Modeling the Effects of Stress, Anxiety, and Depression on Rumination, Sleep, and Fatigue in a Nonclinical Sample

Einar B. Thorsteinsson, PhD,* Rhonda F. Brown, PhD,† and Michelle T. Owens, MClin*

Abstract: Stress and affective distress have previously been shown to predict sleep quality, and all the factors have been shown to predict fatigue severity. However, few prior studies have examined the likely indirect mediational relationships between stress, affective distress, and sleep quality in predicting fatigue severity, and the potential role played by ruminative thinking. A short questionnaire asked 229 participants about their recent experiences of stress, affective distress, rumination, sleep, and fatigue in a community sample. High stress, anxiety, and depression were related to more ruminative thinking, which in turn was related to poor sleep quality (composed of subjective sleep quality, daytime dysfunction, sleep latency, and sleep disturbance) and poor sleep quality predicted worse fatigue. The results suggest that rumination parsimoniously explains the tendency of stress and affective distress to contribute to poor sleep quality, and together with poor sleep, it may also contribute to worse fatigue in some individuals.

Key Words: Stress, depression, sleep, rumination, fatigue

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Fatigue is a pervasive sense of tiredness or lack of energy that is not exclusively related to exertion. Fatigue symptoms can vary according to their intensity, duration, and domain (*i.e.*, physical, mental, emotional, spiritual; Wessely et al., 1998). Fatigue is reported to frequently occur in nonclinical populations including community samples (Loge et al., 1998), healthy working adults (Åkerstedt et al., 2004; Bültmann et al., 2002), and university students (Brown and Schutte, 2006; Brown and Thorsteinsson, 2009), including nursing students (Rella et al., 2009), medical students (Tanaka et al., 2009), and psychology students (Brown and Schutte, 2006; Brown and Thorsteinsson, 2009; Valpiani et al., 2011).

Fatigue in university students is thought to arise as a result of the high demands of university (Bray and Born, 2004), financial stress, relationship difficulties (Shaikh and Deschamps, 2006), affective distress (*e.g.*, anxiety, depression), and worse sleep quality (Valpiani et al., 2011) or circadian rhythm dysfunction such as a phase advance in the sleep-wake cycle (Carskadon et al., 2004; Tanaka et al., 2009). Thus, it often coexists with stress, affective distress, and impaired sleep. However, few prior studies have examined the likely mechanism(s) by which stress, affective distress, and impaired sleep can contribute to fatigue. It has been proposed that cognitive intrusions (*e.g.*, rumination) may contribute to impaired sleep (Drake et al., 2014) and that rumination related to high stress and/or affective distress may contribute to fatigue via impaired sleep (Brown and Thorsteinsson, 2009), but the assertion requires verification in an empirical study, thus, it will be examined in the present study.

However, stressors (*e.g.*, stressful life events [SLEs], work stress) have been shown to precede and/or coexist with fatigue in nonclinical samples such as university students and working adults (Åkerstedt et al., 2002; Åkerstedt et al., 2004; van der Ploeg and Kleber, 2003) in

cross-sectional and longitudinal studies, but the relationship is stronger in some studies (Thorsteinsson and Brown, 2009) than others (Ray et al., 1995). Stress is also a known risk factor for later depression (Hammen et al., 2009), depression increases the risk of later experiencing SLE (Hammen, 1991), and more stress (*e.g.*, SLE) is related to impaired sleep (Shaver et al., 2002).

Similarly, affective distress (*e.g.*, anxiety, depression) cross-sectionally (Ruggiero, 2003) and longitudinally predicts fatigue (Clark and Watson, 1991; Smith et al., 1999), and fatigue predicts later anxiety and depression (Servaes et al., 2007). Similar results were reported in a longitudinal study of multiple sclerosis (MS) patients in which depression predicted later anxiety and fatigue, and both predicted later depression (Brown and Thorsteinsson, 2009). Nonetheless, fatigue does not always coexist with anxiety and depression, especially in people with nonclinical fatigue (Hickie et al., 1990; Kirk et al., 1999), but affective distress is frequently comorbid with impaired sleep (*e.g.*, worse sleep quality) in people with depression (Ford and Cooper-Patrick, 2001) and anxiety (Chambers and Kim, 1993). In addition, people with insomnia disorder are more likely to report later severe anxiety and fatigue than controls (LeBlanc et al., 2007).

Moreover, sleep impairment is reported to be directly related to fatigue in community (Åkerstedt et al., 2004; Lavidor et al., 2003; Pilcher et al., 1997) and student samples (Liffman et al., 2012; Thorsteinsson and Brown, 2009; Valpiani et al., 2011), whereas good quality sleep appears to buffer against the impact of work strain on fatigue in insomnia patients (Winwood et al., 2007). In addition, worse sleep quality was shown to mediate between high stress and affective distress to worse fatigue (Thorsteinsson and Brown, 2009; Valpiani et al., 2011).

Mechanistically, stress-related and affective distress-related rumination is posited to indirectly explain the development of fatigue secondary to impaired sleep (Drake et al., 2014; Thorsteinsson and Brown, 2009). Ruminative thinking is a common maladaptive emotion regulation strategy characterized by the tendency to repeatedly focus on distressing experiences and their related causes and consequences (Nolen-Hoeksema et al., 2008). According to Responses Styles Theory, ruminative thinking involves a perseverative focus on depression symptoms that can spur the development and maintenance of depressed mood (Nolen-Hoeksema, 1991). It is thought to represent a cognitive style or tendency (Nolen-Hoeksema, 1991) that is stable over time (Smith and Alloy, 2009), even if there is a change in depression severity (Nolen-Hoeksema et al., 2008). However, it is also linked to the experience of stress (Guastella and Moulds, 2007), anxiety (Rector et al., 2008), impaired sleep (Carney et al., 2006), and fatigue (Young et al., 2008). Thus, it is possible that rumination might contribute to impaired sleep, which in turn may contribute to fatigue in some people (Thorsteinsson and Brown, 2009). However, few studies have examined the indirect mediational relationships between stress, affective distress, rumination, sleep quality, and fatigue. Thus, in this study, we examined whether rumination explained the tendency of stress and affective distress to impair sleep quality, thereby worsening fatigue.

Finally, few studies have determined which aspects of sleep are disturbed most by ruminative thinking. Rumination has been shown to be associated with longer sleep onset latency, which likely occurs secondary to cognitive arousal and/or negative mood (Bower, 1981). In addition, it has been shown to be related to worse sleep quality (*e.g.*,

**Psychology Lane, University of New England, Armidale; and †Department of Psychology, The Australian National University, Canberra, Australia.
Send reprint requests to Einar B. Thorsteinsson, PhD, Psychology Lane, University of New England, Armidale, New South Wales 2351, Australia.
E-mail: ethorste@une.edu.au.*

Guastella and Moulds, 2007). Thus, results suggest that rumination is most likely to impair sleep quality and the ability to fall asleep, and such a premise will be examined in this study. That is, we will examine if rumination is indirectly related to fatigue via sleep quality, including an assessment of the individual components of sleep.

Consistent with the prior literature, we expected that rumination would explain the tendency of some people to experience worse sleep quality (and longer sleep onset latency and more sleep disturbances) in the context of high stress/affective distress as well as worse fatigue severity. Specifically, we expected that a) high stress, anxiety, depression, rumination, and worse sleep quality would be related to worse fatigue; b) rumination will mediate between high stress, anxiety, and depression to worse sleep quality; and c) worse sleep quality will mediate between high rumination and worse fatigue. The three hypotheses were concurrently examined using a single Structural Equation Model, see Figure 1. The other Pittsburgh Sleep Quality Index (PSQI) subscales were examined, making no a priori assertions, as markers of impaired sleep.

METHODS

Participants

The project was conducted with full human research ethics committee approval (HREC approval HE10/017). Effect sizes of $f^2 = 0.20$ were expected, based on a prior study of stress-fatigue-sleep relationships (citation removed to keep manuscript anonymous). A power analysis using G*Power 3.1.0 determined that a minimum of 89 participants was required assuming an α of 0.05, power of 0.90, and using up to five predictors. Two hundred twenty-nine people clicked on the URL imbedded in the online advertisement and completed the study questionnaire.

Mean age of the 229 participants was 31.4 years (range, 18–66 years; $SD = 11.62$). Most of them were female ($n = 172$, 75.1%) and the rest were male. Most were married or lived in a de facto relationship ($n = 99$, 43.2%) or they were never married ($n = 91$, 39.7%), divorced/separated ($n = 21$), or widowed or did not identify their relationship status ($n = 18$). One half of them were students ($n = 111$, 48.5%), one quarter (23.6%, $n = 54$) worked full-time, 17.5% ($n = 40$) worked part-time, and the rest were homemakers ($n = 9$), permanently disabled/unwell ($n = 6$), or unemployed, retired, or volunteers ($n = 9$).

Measures

Participants completed a short online questionnaire that asked about demographics and their recent experiences of perceived stress, anxiety, depression, rumination, sleep quality, and fatigue, in a community-derived sample.

Subjective fatigue was assessed using the Fatigue Severity Scale (FSS; Krupp et al., 1989), a nine-item self-report scale measuring functional impairments arising from fatigue experienced in the past week. Respondents rated items on seven-point Likert scales from 1 (strongly disagree) to 7 (strongly agree), scores were averaged (divided by 9), and high scores indicated worse fatigue. The FSS is reported to have

high internal consistency, with Cronbach alphas (CA) ranging from 0.81 to 0.89 (Krupp et al., 1989), and it effectively differentiates between fatigued patients and controls (Taylor et al., 2000). In this study, internal consistency reliability was good CA = 0.84. Participants who answered "no" to the question "Have you experienced fatigue in the past week?" were not required to complete the FSS, and they were automatically assigned an FSS score of 1 (*i.e.*, lowest possible score).

Perceived stress was measured using the Perceived Stress Scale (PSS; Cohen and Williamson, 1988), a 10-item self-report scale that examines a person's perceptions of stressfulness in their life, over the past month. Respondents rated the items using five-point frequency rating scales ranging from 0 (never) to 4 (very often), with high scores indicating higher stress. The PSS is reported to have high internal consistency with CAs ranging from 0.78 to 0.89 (Roberti et al., 2006). In this study, the CA for the PSS was high at 0.82.

Depression and anxiety were assessed using the Depression, Anxiety, and Stress Scale (DASS-21), a 21-item self-report scale that records the severity and frequency of depression, anxiety, and stress over the past week (Lovibond and Lovibond, 1995). Items in the DASS-21 were answered using four-point scales, and each of the three factors contained seven items. The stress subscale was not used in this study. Henry and Crawford (2005) report high internal consistency reliability for the scale (CA = 0.93). In this study, the CA was 0.90 for depression and 0.82 for anxiety.

Sleep quality over the past month was evaluated using the PSQI (Buysse et al., 1989), which examines seven sleep quality components including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. The component scores were scaled from 0 to 3 and summed to give a global sleep quality score (maximum of 21), with high scores indicating worse sleep quality. The scale has moderate convergent validity with objective sleep measures and high internal consistency, with a CA = 0.83 (Bray and Born, 2004). In this study, the CA for the PSQI was 0.74.

In the present study, a poor sleep quality variable was constructed based on principal axis factoring, with factor loadings of 0.80 for subjective sleep quality (PSQI component), 0.47 for daytime dysfunction, 0.61 for sleep latency, and 0.62 for sleep disturbance, see Figure 1.

Rumination was evaluated using the Ruminative Thought Style Questionnaire (Brinker and Dozois, 2009), which assesses global (nondepressive) rumination. The scale asked participants to rate the items according to how well each described them, using seven-point scales ranging from 1 (not at all) to 7 (very well). The scale has high internal consistency with a CA = 0.87 to 0.92 (Brinker and Dozois, 2009). In this study, the CA for the scale was high at 0.95.

Statistical Analysis

SPSS and AMOS (Versions 25) were used to analyze the data (citation removed to keep manuscript anonymous). Using the recommendations of Kline (2005), the following indices and associated criteria were used to evaluate the structural equation models: a) comparative fit index (CFI) criterion greater than 0.90, which suggests good fit; b) root mean square error of approximation (RMSEA) values less
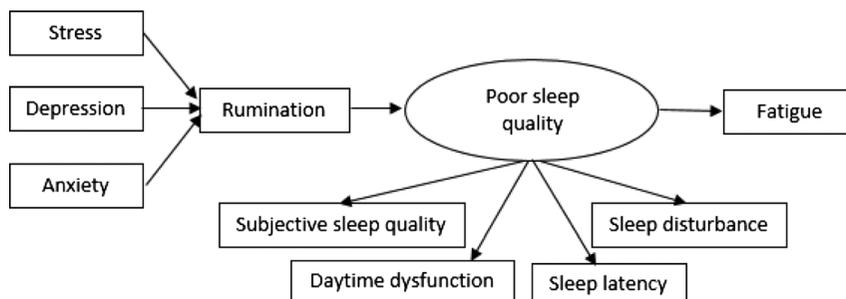

FIGURE 1. Proposed model based on the combined hypotheses.

than 0.08, which indicate good fit; c) squared root mean residual of approximately 0.10, being favorable; and d) Tucker-Lewis coefficient (TLI) values close to 1.0, indicating a good fit. All parameters in the model were estimated using the maximum likelihood algorithm in AMOS.

RESULTS

Means, standard deviations, and correlations of the key study variables are provided in Table 1. Mean fatigue score indicated that most participants (82.1%, $n = 188$ out of a total of 229) reported substantial fatigue (FSS score ≥ 4; Krupp et al., 1989) and most (70.7%, $n = 162$) were classified as poor sleepers (PSQI score > 5; Buysse et al., 1989). Mean perceived stress levels were high (>1 standard deviation above normal value; Cohen and Williamson, 1988). More than one third (34.1%, $n = 78$) reported moderate to extremely severe depression and moderate to extremely severe anxiety (39.7%, $n = 91$), using published DASS-21 norms (Lovibond and Lovibond, 1995). However, mean global rumination was lower than RTSQ values obtained in other studies (Brinker and Dozois, 2009). Results indicate that most participants were anxious, depressed, and fatigued, and they experienced poor sleep quality. All factors were significantly correlated with fatigue, especially stress and poor sleep quality. Highest correlations were between rumination and stress/affective distress and between the PSQI subscales. Of the demographics, only sex was significantly correlated with fatigue, being slightly more common in females ($r = −0.14$).

Figure 2 indicates that 36% of the variance in rumination was explained by high perceived stress, anxiety, and depression. The factors, along with rumination, explained 16% of the variance in poor sleep quality, and together, the model explained 11% of the variance in fatigue severity. Table 2 indicates that, of the PSQI components, only subjective sleep quality individually predicted fatigue severity.

DISCUSSION

A large literature has reported that fatigue often coexists with high stress, affective distress (*e.g.*, Ruggiero, 2003; Servaes et al., 2007), and impaired sleep (*e.g.*, Åkerstedt et al., 2004; Lavidor et al., 2003). Rumination is also practiced by people who experience stress (Guastella and Moulds,

2007), anxiety (Rector et al., 2008), impaired sleep (Carney et al., 2006), and fatigue (Young et al., 2008). However, few prior studies have examined the possible indirect mediational relationships between these factors to determine if rumination can explain the development of sleep problems and fatigue in affected individuals. In this study, participants reported high mean fatigue, stress, anxiety, and depression levels, as well as poor sleep quality, and many of them experienced concurrent stress/affective distress, impaired sleep, and fatigue.

Structural equation modeling results indicate that stress, anxiety, and depression were related to greater rumination; rumination was related to poor sleep quality; and poor sleep quality was related to worse fatigue. Rumination mediated the relationships between stress/affective distress and poor sleep quality, and poor sleep quality mediated the relationship between rumination and fatigue, as shown in Figure 2, supporting hypothesis 1. Table 1 shows that rumination was more strongly (r's > 0.20, p's < 0.001) linked to stress and anxiety symptoms than depression and poor sleep quality, including subjective sleep quality, daytime dysfunction, sleep latency, and sleep disturbance, but not (r's < 0.20) sleep duration, habitual sleep efficiency, or use of sleep mediation.

The findings are consistent with prior research showing that impaired sleep is related to worse fatigue in cross-sectional and longitudinal studies, in community (Åkerstedt et al., 2004; Lavidor et al., 2003) and student samples (Liffman et al., 2012; Thorsteinsson and Brown, 2009; Valpiani et al., 2011); affective distress (*e.g.*, depression) is linked to impaired sleep (Ford and Cooper-Patrick, 2001) and fatigue (Ruggiero, 2003); high perceived stress is related to worse fatigue (Åkerstedt et al., 2004; van der Ploeg and Kleber, 2003); and rumination is related to high stress, affective distress, fatigue, and impaired sleep (Carney et al., 2006; Guastella and Moulds, 2007; Rector et al., 2008; Young et al., 2008). Regarding indirect effects, the results are consistent with prior studies showing that poor sleep quality mediated between high stress, anxiety, and depression to worse fatigue, including between stress and fatigue (Liffman et al., 2012; Thorsteinsson and Brown, 2009), depression to fatigue (Liffman et al., 2012), and anxiety to fatigue (Liffman et al., 2012; Valpiani et al., 2011) in student samples.

Interestingly, after taking sleep into account as a mediator, anxiety, depression, and rumination no longer directly predicted fatigue

TABLE 1. Means, Standard Deviations, and Correlation Matrix for Key Variables ($n = 229$)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Perceived stress													
2. Depression	0.66**												
3. Anxiety	0.52**	0.62**											
4. Rumination	0.52**	0.49**	0.51**										
5. Poor sleep quality[a]	0.48**	0.47**	0.46**	0.40**									
6. Fatigue	0.28**	0.18*	0.19*	0.19*	0.33**								
7. Subjective sleep quality[b]	0.43**	0.40**	0.39**	0.35**	0.91**	0.32**							
8. Daytime dysfunction	0.43**	0.50**	0.36**	0.36**	0.54**	0.23**	0.42**						
9. Sleep latency	0.33**	0.29**	0.26**	0.24**	0.70**	0.22*	0.51**	0.20*					
10. Sleep disturbance	0.29**	0.33**	0.41**	0.28**	0.71**	0.20*	0.45**	0.32**	0.43**				
11. Sleep duration	0.18*	0.18*	0.25**	0.04	0.45**	0.14*	0.43**	0.09	0.34**	0.33**			
12. Habitual sleep efficiency	0.19*	0.17*	0.24**	0.06	0.36**	0.11	0.36**	0.03	0.32**	0.23*	0.60**		
13. Use of sleep medication	0.21*	0.32**	0.33**	0.08	0.30**	0.10	0.28**	0.15*	0.26**	0.18*	0.17*	0.19*	
M	19.09	11.19	8.46	80.39	0.00	4.70	1.50	1.33	1.67	1.67	0.78	0.93	0.44
SD	6.71	9.83	8.01	26.96	0.88	1.34	0.73	0.79	1.09	0.64	1.02	1.04	0.92
Observed range	0–34	0–42	0–40	23–139	−1.88 to 2.14	1–7	0–3	0–3	0–3	0–3	0–3	0–3	0–3

[a]Based on a principal axis factoring with factor loadings of 0.80 for subjective sleep quality, 0.47 for daytime dysfunction, 0.61 for sleep latency, and 0.62 for sleep disturbance.

[b]Component 6 of the PSQI.

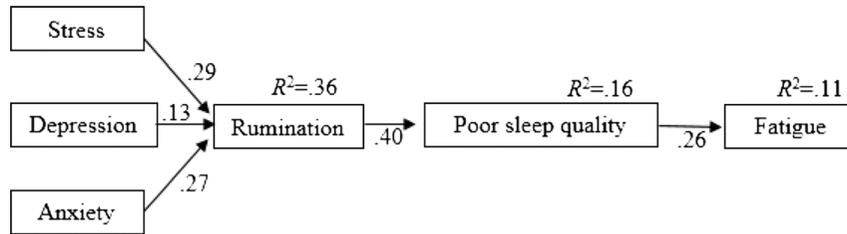*$p < 0.05$ (two-tailed). **$p < 0.001$ (two-tailed).

FIGURE 2. Model fit for key predictors in fatigue. CFI = 0.910, TLI = 0.774, RMSEA = 0.173 (0.129, 0.221).

levels, suggesting that the ill effects of affective distress and rumination on sleep parsimoniously explains the fatigue experienced by affected individuals. Liffman et al. (2012) found a lack of a significant direct relationship between depression and fatigue, after taking the indirect effects of sleep into account. However, poor sleep quality predicted only modest variance in fatigue, and more people reported substantial fatigue (82%) than poor sleep quality (71%), suggesting that there were other potential causes of fatigue. Alternately, the results may be due to the inclusion of multiple potential predictors in the analysis, all of which were correlated with fatigue and each other.

Taken together, the results suggest that rumination is often practiced by people with stress, anxiety, and/or depression, and the practice may interfere with sleep. In turn, impaired sleep may contribute to fatigue. In particular, rumination was strongly linked to poor sleep quality, subjective sleep quality, longer sleep onset latency, sleep disturbance, and daytime dysfunction, suggesting that stressed and/or distressed ruminators tend to take longer to fall asleep and experience disturbed sleep, which may result in poor sleep quality and daytime dysfunction. The results suggested that rumination often coexisted with stress/affective distress, but it may not have always adversely impacted on sleep, and in turn, impaired sleep did not always lead to fatigue. However, only general rumination (rather than nocturnal rumination) was examined in this study. Thus, the results may reflect that only people who ruminated at night were adversely affected or only those who experienced cognitive arousal in association with the rumination were affected, but such an assessment was beyond the scope of this study.

This interpretation is consistent with prior research reporting that stress, anxiety, depression, and rumination likely interfere with sleep via an increase in cognitive arousal (Young et al., 2008) and that anxiety and depression coexist with autonomic hyperarousal (Rivas-Vazquez et al., 2004) and cognitive arousal (Thomsen et al., 2003). Nevertheless, the results were only cross-sectional; therefore, it is equally plausible that impaired sleep or fatigue led to an increase in rumination, stress, anxiety, and depression.

Finally, the results may have implications for the treatment of nonclinical fatigue. First, targeting a person's ruminative thinking in

therapy may lead to improved sleep and fatigue, especially if they experience a difficulty in falling asleep or disturbed sleep. Support for this assertion comes from a systematic review showing that mindfulness and cognitive behavioral interventions can reduce ruminative thinking (Querstret and Cropley, 2013), which, in turn, may lead to a reduction in anxiety and depression symptoms. In addition, the results suggest that sleep hygiene training may assist affected individuals in reducing their experience of fatigue and impaired sleep.

Limitations

This said, the results should be interpreted in light of several study limitations. First, a large proportion of the sample were female university students, but the sample was large and the sex distribution was consistent with the observed tendency of females to study psychology (Gosling et al., 2004). Second, affective distress, sleep, and fatigue were assessed using the DASS-21, PSQI, and FSS, rather than using clinical interviews. Third, the FSS had lower than expected internal consistency, relative to results obtained from other studies (Krupp et al., 1989; Laberge et al., 2005; Valko et al., 2008). Fourth, the statistical model predicted only moderate variance in poor sleep quality and fatigue, suggesting that other causes of fatigue and impaired sleep were not assessed in this study, including viral infection (Hickie et al., 2006), lifestyle factors (Bray and Born, 2004), social support (Thorsteinsson and Brown, 2009), and SLE (Brown et al., 2009).

CONCLUSIONS

Direct and indirect mediational paths were examined between stress, affective distress (*i.e.*, anxiety, depression), rumination, poor sleep quality, and fatigue. Rumination was shown to mediate the relationships between high perceived stress, anxiety, and depression to poor sleep quality, which in turn, predicted significant variance in fatigue severity. Results suggest that rumination may contribute to fatigue by interfering with sleep, over and above the potential direct effects of stress, and affective distress on fatigue. Moreover, poor sleep quality mediated between high rumination and worse fatigue, suggesting that fatigued individuals may benefit from sleep hygiene training, with a specific emphasis on reducing their ruminative thinking.

DISCLOSURE

The authors declare no conflict of interest.

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TABLE 2. Predicting Fatigue From Different Sleep Indices

Predictor	b	95% CI for b		β	r	sr²
		Lower	Upper			
Subjective sleep quality	0.41	0.01	0.80	0.22	0.32	0.02
Sleep latency	0.11	−0.18	0.40	0.09	0.22	0.00
Sleep duration	0.03	−0.33	0.40	0.03	0.14	0.00
Sleep disturbance	0.09	−0.28	0.46	0.04	0.20	0.00
Use of sleep medication	0.02	−0.27	0.31	0.01	0.10	0.00
Daytime dysfunction	0.22	−0.08	0.52	0.13	0.23	0.01
Sleep total	−0.02	−0.22	0.19	−0.05	0.29	0.00

Note: Fit for model $R^2 = 0.12$, adjusted $R^2 = 0.09$, $F(7,221) = 4.20$, $p < 0.001$. The squared semipartial correlation (sr^2) given is the squared part correlation from SPSS. The r given is for the zero-order correlation from SPSS.

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