

Specific aspects of sleep disturbance associated with suicidal thoughts and attempts

Philip J. Batterham¹, Aliza Werner-Seidler², Alison L. Calear¹, Sonia McCallum¹, Amelia Gulliver¹

¹ Centre for Mental Health Research, The Australian National University, Canberra, Australia

² Black Dog Institute, Sydney, Australia

Correspondence: Phil Batterham, Centre for Mental Health Research, 63 Eggleston Road,
The Australian National University, Canberra ACT 2601 Australia;
philip.batterham@anu.edu.au, +61 2 6125 1031

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Abstract

Objective: Previous research suggests that sleep disturbance is associated with suicidal ideation and suicide attempt. However, few studies have accounted for the presence of multiple mental disorders and interpersonal factors associated with suicide risk. Furthermore, limited research has examined which aspects of sleep disturbance are most strongly associated with suicidal thoughts and attempts.

Method: A large community-based sample of Australian adults ($n=3,618$; 81% female; 37% reporting ideation) completed a comprehensive survey assessing suicidal thoughts and behaviours, sleep disturbance, common mental disorders and interpersonal risk factors. Sleep disturbance was assessed using the 6-item PROMIS sleep disturbance scale and suicidality was measured using the Psychiatric Symptom Frequency Scale. Analyses were adjusted for age, sex, perceived burdensomeness, thwarted belongingness, and clinical caseness for six mental disorders, including major depression.

Results: After accounting for mental health, demographic and interpersonal characteristics, increasing sleep disturbance was significantly associated with higher odds of both suicidal ideation ($OR=1.17$ for one-SD increase in PROMIS-SD), and suicide attempt ($OR=1.33$ for one-SD increase in PROMIS-SD). Of the specific indicators of sleep disturbance, only sleep onset (difficulties falling asleep) had a significant independent association with both suicidal ideation ($p<0.001$) and suicide attempt ($p=0.047$).

Conclusions: Sleep disturbance is independently associated with greater risk of suicidal thoughts and behaviours. Sleep disturbance is highly modifiable, so sleep interventions for people with suicide risk and sleep problems may provide an effective and efficient approach to suicide prevention in the community.

Suicide is one of the leading causes of global disease burden (Naghavi and Global Burden of Disease Self-Harm, 2019), which disproportionately affects younger people (World Health Organization, 2019). Suicide attempts and deaths are devastating for the individual, their families and communities (Bernert et al., 2015), with substantial burden of disease attributable to suicide attempt (van Spijker et al., 2020). Identifying potential causes and risk factors for suicidal behaviour is critical to reducing this burden (Australian Institute of Health and Welfare, 2015). There are many identified social, psychological and biological factors associated with suicide; however, many of these factors are not easily modified at the individual level. Mental health problems have been shown to be strongly associated with suicidal thoughts, attempts and deaths (Batterham et al., 2018a; Nock et al., 2009; Nock et al., 2010; Windfuhr and Kapur, 2011), with nearly all mental disorders having a significant association with increased risk of suicide death (Harris and Barraclough, 1997; Nock et al., 2009). Nevertheless, mental illness does not fully account for suicidal thoughts or attempts (Windfuhr and Kapur, 2011) and some of the associations of specific disorders with suicidal behaviour may be accounted for by specific underlying symptoms or transdiagnostic features (Batterham et al., 2018a). Similarly, interpersonal needs are associated with suicidal thoughts and behaviours but do not fully mediate the effects of insomnia on suicidality (Nadorff et al., 2014). Researchers have increasingly sought to identify and target potential modifiable drivers of suicidal thoughts and behaviour (Hamilton and Buysse, 2019). Sleep disturbance is a feature of many mental health problems (Baglioni et al., 2011; Kaplan and Harvey, 2009), is highly prevalent in the community (Lee et al., 2009) and critically, can be modified (Wu et al., 2015; Zachariae et al., 2016), making it an important potential candidate for suicide prevention.

The association between sleep disturbance and suicidal ideation is well-established (Bernert and Joiner, 2007; Littlewood et al., 2017; Liu et al., 2020; Malik et al., 2014; Pigeon et al., 2016; Pigeon et al., 2012b); however, the link between sleep disturbance and suicide attempts has received less attention (Bernert and Joiner, 2007; Liu et al., 2020). Importantly, most studies indicate that shared variation between depression and sleep disturbance does not fully explain the observed effects of sleep disturbance on suicidal thoughts (Bernert and Joiner, 2007). Much of the research to date has focused on clinical samples, particularly the inclusion of participants with diagnoses of major depressive disorder (Bernert et al., 2015; Malik et al., 2014; Pigeon et al., 2012b; Wang et al., 2019). The influence of sleep problems on suicide has also been found for other specific population groups. This includes war veterans, where in one study sleep disturbance was associated with time to suicide in veterans who had died by suicide (Pigeon et al., 2012a). Nonetheless, sleep disturbance is also prevalent in the general population, with between 23-56% of adults experiencing at least one problem with sleep, including difficulties falling asleep, frequent awakening/trouble getting back to sleep, or daytime tiredness (Gosling et al., 2014; Leger et al., 2008). The association of sleep disturbance with suicidal behaviour has been well-established for adolescents, with a recent study showing that adolescents who had insufficient sleep on an average school night were 35% more likely to experience suicidal ideation than those who had sufficient sleep (Baiden et al., 2019). Accordingly, new interventions designed to prevent suicide and the development of depression and anxiety in adults and adolescents now aim to improve sleep (Blake and Allen, 2020; Trockel et al., 2015). However, community-based studies of the relationship between suicidal ideation and behaviours and sleep disturbance that account for multiple mental health problems and interpersonal factors remain lacking.

Mechanisms for the relationship between sleep and suicide may include biological, psychological and mental illness explanations. Physiological sleep fragmentation, including interruptions to rapid eye movement (REM) sleep, is theorised to contribute to suicidal behaviour via the experience of “emotional exhaustion” (Krakow et al., 2000). There are shared genetic and neurobiological factors that underlie both sleep disturbance and suicidal behaviour, such as serotonergic dysregulation (Adrien, 2002). Antidepressant medications may also interfere with sleep (Mayers and Baldwin, 2005). Impairments in mood regulation and executive function are hallmarks of sleep disturbance and may lead to increased vulnerability to suicide (Bernert and Joiner, 2007; Perlis et al., 2016). Alternatively, the association may be explained by shared variance between sleep disturbance and mental health problems. Epidemiological and biological research demonstrating the link between suicidality and sleep have led to treatment studies, which have provided mixed evidence on whether treating sleep disturbance leads to reductions in suicidal ideation (Christensen et al., 2016; Manber et al., 2011; McCall et al., 2019; Pigeon et al., 2019; Trockel et al., 2015).

Many studies have failed to adjust for depression or anxiety symptoms when examining the relationship between sleep disturbance and suicidal ideation and attempts (Bernert and Joiner, 2007). Similarly, there have been few studies that have adjusted for interpersonal factors, which are known to be closely related to suicidal behaviour (Ma et al., 2016; Van Orden et al., 2008). Few studies on sleep and suicidality have been conducted in non-clinical settings, which may lead to difficulties in separating the effects of mental health problems from the effects of sleep disturbance. Understanding the relationship between sleep disturbance and suicidal thoughts and behaviours may be aided by identifying the aspects of sleep disturbance that underlie the relationship (Liu et al., 2020). Particular aspects of sleep disturbance, including nightmares (Nadorff et al., 2013) and problems with sleep maintenance (Fujino et

al., 2005), may have stronger associations with suicidal thoughts or behaviours than other aspects of sleep disturbance. Beyond these studies, limited research has explored differential effects of sleep disturbance aspects such as subjective sleep quality, sleep onset latency or sleep maintenance. The lack of evidence around the nature of the relationship is critical, given the finding that distinct problems with sleep such as sleep onset latency impact suicide ideation and behaviour differently (Chu et al., 2019). In addition, there are few population-based studies that have used validated measures of sleep or suicidal ideation or behaviours (Bernert et al., 2015).

The aim of this study was to examine both the general and specific effects of sleep disturbance on suicidal ideation and attempts. The study was conducted in an Australian community-based sample, with adjustment for both mental health status and interpersonal risk factors for suicide, to provide a rigorous test of the putative relationship between sleep disturbance and suicidal ideation and attempts.

Method

Participants and procedures

The sample used in this study was recruited using advertisements on the online social media platform Facebook, between January and February 2016. Recruitment advertisements targeted Australian adults aged 18 years or older, and linked directly to an online survey delivered on the Qualtrics platform. The advertisement content was deliberately designed to create oversampling of people with symptoms of a mental disorder, by emphasising that the research was on the topic of mental health. From 5,379 individuals who clicked on the advertisement, 5,220 (97%) consented and commenced the survey and 3,620 (69%) of these completed the full survey. Two participants with missing data on age group were excluded

from the analyses, leaving a final total sample of $N=3,618$. Responses were required for all other measures, with participants encouraged to discontinue if they were uncomfortable with the survey. Participants who completed the survey had marginally greater educational attainment (15.3 vs. 14.7 years, $t_{5119}=9.11$ $p<.001$), were in an older age group ($\chi^2_5=124.2$, $p<.001$), and more likely to only speak English at home (92% vs 74%, $\chi^2_1=355.5$, $p<.001$) than those who did not complete the survey, although there were no gender differences in completion rates ($\chi^2_1=0.63$, $p=.43$).

All participants were provided with detailed information about the survey prior to providing informed consent to participate. Participants were given details of local and national mental health resources, along with the contact details of the research team, to facilitate access to mental health support if required. The survey included items to assess a range of mental health problems, substance use problems, suicidality, and sleep disturbance. The survey took approximately 40 minutes to complete. Further information about the study is provided elsewhere (Batterham et al., 2018b). Ethical approval was obtained from the ANU Human Research Ethics Committee (protocols: #2013/509 and #2015/717).

Measures

The primary outcomes were suicidal ideation and suicide attempt, assessed by self-report based on the period of one year before the survey was conducted using the Psychiatric Symptom Frequency Scale (Lindelow et al., 1997). Suicidal ideation was based on a positive response to a single item regarding active ideation (“thought about taking your own life”) and suicide attempt was based on a positive response to a single item regarding attempt (“attempted to take your own life”).

Sleep disturbance was assessed using the Patient Reported Outcomes Measurement Information System (PROMIS[®]) Short Form v1.0 – Sleep Disturbance 6a (Yu et al., 2011), which consists of six items with a past 7-day recall period. The items relate to overall sleep quality, whether sleep was refreshing, difficulty falling asleep, had a sleep problem, restless sleep and trying hard to get to sleep. Each item is rated on a 5-point Likert scale, with scores ranging from 6-30 and lower scores indicative of greater sleep disturbance. Scores were converted to T-scores (mean=50, SD=10 in normative population) based on the manual (Yu et al., 2011). The reliability and validity of the scale has been demonstrated in previous studies (Jensen et al., 2016) and the measure had good internal consistency in the present sample (Cronbach $\alpha = 0.92$).

Analyses were adjusted for mental health status, specifically using binary indicators of whether participants met current DSM-5 clinical criteria for six mental disorders. These indicators for clinical criteria were based on self-report checklists that comprehensively covered DSM-5 criteria for: major depressive disorder (MDD, 15 items), post-traumatic stress disorder (PTSD, 22 items), generalised anxiety disorder (GAD, 14 items), social anxiety disorder (SAD, 8 items), obsessive-compulsive disorder (OCD, 14 items) and panic disorder (PD, 21 items). The DSM-5 symptom checklists for each disorder are provided elsewhere (Batterham et al., 2018a).

Interpersonal factors of perceived burdensomeness (PB), thwarted belongingness (TB) and their interaction were also included in analyses, due to their established associations with suicide risk (Ma et al., 2016). The 15-item version of the Interpersonal Needs Questionnaire (Van Orden et al., 2012) was used to assess these interpersonal risk factors, which is based on recent interpersonal needs (“these days”). Total sum scores were used, ranging from 6-42 for

PB and 9-63 for TB (higher scores indicative of greater PB/TB). Example items include “These days I think I am a burden on society” (PB) and “These days, I feel like I belong” (TB). The subscales for PB (Cronbach $\alpha = 0.95$) and TB (Cronbach $\alpha = 0.92$) showed good internal consistency in the current sample.

Statistical analysis

To test whether sleep disturbance was associated with suicidal ideation and suicide attempt in the current sample, two separate logistic regression analyses were conducted for each of the two outcomes (four regressions in total). The initial analyses included effects of sleep disturbance, clinical caseness for the six mental disorders, PB, TB, the interaction between PB $\times$ TB, and self-reported age group and gender. Subsequently, to determine whether specific aspects of sleep disturbance were related to suicidal ideation and attempts, separate logistic regression analyses tested the six items from the PROMIS sleep disturbance scale as independent variables. Model fit was assessed on the basis of Nagelkerke pseudo R^2 and area under the receiver operating characteristic curve (AUC).

Results

The sample included 3,618 adults, with 32% aged 18-35, 35% aged 36-55, and 33% aged 56 or older (age was collected as a categorical variable). The majority of the sample was female (81%). As per the design of the study, prevalence of mental disorders was elevated relative to the general population, with 9% ($n=309$) meeting criteria for major depression, 11% ($n=410$) for PTSD and 29% ($n=1055$) for one or more anxiety disorders. Suicidal ideation was reported by 37% ($n=689$) of the sample, and 4% ($n=138$) reported an attempt in the past year. The mean sleep disturbance T-score was 55.5 ($SD = 10.0$), which indicates that the sample had a mean score that was 0.55 standard deviations greater than would be expected in a

representative population sample. The majority of the sample (68%) had a T-score below 60, while 23% had scores of 60-<70 and 9% had T-scores of 70 or greater. Interpersonal needs mean scores were 10.8 (SD=8.1, mean item score=1.8) for perceived burdensomeness and 28.7 (SD=13.7, mean item score=3.2) for thwarted belongingness, both elevated relative to normative scores provided for population samples (Hallensleben et al., 2016).

Table 1 presents the primary logistic regression analyses. Greater sleep disturbance was significantly associated with increased odds of suicidal ideation and suicide attempt, after adjusting for mental disorders, interpersonal risk factors, age group and gender. Every 10-unit (one SD) increase on the PROMIS sleep disturbance scale was associated with 17% greater odds of suicidal ideation and 33% greater odds of suicide attempt. By comparison, the unadjusted effect of a one-SD increase in sleep disturbance was a 93% increase in the odds of suicidal ideation and 2.20 times greater odds of suicide attempt. In addition, greater PB, TB and their interaction were significantly associated with higher odds of suicidal ideation, but only PB was significantly associated with suicide attempt. PTSD and GAD were significantly associated with suicidal ideation, while MDD and PTSD were associated with attempt. Other mental disorders (SAD, PD, GAD) were not independently associated with the suicide outcomes. Younger participants had greater prevalence of suicidal ideation and attempt, but no gender differences were observed. Nagelkerke pseudo R^2 (0.41 and 0.29 for ideation and attempt respectively) and AUC (0.83 and 0.87) for the models suggested good fit.

Table 2 presents the logistic regression analyses examining the roles of specific aspects of sleep disturbance on suicidal ideation and attempt. Difficulty with sleep onset was the only item that was significantly associated with both ideation and attempt. Every one-unit increase in difficulty falling asleep was associated with a 25% increase in the odds of ideation and

30% increase in the odds of attempt. Participants who reported sleep being “not refreshing” or “restless” also had increased odds of ideation but not attempt. Nagelkerke pseudo R^2 (0.12 and 0.08 for ideation and attempt respectively) and AUC (0.66 and 0.73) for the models suggested acceptable fit although with limited variance explained.

Discussion

The findings of this study support previous research indicating that sleep disturbance is associated with increased odds of suicidal thoughts and suicide attempts. The effect of sleep disturbance remained robust even after accounting for a range of common mental disorders, interpersonal risk factors, age and gender. These findings suggest that sleep disturbance is an independent risk factor for suicidal behaviour, and not just due to its association with depression or anxiety. Indeed, sleep disturbance had a more robust effect on suicidal thoughts and behaviours than major depression, after accounting for other mental disorders and interpersonal factors. This finding is consistent with other emerging research on the role of depression in suicide (Batterham et al., 2018a; Nock et al., 2009; Nock et al., 2010), suggesting other underlying psychological processes may better explain the development of suicide risk than depressive symptoms per se. The interpersonal risk factor of perceived burdensomeness also had a strong effect on both suicidal thoughts and behaviours, while thwarted belongingness, or sense of isolation, had a direct impact on suicidal ideation only.

The specific aspect of sleep disturbance most strongly associated with suicidal thoughts and attempts was difficulties with sleep onset. This finding might indicate that psychological processes such as rumination may be responsible for the association, as ruminative processes are closely aligned with longer sleep latency (Pillai et al., 2014; Zoccola et al., 2009).

Rumination also has a strong association with suicidal ideation and attempts (Holdaway et

al., 2018; Miranda and Nolen-Hoeksema, 2007). The theory that sleep disturbance leads to suicidal ideation through “emotional exhaustion” (Bernert and Joiner, 2007; Krakow et al., 2000) was not well supported by the findings, as the item assessing subjective sleep quality did not have significant independent associations with either suicidal ideation or attempts, although sleep being less refreshing was associated with suicidal ideation. Restlessness had a significant effect on ideation, which may be related to agitation (Rogers et al., 2016) and rumination (Pillai et al., 2014; Zoccola et al., 2009). Reports of sleep not being refreshing were also associated with ideation but not attempts. This item may have indirectly captured the effect of nightmares or conditions such as sleep apnoea, which have previously been shown to have associations with suicide risk (Bernert and Joiner, 2007; Bishop et al., 2018).

The models also indicated that GAD and PTSD symptoms were associated with significantly greater odds of suicidal ideation, while MDD and PTSD symptoms were associated with significantly greater odds of suicide attempt. The null effects of other disorders may be related to the underlying variance explained by sleep disturbance and interpersonal needs, both of which may have associations with a range of mental health conditions. Irrespective of the null independent effects of depression and OCD in particular, the remaining findings were largely consistent with other epidemiological studies (Batterham et al., 2018a; Nock et al., 2010). Findings were also consistent with the body of research indicating that interpersonal factors may be key determinants of suicidal behaviour (Ma et al., 2016; Van Orden et al., 2008). Greater PB had a robust association with both ideation and attempt, while TB was only associated with ideation. The negative interaction term suggested that TB had a diminishing effect on suicidal ideation at higher levels of PB, which has also been reported in other studies (Batterham et al., 2018c; Ma et al., 2016).

The findings have a number of important implications for reducing suicide risk in clinical and community settings. Interventions that target sleep disturbance may be relevant to a greater proportion of the population than mental health interventions, given the high prevalence of sleep disturbance. As the present findings indicate that the effects of sleep disturbance are independent of common mental disorders, there may be benefit of assessing and treating sleep problems in clinical settings, irrespective of depression severity in people who may be at risk of suicide. Chronic suicidal ideation is difficult to treat and may not respond to depression treatment (Batterham et al., 2019), so a focus on other independent risk factors for suicide risk may offer additional pathways for reducing suicide risk (Bernert et al., 2015; Christensen et al., 2016). The findings suggest that aspects of sleep disturbance related to rumination and agitation may be particularly pernicious, so additional clinical benefit may be derived from interventions that address these underlying psychological elements which perpetuate suicidal thinking (Pillai et al., 2014; Rogers et al., 2016; Zoccola et al., 2009).

Although this study is one of the few community-based samples where the effect of sleep disturbance on suicidality has been rigorously evaluated, there were a number of limitations to the current study. Firstly, the data were cross-sectional. Consequently, the possibility of reverse causation cannot be ruled out, specifically that suicidal thoughts or behaviours may be responsible for sleep disturbance. This possibility is an intriguing avenue for longitudinal investigation, although the few existing longitudinal studies have not definitively established directionality. Further longitudinal research investigate interactions between suicidal ideation with sleep disturbance, rumination and symptoms of depression and anxiety is recommended (Lovato and Gradisar, 2014). Secondly, time frames for the suicide (past year), sleep (past week), mental health (current) and interpersonal needs (“these days”) measures were

inconsistent, which may have further impacted on inferences regarding temporal relationships between risk factors and suicidal thoughts and behaviours.

Thirdly, the measures were brief by necessity in the context of a large epidemiological study, so we were not able to identify specific sleep disorders. More comprehensive clinical measures and objective measures of sleep (e.g., actigraphy, sleep apnoea) were not feasible in the context of a large epidemiological study and may be important for better understanding the mechanisms by which disturbed sleep impacts on suicide risk. The single item measures of SI and SA are also a limitation, as is often the case in epidemiological studies.

Nonetheless, some suicide scales have a reasonable number of items that could be feasibly included in future epidemiological work to assess the severity of suicidal thoughts and attempts (Batterham et al., 2015). The mental health checklist was designed to capture clinical criteria from DSM-5 symptom lists (Batterham et al., 2018a). However, this self-report approach provides a proxy for caseness that would benefit from further validation against structured clinical interviews. The findings should be considered in light of these potential measurement limitations. Finally, while the sample was recruited from the community, it was not representative of the general population, with over-representation of females and people with mental health problems in particular.

In conclusion, this study contributes to a growing literature indicating that sleep disturbance is associated with increased risk of suicidal thoughts and attempts, in a large community-based sample. This study shows that this association is not attributable to other mental disorders including depression, firmly establishing sleep disturbance as an independent risk factor for suicide. These findings are encouraging from a clinical perspective, in that sleep

disturbance is modifiable and therefore may be an acceptable and accessible therapeutic target to reduce suicidal ideation and behaviour.

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Contributors: PJB designed the study, with input from all authors. PJB oversaw the data collection, with support from ALC. PJB conducted the analyses and drafted the manuscript, with contributions to drafting and interpretation of data from all authors. All authors critically revised the manuscript and approved of the final version of the manuscript.

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Table 1: Logistic regression models testing the effect of sleep disturbance on suicidal ideation and suicide attempt (N=3618)

	Suicidal ideation					Suicide attempt			
	OR	95% CI	χ^2	<i>p</i>		OR	95% CI	χ^2	<i>p</i>
Constant			230.857	<0.001				80.916	<0.001
Sleep disturbance	1.016	1.006, 1.026	10.009	0.002		1.029	1.005, 1.053	5.860	0.015
PB	1.310	1.242, 1.381	99.184	<0.001		1.157	1.095, 1.222	26.885	<0.001
TB	1.061	1.048, 1.075	81.992	<0.001		1.012	0.981, 1.043	0.533	0.466
PB × TB	0.997	0.995, 0.998	33.650	<0.001		0.999	0.998, 1.000	2.985	0.084
DSM MDD	0.841	0.599, 1.180	1.001	0.317		0.562	0.335, 0.943	4.759	0.029
DSM PTSD	1.679	1.265, 2.230	12.833	<0.001		1.769	1.147, 2.731	6.645	0.010
DSM GAD	1.481	1.183, 1.853	11.730	0.001		1.413	0.917, 2.177	2.450	0.118
DSM SAD	0.971	0.745, 1.267	0.046	0.830		1.082	0.688, 1.702	0.116	0.733
DSM OCD	0.970	0.737, 1.277	0.046	0.829		1.311	0.845, 2.034	1.464	0.226
DSM PD	0.950	0.645, 1.400	0.067	0.795		0.691	0.367, 1.302	1.306	0.253
Age group			39.037	<0.001				29.839	<0.001
18-35 vs 56+	1.987	1.601, 2.466	38.908	<0.001		2.648	1.520, 4.613	11.820	0.001
36-55 vs 56+	1.416	1.149, 1.746	10.599	0.001		0.806	0.426, 1.527	0.437	0.509
Male vs female	0.859	0.694, 1.063	1.962	0.161		0.853	0.529, 1.378	0.420	0.517

Notes: PB: perceived burdensomeness; TB: thwarted belongingness; DSM: Diagnostic and Statistical Manual of Mental Disorders version 5; MDD: major depression disorder; PTSD: post-traumatic stress disorder; GAD: generalised anxiety disorder; SAD: social anxiety disorder; OCD: obsessive compulsive disorder; PD: panic disorder; **bold** values represent $p < 0.05$

Table 2: Logistic regression models testing the roles of specific aspects of sleep disturbance on suicidal ideation and suicide attempt (N=3618)

	Suicidal ideation				Suicide attempt			
	OR	95% CI	χ^2	<i>p</i>	OR	95% CI	χ^2	<i>p</i>
Constant			319.776	<0.001			191.076	<0.001
Overall sleep quality	1.006	0.887, 1.141	0.009	0.923	1.231	0.900, 1.684	1.696	0.193
Not refreshing	1.305	1.193, 1.428	33.946	<0.001	1.045	0.828, 1.318	0.135	0.713
Had a sleep problem	0.965	0.868, 1.073	0.437	0.509	0.866	0.656, 1.141	1.048	0.306
Difficulty falling asleep	1.254	1.134, 1.386	19.375	<0.001	1.301	1.003, 1.686	3.936	0.047
Sleep was restless	1.151	1.061, 1.249	11.423	0.001	1.134	0.926, 1.388	1.487	0.223
Tried hard to get to sleep	1.009	0.916, 1.112	0.034	0.854	1.243	0.977, 1.582	3.147	0.076

Note: **bold** values represent $p<0.05$