

# Underdiagnosis of Sleep Apnea Syndrome in U.S. Communities

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## ABSTRACT

We hypothesize that clinical recognition rates for obstructive sleep apnea-hypopnea syndrome (OSAHS) are influenced by comorbidity and demographic factors. Data on medical disorders, symptoms of sleep disorders, and cardiovascular risk factors gathered from 15,699 individuals in the Sleep Heart Health Study were compared. Participants were classified into three groups: those with a self-reported physician diagnosis of OSAHS, those with self-reported physician-diagnosed and -treated OSAHS, and those reporting both frequent snoring and daytime sleepiness (two-symptom group). Among all participants, 4.1% reported two symptoms (range across sites: 1.55 to 7.23%), whereas 1.6% reported a physician diagnosis of OSAHS (range: 0.66 to 2.88%) and 0.6% reported physician diagnosis and treatment (range: 0.11 to 0.88%). Recognized OSAHS groups were similar to the two-symptom group in age, having a sleeping partner, measured blood pressure, total cholesterol, and race. In a logistic model that included age along with characteristics found to vary significantly among the three groups (gender, body mass index [BMI], high-density lipoprotein cholesterol levels, hypertension), only male gender and BMI were increased in those with physician-diagnosed and -treated OSAHS. We conclude that disparities (especially in women and in those with lower BMI) exist between current recognition rates for OSAHS and the estimated prevalence by symptom report across the United States.

**KEYWORDS:** Sleep apnea, clinical diagnosis, prevalence, cardiovascular risk

Medical recognition of obstructive sleep apnea-hypopnea syndrome (OSAHS) is based on eliciting symptoms of waketime sleepiness and sleep-time disruptive snoring and breathing disturbances; an elevated number of apneas and hypopneas during sleep is subsequently confirmed in the majority of

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individuals.<sup>1</sup> A number of reports indicate low recognition of sleep apnea by medical systems. In an epidemiological survey of Wisconsin state workers,<sup>2</sup> only 7% of women and 12% of men with frequent symptoms and studies consistent with moderate to severe sleep apnea reported being previously diagnosed through a medical encounter. In the Wisconsin study, level of education, obesity, hypertension, and gender were associated with recognized illness. In other studies of primary care populations, the estimated prevalence of *diagnosed* OSAHS is approximately 0.3% in contrast to the 20 to 30 times greater community prevalence of those with persistent sleepiness and snoring or those regarded as being at high risk for moderate to severe illness.<sup>3</sup>

The Sleep Heart Health Study (SHHS) is a multicenter longitudinal study of the relationship of sleep-disordered breathing and cardiovascular diseases in nine community-based parent cohorts across the United States. Details of the rationale, study design, and primary hypotheses of the SHHS have been published.<sup>4</sup> The major objective of the SHHS is to characterize the relationship between sleep apnea and cardiovascular morbidity. The availability of a large, community-based sample in which cardiovascular risk factors are well characterized provided the opportunity to examine potential associations among cardinal symptoms of OSAHS and medical diagnoses of sleep apnea syndrome. We used this unique cohort to test the hypothesis that host factors of cardiovascular morbidity correlate with medical recognition of OSAHS.

## METHODS

### Study Population

The SHHS parent study cohorts are the Atherosclerosis Risk in Communities Study, the Cardiovascular Health Study, the Framingham Heart Study, the Strong Heart Study, the Tucson Epidemiologic Study of Obstructive Airways Disease, the Health and Environment Cohort Study, and three New

York City cohorts. From December 1995 to February 1998, a total of 15,699 individuals from these cohorts completed a questionnaire that included items about snoring, sleepiness, physician-diagnosed sleep apnea, and treatments for sleep apnea. Additional demographic and medical history data were available from the parent cohorts.

Individuals who reported snoring (frequently [three nights/week or more] or always) and feeling excessively sleepy during the day (often [ $>5$  days month] or always) were placed in the two-symptom group (consistent with a higher probability of OSAHS). Many surveys found that the persistent quality of both symptoms, when associated with apneas and hypopneas during sleep, defines the syndrome.<sup>6-8</sup> The thresholds were chosen so as to identify a person with moderate to severe forms of the illness.<sup>6</sup> The major comparison group (physician-diagnosed OSAHS) was composed of individuals who responded positively to the question, "Have you ever been told by a physician that you have sleep apnea?". This group was subdivided based on their response to follow-up questions regarding treatment for sleep apnea (continuous positive airway pressure, surgery, and oxygen). Individuals who responded positively or identified a treatment were placed in the physician-diagnosed and -treated OSAHS group. We included in this study a comparison group, composed of individuals who reported neither chronic snoring nor sleepiness (no symptoms).

### Statistical Analysis

In addition to descriptive statistics, in some models, individuals in the physician-diagnosed group, the physician-diagnosed and -treated group, the two-symptom group, and the no-symptom group were separated into mutually exclusive categories (those in diagnosed groups were excluded from other groups). Three of these mutually exclusive groups (physician-diagnosed, physician-diagnosed and -treated, and two-symptom groups) were compared in terms of demographic and clinical charac-

teristics using analyses of variance for continuous variables and chi-square tests (linear by linear association) for categorical variables. Multinomial logistic regression was used to determine which variables were independently associated with group. Age and independent variables determined to be significantly associated with group in the membership analyses were included in the regression model. Analyses were performed using SPSS.

## RESULTS

The prevalence among the 10 sites of those with the two symptoms (chronic snoring and sleepiness) highly suggestive of OSAHS varied 4.7-fold (range: 1.55 to 7.23%). Although absolute prevalence was lower, there were comparable variations by site of those reporting physician-diagnosed (range: 0.66 to 2.88%) and physician-diagnosed and -treated (range: 0.11 to 0.88%) OSAHS. All three prevalences varied significantly among sites ( $P < 0.05$ ) after adjustment for gender, body mass index (BMI), and age.

Overall prevalence of the combined parent cohorts was 4.1% for the two-symptom group suggestive of OSAHS, 1.6% for a physician diagnosis, and 0.6% for physician-diagnosed and -treated OSAHS (Table 1). The prevalence of those reporting two major symptoms of OSAHS was 2.6 and 7 times higher than that of participants reporting physician diagnosis or physician-diagnosed and -treated sleep apnea, respectively. Information was not available regarding extent of illness, manner of intervention if any, or current compliance with treatments of those reporting a diagnosis or treatment. Among those who reported two symptoms suggesting OSAHS, 8.3% (54/650) reported physician-diagnosed OSAHS, and only 2.2% (14/650) reported having been both diagnosed with and treated for OSAHS.

Individuals in the physician-diagnosed and -treated group were more likely to be male, report hypertension, be college graduates, and have the highest BMI and lowest high-density lipoprotein

**Table 1 Prevalence by Category in the Sleep Heart Health Study Cohort Completing the Sleep Habits Questionnaire**

Category	N	Prevalence*
Physician diagnosed	253	1.6%
Physician diagnosed and treated	90	0.6%
Two symptoms of OSAHS (frequently snore and sleepy)	650	4.1%

\*Denominator included missing values.

Results in each category are not mutually exclusive, so that the total obstructive sleep apnea-hypopnea syndrome (OSAHS) burden is not the sum of these categories. In addition, not all subjects with doctor-diagnosed or doctor diagnosed and treated OSAHS reported chronic, persistent symptoms.

(HDL) cholesterol levels compared with those in the two-symptom group (Table 2). In regression models that included age plus the variables that differed among the groups, only gender and BMI were significantly associated with having a diagnosis and being treated for sleep apnea. Men were 2.2 times as likely to be in the diagnosed-only group and 4.6 times as likely to be in the diagnosed and treated group than in the symptoms-only group. In the regression analyses, cardiovascular risk factors no longer correlated with any group membership. The group reporting no chronic symptoms was older, had lower levels of BMI and hypertension, had high HDL cholesterol levels, and was composed of fewer men than the two-symptom group ( $P < 0.05$ ).

## DISCUSSION

The estimate of the prevalence of two symptoms of OSAHS in the SHHS cohort is 4.1%, comparable to the range of 2 to 4% found for OSAHS in other U.S. community studies.<sup>2,5</sup> This study-wide average includes a greater than four-fold site variation in prevalence for those with two-symptoms (chronic/persistent snoring and sleepiness), those with physician-diagnosed sleep apnea, and those with diagnosed and treated sleep apnea. There are individuals

**Table 2 Comparison of Those Participants by Groups: Absence or Presence of Two Key Symptoms, Diagnosed, and Diagnosed/Treated**

Variable	No Symptoms of OSAHS (N = 5,752)	Two Symptoms of OSAHS (N = 596)	Physician Diagnosed, Not Treated (N = 163)	Physician Diagnosed and Treated (N = 90)
<i>Mean age</i>	63.4	61.0	62.3	60.7
(SD)	10.6	9.8	9.8	9.1
Valid N	5,301	554	150	81
<i>Male*†</i>	43.5%	55.1%	75.6%	84.1%
Valid N	5,652	592	160	88
<i>Mean BMI*†</i>	27.1	30.3	30.5	32.8
SD	4.9	6.0	6.0	6.7
Valid N	4,889	530	140	76
<i>Mean systolic BP</i>	125.8	127.3	128.7	127.6
SD	19.4	18.5	19.3	14.5
Valid N	4,887	528	141	75
<i>Mean diastolic BP</i>	72.2	75.0	76.3	75.0
SD	10.9	11.6	12.0	11.0
Valid N	4,887	528	141	75
<i>Mean cholesterol</i>	206.7	206.2	205.9	198.0
SD	37.3	36.8	41.0	37.0
Valid N	3,920	477	120	67
<i>Mean HDL level*</i>	52.9	47.3	42.9	40.6
SD	17.1	15.5	12.7	10.6
Valid N	3,752	456	109	60
<i>Hypertension*</i>	32.4%	43.2%	48.9%	53.3%
Valid N	4,833	511	139	75
<i>Race</i>				
<i>White</i>	81.5%	81.3%	80.0%	85.2%
Valid N	5,652	592	160	88
<i>Black</i>	4.1%	5.2%	4.4%	4.6%
Valid N	5,652	592	160	88
<i>American Indian</i>	12.1%	9.6%	11.9%	10.2%
Valid N	5,652	592	160	88
<i>College graduate*</i>	39.3%	40.4%	38.8%	57.5%
Valid N	4,635	497	129	73
<i>Sleeps close by</i>	71.3%	74.3%	71.3%	75.6%
Valid N	5,663	588	160	90

In contrast to Table 1, the groups are mutually exclusive: Physician-diagnosed and -treated individuals were excluded from the physician-diagnosed group, and the symptom-based groups excluded physician-diagnosed and physician-diagnosed and -treated individuals. \* $P < 0.05$  comparing last three columns by analysis of variance or chi-square test (linear by linear association).

† $P < 0.05$  in logistic regression model comparing last three columns that included age, gender, body mass index, high-density lipoprotein, cholesterol level, hypertension, and educational level.

with symptoms consistent with moderate to severe OSAHS who reported a physician diagnosis of sleep apnea;<sup>6</sup> however, the great majority of those who reported two symptoms indicated that their condition had not been medically diagnosed. Although overall numbers in the diagnosed and treated

groups were small, there was no evidence to suggest that race was associated with symptomatic status or medical recognition.

Participants with recognized OSAHS were more likely to be male and, to a small extent, more obese than those with two symptoms. It could be

argued that males and more obese individuals could have had more severe sleep apnea; therefore, the higher recognition in this group may reflect a greater tendency for more severely affected individuals to be referred for evaluation. Alternatively, it may be that physicians appropriately recognize OSAHS in individuals with such well-publicized risk factors. Nevertheless, the use of this restrictive profile would result in a low recognition rate compared with those who report symptoms of illness.

One hypothesis was that individuals with cardiovascular risk factors, such as hypertension or abnormal lipid values, might be more likely to be diagnosed with obstructive sleep apnea, possibly as a result of increased interactions with the health care system or an increased severity of sleep apnea. For instance, sleep apnea is associated with an increased prevalence of cardiovascular disease risk factors, including lower HDL cholesterol levels.<sup>8</sup> However, in a multivariate analysis, no systematic relationship was observed to suggest that this was the case in the recognition of illness in the community.

Similar to the report from Wisconsin,<sup>2</sup> we observed in a univariate analysis that level of education was higher in those with reported physician diagnosis or treatment. However, differences in level of education among groups did not persist after adjusting for age and other confounders.

Reporting biases and misclassifications are likely to occur given our reliance on questionnaire data. For example, Young et al<sup>2</sup> observed that only 33% of those reporting physician-diagnosed sleep apnea were confirmed to have been actually diagnosed by a physician; in contrast, 81% of those who reported having a physician diagnosis and having received therapy for sleep apnea were confirmed to have actually had physician diagnosis. In addition, the SHHS cohort was older than the Wisconsin cohort. Data from older populations will be influenced by the accumulation of comorbidities or exposure to physicians. Older samples, in particular, may underreport symptoms of OSAHS.<sup>5-7</sup> Such effects will confound interpretations from self-report data and interpretation when rates for diagnosis and treatment are low. There are patients who

benefit from treatment and who have only one of the key symptoms or who initially deny sleepiness. One SHHS report,<sup>9</sup> using results from home polysomnography performed in 2,737 men and 3,040 women (mean age: 64 years), examined the association of respiratory disturbances in regard to snoring frequency and sleepiness. An increase in respiratory disturbance index (RDI) was associated with both increases in self-reported sleepiness and increasing frequency of snoring, but both snoring and RDI were independently associated with excess sleepiness in these community-dwelling, middle-aged and older adults. Therefore, our estimate of the prevalence of OSAHS based on criteria for snoring frequency and sleepiness may have resulted in a low estimate of potential illness in the cohort.

Our results showing an effect of hypertension on classification into medical recognition groups may be appropriate to some extent given that sleep-disordered breathing is associated with systemic hypertension<sup>10</sup>; however, overreliance on hypertension and obesity as essential features for a more general medical recognition strategy for OSAHS would result in an underestimation of those who may respond to treatment interventions. Currently, the effect of obesity on recognition appears to be modest; for each elevation of BMI by one unit, there was only a 1.09 greater likelihood of being in the diagnosed and treated group than in the symptom group.

Some limitations for the current analysis are based on the original SHHS design to detect primary outcomes of cardiovascular risk<sup>4,8,10,11</sup> and the secondary outcomes in regard to the impact of sleepiness on those with cardiovascular risk factors.<sup>12</sup> Thus, it was not designed to capture data on diagnosis or treatment. In addition, two of the 10 sites did not include individuals younger than 68 years. Also, in general, there was a low reporting rate for diagnosed or treated sleep apnea, so that site-by-site comparisons that might explain such disparities cannot be performed with confidence. Finally, the sites may not be representative of the surrounding communities, which would include a higher proportion of individuals without cardio-

vascular risk factors or unlikely to enroll in a SHHS cohort.

The data support the premise that few people with symptoms of OSAHS receive a diagnosis of OSAHS and even fewer receive treatment. This was particularly true for women and those who were less obese and who lack a diagnosis of hypertension. It remains to be determined whether low recognition is simply a result of a detection strategy biased for severe disease or whether current detection strategies and treatment thresholds need to be modified to reduce sleepiness-related health hazards and cardiovascular morbidity or improve general health.

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