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The association between sleep dysfunction and psychosis-like experiences among college students

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Abstract

Sleep problems are prominent and pervasive clinical issues experienced by many people with psychotic disorders, often causing distress and functional impairment. Sleep problems are also related to psychosis-like experiences (PLE; non-diagnosable phenomenon such as transient perceptual disturbances, unusual thoughts, periodic suspiciousness) in epidemiological studies. Prior studies in this field have used brief measures that precluded the ability to test (1) whether risk for psychosis-like experiences are related to specific sub-types of sleep disturbance, and (2) whether sleep disturbance is specifically related to clinically significant (i.e., distressing) psychosis-like experiences. The current project examined the relation between specific sleep issues, and PLEs and distress associated with PLEs, in a college sample. Participants (*N*=420) completed the Prodromal Questionnaire-Brief (PQ-B), which assesses PLEs and associated distress, and the Iowa Sleep Disturbances Inventory – extended version (ISDI), which assesses thirteen separate disturbed sleep domains. Symptoms of fragmented sleep, sleep hallucinations,

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and night anxiety significantly correlated with PLEs, and several sleep domains were significantly associated with PLE-related distress.

Keywords

psychosis; schizophrenia; sleep dysfunction; insomnia; psychosis-like experience

1. Introduction

Sleep disturbances are recognized as prominent and pervasive complaints reported by many people with psychotic disorders, with up to 80% of individuals with schizophrenia reporting some form of sleep difficulty (Cohrs, 2008). Sleep disorders often have a deleterious effect on the quality of life of these individuals by impacting tolerance to stress, impairing cognitive functioning, and exacerbating psychopathological symptoms (Hofstetter et al., 2005; Bromundt et al., 2011; Waters et al., 2011). As a result, sleep disturbances negatively affect functional outcomes and increase distress in people with schizophrenia (Green, Kern, and Heaton, 2004; Akerstedt, 2006; Wamsley et al, 2012; Manoach et al., 2015). A growing body of evidence suggests that recognizing and addressing early signs and symptoms of psychosis leads to better outcomes (Millan et al., 2016); therefore, exploring sleep issues may inform our understanding of illness etiology across a continuum of severity, and possibly provide insight into intervention.

Current research suggest high rates of pervasive sleep problems among individuals who develop a diagnosable psychotic illness, with evidence suggesting these difficulties exist along all stages of the illness, often starting in prodromal stages, continuing throughout the first episode of psychosis and lasting throughout the life course (Cohrs, 2008; Lunsford-Avery and Mittal, 2013; Davies et al., 2016). In addition, there is evidence suggesting that individuals high in schizotypy, a personality measure of psychosis proneness, experience significantly more vivid dreams (including both nightmares and enjoyable dreams) (Claridge, Clark, and Davis, 1997). Furthermore, Koffel and Watson (2009) argue that schizotypy and these unusual sleep experiences may collectively belong to a common broader pathological domain.

Psychosis-like experiences (PLEs) are subthreshold expressions of psychosis (e.g., perceptual abnormalities, persecutory ideas, magical thinking) that occur in approximately 7.2% of the US population (Yung et al., 2009; Linscott and van Os, 2013). PLEs do not meet clinical threshold for symptoms of psychotic disorder in that they tend to be relatively mild and transient; however, etiological research has uncovered numerous shared risk factors across the continuum of psychosis severity, consistent with a common developmental pathway (Van Os et al., 2009). PLEs in some cases can develop into more severe expressions of psychosis (Kaymaz et al., 2012). Irrespective of future conversion to psychosis, PLEs may be clinically meaningful in their own right as they have been independently associated with impaired functioning (Yung et al., 2006; Kelleher et al., 2014), perceived need for help (DeVylder et al., 2014), other psychiatric conditions (Kelleher et al., 2012), and suicidal ideation and behavior (Kelleher et al., 2013; DeVylder et al, 2015).

Although current data clearly suggest high rates of sleep problems among individuals across the psychosis-spectrum (e.g., Cohrs, 2008), the literature is relatively less developed with respect to sleep problems among non-clinical populations presenting with PLEs. Reeve et al. (2015) recently conducted a comprehensive review of 66 studies examining the link between sleep dysfunction and PLEs in both community and clinical populations. The authors reported significant associations between PLEs and sleep dysfunction, most notably in regards to insomnia, such that increases in PLEs are associated with increases in insomnia related symptoms. A large international questionnaire study conducted by the World Health Organization (WHO) reported an association between PLEs and sleep dysfunction in adults (Koyanagi and Stickley, 2014). Although informative and noteworthy for its scale, this study was limited in the depth of assessment of both PLEs (only four questions) and sleep disturbances (single item assessment of sleep problems). Additionally, Oh et al. (2015) reported findings from the National Comorbidity Survey Replication, a large nationally representative study, suggesting associations between increases in PLEs and specific forms of insomnia, including problems falling asleep at night and waking up too early in the morning, after controlling for demographic factors and other psychopathological conditions (Oh et al., 2015).

Other community-based studies of PLE and sleep focused on children or young adolescent samples (Nishida et al., 2008; Oshima et al., 2010; Lee et al., 2012; Fisher et al., 2014; Jeppesen et al., 2015; Taylor et al., 2015; Thompson et al., 2015); however, younger aged participants are known to report a higher rate of PLE symptoms relative to older individuals (Kelleher et al., 2012), despite a lack of more overt, behavioral evidence for these symptoms (Hlastala and McClellan, 2005). Additionally, many of the reported studies examined total sleep dysfunction or focused on singular broad concepts of sleep problems such as lack of sleep, or length of sleep, omitting the inclusion of potentially important confounding variables such as depressive symptoms, age, or drug use despite their known effect on both sleep dysfunction and presence of PLEs (Kaneita et al., 2006). In one noteworthy study, Sheaves et al. (2016) examined sleep disturbance and multiple markers of severe mental illness (SMI), including PLEs, in a large sample of college-aged students. The authors reported that symptoms of insomnia, frequency of nightmares, and circadian phase delay correlated with general sub-threshold symptoms of SMI. Although these results are useful in highlighting associations between sleep disturbance and markers of mental illness in the college-aged population, more nuanced examinations of specific psychopathological symptoms, such as PLEs separated from other symptoms of serious mental illness, are still needed to extend this work.

Thus, gathering a more comprehensive picture of specific sleep disturbances' (e.g., probing for insomnia, lassitude, and parasomnia) association with PLEs, as well as PLE related distress, and including potentially confounding variables may facilitate a more nuanced understanding of the relation between sleep disturbances and PLEs. In addition, research is needed on the experiences of young adults, as research suggests that PLEs tend to be more distressing and clinically significant in this population relative to younger children or adolescents (Kelleher et al., 2012; Zammit et al., 2013). Further, it is particularly important to evaluate such symptoms in college students as they are a group of young adults especially vulnerable to dysregulated sleep schedules (Brown, Buboltz, and Soper, 2002).

The present study seeks to address gaps in the understanding of PLEs and sleep dysfunction using a comprehensive measure of PLEs, including PLE-associated distress, as measured by the Prodromal Questionnaire-Brief (PQ-B; Loewy and Cannon, 2010; Loewy et al., 2011), and sleep, as measured by the Iowa Sleep Disturbances Inventory, Extended version (ISDI-E; Koffel, 2011), among a large group of young adults, while controlling for age, gender, drug use, and depressive symptoms. We examined sleep dysfunction through an inclusive assessment of insomnia symptoms and factors affecting insomnia (initial insomnia, fragmented sleep, anxiety at night, light sleep, irregular sleep), lassitude (fatigue, non-restorative sleep, excessive sleep) and parasomnia (nightmares, movement at night, sensations at night, sleep paralysis, sleep hallucinations; Koffel and Watson, 2010). Based on evidence suggesting associations between insomnia and PLEs (Reeve et al., 2015), we predict that abnormalities in this domain of sleep function will be associated with increased PLEs. In addition, based on research suggesting significant distress as a result of sleep dysfunction in individuals with schizotypal personality disorder (individuals who often exhibit PLEs; Levin and Fireman, 2002), we predict that sleep dysfunction will be associated with increased PLE distress.

2. Methods

2.1 Participants

Participants (N=420) were undergraduate students recruited between November 2010 and May 2014 from introductory psychology courses at the University of Maryland, Baltimore County (UMBC). Participants were recruited as part of a larger study aimed at assessing undergraduate emotional, behavioral, and personality characteristics. Eleven participants (2.6%) were excluded from the study due to failure to complete any of the questionnaires, leaving a final analyzed sample of n = 409, with some variability in completion rate across the various measures. Inclusion criteria noted that all participants must be over the age of 18. There were no additional exclusion criteria. All participants were offered extra credit for their participation in the study.

2.2 Procedure

The YouthFIRST Laboratory at UMBC conducted this study and the protocol was approved by the UMBC Institutional Review Board. Prior to participation, all participants received an overview of the study and consented to their involvement. Relevant for this study, all participants completed a demographics and drug history questionnaire as well as the Prodromal Questionnaire-Brief (PQ-B; Loewy and Cannon, 2010; Loewy et al., 2011), the Iowa Sleep Disturbances Inventory (ISDI-E; Koffel, 2011), and the Beck Depression Inventory-II (BDI-II; Beck et al., 1996).

2.3 Measures

2.3.1 The Prodromal Questionnaire-Brief.—The PQ-B is a 21-item questionnaire examining psychosis-like experiences and associated distress within the past month. The majority of items on this measure were adapted from the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), a questionnaire with a long history of examining psychosis-related symptoms in non-clinical populations. Items on the PQ-B focus primarily

on positive symptoms: unusual thinking, perceptual disturbances, suspiciousness, grandiosity, and disorganized communication, as well as one item on social functioning and one on academic/occupational functioning. All initial items are answered yes/no. If an item is positively endorsed, participants are then asked to rate the distress associated with the experience on a Likert-type scale ("When this happens, I feel frightened, concerned, or it causes problems for me") ranging from one (strongly disagree) to five (strongly agree). To avoid the reporting of experiences occurring solely during substance use, participants are asked to disregard experiences occurring only under the influence of drugs, alcohol, and improper use of medications. This measure has been shown to have acceptable psychometric properties in both clinical (Loewy et al., 2011) and clinical/community populations (Kline et al., 2012; Kline et al., 2015) and has been used to examine PLEs in healthy populations (e.g., Mittal et al., 2012; Mittal et al., 2013; Denenny et al., 2015; DeVylder et al., 2015).

Given literature suggesting the importance of distress related to PLEs over and above their presence and absence, and consistent with our prior research, the PQ-B distress scale was examined in addition to endorsement of PLEs alone (Armando et al., 2010; Kline et al., 2012). PLEs were assessed purely based on a positive endorsement of the initial yes/no item, resulting in a possible PLE range between 0–21. Consistent with author recommendations, distress scores for each participant were obtained by summing all distress ratings from the secondary Likert-score item, then dividing this total distress sum by the number of items endorsed in order to differentiate distress from total item endorsement. If no positive endorsements were made, the participant was given a distress score of zero. Therefore, distress ratings represent the general disturbance associated with a participant's experience of PLEs and scores range from 0–5 (Kline et al., 2012).

2.3.2 The Iowa Sleep Disturbances Inventory-extended version.—

The ISDI-E is a 95-item self-report measure of sleep difficulties over the lifetime. Thirteen specific scales are included: nightmares, initial insomnia, fatigue, fragmented sleep, non-restorative sleep, anxiety at night, light sleep, movement at night, sensations at night, excessive sleep, irregular sleep, sleep paralysis and sleep hallucinations (i.e. hypnagogic or hypnopompic). All items are answered in a true/false fashion, and total scores are calculated by summing all endorsed items, resulting in measure scores with a possible range of 0–95. Similarly, subscales noted above are calculated through summing all scale-relevant endorsed items. The authors developed the ISDI to facilitate research on the interconnection of sleep difficulty and psychopathology. The measure was found to demonstrate acceptable psychometric properties within both clinical and community samples (Koffel and Watson, 2010; Koffel, 2011).

2.3.3 The Beck Depression Inventory – second version.—

The BDI-II is a 21-item questionnaire designed to assess depressive disorder symptoms within the past two weeks. Psychometric properties of the BDI-II have been found to be acceptable in clinical and non-clinical samples (Beck et al., 1996) as well as in an ethnically diverse sample of college students (Carmody, 2005).

2.4 Statistical Analyses

Primary study measures (PQ-B raw, PQ-B distress, ISDI, and BDI-II) were correlated using Pearson zero-order correlations to examine general relatedness using pairwise deletion. The total score on the ISDI was then entered into two separate linear regressions controlling for age, gender, depressive symptoms, and recent drug use, known confounds to the link between sleep dysfunction and PLEs (Kaneita et al., 2006; Schierenbeck et al., 2008; Hides et al., 2009). The outcome variable for the first regression was PQ-B raw; the outcome variable for the second regression was PQ-B average distress. These regressions were then repeated, except in the second model all of the subdomains of sleep disturbance were entered as predictor variables replacing the single total sleep disturbance variable. The covariates and outcome variables remained the same. All analyses were completed using SPSS version 23.

3. Results

The mean age of the sample was 20.09 (SD = 3.22); 50.9% were female. The sample represented an ethnically diverse group of participants (34.3% Asian, 34.1% White, 19.7% Black, 2.4% American Indian, and 7.8% “Other” – a category that included individuals who identified as multiracial).

All target measures were normally distributed and met criteria for parametric statistical analysis (Table 1). When examining the frequencies of sleep problems in the total sample, the most commonly endorsed symptoms included nightmares (96.2%), night anxiety (89.4%), non-restorative sleep (85.8%), fatigue (85.3%), and initial insomnia (81.1%). At least one PLE was experienced by 82.5% of participants in our sample. Specifically, at least one item was endorsed by 54.3% of participants on perceptual abnormalities, 65% unusual thought content, 46.9% disorganized communication, 23.0% grandiosity, and 52.8% suspiciousness. Drug use within the past year was endorsed by 26.4% of the participants. The relation between drug use and PLEs was $r = .11$, $p = .027$. Pearson correlations between PLEs and other measures, including all subdomains of sleep disturbances, were statistically significant and ranged from small to large (see Table 2). Correlations between total sleep disturbances, PQ-B raw and PQ-B average distress fell in the moderate to large range.

Two linear regressions examining the predictive value of total sleep dysfunction and subdomains of sleep dysfunction on PLEs as well as on the associated average distress of PLEs while controlling for age, sex, depressive symptoms and recent drug use are presented in Table 3. Multicollinarity between predictors was examined and determined to be appropriate. As presented in the first column of the table, the overall model for this first regression was significant (adjusted $R^2 = 0.31$, $F(15,343) = 11.74$, $p < 0.001$). PLEs were significantly predicted by the symptoms of fragmented sleep, night anxiety, and sleep hallucination, as well as by depressive symptoms. The second column presents associations between various types of sleep dysfunction and distress associated with PLEs. The overall model for this second regression was significant (adjusted $R^2 = 0.26$, $F(15,332) = 9.22$, $p < 0.001$). Findings suggest that initial insomnia, night anxiety, movements at night, sensations at night, and sleep hallucination significantly predict distress associated with PLEs.

4. Discussion

Our study builds on extant literature by finding a relation between sleep dysfunction and PLEs, as well as PLE-related distress, using a measure that captures a relatively comprehensive range of PLEs, as well as a measure that captures a broad range of sleep disturbances. To our knowledge, our study is the first to examine these relations in a non-clinical population of young adults during the peak age of psychosis onset, who are more likely to report pathological PLEs than younger populations (Nishida et al., 2008; Oshima et al., 2010; Lee et al., 2012; Fisher et al., 2014; Jeppesen et al., 2015).

After controlling for age, sex, depressive symptoms and recent drug use, significant associations were found between PLEs and fragmented sleep, night anxiety, and sleep hallucinations, findings that align with previous studies (Oshima et al., 2010; Lee et al., 2012; Fisher et al., 2014; Jeppesen et al., 2015; Oh et al., 2015; Reeve et al., 2015). Sleep hallucinations and PLEs are conceptually similar, and their overlap suggests continuity between PLEs across waking and sleeping cycles. Our findings also suggest similarities in terms of clinical and functional impact (DeVylder and Kelleher, 2016), especially given that both were significantly associated with PLE distress.

We also found that distress associated with PLEs was predicted by initial insomnia, movements at night, and sensations at night. In individuals with schizophrenia, insomnia has been linked to functional disability (Harvey, 2008) and increased rates of suicide (Pompili et al., 2009), both indications of significant distress (Sateia et al., 2000; Garlow et al., 2008). Notably, initial insomnia was only associated with distress rather than PLE alone. Endorsements of symptoms of early insomnia could also be reflecting possible circadian phase delay, an experience common in individuals with schizophrenia (Wulff et al., 2012). Such circadian delay is known to compound functional distress by inducing early morning drowsiness (Klerman, 2005), a potentially distressing experience for college students as it may relate to an inability to attend morning academic or athletic activities. As objective circadian markers were not utilized in this project, this could be an interesting direction for future studies to further evaluate.

In regards to movements or sensations at night, research on sleep hallucinations, along with other parasomnias, have shown significant associations with various psychological stress, chronic stress, experienced trauma, and general distress (Hartmann and Basile, 2003; Soffer-Dudek and Shahar, 2009; Soffer-Dudek, 2015; Umlauf et al., 2015); thus lending support to their association with distress associated with PLEs.

Night anxiety, or repeated worrying at night, was associated with both PLEs and PLE distress, and represents a novel finding from our study. This finding may reflect the known comorbidity between anxiety disorders and PLEs (Varghese et al., 2011; Fusar-Poli et al., 2014), as well as the link between anxiety and sleep problems (Harvey, 2002). Insomnia and anxiety have both been shown to predict symptoms of paranoia, a potentially distressing component of psychosis (Freeman, 2007, Freeman et al., 2012). Additionally, reducing insomnia is associated with improvements in paranoid thinking (Myers et al., 2011); thus, mechanisms behind the relation between night anxiety and both PLEs and average distress

could be through PLEs related to paranoia. Future studies examining PLEs by type would be better able to address such hypotheses.

Biological mechanisms behind the PLE and sleep dysfunction association

Research on the mechanisms driving the associations between PLEs and their associated distress, and sleep dysfunction is still preliminary. To date, focus has primarily been on the relation between sleep and schizophrenia, with proposed possible mechanisms including: changes in circadian rhythm patterns (Wilson and Argyropoulos, 2012), neurocognitive factors (Bromundt et al., 2011; Lunsford-Avery and Mittal, 2013; Manoach et al., 2015), neurophysiological factors such as fluctuations in sleep-related neurotransmitters or changes in neural processes (Vukadinovic, 2011; Anderson and Maes, 2012), stress-physiological effects (Buckley and Schatzberg, 2005; Walker et al., 2008), overlap of genetic influences (Taylor et al., 2015), or exacerbating psychopathological symptoms (Waters et al., 2011). Given the etiological overlap between schizophrenia and PLEs, and the relative methodological convenience of studying PLEs in general population samples rather than individuals with schizophrenia, future studies can incorporate these biological factors to illuminate the mechanistic links between psychosis and sleep concerns.

Clinical implications

Given that PLEs represent a wide range of functional and clinical severity (Armando et al., 2010), improving the field's understanding of factors related to experiencing a PLE with or without distress could allow for a refined focus on those factors that are clinically relevent. Once distressing factors such as initial insomnia, night anxiety, and parasomnias are identified, clinicians can begin to disentangle typical versus clinical variations of PLE experience, and interventions can concentrate on more clinically meaningful symptoms, whether they be sleep problems, distressing PLEs, or both.

Since the effect of sleep dysfunction is related to distress experienced in association with PLEs, application of these findings to clinical practice could improve quality of life in individuals experiencing distressing PLEs. Sleep quality can be improved through various methods, such as changing one's lifestyle to normalize sleep-wake patterns, engaging in psychotherapy that targets behavioral and/or cognitive obstacles to healthy sleep (Morgenthaler et al., 2006; Freeman et al., 2015), and, if necessary, taking sleep or alertness inducing medication. Circadian abnormalities could be addressed with timed light exposure, light avoidance, and melatonin agonists. Such sleep interventions could be especially helpful within a college student population, a group known to struggle with insufficient and irregular sleep (Lund et al., 2010; Rosen et al., 2016). Further, sleep interventions are appealing to college students given their minimized risk for stigma (Goldstein et al., 2014), wide-availability through multiple health-care settings, and collateral health benefits (Lehmann et al., 2016). Freeman et al. (2015) are currently completing such a randomized control trial, examining the effects of cognitive behavioral therapy for insomnia on both sleep problems and psychosis-like symptoms. Future and ongoing studies that track these direct effects of sleep interventions, known to be useful for many different populations and carry minimal risk, on PLEs would clarify the usefulness of sleep treatments in improving the mental health of young adults, including those at-risk for developing psychotic disorders.

Limitations

Although college students are at an age of elevated risk for both PLEs (Thompson et al., 2004) and sleep problems (Lund et al,. 2010), the use of such a sample may limit the generalizability of findings. Similarly, it is important to highlight that the focus of this work was on PLEs and not psychotic disorders. The direct link between PLEs in the general population and diagnosable psychotic disorders remains unclear, and therefore, these results cannot be generalized to the entire spectrum of people experiencing PLEs, especially those experiencing more severe symptoms. Additional work extending this line of inquiry to include those with interview-defined risk for psychosis or diagnosable psychotic illness would further elucidate associations and potential mechanisms explaining the association between the psychosis-spectrum and sleep dysfunction. Additionally, since our sample was cross-sectional, we cannot claim any causal relations (i.e., it is unclear whether sleep dysfunction results in PLEs/distress, if the inverse is true, or if there is a cyclical relation). Regardless of the direction of effects, however, the clinical relevance of the association between sleep and distressful experiences is still useful in justifying interventions that target sleep to mitigate PLE-related distress, and vice versa. It is worth noting that an issue in multiple regression analysis is the possibility for inflated Type I error rate due to testing the significance of multiple predictors. Given our theory-driven hypotheses, however, we did not specifically control for multiple predictors (e.g., Bonferroni adjustment, Perrett et al., 2006). Regardless, the findings about specific sleep issues that are associated with PLE in this study are preliminary and should be replicated in future research. There is the possibility that some sleep domains, most notably sleep hallucinations, were captured by similar questions on the sleep questionnaire as well as the PLE questionnaire, as there is no true time-of-day discrimination on the PLE questionnaire. The sleep questionnaire does, however, specify that participants should only endorse perceptual experiences occurring immediately before sleep or upon waking, increasing confidence that sleep hallucination items are being endorsed in response to experiences associated with sleep rather than hallucinatory experiences more broadly. Additionally, there are known conceptual and functional differences between PLEs occurring purely within the context of sleep and those outside of this period (DeVylder and Kelleher, 2016), further supporting the inclusion of both domains within the analyses. Despite these justifications, the possibility still remains that shared methodological overlap could falsely inflate the magnitude of these associations. Also, we did not measure markers of circadian phase, such as temperature minimum or dim light saliva melatonin onset. We also did not control for medication and the possibility of erratic sleep schedules, and our variables were limited to assessment through self-report rather than interviews, observations, or other methods, such as actigraphy, that can increase reliability and validity. Finally, this study did not measure dissociation, despite the possibility that dissociation, often related to individuals with the personality dimension of PLEs (Watson, 2001), may contribute to the relation between sleep dysfunction and PLEs. Future studies may benefit from pursing this possibility.

Conclusions

This study builds on existing research that has examined PLEs and sleep dysfunction in younger child or adolescent community samples. As the first study to our knowledge to examine these associations in a young adult college sample, to include a specific indicator of

PLE-distress, and to measure a comprehensive mix of sleep dysfunction, we extend findings in this field. Overall, insomnias and parasomnias were significantly associated with both the experience of PLEs, as well as average distress attributable to these experiences.

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Table 1.

Means and distributions of main study measures

	N	Mean	S.D.	Range	Skewness	Kurtosis
PQ-B Raw	399	4.84	4.7	0–21	1.12	.688
PQ-B Average Distress	384	2.06	1.31	0–5	−0.25	−1.05
Sleep Total	403	34.35	16.56	5–84	0.42	−0.39
Nightmares	403	2.89	2.27	0–11	1.52	2.08
Initial Insomnia	397	4.78	3.95	0–11	0.29	−1.43
Fatigue	398	4.16	3.12	0–9	0.20	−1.37
Fragmented Sleep	402	2.36	2.34	0–9	0.99	0.35
Non Restorative Sleep	404	4.31	2.89	0–8	−0.17	−1.44
Night Anxiety	400	3.88	2.34	0–7	−0.20	−1.26
Light Sleep	400	2.53	2.26	0–6	0.36	−1.36
Movement at Night	403	2.46	2.11	0–6	0.32	−1.22
Sensations at Night	406	1.21	1.70	0–6	1.42	0.94
Excessive Sleep	400	2.22	1.84	0–6	0.37	−0.95
Irregular Sleep	405	2.42	1.82	0–5	0.00	−1.34
Sleep Paralysis	406	0.55	1.21	0–4	1.99	2.70
Sleep Hallucination	406	0.78	1.28	0–5	1.70	2.06
BDI-II	409	10.36	8.41	0–43	1.21	1.52

Note, only sleep variables with a Pearson r correlation of at least .30 (indicating a medium strength correlation) with PQ-B Raw were included here

Table 2.

Bivariate correlation matrix of main study measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) PQ-B Raw	-															
(2) PQ-B Average Distress	0.568**	-														
(3) Sleep Total	0.493**	0.452**	-													
(4) Nightmares	0.330**	0.273**	0.499**	-												
(5) Initial Insomnia	0.252**	0.154**	0.636**	0.025	-											
(6) Fatigue	0.372**	0.372**	0.696**	0.316**	0.156**	-										
(7) Fragmented Sleep	0.375**	0.290**	0.620**	0.331**	0.444**	0.217**	-									
(8) Non-Restorative Sleep	0.343**	0.305**	0.642**	0.230**	0.265**	0.670**	0.174**	-								
(9) Night Anxiety	0.371**	0.308**	0.639**	0.290**	0.497**	0.347**	0.377**	0.284**	-							
(10) Light Sleep	0.078	0.123*	0.338**	−0.029	0.385**	0.045	0.368**	0.018	0.213**	-						
(11) Movement at Night	0.229**	0.220**	0.408**	0.197**	0.146**	0.226**	0.204**	0.180**	0.176**	−0.094	-					
(12) Sensations at Night	0.261**	0.313**	0.561**	0.347**	0.299**	0.317**	0.376**	0.232**	0.299**	0.102*	0.372**	-				
(13) Excessive Sleep	0.114*	0.170**	0.313**	0.115*	−0.064	0.475**	0.003	0.254**	0.097	−0.147**	0.138**	0.068	-			
(14) Irregular Sleep	0.187**	0.204**	0.504**	0.075	0.306**	0.440**	0.151**	0.533**	0.221**	0.036	0.078	0.165**	0.269**	-		
(15) Sleep Paralysis	0.228**	0.208**	0.463**	0.365**	0.224**	0.215**	0.334**	0.187**	0.261**	0.085	0.148**	0.248**	0.103*	0.113*	-	
(16) Sleep Hallucinations	0.372**	0.304**	0.523**	0.525**	0.195**	0.243**	0.377**	0.199**	0.287**	0.117*	0.238**	0.309**	0.073	0.109*	0.510**	-
(17) BDI-II	0.385**	0.358**	0.450**	0.275**	0.197**	0.439**	0.263**	0.322**	0.325**	0.125*	0.152**	0.284**	0.119*	0.251**	0.173**	0.207**

** Correlations were significant at p value <0.001 (2-tailed)

* Correlations were significant at p value <0.01 (2-tailed)

Table 3.

Multiple regression for sleep domains predicting psychosis-like experiences and associated distress

	Predicting psychosis-like experiences					**Predicting associated average distress**				
	B	***SE B***	**Beta**	**t**	***Sig***	***B***	***SE B***	**Beta**	**t**	***Sig***
Sleep Dysfunction Total	**0.123**	**0.013**	**0.436**	**9.47**	**<0.001**	**0.032**	**0.004**	**0.393**	**8.18**	**<0.001**
Nightmares	0.193	0.118	0.092	1.64	0.103	0.016	0.035	0.027	0.46	0.646
Initial Insomnia	0.029	0.072	0.025	0.41	0.686	−0.046	0.021	−0.138	−2.17	**0.031**
Fatigue	0.137	0.107	0.093	1.28	0.200	0.036	0.031	0.088	1.16	0.249
Fragmented Sleep	0.392	0.113	0.195	3.46	**0.001**	0.050	0.033	0.088	1.51	0.133
Non-Restorative Sleep	0.202	0.104	0.128	1.94	0.053	0.047	0.031	0.106	1.52	0.130
Night Anxiety	0.233	0.111	0.117	2.10	**0.036**	0.071	0.033	0.128	2.15	**0.032**
Light Sleep	−0.103	0.105	−0.051	−0.98	0.326	0.060	0.031	0.105	1.70	0.051
Movement at Night	0.202	0.107	0.092	1.89	0.**059**	0.067	0.031	0.109	2.14	**0.033**
Sensations at Night	−0.119	0.149	−0.043	−0.80	0.426	0.118	0.044	0.149	2.67	**0.008**
Excessive Sleep	−0.047	0.132	−0.019	−0.36	0.720	0.008	0.039	0.011	0.20	0.839
Irregular Sleep	−0.094	0.140	−0.037	−0.68	0.500	0.018	0.041	0.025	0.44	0.661
Sleep Paralysis	−0.154	0.218	−0.037	−0.71	0.479	0.011	0.065	0.009	0.16	0.871
Sleep Hallucination	0.718	0.209	0.197	3.44	**0.001**	0.130	0.061	0.123	2.11	**0.035**
Depressive Symptoms	1.53	0.604	0.122	2.54	**0.012**	0.332	0.181	0.093	1.84	0.067
	0.711		0.068		0.132	0.240		0.082		0.086
Drug Use		0.470		1.51			0.139		1.72	