

Age and Sleep Disturbances Among American Men And Women: Data From the U.S. Behavioral Risk Factor Surveillance System

Michael A. Grandner, PhD^{1,2}; Jennifer L. Martin, PhD, CBSM^{3,4}; Nirav P. Patel, MD, MPH⁵; Nicholas J. Jackson, MPH^{1,2}; Philip R. Gehrman, PhD, CBSM^{1,6}; Grace Pien, MD, MSCE^{1,2,7}; Michael L. Perlis, PhD^{1,6}; Dawei Xie, PhD⁸; Daohang Sha, PhD⁹; Terri Weaver, PhD⁹; Nalaka S. Gooneratne, MD, MSc^{1,10}

¹Center for Sleep and Circadian Neurobiology, University of Pennsylvania, Philadelphia, PA; ²Division of Sleep Medicine, Department of Medicine, University of Pennsylvania, Philadelphia, PA; ³David Geffen School of Medicine, University of California, Los Angeles, CA; ⁴Geriatric Research, Education and Clinical Center, VA Greater Los Angeles Healthcare System, Los Angeles, CA; ⁵Respiratory Specialists and The Reading Hospital and Medical Center; ⁶Division of Pulmonary and Critical Care Medicine, Department of Medicine, University of Pennsylvania, Philadelphia, PA; ⁷Department of Psychiatry, University of Pennsylvania, Philadelphia, PA; ⁸Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania, Philadelphia, PA; ⁹Biobehavioral and Health Science Department, University of Illinois at Chicago College of Nursing, Chicago, IL; ¹⁰Division of Geriatric Medicine, Department of Medicine, University of Pennsylvania, Philadelphia, PA

Study Objective: Explore the prevalence of sleep-related complaints across age groups, examining effects of sex, general health, and depressed mood.

Design: Cross-sectional analysis of data from the 2006 Behavioral Risk Factor Surveillance System (BRFSS).

Setting: Epidemiologic.

Participants: Complete-case analysis included 155,877 participants who responded to questions related to Self-Reported Sleep Disturbance (SLEEPDIST) and Self-Reported Tiredness/Lack of Energy (TIREDNESS).

Interventions: None.

Measurements and Results: Outcomes were self-reported complaints in response to survey questions assessing SLEEPDIST and TIREDNESS, dichotomized as reporting a complaint < 6 versus ≥ 6 nights or days, respectively, in a 2-wk period. Predictors were age, general health, and depressed mood. All analyses were adjusted for race/ethnicity, income, education, and time since last medical checkup. Across all age groups, women reported more SLEEPDIST and TIREDNESS. Poor general health, mild depressed mood, and moderate/severe depressed mood were associated with SLEEPDIST and TIREDNESS. Both SLEEPDIST and TIREDNESS generally declined across the life span, with fewest endorsements in respondents older than 80 yr. For SLEEPDIST, odds ratios (ORs, reference = 80+) declined from age 18-54 yr, rose slightly, and then declined again after age 59 yr in men. The pattern was similar for women, except a more marked rise was noted from age 40-59 yr. The pattern was similar for TIREDNESS.

Conclusions: Advancing age was not associated with increased Self-Reported Sleep Disturbance or Self-Reported Tiredness/Lack of Energy. These results suggest that the often-reported increase in sleep problems with age is a nonlinear phenomenon, mediated by factors other than physiologic aging.

Keywords: Aging, sleep quality, fatigue, epidemiology, depression

Citation: Grandner MA; Martin JL; Patel NP; Jackson NJ; Gehrman PR; Pien G; Perlis ML; Xie D; Sha D; Weaver T; Gooneratne NS. Age and sleep disturbances among American men and women: data from the U.S. behavioral risk factor surveillance system. *SLEEP* 2012;35(3):395-406.

INTRODUCTION

Multiple epidemiologic studies have shown that sleep-related complaints and daytime sleepiness are more common among older men and women in comparison with their younger counterparts.¹⁻⁴ Others have found, however, that sleep complaints may not necessarily be more prevalent, especially in healthy older adults. The discrepancy among studies examining sleep in the elderly represents a controversy as to the nature of sleep problems associated with aging.⁵⁻⁷ In addition, less is known about the differences between men and women in terms of the trajectory of sleep changes across the life span.

Several epidemiologic studies have explored sleep complaints in older adults. Weyerer and Dilling⁸ found that women reported more insomnia across all age groups and that advanc-

ing age was associated with increasing insomnia complaints: 1.3% in the 15-19 yr age group versus 27.0% in the age group older than 70 yr. Similarly, Foley and colleagues⁹ found that among 9,282 individuals age 65 yr or older, more than 50% reported sleep disturbances. More recently, Morphy and colleagues¹⁰ expanded this finding to show that older adults (age ≥ 65 yr) were more likely to report insomnia symptoms relative to younger adults (age 18-35 yr), with 65% of older adults and 43% of younger adults reporting insomnia symptoms.

In a large study (n = 35,327) of adults in 10 countries, Soldatos and colleagues¹ found that adults older than 65 yr reported similar rates of “poor overall sleep quality” and “poor sense of well-being during the day” compared with those younger than 65 yr, but older adults reported significantly higher rates of “trouble falling asleep,” “trouble staying asleep,” “early morning awakenings,” “problems with daytime functioning,” and “daytime sleepiness.” This study did not explore differences between men and women in terms of these reported symptoms. The increased prevalence of sleep complaints may in part be due to higher rates of primary sleep disorders, with several studies showing that primary sleep disorders, including sleep apnea¹¹ and insomnia,¹² increase with age.

In addition to an increase in sleep disorders, considerable evidence demonstrates that age is associated with significant

Submitted for publication August, 2010

Submitted in final revised form September, 2011

Accepted for publication October, 2011

Address correspondence to: Michael A. Grandner, PhD, Center for Sleep and Circadian Neurobiology, Department of Medicine, Division of Sleep Medicine, University of Pennsylvania, 3624 Market Street, Suite 205, Philadelphia, PA 19104, Tel: (215) 615-1756, Fax: (215) 746-4814, Grandner@upenn.edu

changes in numerous objective sleep parameters¹³. Many of these age-related changes were summarized in a meta-analysis of 65 polysomnographic studies, representing 3,577 subjects age 5-102 years.¹³ This landmark study found that total sleep time generally decreased with age, at the rate of approximately 10 min of sleep per decade. Decreases in slow-wave sleep occurred at the rate of approximately 2% per decade coupled with a decrease in sleep efficiency at the rate of approximately 3% per decade after age 40 yr. These findings clearly show that polysomnographic sleep is notably worse in old age than in younger adulthood, with the exception that some variables, such as sleep latency, were high until approximately age 30 yr.

These findings stand in contrast to several studies that show that healthy older adults may not subjectively think that their sleep pattern is problematic. Buysse and colleagues found that in healthy older adults, most (68%) had subjective sleep quality ratings in the "good sleeper" range.¹⁴ Vitiello and colleagues found that older research subjects without medical or psychiatric problems were unlikely to exhibit sleep problems.⁵ Zilli and colleagues compared satisfaction with sleep among young and elderly subjects.¹⁵ Elderly men and women reported greater satisfaction with their sleep in comparison with younger adults. These findings suggest that there are age-related differences in the internal metrics that an individual uses to assess sleep quality. Comorbid medical illnesses and mood disorders such as depression have also been postulated to significantly influence the prevalence of insomnia symptoms as a function of age.^{6,16,17}

The current study uses one of the largest recent surveys to assess sleep complaints among US adults: the 2006 Behavioral Risk Factor Surveillance System (BRFSS).¹⁸ We hypothesized that sleep complaints and daytime fatigue would increase in prevalence across age groups even when adjusting for known risk factors for sleep disturbance, including demographic and socioeconomic factors, general health, and depressed mood; and sleep complaints and daytime tiredness would be more common among women than men. Understanding the age-related prevalence of sleep complaints when controlling for general health and other factors is crucial for assessing the potential etiology and public health effect of these symptoms.

METHODS

Data Source

Data from the BRFSS¹⁸ were used for this analysis. The BRFSS is an annual, state-based, random-digit-dialed telephone interview survey of adults age ≥ 18 yr from all over the United States. It is the world's largest telephone survey, designed to monitor health-related behaviors in the general population. The overall response rate (completed interviews relative to total eligible households) varied across states, with a mean of 41.1%, median of 40.5%, and range of 20.5% (Georgia) to 72.5% (Puerto Rico). The completion rate (number of interviews completed relative to the number of interviews completed, terminated, and/or refused) also varied across states, with a mean and median of 78.1%, and a range of 66.3% (California) to 92.5% (Puerto Rico). Of those who completed interviews, > 98% of respondents completed the Self-Reported Sleep Disturbance (SLEEPDIST) and Self-Reported Tiredness/Lack of

Energy (TIREDNESS) items, suggesting that the current data accurately represent the sample selected for study.

The sample selected for the BRFSS study has a high likelihood of being representative of the general population. One potential criticism is that the 2006 BRFSS used landline telephone numbers for sampling. However, those without landline telephones do not appear to differ on dimensions relevant to public health estimates.¹⁹ In addition, the validity profile of the BRFSS is similar to other, widely published national surveys such as the National Health and Nutrition Examination Survey.²⁰ Furthermore, to increase generalizability of results, each participant was assigned a weight (described in the next paragraph) to be used in analysis. Thus, even though the sample is, by the nature of the sampling scheme, not representative of the general population, all analyses are adjusted so that biases in the sample do not contaminate results.

The process of determining participant weighting is discussed in more detail in the BRFSS documentation.^{21,22} In brief, each weight is calculated using a combination of (1) a weight that accounts for differences in the basic probability of selection among subsets of regions delineated by combinations of area code and telephone prefix; (2) a weight that adjusts for noncoverage and nonresponse, forcing the sum of all weighted frequencies to equal population estimates for that region, based on age, sex, and race/ethnicity; (3) the number of residential telephone lines in the participant's home; and (4) the number of adults in the participant's household. Thus, although the aggregated sample is not absolutely representative of the general population, each participant's weight is intended to maximize generalizability, accounting for any noncoverage and/or nonresponse based on geographic region, as well as sociodemographic categories of age, sex, and ethnicity.

Participants were respondents who had answered a question regarding SLEEPDIST: "Over the last 2 weeks, how many days have you had trouble falling asleep or staying asleep or sleeping too much?" and who answered the question, "Over the last 2 weeks, how many days have you felt tired or had little energy?" Answers for both questions ranged from 0-14 days. However, the distributions were bimodal, with peaks at 0 and 14 days. Thus, SLEEPDIST and TIREDNESS were dichotomized into those respondents who report complaints ≥ 6 days and those who report complaints < 6 days. This finding is consistent with other classification approaches where a frequency of 3 or more events per wk has been used to denote abnormality.²³

Covariates used to adjust for socioeconomic factors included race/ethnicity (White, Black/African American, Hispanic/Latino, Asian/Other and Multiracial), education (less than high school, high school graduate, some college, college graduate) and income level ($< \$10,000$ pretax income per yr, \$10,000-\$15,000, \$15,000-\$20,000, \$20,000-\$25,000, \$25,000-\$35,000, \$35,000-\$50,000, \$50,000-\$75,000, $> \$75,000$). Previous analyses have found that race/ethnicity, education, and income level are significant predictors of sleep complaint in this sample.²⁴ General health factors adjusted for in analyses included overall health (excellent, very good, good, fair, poor) and time since last checkup (within the past yr, within the past 2 yr, within the past 5 yr, 5 or more yr ago, never). General health rather than specific medical conditions was included because specific medical conditions may not capture an individual's entire health burden.

Time since last checkup was used to provide information related to access to health care. Depressed mood was measured with the item, "Over the last 2 weeks, how many days have you felt down or depressed?" which was categorized as none (0 days), mild (< 6 days) and moderate/severe (≥ 6 days).

Statistical Analyses

Complete-case analysis was implemented for both SLEEPDIST and TIREDNESS; thus, only participants who provided complete data were included for each analysis. Correlation between SLEEPDIST and TIREDNESS was evaluated using Pearson r (examining the variables as continuous, because responses were distributed similarly), as well as θ (examining the variables as dichotomous).

To explore bias in the sample not accounted for by the weighting procedures, we examined differences between survey respondents who were included in analyses and those who did not respond to either the SLEEPDIST or TIREDNESS items. Given the large sample size, we assert that if, in every cell, $\leq 5\%$ of respondents were missing SLEEPDIST and/or TIREDNESS responses, we would consider there to be no notable bias in reporting.

A significant age/sex interaction was present for SLEEPDIST ($P = 0.076$ for Model 1, $P = 0.001$ for Model 2, and $P = 0.001$ for Model 3), as well as TIREDNESS ($P < 0.001$ for Model 1, $P < 0.0001$ for Model 2, and $P < 0.0001$ for Model 3). Thus, all Model 2 and Model 3 analyses were stratified by sex. Percentages of respondents indicating SLEEPDIST and TIREDNESS across variables were calculated and differences among groups were compared using Rao-Scott chi-square tests as implemented in SAS software²⁵ with the PROC SURVEYFREQ procedure. Data were also reviewed graphically to assess distribution and relationship to sleep disturbance.

The logit of odds of the categorical SLEEPDIST and TIREDNESS was modeled using a generalized linear model for each individual variable and all combined variables for all respondents and separated by sex. All sampling was weighted appropriately for representativeness, using weighting scores specifically developed for BRFSS 2006.¹⁸ The odds ratios (ORs) and 95% confidence intervals (CIs) were estimated among groups relative to a preselected reference. These analyses were performed using SAS software²⁵ with the PROC SURVEYLOGISTIC procedure (SAS, Cary, NC). All statistical tests were 2-tailed. Statistical significance was set at the $P < 0.05$ level unless otherwise indicated. The reference for the age variable was the group of individuals age 80 yr or older. This group was chosen because our hypothesis stated that these individuals would demonstrate the highest prevalence of complaints. As the reference group, this question can be evaluated. Other variables studied included education (reference = college graduate), income (reference = $> \$75,000/\text{yr}$), race/ethnicity (separate dichotomous variables for each group), general health (reference = excellent), time since last medical checkup (reference = never), and depressed mood (reference = none). A total of three separate models were tested: (1) age; (2) age + covariates (race/ethnicity, income, education) + health (general health, time since last medical checkup); and (3) age + covariates (race/ethnicity, income, education) + health (general health, time since last medical checkup) + depressed mood. These models were chosen to examine age alone

and age relative to covariates and health variables, with and without depressed mood. Models were assessed with and without depressed mood because depressed mood is known to vary with age²⁶ and is known to be associated (often causally) with sleep disturbance and daytime tiredness.^{17,27,28} Because this variable accounts for such a large portion of the variance of both of our outcomes of interest, including it in analyses may be an issue of "overcontrolling," or understating the contributions of other predictors. In order to account for this issue, we provide two models for the reader to consider, with and without depression.

RESULTS

Sample Characteristics

A total of 155,877 participants provided complete data for the SLEEPDIST and TIREDNESS analyses. Characteristics of the samples are reported in Table S1, which reports both the raw (unweighted) sample characteristics that describe the actual respondents as well as the weighted sample characteristics that represent the statistical analyses. The following states/territories were represented: Alabama, Alaska, Arkansas, California, Delaware, District of Columbia, Florida, Georgia, Hawaii, Indiana, Iowa, Louisiana, Maine, Michigan, Minnesota, Mississippi, Missouri, Montana, Nevada, New Hampshire, New Mexico, North Dakota, Oklahoma, Oregon, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, West Virginia, Wisconsin, Wyoming, Puerto Rico, and the Virgin Islands.

To explore potential nonresponse bias related to SLEEPDIST and TIREDNESS items, we compared subjects who did not respond to at least one of these items with subjects who provided complete data. Comparison of age and demographic, socioeconomic, and health covariates in those who did and did not respond to sleep items is presented in Table S2. Overall, only 1.89% did not respond. All age groups were well represented, ranging from 0.41% missing in the group age 25-29 yr to 4.88% missing in the group older than 80 yr. Among covariates, rates of nonresponse to sleep-related items was low, with the highest (2.23%) among those in the \$10,000-\$15,000/yr income category. Response to sleep-related items by state is reported in Table S3. Values representing percent nonresponse to SLEEPDIST and TIREDNESS items ranged from 0.31% (Delaware) to 2.54% (Louisiana).

Prevalence of Sleep Disturbance and Daytime Tiredness

For both SLEEPDIST (Figure 1A) and TIREDNESS (Figure 1B), women reported more complaints than men in all age groups. For SLEEPDIST, the highest prevalence of complaints was in the youngest group (18-24 yr) and the lowest prevalence of complaints in the oldest groups (older than 80 yr for women and 70-74 yr in men). For TIREDNESS, a different pattern was noted. In those younger than 70 yr, the highest rate of complaints was in the youngest group (18-24 yr) and the lowest rate of complaints was in the group age 65-69 yr. A different pattern was noted at age 70 yr and older: both men and women saw a sharp increase in complaints.

Regression Results

Results of adjusted analyses are reported in Tables 1 and 2 for both SLEEPDIST and TIREDNESS. Table 1 reports results from Model 2 (age, covariates, and health) whereas Table 2

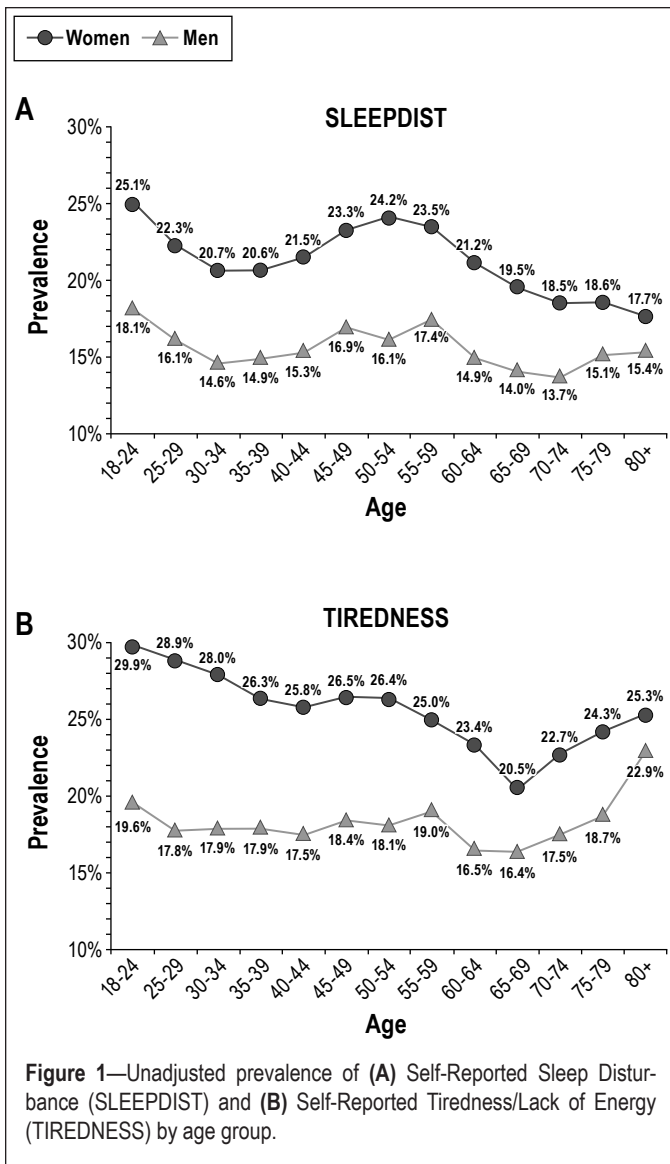


Figure 1—Unadjusted prevalence of (A) Self-Reported Sleep Disturbance (SLEEPDIST) and (B) Self-Reported Tiredness/Lack of Energy (TIREDNESS) by age group.

reports results from Model 3 (age, covariates, health, and depressed mood). Figure 2 displays the ORs for age in Model 2 and Figure 3 shows the results of Model 3. Table 3 displays sex differences by age group in Models 2 and 3, and these results are also integrated into Figures 2 and 3. Figure 4 shows the ORs for general health and Figure 5 shows the ORs for depressed mood for both SLEEPDIST and TIREDNESS (both Figures 4 and 5 report ORs from Model 3 only).

Age

In Model 2 (without depressed mood), almost all age groups demonstrated increased likelihood of SLEEPDIST and TIREDNESS, relative to the age group older than 80 yr, and no age group demonstrated decreased likelihood relative to the age group older than 80 yr. For both outcomes, in both men and women, the oldest age groups did not differ from the age group older than 80 yr. Figure 2 highlights the differential pattern of SLEEPDIST (Figure 2A) ORs for women compared with men. These results are consonant with findings for TIREDNESS (Figure 2B).

In Model 3 (fully-adjusted model with depressed mood), the distributions of SLEEPDIST and TIREDNESS were markedly altered relative to Model 2 for men and, to a lesser extent,

women (Table 2). In men, the youngest age groups (18-39 yr) reported more SLEEPDIST than the group older than 80 yr, but other age groups did not differ. Among women, participants age 18-59 yr reported more SLEEPDIST than those older than 80 yr, whereas older groups did not differ. For TIREDNESS, in men, participants age 18-24 yr were more likely to report TIREDNESS, relative to those older than 80 yr. For women, groups age 18-54 yr were more likely to report TIREDNESS. For both outcomes, in both men and women, no age group was less likely to report complaint than those older than 80 yr. These results are displayed graphically in Figure 3A (SLEEPDIST) and B (TIREDNESS).

Sex

Sex differences within each age group are reported in Table 3 and displayed in Figure 2A and Figure 3A for SLEEPDIST and Figure 2B and Figure 3B for TIREDNESS. In both models, men and women differed in their reports of both SLEEPDIST and TIREDNESS for most age groups.

General health

The data presented in Table 1 show that self-reported general health rating is associated with level of SLEEPDIST and TIREDNESS, after adjustment for demographic, socioeconomic, and health covariates. With the inclusion of depressed mood in Model 3 (Table 2), the magnitude of these relationships decreases (especially for those in the poorest health), although the overall pattern remained consistent. Overall, better general health was associated with fewer sleep-related complaints, independent of age and other factors. Figure 4 represents these ORs against a logarithmic scale.

Time since last checkup

The data presented in Tables 1 and 2 show that for women, a more recent doctor visit was associated with decreased SLEEPDIST and TIREDNESS. For men, there was no relationship in either model between time since last checkup and either SLEEPDIST or TIREDNESS.

Depressed mood

Depressed mood was a significant factor in reports of SLEEPDIST and TIREDNESS. Adjusted for age and other factors, mild depressed mood (< 3 days/wk) was associated with more than double the likelihood of reporting SLEEPDIST and TIREDNESS in men and women, relative to those with no depressed mood. Those with moderate/severe depressed mood (≥ 3 days/wk) were much more likely to report SLEEPDIST and TIREDNESS. Women in this group were 12.81 times as likely to report SLEEPDIST and 16.36 times as likely to report TIREDNESS; similarly, men were 16.00 times as likely to report SLEEPDIST and 16.69 times as likely to report TIREDNESS.

Correlation Between SLEEPDIST and TIREDNESS

Because the pattern of findings for SLEEPDIST and TIREDNESS were so similar, we explored whether these two variables were measuring the same construct. When the variables were compared, 30% of the sample reported SLEEPDIST, TIREDNESS, or both. Of those that reported SLEEPDIST, 63% also

Table 1—Adjusted^a odds ratios and 95% confidence intervals for Self-Reported Sleep Disturbance and Tiredness/Lack of Energy

	SLEEPDIST						TIREDNESS					
	Women			Men			Women			Men		
	OR	(95% CI)	P	OR	(95% CI)	P	OR	(95% CI)	P	OR	(95% CI)	P
Age (in yr)												
18-24	2.61	(2.08-3.29)	< 0.0001	3.04	(2.27-4.07)	< 0.0001	2.62	(2.11-3.26)	< 0.0001	1.96	(1.48-2.60)	< 0.0001
25-29	2.62	(2.10-3.25)	< 0.0001	2.15	(1.62-2.86)	< 0.0001	2.91	(2.37-3.57)	< 0.0001	1.58	(1.21-2.07)	0.0009
30-34	2.25	(1.81-2.78)	< 0.0001	1.94	(1.48-2.55)	< 0.0001	2.98	(2.45-3.64)	< 0.0001	1.71	(1.32-2.20)	< 0.0001
35-39	2.16	(1.75-2.66)	< 0.0001	1.81	(1.39-2.35)	< 0.0001	2.48	(2.04-3.01)	< 0.0001	1.70	(1.31-2.21)	0.0001
40-44	2.25	(1.84-2.76)	< 0.0001	1.76	(1.37-2.26)	< 0.0001	2.07	(1.71-2.51)	< 0.0001	1.49	(1.16-1.91)	0.0017
45-49	2.42	(1.98-2.96)	< 0.0001	1.68	(1.31-2.14)	< 0.0001	2.19	(1.81-2.66)	< 0.0001	1.29	(1.02-1.63)	0.0339
50-54	2.41	(1.97-2.95)	< 0.0001	1.62	(1.27-2.08)	0.0001	2.10	(1.73-2.53)	< 0.0001	1.19	(0.94-1.51)	0.1478
55-59	2.23	(1.82-2.74)	< 0.0001	1.76	(1.38-2.25)	< 0.0001	1.63	(1.35-1.98)	< 0.0001	1.28	(1.01-1.64)	0.0442
60-64	1.61	(1.31-1.97)	< 0.0001	1.35	(1.04-1.76)	0.0261	1.28	(1.06-1.56)	0.0120	1.01	(0.77-1.31)	0.9657
65-69	1.50	(1.21-1.87)	0.0002	1.19	(0.92-1.53)	0.1898	1.02	(0.83-1.24)	0.8561	0.88	(0.68-1.12)	0.2955
70-74	1.11	(0.90-1.36)	0.3438	1.09	(0.83-1.44)	0.5447	1.09	(0.89-1.33)	0.4098	0.99	(0.75-1.30)	0.9298
75-79	1.06	(0.84-1.33)	0.6242	1.19	(0.89-1.61)	0.2447	1.10	(0.89-1.36)	0.3798	0.80	(0.61-1.05)	0.1125
80+	Reference			Reference			Reference			Reference		
Income												
< \$10,000	1.65	(1.39-1.98)	< 0.0001	2.51	(1.91-3.31)	< 0.0001	1.67	(1.39-2.03)	< 0.0001	1.78	(1.38-2.29)	< 0.0001
\$10,000-\$15,000	1.71	(1.44-2.03)	< 0.0001	1.77	(1.36-2.31)	< 0.0001	1.72	(1.43-2.06)	< 0.0001	1.89	(1.45-2.47)	< 0.0001
\$15,000-\$20,000	1.64	(1.39-1.93)	< 0.0001	1.55	(1.24-1.94)	0.0001	1.57	(1.33-1.86)	< 0.0001	1.55	(1.25-1.92)	0.0001
\$20,000-\$25,000	1.47	(1.26-1.71)	< 0.0001	1.50	(1.22-1.84)	0.0001	1.45	(1.25-1.68)	< 0.0001	1.50	(1.24-1.81)	< 0.0001
\$25,000-\$35,000	1.32	(1.15-1.52)	0.0001	1.41	(1.15-1.72)	0.0008	1.40	(1.22-1.61)	< 0.0001	1.40	(1.17-1.69)	0.0003
\$35,000-\$50,000	1.25	(1.09-1.42)	0.0011	1.20	(1.00-1.42)	0.0440	1.32	(1.16-1.50)	< 0.0001	1.28	(1.10-1.49)	0.0018
\$50,000-\$75,000	1.10	(0.97-1.24)	0.1398	1.03	(0.87-1.22)	0.7428	1.16	(1.03-1.32)	0.0162	1.19	(1.01-1.39)	0.0357
\$75,000 +	Reference			Reference			Reference			Reference		
Education												
Less than high school	1.11	(0.96-1.28)	0.1720	0.92	(0.74-1.13)	0.4282	1.01	(0.88-1.17)	0.8867	0.98	(0.80-1.19)	0.8142
High School	1.18	(1.07-1.31)	0.0013	1.09	(0.94-1.26)	0.2401	0.99	(0.90-1.08)	0.7640	1.23	(1.08-1.40)	0.0014
Some college	1.25	(1.13-1.37)	< 0.0001	1.11	(0.97-1.28)	0.1369	1.19	(1.08-1.30)	0.0003	1.18	(1.04-1.35)	0.0097
College graduate	Reference			Reference			Reference			Reference		
Race/ethnicity												
White	Reference			Reference			Reference			Reference		
Black/African American	0.71	(0.64-0.80)	< 0.0001	0.77	(0.65-0.91)	0.0026	0.82	(0.73-0.91)	0.0003	0.73	(0.62-0.86)	0.0002
Hispanic/Latino	0.53	(0.46-0.61)	< 0.0001	0.50	(0.40-0.62)	< 0.0001	0.46	(0.40-0.53)	< 0.0001	0.38	(0.31-0.47)	< 0.0001
Asian/Other	0.66	(0.56-0.79)	< 0.0001	0.77	(0.60-0.98)	0.0373	0.73	(0.60-0.89)	0.0014	0.74	(0.59-0.93)	0.0112
Multiracial	1.48	(1.17-1.86)	0.0011	1.44	(1.03-2.01)	0.0320	1.12	(0.89-1.41)	0.3242	1.08	(0.79-1.48)	0.6196
General health												
Excellent	Reference			Reference			Reference			Reference		
Very good	1.28	(1.14-1.44)	< 0.0001	1.41	(1.18-1.69)	0.0002	1.37	(1.22-1.54)	< 0.0001	1.34	(1.12-1.59)	0.0010
Good	2.15	(1.91-2.42)	< 0.0001	2.15	(1.81-2.56)	< 0.0001	2.61	(2.31-2.95)	< 0.0001	2.29	(1.93-2.71)	< 0.0001
Fair	4.41	(3.87-5.02)	< 0.0001	3.91	(3.22-4.76)	< 0.0001	6.36	(5.55-7.29)	< 0.0001	4.95	(4.09-5.99)	< 0.0001
Poor	8.58	(7.27-10.12)	< 0.0001	10.56	(8.37-13.32)	< 0.0001	17.89	(14.86-21.55)	< 0.0001	17.90	(14.09-22.74)	< 0.0001
Time since last checkup												
Within the past yr	0.65	(0.48-0.88)	0.0057	1.09	(0.62-1.89)	0.7698	0.64	(0.48-0.86)	0.0026	0.79	(0.53-1.18)	0.2458
Within the past 2 yr	0.71	(0.51-0.97)	0.0336	0.93	(0.53-1.64)	0.8089	0.74	(0.55-1.00)	0.0527	0.73	(0.49-1.10)	0.1372
Within the past 5 yr	0.94	(0.68-1.31)	0.7147	0.99	(0.56-1.76)	0.9817	0.81	(0.59-1.11)	0.1823	0.78	(0.51-1.19)	0.2499
5 or more yr ago	1.01	(0.72-1.40)	0.9633	1.49	(0.84-2.64)	0.1692	0.94	(0.69-1.29)	0.7069	1.07	(0.70-1.63)	0.7530
Never	Reference			Reference			Reference			Reference		

^aModel includes race/ethnicity, income, education, age, general health, and time since last checkup (Model 2). CI, confidence interval; OR, odds ratio; SLEEPDIST, Self-Reported Sleep Disturbance; TIREDNESS, Tiredness/Lack of Energy.

reported TIREDNESS; conversely, of those who did not report SLEEPDIST, 87% also did not report TIREDNESS. Although there was a significant correlation between SLEEPDIST and

TIREDNESS ($\theta = 0.47$, Pearson $r = 0.32$, $P < 0.0001$), the overlap in variance (r^2) was only 10%. Thus, they represent two very different constructs that, although related, are not colinear.

Table 2—Fully-adjusted^a odds ratios and 95% confidence intervals for Self-Reported Sleep Disturbance and Tiredness/Lack of Energy

	SLEEPDIST						TIREDNESS					
	Women			Men			Women			Men		
	OR	(95% CI)	P	OR	(95% CI)	P	OR	(95% CI)	P	OR	(95% CI)	P
Age (in yr)												
18-24	1.61	(1.26-2.06)	0.0002	2.19	(1.58-3.05)	< 0.0001	1.64	(1.30-2.07)	< 0.0001	1.38	(1.00-1.89)	0.0467
25-29	1.67	(1.32-2.10)	< 0.0001	1.49	(1.09-2.04)	0.0124	1.93	(1.55-2.40)	< 0.0001	1.08	(0.79-1.48)	0.6103
30-34	1.41	(1.12-1.77)	0.0031	1.36	(1.01-1.84)	0.0451	2.00	(1.62-2.45)	< 0.0001	1.20	(0.90-1.60)	0.2135
35-39	1.32	(1.06-1.63)	0.0129	1.34	(1.01-1.78)	0.0430	1.57	(1.29-1.93)	< 0.0001	1.28	(0.96-1.71)	0.0941
40-44	1.39	(1.12-1.73)	0.0028	1.24	(0.93-1.63)	0.1396	1.30	(1.07-1.59)	0.0093	1.06	(0.80-1.40)	0.6945
45-49	1.55	(1.26-1.92)	< 0.0001	1.23	(0.93-1.63)	0.1448	1.42	(1.17-1.74)	0.0005	0.95	(0.72-1.24)	0.6875
50-54	1.58	(1.28-1.96)	< 0.0001	1.18	(0.88-1.58)	0.2784	1.38	(1.13-1.69)	0.0016	0.85	(0.65-1.11)	0.2382
55-59	1.51	(1.21-1.88)	0.0002	1.31	(0.99-1.73)	0.0578	1.08	(0.88-1.32)	0.4753	0.94	(0.72-1.24)	0.6740
60-64	1.20	(0.96-1.49)	0.1021	1.15	(0.85-1.55)	0.3603	0.95	(0.78-1.16)	0.5982	0.84	(0.62-1.15)	0.2744
65-69	1.26	(1.00-1.58)	0.0536	1.14	(0.87-1.51)	0.3416	0.83	(0.67-1.02)	0.0740	0.82	(0.63-1.08)	0.1667
70-74	1.02	(0.82-1.26)	0.8805	1.12	(0.83-1.51)	0.4673	1.01	(0.82-1.24)	0.9139	1.00	(0.74-1.36)	0.9789
75-79	0.93	(0.73-1.18)	0.5637	1.35	(0.98-1.85)	0.0678	0.97	(0.78-1.21)	0.8167	0.87	(0.65-1.17)	0.3550
80+	Reference			Reference			Reference			Reference		
Income												
< \$10,000	1.03	(0.85-1.25)	0.7669	1.61	(1.19-2.17)	0.0020	1.05	(0.85-1.29)	0.6773	1.05	(0.78-1.42)	0.7449
\$10,000-\$15,000	1.24	(1.03-1.50)	0.0242	1.28	(0.97-1.69)	0.0802	1.25	(1.03-1.52)	0.0209	1.41	(1.02-1.93)	0.0347
\$15,000-\$20,000	1.19	(1.00-1.42)	0.0444	1.24	(0.98-1.56)	0.0775	1.14	(0.96-1.36)	0.1449	1.23	(0.98-1.54)	0.0711
\$20,000-\$25,000	1.16	(0.99-1.36)	0.0675	1.18	(0.94-1.47)	0.1520	1.15	(0.98-1.34)	0.0939	1.19	(0.98-1.45)	0.0835
\$25,000-\$35,000	1.12	(0.97-1.29)	0.1195	1.21	(0.99-1.49)	0.0647	1.20	(1.04-1.38)	0.0119	1.21	(1.02-1.45)	0.0304
\$35,000-\$50,000	1.13	(0.98-1.29)	0.0861	1.12	(0.93-1.34)	0.2266	1.20	(1.05-1.37)	0.0062	1.21	(1.03-1.42)	0.0173
\$50,000-\$75,000	1.01	(0.89-1.15)	0.8669	1.02	(0.85-1.21)	0.8551	1.08	(0.96-1.22)	0.2131	1.19	(1.01-1.40)	0.0418
\$75,000 +	Reference			Reference			Reference			Reference		
Education												
Less than high school	1.02	(0.87-1.19)	0.8392	0.88	(0.71-1.11)	0.2894	0.92	(0.79-1.07)	0.2904	0.95	(0.77-1.16)	0.6107
High school	1.19	(1.07-1.32)	0.0012	1.08	(0.93-1.26)	0.3124	0.97	(0.88-1.07)	0.5624	1.25	(1.09-1.43)	0.0013
Some college	1.23	(1.12-1.36)	< 0.0001	1.08	(0.93-1.25)	0.3159	1.17	(1.06-1.29)	0.0013	1.16	(1.02-1.33)	0.0283
College graduate	Reference			Reference			Reference			Reference		
Race/ethnicity												
White	Reference			Reference			Reference			Reference		
Black/African American	0.70	(0.62-0.79)	< 0.0001	0.75	(0.61-0.91)	0.0036	0.81	(0.72-0.92)	0.0007	0.71	(0.59-0.85)	0.0003
Hispanic/Latino	0.51	(0.44-0.60)	< 0.0001	0.50	(0.40-0.63)	< 0.0001	0.43	(0.37-0.51)	< 0.0001	0.37	(0.30-0.46)	< 0.0001
Asian/other	0.65	(0.54-0.77)	< 0.0001	0.72	(0.57-0.91)	0.0057	0.72	(0.59-0.89)	0.0024	0.69	(0.53-0.90)	0.0067
Multiracial	1.41	(1.10-1.81)	0.0060	1.36	(0.95-1.94)	0.0965	1.02	(0.79-1.32)	0.8705	0.98	(0.68-1.42)	0.9323
General health												
Excellent	Reference			Reference			Reference			Reference		
Very good	1.18	(1.04-1.32)	0.0080	1.30	(1.08-1.56)	0.0065	1.26	(1.12-1.42)	0.0001	1.22	(1.02-1.45)	0.0317
Good	1.73	(1.53-1.96)	< 0.0001	1.73	(1.45-2.06)	< 0.0001	2.15	(1.90-2.44)	< 0.0001	1.85	(1.55-2.20)	< 0.0001
Fair	2.94	(2.56-3.39)	< 0.0001	2.62	(2.12-3.25)	< 0.0001	4.54	(3.93-5.24)	< 0.0001	3.48	(2.85-4.25)	< 0.0001
Poor	4.50	(3.76-5.38)	< 0.0001	5.01	(3.94-6.35)	< 0.0001	10.97	(8.94-13.46)	< 0.0001	9.83	(7.74-12.48)	< 0.0001
Time since last checkup												
Within the past yr	0.66	(0.48-0.91)	0.0122	1.00	(0.56-1.77)	0.9925	0.65	(0.48-0.88)	0.0049	0.69	(0.44-1.09)	0.1128
Within the past 2 yr	0.68	(0.49-0.96)	0.0266	0.89	(0.49-1.59)	0.6825	0.71	(0.52-0.97)	0.0340	0.67	(0.42-1.06)	0.0849
Within the past 5 yr	0.86	(0.60-1.22)	0.3860	0.91	(0.51-1.65)	0.7623	0.71	(0.51-0.98)	0.0379	0.70	(0.43-1.11)	0.1288
5 or more yr ago	0.96	(0.68-1.35)	0.8047	1.27	(0.71-2.29)	0.4178	0.87	(0.63-1.21)	0.4144	0.88	(0.55-1.40)	0.5806
Never	Reference			Reference			Reference			Reference		
Depressed mood												
None	Reference			Reference			Reference			Reference		
Mild	2.31	(2.12-2.51)	< 0.0001	2.60	(2.28-2.96)	< 0.0001	2.38	(2.20-2.58)	< 0.0001	2.50	(2.21-2.82)	< 0.0001
Moderate/severe	12.81	(11.12-14.75)	< 0.0001	16.00	(13.29-19.28)	< 0.0001	16.36	(14.06-19.02)	< 0.0001	16.69	(13.66-20.41)	< 0.0001

^aModel includes race/ethnicity, income, education, age, general health, time since last checkup, and depressed mood (Model 3). CI, confidence interval; OR, odds ratio; SLEEPDIST, Self-Reported Sleep Disturbance; TIREDNESS, Tiredness/Lack of Energy.

● Women ▲ Men

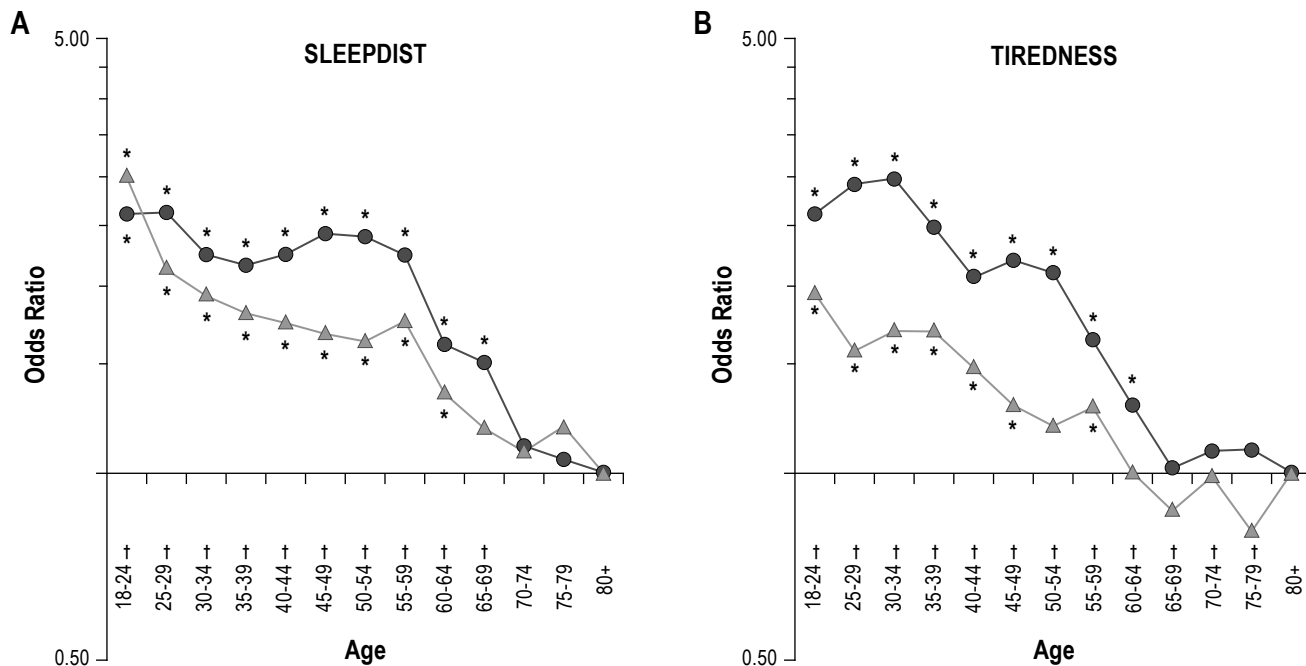


Figure 2—Adjusted^a odds ratios for (A) Self-Reported Sleep Disturbance (SLEEPDIST) and (B) Self-Reported Tiredness/Lack of Energy (TIREDDNESS) by age group (relative to 80+). ^aOdds ratio adjusted for race/ethnicity, income, education, general health, and time since last medical checkup (Model 2). *P < 0.05 versus 80+; †P < 0.05 sex difference.

Table 3—Odds ratios and 95% confidence intervals for differences in reports of sleep disturbance and daytime fatigue by sex, within age groups

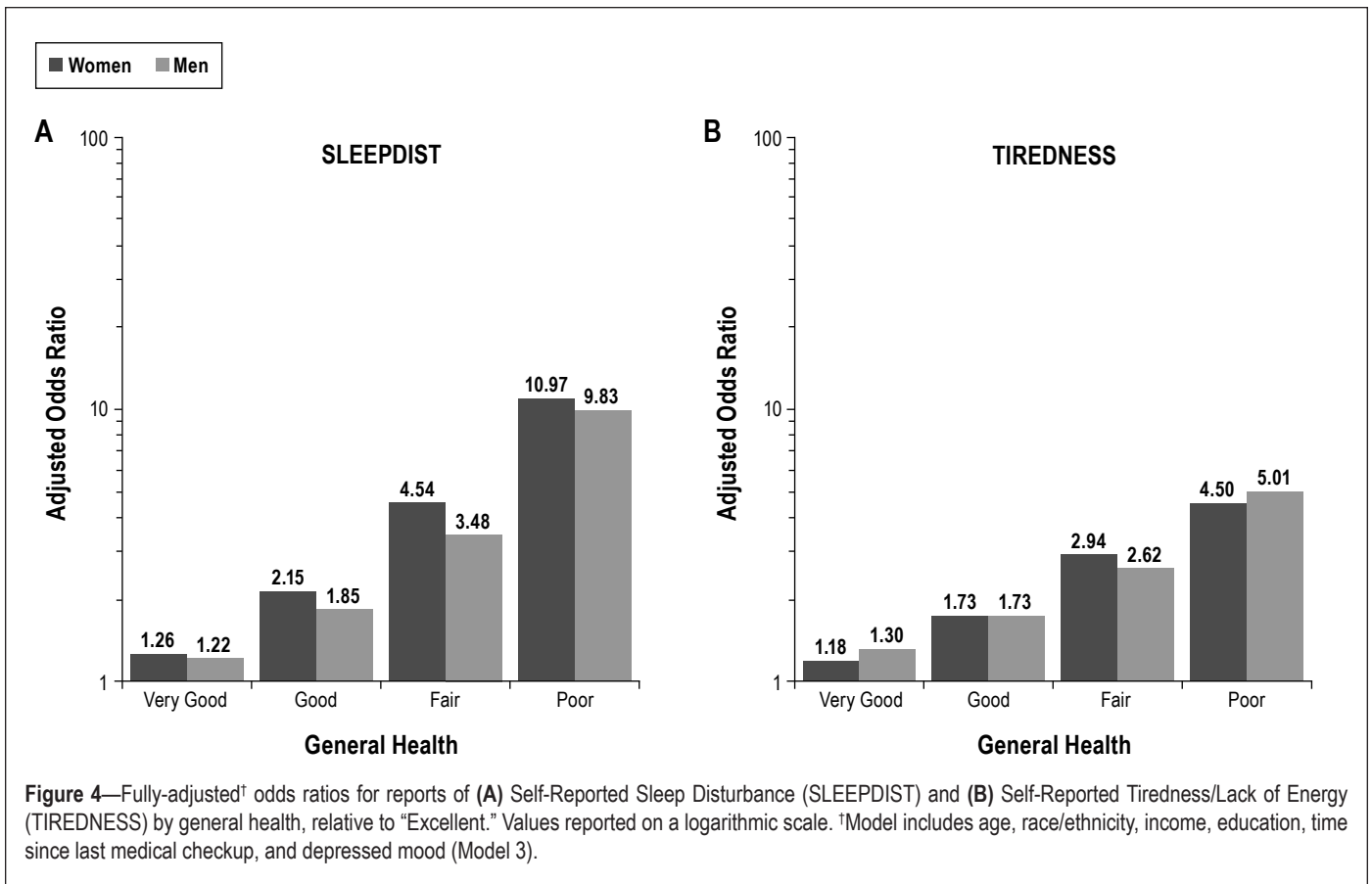
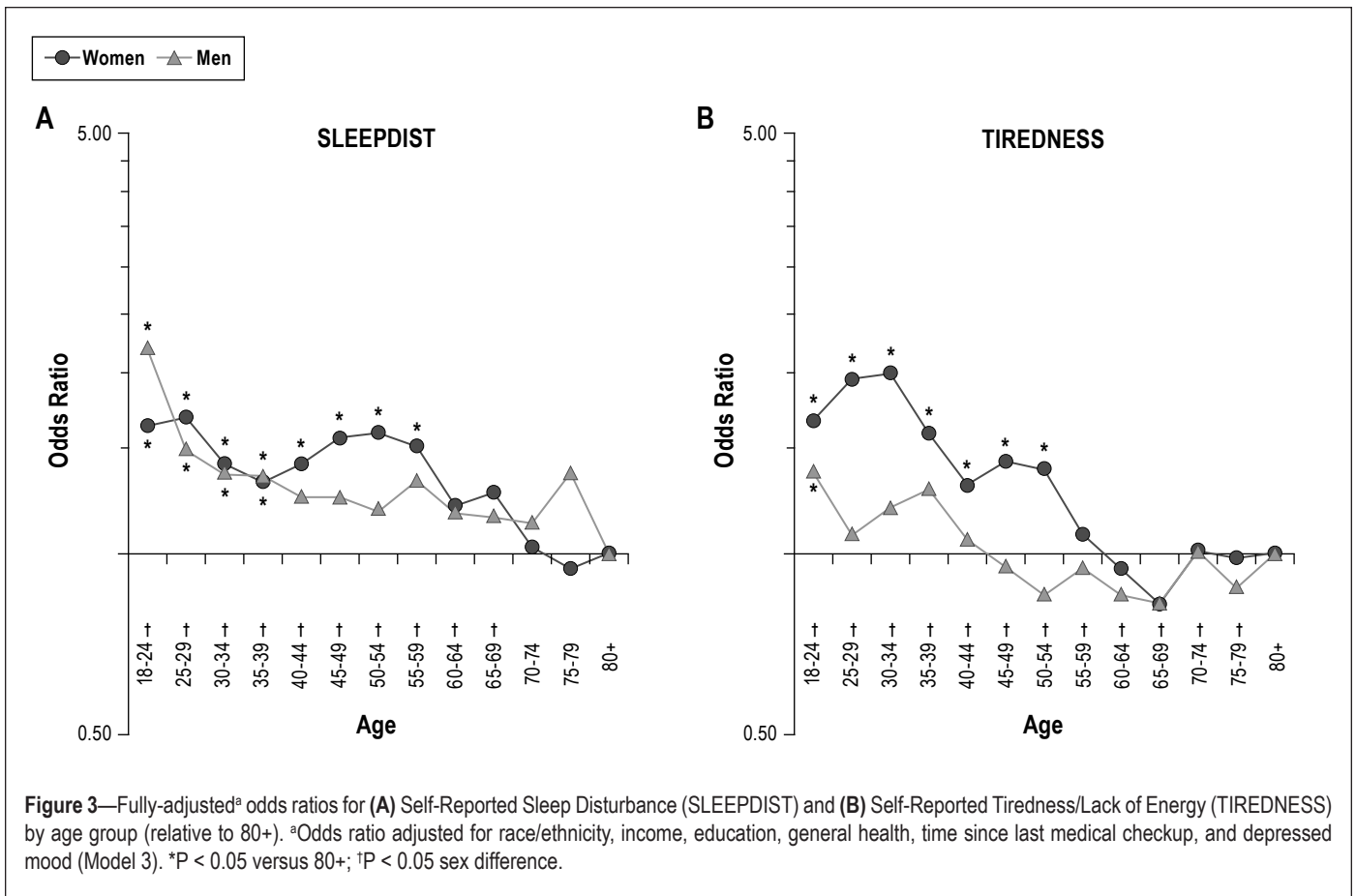
Age group (in yr)	Model 2 ^a Ref = Male				Model 3 ^b Ref = Male			
	Sleep disturbance		Daytime tiredness		Sleep disturbance		Daytime tiredness	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
18-24	1.26 (0.97-1.63)	0.0865	1.69 (1.33-2.16)	< 0.0001	1.10 (0.85-1.44)	0.4658	1.53 (1.19-1.95)	0.0007
25-29	1.59 (1.26-2.00)	0.0001	2.11 (1.73-2.59)	< 0.0001	1.46 (1.15-1.86)	0.0021	2.04 (1.65-2.52)	< 0.0001
30-34	1.45 (1.18-1.78)	0.0004	2.07 (1.73-2.47)	< 0.0001	1.35 (1.08-1.67)	0.0072	2.04 (1.69-2.46)	< 0.0001
35-39	1.56 (1.30-1.88)	< 0.0001	1.77 (1.46-2.15)	< 0.0001	1.28 (1.06-1.55)	0.0100	1.53 (1.24-1.88)	0.0001
40-44	1.59 (1.33-1.91)	< 0.0001	1.66 (1.39-1.97)	< 0.0001	1.46 (1.21-1.77)	0.0001	1.52 (1.27-1.83)	< 0.0001
45-49	1.84 (1.56-2.17)	< 0.0001	2.05 (1.75-2.41)	< 0.0001	1.65 (1.39-1.97)	< 0.0001	1.89 (1.59-2.24)	< 0.0001
50-54	1.86 (1.58-2.20)	< 0.0001	2.18 (1.85-2.56)	< 0.0001	1.79 (1.49-2.14)	< 0.0001	2.16 (1.81-2.57)	< 0.0001
55-59	1.53 (1.29-1.82)	< 0.0001	1.49 (1.25-1.78)	< 0.0001	1.47 (1.21-1.77)	0.0001	1.41 (1.15-1.71)	0.0007
60-64	1.42 (1.15-1.76)	0.0012	1.43 (1.16-1.77)	0.0010	1.32 (1.05-1.65)	0.0193	1.31 (1.03-1.67)	0.0266
65-69	1.57 (1.29-1.91)	< 0.0001	1.36 (1.12-1.64)	0.0016	1.45 (1.18-1.78)	0.0004	1.22 (1.00-1.48)	0.0512
70-74	1.22 (0.99-1.51)	0.0627	1.33 (1.06-1.66)	0.0134	1.16 (0.94-1.45)	0.1736	1.29 (1.01-1.64)	0.0405
75-79	1.23 (0.95-1.59)	0.1230	1.65 (1.28-2.11)	0.0001	1.05 (0.82-1.34)	0.7194	1.41 (1.11-1.79)	0.0047
80+	1.24 (0.97-1.59)	0.0923	1.15 (0.91-1.46)	0.2487	1.27 (0.98-1.64)	0.0666	1.17 (0.91-1.49)	0.2260

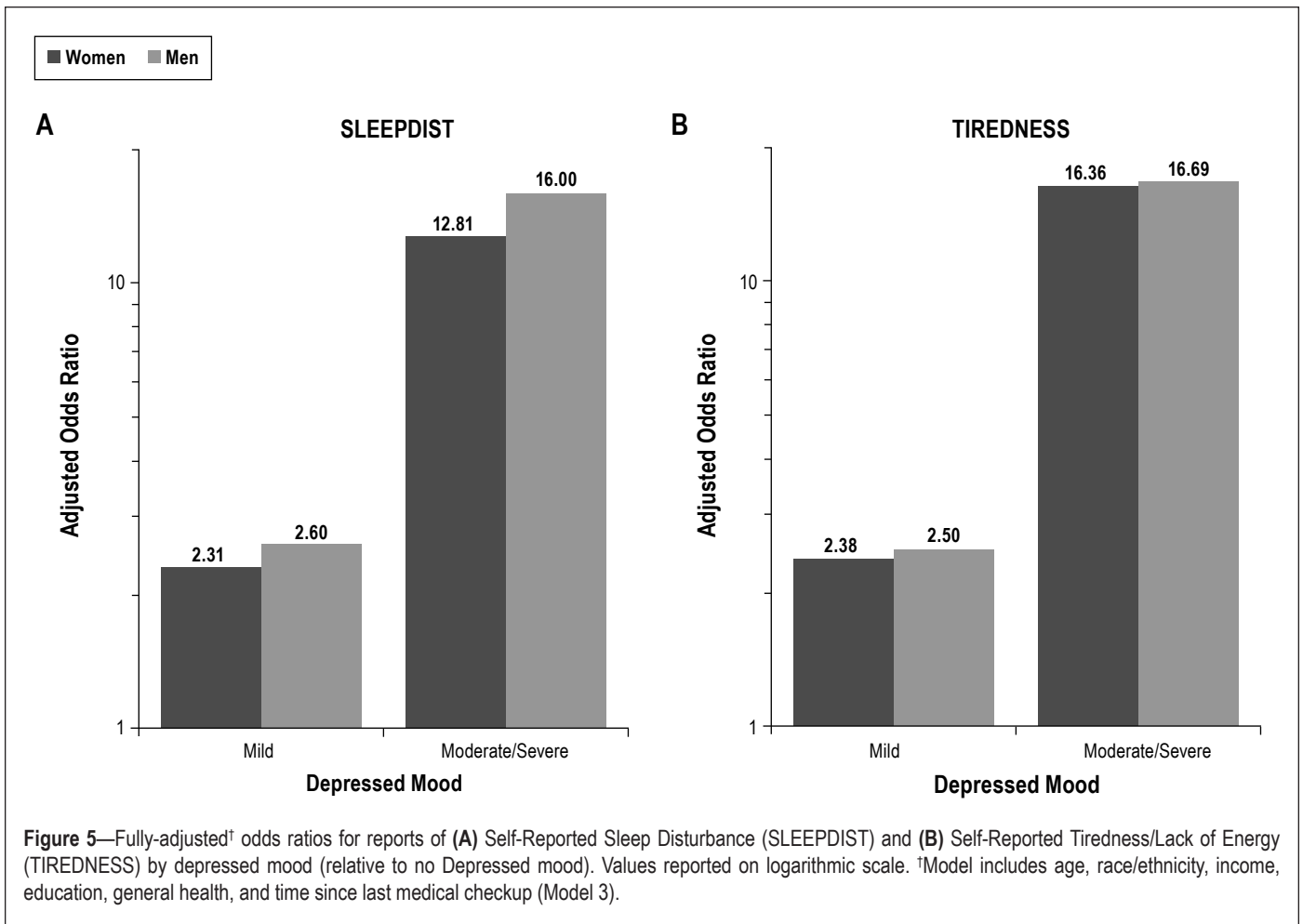
^aModel 2 is adjusted for race/ethnicity, income, education, general health, and time since last checkup. ^bModel 3 is adjusted for race/ethnicity, income, education, general health, time since last checkup, and depressed mood. CI, confidence interval; OR, odds ratio.

DISCUSSION

When adjusting for general health and depressed mood, among other covariates, both SLEEPDIST and TIREDDNESS complaints generally declined across the life span, with fewest endorsements in the oldest respondents (older than 80 yr). For SLEEPDIST, ORs (reference = 80+) declined from 18-54

yr, rose slightly, then declined again after 59 yr in men. The findings were similar for women, except a more marked rise was noted from 40-59 yr. An analogous pattern was noted for TIREDDNESS. Thus, advancing age was not found to be associated with an increased odds of SLEEPDIST or TIREDDNESS when adjusting for these covariates. These results contradict our





initial study hypothesis that aging is associated with increased sleep complaints and suggests that subjective perceptions of poor sleep in older adults may be related to factors other than those associated with physiologic aging.

Of particular relevance is the finding that no group (men or women of any age, in unadjusted (Model 1) or adjusted (Model 2) analyses) was significantly less likely to report SLEEPDIST or TIREDNESS than those participants older than 80 yr. This is demonstrated by the finding that when any age group is compared with the group older than 80 yr, they either report significantly more SLEEPDIST or TIREDNESS or they report no significant differences. This is partially reflected in the differential, nonlinear patterns among men and women (rather than a linear decline). These findings support other recent studies that challenge the common wisdom that subjective problems with nighttime sleep and daytime tiredness are more common in older adults.¹⁵ These findings also challenge the general clinical practice of ignoring these problems as potentially normative when they are reported by older adults—when older adult patients complain of sleep difficulties or fatigue, these complaints do not necessarily reflect normal aging.¹²

The finding that the patients in the oldest age groups were least likely to report SLEEPDIST or TIREDNESS may be putatively explained by a combination of factors such as survivorship, and societal and/or cohort effects. Our findings show that general overall health (especially if health is categorized as poor) is strongly related to sleep-related outcomes. Individuals

in poorest health are least likely to survive to older age. Also, increased age, especially in the oldest age groups, may represent a degree of accumulated chronic disease. Subjects with more exposure to chronic disease states may not have survived to the oldest age groups, or may be particularly resilient to the effects of these processes. Therefore, those in the oldest age group may report the highest sleep quality because those in poorer health (with increased sleep complaints) may have died earlier or be unable to complete a survey. It may also be the case that sleep problems may vary by age, such that younger individuals are likely to experience different stressors (such as college/vocational school/higher education, first jobs, child-bearing, childrearing, and menopause). In addition, younger individuals may be experiencing more sleep-related problems due to societal influences (such as increased technology,²⁹⁻³² work hours,³³⁻³⁷ or other factors^{24,38-41}) experienced less by the older cohort. Given the available data, there is limited evidence for these explanations, and it is unclear to what degree these or other factors contribute to the current findings. It should also be noted that both SLEEPDIST and TIREDNESS may reflect sleep duration, which was not assessed. Changes in sleep duration with age (and adaptation to sleep duration changes) also may partially explain some of these findings.

Another important factor to consider is the age-related change in perception of a so-called acceptable health status. Older adults as a cohort may adjust their expectations of good health and thus be less likely to complain in general⁴² or report specific sleep-

related complaints.^{43,44} The observation that subjective reports of SLEEPDIST decline with age while objective sleep data generally show progressive worsening with age supports this hypothesis.¹⁵ Others have also noticed a discrepancy between objective impairment and self-reported complaints in older adults.^{14,45,46}

In addition to the aforementioned findings, this analysis illustrates normative patterns of sleep complaints for adult men and women across the life span from a large, representative sample. Among both men and women, significant sleep difficulties may be evident during young adulthood as a result of adolescent-like sleep habits (i.e., late bedtimes and rise times) as these individuals enter the workforce or enter higher education—specifically, problems associated with phase delay.^{47,48} These conditions are likely to result in insufficient sleep, reported here as SLEEPDIST and TIREDNESS.

Although this study has a number of methodologic strengths, it also has some limitations. First, the SLEEPDIST item is a compound question, assessing any number or combination of three different sleep-related complaints. This severely limits interpretation as it potentially conflates different types of sleep disturbance. The broad nature of this question captures a gamut of etiologies for suboptimal sleep. Regarding sleep disorders, difficulty falling asleep most likely reflects insomnia, delayed sleep phase syndrome, or restless legs syndrome; difficulty staying asleep could reflect insomnia, sleep apnea, and periodic limb movements of sleep; and sleeping too much could reflect hypersomnia or narcolepsy. SLEEPDIST is not a typical metric that has been used in epidemiologic analyses of sleep in the population. More typically, the number of hours of sleep obtained has been used.^{40,41,49,50} The problem is that the number of hours of sleep obtained does not consider any discrepancy between perceived sleep needed versus sleep actually obtained. The current SLEEPDIST question provides a valuable and sensitive estimate of suboptimal sleep, for whatever reason, in the general population; i.e., a population burden. We purport that the item is sensitive because almost any problem associated with sleep—especially the most common (sleep insufficiency, sleep fragmentation, insomnia, sleep apnea, restless legs syndrome, etc.) could be captured by this question, which is advantageous in a large epidemiologic survey such as the BRFSS. However, although this item has face validity, it has not been validated against standard measures of subjective or objective sleep. Additionally, the SLEEPDIST and TIREDNESS items are not specific to particular sleep disorders, such as sleep apnea. This limits our ability to use responses to this item to describe symptoms or syndromes (e.g., insufficient sleep, long sleep, insomnia, sleep apnea, daytime sleepiness). We do not know whether those who endorse SLEEPDIST or TIREDNESS would meet strict diagnostic criteria for a sleep disorder, or to what degree either of these measures reflect sleep duration or sleep quality (as they would be measured in a more traditional way). We believe, however, that the construct is likely valid because it represents the vague complaints presented when people discuss sleep problems with health care providers.⁵¹⁻⁵³ This is pertinent as recognition for the importance of sleep and sleep disorders in public health continues to rise.⁵⁴ Broad population measures, which are often insensitive for specific diseases, are critical for public health policy, community services infrastructure, and research planning.

Second, as mentioned earlier, this cross-sectional design limits our ability to comment on causality or on the aging process *per se*. Clearly, there are cohorts of Americans in these age categories that have unique life histories and psychosocial characteristics. Only a large-scale longitudinal study could illuminate the role of aging within an individual in the development or remission of sleep difficulties across the life span. In addition, the cross-sectional nature of the study precludes the exploration of seasonality in sleep complaints. Although date and state of the interview were known, accounting for the relevance of seasonality is complicated by a variety of factors such as geographic location (i.e., climatic considerations), time spent outdoors, etc.). Thus, SLEEPDIST and TIREDNESS ORs also may reflect other causes.

Third is the issue of nonresponse. BRFSS has a relatively low response rate. Because it is impossible to determine whether responders and nonresponders differed in any meaningful way, potential bias is mitigated through the use of a weighting scheme in the context of a sample size large enough so that all groups are well represented. Although weighting procedures accounted for nonresponse to the BRFSS in general relative to state, age, sex, etc., weighting procedures did not account for nonresponse to SLEEPDIST and TIREDNESS items. For example, of adults older than 65 yr who completed the BRFSS, 2.16%–4.88% did not complete the sleep items; in those younger than 65 yr, 0.41%–2.02% did not complete the sleep items. This could have produced overestimates or underestimates of likelihood in these groups. However, these effects are probably small in magnitude because, on average, < 2% of the respondents did not endorse these sleep items, and nonresponse did not reach 5% in any specific sociodemographic category for any of these items.

The data from these analyses clearly demonstrate that it is the oldest age groups that are least likely to report problems associated with SLEEPDIST and TIREDNESS after adjustment for sociodemographics, socioeconomic, and health. In addition, the unadjusted analyses show that a typical older adult is less likely to complain of SLEEPDIST than a young or middle-aged adult and only more likely to complain of TIREDNESS if older than 70 yr. These findings challenge the accepted medical wisdom that physiologic aging is necessarily associated with increased subjective sleep complaints.

ACKNOWLEDGMENTS

This work was supported by T32HL007713, K23AG028452 (to Dr. Martin), R21AG31390 (to Dr. Gooneratne) as well as funding for Biostatistical Support from the University of Pennsylvania Center for Sleep and Circadian Neurobiology. The authors thank Allan Pack, MB, ChB, PhD for guidance and other support. Also, the authors thank the BRFSS participants and the Centers for Disease Control and Prevention for collecting these data and making them available.

DISCLOSURE STATEMENT

This was not an industry supported study. Dr. Patel has received research support from Boehringer Ingelheim unrelated to this study. Dr. Pien has the use of equipment on loan from Respiroics unrelated to this study. Dr. Perlis has consulted for Gerson Lehrman Group, Clinical Advisors, Meda Corp / Leerink Swann, Actelion, SleepEasily, Sanofi-Aventis, L.E.K. Consulting LLC. He has received research support from Sanofi-Aven-

tis, Pharma, and Cephalon and had speaking honoraria from Sanofi-Aventis, AASM, UR, and Internet Didactic Services. He has received salary and distributions from Actelion, Takeda, Gerson Lehman, Clinical Advisors, LEK, and MedaCorp. Dr. Weaver has received research equipment from Respiroics, Inc. and Protech; grant support from Respiroics Respiratory and Sleep Research Foundation, Cephalon, Inc. She has consulted for Apnex Medical, Inc., and Cephalon, Inc. and has FOSQ license Agreements with Sanofi-Aventis Pharmaceutical, Merck 7 Co., Inc., Sleep Solutions, N>V> Organon, Apnex Medical, Inc., Ventus medical, GlaxoSmithKline, and Respiroics. The other authors have indicated no financial conflicts of interest.

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Table S1—Characteristics of participants who did and did not respond to the sleep disturbance and tiredness questions

Category	Unweighted			Weighted		
	Men (%) n = 61,798	Women (%) n = 94,079	Total (%) n = 155,877	Men (%) n = 61,798	Women (%) n = 94,079	Total (%) n = 155,877
Age (in yr)						
18-24	4.40	3.92	4.11	12.52	11.58	12.05
25-29	5.48	5.91	5.74	8.98	8.50	8.74
30-34	7.00	7.42	7.25	10.90	10.63	10.76
35-39	8.44	8.80	8.66	9.65	9.53	9.59
40-44	9.74	9.92	9.85	11.04	11.01	11.02
45-49	10.70	10.84	10.78	9.45	9.74	9.59
50-54	11.79	11.23	11.45	10.24	9.73	9.98
55-59	11.41	10.88	11.09	7.55	7.91	7.73
60-64	9.39	8.73	8.99	6.29	5.94	6.12
65-69	7.55	7.09	7.27	4.32	4.78	4.56
70-74	5.85	5.63	5.71	3.60	3.43	3.52
75-79	4.32	4.69	4.54	2.95	3.71	3.33
80+	3.95	4.96	4.56	2.51	3.50	3.01
Race/ethnicity						
White	78.02	75.23	76.34	66.98	67.26	67.12
Black/African American	7.02	10.00	8.82	7.97	9.71	8.84
Hispanic/Latino	8.02	8.63	8.39	17.82	17.05	17.43
Asian/other	4.62	3.85	4.15	5.39	4.20	4.79
Multiracial	2.32	2.29	2.30	1.83	1.78	1.80
Education						
Less than high school	9.73	9.42	9.54	12.87	10.98	11.92
High school	28.94	29.86	29.50	27.21	27.94	27.58
Some college	25.01	28.54	27.14	25.56	28.91	27.24
College graduate	36.32	32.18	33.82	34.36	32.18	33.26
Income						
< \$10,000	4.01	7.20	5.93	4.27	6.94	5.61
\$10,000-\$15,000	4.61	7.21	6.18	4.62	6.25	5.44
\$15,000-\$20,000	6.23	8.77	7.76	6.45	8.00	7.23
\$20,000-\$25,000	8.33	10.13	9.42	8.38	9.72	9.05
\$25,000-\$35,000	12.88	13.38	13.18	12.58	12.23	12.41
\$35,000-\$50,000	17.25	16.35	16.70	15.26	15.58	15.42
\$50,000-\$75,000	18.99	16.23	17.33	18.03	16.53	17.28
\$75,000+	27.71	20.73	23.50	30.41	24.75	27.57
General Health						
Excellent	19.97	19.52	19.70	22.01	20.72	21.36
Very Good	32.55	32.66	32.61	33.02	33.26	33.14
Good	30.38	29.42	29.80	29.67	29.51	29.59
Fair	12.01	12.91	12.55	11.54	11.87	11.70
Poor	5.09	5.49	5.33	3.77	4.64	4.20
Time since last checkup						
Within the past yr	63.32	73.53	69.48	58.94	72.04	65.51
Within the past 2 yr	14.08	12.36	13.04	15.77	12.99	14.38
Within the past 5 yr	9.82	6.73	7.95	11.52	7.59	9.55
5 or more yr ago	11.21	6.33	8.26	11.17	6.19	8.67
Never	1.57	1.06	1.26	2.60	1.19	1.89
Depressed mood						
None	77.11	68.19	71.73	75.12	66.78	70.94
Mild	16.86	23.37	20.79	18.86	24.67	21.77
Moderate/severe	6.03	8.44	7.48	6.02	8.55	7.29

Table S2—Response versus nonresponse on sleep disturbance and tiredness items

Category	Not missing (%) n = 155,877	Missing (%) n = 2,943	% Missing
Sex			
Male	49.85	45.11	1.12
Female	50.15	54.89	1.35
Age (in yr)			
18-24	12.05	6.78	0.70
25-29	8.74	2.86	0.41
30-34	10.76	6.05	0.70
35-39	9.59	6.07	0.78
40-44	11.02	5.45	0.61
45-49	9.59	5.91	0.76
50-54	9.98	9.88	1.22
55-59	7.73	7.52	1.20
60-64	6.12	10.13	2.02
65-69	4.56	8.05	2.16
70-74	3.52	8.93	3.07
75-79	3.33	10.02	3.62
80+	3.01	12.36	4.88
Race/ethnicity			
White	67.12	69.11	1.27
Black/African American	8.84	11.38	1.58
Hispanic/Latino	17.43	12.61	0.89
Asian/other	4.79	4.35	1.12
Multiracial	1.80	2.55	1.73
Education			
Less than high school	11.92	19.95	2.05
High school	27.58	34.07	1.52
Some college	27.24	23.62	1.07
College graduate	33.26	22.35	0.83
Income			
< \$10,000	5.61	9.79	2.13
\$10,000-\$15,000	5.44	8.73	1.96
\$15,000-\$20,000	7.23	13.19	2.23
\$20,000-\$25,000	9.05	12.15	1.65
\$25,000-\$35,000	12.41	16.17	1.60
\$35,000-\$50,000	15.42	11.78	0.94
\$50,000-\$75,000	17.28	10.34	0.74
\$75,000+	27.57	17.84	0.80
General health			
Excellent	21.36	14.10	0.82
Very good	33.14	24.27	0.91
Good	29.59	33.28	1.38
Fair	11.70	20.69	2.16
Poor	4.20	7.66	2.22
Time since medical checkup			
Within the past yr	65.51	73.88	1.39
Within the past 2 yr	14.38	13.59	1.17
Within the past 5 yr	9.55	4.91	0.64
5 or more yr ago	8.67	6.03	0.86
Never	1.89	1.60	1.04
Depression			
None	70.94	73.25	1.27
Mild	21.77	18.07	1.03
Moderate/severe	7.29	8.67	1.46

Table S3—Nonresponse on sleep disturbance and tiredness items by state missing data between states

State	% Missing
Alabama	2.23
Alaska	2.00
Arkansas	1.45
California	0.33
Delaware	0.31
District of Columbia	1.92
Florida	1.84
Georgia	0.93
Hawaii	1.16
Indiana	1.29
Iowa	1.92
Louisiana	2.54
Maine	1.48
Michigan	1.39
Minnesota	0.41
Mississippi	1.65
Missouri	0.98
Montana	1.55
Nevada	1.29
New Hampshire	1.24
New Mexico	1.06
North Dakota	2.04
Oklahoma	1.87
Oregon	2.19
Rhode Island	1.26
South Carolina	1.40
Tennessee	1.47
Texas	1.32
Utah	1.47
Vermont	1.54
Virginia	1.83
West Virginia	1.57
Wisconsin	0.48
Wyoming	1.33
Puerto Rico	1.92
Virgin Islands	2.36