CLINICAL INVESTIGATION

Recognition and Diagnosis of Obstructive Sleep Apnea in Older Americans

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OBJECTIVES: To estimate the proportion of older Americans at risk for obstructive sleep apnea (OSA) who receive OSA evaluations, diagnosis, and treatment.
DESIGN: Cross sectional study.
SETTING: National Health and Aging Trends Study (NHATS), Round 3 survey.
PARTICIPANTS: Community-dwelling Medicare beneficiaries age 65 and older (N=1,052).
MEASUREMENTS: NHATS participants were asked specific questions about sleep disturbances, including items that resembled critical elements of a validated instrument used to assess OSA risk (the STOP-Bang questionnaire). The proportion of older Americans at risk for OSA who received evaluations with home or in-laboratory sleep studies, OSA diagnosis, and OSA treatment was examined, as well as clinical, social, and demographic correlates of OSA.
RESULTS: Of 1,052 participants who completed the sleep module, 56% (95% confidence interval (CI)=53–59%) were estimated to be at high risk of OSA. Only 8% (95% CI=5–11%) of the high-risk individuals had been tested for it. Of those tested, 94% (95% CI=87–100%) were diagnosed with OSA. Treatment with positive airway pressure was prescribed for 82% (95% CI=65–99%) of participants with an OSA diagnosis.
CONCLUSIONS: Evidence from this nationally representative sample of community-dwelling Medicare beneficiaries suggests that high OSA risk is common but seldom investigated. When investigated, OSA is almost always confirmed and usually treated. These findings suggest a significant gap in OSA assessment for older Americans that could have public health implications. **J Am Geriatr Soc 66:1296–1302, 2018.**

Key words: obstructive sleep apnea; Medicare; National Health and Aging Trends Study; polysomnography; STOP-BANG

Obstructive sleep apnea (OSA) is a disorder characterized by repeated episodes of upper-airway obstruction during sleep. A major public health threat, OSA is associated with far-reaching adverse effects that include cardiovascular disease,[1–3] cognitive dysfunction,[4–7] depression,[8] metabolic syndrome,[9,10] motor vehicle crashes,[11] and poor quality of life.[12] It is likely that healthcare costs of OSA and its associated morbidity are substantial.[13,14]

Adults aged 65 and older constitute 14.9% of the U.S. population.[15] Although older age is a recognized risk factor for OSA, estimates regarding OSA risk and discrepancies in OSA recognition and treatment are primarily based on regional data from middle-aged adults.[16–20] Little is known about the national scope of OSA risk underrecognition, and undertreatment in older adults. These limitations are gaps in knowledge, given that older Americans are more likely to experience many of the costly, preventable health consequences associated with OSA,[21–23] and older adults are expected to constitute 21.7% of the U.S. population by 2040.[24] To better characterize the national health burden of OSA, inform initiatives to reduce this burden, and optimize health outcomes for one of the primary consumers of health services in the United States, greater understanding of the scope and treatment patterns of OSA in older persons is necessary.

The purpose of this study was to determine the proportion of older Americans at risk for OSA in a large, representative sample of Medicare beneficiaries and to characterize the national scope of gaps in OSA evaluation, diagnosis, and treatment in these at-risk individuals. We hypothesized that, in comparison to general population

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estimates, a higher proportion of older individuals would be at-risk for OSA, but that these individuals would be less likely to receive OSA evaluations. As an exploratory analysis, social, clinical, and demographic factors associated with OSA diagnosis in older Americans were also evaluated.

METHODS

The University of Michigan institutional review board approved all study procedures.

Data sources and study population

National Health and Aging Trends Study

Data were obtained from Round 3 of the National Health and Aging Trends Study (NHATS), a nationally representative, longitudinal survey of Medicare beneficiaries designed to assess the effect of aging (http://www.nhats.org/). Funded by the National Institute on Aging (U01AG032947), NHATS has performed annual face-to-face interviews in beneficiaries' residences since 2011. The NHATS protocol includes assessment of physical and cognitive capacity, specific health conditions, disability, pain, mood, symptom severity and frequency, well-being, mobility, accommodations, self-care, social support activities, demographic characteristics, and socioeconomic characteristics. Proxy respondents are used if a participant is unable to answer NHATS questions. Completed with an 88% response rate,[25] Round 3 included interviews from 5,097 participants, who through survey weights, represented 32,639,407 older Americans. Survey weights accounted for differential selection probabilities and potential nonresponse bias.

NHATS Sleep Module

In 2013, NHATS asked also questions about sleep disturbances and symptoms of sleep-disordered breathing. Six of these "sleep module" items, which are very similar to items of the (STOP-BANG) questionnaire,[26] were adapted for use in this study. The STOP-BANG is a validated, 8-item screening instrument that assesses characteristics known to confer risk for OSA which form the acronym "STOP-BANG" (**S**noring, **T**iredness, **O**bserved apneas, high blood **P**ressure, **B**MI, **A**ge, **N**eck circumference, **G**ender). Item scores (1/0) are based on yes/no answers.[27,28] The sensitivity of a STOP-BANG score of 3 or greater was 83.9% to predict OSA (apnea hypopnea index (AHI) >5), 92.9% to predict moderate to severe OSA (AHI >15), and 100% to predict severe OSA (AHI >30).[28] In general, a score of 0 to 2 is considered low risk, 3 to 4 moderate risk, and 5 or greater (or a score of 3 that include specific combinations of STOP-BANG items) high risk.[29] The utility of the STOP-BANG has been widely demonstrated in a variety of large samples, many of which included high proportions of elderly adults.[27,30–34] The NHATS sleep module was administered to a random subset of 1,052 Round 3 participants, which, through sampling weights, corresponds to 7,082,963 beneficiaries (Figure 1). Responses to sleep-specific items from this module were used to estimate the proportion of Medicare enrollees at risk for OSA. For primary analyses, participants were considered to be at risk for OSA if they scored 3 points or more on the surrogate NHATS STOP-BANG items (Supplementary Table S1). As all respondents scored at least 1 on the STOP-BANG based on the age item (≥50, which could differentially affect estimation of OSA risk within our pool of respondents), an additional dataset in which the age item was dropped from the score was also created for exploratory analyses. Additional NHATS sleep module items included questions about initial and sleep maintenance insomnia, sleep duration, hypnotic use, napping frequency, and napping duration (Supplementary Table S2).

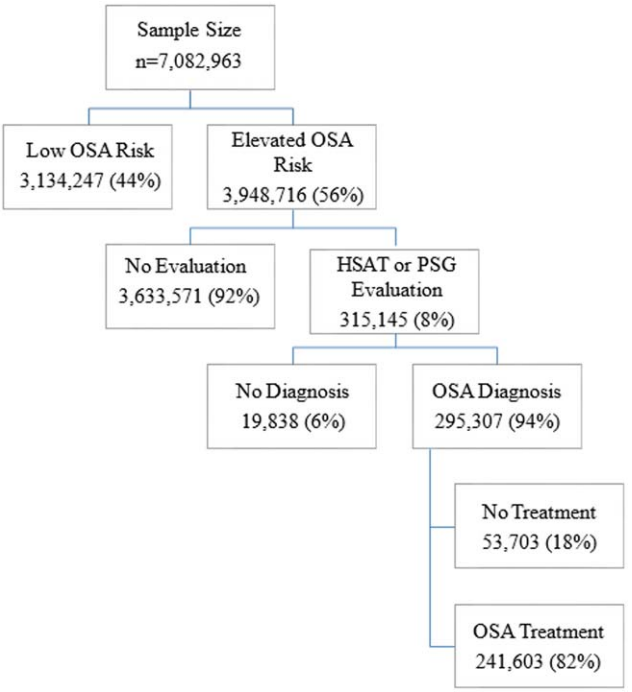

Figure 1. Proportion of obstructive sleep apnea (OSA) recognition and treatment in at-risk National Health and Aging Trends Study participants; 1,052 respondents reflect the unweighted sample frequencies that represent 7,082,963 older Americans in the general population. PSG=polysomnography; HSAT=home sleep apnea testing.

Linkage to claims data

NHATS data were linked to Medicare fee-for-service claims files to identify sleep module participants (n=1,052) who received formal OSA evaluations, diagnosis, and treatment. The linked dataset allowed us to estimate the proportion of beneficiaries whose claims included Current Procedural Terminology codes for in-laboratory polysomnography (PSG, the criterion standard method for OSA diagnosis) or home sleep apnea testing (HSAT), an *International Classification of Diseases, Ninth Revision* (ICD-9)-coded OSA diagnosis, and Healthcare Common Procedure Coding System codes for positive airway pressure (PAP) equipment (Supplementary Table S3). To minimize the likelihood of including prevalent OSA cases diagnosed before 2011, beneficiaries with existing

PAP claims or OSA diagnosis codes who did not have PSG or HSAT claims during the 2011 to 2013 observation period were excluded from analyses.

Statistical methods

Descriptive statistics procedures for complex survey data (chi-square) were used to examine demographic and health characteristics for all Round 3 participants with linked fee-for-service claims. In sleep module participants with available claims, for primary analyses, we estimated the proportion of participants at risk of OSA, the proportion of at-risk participants who were evaluated for OSA with HSAT or in-laboratory PSG, the proportion of at-risk participants diagnosed with OSA after HSAT or PSG, and the proportion of at-risk participants with OSA who were prescribed PAP treatment. These steps were repeated for low-risk participants (surrogate STOP-BANG score ≤ 2).

Bivariate logistic regression models were constructed to examine associations of clinically relevant characteristics postulated to be associated with ICD-9-coded OSA diagnoses amoing the full Round 3 fee-for-service Medicare linked sample (n=3,195).

Clinically relevant independent variables associated with OSA diagnosis ($p<.15$ in bivariate analyses) were included in a multivariable logistic regression model with OSA diagnosis as the dependent variable. Independent variables included age (categorical); sex; marital status; presence of bothersome pain; body mass index (BMI); use of a mobility device; diabetes mellitus; cardiovascular disease; and a composite variable defined as positive if participants endorsed one or more of hypertension, congestive heart failure, myocardial infarction, or stroke.

Bivariate logistic regression models were also used to explore other characteristics not captured in the STOP-BANG items (comorbidities, independent mobility) that could influence the likelihood of OSA evaluation with sleep studies in at-risk respondents.

All analyses were conducted using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

RESULTS

Inclusion and exclusion criteria, and sample sizes of Round 3 and sleep module participants are presented in a flowchart in Supplementary Figure S1. Demographic and clinical characteristics of the 3,195 live NHATS participants are listed in Table 1.

Of the 1,052 sleep module participants, 56% (95% CI=53–59%) were at risk of OSA based on a surrogate STOP-BANG score of 3 or more. Of these at-risk individuals, only 8% (95% CI=5–11%) received OSA evaluation with PSG or HSAT; 94% (95% CI=87–100%) of those evaluated received an ICD-9-coded OSA diagnosis, and 82% (95% CI=65–99%) of those were prescribed PAP equipment (Figure 1). Of the remainder of respondents (44%) with surrogate STOP-BANG scores of 2 or less, 2% received OSA evaluations (95% CI=0.8–4%), 90% of whom received an ICD-9 coded OSA diagnosis (95% CI=88–92%) and 50% of whom were prescribed PAP equipment (95% CI=38–62%). Table 2 summarizes the proportion of sleep module participants who received OSA testing based on each surrogate STOP-BANG score. Proportions of respondents who endorsed sleep-related symptoms or characteristics not included in STOP-BANG and likelihood of evaluation are Summarized in Supplementary Table S2.

Upon recalculation of OSA risk with the age item dropped from the surrogate STOP-BANG score (Supplementary Figure S2), the proportion of at-risk respondents remained high (20%), and of this 20%, 13% underwent a sleep study (87% of those at risk of OSA did not receive a sleep study). Ninety-four percent of the 13% of individuals

Table 1. Demographic and Health Characteristics of National Health and Aging Trends Study (NHATS) Round 3 Participants

Characteristic	Unweighted Frequency, n (N = 3,195)[a]	Weighted Proportion, % (Standard Error)
Sex		
Female	1,910	57 (1.0)
Male	1,285	43 (1.0)
Age		
65–69	267	13 (0.8)
70–74	664	30 (0.9)
75–79	621	21 (0.8)
80–84	676	17 (0.7)
85–89	528	12 (0.6)
≥90	439	7 (0.5)
Race and ethnicity		
White Non-Hispanic	2,348	84 (1.1)
Black Non-Hispanic	626	7 (0.6)
Hispanic, Asian, American-Indian, Pacific Islander	196	8 (0.8)
Race missing	25	<1 (0.3)
Education		
<High school	722	19 (1.0)
High school	769	25 (0.8)
Some college or vocational	737	25 (0.9)
≥Bachelor's degree	780	28 (1.5)
Missing	187	<3 (0.3)
Marital status		
Married	1,419	53 (1.0)
Not married	1,608	45 (1.0)
Missing	168	2 (0.2)
Body mass index, kg/m^2		
>35.0	238	8 (0.6)
≤35.0	2,773	89 (0.7)
Missing	184	<3 (0.2)
Cardiovascular disease		
Yes[b]	1,206	36 (1.1)
No	1,822	62 (1.2)
Missing	167	2 (0.2)
Diabetes		
Yes	802	25 (0.9)
No	2,226	73 (0.9)
Missing	167	2 (0.2)

Unweighted frequencies represent sample counts, weighted proportions represent corresponding population proportions (Through sampling weights, 3,195 respondents corresponds to 20,346,443 beneficiaries.)

[a]Live participants who completed Round 3 NHATS interviews.

[b]Hypertension, myocardial infarction, congestive heart failure, or stroke.

Table 2. Composition of Obstructive Sleep Apnea (OSA) Risk Factors of National Health and Aging Trends Study (NHATS) Sleep Module Participants Evaluated for OSA, Within Each Surrogate (STOP-BANG) Score Category

STOP-Bang Score (%)	Male	BMI>35	HTN	Fatigue	Snore	Age	Evaluated	OSA Diagnosis
1 (10.8)	0	0	0	0	0	100%	1.4%	100%
2 (33.4)	24%	2%	62%	12%	0	100%	3%	88%
3 (35.5)	56%	9%	82%	49%	3%	100%	5%	93%
4 (14.8)	79%	23%	95%	79%	12%	100%	12%	96%
5 (3.2)	37%	27%	94%	83%	79%	100%	16%	83%
6 (2.0)	80%	27%	100%	94%	100%	100%	11%	100%
7 (0.3)	100%	100%	100%	100%	100%	100%	72%	100%

BMI=Body Mass Index; HTN=Hypertension; Risk score=by STOP-Bang items
No surrogate STOP-Bang score of 8 available, as NHATS did not include a neck circumference item.

in this group who underwent sleep studies were diagnosed with OSA.

In analyses of Round 3 sample (n=3,195), older age, male sex, being married or cohabiting, higher BMI, use of a mobility device, pain, cardiovascular disease, and diabetes mellitus were independently associated with OSA diagnosis, but education, race, and depressive symptoms were not (Table 3). Multivariate models suggested significant associations between OSA diagnosis, male sex, and BMI.

Bivariate analyses compared characteristics—those with potential to influence the likelihood of OSA evaluation with PSG or HSAT—of the 92% of unevaluated respondents and the 8% who were evaluated. Independent drivers and those who needed help getting around in and outside the house were more likely to be evaluated. Beneficiaries with a BMI greater than 30.0 kg/m^2 were also more likely to be evaluated. OSA evaluation was not associated with presence of dementia, depression, diabetes mellitus, pain, cancer, or stroke.

Table 3. Predictors of *International Classification of Diseases, Ninth Revision*, Obstructive Sleep Apnea (OSA) Diagnosis in All Round 3 National Health and Aging Trends Study Fee-for-Service Participants

Predictors of OSA	Bivariate Model	Multivariate Model
	OR (95% Confidence Interval)	
Age (reference 65–69)		
70–74	0.8 (0.5–1.3)	0.9 (0.5–1.4)
75–79	0.8 (0.5–1.2)	0.9 (0.5–1.5)
80–84	0.6 (0.3–0.9)	0.8 (0.4–1.3)
85–89	0.5 (0.3–0.8)	0.8 (0.4–1.5)
≥90	0.2 (0.1–0.5)	0.4 (0.2–1.0)
Male	1.4 (1.0–1.9)	1.4 (1.1–2.0)
Married or cohabiting	1.5 (1.1–2.1)	1.4 (1.0–2.0)
BMI[a]	1.1 (1.1–1.2)	1.1 (1.0–1.1)
Use mobility device	1.4 (1.1–1.9)	1.3 (0.9–1.8)
Pain in last month	1.8 (1.3–2.4)	1.4 (1.0–2.0)
Cardiovascular disease	1.6 (1.1–2.4)	1.1 (0.7–1.7)
Diabetes mellitus	2.2 (1.5–3.1)	1.3 (1.0–1.9)

[a]The odds ratio (OR) for body mass index (BMI) represents the effects of a 1-unit increase in BMI on the odds of OSA diagnosis. For example, the odds of an individual with a BMI of 30.0 kg/m^2 having an OSA diagnosis is $(1.1)^4 = 1.46$ times that of an individual with a BMI of 26.0 kg/m^2.

DISCUSSION

This study of a nationally representative sample of Medicare beneficiaries suggests that a large proportion of older Americans who are at risk of OSA are not evaluated for this condition. Using NHATS items similar to those in the STOP-BANG questionnaire, 56% were found to be at risk of OSA. Excluding age as a risk factor, 20% of older beneficiaries still met criteria for moderate OSA risk. Of at-risk individuals who received evaluations with PSG or HSAT, 94% received a diagnosis of OSA, and 82% of these received treatment with PAP. Our study provides new evidence that, in older Americans, increased risk for OSA is common; is seldom investigated; and when investigated, is usually confirmed and treated. These data also invite speculation that older adults may be vulnerable to disparities in clinical evaluation for OSA. Follow-on work that validates the full STOP-BANG questionnaire and demonstrates health consequences that efficient OSA detection in older individuals may offset will be necessary to shape future OSA screening guidelines for older adults, but these data provide an important first step in highlighting the national scope of OSA risk, recognition, and treatment in older Americans.

The magnitude and effect of OSA underevaluation in the United States, particularly in older adults, is unknown.[35–37] Perhaps the most comprehensive study of sleep-disordered breathing and predictive clinical correlates that focused solely on older Americans was completed in the 1980s. In that study, interviews and HSAT were conducted in older San Diego residents.[38] Depending on HSAT measures used, at least 24% had evidence of sleep-disordered breathing. As with the STOP-BANG, features most reliably associated with sleep-disordered breathing included BMI, sex, and sleepiness frequency. Older adults accounted for approximately 60% of the sample in the Sleep Heart Health Study—a cohort study designed to investigate OSA as a risk factor for cardiovascular diseases[39]. In the same study, male sex, snoring, and breathing pauses were also identified as predictors of OSA,[20] although the scope of national gaps of OSA evaluation in older adults was not a focus of these studies, and factors that may prompt or dissuade providers from referring older adults for OSA evaluations have not been sufficiently explored.

Although traditional correlates of OSA (snoring, sleepiness, hypertension) are recognized triggers for PSG and

HSAT in the general population,[40] many of these characteristics are also attributed to normal aging. Consequently, older adults who exhibit these characteristics may be more likely than their middle-aged counterparts to escape sleep evaluations. Older adults may also be less likely to seek medical attention for symptoms that signal OSA in younger individuals[20] or more likely to experience sequelae not classically associated with OSA in younger individuals.[4,41–44] Accordingly, our analyses examined factors associated with OSA diagnosis (and likelihood of evaluation) outside of the STOP-BANG construct in the entire sample of 3,195 participants. As with previous studies,[38,45] male sex and BMI remained strong predictors of OSA diagnosis. Additional noteworthy correlates of OSA diagnosis included bothersome pain, use of a mobility device, diabetes mellitus, and being married or cohabiting (Table 3), as well as poor overall health and independent use of a vehicle (Results). Potential factors associated with likelihood of OSA evaluation included independent use of a vehicle and need for mobility assistance in and around the house. The above associations allow speculation that characteristics that the STOP-BANG does not capture, including symptoms associated with sleep disturbances (pain), input from a bed partner or caregiver, or transportation barriers could confer OSA risk or influence likelihood of evaluation in older adults. In this regard, other sleep-specific characteristics that the NHATS sleep module examines, such as insomnia, short sleep duration, and frequency of hypnotic use (Supplementary Table S2) could explain the high prevalence of OSA diagnosis in the 2% of low-risk respondents who received OSA evaluations with PSG or HSATs. Definitive conclusions cannot be drawn regarding snoring or hypersomnolence as predictors of OSA from our logistic regression models, because NHATS items pertaining to these symptoms were asked only of participants in the sleep module, which precluded their inclusion in logistic regression models. Furthermore, although only 8% of sleep module respondents were classified as snorers, complex item phrasing (Supplemental Table S1) may have discouraged a positive response. Additional studies are necessary to assess the prevalence of snoring and its association with OSA in older Americans.

These findings raise questions about the implications of OSA screening using the STOP-BANG in older adults. Although the STOP-BANG has not been formally validated in adults aged 65 and older, previous validation studies that have included many older individuals[27,30–32] and the large proportion of respondents with surrogate STOP-BANG scores of 3 or more who received an OSA diagnosis (94%) after PSG or HSAT in this sample combine to suggest that this instrument could offer adequate positive predictive value for OSA screening in older adults.

Our findings also raise questions about the predictive value of other factors and symptoms outside of the STOP-BANG. For example, it is hypothesized that age-related weakness of pharyngeal dilator muscles, thought to arise from vibratory trauma to the oropharynx, contributes to OSA risk in older adults. Although snoring, which the STOP-BANG captures, could contribute to this phenomenon, the STOP-BANG does not directly assess signs of pharyngeal muscle weakness.[46–48] Furthermore, the STOP-BANG is designed to capture those who are male and obese, even though OSA is not strongly associated with a sex predilection in older adults and obesity is not as frequently encountered in elderly adults. Future research that focuses on assessment of additional predictors of OSA not included in the STOP-BANG as screening tools could reduce underestimation of this condition in older women and nonobese adults.

Although additional studies are necessary to determine whether complications of OSA in older adults parallel those of middle-aged adults, recent studies that have included older adults would suggest that a substantial proportion of older adults, and men in particular, may be subject to the same cardiovascular risks and all-cause mortality.[49–51] Furthermore, older adults may be more vulnerable to other OSA-related consequences, including falls, cognitive impairment, and dementia.[52–54] Prior work has shown a link between OSA and cognitive dysfunction in individuals with dementia,[55] and some studies suggest that continuous PAP (CPAP) may improve performance in specific cognitive domains or delay cognitive decline.[55,56] Confirmation of effects of CPAP on cognitive function and cardiovascular risk would provide support for population-based OSA screening for older adults.

To our knowledge, this is the first study to characterize the national scope of OSA risk and likelihood of evaluation in older Americans. Strengths include a large representative sample of Medicare beneficiaries and high response rate (88%). Linkage of to Medicare fee-for-service claims files allowed for coupling of beneficiary characteristics (collected through in-person interviews) with objective claims data regarding PSG or HSAT, OSA diagnosis, and Medicare prescriptions of PAP equipment. The use of sampling weights allowed generalization of results to the population.

Potential limitations should be acknowledged. Although 3 of the 6 NHATS surrogate STOP-BANG items were objectively measured (age, sex, BMI), the remaining items required reformatting to allow uniform scoring. Although these items closely resemble STOP-BANG items, these adapted items have not been validated formally. It is also possible that absence of a neck circumference item could have excluded some at-risk participants. To examine the influence on overall OSA risk of allowance of 2 points for the NHATS snoring item (which queried the presence of snoring OR gasping or choking within the same item), we performed sensitivity analyses in subjects with positive responses to this item. Our analyses suggest that the majority of participants who were given 2 points for a positive snoring item (92%) would have still received a surrogate STOP-BANG score of 3 or more, even if they had been assigned only 1 point for the snoring item. In addition, when more specific but less sensitive STOP-BANG scoring methods were applied to our sleep module sample,[57] a similarly low proportion of at-risk participants (2%) were evaluated for OSA. Potential barriers to OSA evaluations of at-risk older adults require further exploration; that said, we acknowledge that data not available in NHATS could in part influence clinical decisions to refer for PSG or HSAT. Finally, it is possible that excluding Medicare Advantage beneficiaries (36% of the sample) could reduce generalizability.

Our data highlight a national gap in evaluation of one of the most rapidly growing demographic groups in the United States. If older individuals with OSA are subject to the same benefits of treatment as middle-aged adults, research that addresses potential causes and solutions for these gaps and demonstrates the value of OSA screening in older adults could offer a vital opportunity to improve one of the nation's top health problems.

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Conflict of Interest: Dr. Braley conducts investigator-initiated studies funded by the National Multiple Sclerosis Society, the American Sleep Medicine Foundation, and the Patient-Centered Outcomes Research Institute and recently completed a sleep apnea clinical trial that received material support, but no financial support, from Biogen-Idec. She is also named in a provisional patent held by the University of Michigan concerning treatment for sleep apnea. Dr. Chervin is named in or has developed patented and copyrighted materials owned by the University of Michigan designed to assist with assessment or treatment of sleep disorders. Dr. Chervin serves on the boards of the American Academy of Sleep Medicine (currently as President), the International Pediatric Sleep Society, and the nonprofit Sweet Dreamzzz. He is an editor for UpToDate, has edited a book for Cambridge University Press, and has consulted for Zansors.

Author Contributions: Braley: study conception and design, analysis and interpretation of data, drafting the article and revising it critically for important intellectual content, final approval of version to be published. Dunietz: acquisition, analysis, and interpretation of data; drafting the manuscript and revising it critically for important intellectual content, final approval of version to be published. Chervin, Lisabeth, Skolarus: analysis and interpretation of data, revising manuscript critically for important intellectual content, final approval of version to be published. Burke: study conception and design, analysis and interpretation of data, revising manuscript critically for important intellectual content, final approval of version to be published.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article.

Table S1. NHATS and corresponding STOP-BANG items.

Table S2. Sleep characteristics of NHATS participants by OSA risk and evaluation with home or in-laboratory sleep apnea testing.

Table S3. Coding scheme for OSA evaluation (Current Procedural Terminology codes), OSA diagnosis (ICD-9 codes), and PAP equipment codes (HCPCS codes).

Figure S1. Flow Chart of participants in the National Health and Aging Trends Survey (NHATS) 2013; In the final analytic sample, the 1,052 respondents reflect the unweighted sample frequencies and represent 7,082,963 older Americans in the general population.

Figure S2. Proportion of OSA recognition and treatment among 'At Risk' NHATS participants (PSG=polysomnography, HSAT=home sleep apnea testing) after scoring the age item as "0" to assess the potential influence of the age item toward OSA risk. N=1,052 respondents reflects the unweighted sample frequencies that represent 7,082,963 older Americans in the general population.

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