Published in final edited form as:

J Am Geriatr Soc. 2011 September ; 59(9): 1697–1704. doi:10.1111/j.1532-5415.2011.03569.x.

Association Between Insomnia Symptoms and Weight Change in Older Women: Caregiver—Study of Osteoporotic Fractures Study

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Abstract

OBJECTIVES—To determine whether self-reported insomnia symptoms were associated with weight change in older women and whether caregiving, comorbidities, sleep medication, or stress modified this association.

DESIGN—One-year prospective study conducted in four communities from 1999 to 2003 nested within a larger cohort study.

SETTING—Home-based interviews.

PARTICIPANTS—Nine hundred eighty-eight participants (354 caregivers and 634 noncaregivers) from the Caregiver—Study of Osteoporotic Fractures.

MEASUREMENTS—Self-reported insomnia symptoms in the previous month: trouble falling asleep, trouble staying asleep, and waking early and having trouble getting back to sleep. Weight was measured at baseline and 12 months.

RESULTS—The average weight change was -1.9 ± 7.8 pounds. Trouble staying asleep was significantly associated with an average weight loss of 1.3 pounds ($P = .03$) in multivariable analyses. Neither of the other insomnia symptoms was associated with weight change. Use of sleep medications modified the association between trouble falling asleep (interaction term $P = .03$) and weight change. Insomnia symptoms were associated with weight loss only in women not taking sleep medications. Neither caregiving status, presence of multiple comorbidities, nor stress modified the association.

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Author Contributions: Craig S. Ross: study concept, data analysis, drafting and revision of the manuscript. Sonia Ancoli-Israel and Susan Redline: interpretation of the results and critical review of the manuscript. Katie Stone: study design, obtaining funding for the SOF parent study, interpretation of results, and critical review of the manuscript. Lisa Fredman: study design, analytic approach, interpretation of results and revisions to the manuscript, obtaining funding, and overseeing all project activities for Caregiver—SOF.

Conflict of Interest: Sonia Ancoli-Israel is a consultant for Ferring Pharmaceuticals Inc., GlaxoSmithKline, Merck, NeuroVigil, Inc., Neurocrine Biosciences, Pfizer, Philips Respironics, Purdue Pharma LP, Sanofi-aventis, Sepracor, Inc., and Schering-Plough. She has relevant grants and contracts from Litebook, Inc. and the National Institutes of Health (NIH).

CONCLUSION—Trouble staying asleep was associated with weight loss over 12 months in older women. Practitioners should inquire about sleep habits of patients presenting with weight loss, because this may identify a marker of declining health and may be a factor that can be modified.

Keywords

insomnia; weight change; medications; aged; women

Insomnia symptoms are highly prevalent in older adults (> 65), with 57% reporting at least one chronic sleep complaint, most notably trouble initiating or maintaining sleep.¹ In addition, studies have found that older caregivers report more insomnia symptoms than noncaregivers,² particularly caregivers for relatives with dementia.^{2,3} Care-givers also report more variable sleep quality than non-caregivers and are more likely to have conditions associated with disrupted sleep,^{4,5} such as stress, depression, and poor subjective well-being.⁶ Sleep problems often present with diseases such as heart disease, arthritis, diabetes mellitus, stroke, and lung disease, many of which are also associated with weight change,⁷ although results of studies of the association between sleep and weight change have been mixed, possibly because of cross-sectional research design or residual confounding due to multiple comorbidities.⁸ Whether insomnia symptoms were associated with weight change over 12 months was evaluated in a sample of older women (mean age 80), as well as whether this association was stronger in caregivers than noncaregivers.

The type of insomnia symptom may influence weight change through biological and behavioral mechanisms.^{9,10} Persons who have trouble falling asleep or staying asleep may consume more calories at night, leading to weight gain. Alternatively, those having trouble staying asleep may experience shorter total sleep duration, which has been associated with lower leptin (an appetite suppressant) and higher ghrelin (an appetite stimulant) level in two studies of adults (mean ages 47 and 53), either of which may stimulate weight gain.^{9,10} Disrupted night-time sleep may also selectively reduce time in slow-wave sleep, a stage associated with numerous endocrine functions. Less slow-wave sleep has been associated with altered glucose metabolism¹¹ and obesity.¹² A further understanding of specific insomnia symptoms and weight change may provide insight into the likely behavioral or biological mechanisms and inform treatment studies.

The association between self-reported insomnia symptoms at baseline and weight change over 12 months was examined in older women in the Caregiver—Study of Osteoporotic Fractures (SOF) Study. Based on associations between short sleep duration and weight gain in cross-sectional studies,^{8,13,14} it was hypothesized that women who reported each of three insomnia symptoms—trouble falling asleep, trouble staying asleep, and waking early and having trouble falling back asleep—would experience greater weight gain over 12 months than women who did not report these problems. It was further expected that caregiver status, use of sleep medications, presence of multiple comorbidities, and perceived stress would modify the amount of weight change.

METHODS

The participants in these analyses were enrolled in SOF, which included 9,704 women aged 65 and older recruited between 1986 and 1988 from population-based listings in four areas of the United States: Baltimore County, Maryland; Minneapolis, Minnesota; Portland, Oregon; and the Monongahela Valley, Pennsylvania.¹⁵ Women were excluded if they were unable to walk without help or had a history of bilateral hip replacement; African-American women were initially excluded because of their low incidence of hip fracture.

In 1997, a cohort of 662 older African-American women with functional characteristics that were similar to those of the baseline SOF sample was added. Approximately every 2 years, SOF participants have a comprehensive evaluation. The Caregiver—SOF sample included members of the original and African-American SOF cohorts who participated in the sixth biennial examination, which took place between 1997 and 1999.

Caregiver—SOF Participants

The Caregiver—SOF sample was identified in two phases.¹⁶ The first phase was a caregiver screening questionnaire administered to 5,952 SOF participants at their sixth biennial examination, between 1997 and 1999 (Appendix 1). SOF participants were not screened if they were cognitively impaired or lived in nursing homes or other long-term care facilities. The second phase began in 1999 and consisted of re-administering the screening questionnaire by telephone to all caregivers and a subset of noncaregivers who had been identified using the initial caregiver screening questionnaire.

The caregiver screening questionnaire asked participants whether they currently helped a relative or friend, without pay, to perform each of seven instrumental activity of daily living (IADL) tasks and seven basic activity of daily living (ADL) tasks because that person was physically, cognitively, or psychologically unable to perform the task independently. Participants were categorized as caregivers if they helped one or more persons with at least one IADL or ADL task and as noncaregivers if they did not help anyone with these tasks, similar to methods used in previous studies.¹⁷

For each caregiver participant, one or two noncaregivers were matched according to SOF site, age, race, and ZIP code. Recruitment methods are described in detail elsewhere.¹⁶

The institutional review boards at each SOF site and at the Boston University Medical Center approved the Caregiver—SOF study. All participants provided written informed consent.

Data Collection

Home-based, face-to-face interviews were conducted with respondents within 2 weeks of completion of the telephone reevaluation of caregiver status (Caregiver—SOF baseline interview) and 12 months later.

Measures

Insomnia Symptoms—Insomnia symptoms were measured at baseline using three questions from the Caregiver—SOF questionnaire that asked about the frequency in the past month (never, sometimes, often) of experiencing trouble falling asleep, trouble staying asleep, or waking early and having trouble falling back asleep. Each participant responded to all three insomnia symptom questions separately. Responses were dichotomized as often versus sometimes or never.

Weight Change—Participants were weighed in their clothes without shoes at each interview. Those who refused to be weighed, were too fatigued, or were unable to be weighed at follow-up were excluded. Weight was measured on portable scales that were recalibrated at the SOF clinics after each interview.

Medications—Participants reported whether they used over-the-counter sleep medications. In addition, interviewers recorded prescription medications; these were coded for indication according to the Physician's Desk Reference. Medications included in these analyses were any sleep medications and prescription medications for anxiety or depression.

Caregiver Status—Participants who helped one or more persons with at least one IADL or ADL task at baseline were classified as caregivers.

Multiple Comorbidities—Participants were classified as having multiple comorbidities if they reported that a physician or healthcare provider had ever told them that they had more than one of the following comorbid health problems: cancer or leukemia, diabetes mellitus, emphysema, high blood pressure, or stroke. Self-report of being diagnosed with heart disease was included as a separate variable.

Covariates—Sociodemographic variables included age, marital status (married vs other), highest education level (<12, 12–16, 17 years), and self-reported race (white or nonwhite). Participants reported their ability to perform seven IADLs and seven ADLs; a single variable was created to indicate the presence of IADL (2 vs 0–1) or ADL (2 vs 0–1) limitations. Stress was measured using the 14-item Perceived Stress Scale.¹⁸ Depression was measured using the 20-item Center for Epidemiologic Studies Depression Scale and dichotomized at 16.¹⁹ Health behaviors included current cigarette smoking (yes/no) and frequency of having consumed alcoholic beverages in the past month (nonuser, 1 day, 2–3 days, 1 days/week). Participants who self-reported walking for exercise at least 1 day in the past 2 weeks, regardless of the duration of walking, were classified as exercisers (yes/no).

Statistical Analyses

Frequency distributions were analyzed for categorical variables, and means and standard deviations were analyzed for weight change. Potential confounders were identified in bivariate analyses as being associated with any of the insomnia symptoms and weight change. Additional potential confounders were identified from a review of published literature.

For each insomnia symptom, an unadjusted and adjusted linear regression analysis that initially included all potential confounders as covariates was performed. Manual backward selection procedures were used to remove covariates that were not statistically significant or did not change the relationship between the insomnia symptom and weight change by at least 10%. To test for effect modification, all main effects and interaction terms for the modifier by each insomnia symptom were included (e.g., caregiver status × insomnia symptom). In a subanalysis, the multivariate models were repeated using a 10% trimmed sample to exclude subjects with extreme weight changes.

All analyses were conducted using SAS version 9.1 (SAS Institute, Inc., Cary, NC).

RESULTS

Of the original sample of 1,069 participants, 27 died and 15 withdrew from the SOF or the Caregiver—SOF study during the follow-up period, 38 were missing weight information at the baseline or follow-up interview, and one was missing insomnia symptom information, leaving 988 women for analysis (Appendix 1). There were no significant differences between study participants and those missing weight or insomnia symptom information.

Study Sample Characteristics

The study sample had an average age of 81.2 ± 3.7 , 86.2% were white, 37.5% were married, and 67.4% had some college education (Table 1). Approximately 12% of the participants were using sleep medications, caregivers made up 35.8% of the sample, and 31% of the participants reported multiple comorbidities. Caregivers taking sleep medications were more likely to have intensive caregiving roles than those not taking sleep medications; they

provided significantly more hours of care per day (3.8 vs 2.8 hours) and more physically intensive care (71% vs 50%) and were more likely to be taking antianxiety medications (22% vs 4%).

At baseline, 21% of women reported that they often had trouble staying asleep overnight in the last month, 13% reported often having had trouble falling asleep, and 14% reported often waking early and having trouble falling back asleep (Table 1). Each of the three insomnia symptoms was moderately correlated with each other (for all correlations, Spearman rho was 0.31 to 0.50, $P < .05$). The average weight change over 12 months was -1.9 ± 7.8 pounds.

Unadjusted and Adjusted Regression Models

Women who reported trouble staying asleep lost more weight than those who did not in unadjusted analysis (mean difference -1.57 , 95% confidence interval (CI) -2.78 to -0.36) and in analyses adjusted for confounders (mean difference -1.34 , 95% CI -2.58 to -0.11) (Table 2). Neither women who reported trouble falling asleep nor those who reported trouble waking early experienced weight change in crude (mean difference 0.26 , 95% CI -1.17 – 1.70 for trouble falling asleep; mean difference -0.37 , 95% CI -1.80 – 1.06 for trouble waking early) or adjusted analyses (adjusted mean difference 0.57 , 95% CI -0.89 – 2.03 for trouble falling asleep; adjusted mean difference -0.07 , 95% CI -1.53 – 1.38 for waking early). Final multivariate models were adjusted for age, stress, and heart disease, which was the only comorbid condition that was a confounder of the associations between insomnia symptoms and weight change. High depressive symptoms were excluded from the multivariate model because of their association with perceived stress.

Effect Modification According to Caregiving Status, Comorbidities, Sleep Medication Use, and Stress

Use of sleep medications modified the association between insomnia symptoms and weight change for women having trouble falling asleep (interaction term $P = .03$). Weight loss was observed only in women not taking sleep medications (Table 2 and Figure 1A–C). There was some evidence of weight gain in participants taking sleep medications, but these findings were not statistically significant. Neither caregiving status, having multiple comorbidities, nor stress modified the association between any of the insomnia symptoms and weight change, although in caregivers who reported trouble staying asleep, the number of physical activities of caregiving (performed 15 minutes/day) had a borderline association with weight gain ($\beta = 0.86$, $P = .06$) after controlling for use of sleep medications.

Subanalysis Excluding Subjects with Extreme Weight Change

The analysis was repeated excluding subjects in the top and bottom 5% of the distribution. The association between trouble staying asleep and weight loss remained statistically significant ($\beta = -1.04$, $P = .01$). Neither of the other two insomnia symptoms was associated with weight change in this subanalysis.

DISCUSSION

In this community-based study, older women who reported often having trouble staying asleep lost significantly more weight over 12 months than those who did not. Neither trouble falling asleep nor waking early and having trouble going back to sleep was associated with weight change.

To the knowledge of the authors, this is the first prospective study of the association between insomnia symptoms and weight change in older women. One intervention study

showed weight loss over 7 years in women aged 70 to 79 in the control group, in contrast to weight gain in women aged 50 to 59.²⁰ The results of the current study are in contrast with results of studies in younger populations that found that disrupted or shortened sleep was associated with weight gain.¹³ The findings of no association between trouble falling asleep or trouble waking early with weight change are consistent with results of previous studies of sleep duration and weight change in older adults,^{13,14} although the finding of statistically significant weight loss for those reporting trouble staying asleep has not been previously reported.

Studies that have found associations between shorter sleep duration and weight gain have mainly been cross-sectional, and few have focused on older adults.^{8,13,14} Longitudinal studies of younger adults (age 27–40)²¹ and children (<age 10)²² have found associations between sleep duration and weight gain. In older adults (age 60), one cross-sectional study reported no association between short sleep duration and body mass index,²³ whereas another found an association between short sleep duration and overweight.²⁴ In contrast to cross-sectional studies that cannot distinguish the temporal relationship, the longitudinal design of the current study provided information on the influence of insomnia symptoms on subsequent weight change in a population of older women.

Use of sleep medications modified the association between insomnia symptoms and weight change for women having trouble falling asleep. Weight loss was associated only with women not taking sleep medications, whereas average weight gain was seen in women taking sleep medications. It is possible that treating insomnia symptoms with sleep medications may mitigate the weight effects of disrupted sleep.

Pathways from Disrupted Sleep to Weight Loss

Self-report of interrupted sleep may be a marker for deprivation of slow-wave sleep, which has been associated with metabolic changes including reduced hypothalamic–pituitary–adrenal hormone, increased growth hormone, and increased prolactin levels.¹¹ Although studies of predominantly younger populations have shown associations between sleep deprivation and weight gain, frailty may confound these associations in older populations. Disturbed sleep has been associated with frailty in older men,²⁵ and weight loss is one marker of a frailty phenotype in older adults.²⁶ Physiological correlates of frailty include endocrine changes such as increased cortisol, decreased growth hormones and decreased sex hormone levels.²⁶ These endocrine changes have been associated with decreased lean body mass and bone mineral density in older adults, all of which may be marked by weight loss.²⁷ Furthermore, disrupted sleep has been associated with changes in cortisol levels.¹⁰ Therefore, future research into the association between disrupted sleep, endocrine changes, and weight loss in older adults may provide greater insight into these results.

Sarcopenia may be another pathway between sleep disruption and weight loss. Sarcopenia, the wasting of muscle tissue, is associated with weight loss in older adults and has been hypothesized to precede frailty.²⁸ Clinical indicators of sarcopenia include changes in gait speed and grip strength.²⁹ The current study did not include these clinical indicators, but future research may examine the associations between trouble staying asleep and these indicators of sarcopenia.

Physical activity has been shown to mitigate sarcopenia.²⁶ The findings of the current study provide additional support for this finding; caregivers who reported trouble staying asleep and who also performed more physical activities of caregiving gained weight, on average. It is possible that the physical activity of caregiving mitigated muscle wasting and prevented weight loss in this group.

Physical Dysfunctions Marked by Trouble Staying Asleep

Different physical dysfunctions that might be associated with a self-report of trouble staying asleep were considered. Nocturia might provide a plausible explanation. Nocturia is highly prevalent in older adults who self-report insomnia, with almost 53% of subjects reporting nocturia in one study.³⁰ While information was not available about the number of nighttime voids for participants, women whose sleep was regularly interrupted to go to the bathroom may have been more likely to associate this disruption with “trouble staying asleep” than with either of the other two insomnia symptoms that were evaluated.

Other physical dysfunctions that a self-report of trouble staying asleep may indicate include depression or stress, chronic pain, restless legs syndrome, and sleep apnea.⁷ The current study controlled for stress, which was strongly associated with depression, but lacked information to assess other associations; exploring these possible explanations should be investigated in future research.

This study had several limitations. First, the measures of insomnia symptoms were based on self-report and did not focus on sleep duration, which is the basis of much research on sleep disruption and weight change, but these sleep questions were validated in a prior study of objective and subjective sleep quality and were correlated with weekday and weekend sleep time in older women.³¹ An attempt was made to assess whether weight loss was intentional, but the study question on intentional weight loss covered the previous 6 months, which was difficult to relate to the total follow-up period. The analyses were limited to 12 months of follow-up, and absolute weight changes in this time interval were smaller than would be expected over a year. Missing information on insomnia symptoms and weight change at later interviews prevented a longer follow-up period from being used, although the changes observed were statistically significant, and longer studies would be expected to show larger effects. Residual confounding is a potential concern, because it was not possible to control for sleep apnea, which has been shown to be strongly associated with disrupted sleep and weight change. Nonetheless, this study had several strengths, including its longitudinal design, multisite cohort, and weight loss findings between trouble staying asleep and weight change that withstood a subanalysis that removed participants with extreme weight change.

In conclusion, the results suggest that interrupted sleep in older women is associated with weight loss. If older women present with unexplained weight loss, practitioners may wish to inquire about insomnia symptoms, which may be linked to the weight loss. Future clinical studies should test whether improving sleep in older women reverses their weight loss. Given that weight loss and loss of muscle strength are risk factors for frailty in older persons, this study presents areas for future research that may improve health outcomes for this population.

Acknowledgments

The authors thank Martha Werler, DSc, and the students of the EP817 Guided Epidemiology Study class at Boston University School of Public Health for their review and comments on the manuscript.

The SOF is supported by the NIH, National Institute on Aging (NIA) under Grants AG05407, AR35582, AG05394, AR35584, AR35583, R01 AG005407, R01 AG027576-22, 2 R01 AG005394-22A1, and 2 R01 AG027574-22A1. Additional funding support came from R01 AG18037 for the Caregiver—SOF Study, R01 AG08415 (Dr. Ancoli-Israel), and T32 HD052458 (Mr. Ross).

Sponsor's Role: None.

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APPENDIX 1: FLOWCHART OF CREATION OF CAREGIVER—STUDY OF OSTEOPOROTIC FRACTURES SAMPLE AND SAMPLE FOR CURRENT ANALYSES

Figure 1. Trouble (A) staying asleep, (B) falling asleep, and (C) waking early: adjusted mean weight change and 95% confidence interval (CI) over 12 months, stratified according to sleep medication use, caregiver status, and multiple comorbidities, in 988 Caregiver—Study of Osteoporotic Fractures participants.

Table 1

Distribution of Insomnia Symptoms, Weight Change, and Covariates at Baseline and 12-Month Follow-Up in 988 Caregiver—Study of Osteoporotic Fractures Participants

Characteristic	Value
Insomnia symptoms (participants were asked about all three), %	
Trouble staying asleep often	20.5
Trouble falling asleep often	13.4
Waking and having trouble falling back asleep often	13.6
Weight, pounds, mean $\pm$ SD	
Baseline	150.3 $\pm$ 30.4
At 12 months	148.4 $\pm$ 30.3
Change	−1.9 $\pm$ 7.8
Demographic	
Age, mean $\pm$ SD	81.2 $\pm$ 3.6
Nonwhite, %	13.8
Married, %	37.5
Education, years, %	
<12	12.2
12–16	67.4
17	20.5
Comorbidities and baseline health	
Heart trouble, %	27.9
2 activity of daily living or instrumental activity of daily living limitations, %	7.1
2 comorbidities	17.3
Perceived stress score, mean $\pm$ SD	16.0 $\pm$ 7.3
Depressive symptoms (Center for Epidemiologic Studies Depression Scale score $\geq$ 16), %	11.0
Medications, %	
Anxiety medications	4.5
Depression medications	10.4
Over-the-counter or prescription sleep medications	11.5
Health behaviors, %	
Currently cigarette smoker	4.9
Current alcohol consumption	
Nonuser	53.7
At least 1 day per month	20.6
2–3 days per month	12.8
At least 1 day per week	13.0
Walks for exercise, %	37.7
Caregiver, %	35.7

SD = standard deviation.

Table 2

Associations Between Insomnia Symptoms and Mean Weight Change over 12 Months: Overall Associations and Modification According to Sleep Medication Use, Caregiving Status, and Multiple Comorbidities in 988 Caregiver—Study of Osteoporotic Fractures Participants

Insomnia Symptom	Weight Difference, Pounds, Mean (95% Confidence Interval)	P-Value for Mean Difference
Unadjusted association		
Trouble staying asleep	−1.57 (−2.78 to −0.36)	.01
Trouble falling asleep	0.26 (−1.17–1.70)	.72
Trouble waking early	−0.37 (−1.80–1.06)	.61
Adjusted association		
Trouble staying asleep	−1.34 (−2.58 to −0.11)	.03
Trouble falling asleep	0.57 (−0.89–2.03)	.44
Trouble waking early	−0.07 (−1.53–1.38)	.92
Modification according to sleep medication use ³		
Trouble staying asleep		
Use of sleep medications	0.80 (−3.06–4.66)	.95
No use of sleep medications	−1.94 (−3.73 to −0.15)	.03
Trouble falling asleep		
Use of sleep medications	3.35 (−0.62–7.32)	.13
No use of sleep medications	−0.43 (−2.66–1.80)	.96
Trouble waking early		
Use of sleep medications	1.61 (−2.97–6.18)	.80
No use of sleep medications	−0.47 (−2.56–1.62)	.94
Modification according to caregiving status [†]		
Trouble staying asleep		
Caregiver	−0.41 (−2.99–2.18)	.98
Noncaregiver	−1.93 (−3.97–0.10)	.07
Trouble falling asleep		
Caregiver	0.12 (−2.99–3.22)	>.99
Noncaregiver	0.84 (−1.56–3.24)	.80
Trouble waking early		
Caregiver	−0.11 (−3.11–2.89)	>.99
Noncaregiver	−0.07 (−2.51–2.38)	>.99
Modification according to presence of multiple comorbidities [‡]		
Trouble staying asleep		
Multiple comorbidities	−1.32 (−3.15–0.51)	.25
No multiple comorbidities	−1.68 (−5.06–1.71)	.58
Trouble falling asleep		
Multiple comorbidities	0.16 (−2.03–2.36)	>.99
No multiple comorbidities	1.69 (−2.17–5.56)	.67

Insomnia Symptom	Weight Difference, Pounds, Mean (95% Confidence Interval)	P-Value for Mean Difference
Trouble waking early		
Multiple comorbidities	−0.25 (−2.45–1.95)	.99
No multiple comorbidities	0.28 (−3.51–4.07)	>.99

All models adjusted for age, stress, and heart trouble.

* Interaction term *P*-values: trouble staying asleep, .10; trouble falling asleep, .03; trouble waking early, .28.

[†] Interaction term *P*-values: trouble staying asleep, .23; trouble falling asleep, .63; trouble waking early, .98.

[‡] Interaction term *P*-values: trouble staying asleep, .81; trouble falling asleep, .79; trouble waking early, .75.