Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Original Article

Insomnia symptoms during the COVID-19 pandemic: an examination of biopsychosocial moderators

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ABSTRACT

Objective/background: Healthy sleep is vital for physical and psychological health, and poor sleep can result in a myriad of negative physical and psychological outcomes. Insomnia symptoms often manifest as a result of acute life stressors or changes, and COVID-19 experiences may be one such stressor. Other known predisposing factors to insomnia may moderate the impact of COVID-19 experiences on sleep. The present study aimed to determine current levels of insomnia severity in a US sample, to investigate the relation of COVID-19 experiences to insomnia symptoms, and to determine which individuals are most susceptible to this association.

Methods: Data were drawn from a larger online survey investigating sleep and health outcomes across the lifespan. COVID-19 experiences were assessed with the exposure and impact subscales of the CAIR Pandemic Impact Questionnaire (C-PIQ). The Insomnia Severity Index (ISI) measured insomnia symptoms. Biological, psychological, and social moderators were measured using other brief self-report measures.

Results: Insomnia symptoms prevalence was as follows: moderate-to-severe symptoms (25.5%), subthreshold symptoms (37.7%), and no symptoms (36.7%). Individuals' COVID-19 experiences significantly predicted insomnia symptom severity [$F(1,997) = 472.92$, $p < 0.001$, $R^2 = 0.32$]. This association was moderated by race, anxiety symptoms, depressive symptoms, physical somatization, and social loneliness, but not age, gender, or education.

Conclusions: Although negative experiences with COVID-19 are associated with worse insomnia symptoms, this relationship is not the same for everyone.

1. Introduction

Healthy sleep is a critical component of physical and psychological health. In fact, there is evidence to suggest that disturbed sleep (ie, insomnia symptoms) increases susceptibility for a host of untoward consequences, including depression [1], anxiety [2], obesity [3], and heart disease [4], to name a few. Theoretical models suggest insomnia symptoms can arise due to acute stressors, changes in routines, or changes in life circumstances, all of which are categorized as precipitating factors [5]. The COVID-19 pandemic has resulted in numerous life alterations which may be conceptualized as precipitating events for the development of insomnia symptoms.

The COVID-19 pandemic has been associated with increased rates of insomnia symptoms across the globe [6–8]. Known risk factors, also termed predisposing factors [5], for insomnia include biological, psychological, and social factors [eg, age [9], female gender [10], non-white race/ethnicity [11], lower education [12], higher levels of anxiety [13] and depression [14], and loneliness [15]]. Whether these factors modulate the sleep response to COVID-19 is unknown.

The present study sought to establish current levels of insomnia severity in a US sample during the COVID-19 pandemic, examine the association between COVID-19 experiences and insomnia symptoms along a continuum, and investigate for whom COVID-19 experiences are most likely to predict insomnia symptoms. We

Abbreviations: IRB, Institutional Review Board; MTurk, Amazon Mechanical Turk; POC, People of Color; C-PIQ, CAIR Pandemic Impact Questionnaire; PHQ-15, Patient Health Questionnaire-15; PHQ-2, Patient Health Questionnaire-2; GAD-2, Generalized Anxiety Disorder-2; ISI, Insomnia Severity Index.

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hypothesized higher than previously reported rates of clinically meaningful insomnia symptoms, that greater COVID-19 experiences would be related to greater insomnia severity, and that select biopsychosocial factors would alter the association between COVID-19 experiences and insomnia symptoms.

2. Methods

2.1. Procedure and participants

Data were collected in July and August 2020 as part of an Institutional Review Board (IRB) approved online study examining sleep and health across the lifespan utilizing Amazon's Mechanical Turk (MTurk), an online platform. The study protocol and procedures were approved by the Virginia Commonwealth University IRB. Data collected via MTurk allows for safe data collection during social distancing and has been found to be as reliable as traditional paper-and-pencil methodology [16]. Inclusion criteria were: (a) residence within the US, and (b) gender such that an equal number of men and women were enrolled. Potential threats to validity were guarded against via an instructional manipulation check and an age consistency check. Participants were compensated $1.00 for participation. Compensation amounts do not affect the quality of MTurk data [16].

2.2. Measures

2.2.1. COVID-19 experiences

COVID-19 experiences were assessed with the CAIR Pandemic Impact Questionnaire [C-PIQ [17]], a 19 item scale assessing exposure to COVID-19, impact of COVID-19, and personal growth due to COVID-19. The impact subscale contains a single item directly querying about sleep which was removed prior to scoring. A single index of negative experiences was created by summing the exposure and impact scales, labeled COVID-19 experiences. Cronbach's alpha for C-PIQ in this study was 0.86.

2.2.2. Biological, psychological, and social moderators

Participants self-reported their age (years), gender (male/female/other), and race/ethnicity [White/People of Color (POC)], and years of education. Somatic symptom severity was assessed with the Patient Health Questionnaire-15 [PHQ-15 [18]]. Cronbach's alpha for the PHQ-15 was 0.89. Depressive symptoms were measured with the Patient Health Questionnaire-2 [PHQ-2 [19]]. Anxiety symptoms were measured with the Generalized Anxiety Disorder-2 [GAD-2 [20]]. Cronbach's alpha for the PHQ-2 and GAD-2 in the current sample were 0.81 and 0.84, respectively. Social loneliness was measured with the social loneliness subscale of the De Jong Gierveld Loneliness Scale [21]. Cronbach's alpha for the social loneliness subscale of the De Jong Gierveld Loneliness Scale in this study was 0.84.

2.2.3. Insomnia Symptoms

The presence and severity of insomnia symptoms was assessed with this Insomnia Severity Index [ISI [22]], a 7-item measure. Cronbach's alpha for ISI in this study was 0.82.

3. Analyses

Levels of insomnia severity were analyzed via frequency distribution of ISI scores, and means (M) and 95% confidence intervals (CI) were calculated for ISI scores that fell within each diagnostic category on the ISI. A linear regression was used to examine the overall association between COVID-19 experiences and insomnia severity. Prior to running the regression model all assumptions were assessed and the data were found to be normal, linear, and homoscedastic. Eight separate moderation models were performed using PROCESS macro for SPSS version 3.5 [23]. Each moderation model examined an individual moderator's influence on the association between COVID-19 experiences and insomnia severity. A post-hoc power analysis using G*Power was used to estimate the power of the moderation analyses [24]. Results indicated that a sample size of 999 participants, an alpha level of 0.05, three predictors, and a small effect size ($f^2 = 0.02$) results in a power level of 0.99.

3. Results

The sample included 999 adults with an average age of 44.18 years (SD = 16.22). The sample was nearly evenly split between men and women, with 45.74% of the participants identifying as female. Please refer to Table 1 for a complete list of demographic and descriptive statistics. 25.5% of the sample indicated moderate-severe insomnia symptoms [M ISI = 17.80, 95% CI = 17.48–18.11]. Another 37.7% reported subthreshold levels of insomnia symptoms (M ISI = 10.99, 95% CI = 10.78–11.19). 36.7% of the sample reported no/low insomnia symptoms (M ISI = 2.73, 95% CI = 2.48–2.98). The linear regression predicting insomnia symptoms based on COVID-19 experiences was significant [F (1,997) = 472.92, $p < 0.001$], with an R^2 of 0.32. Participants' ISI score increased 0.52 units with each additional unit increase in COVID-19 experience. Age ($p = 0.15$), gender ($p = 0.11$), and education ($p = 0.10$) did not moderate the association between COVID-19 experiences and insomnia severity. Race ($\Delta R^2 = 0.005$, $p < 0.01$), somatic symptoms ($\Delta R^2 = 0.009$, $p < 0.001$), depression ($\Delta R^2 = 0.005$, $p < 0.01$), anxiety ($\Delta R^2 = 0.008$, $p < 0.01$), and social loneliness ($\Delta R^2 = 0.004$, $p < 0.05$) each moderated the COVID-19 experience—insomnia severity association. Results are presented in Table 2 and Fig. 1.

Table 1
Participant descriptive statistics (n = 999).

Variable	% (Number)	Range	Cronbach's α
Age, Mean (SD)	44.18 (16.22)	18–82	–
*Sex, % Female	45.74 (457)	–	–
Race, % White	72.77 (727)	–	–
Education, % Bachelor's or higher	74.00 (739)	–	–
COVID-19 Experience, Mean (SD)	13.75 (6.95)	0–35	0.86
Patient Health Questionnaire-2, Mean (SD)	2.28 (1.84)	0–6	0.81
Generalized Anxiety Disorder-2, Mean (SD)	2.40 (1.95)	0–6	0.84
Patient Health Questionnaire-15, Mean (SD)	9.35 (6.58)	0–30	0.89
Social Loneliness, Mean (SD)	4.93 (3.03)	0–12	0.84
Insomnia Severity Index, Mean (SD)	9.69 (6.36)	0–27	0.82

Notes: Age measured in years. *65 participants indicated a sex other than male or female. Cronbach's α calculated from the present sample. Higher scores on all scores = worse functioning.

4. Discussion

The main objective of this report was to understand sleep during the COVID-19 pandemic. Existing research has primarily focused on frontline workers [25] outside of the US. Within the current sample, 25% reported moderate to severe insomnia symptoms, which is lower compared to frontline workers [25], but consistent with a general samples [26,27]. Insomnia symptoms increase in relation to increased levels of COVID-19 experiences, but not consistently across individuals. At low levels of COVID-19 experiences, White and POC reported similar levels of insomnia severity; however, as COVID-19 experiences increased, White participants reported greater insomnia severity compared to POC with similar levels of COVID-19 experiences. Additionally, those with more somatic symptoms, depression, anxiety, and social loneliness reported higher insomnia symptoms at lower, but not higher, levels of COVID-19 experiences. At higher COVID-19 experiences, these differential vulnerabilities disappear, perhaps reflecting the universally debilitating experience of severe COVID-19.

The COVID-19 pandemic, resulting stay at home orders and economic challenges, may have disrupted zeitgebers, circadian rhythms, and heightened stress levels [28]. The resulting insomnia symptoms are unevenly distributed across the population. Reinstituting daily routines, optimizing light exposure and activity during the day, along with compartmentalizing work or school activities to daytime hours and locations outside the bedroom could potentially mitigate some of the sleep challenges (28). While self-report sleep symptoms are the only requirement for insomnia diagnosis and

Table 2
Biopsychosocial moderation of the COVID-19 experience-insomnia severity association.

Predictor	Moderator	Outcome	*b*	R^2 Interaction	Total R^2
COVID-19 Experience	Age	Insomnia Severity	0.43***	0.001	0.32***
COVID-19 Experience	Gender	Insomnia Severity	0.59***	0.001	0.32***
COVID-19 Experience	Race/Ethnicity	Insomnia Severity	0.43***	0.005**	0.33***
COVID-19 Experience	PHQ-15	Insomnia Severity	0.42***	0.009***	0.49***
COVID-19 Experience	GAD-2	Insomnia Severity	0.46***	0.008**	0.43***
COVID-19 Experience	PHQ-2	Insomnia Severity	0.46***	0.005**	0.42***
COVID-19 Experience	Education	Insomnia Severity	0.59***	0.002	0.32***
COVID-19 Experience	Loneliness	Insomnia Severity	0.58***	0.004*	0.36***

Notes. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. *b* represents the unstandardized coefficient between the COVID-19 experience and insomnia symptoms when the moderator is included in the model.

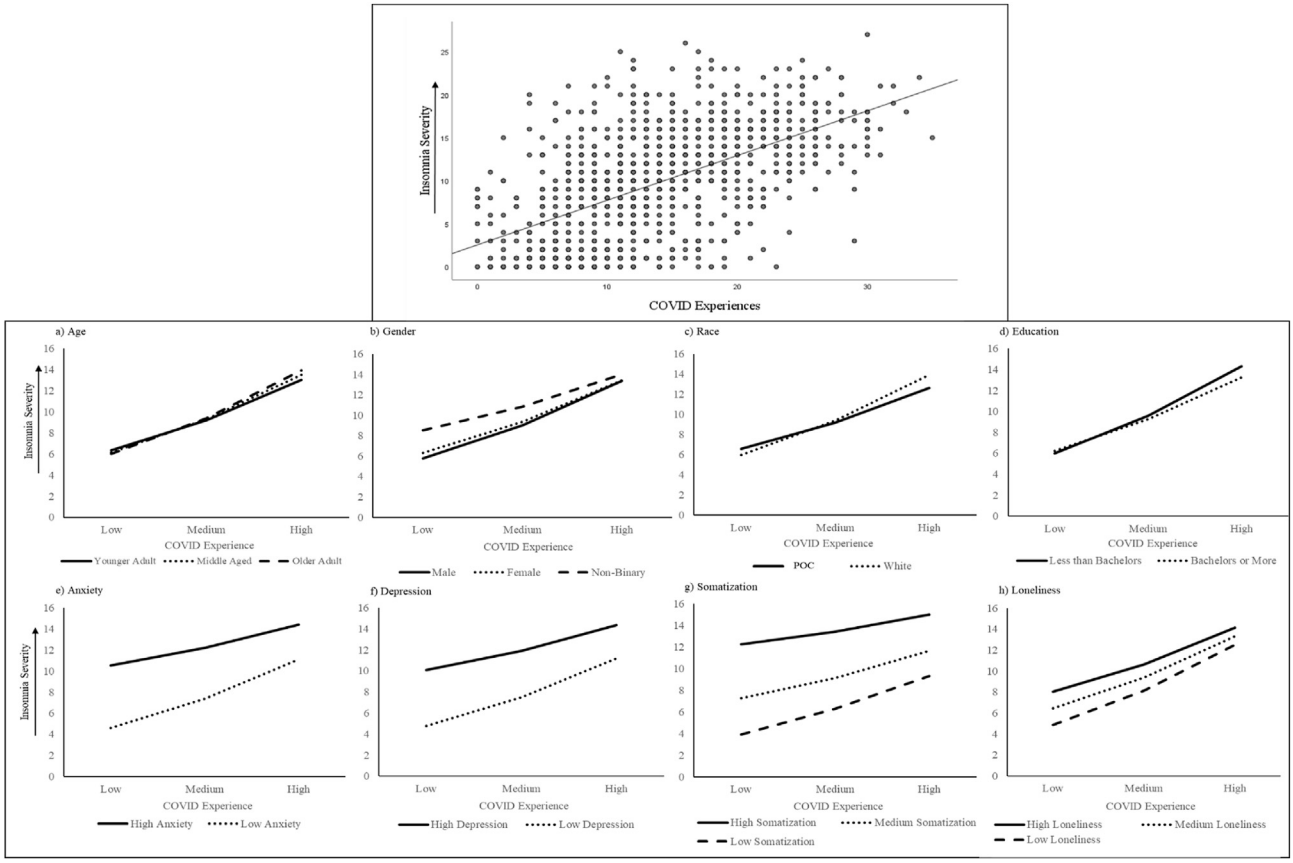

Fig. 1. Insomnia severity as a function of COVID-19 experience (top panel) and age (panel a), gender (panel b), race (panel c), education (d), anxiety (panel e), depression, (panel f), somatization (panel g), and loneliness (panel h). POC = People of Color.

treatment, the addition of objective measures would enhance our understanding of sleep during COVID-19, and longitudinal designs would allow for a better understanding temporal associations.

COVID-19 experiences show a dose–response association with insomnia symptoms in a general US sample. Individual differences in this association abound. Despite the disruption and stress of the pandemic, opportunities remain to prevent insomnia and preserve healthy sleep.

Credit author statement

All authors made contributions to warrant authorship. All authors agree to submission in current form.

Conflicts of interest and source of funding

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2021.02.018.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2021.02.018.

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