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Quantitative measures of nocturnal insomnia symptoms predict greater deficits across multiple daytime impairment domains

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Abstract

This study examined the associations between reported quantitative sleep measures and multiple daytime impairment domains. We collected data from a sub-sample of adults (N = 513) from the Colorado Longitudinal Twin Study and Community Twin Study. Results revealed that greater insomnia symptom frequency (days per week) significantly predicted greater global sleep-related functional impairment and depressive symptoms. Sleep onset latency was also positively associated with depressive symptoms. Receiver-operator-characteristic-curve analyses indicated 3–4 nights-per-week and 36–40 minutes provided optimal sensitivity and specificity for impairment. Thus, insomnia frequency and sleep latency are critical in understanding the impact of insomnia on multiple impairment domains. Using functional impairment as criterion, these findings also support the use of specific quantitative cut-offs for sleep measures in diagnostic systems.

Keywords

insomnia; daytime functioning; depressive symptoms; sleepiness

Introduction

Insomnia has been linked to daytime impairment and distress, such as depressed mood (Riedel & Lichstein, 2000), cognitive deficits (Mendelson, Garnett, Gillin, & Weingartner, 1984; Schneider, Fulda, & Schulz, 2004; Edinger, Means, Carney, & Krystal, 2008), and fatigue (Lichstein, Means, Noe, & Aguillard, 1997; Buysse et al., 2007). However, this evidence has been relatively mixed (Riedel & Lichstein, 2000), and the nature of the relationship between nocturnal insomnia symptoms and daytime impairment has not been fully explored (Shekleton, Rogers, & Rajaratnam, 2010). Specifically, the factors that may explain the links between disturbed sleep and different types of impairment are unknown

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(Kierlin, Olmstead, Yokomizo, Nicassio, & Irwin, 2012). For example, quantitative measures of nocturnal insomnia symptom severity and frequency may be differentially associated with various types of daytime impairment. Examining the role individual quantitative nocturnal insomnia symptoms have on daytime impairment may, therefore, expand our understanding of the degree to which disturbed sleep impacts daytime functioning. Furthermore, dissecting these associations may provide alternative ways of determining the quantitative thresholds or cut-offs for sleep disturbance, symptom frequency, and symptom duration that best characterize insomnia.

Prior research has demonstrated significant deficits in daytime functioning among insomnia patients (Lichstein, Durrence, Riedel, & Bayen, 2001; Buysse et al., 2007; Ustinov et al., 2010) and sleep-disturbed populations (Fernandez-Mendoza et al., 2009; Ohayon, 2009; Ohayon, Riemann, Morin, & Reynolds III, 2012). Recent studies have begun to elucidate these associations by examining specific factors that may explain the impact of insomnia on daytime impairment. For example, daytime impairment has been shown to vary as a function of global measures of insomnia severity (Szelenberger & Niemcewicz, 2000), global sleep dissatisfaction (Ohayon et al., 2012), difficulty resuming sleep (Ohayon, 2009), and polysomnography-determined amount of wake time after sleep onset (Kierlin et al., 2012). Taken together, these findings suggest that separate aspects of insomnia may have independent effects on daytime functioning domains. Yet, these studies have not examined the impact of specific quantitative nocturnal insomnia symptoms across multiple types of daytime impairment. Quantitative nocturnal insomnia symptoms may be differentially associated with different forms of daytime functioning which could further our understanding of the link between sleep in insomnia and daytime impairment.

Investigation of the relationship between quantitative nocturnal insomnia symptoms and daytime impairment may also provide an alternative approach to identifying thresholds for insomnia diagnoses. Historically, the various nosologies have provided little guidance to quantitative insomnia criteria (Lichstein, Durrence, Taylor, Bush, & Riedel, 2003). In contrast, virtually all insomnia clinical trials utilize specific quantitative cut-offs for nocturnal insomnia symptoms as inclusion criteria for the trials (Herring et al., 2012; Randall, Roehrs, & Roth, 2012). Cut-offs are typically determined via sleep history, sleep diaries, objective recordings, or some combination of these, but no rationale is provided as to how cut-offs are determined. It is important to establish empirically supported rationale for identification of quantitative insomnia symptom cut-offs. To this end, the association between nocturnal and daytime insomnia symptoms may provide guidance for determining appropriate diagnostic cut-offs. Thus, while studies have investigated nocturnal symptoms to define an insomnia diagnosis (Lichstein et al., 2003; Lineberger, Carney, Edinger, & Means, 2006), in the present study we propose a different but complementary approach. Specifically, we hypothesize that nocturnal insomnia symptoms could be used in conjunction with assessment of daytime impairment to estimate specific quantitative measures of nocturnal sleep, frequency, and duration of symptoms that provide useful functional significance.

Therefore, the unique approach of the current study and our primary aim was to examine the impact of quantitative nocturnal insomnia symptoms on three types of daytime impairment:

global functional impact, excessive sleepiness, and depressive symptoms. A secondary aim was to use daytime impairment domains to determine appropriate quantitative criteria for insomnia. Thus our goals were to 1) identify which quantitative nocturnal insomnia symptoms predicted different aspects of daytime impairment, and 2) determine the optimal sensitivity and specificity of these nocturnal insomnia symptoms for identifying clinically significant daytime impairment.

Methods

Participants

The sample for this study consisted of 1389 individual twins (854 female) from the Colorado Longitudinal Twin Study and Community Twin Study (Rhea, Gross, Haberstick, & Corley, 2006). The average age of our entire sample was 22.4 years (SD=2.72). The response rate for the study was 65%. Approximately 21% (*N*=292) of the entire sample met Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) criteria for insomnia (please see Drake, Friedman, Wright, & Roth, 2011 for more details on criteria used). This rate is consistent with previously reported population estimates of insomnia (Ohayon, 2002; Roth et al., 2011), thus our sample is likely representative of sleep problems in the general population. Specifically, participants reported how often (e.g., never, sometimes, usually, or always) in the past month they experienced the following 3 sleep problems: difficulty falling asleep, difficulty staying asleep, or experiencing non-refreshing sleep. Nearly 37% (*N*=513; M_{age}=22.5, 347 female) indicated "usually" or "always" experiencing at least one of these 3 sleep problems. In the current study we were interested in understanding the associations between nocturnal insomnia symptoms and daytime impairment among those who report disturbed sleep. Previous attempts to study this relationship have been carried out using only individuals meeting diagnostic criteria for insomnia. If only participants with insomnia are studied, the association between nocturnal and daytime symptoms may be skewed, as both components are required for the diagnosis of insomnia. Therefore, the subsequent analyses were conducted in participants that responded positively (i.e., "usually" or "always") to at least one of these three sleep problems (*N*=513).

Procedure

Participants were invited to complete an online survey about sleep problems and associated health outcomes. The survey took approximately 30–45 minutes to complete and participants were compensated $20 for completing the survey. While the survey included additional questions on sleep and health behaviors, the current analyses only examined questions regarding nocturnal insomnia symptoms, daytime impairment, daytime sleepiness, and depressive symptoms. All research protocols were reviewed and approved by the University of Colorado Investigational Review Board.

Measures

Nocturnal insomnia symptoms—Insomnia symptoms assessed in the current study included weekday total sleep time (TST), sleep onset latency, latency back to sleep after a nocturnal awakening (back to sleep latency), number of nocturnal awakenings, and nocturnal insomnia symptom duration and frequency. Specifically, participants were asked

to report, on average, their TST, sleep onset latency, and back to sleep latency, in hours and minutes. For example, to assess for TST, participants were asked "during the past month, thinking about your average weekday, how long did you actually sleep?" and for back to sleep latency, "during the past month, on average, how long does it take you to fall back asleep after waking up?" Participants were also asked to report the average number of times, during the past month, they wake up during the night. While sleep quality (i.e., the restorative nature of sleep) is an accepted measure of disturbed sleep, it was excluded from the analysis, as it is a qualitative, rather than a quantitative symptom and has recently been removed from the newest version of the DSM as a nocturnal symptom for insomnia (American Psychiatric Association, 2013). We assessed insomnia symptom duration by asking participants how long they have been experiencing nocturnal insomnia symptoms (i.e., difficulty falling asleep or staying asleep), in years and months. Insomnia symptom frequency was the average number of days per week they had experienced one or more of these symptoms.

Global daytime impairment—Participants were asked to report how their disturbed sleep interfered with their daytime functioning. This measure of sleep-related global daytime impairment assessed a number of different domains, including mood, cognitive functioning, vocational performance, and daytime distress. Specifically, participants indicated whether their sleep problems have contributed to increased irritability, forgetfulness, productivity, depressed mood, or reduced concentration. Daytime function items were chosen from those provided by the Research Diagnostic Criteria (RDC) for Insomnia (Edinger et al., 2004). The impairment options also included an open-ended item that allowed participants to write in any additional forms of impairment or distress attributable to their sleep problems. The total number of impairment items endorsed was used as the participant's global sleep-related daytime impairment score. Reliability analyses for this measure indicated adequate reliability (α =0.65).

Depressive symptoms—Participants completed the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) to assess current self-reported depressive symptoms. The CES-D consists of 20 four-point Likert scale items assessing various symptoms commonly reported in depression. High internal consistency (α=0.85) and test retest reliability (r=0.61) have been previously reported for the CES-D (Radloff, 1977; Devins et al., 1988). In the current study, however, the "restless sleep" item was removed from the scale in order to reduce overlap between the CES-D and the sleep problem items. The revised 19-item CES-D scale also demonstrated high internal consistency (α=0.90).

Daytime sleepiness—The Epworth Sleepiness Scale (ESS; Johns, 1991) was used to assess excessive daytime sleepiness. The ESS is a well-validated and widely used self-report measure of general daytime sleepiness. Specifically, the ESS is an 8-item questionnaire that examines the likelihood a participant would fall asleep in different situations (e.g., sitting and reading, watching TV, or in a car, while stopped for a few minutes in traffic). The ESS has previously demonstrated good psychometric properties (Johns, 1992), such as test-retest reliability (r=0.82) and internal consistency (α=0.88). The ESS in our current sample also showed adequate internal consistency (α=0.71). The ESS has demonstrated to be a useful

tool for distinguishing between normal subjects and patients with sleep disorders, such as insomnia, obstructive sleep apnea, and narcolepsy (Johns, 1991; Ustinov et al., 2010).

Statistical Analyses

We used multiple adjusted random effects models via SPSS MIXED to examine the association among nocturnal insomnia symptoms and measures of daytime impairment. Given that twin data includes non-independent observations, we used mixed modeling in order to model the correct within-family covariate structure. Separate models were run for each outcome variable (daytime impairment, depressive symptoms, and daytime sleepiness). All independent variables were mean-centered and skewed variables (i.e., sleep onset latency, nocturnal awakenings, back to sleep latency, and insomnia symptom duration) were log-transformed. Each model included TST, sleep latency, back to sleep latency, nocturnal awakening frequency, insomnia symptom duration, and insomnia symptom frequency as fixed effects. Linear and quadratic estimates of all symptoms were computed for each outcome variable in separate models. All models were conducted using the sleep-disturbed subgroup (*N*=513). Age and sex were significantly associated with several insomnia symptoms and impairment domains; therefore, all models controlled for the effect of age and sex on impairment.

To explore the utility of specific insomnia criteria in relation to daytime impairment, we computed separate receiver-operator characteristic (ROC) curve analyses for each nocturnal insomnia symptom that was significantly associated with measures of daytime impairment, depressive symptoms, or daytime sleepiness. As ROC curves aid in the prediction of dichotomous endpoints, subjects were classified as “depressed”, “excessively sleepy”, and/or “impaired” based on tabulated scores from their CES-D, ESS, and sleep-related daytime impairment responses, respectively. Subjects were classified as depressed when CES-D scores were equal to or greater than 16 (Radloff, 1977; Boyd, Weissman, Thompson, & Myers, 1982). Likewise, subjects were classified with excessive daytime sleepiness when they presented an ESS score equal to or greater than 10 (Johns, 2000). For the sleep-related impairment question, we conservatively defined subjects as “impaired” when their impairment score was greater than one standard deviation above the mean (impairment >3.14 on a 0–6 scale). ROC curve analyses were also conducted using the sleep-disturbed subgroup only.

Results

Descriptive Statistics

Table 1 presents descriptive statistics of each variable for both the sleep disturbed group and the non-sleep disturbed group. By definition, the sleep-disturbed group reported significantly greater sleep problems on all individual symptoms, and had higher scores on all three impairment domains (Table 1). Table 1 also presents the distribution of daytime impairment items endorsed by each group. In the sleep-disturbed group, irritability (59%) and reduced concentration (54%) were the most commonly reported impairment items.

Predicting daytime impairment from quantitative insomnia symptoms

Our first model examined the effects of insomnia symptoms on sleep-related daytime impairment. Results indicated that there was a significant *linear* effect of insomnia symptom frequency on daytime impairment, $\beta = 0.123$, $t(429) = 2.506$, $p < .05$. These results suggest that as insomnia symptom frequency increases, sleep-related impairment increases (Figure 1). The linear and quadratic effects of all other nocturnal insomnia symptoms on sleep-related daytime impairment were non-significant (Table 2).

Next, we conducted a similar adjusted model examining the impact of quantitative insomnia symptoms on depressive symptom severity. In this model, sleep onset latency had a significant *linear* association with depressive symptoms, $\beta = 5.19$, $t(432) = 3.671$, $p < .001$, such that longer sleep onset latency was associated with greater depressive symptoms (Table 2). In addition, insomnia symptom frequency had a significant *quadratic* effect on depressive symptoms, $\beta = -0.334$, $t(425) = -2.258$, $p < .05$. This result indicates that greater insomnia symptom frequency is associated with greater depressive symptoms. However, as insomnia symptom frequency increases, increases in the intensity of the association with depressive symptoms level off (Figure 2). See Table 2 for the linear and quadratic effects of all other insomnia symptoms that were non-significant.

We conducted a third analysis examining the impact of individual quantitative insomnia symptoms on daytime sleepiness. In this model, there was a significant linear effect of sleep onset latency on daytime sleepiness, $\beta = -1.282$, $t(430) = -2.195$, $p < .05$. This effect indicates that shorter sleep latency is linked to greater daytime sleepiness while controlling for all other insomnia symptoms. The linear and quadratic effects of all other insomnia symptoms on daytime sleepiness were non-significant (Table 2).

Sensitivity and specificity of insomnia symptom thresholds

Based on our results from the mixed models, we constructed the following receiver operating characteristic (ROC) curves: insomnia symptom frequency on sleep-related daytime impairment, insomnia symptom frequency on depressive symptoms, sleep onset latency on depressive symptoms, and sleep onset latency on daytime sleepiness. The ROC curve analyses point to insomnia symptom cut-offs consistent with previous recommendations (Lichstein et al., 2003) and recent diagnostic guidelines (American Psychiatric Association, 2013). Specifically, using a symptom frequency threshold of four-nights-per-week led to an optimal sensitivity (78%) and specificity (43%) for global sleep-related daytime impairment classification (Table 3). A threshold of three-nights-per-week was identified for depressive symptom severity with a sensitivity (90%) and specificity (21%; Table 4). Sleep onset latencies in the 36–40 minute range produced the sensitivity (65%) and specificity (48%) for depressive symptom classification (Table 5). In contrast, sleep onset latency did not produce a statistically significant ROC curve for daytime sleepiness classification, area under the ROC curve = .506; SE = .019; $p > .20$. Full results are presented in Tables 3–5.

Discussion

In this study we examined the relation between quantitative nocturnal insomnia symptoms and three types of daytime impairment. Results revealed that insomnia symptom frequency of >3–4 times per week and sleep latency of more than ~35 minutes were the cutoffs which captured the majority of daytime impairment. In terms of daytime morbidity measures our data are largely consistent with established guidelines in diagnostic manuals (American Psychiatric Association, 2013) and reports in the literature (Lichstein et al., 2003), supporting the diagnostic contention that measures of global functional impairment, depressive symptoms, and excessive daytime sleepiness are useful tools in evaluating an insomnia disorder.

Our data indicated that nocturnal insomnia symptom frequency was a strong predictor of global sleep-related daytime functional impairment and depressive symptoms. Specifically, greater symptom frequency was linearly associated with sleep-related daytime impairment. The relationship between symptom frequency and depressive symptoms, however, was nonlinear. Beyond a frequency of approximately three nights per week, the relationship became asymptotic, suggesting a potential cut-off of 3 or more nights per week. This result also indicates that beyond three nights per week, other nocturnal measures of insomnia severity should be utilized in estimating the additional impact of insomnia symptom frequency on depressive symptoms. Taken together, these data indicate that sleep-related daytime impairment and depressive symptom severity may vary primarily as a function of nocturnal symptom *frequency*. This conclusion is based on quantitative estimates of nocturnal symptoms, but it is possible that daytime impairment measures might better relate to qualitative judgments about degree of disturbed sleep. Thus the possibility remains that a scale measuring difficulty staying asleep, varying from not very much to a lot of difficulty, may predict daytime function better than an estimate of the duration of wakefulness during the previous night. This is a potentially important consideration in that clinical trials typically estimate severity of nocturnal insomnia symptoms using quantitative measures (Herring et al., 2012; Randall et al., 2012).

Additionally, prolonged sleep onset latency was independently and linearly associated with depressive symptoms. In particular, as the estimated amount of time to fall asleep increased, there was an associated elevation in depressive symptoms. Taken with symptom frequency, we present clear evidence that the combination of insomnia symptom frequency and sleep onset latency provides important information regarding non-sleep specific depressive symptoms. However, we did not find a significant interaction between sleep latency and symptom frequency, suggesting that these indicators predict daytime pathology only additively. This finding is consistent with both cross-sectional (Taylor, Lichstein, Durrence, Reidel, & Bush, 2005; Buysse et al., 2008) and longitudinal (Ford & Kamerow, 1989; Breslau, Roth, Rosenthal, & Andreski, 1996; Chang, Ford, Mead, Cooper-Patrick, & Klag, 1997) studies demonstrating strong bidirectional relationships between insomnia and depression (for a review see Baglioni et al., 2011). The results of one recent study demonstrating the specificity of “difficulty falling asleep” as a prospective predictor of depression is also consistent with these results (Szklo-Coxe, Young, Peppard, Finn, & Benca, 2010). In addition, shorter sleep latency was independently associated with greater

daytime sleepiness. Although short sleep onset latency may indicate high homeostatic sleep pressure in a subset of patients with insomnia (Riedel & Lichstein, 2000), no cutoff for sleepiness was identified in the ROC analysis, limiting conclusions.

The current investigation into the relationship between nocturnal insomnia symptoms and impairment is also informative with regard to identifying levels of insomnia severity. Nearly all areas of medicine have identified specific ranges of severity for particular disorders. Despite the utility of such a categorization and the fact that quantification of nocturnal insomnia symptoms are amenable to such categorization, insomnia diagnostic criteria remain uncategorized in terms of severity. One reason may be the lack of an empirical basis for calibrating the cut-offs for selected nocturnal sleep parameters. Measures of daytime impairment related to nocturnal insomnia symptoms provide potentially valuable information in this regard. Specifically, ROC curve analyses showed ≥4 nights per week predicted daytime impairment at an optimized sensitivity to specificity ratio, yet ≥3 nights per week predicted depressive symptoms at an optimized sensitivity to specificity ratio. These differences suggest that the impact of insomnia symptoms on daytime impairment may be domain specific (i.e., different types of impairment are going to be affected differently by individual insomnia symptoms). In terms of nocturnal parameters, the present results show that using a reported sleep latency of >35 minutes identifies the vast majority of participants with clinically significant depressive symptoms. Whereas these finding are relatively consistent with previously identified cut-offs (Lichstein et al., 2003), previous studies have used insomnia classification to determine clinical thresholds. The unique contribution of the current study it that it provides further evidence for these thresholds using impairment classification.

Finally, the present findings also provide important information regarding the distribution of specific reports of daytime impairments in relation to nocturnal insomnia symptoms. In particular, irritability (59.1%) was the most commonly endorsed symptom related to sleep problems among individuals reporting disturbed sleep, followed by concentration difficulties (54%). These two symptoms were also the two most frequently reported impairment items in the non-disturbed group, albeit at a much lower rate 28.8%, and 30%, respectively. The distribution of symptoms found in the present study is also consistent with those identified in the RDC for insomnia (Edinger et al., 2004). For the open-ended item, few specific daytime impairments were endorsed by a significant portion of the sample, supporting the notion that those impairments presently identified in the insomnia literature represent a relatively comprehensive set of self-reported impairments related to insomnia (Riedel & Lichstein, 2000; Edinger et al., 2004).

These findings should be considered in light of a number of study limitations. First, we did not utilize objective measures either for identifying cases of disturbed sleep or daytime impairment. Although objective measurement of sleep and impairment could provide additional valuable information, insomnia is a symptom-based diagnosis. Furthermore, objective measures of sleep and impairment are generally not utilized in clinical practice, limiting their practical implementation. Another important limitation is the use of a younger sample with a mean age of 22.5, which may limit the generalizability of our findings. It will be important for future studies to replicate the current findings and compare results to older

samples with an inherently different profile of nocturnal symptoms, including more frequent and severe sleep maintenance problems (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004; Salo et al., 2011; Green, Espie, Hunt, & Benzeval, 2012) and less reported daytime impairment (Duffy, Wilson, Wang, & Czeisler, 2009; Roth et al., 2011).

Conclusions

The results from the current study indicate that insomnia symptoms such as sleep onset latency and symptom frequency are important in understanding the impact of nocturnal insomnia symptoms on extent of daytime impairment and distress. Specifically, we provide evidence for the effects of sleep onset latency and insomnia symptom frequency on depressive symptoms, excessive daytime sleepiness, and a global measure of sleep-related impairment. Moreover, given the tautological limitations of observing these associations among insomnia patients only, the current study included all participants reporting at least one nocturnal insomnia symptom. Therefore, this study advances our understanding of the impact of nocturnal insomnia symptoms on daytime impairment by examining these associations in a broader sleep-disturbed sample. We also provide alternative rationale supporting the use of specific nocturnal symptom cut-offs. Using daytime impairment domains, we identified clinical thresholds consistent with the previous literature (Lichstein et al., 2003) and current diagnostic criteria (American Psychiatric Association, 2013). We recommend a cut-off for symptom frequency ≥ 3 nights per week, and provide support for a cut-off for sleep onset latency of >35 minutes. Taken together, these results further our understanding of the individual impact of nocturnal insomnia symptoms on daytime impairment and distress, which may help inform future diagnostic and intervention efforts.

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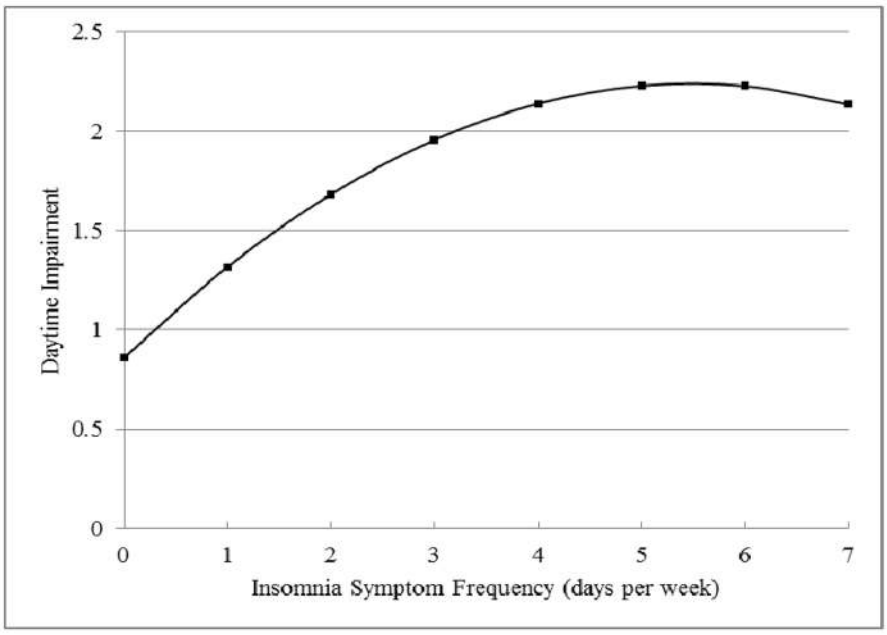

Figure 1.

Global Sleep-Related Daytime Impairment as a Function of Insomnia Symptom Frequency (Days Per Week) Among a Sleep-Disturbed Subgroup.

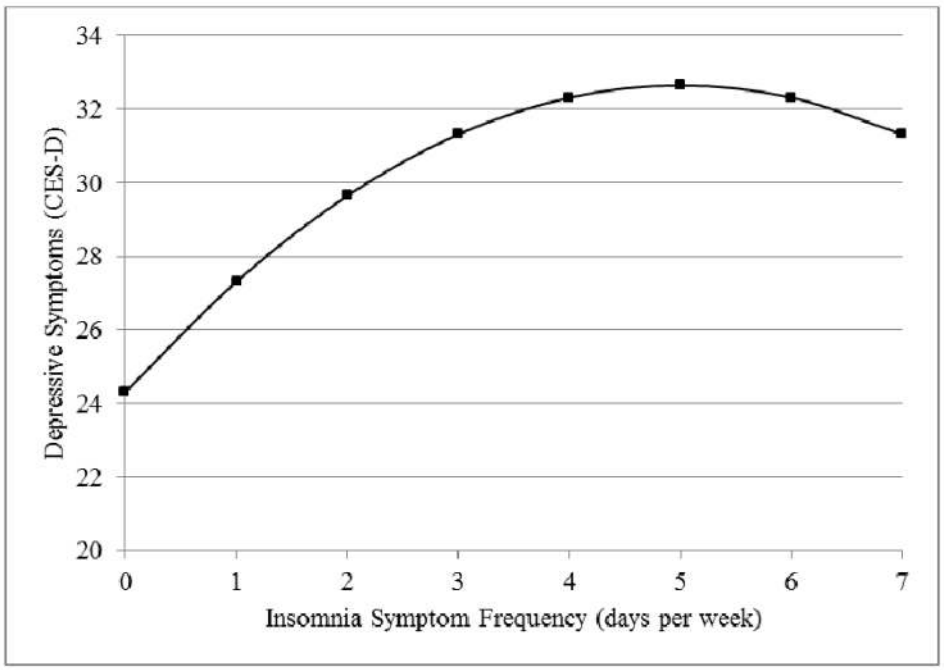

Figure 2.

Depressive Symptoms as a Function of Insomnia Symptom Frequency (Days Per Week) Among a Sleep-Disturbed Subgroup.

Table 1

Descriptive Information - Group Means and Standard Deviations for All Independent and Dependent Variables.

	Sleep-disturbed group (*n* = 513)	Non-sleep-disturbed group (*n* = 876)	p-value
Sex, *n* (%)			<.001
Male	166 (32.4)	376 (42.9)	
Female	347 (67.6)	500 (57.1)	
Age, mean (SD)	22.53 (2.76)	22.40 (2.69)	0.36
Insomnia symptoms, mean (SD)			
Weekday TST	6.64 (1.52)	7.42 (1.08)	<.001
Sleep latency	55.79 (42.72)	23.40 (19.86)	<.001
Nocturnal awakenings	2.74 (2.77)	1.26 (1.70)	<.001
Back to sleep latency	22.38 (24.69)	9.54 (15.83)	<.001
Insomnia symptom duration	40.99 (49.59)	27.58 (46.38)	<.001
Insomnia symptom frequency	4.09 (1.60)	1.23 (1.15)	<.001
Daytime sleepiness, mean (SD)	7.61 (3.75)	6.60 (3.52)	<.001
Depressive symptoms, mean (SD)	34.40 (9.32)	27.44 (6.47)	<.001
Daytime impairment, mean (SD)	2.48 (1.48)	1.18 (1.29)	<.001
Irritability, *n* (%)	303 (59.1)	252 (28.8)	<.001
Depressed mood, *n* (%)	219 (42.7)	131 (15.0)	<.001
Forgetfulness, *n* (%)	213 (41.5)	135 (15.4)	<.001
Productivity, *n* (%)	211 (41.1)	208 (23.7)	<.001
Concentration, *n* (%)	277 (54.0)	263 (30.0)	<.001

Table 2

Independent Linear and Quadratic Associations Between Nocturnal Insomnia Symptoms, Symptoms Duration, and Symptom Frequency and Three Types of Daytime Impairment.

	Daytime Impairment			**Depressive Symptoms**			**Daytime Sleepiness**		
	β	**SE**	***t*-value**	**β**	**SE**	***t*-value**	**β**	**SE**	***t*-value**
Sex	0.351	0.154	2.27*	1.315	0.977	1.35	−0.131	0.405	−0.32
Age	0.002	0.027	0.07	0.033	0.170	0.20	−0.018	0.071	−0.26
Weekday total sleep time (TST)	−0.029	0.048	−0.59	−0.564	0.305	−1.85	−0.113	0.126	−0.90
Sleep onset latency (SOL)	0.332	0.225	1.47	5.189	1.413	3.67***	−1.282	0.584	−2.20*
Nocturnal awakenings (NA)	−0.074	0.320	−0.23	−0.255	2.008	−0.13	1.351	0.830	1.63
Back to sleep latency (BSL)	0.174	0.168	1.04	−0.112	1.056	−0.11	−0.302	0.437	−0.69
Insomnia symptom duration	0.152	0.130	1.17	−0.021	0.816	−0.03	−0.023	0.338	−0.07
Insomnia symptom frequency	0.123	0.049	2.51*	0.563	0.310	1.82	0.076	0.128	0.59
Age* Age	−0.007	0.009	−0.85	−0.098	0.055	−1.77	−0.022	0.023	−0.96
TST* TST	0.029	0.016	1.84	0.037	0.098	0.38	0.045	0.041	1.10
SOL* SOL	0.305	0.368	0.83	2.862	2.307	1.24	1.017	0.966	1.05
NA* NA	0.981	0.732	1.34	6.151	4.567	1.35	−0.234	1.907	−0.12
BSL* BSL	−0.007	0.249	−0.03	1.408	1.556	0.91	−0.623	0.651	−0.96
Duration* Duration	−0.142	0.191	−0.74	1.436	1.191	1.21	0.117	0.498	0.23
Frequency* Frequency	−0.046	0.024	−1.94	−0.334	0.148	−2.26*	−0.015	0.062	−0.24

* $p < .05$;

** $p < .01$;

*** $p < .001$

Table 3

Sensitivity, Specificity, and ROC Curve Data for Insomnia Symptom Frequency as a Predictor of Global Sleep-Related Daytime Impairment.

Symptom Frequency	Sensitivity	Specificity
1 night per week	100.0%	0.9%
2 nights per week	99.2%	6.5%
3 nights per week	91.6%	19.4%
4 nights per week	78.2%	42.9%
5 nights per week	54.6%	65.9%
6 nights per week	26.9%	84.7%
7 nights per week	14.3%	92.6%

Area under ROC curve = 0.638, SE = .029, $p < .001$

Table 4

Sensitivity, Specificity, and ROC Curve Data for Insomnia Symptom Frequency as a Predictor of Depressive Symptoms.

Symptom Frequency	Sensitivity	Specificity
1 night per week	99.4%	0.7%
2 nights per week	98.9%	7.5%
3 nights per week	90.4%	21.0%
4 nights per week	68.5%	41.3%
5 nights per week	45.5%	64.4%
6 nights per week	21.3%	83.6%
7 nights per week	9.6%	91.1%

Area under ROC curve = 0.575, SE = .027, $p < .01$

Table 5

Sensitivity, Specificity, and ROC Curve Data for Sleep Onset Latency Predictor of Depressive Symptoms.

Sleep Onset Latency	Sensitivity	Specificity
6–10 minutes	96.8%	3.1%
11–15 minutes	92.6%	8.1%
16–20 minutes	90.0%	14.6%
21–25 minutes	82.6%	21.5%
26–30 minutes	80.5%	23.1%
31–35 minutes	65.8%	47.0%
36–40 minutes	65.3%	48.3%
41–45 minutes	61.1%	50.5%
51–55 minutes	53.2%	57.6%
>60 minutes	28.4%	80.4%

Area under ROC curve = 0.568, SE = .026, $p < .01$.

Latency ranges with no data excluded (46–50 minutes and 56–60 minutes).