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Self-Reported Sleep and Nap Habits and Risk of Mortality in a Large Cohort of Older Women

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Abstract

Objectives—To determine the association between self-reported sleep and nap habits and mortality in a large cohort of older women.

Design—Study of Osteoporotic Fractures prospective cohort study.

Setting—Four communities within the United States.

Participants—Eight thousand one hundred one Caucasian women aged 69 and older (mean age =77.0 years).

Measurements—Sleep and nap habits were assessed using a questionnaire at the fourth clinic visit (1993/94). Deaths during seven years of follow-up were identified by contacts every 4

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months and confirmed with death certificates. Underlying cause of death was assigned according to the *ICD-9-CM*.

Results—In multivariate models, women who reported napping daily were 44% more likely to die from any cause (95% confidence interval (CI) = 1.23–1.67), 58% more likely to die from cardiovascular causes (95% CI = 1.25–2.00), and 59% more likely to die from non-cardiovascular non-cancer causes (95% CI = 1.24–2.03) than women who did not nap daily. This relationship remained significant among relatively healthy women (those who reported no comorbidities). Compared to those who reported sleeeping 8–9 hours per 24 hours, women who slept 9–10 hours were at increased risk of death from cardiovascular and other (non-cardiovascular, non-cancer) causes.

Conclusion—Older women who reported napping daily or sleeping at least 9 hours per 24 hours are at increased risk of death from all causes except cancer. Future research could determine if specific sleep disorders contribute to these relationships.

Keywords

naps; sleep duration; mortality; aging

INTRODUCTION

The prevalence of sleep disturbances increases with advancing age, yet sleep problems are frequently under-diagnosed and untreated in the elderly[1, 2]. Several epidemiologic studies have reported increased risk of mortality among those with self-reported short or long duration of sleep[3–6]. In general, men and women who reported sleeping 7 hours per night on average had the lowest risk of mortality. However, one study reported that long self-reported night-time sleep duration was associated with increased risk of mortality among men, but not women[7], and no association was found in either gender between short sleep and risk of mortality. Older adults also consistently report more napping than younger adults[8–10]. Napping has been associated with increased risk of all-cause (i.e. death from any cause) mortality in elderly individuals[11–13].

Although no prior studies have examined the relationship between napping and specific causes of death in elderly individuals, one study[14] demonstrated an increased risk of cardiovascular morbidity and mortality in elderly individuals reporting daytime sleepiness. Two studies of younger healthy individuals living in Greece suggested a protective effect of afternoon siesta against coronary mortality[15, 16]. However, these results were no longer significant when those with pre-existing comorbidities were included in the analysis, suggesting that results may differ among healthy and ill individuals.

Few studies have examined the relationship of self-reported sleep and nap habits and mortality in older adults, and none have accounted for both napping and night-time sleep, or total 24-hour sleep duration. Furthermore, few studies have tested the association of sleep or napping patterns and specific causes of death.

This report utilized data from the multi-center Study of Osteoporotic Fractures (SOF) to examine the association between self-reported sleep and nap habits and subsequent risk of all-cause and cause-specific mortality in a large cohort of older women.

METHODS

Participants

SOF is a prospective study of risk factors for osteoporotic fractures17 involving 9,704 ambulatory, community-dwelling women aged 65 and older. Participants were initially recruited between September 1986 and October 1988 from population-based listings in four areas of the United States: Baltimore, Maryland; Minneapolis, Minnesota; the Monongahela Valley, near Pittsburgh, Pennsylvania; and Portland, Oregon. The San Francisco Coordinating Center, based at California Pacific Medical Center Research Institute, and the University of California at San Francisco coordinated the study. Men and black women were initially excluded from SOF because of their low incidence of osteoporotic fractures. Women who were unable to walk without assistance and those with bilateral hip replacements were also excluded. All women provided written informed consent, and the institutional review boards at each site approved the study.

The study sample for this analysis consists of 8,101 women (90.4% of survivors) who completed a brief self-administered questionnaire, including questions on sleep and nap habits, as part of the fourth study visit (1993/94). On average, the fourth exam and questionnaire were administered 5.8 years after baseline, with a minimum time between visits of 4.1 years. Therefore, the minimum age of participants included in this analysis was 69 years.

Assessment and Classification of Sleep and Nap Habits

Sleep and nap habits were assessed using a self-administered questionnaire at the fourth examination (1993/94). Participants were asked the screening question, “Do you take naps regularly?”. Those who responded ‘yes’ to this initial question were then asked about the number of days per week they usually napped (responses ranged from 0 to 7), and the average duration of each nap (<1 hour, 1–2 hours, >2 hours; coded as 0.5 hours, 1.5 hours, and 2.5 hours, respectively). Daily nappers (yes/no) were considered to be those who reported napping 7 days per week. The number of hours of napping per week was calculated by multiplying codes for average duration of naps by number of days per week napped. Total 24-hour sleep duration was estimated as the sum of nighttime sleep hours and average daytime nap hours (estimated weekly number of hours napped divided by 7).

Ascertainment of Deaths

The methods of determining deaths have been published18. Since baseline, participants in SOF have been contacted by postcard or telephone every four months to ascertain vital status. Information from designated proxy sources (e.g. a family member or close friend) is utilized in the event the participant has died. After more than 18 years of follow-up since the baseline examination, these contacts remain over 95% complete. Causes of death were confirmed by death certificates, and when available, hospital discharge summaries. The underlying cause of death was coded by a clinical epidemiologist using the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*, and categorized as due to all causes, cardiovascular disease (*ICD-9-CM* codes 401 to <405, 410 to <415, 425, 428, 429.2, 430 to <439, 440 to <445, and 798), and cancer (*ICD-9-CM* codes 140 to 239). Those that were not classified as cardiovascular or cancer-related deaths were considered due to “other causes.” Participants were followed for an average of 6.9 ± 2.0 years for deaths occurring after the fourth study visit and before December 31, 2001.

Other Measurements

SOF participants completed a questionnaire, interview, and examination at the fourth study visit. Participants provided information on age and health behaviors such as alcohol use (at

least one drink in the past 30 days), current smoking status, and physical activity (walking for exercise). A selected medical history was obtained, including a history of physician diagnosis of cardiovascular disease (angina, myocardial infarction, congestive heart failure, or stroke), hypertension, diabetes, Parkinson's disease, Alzheimer's disease, chronic obstructive pulmonary disease, non-skin cancer, and osteoarthritis. The 15-item Geriatric Depression Scale (GDS) was administered19. Scores range from 0 to 15, with higher scores indicating more symptoms of depression. Depression was defined as having a score of 6 or higher on the GDS20. A trained examiner administered a modified version of the Mini-Mental State Examination (mMMSE)21. This is a brief, global cognitive function test with concentration, language, and memory components designed to screen for cognitive impairment. The mMMSE scale ranges from 0 to 26, with higher numbers indicating better performance. Women with mMMSE score less than or equal to 20 were considered to have poor cognitive function22. A complete inventory of current medication use (including use of hormone preparations and benzodiazepines) was confirmed by examination of pill bottles. Height was measured using a standard held-expiration technique with a wall-mounted Harpenden stadiometer (Holtain Ltd, UK), and weight was assessed using a balance beam scale. Body mass index (BMI) was derived as weight in kilograms divided by the square of the height in meters.

Statistical Analysis

Characteristics of participants were examined by napping status, using chi-square tests for categorical variables and *t* tests for continuous variables. Cox proportional hazards regression was used to assess the association between sleep and nap habits and subsequent risk of death, and results are presented as hazard ratios (HR) with 95% confidence intervals (CI). A variety of potential confounders were screened including age, BMI, medical conditions (diabetes mellitus, Parkinson's disease, dementia, chronic obstructive pulmonary disease, non-skin cancer, and osteoarthritis), history of cardiovascular disease, history of hypertension, walking for exercise, alcohol use, smoking status, depression, cognitive impairment, and use of medications including use of estrogen and benzodiazepines. Variables were considered for inclusion in multivariate models if they were related to sleep and nap habits with an age-adjusted p-value < .20 or if there was previous literature suggesting an association with sleep patterns.

To determine if the association between daily napping and death was significantly different between women who were and were not ill at the fourth study visit, we first performed analyses stratified on pre-existing illness status (presence of one or more comorbidity). We also performed formal tests of interaction between daily napping and pre-existing illness, by adding an interaction term to a combined model which included both daily napping and pre-existing illness. Similar analyses (stratified analyses and tests for interaction) were performed to explore possible interactions between pre-existing illness and 24-hour sleep duration. To determine whether the effect of daily napping on mortality was independent of the effect of total 24-hour sleep duration, multivariate models were developed that included both the daily napping variable and a binary version of the 24-hour sleep duration variable (≥ 9 hours vs. < 9 hours).

Finally, we examined interaction between nightly sleep duration (classified as < 6 hours, 6–8 hours, and > 8 hours per night) and daily napping by testing the relationship between nightly sleep duration and mortality stratified on daily napping status. Formal tests of interaction were also performed in combined models including an interaction term. Similar analyses were performed to test for interaction between 24-hour sleep duration and daily napping status.

All significance levels reported were two-sided and all analyses were conducted using SAS version 8.2 (SAS Institute Inc., Cary, NC).

RESULTS

The average age ± standard deviation of participants was 77.0 ± 5.0, and the average total (24-hour) sleep duration was 7.5 ± 1.4 hours. Eight hundred seventy-four women (10.8%) reported taking daily naps, 586 (7.2%) reported sleeping less than 6 hours per 24-hour period, and 491 (6.1%) reported sleeping at least 10 hours per 24-hour period.

Women reporting daily naps tended to be older, were more likely to report a history of medical conditions, and were more likely to test as depressed and cognitively impaired than those who did not nap daily (Table 1). In addition, daily nappers were less likely to report walking for exercise, alcohol use, or estrogen use, and slept significantly more per 24 hours than the women who did not nap daily. Short (< 6 hours) night-time sleep duration and long (> 8 hours) night-time sleep duration were both more common among women who reported taking daily naps as compared to those who did not (short sleep: 17.3% vs 12.2%; long sleep: 14.3% vs 9.6%). As expected, a higher percentage of those napping daily reported sleeping 9 to less than 10 hours (28.0% vs. 10.9%) and 10 or more hours per 24 hours (27.2% vs. 3.6%).

During 6.9 ± 2.0 years of follow-up, 1,922 women died, with 723 having died from cardiovascular disease, 423 from cancer, and 776 from other causes (non-cardiovascular and non-cancer). Among the women who died from causes other than cardiovascular disease or cancer, 28% died from unknown or natural causes, 12% died from dementia-related causes, 11% from pneumonia, 9% from chronic obstructive pulmonary disease, 7% from renal failure, 3% from actinomycosis, 2% from Parkinson's disease, and 28% from miscellaneous causes (each cause 1% or less).

Napping and Risk of Mortality

Age-adjusted death rates were higher among women reporting daily naps died compared to the women who did not nap daily, both for all-cause mortality and the three specific causes of death (Table 2). After adjustment for age, there was a 1.82-fold (95% CI = 1.62–2.04) increased risk of all-cause mortality, a 1.99-fold (95% CI = 1.65–2.39) increased risk of cardiovascular-related deaths, a 1.31-fold (95% CI = 0.97–1.77) increased risk of cancer-related deaths, and a 2.16-fold (95% CI = 1.81–2.57) increased risk of death from other causes for women who reported daily napping compared to women who did not. After multivariate adjustment, the strength of the associations between daily napping and mortality decreased but remained statistically significant for all-cause (HR = 1.44, 95% CI = 1.23–1.67), cardiovascular (HR = 1.58, 95% CI = 1.25–2.00), and non-cardiovascular non-cancer mortality (HR = 1.59, 95% CI = 1.24–2.03), and the association with cancer-related deaths remained non-significant (HR = 1.20, 95% CI = 0.83–1.75) (Table 3). While the magnitude of the associations differed somewhat among those with or without pre-existing illness, we found no statistically significant interactions between daily napping and illness status for either all-cause or cause-specific mortality (all interaction p-values ≥ 0.15; Table 3).

Compared to women who reported napping less than 3 hours per week, women who napped at least 3 hours per week were 34% more likely to die from any cause (95% CI = 1.18–1.52), 51% more likely to have a cardiovascular-related death (95% CI = 1.24–1.83), and 42% more likely to die from non-cardiovascular non-cancer causes (95% CI = 1.16–1.74) after multivariate adjustment. They were not at significantly increased risk of cancer-related deaths (HR = 1.12, 95% CI = 0.85–1.48). Women who napped more than 0, but fewer than 3

hours per week were not at increased risk of mortality compared to women who did not nap at all.

Sleep Duration and Risk of Mortality

Overall, there was no significant association between self-reported night-time sleep duration and risk of death from any cause (Table 4), although risk was modestly elevated among those who reported sleeping > 8 hours per night (HR=1.16; 95% CI=0.97 – 1.39).

After multivariate adjustment, women with long 24-hour sleep duration (9 to < 10, or 10 or more hours per 24-hours) were at significantly increased risk of all-cause mortality compared to those with sleep durations of 8 to < 9 hours per 24-hours (HR = 1.28, 95% CI = 1.08–1.52 and HR=1.58, 95% CI=1.27–1.95, respectively) (Table 5). Those who slept ≥ 10 hours per 24-hours experienced an approximate 1.8-fold increase in risk of cardiovascular-related deaths (HR=1.77, 95% CI = 1.28 – 2.45) and a 1.7-fold increase in non-cardiovascular non-cancer related deaths (HR = 1.71, 95% CI = 1.22–2.41). The relationship of long sleep duration and cancer-related deaths was not statistically significant (HR = 1.22, 95% CI = 0.73–2.04 for those sleeping 10 or more hours per night, compared with 8 to <9 hours per night). Women who reported sleeping <6 hours and those sleeping 6 to <8 hours per 24 hours were not at increased risk of death from any cause compared to women who reported sleeping 8 to <9 hours per 24-hours.

In multivariate models containing both 24-hour sleep duration and daily napping exposures, both factors remained significantly associated with all-cause mortality, as well as cardiovascular mortality and non-cardiovascular non-cancer mortality.

Interaction of Daily Napping and Sleep Duration on Mortality Risk

As noted above, those who reported daily napping were more likely to report either short or long nightly sleep duration. Although there was no association overall between nightly sleep duration and death from any cause, a significant interaction between short night-time sleep and daily napping was observed (p=.03). Among those who reported daily napping, those who reported sleeping fewer than 6 hours per night were at significantly increased risk of all-cause mortality relative to those who reported 6–8 hours of sleep per night (HR=1.41; 95% CI=1.00 – 1.98; Table 3). This pattern was evident for both cardiovascular-related deaths and non-cardiovascular non-cancer related deaths. There was insufficient power to obtain stable risk estimates for cancer-related deaths.

Among those who did not report napping daily, there was no association between short night-time sleep and mortality (HR=0.91; 95% CI=0.76 – 1.09). The relationship between long night-time sleep duration and mortality was similar regardless of napping status.

Similar patterns of interaction were observed for short 24-hour sleep duration and daily napping (Table 4).

DISCUSSION

The findings from this large prospective study indicate that older women who report daily napping and women who report sleeping at least 9 hours within a 24-hour period are at significantly increased risk of death from all causes other than cancer, even after accounting for a variety of confounding or explanatory variables. Overall, older women who report sleeping fewer than 8 hours per 24 hours, compared to those who report a sleep duration of 8–9 hours, are not at increased risk of death from any cause. However, among older women who report daily napping, mortality rates were elevated in those with both short (< 8 hours)

and long (9 or more hours) 24-hour sleep durations, compared to those reporting sleeping 8–9 hours.

Our findings that all-cause mortality is increased in older women who report daily napping are consistent with results from several previous studies. For example, Hays et al found that, among older men and women, frequent nappers had a 1.3-fold increased risk of death compared to infrequent nappers13. Similarly, Bursztyn reported a 1.6-fold increase in risk for mortality during 12 years of follow-up among older residents of Jerusalem, Israel who reported daily naps12. In women aged ≥ 65 who participated in the Cardiovascular Health Study, Newman et al reported that daytime sleepiness was associated with increased risk of all-cause mortality and cardiovascular morbidity and mortality during 4.8 years of follow-up14.

Our study also found that daily napping increased risk of cardiovascular mortality, independent of baseline health status. In contrast to our findings, Naska et al studied 14,112 middle-aged Greek who were free of coronary heart disease (CHD), stroke, and cancer at baseline16. In this study, there was no association between frequent napping and risk of coronary death. However, the causes of napping are likely quite different in our population of very elderly women, as compared to younger, relatively healthy women in the Naska study.

Few studies have examined the association between total 24-hour hour sleep duration (including nap time) and mortality risk in the elderly. One recent study of 2192 women ages 55 and older reported no association between short (<7 hours) or long (>8 hours) sleep duration over 24 hours and risk of all-cause mortality 23. However, prior studies in younger participants have reported that both short and long sleepers have an increased risk of mortality, though only the association with long sleep remained after multivariate adjustment, which is consistent with the findings of the current study. In a prospective, community-based, observational study of 82,969 women (mean age = 53 years), Patel found that women who reported sleeping 5 hours or less per day had a 12% increase in mortality risk that was of borderline significance compared to women who slept 7 hours per 24 hours, while women who slept at least 9 hours per day had a nearly 40% increase in risk 5. Furthermore, both short and long 24-hour sleep duration were associated with increased non-cancer/non-cardiovascular mortality, whereas only long sleep was related to increased risk of death from cardiovascular disease or cancer. Similarly, in a large prospective population-based study of rural Japanese women (mean age = 55 years), Amagai found that those who reported sleeping at least 9 hours per 24 hours were at significantly increased risk of all-cause death and cardiovascular death (not including stroke), but not for cancer death or non-cardiovascular non-cancer deaths relative to women with 7–7.9 hours sleep3. Those who reported sleeping less than 6 hours per 24 hours were not at increased risk of all-cause or cause-specific mortality.

In contrast to the results of the present study, Burazeri et al. reported that, in a community-based study of 1,001 women (median age = 64 years) in a West Jerusalem neighborhood who were followed for 9–11 years, women who reported sleeping less than 6 hours within a 24-hour period were at significantly increased risk of all-cause mortality compared to women sleeping 6–8 hours per day, whereas women who reported sleeping at least 8 hours were not at increased risk7.

Overall, we found no significant association between night-time sleep duration and risk of mortality, although risk of mortality was elevated among older women with long self-reported night-time sleep, and similar in magnitude to risks observed in other studies (HR=1.14 and 1.22 for women reported > 8 to 9 and > 9 hours of sleep per night,

respectively). For example, in the American Cancer Society's Cancer Prevention Study II of more than 1.1 million men and women ranging in age from 30–102 years who were followed for 6 years, Kripke et al. reported that women who reported 8 hours (HR = 1.13), 9 hours (HR = 1.23), or at least 10 hours (HR = 1.41) of sleep during the night were at significantly increased risk of mortality relative to those who slept 7 hours per night4. Similarly, among the 60,158 women aged 40 to 79 years followed for 9.9 years in the Japan Collaborative Cohort Study, those whose nightly sleep duration was longer than 7 hours were at significantly increased risk of all-cause mortality6. However, both of these studies also found elevated risks of mortality among those with short night-time sleep duration, where as there was no indication of increased risk associated with short sleep in our study. Our results are also consistent with the previously mentioned study by Burazeri and colleagues, which found no association of night-time sleep duration and mortality risk7.

Unlike the current study, previous studies have not considered the combined effect of daily napping and sleep duration. The present study demonstrated that, while there was no effect of short sleep on risk of mortality overall, risk was elevated among short sleepers who reported daily napping. This interaction with daily napping was evident for both night-time sleep duration and total 24-hour sleep duration. Self-reported short sleepers who nap on a daily basis may suffer from excessive daytime sleepiness, which may be caused by comorbidities or by an underlying sleep disorder such as insomnia or sleep disordered breathing. In contrast, those who report short sleep but do not nap had no increased risk of mortality.

Although the mechanisms by which daily napping results in a higher mortality risk are unclear, daytime sleepiness is common among those with primary sleep disorders such as sleep-disordered breathing (SDB)24, those with neuropsychiatric disorders25, and those with comorbidities such as cardiovascular disease25. In particular, the increased risk of cardiovascular mortality observed among daily nappers may be mediated at least in part through SDB26. Another proposed mechanism involves possible increase in cardiovascular disease risk due to the abrupt increase in blood pressure and heart rate upon awakening from a nap, closely resembling the period soon after waking up in the morning when the onset of acute cardiovascular events are high27. In contrast, a few studies conducted in younger participants found that afternoon napping decreased the incidence of and mortality from CHD, suggesting that afternoon napping may act as a stress-releasing habit in younger working persons15, 16. However, the beneficial effect of daily naps does not appear to hold in elderly women. Elderly women who napped less than 3 hours per week were not at increased risk of mortality compared to women who did not nap at all, suggesting that shorter and less frequent naps do not have the negative consequences that longer and more frequent naps do.

The mechanism by which increased 24-hour sleep duration leads to a higher mortality risk remains unclear as well. Patel reported that, among middle-aged women participating in the Nurses Health Study, depression and socioeconomic status were strong candidates for producing the statistical association between long sleep and mortality, either as confounders or causal intermediates28. Although our models were adjusted for medical conditions and depression, it is still possible that lengthy sleep duration may be a marker of frailty and ill health, or it may be indicative of an underlying sleep disorder such as SDB, a treatable condition. Youngstedt and Kripke suggested that restricting the amount of time spent sleeping might may be beneficial for older adults29. Acute sleep restriction can have dramatic antidepressant effects, and sleep restriction is perhaps the most effective treatment for primary insomnia. Conversely, spending excessive time in bed can elicit daytime lethargy and exacerbate sleep fragmentation, resulting in a vicious cycle of further time in

bed and further sleep fragmentation. Longer sleep duration may represent a modifiable lifestyle risk factor, similar to food intake, exercise, smoking, or alcohol consumption.

This study has several limitations. The sleep and nap habits were based on self-report only, and may therefore be more prone to misclassification particularly in older adults. This may be a particular issue for napping information, which would capture only intentional naps. Prior research has also suggested that older adults may tend to underreport napping behavior 30› 31. Therefore, future studies should consider use of sleep diaries and/or actigraphy to more accurately and comprehensively capture the napping exposure. Women who died before the fourth clinic visit may have been most likely to have sleep patterns than those who returned for the clinic visit. Thus, the observed association between sleep and nap habits and risk of mortality likely underestimates the true association. The results of the present study are limited to older Caucasian women, and therefore the findings may not apply to men, non-white women, or younger Caucasian women.

In conclusion, older women who reported daily napping and who reported sleeping at least 9 hours within a 24-hour period were at significantly increased risk of death from all causes other than cancer. Since excessive sleep suggests that night time sleep is disrupted, interventions to treat sleep disorders and improve sleep quality in older women may reduce mortality risk. Future research using comprehensive and objective measures of sleep are needed to elucidate whether specific disorders, such as sleep apnea, contribute towards these relationships.

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Table 1

Characteristics of 8,101 Participants with Self-Reported Napping Data

Characteristic	Napped Daily (N=874)	Did Not Nap Daily (N=7,227)	p-value*
Age, years, mean (± SD)	79.5 (± 5.9)	76.7 (± 4.8)	<.001
Body mass index, kg/m^2, mean (± SD)	26.6 (± 5.1)	26.4 (± 4.7)	.36
History of at least one medical condition, %†	53.9	43.8	<.001
History of cardiovascular disease, %‡	39.9	26.5	<.001
History of hypertension, %	49.9	45.0	.006
Takes walks for exercise, %	33.5	49.2	<.001
Any alcohol within previous 30 days, %	25.9	45.5	<.001
Current smoker, %	6.1	6.0	.89
Depression (GDS short-form score ≥ 6, range 0–15), %	16.3	7.1	<.001
Cognitive impairment (modified Mini-Mental State Examination score ≤ 20, range 0–26), %	6.7	3.6	<.001
Currently taking estrogen, %	14.5	17.5	.03
Currently taking benzodiazepines, %			.96
None	92.1	92.3	
Short-acting benzodiazepine use	4.8	4.8	
Long-acting benzodiazepine use	3.1	2.9	
Pre-existing illness, %§	69.0	56.3	<.001
Sleep duration, hours			
Total 24-hour sleep duration, mean (± SD)	8.7 (± 1.7)	7.4 (± 1.3)	<.001
Total 24-hour sleep duration, %			<.001
< 6	3.1	7.8	
6 to < 8	18.4	43.9	
8 to < 9	23.2	33.9	
9 to < 10	28.0	10.9	
≥ 10	27.2	3.6	
Nightly sleep duration, mean (± SD)	7.0 (± 1.6)	7.0 (± 1.2)	.67
Nightly sleep duration, %			<.001
< 6	17.3	12.2	
6 to 8	68.4	78.2	
> 8	14.3	9.6	

*p-values for continuous data are from *t* tests, and p-values for categorical data are from chi-square tests.

†History of at least one medical condition, including diabetes mellitus, Parkinson's disease, dementia, chronic obstructive pulmonary disease, non-skin cancer, and osteoarthritis.

‡Cardiovascular disease includes angina, myocardial infarction, congestive heart failure, and stroke.

§Pre-existing illness includes diabetes mellitus, Parkinson's disease, dementia, chronic obstructive pulmonary disease, non-skin cancer, osteoarthritis, and cardiovascular disease.

SD = standard deviation; GDS=Geriatric Depression Scale

Table 2

Age-adjusted Rates* (95% Confidence Interval) of Total and Cause-Specific Mortality by Napping Status

	Napped Daily	Did Not Nap Daily
All-cause mortality	61.2 (54.3 – 68.1)	31.4 (29.8 – 33.0)
Cardiovascular mortality	23.3 (19.2 – 27.4)	11.7 (10.8 – 12.7)
Cancer mortality	9.1 (6.3 – 11.8)	7.4 (6.7 – 8.2)
Other mortality	28.9 (24.1 – 33.7)	12.2 (11.3 – 13.2)

* per 1,000 Person-Years

Table 3

Daily Napping and Risk of Mortality

Type of Death	Overall Cohort (n = 8,101) HR (95% CI)*	Disease-free Cohort (n = 3,430) HR (95% CI)†	Pre-existing-illness Cohort (n = 4,665) HR (95% CI)†	p-value for daily napping*health status interaction
All-cause (n = 1,922)	1.44 (1.23–1.67)	1.67 (1.26–2.20)	1.35 (1.12–1.63)	.15
Cause-specific				
Cardiovascular (n = 723)	1.58 (1.25–2.00)	1.96 (1.26–3.06)	1.45 (1.10–1.93)	.19
Cancer (n = 423)	1.20 (0.83–1.75)	1.45 (0.75–2.81)	1.10 (0.70–1.73)	.45
Other causes (n = 776)	1.59 (1.24–2.03)	1.82 (1.19–2.78)	1.50 (1.11–2.02)	.53

*Adjusted for age; body mass index; history of at least one medical condition including diabetes mellitus, Parkinson's disease, dementia, chronic obstructive pulmonary disease, non-skin cancer, and osteoarthritis; history of cardiovascular disease; history of hypertension; walks for exercise; alcohol use; smoking status; depression; cognitive impairment; estrogen use; and benzodiazepine use (base model).

†Base model minus history of at least one medical condition and history of cardiovascular disease.

HR = hazard ratio; CI = confidence interval.

Table 4

Nightly Sleep Duration and Risk of Mortality, Stratified on Daily Napping

Type of Death	Nightly Sleep Duration (hours)	Hazard Ratio (95% Confidence Interval) compared to 6–8 hours nightly sleep duration (referent group)*			p-value†
		Overall Cohort	Did Not Nap Daily	Napped Daily	
All-cause	< 6	1.02 (0.87–1.19)	0.91 (0.76–1.09)	1.41 (1.00–1.98)	.03
	> 8	1.16 (0.97–1.39)	1.12 (0.92–1.36)	1.29 (0.83–2.02)	.53
Cause-specific					
Cardiovascular	< 6	1.03 (0.80–1.31)	0.89 (0.67–1.19)	1.55 (0.91–2.63)	.10
	> 8	1.21 (0.92–1.61)	1.06 (0.76–1.47)	2.05 (1.10–3.83)	.15
Other	< 6	0.91 (0.69–1.19)	0.71 (0.51–0.99)	1.56 (0.93–2.60)	.006
	> 8	1.10 (0.82–1.48)	1.16 (0.85–1.60)	0.64 (0.28–1.47)	.35

*Adjusted for age; body mass index; history of at least one medical condition including diabetes mellitus, Parkinson's disease, dementia, chronic obstructive pulmonary disease, non-skin cancer, and osteoarthritis; history of cardiovascular disease; history of hypertension; walks for exercise; alcohol use; smoking status; depression; cognitive impairment; estrogen use; and benzodiazepine use.

†p-value for daily napping * nightly sleep duration interaction.

Table 5

Total 24-Hour Sleep Duration and Risk of Mortality, Stratified on Daily Napping

Type of Death	Total 24-Hour Sleep Duration (hours)	Hazard Ratio (95% Confidence Interval)* compared to 8 to < 9 hours 24-hour sleep duration (referent group)			
		Overall Cohort	Did Not Nap Daily	Napped Daily	p-value†
All-cause	< 6	0.95 (0.76–1.18)	0.90 (0.71–1.14)	2.03 (0.93–4.42)	.08
	6 to < 8	1.07 (0.94–1.22)	1.03 (0.90–1.19)	1.58 (1.01–2.46)	.06
	9 to <10	1.28 (1.08–1.52)	1.17 (0.96–1.43)	1.46 (0.97–2.21)	.24
	≥ 10	1.58 (1.27–1.95)	1.51 (1.15–1.99)	1.58 (1.02–2.44)	.83
Cause-specific					
Cardiovascular	< 6	0.90 (0.63–1.29)	0.85 (0.59–1.24)	1.75 (0.39–7.89)	.49
	6 to < 8	1.05 (0.84–1.30)	0.98 (0.78–1.22)	1.98 (0.97–4.02)	.04
	9 to <10	1.52 (1.16–2.00)	1.31 (0.96–1.80)	1.95 (1.01–3.77)	.12
	≥ 10	1.77 (1.28–2.45)	1.52 (0.99–2.33)	2.36 (1.20–4.66)	.35
Other	< 6	0.81 (0.54–1.21)	0.72 (0.47–1.11)	2.64 (0.84–8.26)	.04
	6 to < 8	1.16 (0.94–1.44)	1.09 (0.87–1.37)	2.20 (1.08–4.46)	.03
	9 to <10	1.34 (1.00–1.79)	1.19 (0.86–1.66)	1.61 (0.81–3.21)	.30
	≥ 10	1.71 (1.22–2.41)	1.69 (1.09–2.63)	1.64 (0.80–3.39)	.87

*Adjusted for age; body mass index; history of at least one medical condition including diabetes mellitus, Parkinson's disease, dementia, chronic obstructive pulmonary disease, non-skin cancer, and osteoarthritis; history of cardiovascular disease; history of hypertension; walks for exercise; alcohol use; smoking status; depression; cognitive impairment; estrogen use; and benzodiazepine use.

†p-value for daily napping * total 24-hour sleep duration interaction.