Daytime Sleepiness Predicts Mortality and Cardiovascular Disease in Older Adults

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INTRODUCTION: As part of the baseline examination in the Cardiovascular Health Study, sleep disturbance symptoms including snoring and daytime sleepiness, were assessed as potential risk factors or precipitants of cardiovascular disease (CVD). Because of the association of sleep disturbance with poorer health and the possible associations of sleep apnea with CVD, we hypothesized that those with poorer sleep or daytime sleepiness may be at increased risk of mortality or incident CVD.

SETTING: Participants (n = 5888) were recruited in 1989, with an additional minority cohort recruited in 1993, in four US communities for a cohort study designed to evaluate risk factors for cardiovascular disease.

METHODS: An interview-administered questionnaire regarding health and sleep habits with ongoing ascertainment of total mortality and cardiovascular disease morbidity and mortality, including total CVD morbidity and mortality, incident myocardial infarction, and congestive heart failure.

RESULTS: Daytime sleepiness was the only sleep symptom that was significantly associated with mortality in both men and women. The unadjusted hazard ratio was 2.12 (1.66, 2.72) in women and 1.40 (1.12, 1.73) in men. Men who reported difficulty falling asleep also had an increased mortality rate (HR = 1.43 (1.14, 1.80)) which was not seen in women. The risks were attenuated with adjustment for age but remained significant for daytime sleepiness in women (HR = 1.82 (1.42, 2.34)) and for difficulty falling asleep in men. (HR = 1.29 (1.03, 1.63)). Frequent awakenings, early morning awakening, and snoring were not associated with a significantly increased risk of mortality in these older men and women. Crude event rates were evaluated for total incident cardiovascular morbidity and mortality, incident myocardial infarction, and incident congestive heart failure (CHF). Incident CVD rates were higher in both men and women with daytime sleepiness. The aged adjusted HR was 1.35 (95% CI = 1.03, 1.76) in men and was 1.66 (95% CI = 1.28, 2.16) in women. Incident CVD was not higher in those with any other sleep disturbance including snoring. The risk of CVD events associated with daytime sleepiness was attenuated but remained significant in women after adjustment for age. Incident myocardial infarction (MI) rates were also higher in women with daytime sleepiness but were not significantly higher in men. Incident CHF rates were increased in both men and women with daytime sleepiness. In men, the age adjusted HR was 1.49 (95% CI, 1.12- 1.98) and in women, was 2.21 (95% CI, 1.64–2.98). Women reporting both daytime sleepiness and frequent awakening had a hazard ratio of 2.34 (95% CI, 1.66–3.29) for incident CHF compared with those with daytime sleepiness but without frequent awakening. This interaction was not found in men.

CONCLUSIONS: In this study, daytime sleepiness was the only sleep disturbance symptom that was associated with mortality, incident CVD morbidity and mortality, MI, and CHF. These findings were stronger in women than men, i.e., the associations persisted for mortality, CVD, and CHF in women after adjustment for age and other factors. Thus, a report of daytime sleepiness identifies older adults at increased risk for total and cardiovascular mortality, and is an independent risk factor in women. **J Am Geriatr Soc 48:115–123, 2000.**

Key words: sleep disorders; sleepiness

Sleep disorders and daytime sleepiness are symptoms that have been increasingly recognized as components of an important geriatric syndrome. As with most geriatric syndromes, sleep disturbance has numerous potential etiologies and exacerbating factors. Sleep disturbance complaints increase in prevalence with age, and these subjective complaints can be associated with diminished sleep quality measured by polysomnography.[1, 2] In addition to disturbances associated with aging, sleep may be affected by chronic illnesses such as cardiovascular disease (CVD) or chronic pain or by specific occult disorders during sleep such as sleep apnea or periodic leg movements. Several studies have shown that poor sleep in older adults is associated with self-reported poor health, poorer physical function, and depressive symptoms.[3–7]

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Supported by NIH Contracts N01-HC-87079–87086.

Presented at the 55th Annual Meeting of the American Geriatrics Society, May 1998.

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0002-8614/00/$3.50

Daytime sleepiness is largely thought to represent the impact of poor nighttime sleep quality on the ability to function during the day.[8] In older adults participating in the Cardiovascular Health Study (CHS), daytime sleepiness, measured by the Epworth Sleepiness Scale was associated with complaints of frequent awakenings, snoring, lower physical activity, limitation in activities of daily living, and use of medications for congestive heart failure.[9] In a study of sleep complaints among participants in the Duke EPESE Study, daytime sleepiness was associated with a 30% increased risk of mortality, whereas there was no increased risk related to other sleep complaints.[10] Use of hypnotic medication has also been associated with increased mortality, although this relationship seems to be attributable to the connection between hypnotic use and poor health.[11–13] Sleep apnea or sleep-disordered breathing, which occurs quite frequently in older adults, may be a potential underlying mechanism for an association between daytime sleepiness, poor sleep, and mortality although there is little evidence to support an independent association.[14, 15] However, sleep-disordered breathing has increasingly been recognized as a common finding in congestive heart failure and cardiovascular disease.[16] Thus, sleep disturbances and daytime sleepiness could possibly be nonspecific manifestations of sleep-disordered breathing and CVD. The CHS was designed to evaluate the risk factors for CVD in older adults. As part of the baseline examination, sleep disturbance symptoms, including snoring and daytime sleepiness, were assessed as potential risk factors or precipitants of CVD. Because of the association of sleep disturbance with poorer health and the possible associations of sleep apnea with CVD, we hypothesized that those with poorer sleep or daytime sleepiness may be at increased risk of mortality or incident CVD.

METHODS

The CHS, an observational study of 5888 community-dwelling older adults, includes 5201 participants recruited in 1989–1990[17] and 687 additional minority participants recruited in 1992–1993. Participants were recruited from a random sample of the Health Care Finance Administration Medicare eligibility lists in four US communities: Forsyth County, North Carolina, Sacramento County, California, Washington County, Maryland, and Pittsburgh (Allegheny County), Pennsylvania. Potential participants were excluded if they were institutionalized, wheelchair-bound in the home, or currently under treatment for cancer.

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Participants were aged 65 and older at the baseline examination. The age and sex distributions were similar to the US population. The baseline evaluation included medical history and examination, ECG, carotid ultrasound, echocardiogram, and pulmonary function testing. Current medication, physical activity, physical function, and dietary and personal habits, including sleep patterns, were assessed by interview-administered questionnaire.[18]

Sleep Questions

Questions regarding sleep disturbance at baseline included the following:

Q 1: Are you usually sleepy during the daytime? (Daytime Sleepiness or DS)

Q2: Do you have trouble falling asleep? (Difficulty Falling Asleep or DFA)

Q3: Do you usually wake up several times at night? (Frequent Awakenings or FA)

Q4: Do you wake up far too early? (Early Morning Awakening or EMA)

Q5: Has anyone complained about your loud snoring? (Snoring or SN)

Question Q1 was included to evaluate the impact of poor sleep on daytime function. Questions Q2 through Q4 assess disorders of initiating and maintaining sleep.[19] Question Q5 was used to assess snoring as a potential symptom of sleep apnea.[20]

Other Variable Definitions

Potential confounders of a relationship between sleep disturbance and mortality for CVD were chosen on the basis of associations with sleep disturbance symptoms in a previous cross-sectional analysis.[3] These include age, gender, race, marital status, cigarette smoking status (current vs not current), and alcohol use (categorized as 0–7, 8–15, 16+ drinks per week). Cohort membership was also considered a variable to account for the differences related to the later exam and shorter follow-up for most of the minority participants.

Comorbidities considered included those associated with any one sleep disturbance in the previous cross-sectional analysis: obesity (measured as body mass index: kg/m^2); self-report of arthritis; and prevalent cardiovascular disease, which included myocardial infarction (MI), angina, congestive heart failure (CHF), atrial fibrillation, bypass surgery or angioplasty, stroke, transient ischemic attack (TIA), or intermittent claudication. Subclinical cardiovascular disease was defined according to criteria published by Kuller at al.[21] This included the presence of any of the following in the absence of clinical CVD: carotid stenosis > 25%; internal or common carotid wall thickness > 80th percentile; ankle-arm index < 0.9; major ECG abnormalities; echocardiographic evidence of global or regional wall motion abnormality; or a positive Rose questionnaire for angina or intermittent claudication. We used this global summary of clinical and subclinical CVD rather than individual measures because these measures are highly correlated, and the presence of any of these findings has been shown to be strongly predictive of mortality and CVD events in the CHS study.[22] Self-report of chronic obstructive pulmonary disease and forced expiratory volume in 1 second (FEV_1) on pulmonary function testing were also evaluated as confounders because those with COPD have an increased risk of nocturnal hypoxemia.[23]

Depression was measured as a potential confounder using the modified, 10-item CES-D score.[24] Medications considered included diuretics, antidepressants (tricyclics, tetracyclics, or serotonin reuptake inhibitors), antipsychotics, benzodiazepines, or sleeping pills. Disability was evaluated based on self-report of any difficulty in one or more activities of daily living (ADL impairment) or any difficulty in one or more instrumental activities of daily living (IADL impairment).

Definition of Outcomes

At the time of this exam, participants were classified according to the presence or absence of cardiovascular diseases, including MI, angina, CHF, stroke, TIA, and intermittent claudication. Participants with any of these conditions

were classified as having prevalent CVD.[25–27] Methods of ascertainment of these conditions have been described previously. Briefly, baseline disease status was ascertained from the medical history and confirmed by either ECG, appropriate medication, hospital record review, or physician questionnaire. Those with a history of angioplasty, carotid endarterectomy, or bypass surgery were also considered to have prevalent CVD.

The methods used by the CHS for surveillance and ascertainment of CVD events are described in detail in previous manuscripts[22 28] and are summarized as follows. Participants were contacted by the CHS clinical centers every 6 months regarding hospitalizations and outpatient visits for CVD events. Total mortality included all deaths and was documented by death certificates, inpatient records, nursing home or hospice records, physician questionnaires, and autopsy reports. Cardiovascular disease mortality was defined to include death from coronary heart disease, MI, sudden death, or stroke. Non-fatal events (whether new or recurrent) were evaluated by review of all hospital records (ICD-9-CM codes), history and physical exams, discharge summaries, and diagnostic and therapeutic procedures. Outpatient records and physician questionnaires were evaluated for reports of outpatient diagnoses of MI, angina, CHF, and stroke. CVD morbidity and mortality included any CVD death or incident event. Adjudication of each event was reached by consensus. For this analysis, the following categories of events were evaluated: total mortality, incident CVD (fatal and non-fatal), incident MI, and incident CHF.

Participants were followed up annually. Follow-up was 97% complete for morbidity and was 100% complete for mortality. Follow-up for the combined cohorts averaged 4.85 years. Because their baseline exam occurred later, the added minority cohort members were younger and had 3 years less follow-up time than the original cohort. (The original cohort had 5.2 years; the minority cohort had 2.2 years).

Analyses

Descriptive frequencies for each sleep symptom were evaluated for the combined original and added minority cohorts. Crude event rates were calculated in those with and without each sleep disturbance symptom for total mortality. For CVD morbidity and mortality, those with any CVD at baseline were excluded (n = 1806). For the outcome of myocardial infarction, those with MI at baseline were excluded (n = 551), and for CHF, only those with CHF at baseline were excluded (n = 260). Because of a significant interaction between gender and daytime sleepiness for the odds of mortality, all subsequent analyses were done separately for men and women. Crude event rates were calculated and age adjusted hazards ratios were estimated using Cox proportional hazards models.[29] Next, the nighttime sleep disturbances were considered jointly with the symptom of daytime sleepiness to determine the joint impact and potential interactions of nighttime symptoms and daytime function on mortality and CVD outcomes.[3, 9, 20] Finally, all models were adjusted for age, gender, sleep symptoms, and other potential confounders, as listed in above, in a forward stepwise procedure using Cox proportional hazards models. Only the sleep variable of interest was forced into these models. Survival curves for total mortality were computed using the Kaplan-Meier estimate.[30] Cause-specific survival curves for the outcome of congestive heart failure were computed via the methods outlined by Gaynor et al.[31]

RESULTS

Characteristics of the 5888 older adults who completed the baseline examination are shown in Table 1. The mean age was 72.8 years, the majority of participants were white (84%), 59% were women, and 70% had more than a high school education. Almost one-third of participants had clinical evidence of cardiovascular disease at baseline, with men having a higher prevalence than women in each CVD category. Those shown in Table 1 to have a prevalent condition at baseline were excluded from the analysis of incident events for that condition.

The prevalence of each sleep disturbance symptom is shown in Table 2. Difficulty falling asleep was more common in women (29% vs 15%, $P < .001$), whereas snoring was more common in men (34% vs 20%, $P < .001$). Frequent awakening was quite common (64%) in both men and women. Daytime sleepiness and early morning awakening were similar in men and women.

Sleep Disturbances and Mortality

Crude mortality rates were evaluated for those with and without each of the five sleep disturbance symptoms (Table 3). We then tested for interactions between gender and sleep disturbance. There was a strong interaction between gender and daytime sleepiness for mortality ($P = .005$ for the interaction), such that women with daytime sleepiness had a higher hazard ratio for mortality than men. Thus, subsequent analyses were stratified by gender. This survival experience of men and women with or without daytime sleepiness at the baseline exam is illustrated in Figure 1.

Table 1. Distribution of Demographic and Health Variables in the CHS Cohort

	Men (n = 2495)	Women (n = 3393)	Total (n = 5888)
Age: Mean (Range)	73.3 (65–95)	72.5 (65–100)	72.8 (65–100)
White n (%)	2136 (86)	2791 (82)	4927 (84)
Self-Report Health (good, very good, excellent) n (%)	1898 (76)	2482 (73)	4380 (75)
Education ≥ 12 Years n (%)	1746 (70)	2393 (71)	4139 (70)
Cardiovascular disease n (%)	919 (37)	887 (26)	1806 (31)
Myocardial infarction n (%)	347 (14)	204 (6)	551 (9)
Congestive heart failure n (%)	127 (5)	133 (4)	260 (4)

Table 2. Sleep Disturbance Symptoms in the CHS Cohort, N = 5888

	Men n (%)	Women n (%)	Total n (%)
Daytime Sleepiness (DS)	445 (18)	546 (16)	991 (17)
Difficulty Falling Asleep (DFA)	360 (15)	950 (29)	1310 (23)
Frequent Awakening (FA)	1573 (64)	2142 (64)	3715 (64)
Early Morning Wakening (EMA)	732 (30)	1130 (34)	1862 (33)
Frequent Snoring (SN)	788 (34)	570 (20)	1358 (26)

Daytime sleepiness was the only sleep symptom that was significantly associated with mortality in both men and women. Both men and women reporting daytime sleepiness had significantly higher mortality rates than those without daytime sleepiness; however, the unadjusted hazard ratio in women was 2.12 (1.66, 2.72) and in men only 1.40 (1.12, 1.73) (Table 3). Men who reported difficulty falling asleep also had an increased mortality rate (HR = 1.43 (1.14, 1.80)), which was not seen in women. The risks were attenuated with adjustment for age but remained significant for daytime sleepiness in women (HR = 1.82 (1.42, 2.34)) and for difficulty falling asleep in men. (HR = 1.29 (1.03, 1.63)) (Table 4). Frequent awakenings, early morning awakening, and snoring were not associated with a significantly increased risk of mortality in these older men and women. However, there seemed to be a trend, not statistically significant, toward higher mortality rates in men and women with frequent awakening and in men with early morning awakening. Snoring was, surprisingly, inversely associated with mortality in men. In women, the relationship of the presence of daytime sleepiness with increased mortality remained significantly elevated with adjustment for age, whereas in men this relationship was no longer statistically significant.

We hypothesized that nighttime sleep complaints may only be significant in the presence of daytime sleepiness. Therefore, we evaluated interactions between daytime sleepiness and each nighttime sleep disturbance in relationship to each outcome of interest. There were no significant interactions between daytime sleepiness and nighttime sleep disturbance for total mortality.

The association between the presence of daytime sleepiness and increased risk of mortality in women remained significantly increased with adjustment for other demographic and health factors associated with daytime sleepiness at the baseline exam using a Cox regression model. Other factors associated independently with mortality in women included age, the presence of clinical or subclinical CVD, IADL, current smoking, lower FEV_1, lower Mini-Mental State Exam score, shorter height, and not being married. Depression, sleeping medication use, and weight were not independently associated with increased mortality in this model.

Daytime Sleepiness and Cardiovascular Outcomes

Crude event rates were evaluated for total incident cardiovascular morbidity and mortality, incident MI, and incident CHF. Of the five sleep disturbance symptoms, only daytime sleepiness was associated with these outcomes. Table 5 shows the cardiovascular event rates in men and women with and without daytime sleepiness. Incident CVD rates were higher in men and women with daytime sleepiness than in those without daytime sleepiness. The age-adjusted HR was 1.35 (95% CI, 1.03- 1.76) in men, and the HR was 1.66 (95% CI, 1.28–2.16) in women, although there was no significant interaction between daytime sleepiness and gender ($P = .15$). Incident CVD was not increased in those with any other sleep disturbance, including snoring. The risk of CVD events associated with daytime sleepiness was attenuated but remained significant with adjustment for age. Incident MI rates were also higher in women with daytime sleepiness but were not significantly higher in men. Incident CHF rates were increased in both men and women with daytime sleepiness. In men, the age adjusted HR was 1.49 (95% CI, 1.12–1.98), and in women it was 2.21 (95% CI, 1.64–2.98). As stated above, none of the other sleep disturbance symptoms was associated with MI or CHF in men or women (data not shown).

Although there were few main effects of nighttime sleep disturbances, interaction terms for each nighttime sleep disturbance and daytime sleepiness were evaluated. Of note, there was an interaction in women between frequent awakening and daytime sleepiness, such that women reporting both had a hazard ratio of 2.34 (95% CI, 1.66–3.29) for incident CHF compared with those with daytime sleepiness but without frequent awakening (Table 5). This interaction was not statistically significant in men, although the pattern is similar. Figure 2 illustrates these patterns, showing that women with daytime sleepiness and frequent nighttime awakening are the most likely to develop incident CHF. Subsequent analyses were conducted to evaluate whether diuretic use might explain association of daytime sleeping and frequent awakening with incident CHF. Although diuretic use predicted future CHF, it did not explain these associations.

Stepwise multivariate models for each outcome of interest were evaluated to determine whether other demographic and health factors associated with sleep disturbance at baseline would account for the relationship of daytime sleepiness to these cardiovascular health outcomes. In women, the relationships between daytime sleepiness and incident CVD remained significant (mortality HR = 1.46 (1.11, 1.91), CVD HR = 2.33 (1.47, 3.68)), but they lost significance for MI and CHF. In men, the ratios were no longer statistically significant for any of the outcomes. In these models, age, clinical and subclinical cardiovascular health status, current cigarette smoking, lower FEV_1, and impairment in instrumental activities of daily living were all related to each outcome. Neither use of sleeping pills nor depression was associated with CVD events in these models.

DISCUSSION

In this study, daytime sleepiness was the only sleep disturbance symptom that was associated with mortality, incident CVD morbidity and mortality, myocardial infarction, and CHF. These findings were stronger in women than men in that the associations persisted for mortality, CVD, and CHF in women after adjustment for age and other factors. From previous cross-sectional analyses, we know that the symptom of daytime sleepiness was related to poorer self-reported health as well as to several other more specific factors, including carotid stenosis, IADL impairment, and benzodiazepine use in women and depression, obesity, not

Table 3. Total Mortality Rates in CHS Participants by Sleep Disturbance Symptom: (3a) Total Cohort; (3b) Women; (3c) Men

a. Total Cohort Sleep Symptom		No. Deaths	Follow-up (person years)	Mortality Rate (per 100 person years)	Cox Hazard Ratio Unadjusted (95% CI)
Daytime sleepiness	Yes	191	4432	4.31	1.71 (1.45–2.01)
	No	607	23544	2.58	
Difficulty falling asleep	Yes	185	6404	2.89	1.02 (0.86–1.20)
	No	615	21645	2.84	
Frequent awakening	Yes	547	18020	3.04	1.19 (1.03–1.38)
	No	257	10098	2.55	
Early morning awakening	Yes	258	8916	2.89	1.01 (0.87–1.18)
	No	533	18614	2.86	
Snoring	Yes	183	6564	2.79	0.98 (0.83–1.16)
	No	550	19169	2.87	
b. Women Sleep Symptom		**No. Deaths**	**Follow-up (person years)**	**Mortality Rate (per 100 person years)**	**Cox Hazard Ratio Unadjusted (95% CI)**
Daytime sleepiness	Yes	85	2440	3.48	2.12 (1.66, 2.72)
	No	235	13918	1.69	
Difficulty falling asleep	Yes	96	4773	2.01	1.03 (0.81, 1.30)
	No	225	11558	1.95	
Frequent awakening	Yes	223	10530	2.12	1.21 (0.96, 1.53)
	No	103	5917	1.74	
Early morning awakening	Yes	106	5510	1.92	0.94 (0.74, 1.18)
	No	217	10579	2.05	
Snoring	Yes	53	2760	1.92	0.99 (0.74, 1.34)
	No	231	11796	1.96	
c. Men Sleep Symptom		**No. Deaths**	**Follow-up (person years)**	**Mortality Rate (per 100 person years)**	**Cox Hazard Ratio Unadjusted (95% CI)**
Daytime sleepiness	Yes	106	1991	5.32	1.40 (1.12, 1.73)
	No	372	9626	3.86	
Difficulty falling asleep	Yes	89	1630	5.46	1.43 (1.14, 1.80)
	No	390	10087	3.87	
Frequent awakening	Yes	324	7489	4.33	1.17 (0.97, 1.42)
	No	154	4181	3.68	
Early morning awakening	Yes	152	3406	4.46	1.14 (0.94, 1.39)
	No	316	8035	3.93	
Snoring	Yes	130	3804	3.42	0.79 (0.65, 0.97)
	No	319	7373	4.33	

being married and IADL impairment in men.[3] In a follow-up analysis,[9] we also found an association between daytime sleepiness, assessed by the Epworth Sleepiness scale, with use of medications for congestive heart failure as well as poorer nighttime sleep, depression, low physical activity, and impairment in instrumental activities of daily living. In these longitudinal analyses, we found that these factors did not entirely explain the association of daytime sleepiness to mortality and incident CVD in women. Thus, a report of daytime sleepiness, particularly in women, should be attended to and evaluated in the clinical setting.

Although the unadjusted risks of mortality and CVD in men with daytime sleepiness were increased, age adjustment alone attenuated these findings. Thus, the predictive value of this symptom can be explained by the association of daytime sleepiness with age in men but not in women. The difference in the magnitude of the relative risk between men and women may also be related to the higher baseline risk of mortality and CVD in men. For example, the mortality rate in men *without* daytime sleepiness was 3.86 per 100 person years compared with 3.48 per 100 person years in women *with* daytime sleepiness. Similar relationships were seen for all of the CVD outcomes. Thus, daytime sleepiness appears to be less important in men than in women in part because of their higher baseline risk. There are potential biases that may explain the gender difference. Women in this study who are in poorer health may be more likely to exhibit sleepiness than those in better health. Alternatively, women in better health may be less likely to report sleepiness than men. Finally, men with significant daytime sleepiness may have been less likely to survive to participate in the study.

Daytime sleepiness was assessed in this study by response to a single question regarding the tendency to feel sleepy during the day. Total reported sleep time and daytime nap-

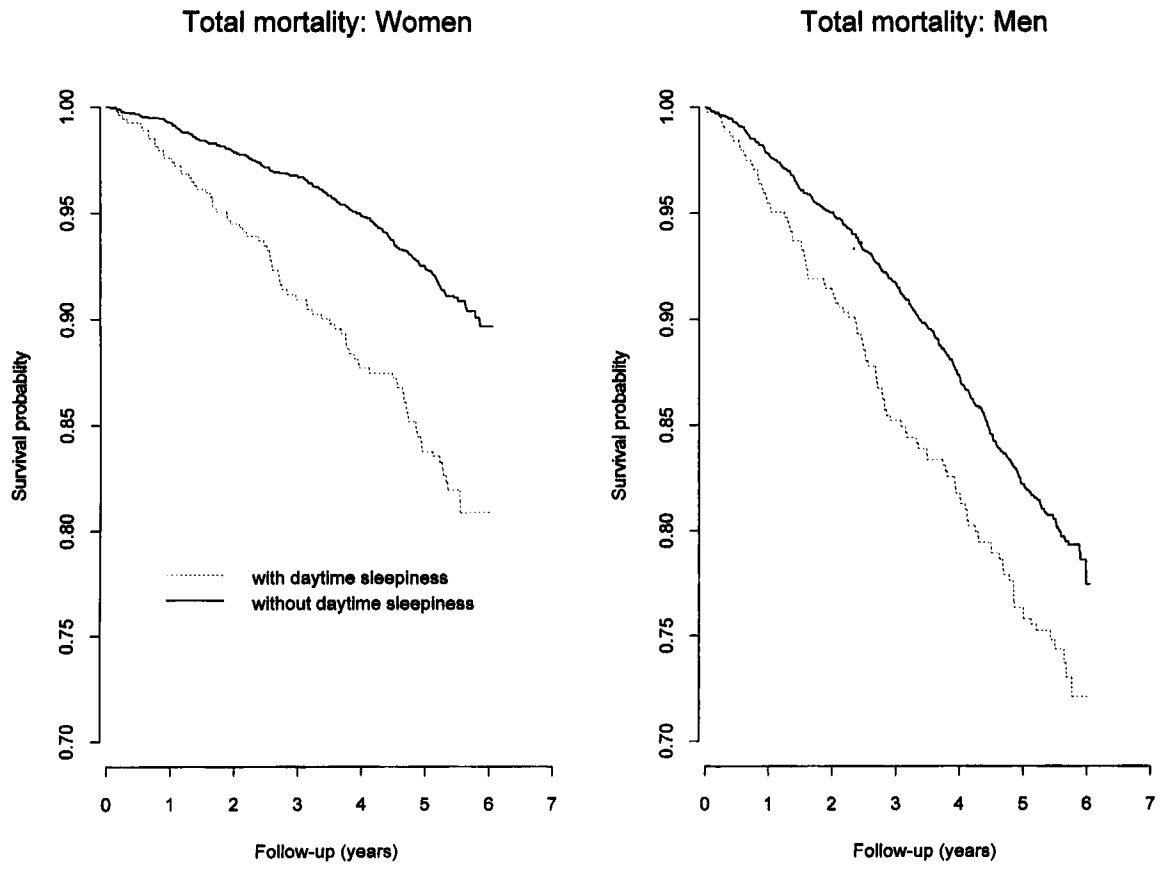

Figure 1. Mortality rates in men (n = 2495) and women (n = 3393) with and without daytime sleepiness.

Table 4. Adjusted Hazards Ratios for Total Mortality in Men and Women with Daytime Sleepiness

	Cox Hazard Ratio, 95% CI: Age Adjusted	Cox Hazard Ratio, 95% CI: Sleep Symptom Adjusted	Cox Hazard Ratio, 95% CI: Multivariate Adjusted
Women	1.82 (1.42, 2.34)	1.75 (1.32, 2.32)	1.46 (1.11, 1.91)
Men	1.15 (.92, 1.43)	1.08 (.86, 1.37)	0.96 (0.77, 1.20)

ping were not assessed. Napping has been shown by others to be associated with poorer health and mortality in older people. It is not clear if the self-report of napping would identify a different group than those who report daytime sleepiness. The question regarding daytime sleepiness was included in this study to evaluate specifically the tendency to fall asleep during the day and because this has been shown to be related to poor nighttime sleep, regardless of the underlying cause of the sleep disturbance. This single question is less sensitive and specific than a more extensive questionnaire, the Epworth Sleepiness Scale,[32] or the more objective multiple sleep latency test.[33] We previously found a strong correlation between this simple question and the Epworth scale in a recent analysis of both methods in the CHS cohort, suggesting that this single question is valid for classifying participants in a large population study.

Although 19% of the CHS cohort overall reported daytime sleepiness, few of the CHS participants reported significant levels of physical impairment or clinical cardiovascular disease. CHS participants, in general, were healthier than the general population of adults more than age 65.[17] More severely impaired individuals were unable to participate in the 4- to 5- hour baseline clinical evaluation. This may have biased our findings toward the null in that those with more severe symptoms, who would be extremely fatigued or unable to be out for most of the day, were not participants in this study.

It is interesting that none of nighttime sleep disturbance symptoms was associated directly with any of the outcomes considered in either men or women. A possible explanation of this lack of association is that many nighttime sleep disturbances, even when causing daytime sleepiness, are unrecognized or considered to be "normal" in older adults. While sleep-disordered breathing and nocturnal myoclonus increase in frequency with age, they do not always cause full arousal and may not be appreciated as causing awakening. However, it has been documented that sleepy older adults are more likely to show arousals as well as sleep-related respiratory disturbance on polysomnography.[34] Brief microarousals on EEG are often seen with sleep-disordered breathing and

Table 5. Event Rates and Hazards Ratios for Incident Cardiovascular Health Outcomes in CHS Participants with Daytime Sleepiness

	CVD Morbidity and Mortality (100 person years) Daytime Sleepiness				
CVD	No	Yes	Cox Hazard Ratio, 95% CI Age Adjusted	Cox Hazard Ratio, 95% CI: Age and Sleep Symptom Adjusted	Cox Hazard Ratio, 95% CI: Multivariate Adjusted
Women	2.84	4.99	1.66 (1.28, 2.16)	1.62 (1.22, 2.16)	1.58 (1.21, 2.06)
Men	4.64	6.72	1.35 (1.03, 1.76)	1.34 (1.01, 1.79)	1.28 (0.98, 1.68)
	MI Rate (100 person years) Daytime Sleepiness				
MI	No	Yes	Cox Hazard Ratio, 95% CI Age Adjusted	Cox Hazard Ratio, 95% CI: Age and Sleep Symptom Adjusted	Cox Hazard Ratio, 95% CI: Multivariate Adjusted
Women	0.66	1.23	1.76 (1.14, 2.73)	1.66 (1.02, 2.68)	1.47 (0.93, 2.31)
Men	1.81	2.24	1.11 (0.77, 1.61)	1.12 (0.76, 1.66)	1.02 (0.71, 1.49)
	CHF Rate (100 person-years) Daytime Sleepiness				
CHF	No	Yes	Cox Hazard Ratio, 95% CI Age Adjusted	Cox Hazard Ratio, 95% CI: Age and Sleep Symptom Adjusted	Cox Hazard Ratio, 95% CI: Multivariate Adjusted
Women	1.18	2.85	2.21 (1.64, 2.98)	2.09 (1.48, 2.94)	0.68 (0.29, 1.61)* 2.34 (1.66, 3.29)†
Men	2.19	3.70	1.49 (1.12, 1.98)	1.58 (1.17, 2.14)	1.25 (0.93, 1.68)

*Hazard ratio for daytime sleepiness by frequent awakening = no.
†Hazard ratio for daytime sleepiness by frequent awakening = yes.

nocturnal myoclonus, suggesting that they may disrupt sleep without awareness. Many older adults are unaware of their snoring habits. The frequency of uncertainty in reporting snoring increases with age, as was shown by the one-third of our participants who could not answer yes or no to our simple question regarding snoring.[20] Although snoring was not associated with CVD morbidity and mortality in this study, the association of daytime sleepiness with mortality and CVD is consistent with the possibility that occult sleep-disordered breathing may be the underlying mechanism of this association. Finally, it is possible that the nighttime sleep disturbance questions assessed a spectrum of severity, and the dichotomous response options were relatively nonspecific. Others have reported that the perception of poor nighttime sleep is often unsupported by polysomnography.[2]

There is a growing literature on the relationship of fatigue and poor nighttime sleep to cardiovascular disease. Poor nighttime sleep has been shown to be a potential trigger for cardiovascular events in the early morning in middle-aged adults.[35] Fatigue is an independent risk factor for poor outcomes in patients undergoing angioplasty, independent of underlying left ventricular function or symptoms of depression.[36] Fatigue has been defined as "tiredness with daily activities"[37] or as a feeling of low energy in the absence of apparent cause.[38] Although fatigue has been conceptualized as a symptom distinct from daytime sleepiness, as assessed in this study, this distinction may not have been appreciated by participants.

Sleep-disordered breathing has been found to be associated with congestive heart failure, even in stable, treated patients.[39] In our study, women with both daytime sleepiness and frequent nighttime awakening were at particularly high risk for incident CHF. It is possible that these women have paroxysmal nocturnal dyspnea, or sleep-disordered breathing, that is unrecognized. Nocturia is extremely common in older adults and is the most common symptom associated with waking up at night in older adults.[40] One study found that older adults with nighttime urinary incontinence were more likely to have concomitant CHF.[41] Another study found that those with nocturia were more likely to have sleep apnea.[42] Thus, nocturia and associated frequent awakening could be related to CHF or sleep apnea. We did not specifically assess the causes of frequent awakening at the baseline evaluation of this cohort. However, in the subsequent cross-sectional analysis, we found that two-thirds of the cohort reported frequent awakening, and almost 90% reported nocturia as the reason for waking up.[20] Nocturia is probably multifactorial.[43] Nevertheless, adjustment for baseline diuretic use in the present longitudinal analyses did not explain the association of daytime sleepiness with CHF. Further exploration of these relationships may support the hypothesis that nocturia causes frequent awakenings and daytime sleep-

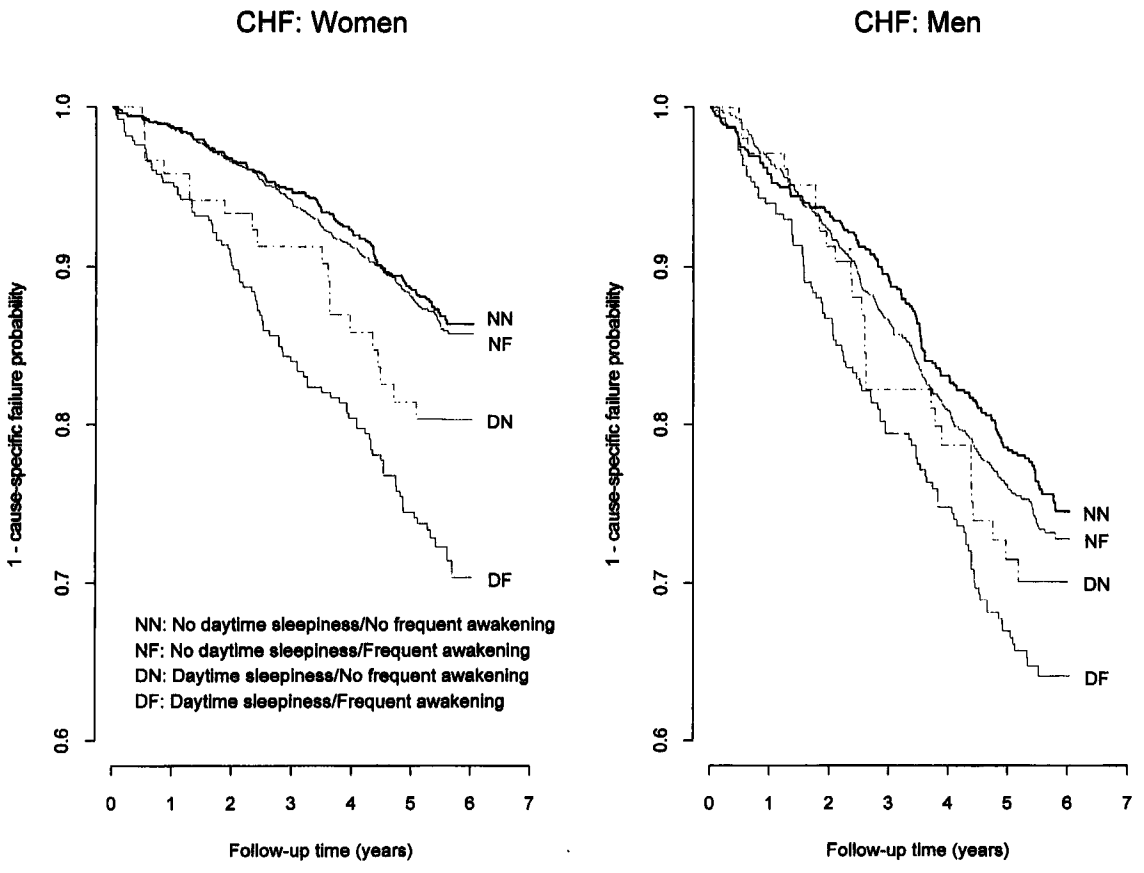

Figure 2. Incident CHF in men (n = 2368) and women (n = 3260) with and without daytime sleepiness and frequent awakening.

iness via an association with occult sleep-disordered breathing or unrecognized early pulmonary vascular congestion, or diuretic use.

The simple report of daytime sleepiness identified participants in this study who were at increased risk for cardiovascular morbidity and total mortality. In older women, daytime sleepiness was an independent predictor of mortality and CVD, whereas in men its predictive value was age-related. Participants in the CHS are somewhat healthier than, but generally representative of, community-dwelling older adults and are healthier than those patients who specifically seek care for sleep problems. Nevertheless, these data suggest that it is not normal or healthy for older adults to feel sleepy. Nighttime sleep disturbance was not associated directly with mortality or CVD. Further research into the numerous factors associated with daytime sleepiness may identify a subgroup with treatable conditions such as sleep apnea or early CHF.

ACKNOWLEDGMENTS

Participating Institutions and Principal Staff: **Wake Forest University, Forsyth County, NC:** Gregory L. Burke, Sharon Jackson, Alan Elster, Walter H. Ettinger, Curt D. Furberg, Gerardo Heiss, Dalane Kitzman, Margie Lamb, David S. Lefkowitz, Mary F. Lyles, Cathy Nunn, Ward Riley, John Chen, and Beverly Tucker; **Wake Forest University-EKG Reading Center, Forsyth County, NC:** Farida Rautaharju, and Pentti Rautaharju; **University of California–Davis, Sacramento County, CA:** William Bommer, Charles Bernick, Andrew Duxbury, Mary Hann, Calvin Hirsch, Lawrence Laslett, Marshall Lee, John Robbins, and Richard White; **The Johns Hopkins University, Washington County, MD:** M. Jan Busby-Whitehead, Joyce Chabot, George W. Comstock, Adrian Dobs, Linda P. Fried, Joel G. Hill, Steven J. Kittner, Shiriki Kumanyika, David Levine, Joao A. Lima, Neil R. Powe, Thomas R. Price, Jeff Williamson, Moyses Szklo, and Melvyn Tockman; **MRI Reading Center-The Johns Hopkins University, Washington County, MD:** R. Nick Bryan, Norman Beauchamp, Carolyn C. Meltzer, Naiyer Iman, Douglas Fellows, Melanie Hawkins, Patrice Holtz, Michael Kraut, Grace Lee, Larry Schertz, Cynthia Quinn, Earl P. Steinberg, Scott Wells, Linda Wilkins, and Nancy C. Yue; **University of Pittsburgh, Allegheny County, PA:** Diane G. Ives, Charles A. Jungreis, Laurie Knepper, Lewis H. Kuller, Elaine Meilahn, Peg Meyer, Roberta Moyer, Anne Newman, Richard Schulz, Vivienne E. Smith, and Sidney K. Wolfson; **Echocardiography Reading Center (Baseline) - University of California, Irvine:** Hoda Anton-Culver, Julius M. Gardin, Margaret Knoll, Tom Kurosaki, and Nathan Wong; **Echocardiography Reading Center (Follow-Up)–Georgetown Medical Center, Washington, DC:** John Gottdiener, Eva Hausner, Stephen Kraus, Judy Gay, Sue Livengood, Mary Ann Yohe, and Retha Webb; **Ultrasound Reading Center-Geisinger Medical Center, Danville, PA:** Daniel H. O'Leary, Joseph F. Polak, and Laurie Funk; **Central Blood Analysis Laboratory-University of Vermont, Colchester, VT:** Edwin Bovill, Elaine Cornell, Mary Cushman, and Russell P. Tracy; **Respiratory Sciences-University of Arizona, Tucson:** Paul Enright; **Coordinating Center–University of Washington, Seattle:** Alice Arnold, Annette L.

Fitzpatrick, Bonnie K. Lind, Richard A. Kronmal, Bruce M. Psaty, David S. Siscovick, Lynn Shemanski, Lloyd Fisher, Will Longstreth, Patricia W. Wahl, David Yanez, Paula Diehr, and Maryann McBurnie; **NHLBI Project Office, Bethesda, MD:** Diane E. Bild, Robin Boineau, Teri A. Manolio, Peter J. Savage, and Patricia Smith.

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