Obstructive Sleep Apnea Syndrome: Are We Missing an At-Risk Population?
Christopher J. Lettieri, M.D.1,2; Am H. Eliasson, M.D.1,2; Teotimo Andrada, M.S.1; Andrei Khramtsov, M.D.1; Marc Raphaelson, M.D.1; David A. Kristo, M.D.1,2

1Pulmonary, Critical Care and Sleep Medicine Service, Walter Reed Army Medical Center, Washington, DC; 2Department of Medicine, Uniformed Services University of the Health Sciences, Bethesda, MD; 3Greater Washington Sleep Disorders Centers, Rockville, MD

Study Objectives: While age and body mass index (BMI) are well-established risk factors for obstructive sleep apnea syndrome (OSAS), this disorder occurs across a wide spectrum of ages and weights. Preconceptions regarding “classic” patients with OSAS may lead to underdiagnosis in at-risk populations, particularly younger non-overweight individuals. We hypothesized that the severity of OSAS is independent of age and BMI in a younger less-obese population.

Methods: Prospective study of consecutive patients diagnosed with OSAS. Active-duty military, National Guardsmen, and civilians were compared to determine if age and BMI correlated with disease severity.

Results: Two hundred seventy subjects (120 active-duty, 80 National Guardsmen, 70 civilians) were included. Active-duty military members were significantly younger and less overweight than both National Guardsmen and civilians. Of the civilians, 64.3% and, of National Guardsmen, 48.8% were obese, whereas only 19.2% of active-duty had a BMI ≥ 30 kg/m² (p<.001). However, the prevalence of severe disease did not differ between groups. Disease severity showed no correlation with BMI among active-duty subjects (r = 0.09, p = .33). Of the active-duty subjects, 37.5% had severe disease, as compared with 42.5% of National Guard and 45.7% of civilian subjects (p = .18 and .09, respectively). BMI did not differ between active-duty subjects with severe disease and those with mild to moderate OSAS (26.7 kg/m² versus 26.9 kg/m², p = .40). There was a low but significant correlation between age and AHI (r = 0.21, p = .02) among all subjects.

Conclusions: OSAS occurs in young nonobese individuals and should be considered in patients reporting excessive daytime sleepiness, regardless of age or BMI.

Keywords: Obstructive sleep apnea, obstructive sleep apnea syndrome, obesity, epidemiology

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The reported prevalence of obstructive sleep apnea syndrome (OSAS) appears to be increasing, likely due to multiple factors.1-5 As awareness of the disease increases, more patients are being diagnosed with OSAS. In addition, the increasing age of the population is contributing to the rising prevalence of OSAS.2,4,6 A third factor impacting the prevalence of OSAS in the United States is the obesity epidemic.2,4,11 Obesity has been linked not only to the prevalence of OSAS, but also to its severity.15 In a large population-based study,12 Nieto and colleagues explored the relationship between severity of OSAS and body mass index (BMI). They found that BMI correlated directly with severity of disease. In this study, nearly half (45.5%) of patients with mild disease and 61.1% of patients with severe disease were obese. Furthermore, weight loss has been reported to reverse or improve OSAS in selected patients.13

While obesity and age are clearly risk factors for sleep apnea, the etiology of OSAS is multifactorial and occurs in patients across a wide spectrum of ages and weights. In fact, a recent study reported that the severity of OSAS may be independent of BMI.14 Despite a broader understanding of patients at risk for OSAS, clinicians may hold to the preconception of the “classic” patient with sleep apnea: an older overweight man with loud habitual snoring. While OSAS is clearly more prevalent in this patient type, a narrowed focus, or diagnostic profiling, based on this prototype may lead to missed diagnoses in other symptomatic patients with more atypical presentations of sleep apnea, particularly patients who are younger and of normal weight.

We hypothesized that the diagnosis and the severity of OSAS may be independent of age and BMI in a younger thinner population. We sought to validate our hypothesis by examining United States military service members diagnosed with OSAS. The military provides a suitable population to test this hypothesis, since individuals are typically younger and must adhere to height and weight requirements.15 This selection of military personnel leads to a much lower prevalence of obesity than is observed in the general population. The military ranks tend to include a younger population than is found in many civilian settings because of mandatory age-based retirement. We conducted a prospective demographic assessment of United States military service members and compared the findings with a prospectively evaluated civilian population of patients who were diagnosed with OSAS by polysomnography (PSG).
METHODS

Subjects

We conducted a prospective study of consecutive military service members diagnosed with OSAS at our institution and consecutive civilians diagnosed with OSAS at a neighboring civilian sleep center over a 1-month observation period. Our sleep center is part of an academic tertiary-care hospital (Walter Reed Army Medical Center, Washington DC), which serves military service members, retired military members, and their civilian dependents. However, to answer the study question and provide a direct comparison between patient groups, only military service members evaluated in our clinic were included in this analysis. The 200 military members included both active-duty soldiers and members of the United States Army National Guard. We chose to include members of the National Guard to serve as an intermediate group between active-duty service members and civilians. The National Guard population is unique in that, although they do not participate daily in military service, they are subjected to the same standards for height, weight, and physical fitness as are their active-duty counterparts. For comparison, we prospectively studied civilian subjects consecutively diagnosed with OSAS at an outside civilian sleep center during the same time period.

The protocol was approved by our institution’s scientific research review committee.

Measurements

For each subject, we collected demographic and PSG data. Demographic data included age, sex, and BMI. Subjective complaints of excessive daytime somnolence and results of the Epworth Sleepiness Scale during the initial evaluation were included to ensure that patients met accepted diagnostic criteria for OSAS. Each subject completed an attended overnight PSG, from which we recorded the apnea-hypopnea index (AHI) to determine the presence and severity of OSAS. Both sleep laboratories used identical PSG scoring and interpretation criteria, and laboratory operating procedures were similar. We reviewed the data from all included studies to ensure diagnostic conformity.

The attended overnight PSG in both sleep laboratories consisted of a standardized 12-channel montage (Sensormedics Alpha Somnostar system, Sensormedics, Yorba Linda, CA). PSG included continuous recordings of central and occipital electroencephalograms, bilateral electrooculograms, submental and bilateral tibial electromyograms, and electrocardiogram. Nasal and oral airflow was measured by temperature thermistor and nasal pressure transducers. Tracheal sounds were monitored using an acoustic microphone. Thoracic and abdominal excursions were measured using inductance plethysmography. Continuous oxygen saturation was assessed using noninvasive pulse oximetry. Body positioning was verified by infrared video recording. The study was terminated following final wakening. Studies were scored in 30-second epochs following Rechtschaffen and Kales criteria for sleep staging. Arousals were defined as a change in electroencephalogram activity from a slower background frequency for at least 3 seconds. All subjects met accepted diagnostic criteria for OSAS according to standards of the American Academy of Sleep Medicine. This included an AHI ≥ 5 events per hour associated with excessive daytime sleepiness, an Epworth Sleepiness Scale score ≥ 10, or both. OSAS was considered mild if the AHI was ≥ 5 per hour but < 15 per hour, moderate if ≥ 15 per hour but < 30 per hour, and severe if ≥ 30 per hour. The AHI was the average number, per hour, of apneas and hypopneas, rounded to the nearest integer. Apneas were defined as a cessation of airflow lasting 10 seconds or longer. Hypopneas were defined as a reduction of airflow or respiratory effort by 30% for more than 10 seconds, accompanied by a EEG arousal of at least 3 seconds and/or a ≥4% desaturation by noninvasive pulse oximetry.

BMI was calculated from measured height and weight in each subject and is expressed as kg/m². Normal was defined as a BMI < 25 and obesity was defined as a BMI ≥ 30. All others were defined as overweight.

Endpoints

Our primary measurements were AHI, BMI, and age, with a primary statistical analysis evaluating the correlation of AHI with BMI and AHI with age. Secondary analyses provided comparisons between the active-duty military population, members of the National Guard, and civilians.

Statistical Analysis

Continuous variables were compared between each of the 3 cohorts using analysis of variance. Pearson bivariate correlations were used to analyze the relationships between RDI, BMI, and age. When applicable, significant differences were verified using a Student t test. All tests were 2 tailed, and p values of less than .05 were assumed to represent statistical significance. Data are presented as the mean ± SD. All analyses were completed using the SPSS 12.0 software package (SPSS, Inc., Chicago, IL).

RESULTS

During the observation period, 270 consecutive patients diagnosed with OSAS were included. Among these, 120 were active-duty United States military service members, 80 were members of the United States Army National Guard, and 70 were civilians. No subjects were excluded. Demographic and polysomnographic data are displayed in the Table.

In this study, active-duty service members diagnosed with OSAS were younger and less overweight than were both members of the National Guard and civilians. Military subjects (active duty and National Guard) were younger than civilian subjects (37.9 ± 7.6 years versus 48.6 ± 4.8 years, p < .001) and a greater percentage of the military cohort were men (85.2% versus 55.7%, p = .007). Obesity was common among both civilians and members of the
National Guard diagnosed with OSAS. Among these, 64.3% of civilians and 48.8% of National Guard members met criteria for obesity, while only 19.2% of active-duty service members with OSAS had a BMI ≥ 30 kg/m² (p < .001 for both). Similarly, among the cohort, 39.3% of active-duty service members had a normal BMI (<25 kg/m²), compared with 12.5% of National Guardsmen and 14.3% of civilians (p < .001 for both).

Despite the differences in BMI, disease severity did not differ between groups; 37.5% of active-duty subjects had severe OSAS, compared with 42.5% of National Guard and 45.7% of civilian subjects (p = .18 and .09, respectively). The BMI did not differ between active-duty service members with severe disease and those with mild and moderate OSAS (26.7 kg/m² versus 26.9 kg/m², p = .40). However, the BMI did differ significantly between civilians with severe disease and those with less-severe OSAS (29.8 kg/m² vs 35.5 kg/m², p = .002). Looking specifically at effects of obesity on AHI, there was even less variation between groups. Among active-duty personnel, those with a normal BMI (<25 kg/m²) had an average AHI of 16.6, compared with 19.7 for those with obesity (p = .21). National Guardsmen also showed a nonsignificant difference in AHI between those with a normal BMI and those with obesity (14.1 vs 22.4, p = .07). Obese civilians tended to have a higher AHI than did nonobese individuals (26.6 vs 45.1, p = .02). Among the entire cohort, the AHI showed a low but significant correlation with the BMI (r = 0.27, p < .001). However, the AHI showed no correlation with BMI among active-duty service members (r = 0.09, p = .33) and among all subjects with a BMI <25 kg/m² (r = 0.11, p = .31).

We similarly analyzed age as a function of disease severity. There was no correlation between age and AHI among both active-duty and National Guard service members (r = 0.07, p = .44). In all subjects, there was a low but significant correlation between age and AHI, suggesting that disease severity worsens with increasing age (r = 0.21, p = .02). However, this correlation was not observed in younger subjects, and a correlation between age and disease severity was not apparent until after the age of 35. Among all subjects, there was no correlation between the AHI and age for those younger than 35 years (r = 0.07, p = .35), but a significant correlation existed for those older than 35 years (r = 0.32, p = .01).

Snoring was not reported by history or identified during PSG in 10.4% of all subjects and was not different between groups. However, among these patients with OSAS, women were less likely than men to snore (24.1% vs 6.7%, p < .001).

**DISCUSSION**

In this study, we demonstrated that OSAS, and severe OSAS, can occur in individuals who do not fit the typical picture of this disease. In consecutively diagnosed patients with OSAS, there was no correlation between age or BMI and disease severity in a younger thinner population. Snoring was absent in more than 10% of subjects, more commonly among women. In this study, not considering OSAS in nonsnorers but otherwise symptomatic patients would have missed the diagnosis in a significant number of individuals and in nearly 25% of women. Similarly, not considering this diagnosis in individuals with a normal BMI (< 25 kg/m²) would also have led to a missed diagnosis in 25% of all patients. In thinner younger individuals, the correlation between age or BMI and the AHI may not apply. Not considering this diagnosis in individuals with these atypical features may lead to underdiagnosis in an at-risk population.

While obesity and age are clearly risk factors for OSAS, we found weak correlations of these factors with disease severity. Severe disease is common, even among patients with a normal BMI. BMI did not predict disease severity, as measured by AHI. While our findings emphasize that many patients with OSAS may not have the commonly associated stigmata of older obese men with snoring, we do not believe our report differs substantially from previously reported data. OSAS is a common condition, reported to occur in at least 2% of adult women and 4% of adult men in the United States. Several epidemiologic studies have suggested that the prevalence is even greater, especially in patients presenting with habitual snoring and hypersomnolence. However, a large randomly sampled study in a racially diverse population has not been conducted, and the true incidence of OSAS remains largely unknown.

Several variables, such as age, male sex, and obesity have been associated with both the incidence and severity of OSAS. How Obesity, and surrogate markers of obesity such as the neck circumference and increased BMI, have been shown to correlate with the development of OSAS and disease severity. However, sleep apnea is not confined to obese individuals. Preconceived notions regarding which patients may suffer from OSAS (ie, older obese individuals) may result in a bias as to whom to refer for a diagnostic PSG. In addition, sleep-disordered breathing has been previously noted to occur in individuals who do not snore. This may result in a large number of patients not being evaluated for and diagnosed with sleep-disordered breathing because they do not fit the stereotype associated with OSAS.

The differences noted between active-duty service members and civilians likely results from a referral bias. In our cohort, civilians diagnosed with OSAS were older and more likely to be obese. There is no obvious factor associated with military service that would predispose and individual to the development of OSAS. One explanation for the discrepancy is that civilian referrals may be limited to patients who fit the stereotype. It is possible that the civilian referral pattern is missing an at-risk population.

A failure to diagnose and treat OSAS has been associated with adverse health consequences. Excessive daytime sleepiness may result in a diminished quality of life and has been associated with the development of depression. Motor vehicle accidents have been attributed to untreated OSAS. Moderate to severe OSAS is associated with an increased risk of developing hypertension, atherosclerotic disease, congestive heart failure, and cerebral vascular disease. Not considering the diagnosis may lead to serious long-term consequences, especially in a younger population who would be expected to have a longer disease course.

Our study has several limitations. Our results focused on specific characteristics of patients diagnosed with OSAS. We did not evaluate other characteristics that have been associated with the risk of disease and its severity, such as neck circumference, Mallampati score, hypothryroidism, hypertension, and family history. In addition, the study was not designed to determine the prevalence of disease in the various cohort populations. Subjects were included after a diagnosis of OSAS was made, and it is unknown how the characteristics noted in these cohorts compare with those of control subjects without sleep-disordered breathing. Furthermore, the proportion of men was much higher in the active-duty and National Guard groups than was found in the civilian group.
This partly reflects the overall demographics of the United States Armed Services and may limit the general applicability of our finding to a civilian population. However, while men constitute a majority in military ranks, there was a disproportionately small percentage of women referred for sleep apnea evaluation at our sleep center. This may reflect an underlying referral bias toward men suspected to have OSAS in our population. The civilian cohort included a greater percentage of women, but this too was lower than the representation of women in the general population and may also reflect a referral bias against women. Civilian women tended to be older than those in the military and may reflect a higher proportion of those who are postmenopausal, which may have contributed to the differences noted in disease severity.

BMI is calculated using an individual’s height and weight and does not account for the percentage of body fat or lean muscle weight. Military service members must perform mandatory physical fitness training and adhere to rigid height and weight requirements, which may result in an increased BMI despite an acceptable muscle-to-fat proportion. We acknowledge that a proportion of the service members we studied had increased BMI due to increased lean muscle mass. In view of this limitation, there may be an even greater difference with regard to obesity between military and civilian cohorts, further strengthening our argument that OSAS is not limited to obese or overweight individuals.

In summary, OSAS occurs in young nonobese individuals. Snoring is common but not required in OSAS, and an over-reliance on this feature may prevent adequate evaluation or under-diagnosis in patients with sleep-disordered breathing. Obesity is similarly common but is not a diagnostic criterion for OSAS, and an elevated BMI should not be required for referring patients for an evaluation. OSAS should be considered in patients reporting excessive daytime sleepiness, regardless of age, BMI, or habitual snoring. Failing to consider sleep-disordered breathing in younger, thinner, or even non-snoring patients may miss the diagnosis in an at-risk population.

REFERENCES