

Original Research Report

Association of Anxiety Symptom Clusters with Sleep Quality and Daytime Sleepiness

Christine E. Gould,^{1,2} Adam P. Spira,^{3,4} Victoria Liou-Johnson,^{5,6}
Erin Cassidy-Eagle,² Makoto Kawai,^{2,6} Nehjla Mashal,^{2,6} Ruth O'Hara,^{2,6,†} and
Sherry A. Beaudreau,^{2,6,†}

¹Geriatric Research Education and Clinical Center (GRECC), Veterans Affairs Palo Alto Health Care System, California. ²Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, California. ³Department of Mental Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland. ⁴Department of Psychiatry and Behavioral Sciences, Johns Hopkins School of Medicine, Johns Hopkins Center on Aging and Health, Baltimore, Maryland. ⁵Pacific Graduate School of Psychology, Palo Alto University, California. ⁶Sierra Pacific Mental Illness Research Education and Clinical Centers (MIRECC), Veterans Affairs Palo Alto Health Care System, California.

[†]These authors contributed equally to this work.

Correspondence should be addressed to Sherry A. Beaudreau, PhD, ABPP, Veterans Affairs Palo Alto Health Care System, Psychiatry/MIRECC (151Y), 3801 Miranda Ave., Palo Alto, CA 94304. E-mail: sherryb@stanford.edu.

Previous Presentation: These data were presented at the 2015 American Association of Geriatric Psychiatry meeting in New Orleans, LA.

Received September 13, 2016; Editorial Decision Date February 8, 2017

Decision Editor: Bob G. Knight, PhD

Abstract

Objectives: To better understand links between anxiety and sleep disturbances in older adults, we examined the association of different phenotypic presentations of anxiety (i.e., affective, cognitive, and somatic clusters) with global sleep quality and daytime sleepiness.

Methods: 109 community-dwelling adults aged 66–92 years old (57% female) completed assessments of global sleep quality (Pittsburgh Sleep Quality Index), daytime sleepiness (Epworth Sleepiness Scale), affective anxiety symptoms (Geriatric Anxiety Scale (GAS) affective subscale), cognitive anxiety symptoms (GAS cognitive subscale), and somatic anxiety symptoms (GAS somatic subscale).

Results: In hierarchical regression models adjusted for depressive symptoms and health status, greater affective and somatic anxiety were associated with poorer global sleep quality (affective $B = 0.30$, $p = .01$; somatic $B = 0.41$, $p = .01$). Somatic and cognitive anxiety were associated with greater daytime sleepiness (somatic $B = 0.74$, $p < .001$; cognitive $B = 0.30$, $p = .03$), but these associations were attenuated by covariates added to the models.

Discussion: These findings indicate that anxiety symptom clusters are differentially associated with specific sleep-related disturbances, underscoring the complex relationship of late-life anxiety to sleep. Results suggest that personalized treatments, such as targeted sleep interventions, may improve specific anxiety-symptom domains, or vice versa.

Keywords: Affective—Cognitive—Daytime sleepiness—Sleep disturbances—Somatic

Sleep disturbances and associated outcomes, such as daytime sleepiness, commonly occur in older adults (Ohayon, 2002) and have a host of negative health outcomes (Fung, Vitiello,

Alessi, & Kuchel, 2016). While sleep disturbances have been identified as a risk factor for late-life depression (Ford & Kamerow, 1989), less is known about the association of

late-life anxiety symptoms and disturbed sleep. Additionally, the association of anxiety and sleep disturbance is likely bidirectional (Goldstein et al., 2013). For the most part, studies to date have considered sleep in the context of broad definitions of anxiety, or have focused on anxiety in the context of Generalized Anxiety Disorder (GAD). Two such studies found that sleep disturbances distinguish older adults with GAD from anxious older adults who did not meet GAD diagnostic criteria (Brenes et al., 2009; Wetherell, Le Roux, & Gatz, 2003). Furthermore, older adults with GAD reported more frequent bad dreams compared with those without GAD (Nadorff, Porter, Rhoades, Greisinger, Kunik, & Stanley, 2014). Potvin and colleagues (2014) also found late-life anxiety disorders to be associated with a greater likelihood of daytime dysfunction, a component of the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) that encompasses both daytime sleepiness and lack of enthusiasm to complete tasks. Findings of subjective sleep disturbance in multiple domains among older adults with GAD are consistent with research findings related to sleep in younger adults with GAD (e.g., Tsypes, Aldao, & Mennin, 2013).

Further evidence for the relationship of sleep disturbance and anxiety symptoms comes from a study, which found that greater state and trait anxiety were associated with more disturbed sleep, measured by self-report and actigraphy, among older adults with insomnia (Spira et al., 2008). In other studies, elevated worry, a cognitive anxiety symptom, was associated with elevated subjective sleep disturbance among older adults with insomnia (Pallesen et al., 2002) and among older adults with GAD (Bush et al., 2012). Further, a study that used wrist actigraphy in community-dwelling older women found that elevated anxiety symptoms were associated with diminished sleep efficiency and greater sleep fragmentation (Spira, Stone, Beaudreau, Ancoli-Israel, & Yaffe, 2009). However, for older men, those with elevated anxiety symptoms did not have any differences in sleep architecture compared with older men without elevated anxiety (Smagula et al., 2015). Taken together, these findings suggest anxiety disorders may be associated with varied types of sleep disturbances, but anxiety symptoms may only be associated with poor sleep quality and difficulty maintaining sleep. Findings of associations of anxiety disorders with different facets of sleep disturbance are difficult to interpret because most individuals with anxiety disorders present with more than one type of anxiety symptoms (i.e., worrying and somatic symptoms). In contrast, the studies of anxiety symptoms are limited in their focus on either a relatively coarse definition of anxiety or on worry, a cognitive anxiety symptom characteristic of GAD. Anxiety, however, is multi-faceted, and includes affective (e.g., fear, irritability) and somatic symptoms (e.g., shortness of breath, muscle tension, heart racing), in addition to the well-studied cognitive symptoms (e.g., worry). Failure to consider these different clusters of anxiety symptoms may limit our understanding of the relationship of sleep to anxiety.

If anxiety symptom domains are differentially associated with sleep disturbances, this could enhance the utility of a finer-grained characterization of late-life anxiety symptoms. This examination is not possible without consideration of two primary domains of older adult subjective sleep complaints, global sleep quality and daytime sleepiness. In fact, geriatric-specific models, such as Vaz Fragoso and Gill (2007)'s model of geriatric insomnia, incorporate multiple facets of subjective sleep complaints into the model. In addition to improving the understanding of late-life anxiety, understanding which specific anxiety symptoms are more likely to be associated with sleep disturbances could facilitate better targeting of treatments for sleep disorders. Knowing which symptoms of anxiety are most likely to impact sleep could identify those who might most benefit from interventions for sleep disturbance. There is evidence that sleep disturbances can be effectively treated across the lifespan using treatments such as cognitive behavioral therapy for insomnia or continuous positive airway pressure for sleep disordered breathing (Bloom et al. 2009; Irwin, Cole & Nicassio, 2006; Karlin, Trockel, Spira, Taylor, & Manber, 2015). Additionally, greater perceived anxiety control is associated with less sleep disturbance in older and younger adults (Gould, Beaudreau, O'Hara, & Edelstein, 2016). Further, in one study late-life GAD treatment compared with enhanced usual care reduced sleep disturbance (Bush et al., 2012). However, in a treatment study of co-occurring panic disorder and GAD in younger adults, insomnia symptoms persisted after treatment in a majority of participants (Cousineau et al., 2016). While improved understanding of anxiety may yield more targeted sleep treatments, it is also possible that some interventions, such as mindfulness, may have beneficial effects on both sleep disturbance (Black et al., 2015) and anxiety (Lenze et al., 2014).

Reciprocally, understanding bidirectional relationships between sleep disturbance and anxiety symptom clusters may provide a window into the etiology of late-life anxiety disorders. Furthermore, a careful examination of both insomnia complaints and daytime sleepiness is essential when working with older adults (Vaz Fragoso & Gill, 2007). To this end, we examined the cross-sectional association of affective, cognitive, and somatic anxiety symptoms with global sleep quality and daytime sleepiness in a community-dwelling sample. We hypothesized that all three anxiety symptom clusters would be associated with poorer global sleep quality and that somatic symptoms would be associated with worse daytime sleepiness.

Methods

Participants

Participants were drawn from a sample of 121 community-dwelling older adults enrolled in an observational, 2-year longitudinal study of cognition and psychiatric symptoms (NIRG-09-133592; P.I. Beaudreau). Participants were

required to be 65 years or older at enrollment, and to score within normal limits on a brief cognitive assessment administered by phone (Blessed, Tomlinson, & Roth, 1968) and be free of psychotic symptoms. The present study uses data from the year-two assessment because some measures were only administered at that time. A 9.1% attrition rate was observed at year 2 (3 dropped out, 3 relocated, 2 died, 3 lost to follow-up). In addition, one participant omitted items on the Geriatric Anxiety Scale, leaving an analytic sample of 109 for the current study.

Measures and Procedures

Participants provided demographic information (i.e., age, gender, marital status) at baseline. Participants completed the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 2002) and a neuropsychological assessment at both annual study visits and rated their perceived health status in comparison with a state of perfect health on a 4-point scale, with higher scores indicating poorer health (1 = Excellent to 4 = Poor). Participants provided researchers with the list of current medications. We used this information to ascertain current use of antidepressants, benzodiazepines, or opioid medications. Participants completed the following self-report measures on which higher total scores indicate more severe problems.

Anxiety symptom cluster measure

The *Geriatric Anxiety Scale* (GAS; Segal, June, Payne, Coolidge, & Yochim, 2010) is a 30-item measure of anxiety symptom severity in the past week. Responses to the GAS items are made on a four-point Likert-type scale ranging from 0 to 3. The GAS contains three subscales: *cognitive* (e.g., difficulty concentrating, could not control worry), *affective* (e.g., afraid of being judged, irritable, restlessness), and *somatic* (e.g., upset stomach, heart raced or beat strongly). Internal consistency for the GAS total score was excellent ($\alpha = 0.90$ – 0.93) and adequate to excellent ($\alpha = 0.68$ – 0.90) for subscales in non-clinical samples of community-dwelling older adults (Gould et al., 2014; Segal et al., 2010). In this study, the internal consistency was 0.90 for total score, $\alpha = 0.68$ for somatic scale, 0.84 for cognitive scale, and $\alpha = 0.80$ for affective scale.

Sleep-related measures

The *Pittsburgh Sleep Quality Index* (PSQI; Buysse et al., 1989) is a 19-item measure of global sleep quality in the past month. Responses are measured on a four-point, Likert-type scale ranging from 0 to 3. Seven components (sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication use, daytime dysfunction) comprise the PSQI and the component scores are summed to form a global score. Internal consistency of the PSQI was adequate to good ($\alpha = 0.69$ – 0.80) among older adults in large observational studies (Beaudreau et al., 2012; Spira et al., 2012) and was found to be lower ($\alpha = 0.56$) in the present study.

The *Epworth Sleepiness Scale* (ESS; Johns, 1991) is an eight-item measure of daytime sleepiness in the past week. Items are scored on a Likert-type scale from 0 to 3, with three indicating a high chance of dozing or sleeping during specific activities. The measure has adequate internal consistency ($\alpha = 0.70$ – 0.76) among older adults (Beaudreau et al., 2012; Spira et al., 2012) and was adequate in the present study ($\alpha = 0.74$).

Depression measure

The *Beck Depression Inventory-II* (BDI-II) (Beck, Steer, & Brown, 1996) is a 21-item measure of depressive symptom severity in the past 2 weeks; each item is rated on a Guttman scale ranging from 0 to 3. The BDI-II has good internal consistency ($\alpha = 0.86$) for older adults (Segal, Coolidge, Cahill, & O'Riley, 2008). Internal consistency of BDI-II scores was good in the present study ($\alpha = 0.89$).

Data Analysis

We calculated descriptive statistics for all measures. Associations of three sleep and fatigue items on the GAS measure and two items on BDI-II measure with PSQI and ESS scores were calculated. Each GAS sleep item was significantly associated (p 's < 0.001) with the PSQI total scores with r 's ranging from 0.37 (felt tired) to 0.63 (difficulty falling asleep). The associations with ESS total score were non-significant for two of the three items. The item regarding feeling tired was associated with ESS total score ($r = 0.43$, $p < .001$). With regards to the BDI-II sleep items, the item assessing changes in sleeping patterns was associated with PSQI total scores ($r = 0.47$, $p < .001$), whereas the items assessing loss of energy was associated with ESS total scores ($r = 0.29$, $p = .002$). Thus, we decided to use a conservative and face-valid approach to our analyses by removing the sleep and fatigue items from the GAS and BDI-II scores in order to accurately estimate the strength of the associations of anxiety and depressive symptoms with sleep difficulties. The GAS and BDI scores calculated without sleep or fatigue items were used in hierarchical regression analyses.

We examined the association of each GAS subscale (affective, somatic and cognitive) with global sleep quality (PSQI total) and daytime sleepiness (ESS total). Three hierarchical regressions were conducted for each dependent variable (PSQI, ESS) with the primary predictor of interest (GAS subscale) entered in the first step (step 1) and covariates (depression symptoms and perceived health) entered in the second step (step 2).

Results

On average, participants had a mean \pm standard deviation age of 75.29 ± 6.99 years. Fifty-seven percent of participants were female and 90.8% were non-Hispanic whites. The majority of participants did not experience clinical

levels of anxiety or depressive symptoms as evidenced by the low GAS total ($M = 7.37$, $SD = 7.14$) and BDI-II ($M = 4.75$, $SD = 6.06$) means displayed in Table 1. On average, however, participants experienced some sleep disturbance, as measured by a mean PSQI score ($M = 4.97$, $SD = 3.01$) falling just below the cut-off of 5 (Buysse et al., 1989). Twenty-four (22.0%) of participants took over the counter or prescription medications for sleep at least once a week according to the PSQI medication use component. Table 2 displays intercorrelations among variables.

Global Sleep Quality (PSQI)

Table 3 displays hierarchical regression analyses that examined the association of each GAS subscale (affective, somatic, and cognitive) with PSQI total scores. The GAS affective and the GAS somatic subscale were significantly associated with global sleep quality in step 1 (affective $B = 0.59$, 95% confidence interval (CI) 0.40, 0.77; somatic $B = 0.82$, 95% CI 0.55, 1.10) and step 2 (affective $B = 0.30$, 95% CI 0.07, 0.53; somatic $B = 0.41$, 95% CI 0.09, 0.73). The GAS cognitive subscale was associated with global sleep quality in step 1 ($B = 0.51$, 95% CI 0.31, 0.72), but not in step 2 ($B = -0.08$, 95% CI = -0.40, 0.25).

Table 1. Participant Characteristics

Characteristic	<i>M</i> or frequency	<i>SD</i> or percent
Age	75.29	6.99
Sex		
Female	63	57.8
Male	46	42.2
Ethnic/racial background		
Asian	7	6.40
Black/African-American	2	1.80
White, Non-Hispanic	99	90.80
White, Hispanic	1	0.90
Self-rated health	2.02	0.65
Medication use		
Antidepressants	17	15.60
Benzodiazepines	11	10.10
Opioids	4	3.70
BDI-II	4.75	6.06
BDI-II ^a	3.92	5.45
ESS	6.06	3.66
GAS	7.37	7.14
GAS ^a	5.50	6.26
GAS affective	1.99	2.66
GAS cognitive	1.65	2.55
GAS somatic ^a	1.85	1.82
PSQI	4.97	3.01

Note: BAI = Beck Anxiety Inventory, BDI-II = Beck Depression Inventory = II, ESS = Epworth Sleepiness Scale, GAS = Geriatric Anxiety Scale, PSQI = Pittsburgh Sleep Quality Index. Lower scores on perceived health indicate better health, whereas, for the other measures (BAI, BDI-II, ESS, GAS, PSQI) higher scores indicate more elevated psychiatric symptoms.

^aSleep-related items were removed from total.

The adjusted R^2 values for step 1 ranged from 0.18 (cognitive symptoms) to 0.26 (affective symptoms). Adjusted R^2 values were 0.34 for both the final multivariable-adjusted models in which affective and somatic symptoms remained significant contributors.

We conducted sensitivity analyses adjusting for antidepressant, benzodiazepine, or opioid use in the regression models. Including antidepressant and benzodiazepine use in step 2 of the models attenuated the association between both GAS affective symptoms and somatic symptoms with PSQI total scores. No changes were noted when opioid use was included in the regression models.

Daytime Sleepiness (ESS)

The hierarchical regressions examining the contributions of GAS subscales to daytime sleepiness (ESS total) also are displayed in Table 3. The GAS affective subscale was not associated with daytime sleepiness. The GAS cognitive subscale was associated with daytime sleepiness in step 1 ($B = 0.30$, 95% CI 0.03, 0.57), but not in step 2 ($B = -0.29$, 95% CI -0.72, 0.15). The GAS somatic subscale was associated with daytime sleepiness in step 1 ($B = 0.74$, 95% CI 0.38, 1.10) and was marginally associated with daytime sleepiness in step 2 ($B = 0.44$, 95% CI 0.00, 0.89). The adjusted R^2 values for step 1 were 0.04 for cognitive symptoms and 0.13 for somatic symptoms. The adjusted R^2 value for the final multivariable-adjusted models for somatic symptoms was 0.16.

We conducted sensitivity analyses adjusting for antidepressant, benzodiazepine, or opioid use in the regression models (results not shown). Including antidepressant and benzodiazepine use strengthened the association between the GAS somatic subscale and ESS total scores. In contrast, including opioid use slightly attenuated the association between GAS somatic subscale and ESS total scores.

Discussion

Our fine-grained cross-sectional investigation of anxiety symptom clusters revealed differing patterns of

Table 2. Correlations Between Anxiety, Depression, Health, and Sleep Variables

Variable	1	2	3	4	5	6	7
1. BDI-II ^a							
2. GAS total ^a	0.78						
3. GAS affective	0.65	0.92					
4. GAS cognitive	0.81	0.92	0.76				
5. GAS somatic ^a	0.60	0.82	0.62	0.64			
6. Self-rated health	0.38	0.34	0.26	0.32	0.35		
7. PSQI total	0.56	0.54	0.52	0.43	0.50	0.26	
8. ESS total	0.34	0.25	0.13	0.21	0.37	0.32	0.11

Note: ^aSleep-related items were removed from total. Bolded numbers indicate significance at $p < .05$.

Table 3. Associations of Anxiety Clusters with Global Sleep Quality and Daytime Sleepiness

	Global Sleep Quality (PSQI)				Daytime Sleepiness (ESS)							
	Step 1		Step 2		Step 1		Step 2					
	B	(95% CI)	p	(95% CI)	B	(95% CI)	p	(95% CI)				
Model: GAS Affective Subscale												
GAS affective	0.59	(0.40, 0.77)	<.001	0.30	(0.07, 0.53)	.01	0.17	(-0.09, 0.44)	.19	-0.23	(-0.55, 0.09)	.15
BDI-II ^a				0.20	(0.08, 0.32)	.001				0.25	(0.08, 0.41)	.003
Self-rated health				0.25	(-0.52, 1.03)	.52				1.24	(0.17, 2.31)	.03
Model: GAS Cognitive Subscale												
GAS cognitive	0.51	(0.31, 0.72)	<.001	-0.08	(-0.40, 0.25)	.64	0.30	(0.03, 0.57)	.03	-0.29	(-0.72, 0.15)	.19
BDI-II ^a				0.33	(0.17, 0.48)	<.001				0.28	(0.07, 0.49)	.009
Self-rated health				0.27	(-0.53, 1.07)	.51				1.24	(0.17, 2.31)	.02
Model: GAS Somatic Subscale												
GAS somatic ^a	0.82	(0.55, 1.10)	<.001	0.41	(0.09, 0.73)	.01	0.74	(0.38, 1.10)	<.001	0.44	(0.00, 0.89)	.05
BDI-II ^a				0.22	(0.11, 0.33)	<.001				0.09	(-0.06, 0.24)	.23
Self-rated health				0.11	(-0.68, 0.90)	.78				1.06	(-0.01, 2.14)	.05

Note: B = unstandardized regression coefficient, BDI-II = Beck Depression Inventory = II, CI = confidence interval, GAS = Geriatric Anxiety Scale. Bolded numbers indicate significance at $p < .05$.
^aSleep-related items were removed from total.

associations with specific sleep disturbances in a non-clinical sample of community-dwelling older adults. Our results demonstrate that even after adjusting for factors known to be associated with sleep difficulties (depressive symptoms and perceived health), affective and somatic anxiety symptoms were most strongly associated with global sleep quality. It may be that affective anxiety symptoms (e.g., fear, nervousness) and depressive symptoms have independent associations with poorer sleep quality, which encompasses a number of different types of sleep disturbances that need to be disentangled in a future study. The finding of an association of somatic anxiety symptoms and poorer sleep quality could be a function of medical problems associated with specific components of the PSQI, such as daytime dysfunction and sleep disturbances. The associations of affective and somatic anxiety symptoms with global sleep quality highlight that these anxiety symptoms clusters could be useful when differentiating particular types of anxiety from depression in the context of sleep disturbances. The lack of association of cognitive symptoms with sleep disturbance in the adjusted model was interesting and surprising. One possible reason for the lack of significance for cognitive symptoms could be the presence of multicollinearity of the cognitive anxiety subscale with depressive measure.

A second finding from the present study was the association of elevated somatic and cognitive anxiety symptoms with daytime sleepiness. This novel finding demonstrates the importance of considering anxiety symptoms in older adults with daytime sleepiness. Although statistical adjustment attenuated the associations, the association of somatic anxiety with daytime sleepiness remained marginally significant ($p = .05$) and is worthy of further examination. A possible mechanism for this association could be the presence of underlying medical conditions, including sleep-disordered breathing that result in daytime sleepiness or the presence of other cardiopulmonary diseases that may be associated with both somatic anxiety symptoms and daytime sleepiness. The presence of pain (e.g., low back pain) and muscle tension could also disrupt nocturnal sleep and lead to daytime sleepiness.

The sensitivity analyses revealed diverging effects of including antidepressant and benzodiazepine use in the models. Interestingly, these two classes of medications attenuated associations of anxiety with global sleep disturbance, but enhanced the association of somatic anxiety with daytime sleepiness. These findings highlight the need to fully understand the biological influences on the relationship of sleep disturbance and anxiety symptoms.

Limitations of the present study include the use of a one-item measure of perceived health as a covariate, the absence of a geriatric-specific depression measure, and the absence of objective measures of sleep disturbance (i.e., polysomnography, actigraphy). Further, the absence of a full medical exam limits our ability to rule out

medical causes of daytime sleepiness. Another limitation is the use of measures that employed varied timeframes (1 week to 1 month) with which participants were to report their current symptoms. Specifically, it is possible that the findings of anxiety symptom associations with PSQI scores could be influenced by the differing timeframes on the PSQI and GAS measures. Despite these limitations, research demonstrates that subjective reports are useful. For example, reports of daytime sleepiness predict cognitive impairment (Tsapanou et al., 2016; Waller et al., 2015) and perceptions of lower health predict mortality (Idler & Benyamini, 1997). Longitudinal studies are needed to investigate the patterns of bidirectional associations between anxiety symptom clusters and sleep disturbances, refine the anxiety and sleep disturbance phenotypes employing objective and subjective measures of sleep, and identify biomarkers underlying these associations. Moreover, studies are needed to investigate whether treating chronic insomnia could reduce particular types of anxiety in older adults, and whether treating sleep-disordered breathing reduces others (e.g., somatic anxiety).

Potential implications of our findings could be that older individuals may benefit from anxiety treatments tailored to their predominant anxiety symptom presentations, with some treatments targeting specific sleep disturbances in addition to anxiety. Furthermore, the present study partially supports the postulation that sleep disturbance is transdiagnostic of psychiatric symptoms (Harvey, Murray, Chandler, & Soehner, 2011) with our findings of distinct variations in the relationships among anxiety symptom clusters and sleep quality disturbance versus anxiety symptom clusters and daytime sleepiness. Our findings clarify the subtle variations in the transdiagnostic nature of sleep disturbance with regards to one particular psychiatric concern, anxiety. Future longitudinal studies should examine multiple facets of sleep in late-life psychiatric disorders with the aim of better characterizing psychiatric disorders and improving treatments.

Funding

This work was supported by an Alzheimer's Association Grant (NIRG-09-133592) to S. A. Beaudreau. C. E. Gould is supported by a VA Career Development Award (IK2 RX001478) and by Ellen Schapiro and Gerald Axelbaum through a 2014 NARSAD Young Investigator Grant from the Brain & Behavior Research Foundation. A. P. Spira has received grants from the National Institute on Aging and the William and Ella Owens Medical Research Foundation. He has agreed to serve as a consultant to Awarables, Inc. in support of an NIH grant.

Acknowledgments

Views expressed in this article are those of the authors and not necessarily those of the Department of Veterans Affairs or the Federal Government.

References

- Beaudreau, S. A., Spira, A. P., Stewart, A., Kezirian, E. J., Lui, L. Y., Ensrud, K.,...Stone, K. L.; Study of Osteoporotic Fractures. (2012). Validation of the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale in older black and white women. *Sleep Medicine*, *13*, 36–42. doi:10.1016/j.sleep.2011.04.005
- Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory-II*. San Antonio, TX: Psychological Corporation.
- Black, D. S., O'Reilly, G. A., Olmstead, R., Breen, E. C., & Irwin, M. R. (2015). Mindfulness meditation and improvement in sleep quality and daytime impairment among older adults with sleep disturbances: a randomized clinical trial. *JAMA Internal Medicine*, *175*, 494–501. doi:10.1001/jamainternmed.2014.8081
- Blessed, G., Tomlinson, B. E., & Roth, M. (1968). The association between quantitative measures of dementia and of senile change in the cerebral grey matter of elderly subjects. *The British Journal of Psychiatry: The Journal of Mental Science*, *114*, 797–811. doi:10.1192/bjp.114.5.12.797
- Bloom, H. G., Ahmed, I., Alessi, C. A., Ancoli-Israel, S., Buysse, D. J., Kryger, M. H.,...Zee, P. C. (2009). Evidence-based recommendations for the assessment and management of sleep disorders in older persons. *Journal of the American Geriatrics Society*, *57*, 761–789. doi:10.1111/j.1532-5415.2009.02220
- Brenes, G. A., Miller, M. E., Stanley, M. A., Williamson, J. D., Knudson, M., & McCall, W. V. (2009). Insomnia in older adults with generalized anxiety disorder. *The American Journal of Geriatric Psychiatry*, *17*, 465–472. doi:10.1097/JGP.0b013e3181987747
- Bush, A. L., Armento, M. E., Weiss, B. J., Rhoades, H. M., Novy, D. M., Wilson, N. L.,...Stanley, M. A. (2012). The Pittsburgh Sleep Quality Index in older primary care patients with generalized anxiety disorder: psychometrics and outcomes following cognitive behavioral therapy. *Psychiatry Research*, *199*, 24–30. doi:10.1016/j.psychres.2012.03.045
- Buysse, D. J., Reynolds, C. F. 3rd, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, *28*, 193–213. doi:10.1016/0165-1781(89)90047-4
- Cousineau, H., Marchand, A., Bouchard, S., Bélanger, C., Gosselin, P., Langlois, F.,...Belleville, G. (2016). Insomnia Symptoms Following Treatment for Comorbid Panic Disorder With Agoraphobia and Generalized Anxiety Disorder. *The Journal of Nervous and Mental Disease*, *204*, 267–273. doi:10.1097/NMD.0000000000000466
- First, M., Spitzer, R., Gibbon, M., & Williams, J. (2002). *Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version*. New York, NY: Biometrics Research Department, New York State Psychiatric Institute.
- Ford, D. E., & Kamerow, D. B. (1989). Epidemiologic study of sleep disturbances and psychiatric disorders. An opportunity for prevention? *JAMA*, *262*, 1479–1484. doi:10.1001/jama.1989.03430110069030
- Fung, C. H., Vitiello, M. V., Alessi, C. A., & Kuchel, G. A. (2016). Report and Research Agenda of the American Geriatrics Society and National Institute on Aging Bedside-to-Bench Conference on Sleep, Circadian Rhythms, and Aging: New Avenues for Improving Brain Health, Physical Health, and Functioning. *Journal of the American Geriatrics Society*. Epub ahead of print. doi: 10.1111/jgs.14493
- Goldstein, A. N., Greer, S. M., Saletin, J. M., Harvey, A. G., Nitschke, J. B., & Walker, M. P. (2013). Tired and apprehensive: anxiety amplifies the impact of sleep loss on aversive brain anticipation. *The Journal of Neuroscience*, *33*, 10607–10615. doi:10.1523/JNEUROSCI.5578-12.2013
- Gould, C. E., Beaudreau, S. A., O'Hara, R., & Edelman, B. A. (2016). Perceived anxiety control is associated with sleep disturbance in young and older adults. *Aging & Mental Health*, *20*, 856–860. doi:10.1080/13607863.2015.1043617
- Gould, C. E., Segal, D. L., Yochim, B. P., Pachana, N. A., Byrne, G. J., & Beaudreau, S. A. (2014). Measuring anxiety in late life: a psychometric examination of the geriatric anxiety inventory and geriatric anxiety scale. *Journal of Anxiety Disorders*, *28*, 804–811. doi:10.1016/j.janxdis.2014.08.001
- Harvey, A. G., Murray, G., Chandler, R. A., & Soehner, A. (2011). Sleep disturbance as transdiagnostic: consideration of neurobiological mechanisms. *Clinical Psychology Review*, *31*, 225–235. doi:10.1016/j.cpr.2010.04.003
- Idler, E. L., & Benyamini, Y. (1997). Self-rated health and mortality: a review of twenty-seven community studies. *Journal of Health and Social Behavior*, *38*, 21–37.
- Irwin, M. R., Cole, J. C., & Nicassio, P. M. (2006). Comparative meta-analysis of behavioral interventions for insomnia and their efficacy in middle-aged adults and in older adults 55+ years of age. *Health Psychology*, *25*, 3–14. doi:10.1037/0278-6133.25.1.3
- Johns, M. W. (1991). A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep*, *14*, 540–545. doi:10.1093/sleep/14.6.540
- Karlin, B. E., Trockel, M., Spira, A. P., Taylor, C. B., & Manber, R. (2015). National evaluation of the effectiveness of cognitive behavioral therapy for insomnia among older versus younger veterans. *International Journal of Geriatric Psychiatry*, *30*, 308–315. doi:10.1002/gps.4143
- Lenze, E. J., Hickman, S., Hershey, T., Wendleton, L., Ly, K., Dixon, D.,...Wetherell, J. L. (2014). Mindfulness-based stress reduction for older adults with worry symptoms and co-occurring cognitive dysfunction. *International Journal of Geriatric Psychiatry*, *29*, 991–1000. doi:10.1002/gps.4086
- Nadorff, M. R., Porter, B., Rhoades, H. M., Greisinger, A. J., Kunik, M. E., & Stanley, M. A. (2014). Bad dream frequency in older adults with generalized anxiety disorder: prevalence, correlates, and effect of cognitive behavioral treatment for anxiety. *Behavioral Sleep Medicine*, *12*, 28–40. doi:10.1080/15402002.2012.755125
- Ohayon, M. M. (2002). Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Medicine Reviews*, *6*, 97–111. doi:10.1053/smr.2002.0186
- Pallesen, S., Nordhus, I. H., Kvale, G., Havik, O. E., Nielsen, G. H., Johnsen, B. H.,...Hjeltnes, L. (2002). Psychological characteristics of elderly insomniacs. *Scandinavian Journal of Psychology*, *43*, 425–432. doi:10.1111/1467-9450.00311
- Segal, D. L., Coolidge, F. L., Cahill, B. S., & O'Riley, A. A. (2008). Psychometric properties of the Beck Depression Inventory II (BDI-II) among community-dwelling older adults. *Behavior Modification*, *32*, 3–20. doi:10.1177/0145445507303833

- Segal, D. L., June, A., Payne, M., Coolidge, F. L., & Yochim, B. (2010). Development and initial validation of a self-report assessment tool for anxiety among older adults: the Geriatric Anxiety Scale. *Journal of Anxiety Disorders, 24*, 709–714. doi:10.1016/j.janxdis.2010.05.002
- Smagula, S. F., Reynolds, C. F. 3rd, Ancoli-Israel, S., Barrett-Connor, E., Dam, T. T., Hughes-Austin, J. M.,...Cauley, J. A.; Osteoporotic Fractures in Men (MrOS) Research Group. (2015). Sleep Architecture and Mental Health Among Community-Dwelling Older Men. *The journals of gerontology. Series B: Psychological sciences and social sciences, 70*, 673–681. doi:10.1093/geronb/gbt125
- Spira, A. P., Beaudreau, S. A., Stone, K. L., Kezirian, E. J., Lui, L. Y., Redline, S.,...Stewart, A.; Osteoporotic Fractures in Men Study. (2012). Reliability and validity of the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale in older men. *The Journals of Gerontology. Series A: Biological Sciences and Medical Sciences, 67*, 433–439. doi:10.1093/gerona/glr172
- Spira, A. P., Friedman, L., Aulakh, J. S., Lee, T., Sheikh, J. I., & Yesavage, J. A. (2008). Subclinical anxiety symptoms, sleep, and daytime dysfunction in older adults with primary insomnia. *Journal of Geriatric Psychiatry and Neurology, 21*, 149–153. doi:10.1177/0891988707317120
- Spira, A. P., Stone, K., Beaudreau, S. A., Ancoli-Israel, S., & Yaffe, K. (2009). Anxiety symptoms and objectively measured sleep quality in older women. *The American Journal of Geriatric Psychiatry, 17*, 136–143. doi:10.1097/JGP.0b013e3181871345
- Tsapanou, A., Gu, Y., O'Shea, D., Eich, T., Tang, M. X., Schupf, N.,...Stern, Y. (2016). Daytime somnolence as an early sign of cognitive decline in a community-based study of older people. *International Journal of Geriatric Psychiatry, 31*, 247–255. doi:10.1002/gps.4318
- Tsypes, A., Aldao, A., & Mennin, D. S. (2013). Emotion dysregulation and sleep difficulties in generalized anxiety disorder. *Journal of Anxiety Disorders, 27*, 197–203. doi:10.1016/j.janxdis.2013.01.008
- Vaz Fragoso, C. A., & Gill, T. M. (2007). Sleep complaints in community-living older persons: a multifactorial geriatric syndrome. *Journal of the American Geriatrics Society, 55*, 1853–1866. doi:10.1111/j.1532-5415.2007.01399.x
- Waller, K. L., Mortensen, E. L., Avlund, K., Osler, M., Fagerlund, B., Lauritzen, M., & Jennum, P. (2015). Subjective sleep quality and daytime sleepiness in late midlife and their association with age-related changes in cognition. *Sleep Medicine, 17*, 165–173. doi:10.1016/j.sleep.2015.01.004
- Wetherell, J. L., Le Roux, H., & Gatz, M. (2003). DSM-IV criteria for generalized anxiety disorder in older adults: distinguishing the worried from the well. *Psychology and Aging, 18*, 622–627. doi:10.1037/0882-7974.18.3.622