

## Fast Track Publication

# Estimation of the Clinically Diagnosed Proportion of Sleep Apnea Syndrome in Middle-aged Men and Women

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**Summary:** The proportion of sleep apnea syndrome (SAS) in the general adult population that goes undiagnosed was estimated from a sample of 4,925 employed adults. Questionnaire data on doctor-diagnosed sleep apnea were followed up to ascertain the prevalence of diagnosed sleep apnea. In-laboratory polysomnography on a subset of 1,090 participants was used to estimate screen-detected sleep apnea. In this population, without obvious barriers to health care for sleep disorders, we estimate that 93% of women and 82% of men with moderate to severe SAS have not been clinically diagnosed. These findings provide a baseline for assessing health care resource needs for sleep apnea. **Key Words:** Sleep apnea—Epidemiology—Sleep disorders—Prevalence.

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The disparity between the high prevalence of occult sleep apnea in the general population and the presumed low level of its clinical recognition has prompted concern that clinically significant disease is being missed (1-3). The diagnosed prevalence, however, has never been measured, so the magnitude of the disparity is unknown. To address this, we determined the prevalences of clinically diagnosed and screen-detected sleep apnea syndrome (SAS) in the Wisconsin sleep cohort study, an ongoing population-based study.

## METHODS

The sample comprised state employees, aged 30-60 years, who resided in south-central Wisconsin, an area served by a university-based sleep clinic. All employees had comprehensive health insurance as part of employment benefits. Data for this analysis are from a mailed questionnaire administered to the total sample ( $n = 4,925$ ) and in-laboratory polysomnography conducted, according to clinical diagnostic guidelines, on a subsample ( $n = 1,090$ ). The sampling and overnight study protocol have been previously reported (4).

Clinically diagnosed cases of sleep apnea were as-

certained by mail and telephone follow-up of participants who indicated on the questionnaire that they were told by a doctor they had sleep apnea. Of the 49 positive respondents, 16 reported that they had been tested or examined and were told they had sleep apnea syndrome; of these, all but three had received treatment (surgery or nasal continuous positive airway pressure). These 16 were considered to have diagnosed sleep apnea syndrome. Of the remaining 33 positive respondents, 30 admitted they had not been examined or diagnosed but suspected they had sleep apnea; one was deceased, one could not be located, and one failed to respond.

Screen-detected SAS was defined by a combination of self-reported sleepiness ("often" or "almost always" experience excessive daytime sleepiness or do not feel rested regardless of the hours of sleep) and the occurrence of apneas (no airflow for at least 10 seconds) and hypopneas (40% decrease in respiratory effort accompanied by 4% oxygen desaturation) during sleep. Prevalences for mild to severe sleep apnea (five or more apneas and hypopneas per hour of sleep and daytime hypersomnolence) and moderate to severe sleep apnea (15 or more apneas and hypopneas per hour of sleep and daytime hypersomnolence) were estimated for the subsample and extrapolated to the total sample using software for stratified samples (5).

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**TABLE 1.** Comparison of adults with clinically diagnosed and screen-detected SAS in a sample of employed men and women aged 30–60 years ( $n = 4,925$ )

Variable	Clinically diagnosed SAS	Screen-detected mild to severe SAS	Screen-detected moderate to severe SAS
Number (prevalence)			
Women	2 (0.08%)	93 (3.5%)	27 (1.0%)
Men	14 (0.62%)	155 (6.8%)	77 (3.4%)
Total	16 (0.32%)	248 (5.0%)	104 (2.1%)
% Men	88	60***	70**
% Ever married	94	88	86
Educational attainment: % with high school or less	18.8	39	35
% History of doctor-diagnosed hypertension	60	31***	44
% History of doctor-diagnosed cardiovascular disease	56	34**	49
Age (mean years, SD)	49 (8)	44 (8)***	43 (9)***
Income (mean dollars/hour, SD)	15.9(5.8)	12.6(4.1)**	13.1(4.3)**
Body mass index [weight (kg)/height <sup>2</sup> (cm)]	32.3(7.1)	32.7(7.6)	34.7(7.9)
% Nonwhite ethnicity	0	7.3	5.4

SAS, sleep apnea syndrome; SD, standard deviation. Screen-detected SAS was measured in a subsample of 1,090 participants and extrapolated to the total sample that provided clinically diagnosed prevalence; mild to severe SAS is defined as daytime hypersomnolence often or almost always and five or more apneas and hypopneas per hour of sleep; moderate to severe SAS is defined as daytime hypersomnolence often or almost always and 15 or more apneas and hypopneas per hour of sleep.

\*\*  $p < 0.1$  for comparison with value for clinically diagnosed group.

\*\*\*  $p < 0.05$  for comparison with value for clinically diagnosed group.

## RESULTS

On the basis of the clinically diagnosed and screen-detected prevalences (Table 1), we calculated the percentage of "undiagnosed" screen-detected cases [100% minus percentage of screen-diagnosed cases that had been clinically diagnosed (1)]. We estimate that 93% of women and 82% of men with moderate to severe SAS were missed; for the less severe definition of SAS, 98% of women and 90% of men were missed. The estimates are based on a nearly complete ascertainment of clinical diagnosis in the sample (94% follow-up). If the three men lost to follow-up had all been clinically diagnosed, the proportion of missed cases would drop by only 2 and 4% for moderate to

severe and mild to severe categories, respectively. Diagnosis status was based on what the participant's physician had concluded after evaluation, regardless of whether the participant was evaluated in a sleep laboratory. Requiring polysomnographic evidence for diagnosis may have eliminated false positives but could have also eliminated true positives. The latter consequence would seriously underestimate the true proportion of clinically recognized SAS.

Comparison of clinically diagnosed and screen-detected cases on sociodemographic characteristics suggested that diagnosed cases were more likely to be men, have a history of cardiovascular disease, be older, be Caucasian, and have higher income and educational attainment. The higher proportion of cardiovascular disease in clinically diagnosed cases may reflect sleep clinic referral as a result of medical care for comorbid conditions (see Table 1).

## DISCUSSION

Our findings indicate that even for a population with access to a sleep disorders clinic, at least 80% of all moderate to severe SAS in middle-aged men and women is likely missed. This estimate provides a starting point for health policy debate on the appropriate response to the high population prevalence of sleep apnea. The results, however, cannot be extrapolated to older adults, for whom sleep apnea may be even less likely to be diagnosed. Although only male gender and age were statistically significant correlates of clinically diagnosed versus undiagnosed SAS, our findings suggest that there is a selection bias that may lead to inequitable care: people with lower socioeconomic status, nonwhites, and women may be the most underserved.

## REFERENCES

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