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**Being kind to self is being kind to sleep? A structural equation modelling approach evaluating the direct and indirect associations of self-compassion with sleep quality, emotional distress and mental well-being**

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## DECLARATIONS

### Funding

The study has been supported by Bolashak scholarship, JSC “Center for International Programs”, Kazakhstan.

### Conflicts of interest/Competing interests

**Financial interests:** The authors declare they have no financial interests.

**Non-financial interests:** Nicole K. Y. Tang received current and past grant funding as principal investigator or co-investigator from National Institute for Health Research and Medical Research Council, UKRI for other projects related to sleep and/or chronic pain, as well as the use of non-pharmacologic sleep interventions.

### Availability of data and material

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

### Authors' contributions

Arman Rakhimov, Anu Realo and Nicole K. Y. Tang designed the study protocol. Arman Rakhimov acquired the data. Arman Rakhimov, Anu Realo and Nicole K. Y. Tang conducted the data analysis. Arman Rakhimov and Nicole K. Y. Tang wrote the first draft of the manuscript and all authors contributed to critical review and revision of the manuscript.

### Ethics approval

The protocol of the study was approved by the Humanities and Social Sciences Research Ethics Committee, University of Warwick, UK on 29 May 2019. All procedures performed in studies involving human participants were in accordance with the ethical standards of Humanities and Social Sciences Research Ethics Committee, University of Warwick, UK and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

### **Consent to participate**

Informed consent was obtained from all individual participants included in the study.

### **Consent for publication**

Not applicable

### **Acknowledgments**

We are thankful to our participants and Professor Elizabeth A. Maylor, University of Warwick, the United Kingdom for permission to access her lab's older adult research panel.

## ABSTRACT

**Objectives** The study examined the relationship between self-compassion and sleep quality. We also investigated whether the relationship was mediated by brooding, perceived stress, sleep hygiene, and anxiety about sleep and whether self-compassion was associated with anxiety, depression, and mental well-being indirectly through sleep quality.

**Methods** A sample of 468 adults completed measures of demographics, health, sleep quality, self-compassion, predisposing (arousability, brooding, perfectionism, interpersonal problems), precipitating (perceived stress, presence of life-changing events) and perpetuating (sleep hygiene, anxiety about sleep) factors of insomnia, depression, anxiety and mental well-being.

**Results** The results of the hierarchical multiple regression analysis revealed that low self-compassion was significantly associated with poorer sleep quality when controlling for socio-demographic variables, health-related factors and predisposing factors of insomnia. The association, however, became non-significant when precipitating and perpetuating factors of insomnia were added to the model. Structural equation modelling showed that the relationship between self-compassion and sleep quality was mediated by anxiety about sleep and through sequential mediations involving anxiety about sleep and then sleep hygiene; or anxiety about sleep, perceived stress and then sleep hygiene; or perceived stress and then sleep hygiene. Poor sleep in turn was associated with anxiety and depression, which had a negative effect on mental well-being.

**Conclusions** This study provided cross-sectional evidence that low self-compassion is a potential risk factor for poor sleep quality, and consequently, poor mental well-being. These findings provide insights into possible mechanisms underlying the relationship between self-compassion and sleep quality that could inform etiological models of insomnia.

*Keywords:* sleep quality; self-compassion; sleep hygiene; anxiety about sleep; stress; insomnia

## INTRODUCTION

Previous studies have identified a number of risk factors for insomnia including socio-demographic factors (e.g., personal and family history of insomnia), poor physical (e.g., pain, problems with kidney/bladder) and mental (e.g., anxiety and depression symptoms) health, personality traits (e.g., arousability, perfectionism), high number of negative life events, and overconsumption of stimulants such as caffeine (LeBlanc et al., 2009; Singareddy et al., 2012). In contrast, research into positive protective factors that promote good sleep quality have only renewed its momentum (Buysse, 2014; Tanaka & Tamura, 2016) following the early work on sleep hygiene and relaxation strategies (Hauri, 1991). For example, recent studies have shown that interventions that help individuals to cultivate mindfulness (i.e., the non-judgmental awareness of the present moment) improve sleep quality (Gong et al., 2016; Kanen et al., 2015) via reduction of stress and intrusive thoughts (Winbush et al., 2007).

Other studies (Brown et al., 2020; Butz & Stahlberg, 2020) have highlighted the potential beneficial role of self-compassion in enhancing sleep quality. Self-compassion is defined as the tendency to be kind towards oneself in hard times, and has strong associations with adaptive psychological functioning, such as increased happiness, and decreased anxiety and depression (Neff & Germer, 2013). According to Neff and colleagues (Germer & Neff, 2013; Neff & Dahm, 2015), self-compassion has three components: self-kindness, sense of common humanity and mindfulness. Self-kindness is the opposite of self-judgment and represents the tendency to be more understanding, caring and warm towards oneself. The sense of common humanity refers to being able to recognise that all people are prone to failing and making mistakes. Mindfulness involves the awareness and acceptance of negative feelings without avoiding or overidentifying with them. While some researchers consider self-compassion as a stable trait that has origins in early

childhood experiences (Neff & Dahm, 2015), it has been shown in recent experiments that the level of self-compassion can be enhanced with well-designed interventions (Neff & Germer, 2013).

The positive relationship between self-compassion and sleep quality has been noted in a number of studies ( $r=0.30-0.32$ ) (Brown et al., 2020; Butz & Stahlberg, 2020), but it is not clear whether it holds when controlling for the effect of other identified factors of insomnia. For example, according to the widely accepted 3-P model of insomnia (Spielman et al., 1987) that factors contributing to insomnia can be broadly categorised into “predisposing”, “precipitating” and “perpetuating”. Predisposing factors include traits that can make individual vulnerable to insomnia, such as genetics, physiological hyperarousal, tendencies to worry or ruminate (Gehrman et al., 2012), maladaptive perfectionism (Azevedo et al., 2010), and interpersonal problems (e.g., interpersonal sensitivity) (Lundh et al., 1995). These factors do not generate chronic insomnia but may increase the likelihood for its occurrence (Gehrman et al., 2012). Precipitating factors include factors and events that trigger acute insomnia, such as physiological stressors (e.g., illness), environmental, or psychological stressors (Spielman et al., 1987). Perpetuating factors include maladaptive coping behaviours and cognitions that maintain insomnia, such as the practice of staying in bed although not sleeping (Gehrman et al., 2012; Spielman et al., 1987), sleep-related anxiety (Harvey et al., 2005), or poor sleep hygiene practices such as excessive caffeine before bed (Yang et al., 2010). There is a possibility that one of the abovementioned factors or even a combination of several factors, common to both self-compassion and sleep quality, might fully or partially account for their relationship. For example, both the lack of self-compassion and insomnia are often associated with maladaptive perfectionism, especially concern over mistakes (Mosewich et al., 2013; Neff, 2003; C. W. Ong et al., 2019), which could then explain why lower self-

compassion is related to worse sleep quality. To test this possibility, we need to determine whether the association between self-compassion and sleep would remain significant when the abovementioned factors of insomnia are controlled for.

Further, there is much to be learned about the underlying mechanisms of the relationship between self-compassion and sleep quality, if such an association exists. Past research has suggested that self-compassion is negatively correlated with both anxiety and maladaptive perfectionism (Neff, 2003; Neff & Germer, 2013) and may improve sleep quality via reduced rumination (Butz & Stahlberg, 2018) and perceived stress (Hu et al., 2018). As such, it is plausible that - in the face of stress and adversity (including sleeplessness) - people with higher levels of self-compassion are less absorbed with self-critical thoughts, and hence - would experience less sleep-related anxiety and sleep-interfering cognitive arousal that perpetuate the cycle of stress and insomnia. Previous research has also shown that those who are high in self-compassion tend to go to bed on time (Sirois et al., 2018) and practise health-promoting behaviour such as exercising or taking time to relax (Sirois et al., 2015). It is therefore also plausible that self-compassion contributes to better sleep quality by promoting good sleep hygiene. In view of these findings and possibilities, two key research questions need to be answered to clarify the role of self-compassion in poor sleep quality. First, is self-compassion an independent risk factor of poor sleep quality, and if so, should it be considered as a predisposing or a perpetuating factor? Second, is the association of self-compassion on sleep quality direct or indirect, and what are the potential mechanisms that might mediate the self-compassion-sleep quality relationship? Identifying potential mediators would help to design future studies investigating the role of self-compassion in the improvement of sleep quality.



To address these gaps in the literature, we conducted an online survey in which self-compassion, sleep quality, and predisposing, precipitating and perpetuating factors of insomnia were simultaneously assessed. To maximise generalisability of the findings, we recruited adult participants from different sections of the age spectrum. The primary aim of the study was to examine the relationship between self-compassion and sleep quality in the presence of other identified 3-P factors of insomnia. The 3-P theoretical model is widely accepted as a theoretical framework summarising the aetiology of insomnia (Perlis et al., 2011) and for this reason was chosen in our study as a conceptual framework for organising variables. In selecting factors, we prioritised variables that as self-compassion are relatively changeable in treatment (Egan & Shafran, 2017; Hofmann et al., 2012; McFarquhar et al., 2018; McIntyre et al., 2019; Tang & Harvey, 2004; van der Zweerde et al., 2019; Watkins & Roberts, 2020). The second aim of the study was to test the roles of brooding, sleep hygiene, and anxiety about sleep in mediating the association between self-compassion and sleep quality. We included brooding (i.e. self-critical moody pondering) as a mediator, since it was recognised as the more maladaptive component of rumination than reflective rumination (i.e., active examination of one's emotions) (Moulds et al., 2007). Considering the previously established associations of self-compassion and insomnia with anxiety, depression, and mental well-being, we also investigated, as the third aim of the study, self-compassion as both a direct predictor of mental well-being and emotional distress and an indirect predictor via sleep quality. Specifically, our hypotheses were:

H1. Higher self-compassion is significantly and positively associated with better sleep quality in the presence of predisposing (arousability, perfectionism, brooding, interpersonal problems), precipitating (stress, life-changing events) and perpetuating (poor sleep hygiene, anxiety about sleep) factors of insomnia.

H2. Lower brooding, perceived stress, sleep hygiene, and anxiety about sleep mediate the positive relationship between self-compassion and sleep quality.

H3. Higher self-compassion is directly as well as indirectly via sleep quality associated with better mental well-being, and lower depression and anxiety.

## METHODS

### Participants

Five hundred individuals completed the online survey. As part of our data preparation, we excluded individuals who (a) reported being pregnant ( $n = 2$ ), (b) did not complete all of the PSQI items ( $n = 2$ ) or items with categorical responses ( $n = 21$ ) or (c) had missing data of  $> 30\%$  ( $n = 1$ ). Six multivariate outliers (a combination of unusual scores on all study variables) above 3  $SD$  from the mean were identified and removed. The final sample for data analysis comprised 468 participants (188 males; 278 females; 2 non-binaries;  $M$  age = 39.0 years;  $SD = 19.4$ ; range 18 to 85 years). Participants were recruited via a university research participant recruitment platform, an electronic research panel of older adults and placing an advert on social media. Inclusion criteria were that participants should be at least 18 years old and English-speaking. Participants were reimbursed a £5 eGift Vouchers for taking part in the study.

### Procedure

Data were collected between May and July 2019. The online questionnaire was hosted via Qualtrics ([www.qualtrics.com](http://www.qualtrics.com)). Participants could directly access the questionnaire using a link provided in recruitment advert, after providing informed consent.

### Measures

149

150 ***Demographic and health-related information***

151 The section of the questionnaire asked for voluntary information on age, gender, ethnicity, highest  
152 educational qualification, employment, and marital status. Participants were asked to provide  
153 health-related information by indicating their perceived health and pregnancy status if applicable,  
154 history of sleep disorders, as well as the use of sleep and other medications that can affect sleep.  
155 Additionally, participants were asked to provide ratings on physical pain severity and interference  
156 in the last 24 hours using the 9-item Brief Pain Inventory Short Form (BPI-SF; Cleeland, 1989).  
157 The total score on each pain scale ranges from 0 to 10, with higher scores representing higher  
158 levels of pain severity/interference.

159

160 ***Outcome variables***

161

162 ***Sleep Quality***

163 The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality in the past month  
164 (Buysse et al., 1989). The tool consists of the seven subscales: duration of sleep, sleep latency,  
165 sleep disturbance, daytime dysfunction due to sleepiness, sleep efficiency, subjective sleep quality,  
166 use of sleep medication. The sum of all seven subscales forms the total score ranging from 0 to 21  
167 with higher scores indicating worse sleep quality. As recommended, we used a global score of >5  
168 as a cut-off for poor sleep quality (Buysse et al., 1989).

169

170 ***Depression and Anxiety***

171 Anxiety and depression were measured respectively with the Patient-Reported Outcomes  
172 Measurement Information System (PROMIS) Emotional Distress-Anxiety Short Form and the

PROMIS Emotional Distress-Depression Short Form (Cella et al., 2019). Participants were asked to assess their feelings/symptoms over the past week. Each form has four items, giving a score range of 8-20. Higher scores are indicative of higher levels of anxiety or depression.

### *Mental Well-being*

The 7-item short Warwick-Edinburgh Mental Well-being Scale (sWEMWBS; Stewart-Brown et al., 2009) was used to measure mental well-being. Participants were asked to rate the extent to which each statement describes their experience over the previous two weeks. The total score ranges from 7 to 35, with higher scores representing higher levels of mental well-being.

### *Predictors*

#### *Measures of predisposing factors of insomnia*

#### *Self-compassion*

The 26-item Self-Compassion Scale (SCS; Neff, 2003) was used to assess six sub-components of self-compassion: self-kindness, self-judgment, common humanity, isolation, mindfulness, and over-identification. The SCS score is the average of the six subscales scores and ranges from 1 to 5, with higher scores indicating higher levels of self-compassion.

#### *Arousability*

The Arousal Predisposition Scale (APS; Coren, 1988) has 12 items to assess one's predisposition toward cognitive hyperarousal. The total score ranges from 12 to 60, with higher scores indicating greater arousability.

197

198 *Brooding*

199 Brooding (self-critical moody pondering) was measured using the 5-item Brooding subscale of  
 200 Ruminative Responses Scale (RRS; Treynor et al., 2003). The total score ranges from 5 to 20, with  
 201 higher scores representing higher tendency of brooding.

202

203 *Perfectionism*

204 The 8-item Short Almost Perfect Scale (SAPS; Rice et al., 2014) was used to assess two key  
 205 dimensions of perfectionism: Standards (high personal performance expectations) and  
 206 Discrepancy (concerns about the discrepancy between personal standards and one's evaluation of  
 207 performance). The total score for each subscale ranges from low perfectionism (4) to high  
 208 perfectionism (28).

209

210 *Interpersonal Problems*

211 The Inventory of Interpersonal Problems-C-IRT (IIP-C-IRT; Sodano & Tracey, 2011) is a 32-item  
 212 instrument used to measure different types of interpersonal problem behaviour (Domineering-  
 213 Controlling; Vindictive-Self-Centered; Cold-Distant; Socially Inhibited; Nonassertive; Overly  
 214 Accommodating; Self-Sacrificing; Intrusive-Needy). The average score of 32 items ranges from 0  
 215 to 4, with higher average scores indicating a greater likelihood of interpersonal problems.

216

217 *Measures of precipitating factors of insomnia*

218

219 *Perceived Stress*

The Perceived Stress Scale (PSS; S. Cohen et al., 1983) is a 10-item questionnaire used to measure the level of stress in the last month. Total score ranges from 0 to 40, with higher scores indicating higher levels of perceived stress.

#### *Presence of Life-changing Events*

The Social Readjustment Rating Scale (SRRS; Holmes & Rahe, 1967) contains a list of 43 events, commonly perceived as stressful. Participants were asked to check any major life events that they had experienced in the past 12 months. Each event listed has a certain value, which is summed to give a total score from 0 to more than 300, with higher scores indicating significant life changes. In this study, most participants did not indicate the frequency of events checked, and therefore instead of using the total score, we simply coded the presence (1) or absence (0) of life-changing event(s) in the past 12 months.

#### *Measures of perpetuating factors of insomnia*

##### *Sleep Hygiene*

The Sleep Hygiene Index (SHI; Mastin et al., 2006) consists of 13 items and assess the practice of sleep hygiene behaviours. A total score for the SHI ranges from 0 to 52, with higher scores representing poorer sleep hygiene.

##### *Anxiety about Sleep*

Participants completed Anxiety and Preoccupation about Sleep Questionnaire (APSQ; Tang & Harvey, 2004), which assesses worry in insomnia. The scale has 10 items and each item is rated for the extent to which they apply to the participants' experience in the past month. The total score

ranges from 10 to 100, with higher scores representing greater anxiety and preoccupation about sleep.

### **Statistical analysis**

There were <5% missing responses; mean/median substitution was performed (Hair, 2014). For performed correlational analyses we used  $p$ -value <.05 to determine statistical significance; Cohen's (J. Cohen, 1988) criteria to determine strength of the correlation (weak:  $0.1 < r < 0.3$ ; medium:  $0.3 < r < 0.5$ ; strong:  $r > 0.5$ ). Internal consistency reliability (Cronbach's  $\alpha$ ) of all measures was found to be acceptable to high (see supplementary information file, Appendix 3).

To test hypothesis 1, we performed a hierarchical multiple regression analysis, which had a model structure informed by the 3-P model of insomnia (Spielman et al., 1987). Predictor variables were added to the regression equation in steps of five blocks. Demographic variables were all entered into Block 1, creating Model 1. This was followed by Block 2 adding health-related variables (Model 2). Blocks 3, 4 and 5 included variables that constituted predisposing, precipitating and perpetuating factors respectively (forming Models 3, 4 and 5). To address multicollinearity we excluded variables with variance inflation factor (VIF) more than 3 (Hair, 2014).

Finally, we used structural equation modelling (SEM) with maximum likelihood estimation using IBM SPSS AMOS statistical package (version 26) to test hypothesis 2. We used only those hypothesized mediating variables that were significant predictors of sleep quality in the hierarchical multiple regression analysis. These mediating variables were entered simultaneously to account the presence of one another. SEM was also performed to test hypothesis 3. We used a bootstrapping method with 5000 resamples and 95% bias-corrected confidence intervals. To assess

model fit, we used the following indices and cut-off criteria: an RMSEA value of .05 or below, TLI and CFI of .95 and more indicate a good fit; an RMSEA of .08 or less, CFI and TLI of .90 or above are considered as indicators of an acceptable model fit (Keith, 2015; Schumacker & Lomax, 2010). Chi-square test statistic was reported, but not used in assessing model fit, because it is highly sensitive to sample size (Keith, 2015). We followed the two-step method (Hatcher, 2013), in which the measurement model should demonstrate a good fit to the data, before the structural model is tested. Multicollinearity was addressed by excluding the variables concerned if a correlation between them exceeds  $r=\pm 80$  (Hatcher, 2013). When testing the structural model, a parceling of items was performed to control the inflated measurement errors due to multiple items for the latent variables and to reduce the model complexity by increasing the sample size to per parameter ratio (Matsunaga, 2008). We followed the algorithm described by Russel (1998) and developed parcels by summing individual items. For each latent variables, three parcels were created as per recommendations (Matsunaga, 2008; Russell et al., 1998). . The internal reliability of the latent factors was calculated and was found to be acceptable (see supplementary information file, Appendix 4). Specific indirect effects were identified using Gaskin's plugin (Gaskin, 2016).

## RESULTS

### Participant characteristics

Characteristics of the final sample are provided in the supplementary information file (Appendix 1). Our sample comprised participants ranging from 18 to 85 years of age, but with a greater proportion of adults of young age (18-29 years) and people with female gender compared to other age and gender groups. Most participants indicated having White ethnic background, with smaller proportions of individuals with Asian, Black and Mixed-race ethnicity. Over half of participants had a university degree. About one-quarter of all participants were employed, married or in a civil



partnership. Most participants identified themselves as having good health. The majority neither had a history of diagnosed sleep disorder nor were taking sleep tablets or other medications that could affect sleep. The ratio of people with good sleep quality and poor sleep quality based on their PSQI score ( $>5$  as the cut-off) was 52:48.

### **Correlational analyses**

The results of correlational analyses are provided in the supplementary information file (Appendix 2). The main variables of interest – self-compassion and poor sleep quality – were negatively and moderately correlated with each other,  $r = -.31$ ,  $p < .001$ .

### **Hierarchical multiple regression analysis**

The results of the hierarchical multiple regression analysis are presented in Tables 1 and 2. Pain interference was dropped due to issues of multicollinearity ( $VIF = 5.44$ ). The assumptions of independence of observations, linearity, homoscedasticity, and normality were met.

Model 1 containing six demographic variables accounted for 8% of the variance in sleep quality,  $F(6, 461) = 6.84$ ,  $p < .001$ . Older age, being female, and not having university education were all significant predictors of worse sleep quality at  $p < .001$ .

Model 2 explained about 37% of the variance in poor sleep quality. The addition of health-related variables in Block 2 increased the amount of explained variance by roughly 28%,  $F(11, 456) = 23.83$ ,  $p < .001$ . Pain severity had the largest standardised multiple regression coefficient in Model 2,  $\beta = .27$  [95% CI: .18, .37],  $p < .001$ .

The addition of predisposing factors (Block 3) and precipitating factors (Block 4) increased the explanatory power of the models; the  $R^2$  increased by 8% in Model 3,  $F(17, 450)=21.50$ , and then again by 4% in Model 4,  $F(19, 448)=22.61$ . In both cases, the increases in  $R^2$  were statistically significant at  $p<.001$ . Self-compassion was a statistically significant predictor of sleep quality in Model 3,  $\beta=-.10$  [95% CI:  $-.20, -.00$ ],  $p=.042$ , but no longer in Model 4,  $\beta=-.06$  [95% CI:  $-.15, .03$ ],  $p=.182$ .

In Model 5, the inclusion of perpetuating factors (Block 5) further increased the explanatory power of the model to 59%,  $F(21, 446)=30.78$ ,  $p<.001$ .  $R^2$  value increased by .10 and this increase was statistically significant,  $p<.001$ . In this final model, the variables of interest (Block 3-5) that were found to be significant were perceived stress,  $\beta=.13$  [95% CI:  $.03, .23$ ],  $p=.010$ , poor sleep hygiene,  $\beta=.19$  [95% CI:  $.11, .28$ ],  $p<.001$ , and anxiety and preoccupation about sleep,  $\beta=.32$  [95% CI:  $.22, .40$ ],  $p<.001$ . The control variables (Block 1-2) that were found to be significant were age,  $\beta=.23$  [95% CI:  $.14, .32$ ],  $p<.001$ , educational level,  $\beta=-.09$  [95% CI:  $-.16, -.03$ ],  $p=.007$ , poor perceived health,  $\beta=.09$  [95% CI:  $.02, .17$ ],  $p=.007$ , taking sleep medications,  $\beta=.14$  [95% CI:  $.06, .23$ ],  $p<.001$ , taking non-sleep medications,  $\beta=.08$  [95% CI:  $-.01, .16$ ],  $p=.022$ , history of sleep disorders,  $\beta=.11$  [95% CI:  $.02, .19$ ],  $p=.001$ , and pain severity,  $\beta=.14$  [95% CI:  $.06, .22$ ],  $p=.001$ . Self-compassion remained non-significant in Model 5,  $\beta=-.06$  [95% CI:  $-.15, .03$ ],  $p=.182$ . This indicates that the relationship between self-compassion and poor sleep quality is possibly mediated by the one of precipitating and/or perpetuating factors.

Table 1. The Results of Hierarchical Multiple Regression Analysis for Poor Sleep Quality:  
coefficients of determination.

	F	$R^2$	$\Delta R^2$
Model 1 – Demographic variables	6.84***	.082	.082
Model 2 – Health-related variables	23.83***	.365	.283
Model 3 – Predisposing factors	21.50***	.448	.083
Model 4 – Precipitating factors	22.61***	.490	.041
Model 5 – Perpetuating factors	30.78***	.592	.102

\*\*\*  $p < .001$ .

*Note.*  $N = 468$ .  $R^2$  = Percent of variance in the sleep quality accounted for by all variables in the model.  $\Delta R^2$  = Increase in the percent of variance accounted for by the variables added at a specific step.

Table 2. The Results of Hierarchical Multiple Regression Analysis for Poor Sleep Quality.

	Model 1		Model 2		Model 3		Model 4		Model 5	
	$\beta$ (95% CI)	<i>p</i>	$\beta$ (95% CI)	<i>p</i>	$\beta$ (95% CI)	<i>p</i>	$\beta$ (95% CI)	<i>p</i>	$\beta$ (95% CI)	<i>p</i>
<b>Block 1</b>										
Age	.20 (.11, .30)	.000	.09 (-.01, .18)	.057	.16 (.07, .26)	.000	.17 (.08, .27)	.000	.23 (.14, .32)	<b>.000</b>
Gender	-.16 (-.24, -.07)	.000	-.11 (-.18, -.03)	.005	-.08 (-.15, -.01)	.037	-.07 (-.13, .00)	.070	-.06 (-.12, .01)	.072
Ethnicity	.05 (-.04, -.15)	.321	.05 (-.03, .13)	.243	.03 (-.05, .11)	.512	-.02 (-.10, .06)	.581	-.04 (-.11, .03)	.310
Educational level (university degree)	-.16 (-.26, -.07)	.001	-.13 (-.21, -.06)	.001	-.10 (-.00, -.00)	.007	-.10 (-.17, -.03)	.005	-.09 (-.16, -.03)	<b>.007</b>
Employment status (unemployment)	-.03 (-.13, -.08)	.570	-.06 (-.15, .03)	.174	-.06 (-.18, -.03)	.144	-.05 (-.13, .04)	.230	-.07 (-.14, .01)	.068
Marital status (having partner)	.00 (-.12, .11)	.996	-.03 (-.14, .06)	.458	-.00 (-.10, -.09)	.926	.02 (-.08, .11)	.688	.02 (-.07, .10)	.630
<b>Block 2</b>										
Poor perceived health			.15 (.07, .24)	.000	.11 (.03, .20)	.004	.09 (.01, .17)	.017	.09 (.02, .17)	<b>.007</b>
Taking sleep medication			.19 (.09, .30)	.000	.16 (.06, .26)	.000	.16 (.06, .26)	.000	.14 (.06, .23)	<b>.000</b>
History of sleep disorders			.14 (.03, .23)	.001	.15 (.04, .24)	.000	.15 (.04, .24)	.000	.11 (.02, .19)	<b>.001</b>
Taking non-sleep medication			.14 (.04, .23)	.001	.09 (-.01, .18)	.023	.07 (-.03, .16)	.058	.08 (-.01, .16)	<b>.022</b>
Pain severity			.27 (.18, .37)	.000	.21 (.12, .30)	.000	.17 (.08, .26)	.000	.14 (.06, .22)	<b>.000</b>
<b>Block 3</b>										
Self-compassion					-.10 (-.20, -.00)	.042	-.03 (-.13, .07)	.508	-.06 (-.15, .03)	.182
Arousability					.20 (.11, .29)	.000	.07 (-.03, .17)	.175	-.00 (-.10, .09)	.957
Brooding					-.02 (-.12, .10)	.781	.01 (-.10, .12)	.924	-.02 (-.12, .08)	.690
Perfectionism standard					-.05 (-.13, .03)	.196	-.05 (-.12, .03)	.233	-.06 (-.13, .01)	.084
Perfectionism discrepancy					.02 (-.08, .11)	.730	-.02 (-.11, .08)	.749	-.02 (-.10, .07)	.696
Interpersonal problems					.09 (-.02, .19)	.083	.07 (-.04, .17)	.174	.05 (-.05, .14)	.302
<b>Block 4</b>										
Perceived stress							.29 (.20, .39)	.000	.13 (.03, .23)	<b>.010</b>
Presence of life- changing events							.04 (-.03, .11)	.281	-.04 (-.10, .03)	.336
<b>Block 5</b>										
Poor sleep hygiene									.19 (.11, .28)	<b>.000</b>

Anxiety and  
preoccupation about  
sleep

.32 (.22, .40)

**.000**

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348 *Note.*  $N = 468$ .  $\beta$  = Standardized multiple regression coefficient (beta weight), 95% CI – 95% confidence interval. Categorisation: Gender, 0-  
349 female, 1-male and non-binary; Ethnicity, 0-White, 1-Other (Asian, Black, Mixed); Educational level, 0-without university degree, 1-with  
350 university degree; Employment status, 0-employed/self-employed, 1-other; Marital status, 0-single, 1-married/in partnership; Poor perceived  
351 health – 0-good health, 1-poor health; Taking sleep medication, 0-no, 1-yes; History of sleep disorders, 0-no, 1-yes; Taking non-sleep  
352 medication, 0-no, 1-yes.

### Structural equation modelling analysis

The initial measurement model included seven latent factors (self-compassion, anxiety about sleep, sleep hygiene, perceived stress, sleep quality, emotional distress and mental well-being) and 20 observed variables representing parcels or scales. Given the results of the multiple regression analysis (see Table 2), brooding was not included in the SEM analyses as it was not a significant predictor of sleep quality. All latent factors contained three parcels each except for emotional distress, which had two components and was measured by PROMIS Emotional Distress Anxiety and Depression scales. Control variables were the demographic and health-related variables that were statistically significant in the multiple regression analysis. The initial measurement model test indicated an acceptable fit to the data:  $\chi^2 = 723.29$ ,  $df = 240$ ,  $\chi^2/df = 3.01$ ,  $p < .001$ , CFI = .94; TLI = .91; RMSEA = .07 [90% CI: .06, .07]. However, perceived stress had a very high correlation with emotional distress,  $r = 0.92$ ,  $p < .001$  creating multicollinearity issues. When we excluded perceived stress factor from the measurement model, the model fit improved as a result:  $\chi^2 = 519.01$ ,  $df = 181$ ,  $\chi^2/df = 2.87$ ,  $p < .001$ , CFI = .95; TLI = .92; RMSEA = .06 [90% CI: .06, .07]. All standardised factor loadings were statistically significant and ranged from .69 to .93,  $Mdn = .84$ ,  $p \leq .001$ . The correlations between latent factors were statistically significant,  $p \leq .001$ .

To circumvent the issues of multicollinearity, we tested structural models for hypotheses 2 and 3 separately. Model 1 tested the direct effect of self-compassion on sleep quality as well as the indirect effect via perceived stress, anxiety about sleep, and sleep hygiene. Model 2 tested the direct effect of self-compassion on two outcome variables of mental well-being and emotional distress and the indirect effect of self-compassion on two outcome variables via anxiety about sleep, sleep hygiene and sleep quality. Perceived stress was not included in Model 2 due to its high correlation with emotional distress.

The initial structural Model 1 showed poor fit to the data:  $\chi^2 = 813.84$ ,  $df = 153$ ,  $\chi^2/df = 5.32$ ,  $p < .001$ , CFI = .88; TLI = .82; RMSEA = .10 [90% CI: .09, .10]. Based on the SPSS modification indices we added two additional paths from anxiety about sleep to perceived stress and to sleep hygiene plus one additional path from perceived stress to sleep hygiene to improve model fit (Figure 1):  $\chi^2 = 477.30$ ,  $df = 150$ ,  $\chi^2/df = 3.18$ ,  $p < .001$ , CFI = .94; TLI = .91; RMSEA = .07 [90% CI: .06, .08]. As can be seen in Figure 1 and Table 3, higher self-compassion significantly and negatively predicted lower perceived stress,  $\beta = -.30$ ,  $p < .001$ , lower anxiety about sleep,  $\beta = -.20$ ,  $p < .001$ , and poorer sleep quality,  $\beta = -.11$ ,  $p = .032$ , but not poorer sleep hygiene,  $\beta = -.06$ ,  $p = .271$ . The indirect effect of self-compassion on poor sleep quality via anxiety about sleep was also statistically significant,  $\beta = -.07$ ,  $p < .001$ , while that via perceived stress or poor sleep hygiene was not statistically significant ( $\beta = -.02$ ,  $p > .05$ , and  $\beta = -.01$ ,  $p > .05$  respectively).

Additionally, two of the three mediating paths that involved two sequential mediators were significant, first via anxiety about sleep and then poor sleep hygiene,  $\beta = -.06$ ,  $p < .01$ , and second via perceived stress and then poor sleep hygiene,  $\beta = -.14$ ,  $p < .01$ . Finally, the mediating path that involved three sequential mediators was significant; via anxiety about sleep, perceived stress and then poor sleep hygiene,  $\beta = -.10$ ,  $p < .01$ . The Model 1 explained 68% of the variance in sleep quality,  $p = .005$ .

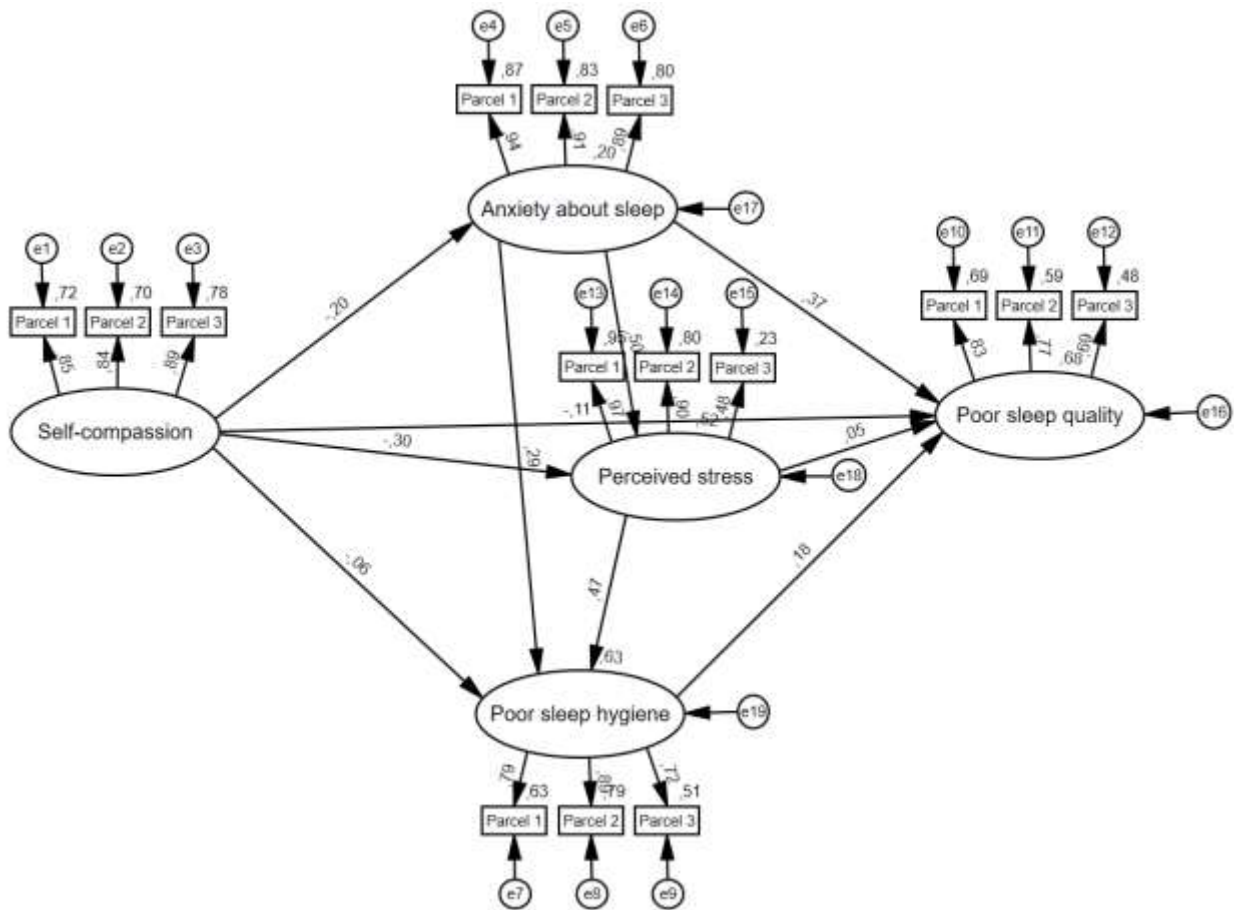
The initial structural Model 2 demonstrated poor fit to the data:  $\chi^2 = 710.89$ ,  $df = 186$ ,  $\chi^2/df = 3.82$ ,  $p < .001$ , CFI = .92; TLI = .88; RMSEA = .08 [90% CI: .07, .08]. Based on the SPSS modification indices we added an additional path from anxiety about sleep to sleep hygiene, which improved model fit (Figure 2):  $\chi^2 = 586.83$ ,  $df = 185$ ,  $\chi^2/df = 3.17$ ,  $p < .001$ , CFI = .94; TLI = .91;

RMSEA =.07 [90% CI: .06, .07]. As can be seen in Figure 2 and Table 4, self-compassion significantly predicted lower anxiety about sleep,  $\beta = -.20$ ,  $p = .001$ , better sleep hygiene,  $\beta = -.21$ ,  $p = .001$ , lower emotional distress,  $\beta = -.24$ ,  $p = .003$ , and higher mental well-being,  $\beta = .41$ ,  $p = .002$ . Direct effect of self-compassion on poor sleep quality was not statistically significant,  $\beta = -.09$ ,  $p = .076$ . The indirect effects of self-compassion on poor sleep quality via anxiety about sleep and via poor sleep hygiene were statistically significant ( $\beta = -.07$ ,  $p < .001$ , and  $\beta = -.08$ ,  $p < .001$  respectively), as well as via sequential mediation involving these two mediators,  $\beta = -.10$ ,  $p < .001$ . The Model 2 explained 86% of the variance in sleep quality,  $p = .007$ .

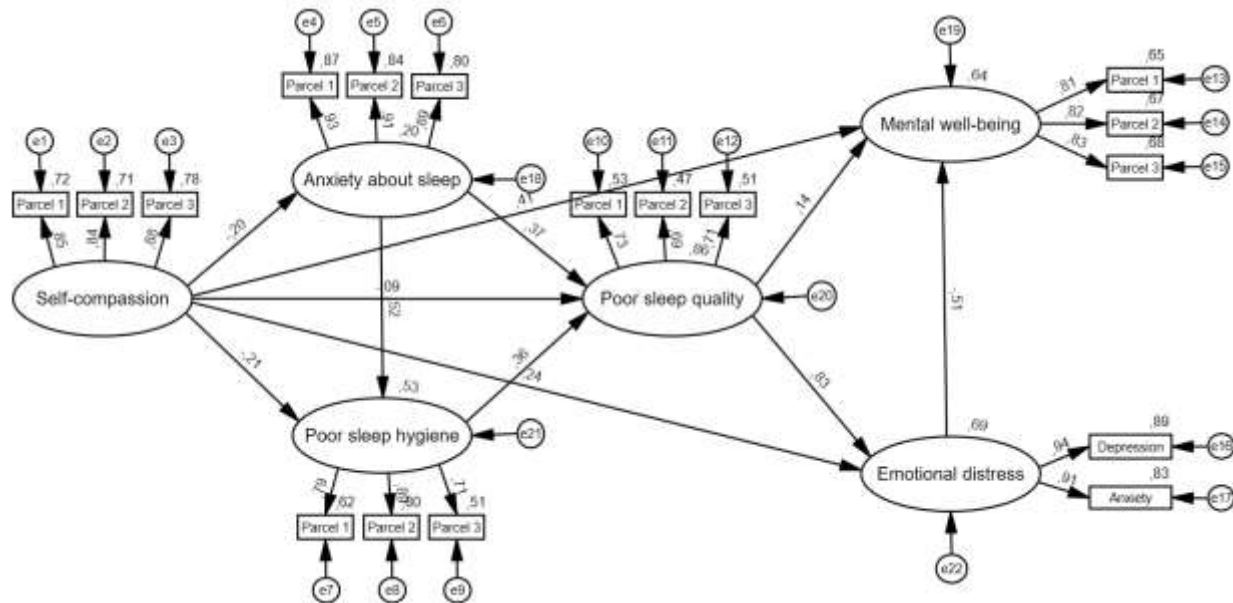
The indirect effect of self-compassion on emotional distress via poor sleep quality was not statistically significant,  $\beta = -.08$ ,  $p > .05$ . Two mediating paths that involved two sequential mediators were significant, first via anxiety about sleep and then poor sleep quality,  $\beta = -.07$ ,  $p < .001$ , and second via poor sleep hygiene and then poor sleep quality,  $\beta = -.08$ ,  $p < .001$ . One mediating path that involved three sequential mediators was significant; via anxiety about sleep, poor sleep hygiene and then poor sleep quality,  $\beta = -.10$ ,  $p < .01$ . For emotional distress, the  $R^2 = .69$ ,  $p = .006$ , which means that model explained 69% of the variance in emotional distress.

Regarding mental-well-being, only one mediating path was statistically significant, in which self-compassion influenced sleep quality through anxiety about sleep and then sleep hygiene, and sleep quality in turn influence mental well-being through emotional distress,  $\beta = -.10$ ,  $p < .001$ . For mental well-being, the  $R^2 = .64$ ,  $p = .011$ , which means that model explained 64% of the variance in mental well-being.





**Figure 1** Model 1 (N=468). Rectangles represents observed variables and ovals represents latent variables. All values are standardised coefficients, except for values near variables, which are squared multiple correlations. Error terms of variables are depicted as e1-e19. Control variables (age, educational level, poor perceived health, taking sleep medication, taking non-sleep medications, history of sleep disorders, and pain severity) were hidden in the figure for visual clarity



**Figure 2** Model 2 (N=468). Rectangles represents observed variables and ovals represents latent variables. All values are standardised coefficients, except for values near variables, which are squared multiple correlations. Error terms of variables are depicted as e1-e22. Control variables (age, educational level, poor perceived health, taking sleep medication, taking non-sleep medications, history of sleep disorders, and pain severity) were hidden in the figure for visual clarity

Table 3. Standardised direct and indirect effects of antecedent variables on consequent variables for Model 1 in SEM.

	Direct effect	Indirect effect
<b>Self-compassion</b>		
→Perceived stress	-.30***	
→Anxiety about sleep	-.20***	
→Poor sleep hygiene	-.06	
→Poor sleep quality	-.11*	
→Perceived stress→Poor sleep quality		-.02
→Perceived stress→Poor sleep hygiene→Poor sleep quality		-.14**
→Anxiety about sleep→Poor sleep quality		-.07***
→Anxiety about sleep→Perceived stress→Poor sleep quality		-.10
→Anxiety about sleep→Perceived stress→Poor sleep hygiene→Poor sleep quality		-.10**
→Anxiety about sleep→Poor sleep hygiene→Poor sleep quality		-.06**
→Poor sleep hygiene→Poor sleep quality		-.01
<b>Perceived stress</b>		
→Poor sleep hygiene	.47***	
→Poor sleep quality	.05	

**Anxiety about sleep**

→Perceived stress	.50**
→Poor sleep hygiene	.29**
→Poor sleep quality	.37***

**Poor sleep hygiene**

→Poor sleep quality	.18*
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\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

Note.  $N = 468$ . SEM = structural equation modelling.

Table 4. Standardised direct and indirect effects of antecedent variables on consequent variables for Model 2 in SEM.

	Direct effect	Indirect effect
<b>Self-compassion</b>		
→Anxiety about sleep	-.20**	
→Poor sleep hygiene	-.21**	
→Poor sleep quality	-.09	
→Emotional distress	-.24*	
→Mental well-being	.41**	
→Perceived stress→Poor sleep quality		
→Anxiety about sleep→Poor sleep quality		-.07***
→Anxiety about sleep→Poor sleep quality→Emotional distress		-.07***
→Anxiety about sleep→Poor sleep quality→Mental well-being		-.07
→Anxiety about sleep→Poor sleep hygiene→Poor sleep quality		-.10***
→Anxiety about sleep→Poor sleep hygiene→Poor sleep quality→Emotional distress		-.10**
→Anxiety about sleep→Poor sleep hygiene→Poor sleep quality→Mental well-being		-.10
→Anxiety about sleep→Poor sleep hygiene→Poor sleep quality→Emotional distress→Mental well-being		-.10***
→Poor sleep hygiene→Poor sleep quality		-.08***
→Poor sleep hygiene→Poor sleep quality→Emotional distress		-.08***
→Poor sleep hygiene→Poor sleep quality→Mental well-being		-.08
→Poor sleep quality→Emotional distress		-.08
→Poor sleep quality→Mental well-being		-.01
<b>Anxiety about sleep</b>		
→Poor sleep hygiene	.52**	
→Poor sleep quality	.37***	
<b>Poor sleep hygiene</b>		
→Poor sleep quality	.36**	
<b>Poor sleep quality</b>		
→Emotional distress	.83**	
→Mental well-being	.14	
<b>Emotional distress</b>		
→Mental well-being	-.51***	

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\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

*Note.*  $N = 468$ . SEM = structural equation modelling.

## DISCUSSION

The present study extends previous research on the association of self-compassion with sleep quality by examining the strength of the relationship in the presence of multiple risk factors featured in the 3-P model of insomnia. Our findings partially support the first hypothesis and suggest that higher self-compassion is positively associated with better sleep quality, even when demographics, health and other predisposing factors of insomnia are adjusted for. The self-compassion-sleep quality association, however, became non-significant once several precipitating and perpetuating factors of insomnia were added to the model. The final model comprised ten significant predictors and explained a sizeable 59% of the total variance in sleep quality. The amount of variance explained by the predisposing factors (8.3%; hyperarousability and self-compassion) was modest, but was comparable to the amount of variance explained by demographic variables (8.2%; age, gender and education) when they were the only predictors of sleep quality included in the model.

Our findings also indicate that the self-compassion-sleep quality relationship is both direct and indirect, with the indirect association manifested through four potential mechanisms: (i) perceived stress → poor sleep hygiene, (ii) anxiety about sleep, (iii) anxiety about sleep → perceived stress → poor sleep hygiene, and (iv) anxiety about sleep → poor sleep hygiene. With regard to our second hypothesis, our findings do not support a mediating role of brooding but point to the importance of perceived stress, anxiety about sleep, and sleep hygiene as valid potential mediators of the relationship. The first mediating path identified affirms findings reported by Hu and colleagues (2018) that perceived stress mediates the effect of self-compassion on sleep quality,

474 and at the same time brings to light the missing behavioural link that connects perceived stress  
475 with sleep quality, and that is the practice of sleep hygiene. Interestingly, sleep hygiene alone was  
476 not a significant mediator of the self-compassion-sleep quality relationship, even though it was  
477 identified as the final mediator of all sequential mediating paths. Through these sequential  
478 mediating paths, our study offers initial support for the potential mediating role of anxiety about  
479 sleep and suggests a physiological self-soothing effect of self-compassion in reducing threat  
480 responses (Johnson & O'Brien, 2013). These findings are consistent with the idea that self-  
481 compassion promotes more accepting thoughts (Leary et al., 2007) and better emotion regulation  
482 (Sirois et al., 2018). Our results also support previous research that has shown that people with  
483 higher self-compassion have more positive than negative automatic thoughts, which in turn, are  
484 associated with lower negative affect including anxiety (Arimitsu & Hofmann, 2015). In the  
485 current analysis, we examined the profile of sleep hygiene practice as a whole and therefore, we  
486 cannot pinpoint which specific sleep hygiene practices are particularly conducive to promoting  
487 sleep quality but it is conceivable that high levels of anxiety about sleep and perceived stress can  
488 transpire into poor sleep hygiene practices, such as going to bed feeling stressed and worrying  
489 while in bed (Mastin et al., 2006). Surprisingly, brooding was not a significant predictor of sleep  
490 quality in our study and therefore, was not examined as a potential mediator of the self-  
491 compassion-sleep relationship. Earlier research – both the correlational and experimental – has  
492 shown rumination as a mediator of the self-compassion-sleep quality relationship in student  
493 samples and as an outcome positively responsive to a one-week self-compassion intervention  
494 offered to patients with major depressive disorder (Butz & Stahlberg, 2018). The discrepant results  
495 may be explained by the methodological differences between two studies and subtle differences in  
496 the nature of these cognitive processes, with brooding being “a passive comparison of one’s current  
497 situation with some unachieved standard” (Treynor et al., 2003, p. 256) and reflection being “a

purposeful turning inward to engage in cognitive problem solving to alleviate one's depressive symptoms"(Treyner et al., 2003, p. 256). Further studies are needed to clarify the role of these repetitive thinking processes in the relationship between self-compassion and sleep quality.

Our third hypothesis was that self-compassion would have a direct association with emotional distress and mental well-being, and an indirect association with emotional distress and mental well-being through sleep quality. Consistent evidence was there to support a direct association of self-compassion with both emotional distress and mental well-being, although the magnitude of the association were small to moderate ranging from .24 to .41. The indirect association of self-compassion with emotional distress and mental well-being was smaller in magnitude ( $<0.10$ ). The effect was not solely mediated by sleep quality, but sequentially by multiple variables included in our analysis involving anxiety about sleep and/or sleep hygiene preceding poor sleep quality. Emotional distress, in turn, had a strong direct association with mental well-being (.51). These findings together suggest that self-compassion can have a broader effect on mental well-being in addition to its influence on sleep quality through reducing anxiety about sleep and poor sleep hygiene practices.

Although our analyses were conducted on a non-clinical sample (with 48% reporting a PSQI score indicative of a clinical sleep disorder; Buysse et al., 1989), our study offers an important starting point to investigate the link between self-compassion and sleep and its underlying mechanisms. The next step would be to replicate the current studies in clinical samples and extend it using longitudinal design. The longitudinal studies will allow us to look at temporal relationships between self-compassion and sleep quality. Self-compassion can be potentially viewed as a modifiable risk factor for poor sleep quality and a viable target of treatment if further studies with

longitudinal and experimental design establish the causality and directionality of the relationship between self-compassion and sleep quality. However, as opposed to being offered as a stand-alone intervention, techniques aimed at increasing self-compassion (such as writing a letter to oneself from the perspective of the close friend, for instance, (Neff & Germer, 2013) could be combined with recommended strategies in cognitive-behavioural therapy for insomnia (CBT-I) to optimise outcomes, allowing for more effective changes in processes that are known to be precipitating and perpetuating insomnia. Self-compassion techniques can also be combined with mindfulness-based therapy for insomnia (MBTI), which uses combinations of mindfulness meditations and behavioural strategies for insomnia such as sleep restriction therapy (J. C. Ong et al., 2014).

This study has several limitations. First, although our SEM was theoretically driven and we found evidence to support an indirect link from self-compassion to sleep quality through stress, anxiety about sleep and sleep hygiene, the cross-sectional design of the study precludes us from making directional inferences. It is also possible that low sleep quality leads to lower self-compassion or that the two constructs mutually influence each other. Indeed, a post-hoc analysis we conducted supported the idea that the self-compassion-sleep relationship is bidirectional (see supplementary information file for results and discussion, Appendix 5). Second, it is possible that there is underlying third variable that influences both sleep quality and self-compassion, such as emotional reactivity. Although hypothesised causal linkages in our regression and SEM models were both theoretically and empirically driven (Butz & Stahlberg, 2018; Hu et al., 2018), prospective longitudinal studies and controlled experimental studies are required to establish the temporality and causality of the sleep quality-self-compassion relationship. Another limitation is that using self-reported measures for sleep quality often increases the possibility of recall and inferential bias (Harvey & Tang, 2012; Ramlee et al., 2017). The use of objective measures (e.g.,

polysomnography and/or actigraphy) of sleep quality may help minimise this bias. However, considering that sleep is a multidimensional experience, future studies should consider including both types of sleep quality measures (objective and subjective). Finally, not all factors from the 3-P model of insomnia (Spielman et al., 1987) were included in the study, because of limitations related to survey methodology and questionnaire length. Besides, apart from demographic and health-related variables, we prioritised variables that are amenable to change in treatment. It is also likely that personality traits such as neuroticism (Gurtman et al., 2014) or internalisation (Singareddy et al., 2012) would have affected the association between self-compassion and sleep if included in the model. Future studies should consider including factors not investigated in the current study. We should also note that although the way the factors were grouped in this study was based on Spielman and Glovinsky's conceptualisation (Spielman et al., 1987), it was not necessarily unequivocal. The 3-P factors are broad conceptual categories and a factor could be both precipitating and perpetuating depending on the chronicity of presentation. Future studies may consider the other ways of grouping factors.

In summary, the current study demonstrates that low self-compassion may serve as a factor that predisposes people to develop poor sleep quality. We identified anxiety about sleep and poor sleep hygiene as potential mechanisms mediating this relationship in addition to the mediating role of perceived stress that was highlighted in the literature. Worsened sleep quality in turn increases states of depression and anxiety which can have a negative effect on mental well-being. Future studies with experimental and longitudinal designs are needed to ensure the direction of causation as well as potential benefits of cultivating self-compassion for optimising the effect of CBT-I and other interventions for promoting mental well-being.



## REFERENCES

- Arimitsu, K., & Hofmann, S. G. (2015). Cognitions as mediators in the relationship between self-compassion and affect. *Personality and Individual Differences*, 74, 41–48.  
<https://doi.org/10.1016/j.paid.2014.10.008>
- Azevedo, M. H., Bos, S. C., Soares, M. J., Marques, M., Pereira, A. T., Maia, B., Gomes, A. A., & Macedo, A. (2010). Longitudinal study on perfectionism and sleep disturbance. *The World Journal of Biological Psychiatry*, 11(2–2), 476–485.  
<https://doi.org/10.3109/15622970903304467>
- Brown, L., Houston, E. E., Amonoo, H. L., & Bryant, C. (2020). Is self-compassion associated with sleep quality? A Meta-analysis. *Mindfulness*. <https://doi.org/10.1007/s12671-020-01498-0>
- Butz, S., & Stahlberg, D. (2018). Can self-compassion improve sleep quality via reduced rumination? *Self and Identity*, 17(6), 666–686.  
<https://doi.org/10.1080/15298868.2018.1456482>
- Butz, S., & Stahlberg, D. (2020). The relationship between self-compassion and sleep quality: An overview of a seven-year German research program. *Behavioral Sciences*, 10(3), 64.  
<https://doi.org/10.3390/bs10030064>
- Buysse, D. J. (2014). Sleep health: Can we define it? Does it matter? *Sleep*, 37(1), 9–17.  
<https://doi.org/10.5665/sleep.3298>
- Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, 28(2), 193–213. [https://doi.org/10.1016/0165-1781\(89\)90047-4](https://doi.org/10.1016/0165-1781(89)90047-4)
- Cella, D., Choi, S. W., Condon, D. M., Schalet, B., Hays, R. D., Rothrock, N. E., Yount, S., Cook, K. F., Gershon, R. C., Amtmann, D., DeWalt, D. A., Pilkonis, P. A., Stone, A. A.,

- 594 Weinfurt, K., & Reeve, B. B. (2019). PROMIS Adult Health Profiles: Efficient Short-  
 595 Form Measures of Seven Health Domains. *Value in Health*, 22(5), 537–544.  
 596 <https://doi.org/10.1016/j.jval.2019.02.004>
- 597 Cleeland, C. S. (1989). Measurement of pain by subjective report. *Measurement of Pain by*  
 598 *Subjective Report*, 391–403. Scopus.
- 599 Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed). L. Erlbaum  
 600 Associates.
- 601 Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress.  
 602 *Journal of Health and Social Behavior*, 24(4), 385–396. <https://doi.org/10.2307/2136404>
- 603 Coren, S. (1988). Prediction of insomnia from arousability predisposition scores: Scale  
 604 development and cross-validation. *Behaviour Research and Therapy*, 26(5), 415–420.  
 605 [https://doi.org/10.1016/0005-7967\(88\)90076-9](https://doi.org/10.1016/0005-7967(88)90076-9)
- 606 Egan, S. J., & Shafran, R. (2017). Cognitive-behavioral treatment for perfectionism. In *The*  
 607 *Psychology of Perfectionism* (1st ed.). Routledge.
- 608 Gaskin, J. (2016). ‘Specific Indirect Effect’, *Gaskination’s Statistics*.  
 609 <http://statwiki.gaskination.com/index.php?title=Plugins>
- 610 Gehrman, P., Findley, J., & Perlis, M. (2012). Insomnia I. *The Oxford Handbook of Sleep and*  
 611 *Sleep Disorders*. <https://doi.org/10.1093/oxfordhb/9780195376203.013.0021>
- 612 Germer, C. K., & Neff, K. D. (2013). Self-compassion in clinical practice. *Journal of Clinical*  
 613 *Psychology*, 69(8), 856–867. <https://doi.org/10.1002/jclp.22021>
- 614 Gong, H., Ni, C.-X., Liu, Y.-Z., Zhang, Y., Su, W.-J., Lian, Y.-J., Peng, W., & Jiang, C.-L.  
 615 (2016). Mindfulness meditation for insomnia: A meta-analysis of randomized controlled  
 616 trials. *Journal of Psychosomatic Research*, 89, 1–6.  
 617 <https://doi.org/10.1016/j.jpsychores.2016.07.016>

- 618 Gurtman, C. G., McNicol, R., & McGillivray, J. A. (2014). The role of neuroticism in insomnia:  
 619 Neuroticism in insomnia. *Clinical Psychologist*, 18(3), 116–124.  
 620 <https://doi.org/10.1111/cp.12029>
- 621 Hair, J. F. (Ed.). (2014). *Multivariate data analysis* (7th ed.). Pearson.
- 622 Harvey, A. G., & Tang, N. (2012). (Mis)Perception of sleep in insomnia: A puzzle and a  
 623 resolution. *Psychological Bulletin*, 138(1), 77–101. <https://doi.org/10.1037/a0025730>
- 624 Harvey, A. G., Tang, N. K. Y., & Browning, L. (2005). Cognitive approaches to insomnia.  
 625 *Clinical Psychology Review*, 25(5), 593–611. <https://doi.org/10.1016/j.cpr.2005.04.005>
- 626 Hatcher, L. (2013). *Advanced statistics in research: Reading, understanding, and writing up*  
 627 *data analysis results*. ShadowFinch Media, LLC.
- 628 Hauri, P. J. (1991). Sleep hygiene, relaxation therapy, and cognitive interventions. In P. J. Hauri  
 629 (Ed.), *Case Studies in Insomnia* (pp. 65–84). Springer US. [https://doi.org/10.1007/978-1-](https://doi.org/10.1007/978-1-4757-9586-8_5)  
 630 [4757-9586-8\\_5](https://doi.org/10.1007/978-1-4757-9586-8_5)
- 631 Hofmann, S. G., Asnaani, A., Vonk, I. J. J., Sawyer, A. T., & Fang, A. (2012). The efficacy of  
 632 cognitive behavioral therapy: A review of meta-analyses. *Cognitive Therapy and*  
 633 *Research*, 36(5), 427–440. <https://doi.org/10.1007/s10608-012-9476-1>
- 634 Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. *Journal of*  
 635 *Psychosomatic Research*, 11(2), 213–218. [https://doi.org/10.1016/0022-3999\(67\)90010-4](https://doi.org/10.1016/0022-3999(67)90010-4)
- 636 Hu, Y., Wang, Y., Sun, Y., Arteta-Garcia, J., & Purol, S. (2018). Diary study: The protective role  
 637 of self-compassion on stress-related poor sleep quality. *Mindfulness*.  
 638 <https://doi.org/10.1007/s12671-018-0939-7>
- 639 Johnson, E. A., & O'Brien, K. A. (2013). Self-compassion soothes the savage ego-threat system:  
 640 Effects on negative affect, shame, rumination, and depressive symptoms. *Journal of*

*Social and Clinical Psychology*, 32(9), 939–963.

<https://doi.org/10.1521/jscp.2013.32.9.939>

Kanen, J., Nazir, R., Sedky, K., & Pradhan, B. (2015). The effects of mindfulness-based interventions on sleep disturbance: A meta-analysis. *Adolescent Psychiatry*, 5(2), 105–115.

Keith, T. Z. (2015). *Multiple regression and beyond: An introduction to multiple regression and structural equation modeling* (2nd ed.). Routledge/Taylor & Francis Group.

<https://doi.org/10.4324/9781315749099>

Leary, M. R., Tate, E. B., Adams, C. E., Allen, A. B., & Hancock, J. (2007). Self-compassion and reactions to unpleasant self-relevant events: The implications of treating oneself kindly. *Journal of Personality and Social Psychology*, 92(5), 887–904.

LeBlanc, M., Mérette, C., Savard, J., Ivers, H., Baillargeon, L., & Morin, C. M. (2009).

Incidence and risk factors of insomnia in a population-based sample. *Sleep*, 32(8), 1027–1037. <https://doi.org/10.1093/sleep/32.8.1027>

Lundh, L.-G., Broman, J.-E., & Hetta, J. (1995). Personality traits in patients with persistent insomnia. *Personality and Individual Differences*, 18(3), 393–403.

[https://doi.org/10.1016/0191-8869\(94\)00125-C](https://doi.org/10.1016/0191-8869(94)00125-C)

Mastin, D. F., Bryson, J., & Corwyn, R. (2006). Assessment of sleep hygiene using the Sleep Hygiene Index. *Journal of Behavioral Medicine*, 29(3), 223–227.

<https://doi.org/10.1007/s10865-006-9047-6>

Matsunaga, M. (2008). Item parceling in structural equation modeling: A primer.

*Communication Methods and Measures*, 2(4), 260–293.

<https://doi.org/10.1080/19312450802458935>

- 664 McFarquhar, T., Luyten, P., & Fonagy, P. (2018). Changes in interpersonal problems in the  
 665 psychotherapeutic treatment of depression as measured by the Inventory of Interpersonal  
 666 Problems: A systematic review and meta-analysis. *Journal of Affective Disorders*, 226,  
 667 108–123. <https://doi.org/10.1016/j.jad.2017.09.036>
- 668 McIntyre, K. M., Mogle, J. A., Scodes, J. M., Pavlicova, M., Shapiro, P. A., Gorenstein, E. E.,  
 669 Tager, F. A., Monk, C., Almeida, D. M., & Sloan, R. P. (2019). Anger-reduction  
 670 treatment reduces negative affect reactivity to daily stressors. *Journal of Consulting and*  
 671 *Clinical Psychology*, 87(2), 141–150. <https://doi.org/10.1037/ccp0000359>
- 672 Mosewich, A. D., Crocker, P. R. E., Kowalski, K. C., & DeLongis, A. (2013). Applying self-  
 673 compassion in sport: An intervention with women athletes. *Journal of Sport and Exercise*  
 674 *Psychology*, 35(5), 514–524. <https://doi.org/10.1123/jsep.35.5.514>
- 675 Moulds, M. L., Kandris, E., Starr, S., & Wong, A. C. M. (2007). The relationship between  
 676 rumination, avoidance and depression in a non-clinical sample. *Behaviour Research and*  
 677 *Therapy*, 45(2), 251–261. <https://doi.org/10.1016/j.brat.2006.03.003>
- 678 Neff, K. D. (2003). The development and validation of a scale to measure self-compassion. *Self*  
 679 *and Identity*, 2(3), 223–250. <https://doi.org/10.1080/15298860309027>
- 680 Neff, K. D., & Dahm, K. A. (2015). Self-compassion: What it is, what it does, and how it relates  
 681 to mindfulness. In B. D. Ostafin, M. D. Robinson, & B. P. Meier (Eds.), *Handbook of*  
 682 *Mindfulness and Self-Regulation* (pp. 121–137). Springer. [https://doi.org/10.1007/978-1-](https://doi.org/10.1007/978-1-4939-2263-5_10)  
 683 [4939-2263-5\\_10](https://doi.org/10.1007/978-1-4939-2263-5_10)
- 684 Neff, K. D., & Germer, C. K. (2013). A pilot study and randomized controlled trial of the  
 685 mindful self-compassion program: A pilot and randomized trial of MSC program.  
 686 *Journal of Clinical Psychology*, 69(1), 28–44. <https://doi.org/10.1002/jclp.21923>

- 687 Ong, C. W., Barney, J. L., Barrett, T. S., Lee, E. B., Levin, M. E., & Twohig, M. P. (2019). The  
 688 role of psychological inflexibility and self-compassion in acceptance and commitment  
 689 therapy for clinical perfectionism. *Journal of Contextual Behavioral Science*, 13, 7–16.  
 690 <https://doi.org/10.1016/j.jcbs.2019.06.005>
- 691 Ong, J. C., Manber, R., Segal, Z., Xia, Y., Shapiro, S., & Wyatt, J. K. (2014). A randomized  
 692 controlled trial of mindfulness meditation for chronic insomnia. *Sleep*, 37(9), 1553–1563.  
 693 <https://doi.org/10.5665/sleep.4010>
- 694 Perlis, M., Shaw, P. J., Cano, G., & Espie, C. A. (2011). Models of Insomnia. In *Principles and*  
 695 *Practice of Sleep Medicine: Fifth Edition* (pp. 850–865). W.B. Saunders.  
 696 <https://doi.org/10.1016/B978-1-4160-6645-3.00078-5>
- 697 Ramlee, F., Sanborn, A. N., & Tang, N. K. Y. (2017). What sways people’s judgment of sleep  
 698 quality? A quantitative choice-making study with good and poor sleepers. *Sleep*,  
 699 40(zsx091). <https://doi.org/10.1093/sleep/zsx091>
- 700 Rice, K. G., Richardson, C. M. E., & Tueller, S. (2014). The short form of the Revised Almost  
 701 Perfect Scale. *Journal of Personality Assessment*, 96(3), 368–379.  
 702 <https://doi.org/10.1080/00223891.2013.838172>
- 703 Russell, D. W., Kahn, J. H., Spoth, R., & Altmaier, E. M. (1998). Analyzing data from  
 704 experimental studies: A latent variable structural equation modeling approach. *Journal of*  
 705 *Counseling Psychology*, 45(1), 18–29. <https://doi.org/10.1037/0022-0167.45.1.18>
- 706 Schumacker, R. E., & Lomax, R. G. (2010). *A beginner’s guide to structural equation modeling*.  
 707 Routledge/Taylor & Francis Group.
- 708 Singareddy, R., Vgontzas, A. N., Fernandez-Mendoza, J., Liao, D., Calhoun, S., Shaffer, M. L.,  
 709 & Bixler, E. O. (2012). Risk factors for incident chronic insomnia: A general population

- 710 prospective study. *Sleep Medicine*, 13(4), 346–353.  
 711 <https://doi.org/10.1016/j.sleep.2011.10.033>
- 712 Sirois, F. M., Kitner, R., & Hirsch, J. K. (2015). Self-compassion, affect, and health-promoting  
 713 behaviors. *Health Psychology*, 34(6), 661–669. <https://doi.org/10.1037/hea0000158>
- 714 Sirois, F. M., Nauts, S., & Molnar, D. S. (2018). Self-compassion and bedtime procrastination:  
 715 An emotion regulation perspective. *Mindfulness*. [https://doi.org/10.1007/s12671-018-](https://doi.org/10.1007/s12671-018-0983-3)  
 716 0983-3
- 717 Sodano, S. M., & Tracey, T. J. G. (2011). A brief Inventory of Interpersonal Problems-  
 718 Circumplex using nonparametric Item Response Theory: Introducing the IIP-C-IRT.  
 719 *Journal of Personality Assessment*, 93(1), 62–75.  
 720 <https://doi.org/10.1080/00223891.2010.528482>
- 721 Spielman, A. J., Caruso, L. S., & Glovinsky, P. B. (1987). A behavioral perspective on insomnia  
 722 treatment. *The Psychiatric Clinics of North America*, 10(4), 541–553.
- 723 Stewart-Brown, S., Tennant, A., Tennant, R., Platt, S., Parkinson, J., & Weich, S. (2009).  
 724 Internal construct validity of the Warwick-Edinburgh Mental Well-being Scale  
 725 (WEMWBS): A Rasch analysis using data from the Scottish Health Education Population  
 726 Survey. *Health and Quality of Life Outcomes*, 7, 15. [https://doi.org/10.1186/1477-7525-](https://doi.org/10.1186/1477-7525-7-15)  
 727 7-15
- 728 Tanaka, H., & Tamura, N. (2016). Sleep education with self-help treatment and sleep health  
 729 promotion for mental and physical wellness in Japan. *Sleep and Biological Rhythms*,  
 730 14(S1), 89–99. <https://doi.org/10.1007/s41105-015-0018-6>
- 731 Tang, N. K. Y., & Harvey, A. G. (2004). Correcting distorted perception of sleep in insomnia: A  
 732 novel behavioural experiment? *Behaviour Research and Therapy*, 42(1), 27–39.  
 733 [https://doi.org/10.1016/S0005-7967\(03\)00068-8](https://doi.org/10.1016/S0005-7967(03)00068-8)

- 734 Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination reconsidered: A  
735 psychometric analysis. *Cognitive Therapy and Research*, 27(3), 247–259.  
736 <https://doi.org/10.1023/A:1023910315561>
- 737 van der Zweerde, T., Bisdounis, L., Kyle, S. D., Lancee, J., & van Straten, A. (2019). Cognitive  
738 behavioral therapy for insomnia: A meta-analysis of long-term effects in controlled  
739 studies. *Sleep Medicine Reviews*, 48, 101208. <https://doi.org/10.1016/j.smr.2019.08.002>
- 740 Watkins, E. R., & Roberts, H. (2020). Reflecting on rumination: Consequences, causes,  
741 mechanisms and treatment of rumination. *Behaviour Research and Therapy*, 127,  
742 103573. <https://doi.org/10.1016/j.brat.2020.103573>
- 743 Winbush, N. Y., Gross, C. R., & Kreitzer, M. J. (2007). The effects of mindfulness-based stress  
744 reduction on sleep disturbance: A systematic review. *EXPLORE*, 3(6), 585–591.  
745 <https://doi.org/10.1016/j.explore.2007.08.003>
- 746 Yang, C.-M., Lin, S.-C., Hsu, S.-C., & Cheng, C.-P. (2010). Maladaptive sleep hygiene practices  
747 in good sleepers and patients with insomnia. *Journal of Health Psychology*, 15(1), 147–  
748 155. <https://doi.org/10.1177/1359105309346342>
- 749



## Supplementary Information

Article: Being kind to self is being kind to sleep? A structural equation modelling approach evaluating the direct and indirect associations of self-compassion with sleep quality, emotional distress and mental well-being.

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Appendix 1. Participant characteristics

Appendix 2. Correlational analyses

Appendix 3. Internal consistency of the measures

Appendix 4. Psychometric properties of the latent factors

Appendix 5. Exploratory post hoc analysis.

### Appendix 1.

Table 1. Participant characteristics

	Total	Good sleep	Poor sleep	$\chi^2/t$	$p$	$V/d$
	$N=468$	$n=244$	$n=224$			
Demographic variables						
Gender						
Female	278 (59.4%)	128 (52.5%)	150 (67.0%)	13.21	.001	.17
Male	188 (40.2%)	116 (47.5%)	72 (32.1%)			
Non-binary	2 (0.4%)	0 (0.0%)	2 (0.9%)			
Age (M±SD)	38.97 ± 19.40	37.16 ± 19.67	40.95 ± 18.94	-2.12	.035	.20
18-29	198 (42.3%)	123 (50.4%)	75 (33.5%)			
30-39	78 (16.7%)	39 (16.0%)	39 (17.4%)			
40-49	63 (13.5%)	22 (9.0%)	41 (18.3%)			
50-59	38 (8.1%)	11 (4.5%)	27 (12.1%)			
60 and above	91 (19.4%)	49 (20.1%)	42 (18.8%)			
Ethnicity						
Asian	76 (16.2%)	37 (15.2%)	39 (17.4%)	1.61	.824	.06
Black	12 (2.6%)	8 (3.3%)	4 (1.8%)			
Mixed	11 (2.4%)	5 (2.0%)	6 (2.7%)			
White	365 (78.0%)	192 (78.7%)	173 (77.2%)			
Other	4 (0.9%)	2 (0.8%)	2 (0.9%)			
Educational level						
With university degree	269 (57.5%)	153 (62.7%)	116 (51.8%)	7.68	.006	.13
Without university degree	199 (42.5%)	91 (37.3%)	108 (48.2%)			
Employment status						
Employed/Self-employed	176 (37.6%)	92 (37.7%)	84 (37.5%)	0.00	.964	.00
Other (studying, etc.)	292 (62.4%)	152 (62.3%)	140 (62.5%)			
Marital status						
Married/In partnership	204 (43.6%)	103 (42.2%)	101 (45.1%)	0.39	.531	.03
Single	264 (56.4%)	141 (57.8%)	123 (54.9%)			
Health-related variables						
Perceived health status (M±SD)	2.71 ± 1.00	2.41 ± 0.88	3.04 ± 1.02	-7.07	<.001	.66

Good health	366 (78.2%)	213 (87.3%)	153 (68.3%)			
Poor health	102 (21.8%)	31 (12.7%)	71 (31.7%)			
History of sleep disorders						
Yes	34 (7.3%)	5 (2.0%)	29 (12.9%)	20.59	<.001	.21
No	434 (92.7%)	239 (98.0%)	195 (87.1%)			
Taking sleep medication						
Yes	24 (5.1%)	4 (1.6%)	20 (8.9%)	12.75	<.001	.17
No	444 (94.9%)	240 (98.4%)	204 (91.1%)			
Taking non-sleep medication						
Yes	55 (11.8%)	13 (5.3%)	42 (18.8%)	20.29	<.001	.21
No	413 (88.2%)	231 (94.7%)	182 (81.3%)			
Pain interference (M±SD)	1.12 ± 2.29	0.63 ± 1.58	1.80 ± 2.74	-5.60	<.001	.52
Pain severity (M±SD)	1.12 ± 2.02	0.60 ± 1.47	1.67 ± 2.36	-5.80	<.001	.54
<b>Outcome variables (M±SD)</b>						
Sleep quality	6.17 ± 3.51	3.59 ± 1.31	8.97 ± 2.97	-25.00	<.001	2.35
Depression	52.85 ± 11.29	48.00 ± 9.40	58.10 ± 10.80	-10.85	<.001	1.00
Anxiety	54.41 ± 11.30	49.90 ± 10.10	59.40 ± 10.50	-9.99	<.001	.92
Mental well-being	22.61 ± 4.99	24.00 ± 5.00	21.00 ± 5.00	6.32	<.001	.58
<b>Predictors (M±SD)</b>						
<b><i>Predisposing factors</i></b>						
Self-compassion	2.89 ± 0.68	3.04 ± 0.66	2.72 ± 0.65	5.17	<.001	.48
Arousability	33.18 ± 8.84	31.00 ± 8.00	36.00 ± 9.00	-7.20	<.001	.67
Brooding	11.57 ± 3.47	11.21 ± 3.37	11.96 ± 3.55	-2.33	.020	.22
Perfectionism						
Perfectionism standard	21.75 ± 4.60	22.00 ± 4.00	22.00 ± 5.00	1.01	.312	.09
Perfectionism discrepancy	18.28 ± 5.46	17.00 ± 5.00	19.00 ± 5.00	-3.58	<.001	.33
Interpersonal problems	1.31 ± 0.55	1.19 ± 0.49	1.44 ± 0.57	-5.11	<.001	.47
<b><i>Precipitating factors</i></b>						
Perceived stress	17.99 ± 7.89	15.00 ± 7.00	22.00 ± 7.00	-10.24	<.001	.95
Presence of life-changing events						
Yes	363 (77.6%)	165 (67.6%)	198 (88.4%)	28.95	<.001	.25
No	105 (22.4%)	79 (32.4%)	26 (11.6%)			

***Perpetuating factors***

Poor sleep hygiene	17.24 ± 8.36	14.00 ± 7.00	20.00 ± 8.00	-8.47	<.001	.79
Anxiety about sleep	42.32 ± 23.22	31.90 ± 20.47	53.67 ± 20.60	-11.46	<.001	1.06

*Note.* To simplify the presentation of findings, we combined categories of education, employment, marital and perceived health status. Participants scored  $\leq 5$  on PSQI were included in the “Good sleep” group,  $> 5$  in the “Poor sleep” group. For each variable, percentages across subcategories (i.e., in each column) should add up to ~100%. Chi-square test of independence was performed with categorical variables. SPSS Statistics' Exact Module was used where cells have expected count less than 5: gender and ethnicity. Two-tailed t-test of independence and Welch t-test were performed with continuous variables. V-Cramer's effect size for categorical variables. d-Cohen's effect size for continuous variables.

## **Appendix 2.**

### **Correlational analyses**

As shown in Table 2, self-compassion had strong positive correlations with mental well-being and strong negative correlation with depression, and moderate negative correlations with poor sleep quality and anxiety. In terms of its association with various predictors of insomnia, self-compassion had strong negative correlations with brooding, perfectionism discrepancy, and interpersonal problems, and moderate negative correlations with arousability. Self-compassion, however, did not correlate with perfectionism standard. Self-compassion correlated weakly with the presence of life-changing events, though its association with perceived stress as a precipitating factor was strong and negative. Self-compassion was negatively correlated with both perpetuating factors measured; the strength of the correlation was medium for poor sleep hygiene and close to medium for anxiety about sleep.

Table 2. Pearson Correlations for the Outcome Variables and Predictors

	1.PSQ	2.DP	3.AN	4.MW B	5.SC	6.AR	7.BR	8.PS	9.PD	10.IP	11.PSt	12.PLE	13.PSH
<b>Outcome variables</b>													
1.(Poor) sleep quality	—												
2.Depression	.53***	—											
3.Anxiety	.51***	.86***	—										
4.Mental well-being	-.35***	-.62***	-.54***	—									
<b>Predictors</b>													
<i>Predisposing factors</i>													
5.Self-compassion	-.31***	-.51***	-.44***	.61***	—								
6.Arousability	.38***	.60***	.64***	-.39***	-.45***	—							
7.Brooding	.15**	.39***	.31***	-.46***	-.57***	.36***	—						
8.Perfectionism standard	-.07	.03	.04	.16***	-.01	.14**	.11*	—					
9.Perfectionism discrepancy	.20***	.40***	.35***	-.42***	-.52***	.41***	.58***	.30***	—				
10.Interpersonal problems	.31***	.52***	.47***	-.52***	-.57***	.53***	.57***	-.03	.47***	—			
<i>Precipitating factors</i>													
11.Perceived stress	.48***	.80***	.81***	-.64***	-.53***	.66***	.38***	.06	.46***	.51***	—		
12.Presence of life-changing events	.27***	.42***	.48***	-.11*	-.11*	.39***	-.02	.07	.08	.09*	.40***	—	
<i>Perpetuating factors</i>													
13.(Poor) sleep hygiene	.41***	.55***	.60***	-.36***	-.33***	.53***	.24***	.10*	.29***	.32***	.56***	.39***	—
14. Anxiety about sleep	.55***	.54***	.61***	-.34***	-.28***	.49***	.26***	.11*	.31***	.34***	.57***	.36***	.57***

\* p &lt; .05, \*\* p &lt; .01, \*\*\* p &lt; .001

### Appendix 3. Internal consistency of the measures

Internal consistency of all measures in the current sample was found to be acceptable to high and consistent with previous reports:

Table 3. Reliability of the scales and subscales used in the current study

<b>№</b>	<b>Scale</b>	<b>Cronbach's <math>\alpha</math></b>
1	Pittsburgh Sleep Quality Index (PSQI)	.76
2	Patient-Reported Outcomes Measurement Information System (PROMIS) Emotional Distress-Anxiety Short Form	.93
3	PROMIS Emotional Distress-Depression Short Form	.95
4	Short Warwick-Edinburgh Mental Well-being Scale (sWEMWBS)	.86
5	Self-Compassion Scale (SCS)	.92
6	Arousal Predisposition Scale (APS)	.88
7	Brooding subscale of the Ruminative Responses Scale (RRS)	.79
8	Standards subscale of the Short Almost Perfect Scale (SAPS)	.87
9	Discrepancy subscale of the Short Almost Perfect Scale (SAPS)	.86
10	Inventory of Interpersonal Problems-C-IRT (IIP-C-IRT)	.89
11	Perceived Stress Scale (PSS)	.88
12	Sleep Hygiene Index (SHI)	.83
13	Anxiety and Preoccupation about Sleep Questionnaire (APSQ)	.95

#### Appendix 4. Psychometric properties of the latent factors

All latent variables in both models had acceptable values for indices of composite reliability ( $\geq .70$ ; Hair, 2014) and average variance extracted ( $\geq .50$ ; Hair, 2014), indicating adequate internal consistency and convergent validity of the latent factors.

Table 4. Composite reliability and variance extracted of the latent factors

<b>Factor</b>	<b>Composite reliability</b>	<b>Average variance extracted</b>
<b>Model 1</b>		
Self-compassion	.89	.74
Anxiety about sleep	.94	.84
Perceived stress	.84	.66
Sleep hygiene	.84	.64
Sleep quality	.81	.59
<b>Model 2</b>		
Self-compassion	.89	.74
Anxiety about sleep	.94	.84
Sleep hygiene	.84	.64
Sleep quality	.75	.50
Mental well-being	.86	.67
Emotional distress	.92	.86



### Appendix 5. Exploratory post hoc analysis

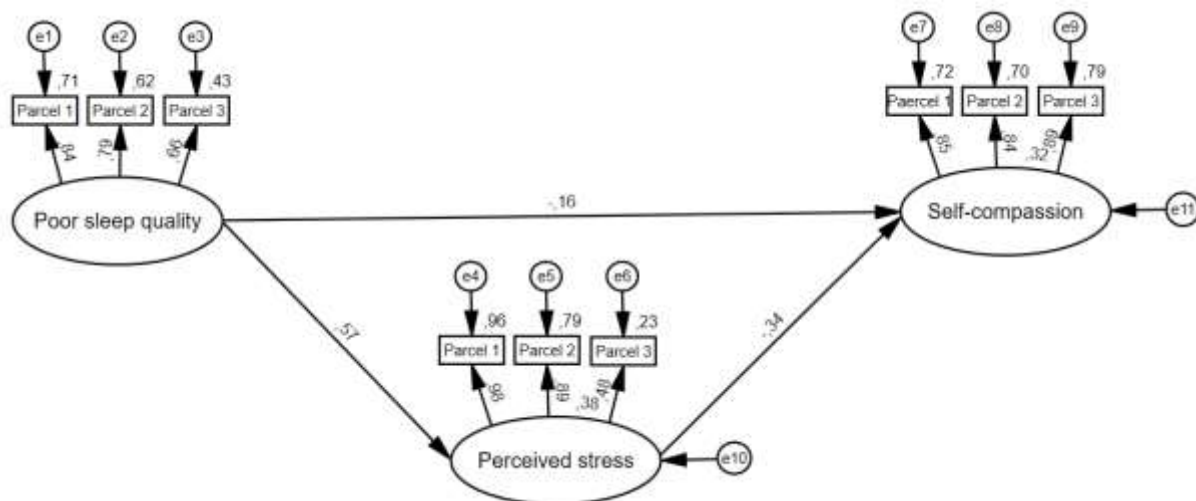
Considering the correlational nature of the study, there is a possibility of the opposite direction of association: from sleep quality to self-compassion. The existence of this potential association is indicated by the sleep to forget and sleep to remember (SFSR) model, according to which sleep (especially the REM phase) helps the person to consolidate the memories while simultaneously separating and decreasing the affective tone associated with these memories (van der Helm & Walker, 2009). It is possible that poor sleep quality may impair the processing of the self-relevant distressing emotions such as shame which in turn may decrease the ability of the person to be compassionate towards oneself. Recent studies conducted by Wassing et al. (2019), revealed that exposure to feelings of shame before sleep resulted in the decrease of the emotional intensity the next day in the good sleepers, but with the opposite result in the people with insomnia.

Based on the abovementioned research, we conducted the separate analysis using the structural equation modelling (SEM) to see whether the poor sleep quality would be directly associated with self-compassion and indirectly via perceived stress. We followed the same data analysis strategy described in the article. The SEM model (Figure 1) showed an acceptable fit to the data:  $\chi^2 = 231.39$ ,  $df = 66$ ,  $\chi^2/df = 3.51$ ,  $p < .001$ , CFI = .94; TLI = .90; RMSEA = .07 (90% CI: .06-.08). Poor sleep quality significantly predicted higher perceived stress,  $\beta = .57$ ,  $p = .001$ , perceived stress negatively predicted self-compassion,  $\beta = -.34$ ,  $p < .001$ , but poor sleep quality did not predict self-compassion directly,  $\beta = -.16$ ,  $p = .075$  (Figure 1). However, results showed the significant negative indirect effect of poor sleep quality on self-compassion via perceived stress,  $\beta = -.20$ ,  $p < .001$ . For self-compassion, the  $R^2 = .32$ ,  $p = .005$ , which means that model explained 32% of the variance in self-compassion.

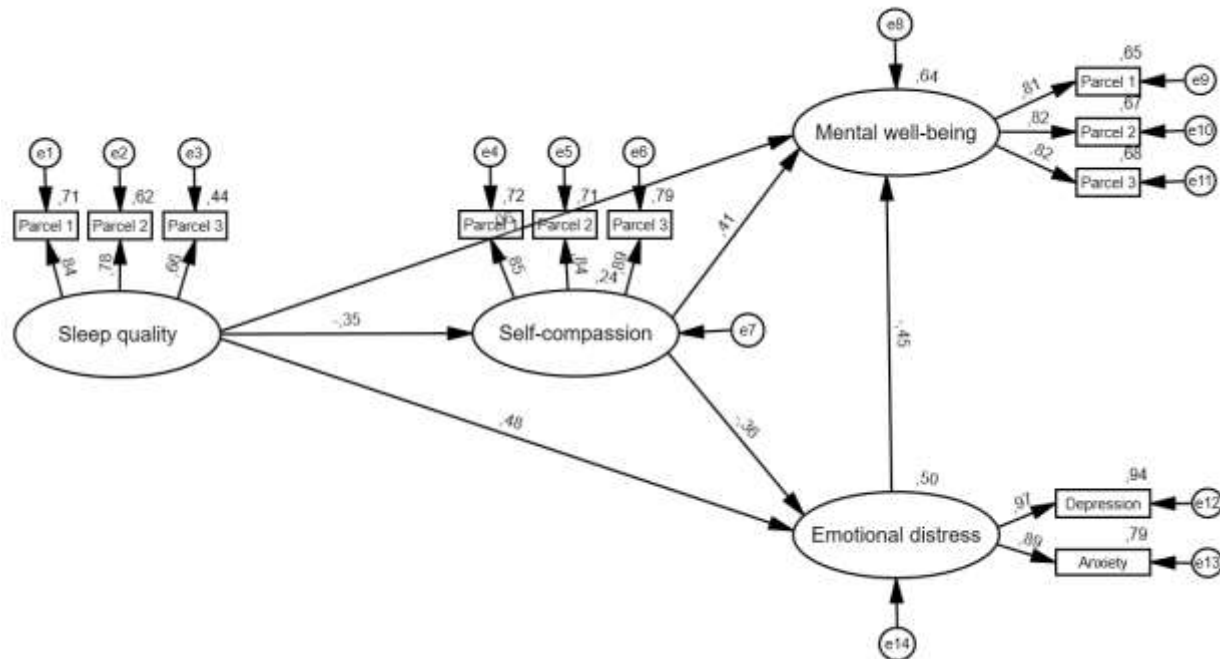
Due to issue of multicollinearity (high correlation of perceived stress with emotional distress), we tested the second model (without perceived stress) investigating the direct effect of poor sleep quality on two outcome variables of mental well-being and emotional distress, and the indirect effect of poor sleep quality on two outcome variables via self-compassion (Figure 2). The SEM model showed an acceptable fit to the data:  $\chi^2 = 260.81$ ,  $df = 87$ ,  $\chi^2/df = 3.00$ ,  $p < .001$ , CFI = .95; TLI = .92; RMSEA = .07 (90% CI: .06-.08). Poor sleep quality significantly and negatively predicted self-compassion,  $\beta = -.35$ ,  $p = .002$ , emotional distress,  $\beta = .48$ ,  $p = .003$ , but did not predict mental well-being,  $\beta = .06$ ,  $p = .398$ . Self-compassion significantly predicted both higher

mental well-being,  $\beta = -.36, p = .001$ , and lower emotional distress,  $\beta = .42, p = .002$ . Emotional distress significantly and negatively predicted mental well-being,  $\beta = -.45, p = .001$ . The indirect effects of poor sleep quality on both mental well-being and emotional distress via self-compassion were statistically significant ( $\beta = -.15, p < .01$ , and  $\beta = .13, p < .001$  respectively). The indirect effect of poor sleep quality on mental well-being via emotional distress was statistically significant,  $\beta = -.21, p < .01$ . For self-compassion, the  $R^2 = .24, p = .010$ , which means that model explained 24% of the variance in self-compassion.

Thus, results indicate that poor sleep quality may negatively influence the ability of the person to be self-compassionate presumably by contributing to the increasing level of distress. This in turn may increase the level of distress and lower the mental well-being. In the light of these findings, the association between sleep quality and self-compassion maybe bidirectional. Future longitudinal and experimental studies are needed to investigate the directions of association.



**Figure 1** N=468. Rectangles represents observed variables and ovals represents latent variables. All values are standardised coefficients, except for values near variables, which are squared multiple correlations. Error terms of variables are depicted as e1-e11. Control variables (age, educational level, poor perceived health, taking sleep medications, taking non-sleep medications, history of sleep disorders, and pain severity) were hidden in the figure for visual clarity.



**Figure 2** N=468. Rectangles represents observed variables and ovals represents latent variables. All values are standardised coefficients, except for values near variables, which are squared multiple correlations. Error terms of variables are depicted as e1-e14. Control variables (age, educational level, poor perceived health, taking sleep medications, taking non-sleep medications, history of sleep disorders, and pain severity) were hidden in the figure for visual clarity.

## References

- van der Helm, E., & Walker, M. P. (2009). Overnight Therapy? The Role of Sleep in Emotional Brain Processing. *Psychological Bulletin*, 135(5), 731–748. <https://doi.org/10.1037/a0016570>
- Wassing, R., Schalkwijk, F., Lakbila-Kamal, O., Ramautar, J. R., Stoffers, D., Mutsaerts, H. J. M. M., Talamini, L. M., & Van Someren, E. J. W. (2019). Haunted by the past: Old emotions remain salient in insomnia disorder. *Brain*, 142(6), 1783–1796. <https://doi.org/10.1093/brain/awz089>
- Wassing, R., Benjamins, J. S., Talamini, L. M., Schalkwijk, F., & Van Someren, E. J. W. (2019). Overnight worsening of emotional distress indicates maladaptive sleep in insomnia. *Sleep*, 42(4). <https://doi.org/10.1093/sleep/zsy268>