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Disassembling insomnia symptoms and their associations with depressive symptoms in a community sample: the differential role of sleep symptoms, daytime symptoms, and perception symptoms of insomnia

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ABSTRACT

Objective: Insomnia and depression are closely related. However, few studies have investigated whether certain insomnia symptoms differentially relate to certain depressive symptoms. The present study aimed to examine relationship between specific types of insomnia symptoms (sleep symptoms, daytime symptoms, and perception symptoms) and specific symptoms of depression.
Design: Cross-sectional, observational study data from the Sleep, Health, Activity, Diet and Environment and Social Factors (SHADES) Survey.
Setting: Community-level population.
Participants: A total of 1003 community-based adults aged 22–60 from the Philadelphia area.
Measurements: Insomnia symptoms were represented by scores of sleep symptoms, daytime symptoms and perception symptoms, derived from the Insomnia Severity Index (ISI). Depression symptoms were assessed with the items of the Patient Health Questionnaire 9 (PHQ-9).
Results: A Confirmatory Factor Analysis (CFA) supported the three-factor model based on ISI data. Binary logistic regressions examined independent associations between the three insomnia symptom types and individual depression symptoms. Sleep symptoms were more strongly associated with physiological aspects of depressive symptoms (appetite symptoms, psychomotor symptoms, and suicidal ideation). The daytime symptoms, on the other hand, were significantly associated with almost all depressive symptoms, except for appetite. Moreover, daytime symptoms were exclusively related to cognitive symptoms of depression (eg, trouble concentrating). The perception symptoms were independently associated with mood symptoms, tiredness, appetite, and judgment of oneself as a failure, but not with psychomotor, cognitive and suicidal ideation symptoms.
Conclusion: Daytime symptoms and perception symptoms of insomnia were more strongly associated with a full range of depressive symptoms than sleep symptoms. The sleep symptoms were mainly associated with more physiological symptoms of depression, implicating more biological mechanisms. Further research is needed regarding how these types of insomnia symptoms differentially related to multiple health consequences.

Introduction

Sleep dysregulation is a common symptom of depression[1] and symptoms of insomnia and depression often co-occur.[2] Prospective studies have shown that insomnia symptoms are strong predictors

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of future depressive episodes.[3] In addition, insomnia is a major risk factor for suicidal ideation, attempted suicide, and completed suicide.[4] Previous studies have shown that cognitive-behavioral treatment of depression often does little to ameliorate symptoms of insomnia,[5] though cognitive-behavioral treatment of insomnia (CBT-I) can produce improvements in depression.[6] Many previous studies have explored mechanisms linking depression and insomnia, including genetic,[7] physiologic,[8] and environmental[9] influences.

Although many studies associate depression and insomnia in general terms, there is much less evidence linking specific aspects of insomnia symptoms with types of depression symptoms. Growing studies on insomnia subtypes have lent supports to the argument that insomnia is a multifaceted disturbances and patients of one phenotype can manifest heterogenous symptoms from the others. Studies suggested that insomnia patients who were objective short sleeper had severe neurocognitive function impairments.[10,11] In addition, study also identified those who were cognitively vulnerable to the sleep deprivation in relative to others who were more "resilient" to the sleep loss.[12,13] Moreover, sub-constructs have also been revealed on subjective measures of insomnia[13,14] which showed that daytime disturbances as a result of insomnia and subjective dissatisfaction about insomnia were separate components from nocturnal sleep disruptions. Therefore, it's plausible that certain subtypes may be more indicative of illness severity as well as comorbidities, like depression. Different symptoms of insomnia also impact depression risk in different ways. Emerging studies have shown that improvements in daytime symptoms of insomnia mediated changes to depression scores following an insomnia intervention[15];and in cognitive-behavioral therapy, the mediator of treatment effects on sleep quality is the changed perceptions on sleep.[16,17] It is noteworthy that individuals with both insomnia and depression were at increased likelihood of negative appraisals of situations.[18,19] According to Beck (2009), the physiologic manifestation of depression includes the loss of appetite, sleep disturbances, loss of libido, and fatigability.[20] It has been also indicated that appetite dysregulation (which is known to be related to sleep and circadian regulation)[21] and psychomotor symptoms (which may also be physiologically linked to sleep deprivation)[22] were closely associated with sleep conditions.

Previous insomnia studies have not addressed different phenotypes of insomnia directly in this regard. Neither have studies examined a population-level group of adults, simultaneously assessed for mood and insomnia symptoms, to examine whether certain insomnia symptoms differentially relate to certain depressive symptoms and whether daytime distress is more associated with overall depression symptoms than to insomnia. Accordingly, the present study examined whether specific types of insomnia symptoms (sleep symptoms, daytime symptoms, and perception symptoms) differentially predicted symptoms of depression. We hypothesized that: (1) sleep symptoms would be more associated with physiologic depression symptoms (eg, change in appetite; psychomotor dysregulation); (2) daytime symptoms would be more associated with cognitive depressive symptoms and experiential symptoms in general (eg, trouble concentrating; lost interest; depressed mood); and (3) perception symptoms would be more associated with attributional depressive symptoms (eg, feelings of worthless and dissatisfaction with the self).

Methods

Data source

Data from the Sleep, Health, Activity, Diet and Environment and Social Factors (SHADES) survey were used for the analysis. A total of N = 1003 individuals provided data. The SHADES survey was a community-level study of adults age 22–60 in the Philadelphia area and included adults from Philadelphia County and the neighboring Delaware, Montgomery, Bucks, and Chester Counties. Respondents were recruited through advertisements and outreach to local community centers. The study included a survey that was completed online or in person, and consisted of a number of items assessing sleep, health, behavior, and environmental factors. Because all online surveys (ISI and PHQ9) were validated and all in-person surveys ensured completion, there was no missing data.

Measures

Insomnia was assessed with the Insomnia Severity Index (ISI),[23] a well-validated, standard screening tool for insomnia. The ISI consists of 7 items on a 0–4 scale. The items assess (1) difficulty falling asleep, (2) difficulty staying asleep, (3) difficulty with early morning awakenings, (4) dissatisfaction with sleep, (5) degree to which sleep problems interfere with functioning, (6) degree to which sleep problems are noticeable to others, and (7) degree of worry about sleep problems. Items 1, 2, and 3 address sleep symptoms of insomnia (ie, inability to sleep). Items 5 and 6 address symptoms that reflect waking experience (ie, how much it interferes and is noticeable). Items 4 and 7 address a person's perceptions of the problem (eg, how dissatisfied or worried she is). For the purposes of the analyses in this study, separate scores were computed by adding items 1 + 2 + 3 (sleep symptoms), 5 + 6 (daytime symptoms), and 4 + 7 (perception symptoms).

Depressive symptoms were measured with the Patient Health Questionnaire 9[24] depression scale. This is a well-validated and frequently used screening tool for depression, addressing a wide range of depression symptoms. Symptoms include: (1) anhedonia or decreased interest in things, (2) depressed mood, (3) sleep difficulties, (4) daytime tiredness and fatigue, (5) appetite symptoms (decreased or increased appetite), (6) feelings of failure, (7) difficulty concentrating, (8) psychomotor symptoms (agitation or retardation), and (9) suicidal ideation. Items are presented on a 0–3 scale (0 = "not at all", 1 = "some of the days", 2 = "more than half of the days", and 3 = "nearly every day.") Responses were dichotomized as present or absent; symptoms were considered present if they were reported "more than half the days" or "nearly every day."

Covariates included age (self-reported), sex (self-reported), race/ethnicity (self-reported as Non-Hispanic White, Black/African-American, Hispanic/Latino, Asian, or Other/Multiracial), and education (self-reported as College Graduate, Some College or Associate's Degree, High School Graduate, or Less Than High School). These variables were included as covariates in all models to exclude potential, confounding effects.

Statistical analyses

Descriptive statistics were calculated for all variables (mean and standard deviation for continuous variables and percent for categorical variables). To evaluate whether the proposed method of dividing the ISI into three components (sleep, daytime, and perception symptoms), a confirmatory factor analysis (CFA), using a maximum likelihood approach, evaluated the plausibility of a 3-factor approach to the ISI. The purpose of the CFA was not to discern a latent factor structure of the ISI (for which an exploratory factor analysis would have been more appropriate); rather, it was to empirically evaluate whether the 3-factor approach derived from our conceptual model could plausibly be evaluated in the present data. The chi-square test suggests the degree of difference between observed and expected covariance matrices. To evaluate how different aspects of insomnia symptom were associated with depressive symptoms, binomial logistic regression analyses were used. Depressive symptom (present

vs. absent) was entered as the outcome variable, and the three insomnia symptom scores (sleep, daytime, and perception symptoms) were simultaneously entered as predictor variables. This was done to address high correlations among insomnia symptoms by evaluating each type of symptom adjusted for the others. Covariates (age, sex, race/ethnicity, and education) were included in all models. Adjusted Odds Ratios (ORs), 95% Confidence Intervals (95% CI), and p values are reported. P values <.05 were considered statistically significant. All analyses were conducted using STATA 14.0 (College Station, TX).

Results

Characteristics of the sample

Characteristics of the sample are shown in Table 1. The average age was 34 (SD 9.4). Overall, the sample included more women than men, individuals from a range of racial/ethnic groups, and a range of educational backgrounds.

Responses to PHQ-9 and ISI items are reported in Table 2. Depression symptoms were commonly endorsed, with 5 of the 9 depressive symptoms endorsed by >25% of the sample. Moreover, 18% of the participants reported moderate to severe depressive symptoms (Table 2). Similarly, sleep disturbances symptoms were frequently reported by participants. Regarding sleep symptoms on the ISI, 15–16% of participants reported severe nighttime symptoms of difficulties falling asleep, staying asleep, or waking too early. Regarding waking symptoms, approximately 26% reported that sleep problems interfered "much" or "very much" with daytime functioning, and approximately 13% reported that their sleep problems are "much" or "very much" noticeable to others. Regarding perception symptoms of insomnia, approximately 42% reported at least severe dissatisfaction with their sleep and approximately 19% reported feeling "much" or "very much" worried about their sleep problems. Table 2 also shows the distribution of ISI total score and 26.61% of the participants have moderate to severe insomnia symptoms (ISI ≥ 15).

Confirmatory factor analysis

To evaluate the plausibility of a 3-factor structure for the ISI, a confirmatory factor analysis evaluated ISI items along the dimensions of sleep symptoms (items 1, 2, and 3), daytime symptoms (items 5 and 6), and perception symptoms (items 4 and 7). For Sleep Symptoms, the standardized factor loadings (which could be interpreted as correlation coefficients) for items 1, 2, and 3 were 0.75 (95% CI = 0.71, 0.78), 0.69 (95% CI = 0.65, 0.73), and 0.54 (95% CI = 0.49, 0.59), respectively, all $P < .0001$. For Daytime symptoms, the standardized factor loadings for items 5 and 6 were 0.89 (95% CI = 0.87, 0.92) and 0.83 (95% CI = 0.80, 0.85), respectively, both $P < .0001$. For perception symptoms, the standardized factor loadings for items 4 and 7 were 0.81 (95% CI = 0.79, 0.84) and 0.89 (95% CI = 0.87, 0.91), respectively, both $P < .0001$. Overall, this model is plausible. This was demonstrated by a root mean square error of approximation (RMSEA) of 0.08 (90% CI 0.067, 0.099); typically, the lower bound of the 90% CI for RMSEA should be >0.050 and the upper bound should be <0.100. Also, pclose (probability that RMSEA <0.05) is <0.001, indicating model fit. Good model fit is also supported by a Tucker-Lewis Index and Comparative Fit Index approaching 1.0 (0.96 and 0.98, respectively), as well as a standardized root mean square residual (SRMR) <0.08 (SRMR = 0.02) and a coefficient of determination (CD) approaching 1.0 (CD = 0.96).

Table 1
Characteristics of the sample (n = 1003)

Variable	Category or units	% or M ± SD
Demographics		
Age	Years	34.0 ± 9.4
Sex	Female	61.47%
Race/Ethnicity	Non-Hispanic White	59.52%
	Black/African-American	25.02%
	Hispanic/Latino	4.59%
	Asian	5.48%
	Multiracial/Other	5.38%
Education	College Graduate	55.91%
	Some College	30.98%
	High School	10.53%
	Less Than High School	2.58%

Differential associations between insomnia symptoms and depressive symptoms

Table 3 summarizes the adjusted odds ratios (OR) for each symptom of PHQ-9, with insomnia symptom score as a predictor, adjusted for age, sex, race/ethnicity, and education. Each point on the "sleep symptoms" subscale was associated with approximately 30% increased likelihood of sleep disturbance symptoms in PHQ-9, 20% increased likelihood of psychomotor symptoms, 15% increased likelihood of suicide ideation and 12% increased likelihood of appetite symptoms. Each point on the "daytime symptoms" subscale was associated with 47% increased likelihood of tiredness, 36% increased likelihood of anhedonia, 30% increased likelihood of trouble concentrating, 28% and 22% increased likelihood of psychomotor symptoms and suicidal ideation respectively, 17% increased likelihood of depressed mood, and 16% increased likelihood of sleep disturbances and feeling of failure. For the "perception symptoms" scale, each increased point was associated with 54% increased likelihood of sleep disturbances, 36% increased probability of tiredness, 29% increased probability of feeling of failure, 26% and 24% increased probability of appetite and depressed mood respectively, and 21% increased probability of anhedonia.

Discussion

The present study examined whether specific aspects of insomnia symptoms (sleep symptoms, daytime symptoms, and perception symptoms) were differentially related to symptoms of depression in a general community-based population. Overall, sleep symptoms were more strongly associated with physiological aspects of depressive symptoms (appetite symptoms and psychomotor symptoms) as well as the suicidal ideation than the other symptom domains of depression. The daytime symptoms, on the other hand, were significantly associated with almost all depressive symptoms except for appetite. Moreover, only daytime symptoms were related to cognitive symptoms (eg, trouble concentrating) in comparison to sleep and perception symptoms, which were not associated with cognitive symptoms. The perception symptoms were independently associated with mood symptoms, tiredness, appetite, and judgment of oneself as a failure, but not with psychomotor, cognitive and suicidal ideation symptoms. Therefore, the daytime symptoms were the most strongly associated with depressive symptoms in general and the perceptions symptoms were also quite relevant to experiential feelings of depression and depressive perceptions about the self. Sleep symptoms, on the other hand, were more restricted to symptoms associated with the physiological aspects of depression, like appetite and psychomotor symptoms.

Further, by using the confirmative factor analysis (CFA) model, the present study demonstrated the plausibility of three factors of insomnia symptoms measured by ISI, including sleep symptoms, daytime symptoms and perception symptoms. Sleep symptoms represent nocturnal sleep disturbances including difficulty falling into sleep, difficulty staying asleep and early-morning awakening

Table 2
Distribution of participants' scores on the PHQ-9 and ISI items

Variable	Category or units	% or M ± SD
PHQ-9 Items		
PHQ-9 total categories	0–4: minimal	31%
	5–14: mild to moderate	51%
	15 and above: severe	18%
Item 1: Anhedonia	Yes (More than Half the Days)	22.94%
	Several days	35.75%
	Not at all	41.31%
Item 2: Depressed mood	Yes (More than Half the Days)	25.62%
	Several days	38.73%
	Not at all	35.65%
Item 3: Sleep disturbance	Yes (More than Half the Days)	40.22%
	Several days	32.97%
	Not at all	26.81%
Item 4: Tiredness	Yes (More than Half the Days)	38.83%
	Several days	42.80%
	Not at all	18.37%
Item 5: Appetite symptoms	Yes (More than Half the Days)	31.98%
	Several days	30.29%
	Not at all	37.74%
Item 6: Feelings of failure	Yes (More than Half the Days)	31.68%
	Several days	28.90%
	Not at all	39.42%
Item 7: Trouble concentrating	Yes (More than Half the Days)	22.34%
	Several days	34.26%
	Not at all	43.40%
Item 8: Psychomotor symptoms	Yes (More than Half the Days)	13.11%
	Several days	21.35%
	Not at all	65.54%
Item 9: Suicidal ideation	Yes (More than Half the Days)	9.73%
	Several days	13.70%
	Not at all	76.56%
ISI total score and Items		
ISI total (Category)	0–7:No clinically significant insomnia	34.76%
	8–14:Subthreshold insomnia	38.63%
	15–21:Clinical insomnia (moderate severity)	21.05%
	22–28:Clinical insomnia (severe)	5.56%
Item 1: Difficulty falling asleep	0 = None	26.91%
	1 = Mild	28.10%
	2 = Moderate	28.80%
	3 = Severe	12.12%
	4 = Very Severe	4.07%
Item 2: Difficulty staying asleep	0 = None	30.69%
	1 = Mild	27.51%
	2 = Moderate	26.91%
	3 = Severe	11.12%
	4 = Very Severe	3.77%
Item 3: Early morning awakening	0 = None	35.45%
	1 = Mild	26.12%
	2 = Moderate	22.64%
	3 = Severe	11.62%
	4 = Very Severe	4.17%
Item 4: Dissatisfaction about sleep pattern	0 = Very Satisfied	7.94%
	1 = Mild	17.87%
	2 = Moderate	31.78%
	3 = Severe	26.32%
	4 = Very Dissatisfied	16.09%
Item 5: Sleep problems interfere with daily functioning	0 = Not at All	15.89%
	1 = A Little	23.93%
	2 = Somewhat	33.86%
	3 = Much	17.78%
	4 = Very Much	8.54%
Item 6: Sleep problems noticeable to others	0 = Not at All	35.45%
	1 = A Little	28.70%
	2 = Somewhat	22.34%
	3 = Much	8.84%
	4 = Very Much	4.67%
Item 7: Worried or distressed about sleep problem	0 = Not at All	28.20%
	1 = A Little	27.90%
	2 = Somewhat	24.93%
	3 = Much	11.22%
	4 = Very Much	7.75%
Sleep symptoms	Item 1 + 2 + 3	3.91 ± 2.70
Daytime symptoms	Item 5 + 6	2.98 ± 2.15
Perception symptoms	Item 4 + 7	3.67 ± 2.21

Table 3
Adjusted associations between sleep, wake, and perception symptoms of insomnia and depressive symptoms

Insomnia symptoms	OR	95% CI	*P*
Item 1: Anhedonia			
Sleep symptoms	0.993	0.912–1.080	0.868
Daytime symptoms	1.362	1.214–1.528	<0.001
Perception symptoms	1.212	1.061–1.385	0.005
Item 2: Depressed Mood			
Sleep symptoms	1.073	0.989–1.165	0.088
Daytime symptoms	1.176	1.055–1.311	0.003
Perception symptoms	1.239	1.091–1.408	0.001
Item 3: Sleep disturbances			
Sleep symptoms	1.296	1.185–1.417	<0.001
Daytime symptoms	1.160	1.030–1.305	0.014
Perception symptoms	1.542	1.345–1.767	<0.001
Item 4: Tiredness			
Sleep symptoms	0.967	0.891–1.050	0.425
Daytime symptoms	1.474	1.319–1.647	<0.001
Perception symptoms	1.361	1.202–1.541	<0.001
Item 5: Appetite symptoms			
Sleep symptoms	1.124	1.039–1.216	0.004
Daytime symptoms	1.109	0.999–1.231	0.052
Perception symptoms	1.260	1.116–1.423	<0.001
Item 6: Feeling of failure			
Sleep symptoms	0.994	0.920–1.074	0.889
Daytime symptoms	1.159	1.045–1.285	0.005
Perception symptoms	1.294	1.147–1.460	<0.001
Item 7: Trouble concentrating			
Sleep symptoms	1.052	0.967–1.143	0.236
Daytime symptoms	1.299	1.159–1.457	<0.001
Perception symptoms	1.108	0.971–1.264	0.127
Item 8: Psychomotor symptoms			
Sleep symptoms	1.200	1.082–1.331	0.001
Daytime symptoms	1.286	1.119–1.478	<0.001
Perception symptoms	0.991	0.842–1.167	0.915
Item 9: Suicidal ideation			
Sleep symptoms	1.153	1.028–1.292	0.015
Daytime symptoms	1.224	1.050–1.426	0.010
Perception symptoms	1.085	0.903–1.304	0.381

Note: Sleep symptoms are the sum of scores of item 1 to 3; daytime symptoms are the sum of the scores of item 5 and 6; perception symptoms are the sum of the scores of item 4 and 7. The regression analyses are adjusted for age, sex, race/ethnicity and education level.

(in other words, the 'severity' of the sleep problem). Daytime symptoms include symptoms individuals experience during the daytime like interference of sleep problems with their daily functioning and the impairments noticeable to others. The perception symptoms involve the individuals' judgments about the sleep quality like dissatisfaction and distress about the quality of sleep, which are probably 24-hour experiences.[18] The three factors of insomnia symptoms have also been shown in previous studies of ISI validation[14,25]although they are named as impact of insomnia, sleep dissatisfaction and nighttime sleep difficulties. However, slightly different from the present study, the previous three-factor model contains two double-loading items - Item 7 (worried about sleep) loaded on both impact of insomnia and sleep dissatisfaction and Item 1 (difficulty falling asleep) loaded on nighttime sleep disturbances and sleep dissatisfaction. With the current community-based sample, we are able to identify this three-factor model which resonates with theoretical and empirical studies about insomnia constructs in nighttime and daytime aspects.[26,27] We took a CFA approach to validate the theoretical division of ISI items into nighttime and daytime (and perception) symptoms, in line with our theoretical/conceptual framework. The important question is whether the daytime or nighttime symptoms differentially relate to depression symptoms. Our findings verified this difference imbedded. In addition, Ong and colleagues[28] proposed a metacognitive process involved in the development of chronic insomnia which indicates secondary arousal in insomnia induced by individuals' cognitive bias and maladaptive attitude (rigidity and absorption) toward their sleep conditions which may be reflected on the perception symptoms.

Traditionally, within the relationship between insomnia and depression, insomnia has been frequently considered as a unidimensional concept, along with the concomitant depression. Our findings suggest that daytime symptoms of insomnia have a more direct and strong relationship with multiple depressive symptoms than do the other symptoms. Likewise, previous studies have also shown that daytime lassitude was more associated with depression than nighttime insomnia symptoms.[29]

Various studies have found complex relationships between subtypes of insomnia symptoms and depressive symptoms. One study showed that the dysfunctional beliefs about sleep and nightmares mediated relationships between general insomnia symptoms and suicidal ideation.[30] Moreover, depressive mood can also, in turn, increase dysfunctional beliefs about sleep.[31] Our study also revealed a critical role of perception symptoms in association with negative attributional style, one major feature of depression, that worry and dissatisfaction about sleep are strong indicators of "feeling of failure". As for nighttime sleep symptoms, although a study also found a direct relationship between nighttime symptoms and general depression symptoms,[32] the association may be attenuated after adding daytime symptoms and perception symptoms. The remaining associations between sleep symptoms and physiological symptoms of depression may indicate common neurobiological mechanisms shared by insomnia and depression. Therefore, more comprehensive examination and treatment of insomnia subtypes is required in order to address how various paths between (subtypes of) insomnia and depression may be leveraged to optimize current treatments.

Although the symptoms of insomnia are multidimensional, current Cognitive Behavioral Therapy for Insomnia (CBT-I) protocols still mainly focus on insomnia symptoms during the night and largely neglects daytime impairments and to a lesser extent, the perceptual symptoms of insomnia. A recent review suggested that CBT-I did not exert a significant treatment effect on fatigue, which is one of the major daytime complaints among insomnia patient.[33] Yet, CBT-I has been found to effectively reduce comorbid depressive symptoms.[34,35] Moreover, a bidirectional relationship was found between improvements in insomnia and depression symptoms after the treatment[31] that further indicates symptom connectedness between insomnia and depression. To further examine the specific associations between insomnia symptoms and depression, one study[15] examined nighttime and daytime symptoms of insomnia separately and found that changes in daytime symptoms are more strongly associated with depression in contrast with nighttime sleep symptoms after a mind–body treatment. As such, it appears that the alleviation of daytime symptoms may be more beneficial to overall mood, but it is still unknown which type of depression symptoms are mostly affected by daytime improvements.

Limitations

Despite these promising findings, this study has several limitations. First, confounding variables like chronic illness were not controlled in this population-based sample. Given that chronic illness, such as arthritis, diabetes, or respiratory disease, can disturb individuals' sleep quality and mood conditions severely, further study may need to better account for individuals' medical conditions. Furthermore, subjective sleep symptoms may reflect personal bias perceptions of sleep but not objective sleep quality and quantity during the night. Similarly, daytime symptoms may reflect discomfort but

not actual impairment. Therefore, objective measures of nighttime sleep parameters and daytime psychomotor performance are required to differentiate sleep and daytime symptoms from perception biases. Still, it is always from the individual's perception that the diagnosis of insomnia is derived and not objective data. Third, the cross-sectional relationship examined in this study cannot be used to denote any causal relationship between insomnia symptoms and depression. Moreover, this is a community-based sample lacking of diagnosis information on insomnia and depression disorders. Future research should investigate temporal relations between three factors of insomnia symptoms and development of phenotypes of depression also in clinical studies.

Conclusion

This study proposed and tested a three-factor understanding of insomnia symptoms as they relate to depressive symptoms, including sleep symptoms, daytime symptoms and perceptions symptoms. In their relationship to depressive symptoms, daytime symptoms were most strongly associated with a range of depressive symptoms after controlling for sleep and perceptions symptoms. Perception symptoms are relevant to experiential symptoms ranging from mood conditions to somatic disturbances. More importantly, they were also strongly associated with judgmental thinking. Such depressive perception could influence perceptions on sleep quality as well. Nevertheless, sleep symptoms are primarily associated with physiological symptoms of depression when adjusting for severity of daytime and perception symptoms. Careful examinations are required on phenotypes of insomnia symptoms based on the three factors and their correlations with multiple health consequences. It is important to address these relations for optimizing treatment of individuals with coexisting insomnia and depression symptoms or insomnia interventions in the prevention of depression. Currently, insomnia interventions focus almost exclusively on nighttime symptoms of insomnia. Future work could examine whether focus on daytime and perception symptoms could increase the ability of insomnia interventions to impact on depression risk.

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