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Prevalence and Correlates of Snoring and Observed Apneas in 5,201 Older Adults

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Summary: The objectives of this study were to describe the prevalence of snoring, observed apneas, and daytime sleepiness in older men and women, and to describe the relationships of these sleep disturbances to health status and cardiovascular diseases (CVD). A cross-sectional design was employed to study sleep problems, CVD, general health, psychosocial factors, and medication use. The subjects were participants in the Cardiovascular Health Study, which included 5,201 adults, aged 65 and older, who were recruited from a random sample of Medicare enrollees in four U.S. communities. Study measures employed were sleep questions, echocardiography, carotid ultrasound, resting electrocardiogram, cognitive function, cardiopulmonary symptoms and diseases, depression, independent activities of daily living (IADLs), and benzodiazepine use. Thirty-three percent of the men and 19% of the women reported loud snoring, which was less frequent in those over age 75. Snoring was positively associated with younger age, marital status, and alcohol use in men, and obesity, diabetes, and arthritis in women. Snoring was not associated, however, with cardiovascular risk factors or clinical CVD in men or women. Observed apneas were reported much less frequently (13% of men and 4% of women) than snoring, and they were associated with alcohol use, chronic bronchitis, and marital status in men. Observed apneas were associated with depression and diabetes in women. In both men and women, daytime sleepiness was associated with poor health, advanced age, and IADL limitations. The conclusions of the study were that loud snoring, observed apneas, and daytime sleepiness are not associated cross-sectionally with hypertension or prevalent CVD in elderly persons. **Key Words:** Snoring—Observed apneas—Daytime sleepiness—Cardiovascular disease—Older adults.

Sleep problems may interact with subclinical disease to increase the risk of (or precipitate) overt clinical disease. Snoring, for example, has been associated with hypertension, coronary artery disease, and stroke (1). Snoring may be most important in those with other cardiovascular risk factors (2) or with sleep apnea syndrome (1–3). Alternatively, snoring may simply be a marker for cardiovascular risk factors, such as obesity and hypertension (4).

Sleep problems are common in the elderly (5), but their relationships to daytime function, general health status, and cardiovascular risk are not well described in this age group. Because of the potential contribution of sleep disorders to cardiovascular risk, questions regarding loud snoring and observed apneas were asked during the baseline exam of the Cardiovascular Health Study (CHS). The CHS is a prospective study of 5,201 adults, aged 65 and older, that was designed to identify factors related to the onset and course of coronary heart disease and stroke. In this paper we describe the prevalence of self-reported sleep disturbances in elderly men and women, and the association of these sleep disturbances with other markers of physical and psychologic health.

METHODS

Participants in the CHS were recruited from a random sample of the Health Care Finance Administration Medicare eligibility lists in four U.S. communi-

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Participating institutions and principal staff are listed in the Appendix.

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TABLE 1. *Characteristics of the Cardiovascular Health Study participants (n = 5,201)*

Gender:	male	43%		
	female	57%		
Married:	men	85%		
	women	57%		
Race:	white	95%		
	black	5%		
	other	<1%		
Education:	<8th grade	15%		
	some high school	13%		
	high school graduate	51%		
	college graduate or better	21%		
Health status:	excellent	14%		
	very good	25%		
	good	37%		
	fair	20%		
	poor	3%		
Age distribution:				
	Age range	Women	Men	Total
	65–69	1,140	695	35%
	70–74	895	721	31%
	75–79	592	469	20%
	80–84	244	252	10%
	85+	91	102	4%
Prevalence (%) of other selected characteristics:				
	Characteristic	Women	Men	
	alcohol use	2	7	
	diabetes[a]	49	51	
	arthritis	56	44	
	IADL limitation	30	20	
	benzodiazepines	12	7	
	current smoking	13	10	

[a] Or glucose intolerance; see Methods section for definitions.
IADL, independent activities of daily living.

ties: Forsyth County, NC; Sacramento County, CA; Washington County, MD; and Pittsburgh (Allegheny County), PA. Potential participants were excluded if they were institutionalized, wheelchair-bound in the home, or currently under treatment for cancer. Details of the study design and recruitment have been published (6,7).

The participants were 65 or more years old at the time of the baseline examination (1989–1990), and their age and sex distributions were similar to those of the U.S. population. Their age distribution and other characteristics are summarized in Table 1. Participants answered standardized questionnaires that included medical history, current medications, and dietary and personal habits. In order to make reported odds ratios easy to interpret, obesity was defined as a body mass index (BMI; measured in kg/m^2) above the 80th percentile (30 for women and 29 for men). Similarly, a high waist-to-hip-circumference ratio was defined as being above the 80th percentile (0.97 for women and 1.01 for men). Neck size was not measured at this examination.

The presence or absence of sleep disturbance was determined using an interviewer-administered questionnaire. Three questions were designed to assess daytime drowsiness, snoring, and breathing pauses—the hallmarks of obstructive sleep apnea (8). The possible responses were limited to "yes", "no", or "don't know" (categorical variables coded as 1, 0, or missing, respectively).

Q1. Has anyone complained about your loud snoring?
Q2. Has anyone observed you while sleeping to have episodes where you stop breathing for a while then snore or snort loudly? (Hereinafter referred to as "observed apneas.")
Q3. Are you usually sleepy in the daytime?

Participants assessed their general health by answering the question: "Would you say, in general, your health is (excellent, very good, good, fair, or poor)?" Limitation of instrumental activities of daily living (IADLs) was defined as trouble performing any of the following: light or heavy housework, shopping, meal preparation, money management, and using the telephone (9).

Symptoms of depression were assessed using the modified Center for Epidemiologic Studies Depression (CES-D) scale of 0–30 (10). Mean CES-D values were 5.10 for women [standard deviation (SD) = 4.70] and 3.75 for men (SD = 4.04). Cognitive function was assessed by trained interviewers using a modified mini-mental status exam (11), scored on a scale of 0–35 (including both serial sevens and spelling "world" backwards).

Angina [based on a Rose et al. questionnaire (12)], myocardial infarction, congestive heart failure (CHF), transient ischemic attacks, and strokes were defined as possible (only self-reported) or definite [confirmed by electrocardiography (ECG), current use of anti-angina medications, or medical records] (13). M-mode and Doppler measurements of the heart were made by centrally trained sonographers using a Toshiba SHH-160A echocardiograph machine. Left ventricular (LV) mass could be estimated by echocardiography in two-thirds of the participants (14). The categorical variable "high LV mass" was defined as a value above the gender-specific 95th percentile (230 g for men and 165 g for women). Right and left common carotid artery dimensions were measured using pulsed Doppler ultrasound, with a 4 MHz probe and a Toshiba SSA-270A ultrasound machine. Mean values were 0.97 mm (SD = 0.19) for women and 1.06 mm (SD = 0.23) for men. "Carotid disease" was defined as a right or left common carotid artery maximum wall thickness above the 90th percentile (1.19 mm for women and 1.34 mm for men) (15).

Blood pressure was measured in the right arm after 5 minutes of rest, using standardized techniques (16). Hypertension was defined as systolic ≥160 mmHg, or

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TABLE 2. *Bivariate correlates of sleep disturbances*

	Loud snoring		Observed apneas		Daytime sleepiness	
	M	F	M	F	M	F
n	2,123	2,644	1,956	2,545	2,187	2,906
Prevalence	33%	19%	13%	4%	17%	15%
Age	–	−0.022	−0.027		+	+
BMI	+	+	+0.002	+0.005	+	
Waist/hip ratio		+	+0.028		+	
Married	+		+0.006		+	
Current smoker		+0.027				
Hypertension				+0.015	+	
Carotid disease					+	+
Diabetes		+		+0.010	+0.003	+
Arthritis		+			+	+
Poor health	−0.004	+0.033	−0.017		+	+
Benzodiazepine use				+0.038	+	+0.020
Emphysema						+0.040
Alcohol use	+0.014					

A two-sample *t* test or chi-squared p-values were used. The plus sign (+) indicates a positive association, and the minus sign (−) indicates a negative association, with $p \leq 0.001$ unless given. M, male; F, female; BMI, body mass index.

diastolic ≥95 mmHg, or reported history of hypertension and current use of an antihypertensive medication. Results from the 12-lead resting ECG were Minnesota coded, with major ECG abnormality defined as any one of the following: ventricular conduction defect, major Q/QS wave abnormality, LV hypertrophy, major ST-T wave abnormality, atrial fibrillation, or first degree AV block (17).

Participants brought all currently used medications to the clinic. Each medication used and its dose (but not indication) was coded using the National Drug Code (18). The use of benzodiazepines, tricyclic antidepressants, or other psychotropic medication was coded as separate categorical variables for this analysis. Diabetes was defined as a history of diabetes mellitus, current use of insulin or oral hypoglycemic medication, fasting glucose ≥140 mg/dl, or 2-hour postload glucose ≥200 mg/dl. Chronic bronchitis, asthma, and emphysema were defined as self-reported, physician-diagnosed lung disease, based on a subset of the standardized ATS-DLD-78 questionnaire (19). Alcohol use was defined as 25 or more self-reported drinks per week.

Analysis

Variables that had previously been described by other investigators to be associated with sleep disorders, as well as echocardiogram and carotid ultrasound results, were considered for association with the three sleep variables using a two-sample *t* test for continuous variables and the Pearson chi-squared test for categorical variables. Several groups of highly correlated variables were also found to be functionally related. In such cases, only the variable that was most highly correlated with sleep variables was retained for entry into multivariate models. For instance, height, weight, waist and hip size, BMI, and bioelectric impedance were all highly correlated indices of body size and obesity; however, BMI and the waist/hip ratio were more highly correlated with sleep variables, so height, weight, waist size, hip size, and bioelectric impedance were not used in later analyses.

Variables that were bivariately significantly associated with at least one of the sleep variables were considered for step-wise inclusion into a gender-specific logistic regression model (20). Bivariate significance was defined as a Bonferroni-adjusted p-value of 0.002, yielding a 5% overall p-value for each sleep variable.

Models with men and women combined using gender and gender interaction terms were also examined. The significant gender differences were verified, but the presence of complex gender interaction terms made interpretation of odds ratios more difficult than those for the simpler gender-specific models.

RESULTS

Loud snoring

Men were more likely to report that others had complained about their loud snoring (33% vs. 19%, $p < 0.0001$, see Table 2). The prevalence of reported snoring decreased with age, markedly so in men (Fig. 1). Men aged 65–69 reported a prevalence of 41%, that declined to 17% in those over age 80 ($p < 0.0001$ for trend), whereas the prevalence in women decreased from 20% to 10% over the same age range ($p = 0.04$ for a trend). In men, being married and having a high BMI were associated with loud snoring (Table 2), but after correcting for age and being married, only the number of alcoholic drinks per week was positively

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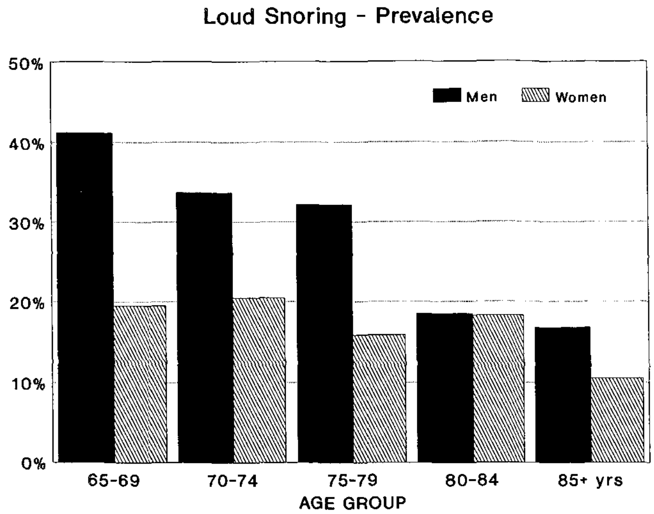

FIG. 1. Prevalence of loud snoring in elderly men and women by age group. The negative age trends were significant.

TABLE 3. *Factors independently related to sleep disturbances*

	p-value	Odds ratio	95% CI
Loud snoring—Men (n = 2,096)			
Age 75+	<0.0001	0.65	(0.52–0.78)
Married	<0.0001	2.85	(2.04–4.01)
Alcohol use	0.024	1.49	(1.05–2.13)
Loud snoring—Women (n = 2,601)			
BMI high	<0.0001	1.60	(1.58–4.06)
Hopkins clinic	0.0006	0.65	(0.51–0.84)
Diabetes	0.0045	1.34	(1.10–1.65)
Arthritis	0.0067	1.34	(1.08–1.64)
Observed apneas—Men (n = 1,922)			
Alcohol use	0.049	1.59	(1.00–2.53)
Chronic bronchitis	0.049	1.40	(1.00–1.97)
Married	0.038	1.65	(1.03–2.65)
Pittsburgh clinic	<0.0001	0.29	(0.19–0.45)
Observed apneas—Women (n = 2,601)			
Depression	0.0006	1.92	(1.85–2.00)
Diabetes	0.013	1.74	(1.12–2.70)
Sleepiness—Men (n = 2,173)			
Age 75+	<0.0001	1.89	(1.50–2.39)
IADL limits	<0.0001	2.06	(1.59–2.68)
Poor health	0.0014	2.35	(1.39–3.98)
Carotid disease	0.0056	1.98	(1.22–3.21)
Benzodiazepine use	0.008	1.70	(1.15–2.54)
Sleepiness—Women (n = 2,891)			
IADL limits	<0.0001	1.66	(1.32–2.08)
BMI high	<0.0001	1.71	(1.36–2.15)
Depression	<0.0001	2.31	(2.26–2.36)
Married	0.0015	0.70	(0.57–0.87)
Poor health	0.0027	1.99	(1.27–3.12)
Age 75+	0.0045	1.39	(1.12–1.77)

CI, confidence interval; BMI, body mass index; Hopkins clinic, participants living in Washington County, MD; Pittsburgh clinic, participants living in Allegheny County, PA; Depression, CES-D score × 10 [see Orme et al. (10)]; IADL, independent activities of daily living.

associated with loud snoring (Table 3). In women, snoring was independently associated with obesity (a high BMI), diabetes, and arthritis. Elderly women in Hagerstown, MD reported loud snoring less frequently than those living in other communities. A high waist to hip ratio (apple-shaped rather than pear-shaped body habitus), current smoking, and poor health were associated with loud snoring only before adjustment for other factors (Table 2).

Observed apneas

Men were much more likely to have been told that they had been observed to stop breathing during sleep (13% vs. 4%, $p < 0.0001$), and this was reported less frequently by the oldest men. There were no highly significant bivariate associations ($p < 0.001$) with observed apneas, but the multivariate models revealed the following positive associations in men: chronic bronchitis, alcohol use, and being married. Men in Pittsburgh were much less likely than those in other clinic locations to report this symptom. In women, observed apneas were independently associated only with depression and diabetes in the multivariate model (Table 3).

"Don't know" answers

Overall, 5% of the men and 11% of the women answered "don't know" to the loud snoring question. Thirteen percent of the men and 14% of the women answered "don't know" to the observed apneas question. Unmarried women and men (widowed, divorced, separated, or never married) were much more likely to answer "don't know" when asked about loud snoring (18% vs. 3.3%), and they were twice as likely to answer "don't know" when asked about observed apneas (20% vs. 10%). Men and women aged 70 and above were about twice as likely to answer "don't know" to the loud snoring question, compared to those in the 65 to 69-year-old age category, but there was no age trend for a "don't know" answer to the observed apnea question.

Daytime sleepiness

Men were slightly more likely than women to report daytime sleepiness (17% vs. 15%, $p = 0.025$). Daytime sleepiness increased with age, from 12% to 19% in women ($p < 0.0001$ for age trend) and from 13% to 31% in men ($p < 0.0001$ for trend) (Fig. 2). Daytime sleepiness was more common in men and women with carotid artery disease, diabetes, arthritis, poor health, and use of benzodiazepines. The logistic models (Table 3) showed that daytime sleepiness was in-

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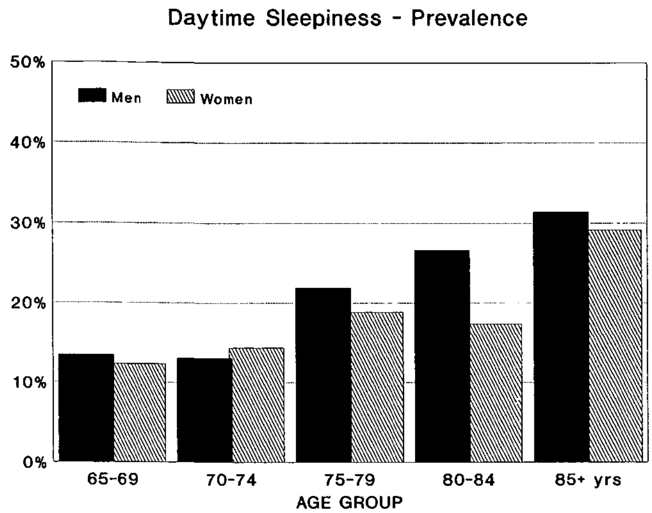

FIG. 2. Prevalence of daytime sleepiness in elderly men and women by age group. See Table 1 for the number of cases in each age and gender category.

dependently associated with advanced age, poor health, and IADL limitations in both men and women; with carotid artery disease and use of benzodiazepines only in men; and in women with obesity, depression, and not being married.

Elderly men and women who reported either loud snoring or observed apneas were more likely to also report daytime sleepiness (using a chi-squared analysis, with $p < 0.001$ for women and $p < 0.01$ for men). None of the following factors were independently associated with loud snoring, observed apneas, or daytime sleepiness: a history of angina, myocardial infarction, congestive heart failure, transient ischemic attacks, strokes, asthma, emphysema, hypertension, or major ECG abnormalities.

DISCUSSION

Prevalence

The prevalence of self-reported problems with sleep was substantial in the elderly participants of our cohort; 41% of the men and 20% of the women admitted that someone had complained about their loud snoring, and 16% of all participants were usually sleepy in the daytime. The prevalence of snoring in these participants was considerably lower than that noted in previous investigations, in which up to 80% of men and 40% of women over age 60 were snorers (21–24). This difference could be due in part to the wording of our question, requiring that the snoring be *loud*. We did not ask bed partners or those living in the same house about their snoring, and 5% of the men and 11% of the women did not know if they snored loudly or not.

Gender differences

The apparently lower snoring rates in women (when compared to men) could be explained by any combination of the following: 1) women actually snore less, 2) women snore less loudly than men, 3) more women than men live alone and have no one in the household to hear the snoring, 4) a husband is more reluctant to tell his wife that she snores (than vice-versa), or 5) women deny or forget the problem more than men. In a sample of 427 elderly persons in San Diego (5), women in the 65- to 79-year-old age group demonstrated less sleep-disordered breathing [defined as respiratory disturbance index (RDI) >10] than the men. In the small community sample (24 women and 41 men) studied by Redline et al. (25), the women also reported snoring that disturbed others and observed apneas much less frequently than did the men. These gender differences were not explained by a gender difference in the availability of roommates or bed partners. Sleep symptoms were positively associated with an objective measure (RDI >15); the men were twice as likely to have sleep-disordered breathing (25). The women with an RDI >15 were more likely to be postmenopausal than premenopausal (25). Similar gender differences were noted in the community sample of 602 middle-aged adults analyzed by Young et al. (26). Again, habitual snorers (both men and women) were more likely to have higher objective apnea scores [apnea/hypopnea index (AHI) >15] (26). Middle-aged women were more likely to report daytime sleepiness than the men in their study (26), but not in our cohort of older women.

Age trends

Because the age range of CHS participants is relatively limited, age-related trends in self-reported sleep problems were less likely to be seen than in studies including middle-aged adults. The oldest men and women were much less likely to have had someone complain about their loud snoring. However, even after correcting for other factors, advanced age was independently associated with a lower prevalence of loud snoring and an increased prevalence of daytime sleepiness.

Snoring correlates

Loud snoring was clearly inversely associated with age in our cohort. Other recent reports that have included adults over age 60 have also reported this age trend (27,28). These studies also included younger men, and they showed a peak snoring prevalence in the 50- to 60-year-old age group, suggesting that the

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decline may reflect survivorship. Reported risk factors for loud snoring and for sleep apnea in middle-aged men include obesity, hypertension, and angina (4,27,29). Loud snoring was independently associated with BMI, diabetes, and arthritis in our elderly women and only with alcohol use in our elderly men. The association with osteoarthritis was previously noted (30); however, a recent study of 294 middle-aged Australian men did not find an association between alcohol consumption and sleep disordered breathing (31).

Apnea correlates

Observed apneas were associated with chronic bronchitis and alcohol use in the men and with factors previously unreported in the women: depression and diabetes. The observation of pauses in breathing during sleep has a high positive predictive value for the presence of obstructive sleep apnea (32,33). If the observed apneas reported by CHS participants reflect repetitive apneic episodes associated with clinical sequelae, then clinically important sleep apnea may be a more prevalent condition than is generally appreciated in community-living elderly.

Cardiovascular disease correlates

Previous investigators described a much higher prevalence of cardiovascular risk factors and overt CVD in patients with severe obstructive sleep apnea (34–36). It is not clear, however, whether these associations were also present in persons with less severe sleep problems, or if sleep disorders were independent risk factors for cardiovascular morbidity and mortality.

Sleeping pills

Elderly persons are more likely to receive sleeping pills from physicians than are younger persons, and elderly women are much more likely to use sedatives than are elderly men (37,38). Other investigators have shown that the long-term use of sleeping pills is associated with impaired cognition and slow psychomotor function (39). Not surprisingly, then, the use of benzodiazepines was associated with daytime sleepiness in the elderly men of our cohort.

Misclassification

Self-reports of snoring, observed apneas, and daytime sleepiness produce some misclassification when compared to objective measurements, making one less confident in the correlations reported in this study. However, self-reported snoring and observed apneas are statistically significant (although weak) independent predictors of objective measures of sleep disordered breathing (25,26,31,33,40). The degree of misclassification when using symptoms may be higher in elderly persons when compared to middle-aged persons because the elderly are more likely to have faulty memory and other problems with cognitive function, and because they may be less likely to have a roommate or bed partner to report snoring or observed apenas. There was modest spouse and subject agreement on snoring in a community-based study of Hispanics in New Mexico (41). The spouse report of snoring, however, was positively associated with a history of angina or myocardial infarction in the men, but this association did not reach statistical significance when only the men's own report of snoring was considered (41). A woman would report her husband's snoring (to him) more often than vice versa (41). This may explain why "being married" entered our models for men (Table 3) for loud snoring and observed apnea, but not for women.

In one study (42) there was poor agreement between the patients' and sleep technicians' ratings of the intensity of the patients' snoring (42). In another study, however, there was modest to excellent agreement on sleep questions between the subjects and their roommates (40). There was only marginal improvement in the ability of a model to predict the measured apnea/hypopnea index (AHI) when the results of a roommate questionnaire were added to self-reported sleep symptoms and anthropometric measures as predictors (40).

Because self-reports of sleep problems are only poorly correlated with objective measures of sleep-disordered breathing and because cross-sectional correlations of sleep-disordered breathing with cardiovascular diseases and risk factors are inferior to longitudinal studies, further research is necessary. A large prospective multicenter study of the cardiovascular consequences of sleep-disordered breathing is now underway in the U.S. Many of the participants of the Cardiovascular Health Study, the subjects of this report, will also be included in the new Sleep Heart Health Study.

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APPENDIX

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