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Anxiety Symptoms and Objectively Measured Sleep Quality in Older Women

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Abstract

Objectives—Few studies have examined the association between anxiety symptoms and objectively measured sleep quality in older adults. We determined this association in a large cohort of very old community-dwelling women.

Design—Cross-sectional.

Setting—Participants' homes, sites of the Study of Osteoporotic Fractures.

Participants—3,040 women (mean age = 83.6 years) enrolled in a prospective study of aging.

Measurements—Participants completed the Goldberg Anxiety Scale (ANX), the 15-item Geriatric Depression Scale (GDS), and ≥3 nights of *actigraphy*--a means of measuring sleep by recording movement using a device called an *actigraph*. Elevated anxiety symptoms were defined as ANX ≥6. Elevated depressive symptoms were defined as GDS ≥6.

Results—Participants' mean ANX score was 1.4 (SD = 2.2); 9.2% (*n* = 280) had ANX ≥6. Elevated anxiety symptoms were associated with greater odds of poor sleep efficiency (odds ratio (OR) = 1.73, 95% confidence interval (CI) 1.34, 2.23) and time awake after sleep onset (OR = 1.64, 95% CI 1.27, 2.11). Associations remained after adjustment for GDS ≥6, anti-anxiety medications, and other potential confounders (sleep efficiency OR = 1.50, 95% CI 1.15, 1.97; time awake after sleep onset OR = 1.33, 95% CI 1.01, 1.75). Anxiety symptoms were not associated with other sleep parameters.

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Conclusion—Anxiety symptoms are associated with poor objectively measured sleep efficiency and elevated sleep fragmentation in very old women. These associations are independent of elevated depressive symptoms, medical co-morbidities, and use of anti-anxiety medications. Elevated anxiety is a robust predictor of lower sleep quality in this population.

Keywords

anxiety; sleep; older adults; depression; actigraphy

Sleep disturbances are common among older adults. Insomnia--characterized by difficulty initiating or maintaining sleep(1)--is among the most common complaints made by older people to their physicians.(2) In a recent study of women aged 73 to 78 years of age, 63% reported difficulty sleeping including insomnia and other complaints.(3) Poor sleep quality has been linked to numerous negative outcomes, including cognitive and functional impairment (4,5) and cognitive decline.(6,7) A broad literature supports an association between symptoms of depression and poor sleep quality in older adults.(8-11)

Like sleep disturbances, anxiety is common among older people, and anxiety disorders might even be more prevalent in this population than both depression and dementia.(12,13) High levels of anxiety have been shown to predict a range of adverse outcomes in this population, including mortality,(14,15) and even anxiety symptoms that fail to meet criteria for a disorder have been linked with lower functioning in older adults.(16) However, relatively few studies have investigated the degree to which anxiety symptoms are predictive of poor sleep quality in elders. In addition, as anxiety symptoms often co-occur with depressive symptoms,(17) it is not clear if anxiety symptoms are independently associated with poor sleep quality after adjusting for depressive symptoms. An improved understanding of the association between anxiety and sleep could inform the development of interventions to treat both sleep disturbance and anxiety symptoms--two considerable problems among community-dwelling elders.

We investigated the association between elevated anxiety symptoms and objectively measured sleep quality in a large sample of very old community-dwelling women, accounting for significant depressive symptoms. We also examined the extent to which use of anti-anxiety medications explained this association. We hypothesized that symptoms of anxiety would be associated with poor sleep quality in this population, both prior to and after adjusting for the presence of significant depressive symptoms, use of anti-anxiety medications, and other potential confounders. We also explored the association between anxiety symptoms and napping time in elders, before and after adjustment for relevant covariates.

Methods

Participants

Participants were older women enrolled in the Study of Osteoporotic Fractures (SOF), an observational study of primarily Caucasian, community-dwelling women aged 65 years and older from four metropolitan areas (Portland, OR; Minneapolis, MN; Pittsburgh/Monongahela Valley, PA; Baltimore, MD). All women provided informed consent for participation at each respective clinic site. Enrollment began between September 1986 and October 1988; participants were re-assessed at biannual follow-up visits. The 9,704 participants comprising the original cohort were recruited via community listings and mailed announcements. 662 African American women were recruited between February 1997 and February 1998. Women were excluded from the baseline visit if they required assistance with ambulation or had previously received bilateral hip replacement. Further details of the study have been published elsewhere.(18) Our current study focused on women participating in the SOF Visit 8 (15 years into the SOF), which occurred between January 2002 and February 2004, and included data

from the 3,040 women who conducted actigraphy and completed measures of anxiety and depression.

Measures

Demographic information (age, ethnicity, years of education) were recorded at baseline. At Visit 8, participants completed questionnaires concerning medical history and health habits (i.e., smoking, alcohol use, and walking for exercise). Cognition was measured at Visit 8 using the Mini-Mental State Exam(19) and the Trailmaking Test, Part B.(20) Participants were asked to bring in all medications taken daily or almost daily during the prior thirty days. Medications were categorized according to a computerized coding dictionary according to brand or generic names.(21) In the present study, we were interested in medications commonly used to treat anxiety symptoms that also can affect sleep, such as benzodiazepines (BZD) and antidepressants.

Anxiety was measured by the 9-item Goldberg Anxiety Scale (ANX),(22) which assesses the presence of cognitive, affective, and somatic anxiety symptoms over the preceding month, using a yes/no response format. The first four items are screening items. Respondents must endorse at least two of these to warrant completion of the remaining five. ANX scores of 5 indicate a 50% chance of clinically significant anxiety, and the probability of a significant anxiety disturbance increases rapidly with higher scores.(22) To increase the likelihood that participants without significant anxiety problems would be categorized as such, we selected an ANX score ≥6 to indicate elevated anxiety symptoms. Depression was measured by the 15-item Geriatric Depression Scale (GDS), on which scores ≥6 represent clinically significant depressive symptoms.(23)

Sleep was measured via *actigraphy*, a well-validated,(24) unobtrusive measure of sleep involving the recording of movement using an actigraph. Actigraphs (SleepWatch-O; Ambulatory Monitoring, Inc., Ardsley, NY) were worn on participants' non-dominant wrists, and measured movement using a piezoelectric bimorph-ceramic cantilevered beam that creates a voltage when the unit is moved. Voltages were recorded continuously and summarized in 1-min epochs. Participants completed at least three 24-hour periods of actigraphy. Data were analyzed using ActionW-2 software (Ambulatory Monitoring, Inc.). The following sleep parameters were derived using the University of California San Diego algorithm(25,26): total sleep time (average number of minutes slept per night while in bed); sleep efficiency (average percentage of time asleep per night while in bed); time awake after sleep onset (average number of minutes awake after initial onset of sleep, a measure of sleep fragmentation); sleep onset latency (average number of minutes between going to bed and falling asleep); and napping time (average number of minutes spent asleep while out of bed).

Statistical Analyses

Analyses were conducted using STATA SE v. 9.2 (StataCorp). ANX score ≥6 was our primary predictor. Outcomes were sleep parameters. We first compared characteristics of participants at SOF Visit 8, by anxiety symptom severity (ANX ≤5, ≥6) (Table 1). Possible confounders were identified on the basis of their association with anxiety and/or sleep disturbances in prior studies and association with both ANX ≥6 and most sleep parameters, at the $p < .10$ level (using t-tests assuming unequal variances for normally distributed data, Mann-Whitney tests for skewed data, and χ^2 tests for categorical data).

To determine if elevated anxiety symptoms were associated with a greater odds of clinically significant sleep disturbances, we conducted a series of logistic regression analyses using an alpha level of <.05 to determine statistical significance. We used the following cut-points for outcomes, to reflect clinically significant sleep disturbances: increased total sleep time:

increased total sleep time >8 hrs (reference = 5-8 hrs); decreased total sleep time <5 hrs (reference = 5-8 hrs); sleep efficiency <80%; time awake after sleep onset ≥90 min; sleep onset latency ≥1 hr; napping >2 hrs. The associations between elevated anxiety and each sleep parameter were assessed in four different models to evaluate the degree to which this association was modified by incremental adjustment for different categories of potential confounders. Model I investigated the simple, bivariate association between ANX ≥6 and sleep parameters; Model II added variables associated with having both ANX ≥6 and any sleep parameters; Model III added GDS score ≥6 as a predictor; and Model IV adjusted for use of anti-anxiety medications.

Results

Demographics

Participants had a mean age of 83.6 years (SD = 3.8) and the majority (89.3%) were Caucasian. On average, they had 12.9 years (SD = 2.6) of education. Participants had a mean ANX score of 1.4 (SD = 2.2) and a mean GDS score of 2.4 (SD = 2.6). Overall. 9.2% of participants (*n* = 280) had ANX score ≥6, and 11.8% (*n* = 360) had GDS score ≥6.

Anxiety Symptoms and Sleep

Compared to those with few anxiety symptoms, women with ≥6 anxiety symptoms were slightly less educated, had a greater number of depressive symptoms, were more likely to have a history of stroke, Parkinson's disease, coronary artery disease, congestive heart failure, chronic obstructive pulmonary disease, osteoarthritis, and to take antidepressant or benzodiazepine medications (see Table 1).

Participants' mean sleep parameters are displayed in Table 2. Compared to participants with few symptoms, those with ANX ≥6 had slightly lower sleep efficiency, and spent more time awake after sleep onset.

In bivariate analyses, compared to those with ANX ≤5, participants with ANX ≥6 had a 73% increase in odds of having sleep efficiency <80% (odds ratio (OR) = 1.73, 95% confidence interval (CI) 1.34, 2.23) (see Table 3, Model I). After adjustment for potential confounders (Model II), this decreased slightly but remained significant (OR = 1.61, 95% CI 1.24, 2.08). After further adjustment for depression, elevated anxiety was associated with a 51% increased odds of low sleep efficiency (OR = 1.51, 95% CI 1.15, 1.97) (Model III). Additional adjustment for antidepressant and BZD use (OR = 1.50, 95% CI 1.15, 1.97) failed to attenuate this association (Model IV).

Similarly, in bivariate analyses, compared to those with few symptoms, women with ANX ≥6 had a 64% increase in odds of time awake after sleep onset ≥90 min (OR = 1.64, 95% CI 1.27, 2.11) (Model I). After adjustment for potential confounders, a 47% increased odds of elevated WASO remained (OR = 1.47, 95% CI 1.14, 1.91) (Model II). After further adjustment for depression, those with elevated anxiety still had a 34% increased odds of high time awake after sleep onset (OR = 1.34, 95% CI 1.03, 1.76) (Model III). This association remained after incremental adjustment for antidepressant and BZD use (OR = 1.33, 95% CI 1.01, 1.75) (Model IV).

No significant associations emerged between elevated anxiety symptoms and either total sleep time or napping in any of the Models.

Discussion

This study investigated the association between elevated symptoms of anxiety and indices of objectively measured sleep quality in a large sample of very old community-dwelling women, before and after adjustment for potential confounders. Consistent with our hypotheses, results indicated that elevated anxiety symptoms were associated with poor sleep efficiency and greater time spent awake after sleep onset (i.e., sleep fragmentation) in this population, after accounting for numerous potential confounders and significant depressive symptoms. Contrary to our hypotheses, elevated anxiety symptoms were not significantly associated with total sleep time. The associations we observed between elevated anxiety and poor sleep quality, measured by actigraph in older women, are consistent with what has been noted in some studies of younger populations. Elevated levels of anxiety have been linked to worse actigraphic sleep in children and younger adults undergoing surgery,(27,28) and in perimenopausal women.(29)

It is important to note that adjustment for elevated depressive symptoms did not substantially alter the association between elevated anxiety symptoms and sleep efficiency or time awake after sleep onset. This suggests that, among very old women, much of the association between anxiety and these indices of sleep quality is independent of depressive symptoms. Similarly, adjustment for use of antidepressants and benzodiazepines scarcely affected the associations between anxiety symptoms and sleep quality. This raises the possibility that untreated anxiety symptoms might account for poor sleep quality in older women that remains even after treatment of depressive symptoms and insomnia.

The few prior studies of older adults that have included a measure of anxiety and an objective measure of sleep have used small samples, did not administer objective sleep measures to all participants (e.g., only to self-reported poor sleepers), or have been limited to older veterans with PTSD, resulting in mixed findings and limited generalizability.(16,30-33) This could explain why our findings of robust associations between anxiety symptoms and sleep parameters conflict with those of some prior studies. In addition, all participants in the present study were women, in whom both anxiety symptoms and sleep complaints are more common, compared with men.(1) Second, although the SOF had very limited exclusion criteria, other studies excluded participants with sleep apnea,(16,31-33) depression or other psychiatric diagnoses,(16) medications that affected sleep,(31-33) cognitive impairment,(16) and relatively low levels of functional impairment.(16) Although we adjusted for some of these variables in the present study, the populations sampled across studies might have differed in other important, unmeasured ways that could have led to divergent results. Finally, our detection of associations where prior studies did not find them could be due to increased statistical power afforded by our large sample.

A number of mechanisms could explain the associations we observed. For instance, recent findings from the animal literature have identified the ventrolateral preoptic nucleus (VLPO) of the hypothalamus as a “sleep switch” that maintains stable sleep or wakefulness.(34) Emotional states leading to arousal, including anxiety, might override the sleep switch and consequently produce wakefulness.(35) Age-related volume reduction in VLPO suggests that older age may confer risk for instability of the sleep switch.(36) This instability might account for the association between anxiety and sleep fragmentation that we observed. In addition, normal age-related volume reductions have been observed in the suprachiasmatic nucleus of the anterior hypothalamus.(37) Such changes can affect circadian rhythms, and might contribute to the reductions in sleep quality that are commonly observed in late life.(37) It is possible that these changes increase older adults’ susceptibility to the effects of anxiety-related arousal on sleep. Alternatively, pathological neurodegenerative processes affecting both circadian arousal and anxiety could underlie this association. Finally, inflammatory processes

could be a mechanism, as both anxiety and sleep disturbances have independently been linked to inflammatory markers.(38,39) Additional research is needed to elucidate mechanisms underlying the sleep-anxiety association in older adults.

This study's strengths are its inclusion of objectively measured sleep parameters, its large well-described sample of very old community-dwelling women, and its statistical adjustment for numerous potential confounders. Its limitations include its homogeneous sample (in terms of both race and sex), and its cross-sectional design. The latter precludes the drawing of conclusions concerning the direction of causality between anxiety and sleep disturbances among older, community-dwelling adults. In addition, the Goldberg Anxiety Scale is not a commonly used measure of late-life anxiety, and has neither been validated extensively in elders, nor in ethnically diverse populations. Thus, longitudinal studies in ethnically diverse samples of elders that use better-validated measures of late-life anxiety are needed to confirm our findings. Finally, although we examined the impact of anti-anxiety medications on the association between anxiety symptoms and sleep parameters, other classes of agents for which we did not adjust (e.g., bronchodilators, cognitive enhancers) could impact both anxiety symptoms and sleep. Future studies are needed that examine the role of a broader spectrum of medications in the anxiety-sleep association.

Our findings of a robust association between anxiety symptoms and poor sleep quality in very old women, after adjustment for significant depressive symptoms and numerous potential confounders indicate that anxiety symptoms are an important, independent correlate of sleep disturbances in older women. This suggests that clinicians treating older adults with anxiety complaints screen for poor sleep quality that could cause or result from anxiety, and *vice versa*. Efficacious behavioral and pharmacologic treatments exist for both anxiety disorders and poor sleep quality in late life. If a causal association can be drawn between these problems, the application of either an anxiety- or sleep-focused intervention could produce relief in both symptoms, maximizing improvements in patients' quality of life. The 2005 NIH State-of-the-Science Conference on Manifestations and Management of Chronic Insomnia in Adults concluded that insomnia often is a co-morbid condition, that it is unclear how treatment of cooccurring conditions could affect insomnia, and that further research in this domain is needed.(40) Initial findings in this domain are promising. For example, Blank et al. recently found that older adults with an anxiety disorder treated with citalopram reported improvements in sleep quality.(41)

Summary and Conclusion

The present study investigated the associations between anxiety and objectively measured sleep quality in a large sample of very old community-dwelling women. We found that elevated anxiety is independently associated with low sleep efficiency and greater sleep fragmentation in this population. This is notable, given that the majority of studies concerning the relation between psychiatric symptoms and sleep quality in older adults have focused on the role of depression in exacerbating sleep disturbances. Our results indicate that anxiety deserves greater recognition--both in research and clinical contexts--as a correlate and potential cause or consequence of sleep disturbances in older adults. Longitudinal studies are needed to investigate potential causal associations between these variables and to inform the development of efficacious behavioral and pharmacological interventions to address them.

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Table 1

Participants' characteristics, by number of anxiety symptoms (N = 3,040)

Characteristics (***mean* ± *SD or N (%)***)	**ANX ≤5** (***n* = 2,760**)	**ANX ≥6** (***n* = 280**)	**Test statistic***	***p*-value**
Age, years	83.6 ± 3.8	83.3 ± 3.4	$z = 1.3$	0.21
Education, years	12.9 ± 2.6	12.4 ± 2.5	$z = 3.4$	0.0007
Caucasian	2,473 (89.6)	243 (86.8)	$\chi^2 = 2.1$	0.15
Geriatric Depression Scale	2.1 ± 2.3	5.2 ± 3.4	$z = -16.1$	< 0.0001
Geriatric Depression Scale ≥6	246 (8.9)	114 (40.7)	$\chi^2 = 246.3$	< 0.001
MMSE score	27.8 ± 2.0	28.0 ± 1.7	$z = -0.4$	0.65
Trails B (seconds to completion)	166.3 ± 148.2	163.4 ± 87.0	$z = -1.2$	0.24
History of stroke	352 (12.8)	48 (17.1)	$\chi^2 = 4.3$	0.04
Alzheimer disease	64 (2.3)	3 (1.1)	$\chi^2 = 1.8$	0.18
Parkinson's disease	20 (0.7)	6 (2.1)	$\chi^2 = 6.0$	0.01
coronary artery disease	530 (19.2)	79 (28.2)	$\chi^2 = 12.9$	< 0.001
congestive heart failure	221 (8.0)	36 (12.9)	$\chi^2 = 7.7$	0.005
COPD	321 (11.6)	52 (18.6)	$\chi^2 = 11.4$	0.001
osteoarthritis	1,041 (37.7)	140 (50.0)	$\chi^2 = 16.1$	<0.001
rheumatoid arthritis	230 (8.3)	32 (11.4)	$\chi^2 = 3.1$	0.08
Current smoker	76 (2.8)	9 (3.2)	$\chi^2 = 0.2$	0.66
Number of cups of coffee/day	1.2 ± 1.5	1.1 ± 1.5	$z = 0.9$	0.35
Number of alcoholic drinks/day	0.5 ± 0.7	0.5 ± 0.8	$z = -0.04$	0.97
Taking any antidepressants	355 (12.9)	61 (21.9)	$\chi^2 = 17.3$	< 0.001
Taking a benzodiazepine	180 (6.5)	41 (14.7)	$\chi^2 = 25.1$	< 0.001

Note: ANX = Goldberg Anxiety Scale, COPD = chronic obstructive pulmonary disease, SSRI = selective serotonin reuptake inhibitor.

*Mann-Whitney tests for skewed data, and χ^2 tests for categorical data. Degrees of freedom = 1 for χ^2 tests.

Table 2

Participants' sleep parameters (mean ±SD), by level of anxiety symptoms

Sleep Parameter	ANX ≤5 (*n* = 2,760)	ANX ≥6 (*n* = 280)	Test statistic	*p*-value*
Total sleep time (min)	405.3 ± 77.4	404.6 ± 79.0	$t = 0.1$**	0.89
Sleep efficiency (%)	77.4 ± 12.0	75.4 ± 11.3	$z = 4.0$	0.0001
Time awake after sleep onset (min)	76.9 ± 48.0	88.5 ± 49.1	$z = -4.6$	<0.0001
Sleep onset latency (min)	41.6 ± 41.7	43.5 ± 39.5	$z = -1.4$	0.15
Napping time (min)	75.8 ± 65.6	80.9 ± 70.2	$z = -0.8$	0.40

Note: $N = 3{,}040$ for total sleep time, sleep efficiency. $N = 3{,}039$ for time awake after sleep onset and sleep onset latency. $N = 2{,}990$ for napping time. ANX = Goldberg Anxiety Scale

* t-tests assuming unequal variances for normally distributed data, Mann-Whitney tests for skewed data.

** Satterthwaite's degrees of freedom = 335.7.

Table 3

Associations between elevated anxiety symptoms* and clinically significant sleep disturbance

Outcome	Model I: Unadjusted OR (95% CI)	Model II: MV-Adjusted** OR (95% CI)	Model III: Model II + GDS ≥6 OR (95% CI)	Model IV: Model III +antidepressant, BZD use OR (95% CI)
Total sleep time >8 hrs (ref = 5-8 hrs)	1.13 (0.80, 1.60) $p = 0.49$	1.13 (0.79, 1.60) $p = 0.51$	0.99 (0.69, 1.43) $p = 0.97$	0.91 (0.63, 1.33) $p = 0.64$
Total sleep time <5 hrs (ref = 5-8 hrs)	1.00 (0.64, 1.56) $p = 0.99$	0.91 (0.58, 1.43) $p = 0.67$	0.91 (0.57, 1.46) $p = 0.70$	0.91 (0.57, 1.45) $p = 0.68$
Sleep efficiency <80%	1.73 (1.34, 2.23) $p < 0.001$	1.61 (1.24, 2.08) $p < 0.001$	1.51 (1.15, 1.97) $p = 0.003$	1.50 (1.15, 1.97) $p = 0.003$
Time awake after sleep onset ≥90 min	1.64 (1.27, 2.11) $p < 0.001$	1.47 (1.14, 1.91) $p = 0.004$	1.34 (1.03, 1.76) $p = 0.03$	1.33 (1.01, 1.75) $p = 0.04$
Sleep onset latency ≥1 hr	1.25 (0.93, 1.68) $p = 0.13$	1.17 (0.87, 1.58) $p = 0.30$	1.06 (0.77, 1.45) $p = 0.73$	1.04 (0.76, 1.43) $p = 0.79$
Napping >2 hrs	1.30 (0.96, 1.74) $p = 0.09$	1.21 (0.90, 1.63) $p = 0.22$	0.94 (0.68, 1.30) $p = 0.71$	0.95 (0.69, 1.31) $p = 0.76$

Note: N = 2,600 to 3,040.

* Elevated anxiety symptoms = Goldberg Anxiety Scale score ≥6.

** MV-Adjusted = Multivariate adjusted for years of education, history of stroke, Parkinson's disease, coronary artery disease, congestive heart failure, chronic obstructive pulmonary disease, osteoarthritis, and rheumatoid arthritis. GDS = 15-item Geriatric Depression Scale, BZD = benzodiazepine medications. *p*-values refer to *z*-statistics.