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Effect of asthma on the risk of obstructive sleep apnea syndrome in atopic women

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Abstract

Background—Obstructive sleep apnea syndrome is associated with significant morbidity and remains underdiagnosed in women. Identification of high-risk groups among women is important for early detection and treatment.

Objective—To describe the prevalence of snoring in young women with atopy and to determine the risk factors for snoring in these individuals.

Methods—The Cincinnati Childhood Allergy and Air Pollution Study is an ongoing prospective birth cohort study of infants with at least 1 atopic parent. Mothers of study participants were evaluated by questionnaire for snoring, respiratory symptoms, and smoking status. Women who snored were compared with those who did not snore. Logistic regression analysis was performed to determine risk factors for snoring.

Results—Data were available on 677 women who had at least 1 live birth. Of these 677 women, 546 (81%) were white, 122 (18%) were African American, and 9 (1%) were biracial or Asian. The mean ± SD age of the cohort at the time of evaluation for snoring was 29.6 ± 5.6 years. Of the 677 women, 231 (34%) reported snoring at least 1 night per week, and snoring almost always (5–7 nights per week) was reported by 85 (13%). An almost 2-fold risk of snoring was associated with asthma (diagnosis and current symptoms) (odds ratio, 1.8; 95% confidence interval, 1.1–2.8) and African American race (odds ratio, 1.6; 95% confidence interval, 1.04–2.6) after controlling for income level and smoking status.

Conclusions—We found a high prevalence of snoring in young women with atopy and a significant association with asthma.

INTRODUCTION

Obstructive sleep apnea syndrome (OSAS) is a condition characterized by repetitive complete/partial occlusion of the upper airway during sleep, with snoring being the cardinal symptom.[1] Early identification and treatment of OSAS is essential in that when untreated, OSAS has

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been shown to be associated with a wide spectrum of neurocognitive, metabolic, and cardiovascular sequelae.[1–5] Several studies have shown that snorers are at an increased risk of OSAS.[6] Early epidemiologic studies[7] estimated that the male-female ratio of OSAS was 10:1, but more recent studies[8] estimate a ratio of 2:1 to 4:1, suggesting that up to 2% of women in the United States older than 18 years, or approximately 2 million women, may have OSAS. Furthermore, in women who are severely obese, pregnant, or postmenopausal, the prevalence of OSAS has been shown to be as high as that in men.[9–11] Such findings dispel the long-held notion that OSAS predominantly affects males and highlight the importance of identifying other specific groups of females at high risk of OSAS.

Studies indicate that asthma is a frequent comorbidity in patients with OSAS[12,13] and that there is a higher prevalence of OSAS in patients with asthma.[13] These studies have not, however, investigated these relationships exclusively in younger females. Conducting such research is important because several researchers[10,14–17] report on sex differences in airway structure and control of breathing, both of which are key components in the pathogenesis of OSAS. In light of these findings, we restricted the study population to a homogeneous group of women at increased risk of asthma because of their positive atopic status. We sought to determine the prevalence of snoring in young women with atopy and the risk factors for snoring in this targeted group.

METHODS

Participants and Study Design

The Cincinnati Childhood Allergy and Air Pollution Study (CCAAPS) is an ongoing prospective birth cohort study of infants born to atopic parents. The patients in this study consisted of mothers of infants who are participants in the CCAAPS. Briefly, parents were identified from the general population using infant birth records between October 1, 2001, and July 31, 2003. All the parents were informed of the study by a letter mailed to their home and were screened by telephone, mail, or personal interview at their home using an allergy and asthma symptom questionnaire. A follow-up interviewer-administered questionnaire at the infant's first study visit collected data on maternal snoring frequency and household smoking history. Snoring frequency was classified as never or rarely (<1 night per week), sometimes (1–2 nights per week), frequently (3–4 nights per week), and almost always (5–7 nights per week). The presence of snoring was defined as snoring at least 1 night per week. Women who snored were compared with those who rarely or never snored.

Atopic status was determined by means of skin prick testing with a panel of 15 aeroallergens.[18] Testing was performed using a bifurcated testing device (Accusets Test; ALK America, Round Rock, TX). All the tests were administered and interpreted by an allergist who was blinded to the snoring status of the patients. Patients were tested for outdoor and indoor allergens, including meadow fescue and timothy grass pollens, white oak, maple mix, American elm, red cedar, short ragweed, *Alternaria*, *Aspergillus fumigatus*, *Penicillium* mix, *Cladosporium*, dust mite mix, German cockroach, cat, and dog. A positive skin prick test reaction was defined as the presence of a wheal 3 mm or greater than the wheal size of the control (saline) with surrounding erythema.[19]

The presence of asthma was defined based on physician diagnosis and self-reported symptoms (shortness of breath when in bed or making a bed or when housecleaning, when hurrying on level ground or walking up slight hills, when near animals, or when near grass, trees, or flowers). The women had no diagnosis or current symptoms, current symptoms only, diagnosis only, or current symptoms and diagnosis. Rhinitis was defined as a positive response on the questionnaire regarding "problems with sneezing, or a runny, or a stuffed nose without a cold or flu during the spring or fall." Cigarette smoking status was classified as positive in those

who smoked at least 1 cigarette per day at the time of interview. Exposure to environmental tobacco smoke was classified as positive in those who reported that other household members smoked at least 1 cigarette per day.

Statistical Analysis

Descriptive statistical analyses were performed to calculate the mean and median ages of the patients and their distribution by sex and race. The data were stratified by the frequency of snoring. Prevalence rates for each of the snoring frequency strata were then calculated. Demographic comparisons between women who snored and those who did not snore were performed using the unpaired *t* test for continuous variables and the χ^2 test for categorical variables. Univariate χ^2 analysis was performed to identify risk factors that independently predicted the presence of snoring in participants. Multiple logistic regression analysis was then used to calculate odds ratios (ORs), which were adjusted for the effects of other risk factors in the model. A software program (SAS version 8.2 for Windows; SAS Institute Inc, Cary, NC) was used for all analyses. In all analyses, $P < .05$ was considered statistically significant.

RESULTS

Data were obtained from 677 mothers of the 881 infants in the CCAAPS. Of the 677 women, 546 (81%) were white, 122 (18%) were African American, and 9 (1%) were either biracial or Asian. The mean ± SD and median ages of the mothers at the time of evaluation for atopy and snoring were 29.6 ± 5.6 years and 29 years, respectively. Current cigarette smoking was reported by 98 (14%) of 677 women.

The prevalence of snoring is given in Table 1. The presence of snoring (≥1 night per week) was reported in 231 (34%) of 677 patients, and snoring almost always (5–7 nights per week) was reported in 85 patients (13%). In the unadjusted analysis, women who snored (≥1 night per week) did not significantly differ from those who did not snore regarding age, educational status, exposure to environmental tobacco smoke, or presence of rhinitis (Table 2). In those who snored, however, there was an increased prevalence of asthma symptoms (34% vs 25%; $P = .004$), cigarette smoking (19% vs 13%; $P = .03$), African Amer-ican race (24% vs 15%; $P = .007$), and lower household income (39% vs 31%; $P = .03$). Univariate analysis revealed that women with habitual snoring (≥3 nights per week) had a significantly higher prevalence of asthma (37% vs 25%; $P = .03$), cigarette smoking (19% vs 13%; $P = .03$), African American race (26% vs 16%; $P = .01$), and lower household income (45% vs 32%; $P = .004$) compared with women who did not snore.

The adjusted analysis with snoring as the dependent variable and asthma, current cigarette smoking, race, age, and income as covariates is given in Table 3. A diagnosis of asthma with current symptoms almost doubled the risk of snoring (OR, 1.8; 95% confidence interval [CI], 1.1–2.8), and having current symptoms alone also increased the risk (OR, 1.6; 95% CI, 1.1–2.4). Being African American also almost doubled the risk of snoring (OR, 1.6; 95% CI, 1.04–2.6). The effect of current cigarette smoking on snoring was analyzed in a subgroup of women without asthma (n = 313) using race, income, and age as covariates (Table 3). Cigarette smoking more than doubled the risk of snoring (OR, 2.4; 95% CI, 1.1–5.3), whereas race was no longer significant.

DISCUSSION

Obstructive sleep apnea syndrome is believed to result from a combination of factors, including an airway that is anatomically predisposed to collapse and insufficient neuromuscular compensation to maintain airway patency.[1] Snoring is the primary symptom and is produced by the vibration of soft tissues of the pharynx, soft palate, and uvula.[6] The plethora of literature

pertaining to the adverse health effects of OSAS[2,4,5] underscores the need for its early identification and treatment. In light of the lack of availability and the high cost of overnight polysomnography, which is considered the gold standard diagnostic test for OSAS,[20] it is essential for clinicians to be aware of predisposing risk factors for OSAS. This will ultimately enable better use of resources by prioritizing those who undergo objective OSAS testing.

In a large population-based cohort of young atopic women, we found a 20.5% prevalence of habitual snoring (≥3 nights per week). This finding is particularly striking compared with the results of a large Danish population-based study[20] that reported a habitual snoring prevalence of only 9% in young women. Furthermore, it indicates the need for increased awareness among clinicians of the higher risk of OSAS in this select group. We also report a significant association between asthma and snoring. This effect was independent of upper respiratory tract symptoms (eg, rhinitis), cigarette smoking, and race. This supports the findings of Fitzpatrick et al,[12] who reported a higher prevalence of snoring among asthmatic patients compared with nonasthmatic patients. Although the cause of this association is not clear, several theories have been proposed for the exacerbating effect of OSAS on asthma. Hypoxia associated with OSAS can induce reflex bronchoconstriction.[21] Another potential mechanism for OSAS-induced bronchoconstriction is through gastroesophageal reflux resulting from the negative intrathoracic pressure generated owing to upper airway obstruction.[22,23] Recent studies[24–26] indicate that OSAS is independently associated with systemic inflammation. Thus, OSAS can contribute to the development of lower airway obstruction through its effect on airway inflammation. Strong support for a causative association between OSAS and asthma is provided by studies that demonstrate improvement in asthma with treatment of OSAS.[27,28]

Corroborating the findings of Redline and Young[29] and Ancoli-Israel,[30] we also found an increased prevalence of habitual snoring in African American patients. The effect of race persisted after controlling for cigarette smoking, education level, and socioeconomic status. This increased prevalence may be secondary to abnormal ventilatory control and unique craniofacial features.[31]

We found an association between current cigarette smoking and snoring in the univariate analysis. This is in agreement with the finding of Franklin et al,[32] who reported this association in a large population-based cohort of young women in northern Europe. However, in multivariate regression analysis of our data with asthma as the covariate, cigarette smoking was not significant. To determine whether the strong association between asthma and snoring in our cohort was masking the effect of smoking, we analyzed nonasthmatic women and found that in this group, current cigarette smoking was associated with snoring. The mechanism proposed for the causative role of cigarette smoking in OSAS is via its irritant effect leading to local airway inflammation.[33,34]

A limitation of the present study is the lack of objective testing for OSAS. Also, we used self-report of smoking behavior to evaluate exposure to tobacco smoke. This could have resulted in misclassification of patients owing to underreporting. Future studies should include biomarkers for environmental tobacco smoke exposure, such as cotinine levels.

In conclusion, in a large population-based cohort of young women with atopy we found a high prevalence of snoring and significant associations between snoring and asthma, African American race, and cigarette smoking. Given the potentially serious impact of OSAS, we strongly recommend that these high-risk groups be targeted for early identification and treatment.

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Table 1

Prevalence of Snoring in 677 Women With Atopy

Snoring frequency		Women, No. (%)
Description	**Nights per week**	
Never	0	350 (52)
Rarely	<1	96 (14)
Sometimes	1–2	92 (14)
Frequently	3–4	54 (8)
Almost always	5–7	85 (13)

Table 2

Characteristics of Snorers and Nonsnorers*

Variable	Nonsnorers (n = 446)	Snorers (n = 231)	*P* value
Age, mean ± SD, y	29.28 ± 5.60	29.86 ± 5.66	.9†
African American race	15.3	23.6	.007‡
Yearly income ≥$40,000	69.1	60.6	.03‡
Education status			.09‡
High school or less	21.5	24.9	
College (no degree)	25.8	26.2	
College (degree)	52.7	48.9	
Maternal cigarette smoking	12.5	18.8	.03
Environmental tobacco smoke exposure	22.2	20.3	.06‡
Asthma			.004
Ever diagnosed (no symptoms)	6.5	4.1	
Symptoms (but not diagnosed)	25.2	34.2	
Ever diagnosed + symptoms	17.1	23.0	
Rhinitis	73.5	74.9	.5‡

* Data are given as percentages except where indicated otherwise.

† By *t* test.

‡ By χ^2 test.

Table 3

Adjusted Analysis of Predictors of Snoring in Asthmatic and Nonasthmatic Women

Predictors of snoring	Adjusted OR (95% CI)	*P* value
In all women		
Asthma (diagnosed + symptoms)	1.8 (1.1–2.8)	.01
Asthma (symptoms only)	1.6 (1.1–2.4)	.02
Asthma (diagnosis only)	0.8 (0.3–1.8)	.6
African American race	1.6 (1.04–2.6)	.03
Yearly income >$40,000	0.8 (0.5–1.3)	.37
Age	1.04 (1.01–1.1)	.01
In nonasthmatic women		
Cigarette smoking	2.4 (1.1–5.3)	.03
African American race	1.9 (0.8–4.4)	.14
Age	1.1 (1.01–1.1)	.03
Yearly income >$40,000	0.6 (0.3–1.3)	.21

Abbreviations: CI, confidence interval; OR, odds ratio.