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Financial Strain is a Significant Correlate of Sleep Continuity Disturbances in Late-Life

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Abstract

Although psychological stress has been associated with disturbed sleep in younger populations, little is known about the stress-sleep relationship in late life. In the present study, we evaluated relationships among a chronic stressor, ongoing financial strain, and sleep in a heterogeneous sample ($n = 75$) of community-dwelling elders (mean age = 74.0 years). Self-report measures included ongoing financial strain, mental health, physical health and subjective sleep quality. Sleep duration, continuity, and architecture were measured by polysomnography (PSG). Analysis of variance and regression were used to test the hypothesis that ongoing financial strain is a significant correlate of disturbed sleep in the elderly. Covariates included age, sex, mental health and physical health. Analyses revealed that ongoing financial strain is a significant correlate of PSG-assessed sleep latency, wakefulness after sleep onset, and sleep efficiency. After adjusting for the effects of age, sex, mental health, and physical health on sleep, ongoing financial strain was associated with lower sleep efficiency ($p < .01$). Our results show that chronic stress, as measured by ongoing financial strain, is a significant correlate of sleep disturbances in the elderly, even after adjusting for factors known to impact sleep in late-life.

Keywords

stress; socio-economic status; sleep; insomnia; elderly

INTRODUCTION

The elderly are at increased risk for disturbed sleep, which may adversely affect health, functioning and quality of life (Chevalier et al., 1999; Dew et al., 2003; Groeger et al., 2004; Kojima et al., 2000; Newman et al., 2000; Riemann and Voderholzer, 2003; Spiegel et al., 1992). Sleep disturbances in the elderly may be related to normal aging processes such as

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neuroanatomic changes in sleep and arousal systems (Nofzinger and Keshevan, 2002) and/or diminished transduction of circadian rhythm signals to the sleep system (Bliwise et al., 1983; Monk and Kupfer, 2000). Others have proposed that age-related changes in sleep are the result of pathological processes such as medical and psychiatric morbidity, and that normal aging processes are less important (Ohayon et al., 2004; Roberts et al., 1999; Vitiello et al., 2002). A greater understanding of the processes that influence sleep in the elderly is important for identifying individuals at risk, designing effective treatment strategies, and, ultimately, improving health and functioning during the later years of life.

Although fewer studies have considered the role of psychological stress in late-life sleep disturbances (Hall et al., 1997; McDermott et al., 1997), psychological stress has been shown to play a significant role in the onset and maintenance of primary insomnia in younger samples (Drake et al., 2004; Linton, 2004; Morin and Buysse, 2003). Psychological stress has been similarly associated with subjective sleep complaints, reports of shorter sleep duration, PSG-assessed sleep continuity disturbances and reductions in slow-wave sleep, as well as increased indices of physiological hyperarousal during sleep across the adult life span (Akerstedt et al., 2002; Davidson et al., 1987; Geroldi et al., 1996; Hall et al., 2000; Kecklund and Akerstedt, 2004; Nakata et al., 2001, 2004; Ohayon, 2005; Roberts et al., 2000). Although some researchers have hypothesized that a general negative affective bias associated with depression accounts for the effects of naturalistic stress on sleep, empirical data suggest that psychological stress may impact sleep independently of symptoms of depression (Hall et al., 1997, 2000, 2004, 2007; Kecklund and Akerstedt, 2004).

In the present study, we modeled relationships among concurrent measures of chronic stress, mental health, physical health, and sleep in a heterogeneous sample of community-dwelling elders. In particular, ongoing financial strain was used as a measure of chronic stress, given the prevalence and salience of financial strain in the elderly (Centers for Disease Control and Prevention, 2004; Kubzansky et al., 2000). We hypothesized that ongoing financial strain would be a significant correlate of disturbed sleep in the elderly, above and beyond the effects of age, mental health and physical health on sleep.

METHODS

Participants were drawn from 5 component projects that comprise the “Aging Well, Sleeping Efficiently: Intervention Studies” (AgeWise) program project (AG020677). The unifying theme of the AgeWise program project is the hypothesis that sleep is related to health and functioning in the elderly and behavioral interventions that target late-life sleep disturbances will have positive effects on health and functioning. Component projects each focused on a specific late-life challenge including bereavement (Project 1), caregiving (Project 2), insomnia complicated by medical co-morbidity (Project 3), and advancing into the final years of life (Projects 4 and 5). Projects 1 – 4 included behavioral interventions that were specific to the population of interest; in each project, participants were randomly assigned to the behavioral intervention or a plausible control condition. The fifth component project used neuroimaging techniques to evaluate the effects of age and aging on sleep neurobiology in a sub-sample of Project 4 participants. Protocols were standardized across projects, including collection of program-wide assessments of sleep, health, functioning, and major mediators and moderators thought to significantly impact relationships between sleep and health. Program-wide measures were evaluated at baseline, immediately following the intervention phase, and at a longer-term follow-up assessment that varied by project. Baseline data are presented here.

AgeWise participants (total $n = 75$) included bereaved elders ($n=9$), caregivers ($n=19$), patients with insomnia and co-morbid medical disorders ($n=23$), and the healthy “Old, Old” ($n=24$). Participants were recruited through media advertisements, flyers and clinical referrals. Written,

informed consent was obtained from individual participants prior to collection of data. Program-wide exclusion criteria were current significant medical conditions (e.g., hospitalized within the last month, ongoing radiation or chemotherapy, too frail to complete study procedures, seizures, head trauma, uncontrolled hypertension or diabetes), current untreated major syndromal psychiatric disorders, and clinically-significant sleep disordered breathing (apnea-hypopnea index [AHI] > 20). Eligibility was established via medical and psychiatric interviews performed by study clinicians.

The study protocol was carried out in the Neuroscience Clinical and Translational Research Center (N-CTRC) of Western Psychiatric Institute and Clinic (RR024153) as well as in participants' homes. Projects 1, 4 and 5 conducted sleep studies in the N-CTRC sleep laboratory, whereas Projects 2 and 3 conducted in-home sleep studies using equipment comparable to that used in the N-CTRC. Prior to PSG sleep studies, participants completed a daily sleep diary for two weeks, which was used to establish habitual sleep-wake times (Reynolds et al., 1992). Baseline data relevant to this paper included demographics, measures of financial strain, sleep, and selected covariates as defined below.

Financial strain was measured by self-report. Participants were asked to indicate the degree to which they were experiencing financial strain that was currently ongoing and of at least twelve months' duration (Bromberger and Matthews, 1996). Response choices were dichotomized as '0' ("absent" or "not upsetting") or '1' ("somewhat upsetting" or "very upsetting") due to the small number of participants ($n = 3$) who endorsed ongoing financial strain as "very upsetting." Overall, 25% of the sample endorsed ongoing financial strain as "somewhat" to "very upsetting."

The 19-item Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) was used to evaluate subjective sleep quality over the previous month. Individual questions on the PSQI are combined into seven clinically-derived component scores (e.g., sleep efficiency, daytime disturbance, sleep aid use), each weighted equally from 0–3. The seven component scores were summed to obtain a global score ranging from 0–21, with higher scores indicating worse sleep quality. In the present study, we used the global sleep quality rating to quantify subjective sleep quality complaints.

Polysomnographic (PSG) sleep studies included a screening night as well as one to two nights of basic PSG for sleep staging alone. Differences in number of basic PSG nights were related to the collection of neuroimaging data during sleep (Projects 4 and 5). Sleep studies were conducted in the N-CTRC (Projects 1, 4, 5) or participants' homes (Projects 2, 3) using ambulatory PSG monitors (Compumedics Siesta). In both settings, participants were prepared for sleep studies by trained sleep technicians. In-home studies were unattended; sleep technicians returned to the laboratory after preparing participants for sleep studies and verifying the integrity of signals. Mean values for PSG-assessed sleep measures collected in the ambulatory setting ($n = 42$) did not differ from data collected in the laboratory ($n = 33$), which is consistent with other reports comparing PSG data across ambulatory and laboratory environments (Edinger et al., 1997; Wohlgemuth et al., 1999).

Sleep studies were conducted at participants' usual sleep-wake times, as determined by sleep diaries (Monk et al., 1994). The basic PSG montage included bilateral central and occipital electro-encephalogram (EEG) channels, electro-oculogram (EOG), submental is electromyogram (EMG) and a V_2 electrocardiogram (EKG) lead. On the screening night, participants were also monitored for sleep-disordered breathing and periodic limb movements. Trained PSG technicians used Stellate Harmonie software to visually score sleep records in 20-second epochs. Night 2 data were selected for the current analyses to minimize habituation effects seen on PSG screening nights (Le Bon et al., 2001). Summary measures included sleep

duration (time spent asleep), sleep continuity (sleep latency, wakefulness after sleep onset and sleep efficiency) and sleep architecture (percent NREM delta sleep, percent REM sleep), which are the domains of sleep generally associated with psychological stress (Akerstedt et al., 2002; Hall et al., 1997; Kecklund and Akerstedt, 2004). Operational definitions for PSG-assessed sleep measures are included in Table 1.

Covariates included age, sex, physical health, mental health and an identifier for specific projects. Age and sex were assessed by self-report during the baseline medical exam. The Physical Health (PCS) and Mental Health (MCS) Component Summary measures of the Short Form 36 (SF-36; Ware and Sherbourne, 1992) were used to evaluate mental and physical health burden. The PCS and MCS are reliable and valid measures of mental and physical health that take into account the inter-relationships among different dimensions of health including general health perceptions, physical functioning, bodily pain, role limitations due to physical health, general mental health, social functioning, role limitations due to emotional problems, and vitality (Ware et al., 1994). Scores range from 0 to 100 on each measure; higher scores indicate better health and functioning. Categorical variables were used to evaluate the possible influence of individual projects and study setting on study outcomes. Project was dummy-coded; Project 4 (healthy elders) served as the referent group for Projects 1 and 2 (bereaved elders and caregivers were combined into one group) and Project 3 (patients with insomnia). Finally, study setting was defined as in-laboratory or in-home.

Descriptive statistics were used to characterize the sample. Skewed variables were transformed prior to analyses, as noted in Table 2 – Table 3. Three analytic steps were used to test the hypothesis that ongoing financial strain is a significant correlate of disturbed sleep in a heterogeneous sample of community-dwelling elders. First, analysis of variance (ANOVA) was used to evaluate univariate relationships among financial strain and sleep. Second, linear models were used to assess observed univariate associations among financial strain and sleep, after adjusting for age, sex, mental health and physical health. Selection of covariates was guided by the results of the Ohayon et al. (2004) meta-analysis on sleep and aging. Project was also included as a covariate in order to adjust for the possible influence of project-specific characteristics on outcome measures. Regression models included two steps: age, sex, project (dummy code for bereaved or caregivers and insomnia patients), mental health (SF-36 MCS), and physical health (SF-36 PCS) were entered in the first step, followed in step 2 by the dichotomous measure of financial strain. Collinearity of predictor variables was minimal, as established by tolerance values above 0.80 and correlation coefficients below $r = 0.35$ (Belsley et al., 1980). Finally, exploratory regression analyses were conducted to examine the possible effect of study setting (in-laboratory versus in-home PSG) on observed relationships among financial strain and sleep. This final set of analyses must be considered exploratory given the total number of variables entered in the model (Tabachnick and Fidell, 1996).

RESULTS

Background and sleep characteristics of the study sample are shown in Table 1. The sample age range was 61 to 85 years, roughly 1/3 of whom were male. Participants' physical and mental health ratings were comparable to age-normed values for the general US population (Ware et al., 1994). One-fourth of the sample endorsed experiencing ongoing financial strain (bereaved elders = 22%; caregivers = 26%; patients with insomnia = 30%; healthy "Old, Old" = 21%). On average, participants took approximately 25 minutes to fall asleep and spent an hour awake during the night during PSG sleep studies. Mean sleep duration was just under 6 hours. Sleep architecture profiles were typical of late life (Ohayon et al., 2004). Sleep disordered breathing and periodic limb movements were not in the pathological range for older adults, pursuant to program-wide eligibility criteria.

As shown in Table 2, univariate associations among financial strain and sleep revealed that participants who endorsed ongoing financial strain took longer to fall asleep (35.44 *versus* 23.53 minutes) and spent more time awake after sleep onset (87.93 *versus* 68.94 minutes) (*p* values <.05). Difficulties initiating and maintaining sleep resulted in a significant group difference for sleep efficiency (73.80% *versus* 80.93%) (*p* < .001). Ongoing financial strain was not a significant correlate of subjective sleep quality, time spent asleep or indices of sleep architecture (*p* values > .05).

Stepwise linear regression models were used to evaluate the extent to which observed univariate relationships among financial strain and indices of sleep continuity were independent of the effects of age, sex, mental health, physical health and project (see Table 3). The overall models for sleep latency and efficiency were no longer significant when covariates and financial strain were included (*p* values > .05). Ongoing financial strain remained a significant correlate of sleep efficiency in the fully adjusted model (overall $R^2 = 0.30$, *p* < .001). In the first step of the model, covariates accounted for 20% of the variance in sleep efficiency (*p* < .05). The addition of financial strain increased the model R^2 by 9.6% (*p* < .01). The physical health component score of the SF-36 was the only predictor variable independently associated with indices of sleep continuity. Better physical health ratings were associated with shorter sleep latency values (standardized Beta = -0.35 , *p* < .05) and higher sleep efficiency values (standardized Beta = 0.28 , *p* < .05). Inclusion of sleep study environment (laboratory or home) did not alter any of the observed relationships among ongoing financial strain and indices of sleep continuity.

DISCUSSION

Ongoing financial strain was associated with sleep continuity disturbances in a heterogeneous sample of community-dwelling elders. After adjusting for the effects of age, sex, project, mental health and physical health on sleep, ongoing financial strain was significantly associated with poorer overall sleep efficiency. Elders experiencing ongoing financial strain took longer to fall asleep and spent an average of 88 minutes awake after sleep onset, as compared to 69 minutes of wakefulness among elders who did not report ongoing financial strain. These results extend previous reports on stress and sleep by focusing on financial strain, which is a prevalent and salient stressor in the aging population (Centers for Disease Control and Prevention, 2004; Kubzansky et al., 2000), and by covarying for concurrent measures of mental and physical health, which impact sleep and covary with aging (Ohayon et al., 2004).

Self-rated physical health burden emerged as an independent correlate of sleep latency and sleep efficiency after adjusting for age, sex, mental health burden and project-specific sample characteristics. These effects were observed in the absence of uncontrolled major medical conditions and despite considerable heterogeneity in sample characteristics (e.g., men and women; bereaved elders, caregivers, patients with insomnia, the healthy “Old, Old”) pursuant to eligibility criteria for participation in the AgeWise program project. Contrary to expectation, mental health burden was not a significant correlate of sleep continuity disturbances, when evaluated in conjunction with concurrent measures of age, sex, project-specific characteristics and physical health. These results are somewhat surprising in light of the large literature on sleep and psychiatric morbidity, including data from our own laboratory (Buysse et al., 1998, 2001; Ohayon and Shapiro, 2000; Ohayon et al., 2004). A number of factors may have contributed to the absence of significant mental health – sleep relationships in the present study. First, the overall study sample was characterized by low levels of symptoms of depression (Hamilton Rating Scale for Depression mean = 5.44 ± 4.55) and anxiety (Hamilton Rating Scale for Anxiety mean score = 4.49 ± 3.13) (Mulsant et al., 1994). In addition, the present analyses may have been underpowered to find significant relationships among mental health and sleep, given the lack of significant variability in self-reported mental health burden. Finally,

our choice of mental health burden measures may have affected study results. The SF-36 Mental Component Summary Scale measures numerous components of mental health and applies negative weights to various components of physical health (e.g., physical functioning, bodily pain) that might influence reports of mood, interpersonal difficulties, social functioning and vitality. These results suggest that physical health burden may be an important correlate of the relationship between mental health and sleep, which will need to be evaluated in larger studies of sleep in elders characterized by greater variability in measures of mental and physical health burden.

The absence of marked relationships among age and sleep continuity disturbances in the present sample is consistent with the hypothesis that pathological processes that occur with aging (i.e., medical morbidity) may contribute more significantly to age-related changes in sleep than do physiological processes associated with aging, *per se* (see Ohayon et al., 2004; Roberts et al., 1999; Vitiello et al., 2002). However, these data do not tease apart physiological processes that might affect sleep on their own (e.g., age-related changes in sleep-arousal systems) from central processes that affect summary measures of physical health (e.g., pain and functioning). Imaging data collected during waking and sleep in a subsample of AgeWise participants will be used to explore the effects of age and aging on brain structures critical to sleep and arousal, as well as their interactive effects with symptoms of stress, mental health, and physical health.

The present results should be evaluated in light of a number of limitations. First, significant univariate stress-sleep results were restricted to three related measures of sleep continuity. Statistical adjustments for covariates further restricted study findings to poorer sleep efficiency among individuals with ongoing financial strain. Nevertheless, observed relationships among financial strain and sleep efficiency were clinically significant; mean sleep efficiency among elders with ongoing financial strain was 73.8 percent (± 7.7), as compared to 80.9 percent (± 8.2) among elders who did not endorse ongoing financial strain. We previously reported in a separate study of community-dwelling elders that PSG-assessed sleep efficiency values of $< 80\%$ increased the relative risk for mortality to 1.93, after adjusting for age, sex, and medical burden (Dew et al., 2003). Second, the sample was comprised of several highly selected subgroups of elders (e.g., bereaved, caregivers, insomnia with co-morbid medical conditions, healthy “Old, Old”) which might be expected to differ in terms of characteristics that affect sleep. Although analyses were adjusted for many of the factors that differentiate the various AgeWise project samples (age, sex, project), definitive tests of the financial strain-sleep relationship will need to be evaluated in larger samples where risk factors for disturbed sleep are known and can be stratified. Third, we cannot infer causality of observed relationships among financial strain and sleep, given the cross-sectional design of this study. Although worry related to financial strain may interfere with sleep, it is also likely that sleep disturbances unrelated to financial strain might influence subjective appraisals. The bi-directional relationship between stress and sleep merits further study, especially in populations at risk for sleep disturbances, such as the elderly. Finally, results may not be generalizable to large segments of the age 60+ population. The current sample included few nonwhites, the majority of participants were recruited in response to community advertisements and outreach efforts, and protocol burden may have deterred more vulnerable individuals from participation. Despite these limitations, the present data are striking in that, despite the heterogeneity of the sample and differences in participant selection techniques, ongoing financial strain was strongly associated with poorer overall sleep efficiency, after covarying for factors previously shown to impact sleep in late-life (Ohayon et al., 2004).

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Reference List

- Akerstedt T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G. Sleep disturbances, work stress and work hours: a cross-sectional study. *Journal of Psychosomatic Research* 2002;53:741–748. [PubMed: 12217447]
- Belsley, DA.; Kuh, E.; Welsch, RE. *Regression Diagnostics: Identification Influential Data and Sources of Collinearity*. New York: John Wiley and Sons, Inc.; 1980.
- Bliwise DL, Carey E, Dement WC. Nightly variation in sleep-related respiratory disturbance in older adults. *Exp.Aging Res* 1983;9:77–81. [PubMed: 6628492]
- Bromberger JT, Matthews KA. A longitudinal study of the effects of pessimism, trait anxiety, and life stress on depressive symptoms in middle-aged women. *Psychology and Aging* 1996;11:207–213. [PubMed: 8795049]
- Buysse DJ, Hall M, Begley A, Cherry CR, Houck PR, Land S, Ombao H, Kupfer DJ, Frank E. Sleep and treatment response in depression: New findings using power spectral analysis. *Psychiatry Research* 2001;103:51–67. [PubMed: 11472790]
- Buysse DJ, Hall M, Tu XM, Land S, Houck PR, Cherry CR, Kupfer DJ, Frank E. Latent structure of EEG sleep variables in depressed and control subjects: descriptions and clinical correlates. *Psychiatry Research* 1998;79:105–122. [PubMed: 9705049]
- Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research* 1989;28:193–213. [PubMed: 2748771]
- Centers for Disease Control and Prevention. Self-reported frequent mental distress among adults. *Morbidity and Mortality Weekly Report* 2004;53:963–966. [PubMed: 15496824]
- Chevalier H, Los F, Boichut D, Bianchi M, Nutt DJ, Hajak G, Hetta J, Hoffmann G, Crowe C. Evaluation of severe insomnia in the general population: results of a European multinational survey. *J.Psychopharmacol* 1999;13:S21–S24. [PubMed: 10667452]
- Davidson LM, Fleming R, Baum A. Chronic stress, catecholamines, and sleep disturbance at Three Mile Island. *Journal of Human Stress* Summer 1987:75–83.
- Dew MA, Hoch CC, Buysse DJ, Monk TH, Begley AE, Houck PR, Hall M, Kupfer DJ, Reynolds CF. Healthy older adults' sleep predicts all-cause mortality at 4 to 19 years of follow-up. *Psychosomatic Medicine* 2003;65:63–73. [PubMed: 12554816]
- Drake C, Richardson G, Roehrs T, Scofield H, Roth T. Vulnerability to stress-related sleep disturbance and hyperarousal. *Sleep* 2004;27:285–291. [PubMed: 15124724]
- Edinger JD, Fins AI, Sullivan RJ, Marsh GR, Dailey DS, Hope TV, Young M, Shaw E, Carlson D, Vasilas D. Sleep in the laboratory and sleep at home: comparisons of older insomniacs and normal sleepers. *Sleep* 1997;20:1119–1126. [PubMed: 9493921]
- Geroldi C, Frisoni GB, Rozzini R, De Leo D, Trabucchi M. Principal lifetime occupation and sleep quality in the elderly. *Gerontology* 1996;42:163–169. [PubMed: 8796375]
- Groeger JA, Zijlstra FR, Dijk DJ. Sleep quantity, sleep difficulties and their perceived consequences in a representative sample of some 2000 British adults. *Journal of Sleep Research* 2004;13:359–371. [PubMed: 15560771]
- Hall M, Buysse DJ, Dew MA, Prigerson HG, Kupfer DJ, Reynolds CF. Intrusive thoughts and avoidance behaviors are associated with sleep disturbances in bereavement-related depression. *Depression and Anxiety* 1997;6:106–112. [PubMed: 9442984]
- Hall M, Buysse DJ, Nowell PD, Nofzinger EA, Houck PR, Reynolds CF, Kupfer DJ. Symptoms of stress and depression as correlates of sleep in primary insomnia. *Psychosomatic Medicine* 2000;62:227–230. [PubMed: 10772402]
- Hall M, Vasko R, Buysse DJ, Ombao H, Chen Q, Cashmere JD, Kupfer D, Thayer JF. Acute stress affects heart rate variability during sleep. *Psychosomatic Medicine* 2004;66:56–62. [PubMed: 14747638]
- Kecklund G, Akerstedt T. Apprehension of the subsequent working day is associated with a low amount of slow wave sleep. *Biological Psychology* 2004;66:169–176. [PubMed: 15041138]

- Kojima M, Wakai K, Kawamura T, Tamakoshi A, Aoki R, Lin Y, Nakayama T, Horibe H, Aoki N, Ohno Y. Sleep patterns and total mortality: a 12-year follow-up study in Japan. *Journal of Epidemiology* 2000;10:87–93. [PubMed: 10778032]
- Kubzansky LD, Berkman LF, Seeman TE. Social conditions and distress in elderly persons: findings from the MacArthur Studies of Successful Aging. *Journals of Gerontology Series B-Psychological Sciences and Social Sciences* 2000;55:238–246.
- Le Bon O, Staner L, Hoffmann G, Dramaix M, San S, Murphy JR, Kentos M, Pelc I, Linkowski P. The first-night effect may last more than one night. *Journal of Psychiatric Research* 2001;35:165–172. [PubMed: 11461712]
- Linton SJ. Does work stress predict insomnia? A prospective study. *Br.J.Health Psychol* 2004;9:127–136. [PubMed: 15125800]
- McDermott OD, Prigerson HG, Reynolds CF, Houck PR, Dew MA, Hall M, Mazumdar S, Buysse DJ, Hoch CC, Kupfer DJ. Sleep in the wake of complicated grief: An exploratory study. *Biological Psychiatry* 1997;41:710–716. [PubMed: 9066995]
- Monk TH, Kupfer DJ. Circadian rhythms in healthy aging -- effects downstream from the pacemaker. *Chronobiology International* 2000;17:355–368. [PubMed: 10841210]
- Monk TH, Reynolds CF, Kupfer DJ, Buysse DJ, Coble PA, Hayes AJ, Machen MA, Petrie SR, Ritenour AM. The Pittsburgh Sleep Diary. *Journal of Sleep Research* 1994;3:111–120.
- Morin, CM.; Buysse, DJ. Behavioral Treatment of Insomnia. In: Aminoff, M.; Daroff, RB., editors. *Encyclopedia of the Neurological Sciences*. USA: Elsevier Science; 2003. p. 661–664.
- Mulsant B, Sweet RA, Rifai AH, Pasternak RE, Zubenko GS. The use of the Hamilton Rating Scale for Depression in elderly patients with cognitive impairment and physical illness. *American Journal of Geriatric Psychiatry* 1994;2:220–229.
- Nakata A, Haratani T, Takahashi M, Kawakami N, Arito H, Fujioka Y, Shimizu H, Kobayashi F, Araki S. Job stress, social support at work, and insomnia in Japanese shift workers. *J.Hum.Ergol.(Tokyo)* 2001;30:203–209. [PubMed: 14564883]
- Nakata A, Haratani T, Takahashi M, Kawakami N, Arito H, Kobayashi F, Araki S. Job stress, social support, and prevalence of insomnia in a population of Japanese daytime workers. *Social Science and Medicine* 2004;59:1719–1730. [PubMed: 15279928]
- Newman AB, Spiekerman CF, Enright P, Lefkowitz D, Manolio T, Reynolds CF, Robbins J. Daytime sleepiness predicts mortality and cardiovascular disease in older adults. The Cardiovascular Health Study Research Group. *Journal of the American Geriatrics Society* 2000;48:115–123. [PubMed: 10682939]
- Nofzinger, EA.; Keshavan, M. Sleep disturbances associated with neuropsychiatric disease. In: Davis, KL.; Charney, D.; Coyle, JT., editors. *Neuropsychopharmacology: The Fifth Generation of Progress*. Philadelphia: Lippincott Williams and Wilkins; 2002. p. 1945–1959.
- Ohayon MM. Prevalence and correlates of nonrestorative sleep complaints. *Archives of Internal Medicine* 2005;165:35–41. [PubMed: 15642872]
- Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. *Sleep* 2004;27:1255–1273. [PubMed: 15586779]
- Ohayon MM, Shapiro CM. Sleep disturbances and psychiatric disorders associated with posttraumatic stress disorder in the general population. *Comprehensive Psychiatry* 2000;41:469–478. [PubMed: 11086154]
- Reynolds CF, Grochocinski VJ, Monk TH, Buysse DJ, Giles DE, Coble PA, Matzzie JV, Doman J, Monahan J, Kupfer DJ. Concordance between habitual sleep times and laboratory recording schedules. *Sleep* 1992;15:571–575. [PubMed: 1475574]
- Riemann D, Voderholzer U. Primary insomnia: a risk factor to develop depression? *Journal of Affective Disorders* 2003;76:255–259. [PubMed: 12943956]
- Roberts RE, Shema SJ, Kaplan GA. Prospective data on sleep complaints and associated risk factors in an older cohort. *Psychosomatic Medicine* 1999;61:188–196. [PubMed: 10204972]
- Roberts RE, Shema SJ, Kaplan GA, Strawbridge WJ. Sleep complaints and depression in an aging cohort: A prospective perspective. *American Journal of Psychiatry* 2000;157:81–88. [PubMed: 10618017]

- Spiegel K, Sheridan JF, Van Cauter E. Effect of sleep deprivation on response to immunization. *Journal of the American Medical Association* 2002;12:1471–1472. [PubMed: 12243633]
- Tabachnick, BG.; Fidell, LS. *Using Multivariate Statistics*. New York: Harper Collins; 1996.
- Vasko RC, Brunner DP, Monahan JP, Doman J, Boston JR, El-Jaroudi A, Miewald J, Buysse DJ, Reynolds CF, Kupfer DJ. Power spectral analysis of EEG in a multiple-bedroom, multiple-polygraph sleep laboratory. *International Journal of Medical Informatics* 1997;46:175–184. [PubMed: 9373779]
- Vitiello MV, Moe KE, Prinz PN. Sleep complaints cosegregate with illness in older adults: clinical research informed by and informing epidemiological studies of sleep. *Journal of Psychosomatic Research* 2002;53:555–559. [PubMed: 12127171]
- Ware, JE.; Kosinski, M.; Keller, SD. *SF-36 Physical and Mental Health Summary Scales: A User's Manual*. Boston: Health Assessment Lab, New England Medical Center; 1994.
- Ware JE, Sherbourne CD. The MOS-36-Item short form health survey (SF-36): I. Conceptual framework and item selection. *Medical Care* 1992;30:473–483. [PubMed: 1593914]
- Wohlgemuth WK, Edinger JD, Fins AI, Sullivan RJ. How many nights are enough? The short-term stability of sleep parameters in elderly insomniacs and normal sleepers. *Psychophysiology* 1999;36:233–244. [PubMed: 10194970]

Table 1

Background and sleep characteristics

Variable	mean (s.d.) or percent
Age (years)	73.97 (6.62)
Sex (percent male)	27%
MOS Physical Health Component Summary	46.42 (10.09)
MOS Mental Health Component Summary	53.98 (9.37)
Ongoing Financial Strain (percent "somewhat" to "very upsetting")	25%
PSQI Subjective Sleep Complaints	6.45 (3.91)
Apnea-Hypopnea Index	8.41 (5.78)
Periodic Leg Movement Index	5.25 (4.68)
Time Spent Asleep (minutes) ¹	347.66 (82.80)
Sleep Latency (minutes) ²	26.55 (27.90)
Wakefulness After Sleep Onset (minutes) ³	73.82 (37.68)
Sleep Efficiency (percent) ⁴	79.12 (8.62)
NREM Delta Sleep (percent) ⁵	3.89 (5.22)
REM Sleep (percent) ⁶	22.70 (6.18)

¹ Times spent asleep = total recording period minus (sleep latency + wakefulness after sleep onset)

² Sleep latency = minutes from lights out to the first of 10 minutes of stage 2 or deeper sleep interrupted by no more than 2 minutes of stage 1 or wakefulness

³ Wakefulness after sleep onset = total number of minutes scored as awake, following sleep onset

⁴ Sleep efficiency = (time spent asleep/total recording period)*100

⁵ NREM Delta Sleep = (total number of minutes scored as stage 3 or 4 NREM sleep/time spent asleep)*100

⁶ REM Sleep = (total number of minutes scored as stage REM sleep/time spent asleep)*100

Table 2
Univariate relationships among ongoing financial strain and sleep

Outcome	Ongoing Financial Strain		Test Statistic
	“Absent” or “Not Upsetting” N = 56 Mean (s.d.)	“Somewhat” or “Very Upsetting” N = 19 Mean (s.d.)	
PSQI Global Sleep Quality	6.29 (3.94)	7.11 (3.86)	F(1,72)=0.61
Time Spent Asleep ¹ (minutes)	349.32 (92.54)	342.79 (44.57)	F(1,73)=0.39
Sleep Latency (minutes) ²	23.53 (24.52)	35.44 (35.36)	F(1,73)=3.86*
Wakefulness After Sleep Onset ¹ (minutes)	68.94 (37.40)	87.93 (35.75)	F(1,73)=4.08*
Sleep Efficiency (percent)	80.93 (8.22)	73.80 (7.68)	F(1,73)=10.99***
NREM Delta Sleep ¹ (percent)	4.22 (5.44)	2.90 (4.49)	F(1,72)=0.46
REM Sleep (percent)	22.85 (6.43)	22.21 (5.51)	F(1,73)=0.15

¹Time spent asleep, wakefulness after sleep onset, and percent delta sleep were square root transformed prior to analyses

²Sleep latency was log transformed prior to analyses

* p < .05

** p < .01

*** p < .001

Table 3
Relationships among ongoing financial strain and sleep, adjusting for age, sex, study group, overall physical health, and overall mental health

Outcome	Age Standardized Beta	Sex Standardized Beta	Bereaved & Caregivers Standardized Beta	Insomnia Patients Standardized Beta	Physical Health Standardized Beta	Mental Health Standardized Beta	Ongoing Financial Strain Standardized Beta
Sleep Latency ¹	-0.17	-0.18	-0.11	-0.27	-0.35*	-0.01	0.14
Wakefulness After Sleep Onset ²	0.26	-0.08	0.19	0.12	-0.19	0.05	0.24
Sleep Efficiency	-0.23	0.09	-0.21	-0.09	0.28*	-0.09	-0.34**

¹ Sleep latency was log transformed prior to analyses

² Wakefulness after sleep onset was square root transformed prior to analyses

* p < .05

** p < .01

*** p < .001