scale and "do not know," were used to classify survey respondents as high risk according to whether they reported habitual (ie, 3-7 nights per week) or frequent (ie, at least 1 night per week) snorting or breathing pauses or extremely loud snoring. All other survey respondents were classified as low risk. A sampling ratio of 2:1 high- to low-risk survey respondents, frequency matched by sex and 2-year age groups, was used. The resultant sampling fractions and underlying proportions of men and women by risk group in the defined sampling frame were used to unweight results to reflect the sampling frame.

Subjects were recruited for the overnight sleep study by both mail and telephone calls. Exclusion criteria included pregnancy, unstable or decompensated cardiopulmonary disease, airway cancer, recent upper airway surgery, and tracheostomy. Eight respondents were excluded based on these criteria. Of the 2019 invited, 970 have thus far completed an overnight sleep study, resulting in a participation rate of 48.0% for this investigation. The most common reason for declining to participate was the inconvenience of sleeping away from home.

COLLECTION OF DATA

Self-reported Sleep Disturbances and Other Problems

Each subject completed a self-administered questionnaire by mail[16] and had a structured personal interview on the night of their sleep study. These instruments addressed most presenting complaints encountered in sleep disorder clinics and included questions on life and health satisfaction and a depression scale. Separate questions on frequency of snoring, snorting, and breath pauses during sleep were introduced by the following: "According to what others have told you, how often, if ever, do you ———?" and "Aside from what others have told you, how often, if ever, do you have the feeling that you ———?" Six semiquantitative response categories were offered, ranging from never to every night or almost every night. For other sleep problems, subjects were asked to check a 5-point scale ranging from never to almost always (16-30 times per month). All questions included "do not know" as a category. Dichotomous variables to represent often or always having each of the symptoms or problems, corresponding to usual clinical complaint levels of significance, were constructed. Do not know responses were treated as missing data. Snoring loudness was rated using 4 categories; subjects who reported snoring louder than talking were classified as loud snorers.

Questions about daytime sleepiness and its functional impact were designed to help discriminate between physical fatigue and underlying somnolence. Subjects were first asked about feeling tired or fatigued, followed by this question: "Many people have periods of low energy or fatigue, but do you experience excessive sleepiness, when it is difficult to fight an uncontrollable urge to fall asleep?" For both questions, subjects were asked if the fatigue or sleepiness interfered with any of 7 aspects of daily living. Reporting fatigue or sleepiness that interfered with at least 1 aspect of life was considered a positive response. Subjects were also asked to rate their satisfaction with life (completely, mostly, moderately, or not very satisfied) and general health (excellent, very good, good, fair, or poor). The Zung Self-rating Depression Scale[29] was used to measure depression. Zung scores range from 20 to 80 (most depressed); a score of 50

women, compared with men with undiagnosed sleep apnea, underreport the classic symptoms.[17] Two studies of clinic patients have shown that women with sleep apnea report other problems in addition to the classic symptoms.[18,28] In the present study, we compared men and women, matched for severity level of sleep apnea as determined by standard polysomnography, on typical sleep apnea symptoms, daytime somnolence, fatigue, other sleep-related problems, depression, life satisfaction, and health perception.

RESULTS

Responses to questionnaire items of subjects who underwent polysomnography and those who refused were compared, according to gender. Questionnaire items included sleep characteristics, body height and weight, smoking habits, and sociodemographics (**Table 2**). There were no gender differences in response trends; participants and nonparticipants, regardless of gender, did not differ on reported occurrences of snoring or other breathing abnormalities during sleep. Both men and women who underwent polysomnography tended to have higher educational status and, particularly for the low-risk subjects, to report more excessive daytime sleepiness. For the other somnolence measures, however, no participation bias was seen.

The sensitivity of the classic sleep apnea symptoms, other sleep problems, and other characteristics for each AHI category, according to gender, are shown in **Table 3**. There are interesting differences in the male and female prevalence of typical sleep apnea symptoms

or greater is commonly used to indicate mild or worse depression. We also ascertained from subjects' history of drug use whether they used antidepressants. Subjects with a Zung score of 50 or greater or who used antidepressants received a code of positive for depression.

Polysomnographic Assessment of Sleep Apnea

Full-night polysomnography was performed to determine the occurrence and frequency of apneas and hypopneas during sleep for each subject. Sleep studies were conducted in the sleep research laboratory designed specifically for the Sleep Cohort Study. Use of a single-night assessment of breathing parameters was deemed acceptable based on results from repeated studies on a subset of 40 subjects.[16]

The polysomnography consisted of continuous polygraphic recording from surface leads for electroencephalography, electro-oculography, electromyography, and electrocardiography and from noninvasive sensors for nasal airflow (thermocouples), oral airflow (capnograph), tracheal sounds (a miniature microphone), thoracic and abdominal respiratory effort (inductance plethysmograph), and oxyhemoglobin level (finger-pulse oximeter). The transducers and lead wires permitted normal positional changes during sleep. Bedtime and awakening time were at each subject's discretion; the polysomnography was terminated after final wakening.

Each polysomnograph record was manually scored by a sleep technician and validated by a board-certified sleep specialist (S.B.). Sleep data were staged (stages I, II, III, and IV and rapid eye movement sleep) according to the system of Rechtschaffen and Kales.[30] An abnormal breathing event occurring during objectively measured sleep was defined according to the commonly used clinical criterion of either a complete cessation of airflow lasting 10 seconds or more (apnea) or a reduction in ventilation (determined by a 25% or greater decrease in the amplitude in either of the 2 respiratory effort signals) resulting in a decrease of 4% or more in oxyhemoglobin saturation (hypopnea).

The average number of episodes of apnea and hypopnea per hour of sleep (the apnea-hypopnea index [AHI]) was calculated as the summary measure of sleep-disordered breathing. For categorical analysis, cutoff points of 0 to less than 2, 2 to less than 5, 5 to less than 15, and 15 or greater were used. Typically, a cutoff point of 5 is used to indicate physiologic evidence of at least mild sleep apnea, and a cutoff point of 15 is often used to indicate clinically significant sleep apnea. However, the significance of any particular cutoff point has not been adequately determined.

Of the 970 completed studies, 31 did not meet the criteria for acceptable quality. These were excluded due to technical problems with the polysomnography signals, less than 4 hours of scorable sleep, or the absence of rapid eye movement sleep. The distributions of men and women who completed sleep studies, according to sampling stratum and AHI, are presented in **Table 1**.

Ascertainment of Previously Diagnosed Sleep Apnea

To determine the ratio of men to women with previously diagnosed sleep apnea in our sampling frame, we contacted all surveyed respondents who indicated that they had been told by a physician that they had sleep apnea. These respondents were asked for the date of diagnosis, treatment prescribed, and their detailed experience with the treatment, if any.

STATISTICAL ANALYSIS

Data were analyzed with SAS[31] and SUDAAN[32] software modules for descriptive statistics, contingency tables, and multiple logistic regression. Two-tailed P values of less than .05 indicated statistical significance. In all analyses, sample weighting was used to give unbiased estimates and SEs of the sampling frame prevalences of snoring and other self-reported sleep-related breathing disturbances. Within each AHI category, the χ^2 test was used to determine significant differences in proportions of men and women with the sleep problems and other factors of interest. Differences in mean values were assessed by the Student t tests.

Multiple logistic regression was used to estimate gender-specific odds ratios for associations of sleep apnea with each potential sleep apnea symptom or other problem. Models included sleep apnea status as the dependent variable (either AHI >5 vs AHI <2, or AHI >15 vs AHI <2), 1 potential symptom or problem (coded as present or not present), terms for sex and age in years, and an interaction term for sex and the potential symptom. The interaction term allowed assessment of the statistical significance of the difference in odds ratios for men and women.

within each AHI category (Table 3). For those with an AHI greater than 15, men tended to report these symptoms more often than women did, but the differences were not statistically significant. In subjects with mild sleep apnea (AHI from 5 to <15), male and female prevalences were surprisingly similar. The most significant gender difference for these symptoms, however, was among the subjects without evidence of sleep apnea (AHI from 0 to <2). Men without sleep apnea were 3 times as likely to report these symptoms as were women, indicating the poor specificity of these symptoms for men. For both men and women, the symptoms of snoring and other breathing symptoms and hypersomnolence increased in prevalence with higher AHI. However, there was a different trend for women, compared with men. As seen in the **Figure**, the prevalence for reporting any sleep apnea symptoms (loud or frequent snoring, snorting, or breathing pauses) increased more sharply at a lower AHI for women and more sharply at a higher AHI for men.

For the other sleep problems, the only variable that showed a gender difference was waking up with headaches (Table 3). Prevalences, however, did not increase with AHI, and for all AHI categories, a higher proportion of women reported waking up with headaches than did men.

As shown in Table 3, age and body mass index (BMI), common clinical correlates of sleep apnea, increased with AHI for both men and women. Compared with men, women with an AHI of 15 or greater appeared to have a significantly greater BMI. This finding supports clinical observations that women with sleep apnea, compared with men, tend to be more overweight.[22] Women were more

likely than men to be depressed or to report dissatisfaction with life, regardless of AHI category.

The gender comparison of odds ratios reflecting the ability of basic sleep apnea symptoms (snoring, breath pauses, and hypersomnolence) to predict sleep apnea at 2 severity levels (AHI of 5 to <15 and ≥15) are given in **Table 4**. The breathing symptoms that were strong predictors of sleep apnea for both men and women appeared to be strongest (reflected by higher odds ratios) for women, regardless of AHI cutoff point. Although the same trend predicted AHIs of 5 to less than 15 and 15 or greater, the gender difference in strength was statistically significant only at the lower cutoff point. Thus, in contrast to the study hypothesis that predicted the odds ratios would be significantly higher for men compared with women, these findings support the converse. Hypersomnolence was a significant predictor of sleep apnea for men and women, and there was no difference in the strength of the association by gender. There were no significant gender effects for any other sleep problems, quality of life measure, or any other study factors.

We determined through personal contact that 10 men and 1 woman in the entire surveyed sample had a diagnosis of sleep apnea. Based on the total number of male (n=2275) and female (n=2650) survey respondents for whom we had complete data, the male-female ratio for diagnosed sleep apnea in our sampling frame was 11:1, corresponding to the ratio reported by sleep disorder clinics.

Table 1. Gender and Risk-Specific Distribution of the Sample by AHI*

	No. (%) of Subjects			
	Men		Women	
AHI	High Risk	Low Risk	High Risk	Low Risk
<2	155 (42.9)	115 (60.5)	114 (54.5)	159 (88.8)
2 to <5	75 (20.8)	45 (23.7)	44 (21.0)	9 (5.0)
5 to <15	66 (18.3)	23 (12.1)	37 (17.7)	8 (4.5)
≥15†	65 (18.0)	7 (3.7)	14 (6.7)	3 (1.7)
Total	361 (100)	190 (100)	209 (100)	179 (100)

*AHI indicates apnea-hypopnea index. N=939. Percentages have been rounded and may not total 100.

†Mean±SD (range) score for women with AHI of 15 or greater was 31.1±18.3 (15.2-76.4); for men, 34.7±20.2 (15.2-97.5).

COMMENT

This analysis has shown that in a community-based sample of middle-aged adults, women with mild (AHI from 5 to less than 15) and more severe (AHI of >15) sleep apnea generally report the same symptoms as do men with similar sleep apnea status. Neither the sensitivity nor specificity of the classic symptoms was significantly higher for men compared with women, and no unique symptoms for women were found. Although most of the symptoms other than snoring had a low sensitivity in both men and women, the gender similarity in symptom profiles importantly indicates a similar disorder. Furthermore, the ability of the symptoms to predict sleep apnea (eg, positive predictive value) was not higher for men, compared with women. Regardless of the AHI cutoff point, habitual snoring was the best predictor of sleep apnea for both men and women. The other 2 clinically recognized symptoms of reported breathing pauses and hypersomnolence were significant predictors for both men and women also.

Although we found a nominal gender difference in the sensitivity of frequent snoring for an AHI of 15 or

Table 2. Characteristics of Participants and Nonparticipants According to Gender and Risk Group

	High-Risk Group				Low-Risk Group			
	Men		Women		Men		Women	
	Participants	Nonparticipants	Participants	Nonparticipants	Participants	Nonparticipants	Participants	Nonparticipants
Total, %	51.7	48.3	50.8	49.2	41.2	58.8	39.7	60.3
Mean age, y	45.4	44.8	43.7	44.0	42.8	44.3	43.2	43.5
Mean BMI*	28.5	28.4	30.4	29.3	25.6	25.8	25.4	24.9
High school graduate or less, %	54	64	73	75	32	41	53	60
Snoring, %								
≥6 nights/wk†	68	62	67	66	0	0	0	0
Few nights/mo	3	2	2	2	37	39	22	27
Snorting ≥1 night/wk, %†	34	30	32	26	0	0	0	0
Breathing pauses ≥1 night/wk, %†	18	15	9	7	0	0	0	0
Dozing while watching television, %‡	48	42	43	47	25	21	33	24§
Excessive sleepiness, %‡	22	16§	30	21§	13	8	17	9§
Nonrestorative sleep, %‡	29	27	43	35	15	13	21	14§

*BMI indicates body mass index.

†Low-risk men and women by definition did not report snoring more than 3 nights per week or snorting or breathing pauses 1 night/week or more.

‡Indicates more than once per week.

§Participants were significantly different from nonparticipants (P<.05).

Table 3. Gender Comparison According to AHI Category*

Problem	AHI Category <2 Men	<2 Women	2 to <5 Men	2 to <5 Women	5 to <15 Men	5 to <15 Women	≥15 Men	≥15 Women	Total Men	Total Women
Clinical Sleep Symptoms										
Subject's informant-based perception										
Snoring ≥3 nights/wk	30.4	10.8†	28.5	46.8†	45.9	50.7	82.6	58.0	36.5	17.5†
Loud snoring	22.7	9.2†	40.0	24.1	39.5	31.5	61.3	36.8	32.4	12.6†
Snorting ≥1 night/wk	10.7	4.5†	10.4	13.7	17.0	19.1	32.2	16.4	13.3	6.5†
Breathing pauses ≥1 night/wk	5.2	0.7†	6.0	4.6	6.7	9.6	24.4	12.1	7.2	1.9†
Snoring ≥3 nights/wk or loud	31.7	11.2†	30.5	50.0	47.8	52.2	82.5	62.0	37.9	18.0†
Leg kicks, ≥1 night/wk	16.2	9.6	10.2	21.6	9.5	18.4	14.2	4.0	13.6	11.1
Subject's self-perception										
Snoring ≥3 nights/wk	5.0	3.2	6.0	9.0	12.5	14.2	24.3	20.6	7.9	4.8†
Snorting ≥1 night/wk	1.8	1.2	0.8	8.2†	3.0	9.6	6.5	8.0	2.1	2.4
Excessive sleepiness >1 time/wk	12.8	21.1†	12.7	10.9	16.7	28.6	30.2	24.9	14.4	20.8
Nonrestorative sleep >1 time/wk	17.2	27.0	25.2	29.1	32.6	34.7	35.3	28.9	22.9	27.7
Dozing while watching television >1 time/wk	27.9	31.1	41.5	46.7	52.8	41.6	53.7	29.0	37.0	33.0
Dozing at meetings >1 time/wk	4.7	8.1	6.3	5.8	5.0	8.1	16.7	0.0†	6.1	7.7
Sleep Problems										
Present >1 time/wk										
Difficulty initiating sleep	18.7	18.0	20.2	17.2	15.7	23.7	18.0	21.0	18.6	18.4
Difficulty maintaining sleep	21.0	25.1	29.4	12.0	10.6	15.8	21.1	24.8	21.6	23.4
Repeated wakenings	30.6	28.0	17.6	25.3	26.8	22.5	33.5	25.0	27.1	27.4
Too early wakening in morning	16.0	19.2	22.4	30.5	8.3	19.0	21.5	12.3	17.0	20.0
Difficulty waking up	12.5	20.7	12.3	15.8	21.3	19.1	20.6	12.7	14.4	20.0
Nightmares	4.5	8.7	1.2	8.5	15.1	8.1	7.9	8.3	5.5	8.6
Restless legs	10.9	9.9	19.4	13.0	9.6	19.2	16.7	8.5	13.3	10.7
Waking with headache	4.4	12.1†	0.9	12.6†	3.0	17.1*	4.2	12.3†	3.3	12.5†
Need sedatives to sleep	2.0	2.2	2.6	4.6	1.5	4.9	0.0	0.0	1.9	2.5
Nasal congestion at night	15.5	18.8	9.3	17.9	25.5	23.8	15.9	25.0	15.4	19.2
Quality of Life Measures, Age, and BMI										
Not satisfied with life	2.8	4.9	0.5	13.9	2.2	11.8	9.1	26.6	2.7	6.6†
Fair or poor health evaluation	2.9	1.3	1.0	3.6	2.8	5.0	16.8	4.7	3.6	1.8
Zung score of ≥50 or antidepressant use	14.7	22.7	6.8	14.8	24.9	19.4	18.8	42.8	14.6	22.3
≥1 life function affected by fatigue‡	43.4	60.4†	60.1	61.0	56.2	65.1	38.4	62.5	49.1	60.8†
≥1 life function affected by sleepiness‡	10.0	13.0	19.5	24.8	27.3	14.7	32.2	39.0	17.0	14.7
Mean age, y	42.9	42.8	46.7	48.2	46.3	49.2	47.5	46.0	44.7	43.8
Mean BMI	26.5	27.1	29.0	30.9	31.9	33.3	33.3	41.4†	28.5	28.0

*AHI indicates apnea-hypopnea index; BMI, body mass index. N=939. Unless otherwise indicated, data are given as percent of subjects.
†Proportion of women was significantly different from proportion of men (P<.05).
‡Includes mood, work, relationships, enjoyment of life, ability to concentrate, motivation, and housework.

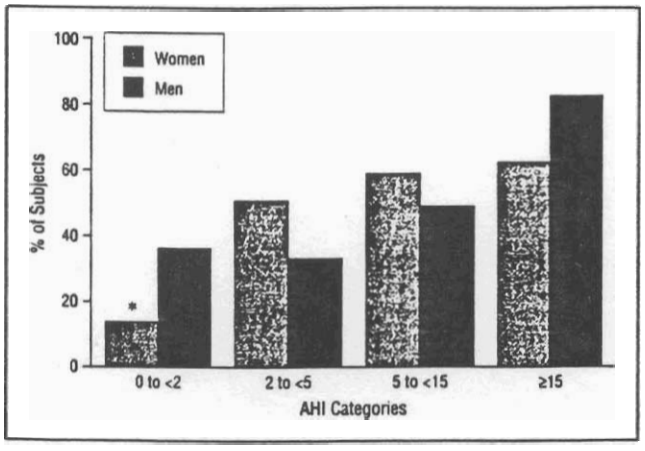
greater, the difference is too small to explain the 11:1 male-female ratio for previously diagnosed sleep apnea that we estimated for this population. Among subjects with an AHI of 15 or greater, 83% of the men and 62% of the women reported at least 1 of the classic breathing symptoms of habitual snoring, loud snoring, snorting, or breath pauses. Assuming that subjects with an AHI of 15 or greater sought care and that only those who reported the classic symptoms subsequently underwent evaluation, 40% of women and 20% of men would be missed. However, given the 2.3:1 male-female ratio for undiagnosed sleep apnea in this population,[16] the degree to which women underreported typical symptoms in our sample would only lead to a ratio of 3:1, rather than 11:1.

Similar conclusions can be drawn from the data of Redline et al[17] in a community-based study of relatives and neighbors of patients with sleep apnea. The male-female ratio for undiagnosed sleep apnea in their study was 2:1, and they estimated that the male-female ratio for diagnosed sleep apnea was 8:1. Among subjects with an AHI of 15 or greater determined by home monitor studies, 76% of the men and 41% of the women reported at least 1 snoring symptom. This degree of underreporting by women, assuming that other aspects of care seeking and provider responses are equal, would lead to a clinical ratio of 3.7:1. Thus, underreporting of the classic symptoms, although present to a small degree, does not appear to be a sufficient explanation for the underrepresentation of women with sleep apnea in sleep clinic populations.

Our findings do not support the hypothesis that the higher male-female ratio for sleep apnea in sleep clinic populations can be explained by a unique symptom profile for women, and strongly suggest that the cause of the gender disparity lies elsewhere. Several features of our study increase the robustness of this conclusion. A particular strength is that we measured sleep-disordered breathing with full-night laboratory polysomnography,

the same test used in clinical practice that has given rise to the high male-female prevalence ratios at issue. Thus, the AHIs assigned to subjects in this study are directly comparable to scores that would have been recorded if the subjects had undergone a clinical evaluation, although the findings could be spurious if there was a systematic response bias (eg, if women, but not men, with sleep apnea who had atypical symptoms refused to participate). However, we found no evidence of any gender-specific response bias that could explain our findings.

Other hypotheses for underdiagnosis in women include failure of women to acknowledge or to seek help for sleep apnea symptoms and failure of medical care providers to respond to these symptoms in women. Our analysis has shown that women, at least when specifically asked on a questionnaire or in a personal interview, will report their sleep problems such as snoring, gasping, and breathing pauses. It cannot be assumed from these data that women would report similarly in a clinical situation, but we found no evidence to suggest that the underdiagnosis of women is due to reluctance to admit to such symptoms. In our study, we did not determine if women, compared with men, were less likely to seek medical treatment for sleep apnea symptoms. However, women have more frequent contacts with medical care providers than do men,[33,34] and thus general care-seeking patterns do not support the hypothesis that the gender ratio discrepancy in sleep clinics is due to fewer women seeking help for sleep problems than men.



Percentage of men and women reporting any of the following: frequent snoring (3 or more nights per week), loud snoring, or occasional (1 or more nights per week) snorting or apnea, by apnea-hypopnea index (AHI) categories. Asterisk indicates that proportion of women is significantly different from proportion of men (P<.001).

The possibility has been raised that subjects with screen-detected sleep apnea may differ from patients with a diagnosis of the clinical syndrome, even at the same level of apnea and hypopnea occurrence. If this were true, the high male-female ratio in patients with sleep apnea would not necessarily indicate underrepresentation of women, but could simply reflect genuine excessive male prevalence. However, it appears that our sample and other community samples of subjects with screen-detected sleep apnea are quite similar to those with sleep apnea seen in clinics with respect to age, BMI, and symptoms.[35-37]

We did find that prevalences of morning headache, depression, and anxiety were significantly higher in general for women, compared with men, regardless of sleep apnea status. It is possible that the presence of these complaints in women, although they are independent of the underlying apnea, may indirectly contribute to underevaluation of the problem in women, as suggested by Ambrogetti and colleagues.[28] On finding a higher prevalence of atypical symptoms in addition to the classic symptoms among women in their sample of patients with sleep apnea, these authors hypothesized that although the atypical symptoms reflect a general difference between men and women, the mention of these symptoms could cause physicians to discount sleep apnea and turn to other diagnostic possibilities.

An intriguing finding was the lower AHI cutoff point at which women, compared with men, were distinctly more symptomatic. Women with an AHI from 2 to less than 5 were more similar to women with an AHI of 15 or greater than they were to those with very few or no events (AHI from 0 to <2). In contrast, men with an AHI from 2 to less than 5 could not be distinguished from those with an AHI from 0 to less than 2. This gender difference may be due to a higher prevalence of upper airway resistance sleep-disordered breathing in women, described by Guilleminault and colleagues.[18] This condition seems to differ from sleep apnea only in that the abnormal breathing events do not manifest as breath pauses measurable by airflow and oxygen desaturation. Detection of the resistance events requires intraesophageal or other airway pressure monitoring, which is not a part of standard polysomnography. However, because neither population studies nor clinical diagnostic studies use the invasive monitoring necessary to detect this syndrome,

Table 4. Odds Ratio Estimates of the Relative Predictive Value of Self-reported Symptoms for AHI Category According to Gender*

	Odds Ratio (95% Confidence Interval)			
	AHI 5 to <15 vs AHI 0 to <2		AHI ≥15 vs AHI 0 to <2	
Reported Symptom	Men	Women	Men	Women
Snoring ≥3 nights/wk†	2.7 (1.3-5.7)	11.8 (5.4-25.9)‡	13.3 (4.2-42.4)	15.5 (3.9-61.1)
Breathing pauses ≥1 night/wk†	2.1 (1.1-4.3)	13.5 (3.9-46.3)‡	4.9 (2.3-10.4)	16.4 (2.7-99.8)
≥1 Life function affected by sleepiness§	3.3 (1.5-7.3)	2.2 (0.9-5.1)	3.8 (1.8-7.8)	5.2 (1.5-18.6)

**AHI indicates apnea-hypopnea index. N=939.*
†Informant based.
‡Odds ratio for women was significantly different from odds ratio for men (P<.05).
§Includes mood, work, relationships, enjoyment of life, ability to concentrate, motivation, and housework.

undetected upper airway resistance syndrome in women would not explain the gender disparity reflected by conventional polysomnography.

The American College of Chest Physicians,[38] the Association of Sleep Disorder Centers,[39] and the American Thoracic Society[39] all emphasize the importance of snoring and daytime sleepiness as indications for sleep studies. We conclude from our study that these indications for referral are no less appropriate for women than for men. A more plausible, but untested hypothesis is that health care providers are failing to ask the appropriate follow-up questions for sleep apnea screening when women complain of problems associated with sleep apnea. It is also possible that providers are failing to interpret the classic sleep features associated with sleep apnea as an indication for sleep evaluation or referral when they are reported by women. The latter explanation may hold particularly true when women coincidently present with psychological or atypical symptoms in addition to the classic sleep apnea features. To help remedy the underrepresentation of women in sleep clinic populations, efforts should be made to educate primary care and other physicians concerning the prevalence of sleep apnea in women, the need to take histories of snoring and sleep problems from women as well as men, and the importance of referring women for sleep studies when they complain of snoring and other symptoms associated with sleep apnea, even if other atypical symptoms are also mentioned.

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