

SCIENTIFIC INVESTIGATIONS

# Pre-existing and post-pandemic insomnia symptoms are associated with high levels of stress, anxiety, and depression globally during the COVID-19 pandemic

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**Study Objectives:** The coronavirus disease 2019 (COVID-19) pandemic has led to an increased prevalence of insomnia and mental health symptoms globally. However, most studies to date have not examined mental health symptoms between individuals with insomnia, either pre-existing or developing post-pandemic compared with good sleepers. This study examined differences in stress, anxiety, and depression between individuals with pre-existing insomnia symptoms, post-pandemic insomnia symptoms, and no insomnia symptoms in response to the COVID-19 pandemic.

**Methods:** A cross-sectional survey was completed by 2724 participants from 67 countries during the COVID-19 pandemic. Perceived stress, anxiety, and depressive symptoms were compared between individuals with post-pandemic insomnia symptoms (n = 1007), pre-existing insomnia symptoms (n = 804), and no insomnia symptoms (n = 913).

**Results:** Post-pandemic insomnia symptoms were associated with higher levels of stress, anxiety, and depression than pre-existing or no insomnia symptoms ( $P < .001$ ). Pre-existing insomnia symptoms were also associated with higher levels of stress, anxiety, and depression than no insomnia symptoms ( $P < .001$ ). Individuals who met likely criteria for acute insomnia also reported higher stress, anxiety, and depression than those with insomnia disorder ( $P < .001$ ). Across all groups, individuals reporting a previous mental health diagnosis had worse stress, anxiety, and depression than those without a previous mental health diagnosis ( $P < .001$ ). Last, individuals from South Africa reported higher levels of stress, anxiety, and depression than other countries ( $P < .01$ ).

**Conclusions:** Internationally, individuals with pre-existing and post-pandemic insomnia symptoms may be more susceptible to stress, anxiety, and depression during the COVID-19 pandemic. Public health initiatives should include insomnia management to improve mental health during the pandemic.

**Keywords:** insomnia, acute insomnia, COVID-19 pandemic, sleep, mental health, stress, anxiety, depression, South Africa

**Citation:** Meaklim H, Junge MF, Varma P, Finck WA, Jackson ML. Pre-existing and post-pandemic insomnia symptoms are associated with high levels of stress, anxiety, and depression globally during the COVID-19 pandemic. *J Clin Sleep Med*. 2021;17(10):2085–2097.

## BRIEF SUMMARY

**Current Knowledge/Study Rationale:** Research during the coronavirus disease 2019 (COVID-19) pandemic suggests higher rates of insomnia, stress, anxiety, and depression than previously recorded. However, mental health symptoms between individuals with insomnia, either pre-existing or developing post-pandemic, compared with good sleepers has not been explored. The current study examined global differences in stress, anxiety, and depression between those experiencing post-pandemic, pre-existing, or no insomnia symptoms in response to the COVID-19 pandemic.

**Study Impact:** This study indicates that, worldwide, individuals with insomnia symptoms, either pre-existing or developing post-pandemic, may have worse stress, anxiety, and depression symptoms during the COVID-19 pandemic than those with no history of insomnia. Therefore, public health officials should consider insomnia management in their mental health response to the pandemic.

## INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic spread quickly across the globe, infecting 65 million people and resulting in more than 1.5 million COVID-19–related deaths by December 2020.<sup>1</sup> Many countries enforced lockdowns to contain the spread of the virus, resulting in major disruptions to employment, daily routines, and sleep–wake patterns.<sup>2,3</sup> These disruptions, along with the virus threat, caused heightened levels of stress, fear, and uncertainty throughout the world. There is growing concern that the fallout from the pandemic could take an enormous toll on both sleep and mental health worldwide.<sup>4</sup>

Stress and disruptions to sleep–wake patterns are known precipitants of insomnia.<sup>5–7</sup> Insomnia is a sleep–wake disorder characterized by difficulty falling asleep, staying asleep, or waking too early, resulting in daytime impairments.<sup>8</sup> During the early phase of the pandemic, there was an increased number of internet-based search queries for insomnia,<sup>9</sup> suggesting that the pandemic triggered insomnia symptoms. Emerging research indicates higher prevalence rates of insomnia and mental health symptoms, such as anxiety and depression, compared with pre-pandemic estimates.<sup>10–15</sup> Although insomnia can be a symptom of anxiety and depression, it is recognized as a distinct disorder that can precipitate and exacerbate mental health issues.<sup>16–20</sup> In addition, insomnia severity has been linked to elevated suicide ideation during the COVID-19 pandemic.<sup>21</sup>

Insomnia, therefore, warrants independent assessment and treatment, along with more research into the consequences of insomnia symptoms in the time of COVID-19.

First, the mental health implications of experiencing insomnia symptoms during the COVID-19 pandemic are not yet clear. Although the pandemic is assumed to be a stressful event for most people, previous research has shown that stressful events have a greater impact on people with insomnia than good sleepers.<sup>22</sup> There are also well-established links between both acute and chronic insomnia with anxiety and depression.<sup>17–19,23–27</sup> It therefore follows that people with pre-existing or post-pandemic insomnia symptoms may be more susceptible to anxiety and depression than people who sleep well during the COVID-19 pandemic. However, to the best of our knowledge, this has not yet been established.

Second, individuals with acute sleep disturbances during the pandemic may be at a higher risk of anxiety and depression than those with more chronic insomnia symptoms. Most research conducted during the COVID-19 pandemic has only reported on current levels of insomnia and mental health symptoms.<sup>10,11,13,15,28,29</sup> However, one recent study<sup>30</sup> identified that acute insomnia symptoms during the pandemic had stronger associations with anxiety and depression than pre-existing insomnia disorder. In addition, although there has been a global increase in acute sleep disturbances/insomnia during the pandemic,<sup>14,31,32</sup> 20–25% of individuals with pre-existing insomnia symptoms have reported improvements in sleep quality during the pandemic.<sup>30,31</sup> Therefore, it is crucial for pandemic research to distinguish between pre-existing and post-pandemic insomnia symptoms, as they may have different implications for sleep and mental health outcomes during the pandemic.

Third, despite a surge in sleep problems worldwide,<sup>12</sup> research has not yet identified differences in insomnia and mental health symptoms across countries during the pandemic. Government response measures across countries have varied,<sup>32</sup> which may influence sleep and mental health outcomes. Also, prevalence rates of insomnia and mental health conditions differ between countries. For example, lower rates of insomnia symptoms and lifetime depression have been reported in South Africa<sup>33,34</sup> than in Australia.<sup>35,36</sup> Understanding which countries are most affected by poor sleep and mental health during the pandemic could inform policymakers and provide targeted support to the nations and individuals who need it most. Therefore, the current study aimed to do the following:

1. Examine differences in stress, anxiety, and depression in response to the COVID-19 pandemic between individuals with post-pandemic insomnia symptoms, pre-existing insomnia symptoms, and no insomnia symptoms.
2. Explore whether factors such as meeting diagnostic criteria for acute insomnia or insomnia disorder, or having a previous mental health condition diagnosis, influenced stress, anxiety, and depressive symptoms across insomnia groups during the COVID-19 pandemic.
3. Examine differences between countries in mental health and insomnia symptoms during the early phase of the COVID-19 pandemic.

## METHODS

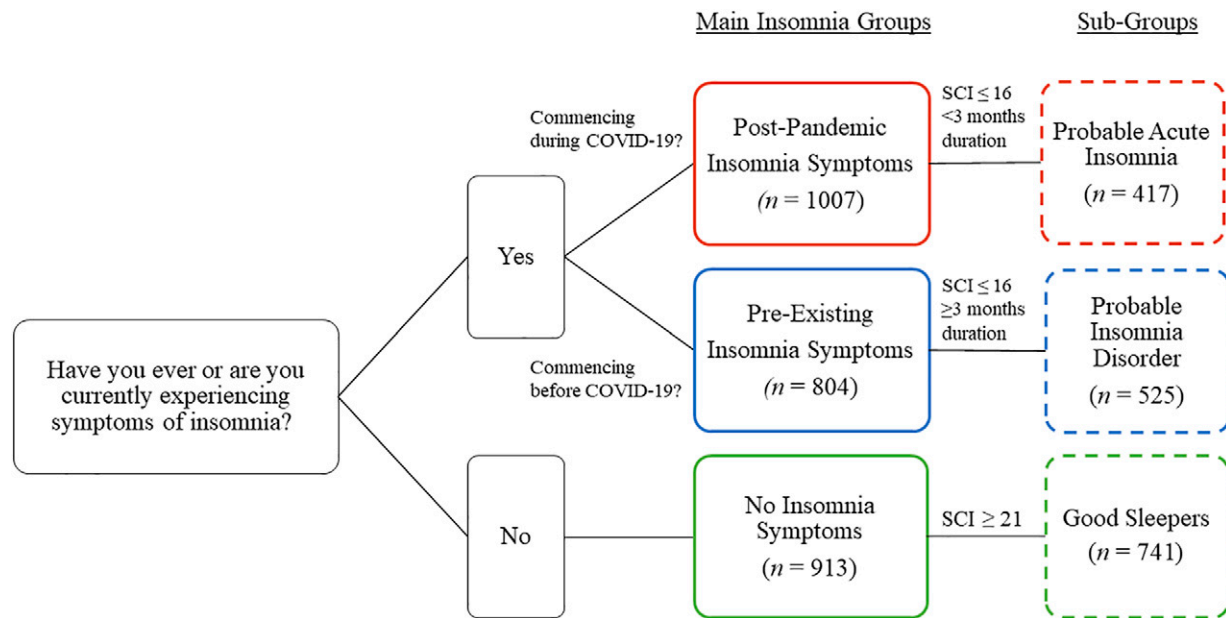
### Design and participants

The current study reports the baseline cross-sectional survey data of an international longitudinal study investigating sleep and insomnia symptoms during the COVID-19 pandemic. Participants aged 18 years or above were recruited to the baseline survey between April 6 to May 15, 2020. The online survey was hosted on Qualtrics (Provo, UT, USA). Participants with and without insomnia symptoms were recruited via social media (eg, Facebook, Twitter) and snowballing methods. Separate social media advertisements were designed to capture participants with current insomnia symptoms during the pandemic, those with pre-existing insomnia symptoms, and those who were sleeping well during the pandemic. The study received approval from the Monash University Human Research Ethics Committee in March 2020.

### Insomnia group allocation

Participants were grouped based on their self-reported history of insomnia symptoms and when insomnia symptoms commenced in relation to the COVID-19 pandemic (**Figure 1**). Participants were asked at the beginning of the survey “Have you ever had or are you currently experiencing insomnia symptoms? (eg, difficulty falling asleep, staying asleep, or waking up too early).” If participants endorsed insomnia symptoms, they were asked whether their insomnia symptoms started before or during the COVID-19 pandemic. Insomnia symptom duration as per *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition (DSM-5), criteria for Insomnia Disorder (eg,  $\geq 3$  months)<sup>8</sup> was not used to group participants for the initial analysis, as we were more interested in insomnia symptom onset in relation to the pandemic. The groups were labeled as follows: (1) those experiencing insomnia symptoms that began during the COVID-19 pandemic (Post-Pandemic Insomnia Symptoms,  $n = 1007$ ), (2) those with pre-existing insomnia symptoms to the COVID-19 pandemic (Pre-existing Insomnia Symptoms,  $n = 804$ ), and (3) those who have never experienced insomnia symptoms (No Insomnia Symptoms,  $n = 913$ ).

Given that there is diversity within epidemiology literature regarding insomnia classification (eg, nighttime insomnia symptoms only vs insomnia symptoms with sufficient frequency, duration, daytime consequences, and/or distress to meet criteria for Insomnia Disorder<sup>8</sup>), we additionally performed a subanalysis on participants likely to meet criteria for Acute Insomnia and Insomnia Disorder based on their Sleep Condition Indicator (SCI) scores and SCI-reported symptom duration. Participants in the Pre-existing Insomnia Symptoms group who scored at or below the cutoff of 16 on the SCI (indicative of a greater likelihood of Insomnia Disorder) and reported insomnia symptoms of more than 3 months' duration were allocated to the probable Insomnia Disorder group ( $n = 525$ ).<sup>37,38</sup> Participants in the Post-Pandemic Insomnia Symptoms group who scored less than 16 on the SCI but reported symptom duration of less than 3 months were allocated to the probable Acute Insomnia group ( $n = 417$ ).<sup>39–41</sup> Participants in the No Insomnia Symptoms group who self-reported as good sleepers ( $n = 741$ ) and scored greater

**Figure 1**—Participant allocation to main insomnia groups and for the secondary subgroup analysis.

COVID-19 = coronavirus disease 2019, SCI = Sleep Condition Indicator.

than 21 on the SCI were labeled as Good Sleepers.<sup>39,42,43</sup> Participant group allocation is outlined in **Figure 1**.

### Demographic information

The survey collected participants' demographic and lifestyle information (eg, age, sex, country of residence, employment status, college education, sleep medication use, and physical and mental health conditions). It also inquired about changes to participants' circumstances and lifestyle during the COVID-19 pandemic (eg, changes in employment and finances).

### Sleep measures

#### SCI

The SCI is an 8-item measure of insomnia, with scores ranging from 0 to 32, with lower scores indicating worse sleep.<sup>37</sup> The SCI taps into DSM-5 Insomnia Disorder criteria,<sup>8</sup> asking questions around sleep continuity and quality, frequency and duration of insomnia symptoms, sleep satisfaction/dissatisfaction, and daytime consequences of poor sleep.<sup>38</sup> Each item is scored on a 5-point scale (0 to 4). Total scores of ≤ 16 are indicative of being within the threshold for DSM-5 Insomnia Disorder.<sup>38</sup>

#### Sleep quality

Sleep quality during COVID-19 was assessed using item 4 of the SCI.<sup>37</sup> To assess sleep quality before COVID-19, a separate question was created asking participants to rate their sleep quality in the period immediately prior to the pandemic (eg, December 2019) using the same question and scale as item 4 of the SCI. Both sleep-quality items were scored on a 5-point scale from 0 (very poor) to 4 (very good).

### Ford Insomnia Response to Stress Test

The Ford Insomnia Response to Stress Test is a measure of sleep reactivity or vulnerability toward experiencing sleep disturbance in times of stress.<sup>44</sup> The Ford Insomnia Response to Stress Test comprises 9 items scored on a 4-point scale from 1 (not likely) to 4 (very likely), with total scores ranging from 9 to 36. Higher scores indicate a greater level of sleep reactivity.

### Glasgow Sleep Effort Scale

The Glasgow Sleep Effort Scale is a self-report questionnaire consisting of 7 items related to the perceived controllability or effort required to sleep.<sup>45</sup> Each item is scored on a 3-point scale from 0 (not at all) to 2 (very much), with total scores ranging from 0 to 14 and higher scores indicating greater effort required to sleep.

### Pre-Sleep Arousal Scale

The Pre-Sleep Arousal scale (PSAS) consists of 2 scales to measure somatic (PSAS-S) and cognitive (PSAS-C) arousal that a person experiences at bedtime when trying to fall asleep.<sup>46</sup> Each scale consists of 8 items rated on a 5-point scale from 0 (not at all) to 5 (extremely). Total scores range from 8 to 40. Higher scores on PSAS-S and PSAS-C are indicative of greater somatic or cognitive arousal before falling asleep.

### Mental health measures

#### Perceived Stress Scale

The 10-item Perceived Stress Scale (PSS-10) was used to assess the perceived stress levels in participants' lives.<sup>47</sup> The 10 items are rated on a 5-point scale from 0 (never) to 4 (very often),

with total scores ranging from 0 to 40.<sup>48</sup> Higher scores on the PSS-10 indicate higher perceived stress in participant's current lives. Scores  $\geq 14$  are suggestive of moderate stress levels.

### 6-Item State Trait Anxiety Inventory

The 6-item State Trait Anxiety Inventory (STAI-6) was used to measure current state anxiety (eg, feeling calm, tense, upset, relaxed, content, and worried).<sup>49</sup> STAI-6 total scores are multiplied by (20/6) to convert total scores to the same scale as the 20 item STAI for score interpretation.<sup>50</sup>

### 9-Item Patient Health Questionnaire

The 9-item Patient Health Questionnaire (PHQ-9) was used to assess depression symptoms.<sup>51</sup> Participants rate their depression symptoms over the past 2 weeks on a 4-point scale, ranging from 0 (never) to 3 (nearly every day). Total scores range from 0 to 27, with higher scores indicating more severe depression symptoms. Total scores greater than 10 on the PHQ-9 are suggestive of clinical depression.<sup>51</sup> Additionally, item 9 of the PHQ-9 asks participants about their suicidal ideation ("thoughts that you would be better off dead, or of hurting yourself") over the past 2 weeks. Participants responding to this item with a 1 (several days) to 3 (more than half of days) were classed as displaying suicidal ideation for this study.<sup>52</sup>

### Government COVID-19 restrictions

We utilized the Oxford COVID-19 Government Response Tracker (OxCGRT),<sup>32</sup> which includes information regarding the stringency of government COVID-19 policies (eg, school and workplace closures, travel bans) in the participants' country of residence by date. The OxCGRT is a composite measure, ranging from 0 to 100, with higher scores indicating greater restrictions. An OxCGRT score was allocated to participants based on their country of residence and date of survey completion.

### Data analysis

All data were analyzed using IBM SPSS version 26 (IBM Corporation, Armonk, NY). Descriptive data for all demographic data and sleep and mental health measures were examined. Where missing data exist, the number of participants who completed the questions are reported (n). Between-group analyses of variance (ANOVAs) were used with Games-Howell post hoc tests to characterize differences in sleep and insomnia measures between groups due to violation of normality for the SCI. Analysis of covariance (ANCOVA) was conducted to assess the differences in stress, anxiety, and depression between insomnia groups. Given the impacts of sex, age, education, and socioeconomic status on both insomnia<sup>53</sup> and COVID-related mental health symptoms,<sup>54-57</sup> age, sex, employment (unemployed/employed), finances impacted during COVID-19 (yes/no), college education (yes/no), use of sleep medications (yes/no), and OxCGRT scores were added as covariates in the models. A prior diagnosis of a mental health condition was also included as a covariate in some analyses, where stated.  $F_{\text{Max}}$  scores were calculated to assess for the severity of heterogeneity of variance due to the unequal sample sizes between the groups.<sup>58,59</sup> Across stress-, anxiety-, and depression-dependent variables,  $F_{\text{Max}}$  values were

less than 2, and therefore homogeneity of variance was not deemed to be severely violated in the present study.<sup>58</sup> The  $\alpha$  level was set at .01 to correct for potential type 1 errors due to the large number of analyses conducted. Group differences in suicidal ideation were compared using chi-square tests. Group differences in the proportion of participants meeting clinical cutoff scores for stress, anxiety, and depression were compared using chi-square tests and reported for clinical relevance in **Table S2** of the supplemental materials.

As current research has found that individuals with pre-existing mood and anxiety disorders are more negatively affected by the COVID-19 pandemic,<sup>58</sup> we used a 2-way between-groups ANCOVA to investigate differences in stress, anxiety, and depression for participants across insomnia groups who self-reported previous diagnosis of a mental health condition, adjusting for covariates. Last, we explored country differences in stress, anxiety, and depression symptoms across groups using the same covariates as previous analyses with the exception of the OxCGRT. The top 5 countries with the highest number of survey responses (United Kingdom, South Africa, Australia, India, and Ireland) were investigated in the cross-country analysis, with participants from all other countries grouped as "other."

## RESULTS

A total of 3,527 persons from 67 countries commenced the online survey. After removing incomplete responses (responses were deemed incomplete if they did not include the SCI), 2,724 responses were left for analysis. A total of 1,007 participants were allocated to the Post-Pandemic Insomnia Symptoms group (with 417 meeting the stricter criteria for Probable Acute Insomnia), 804 participants were assigned to the Pre-existing Insomnia Symptoms group (with 525 meeting the stricter criteria for Probable Insomnia Disorder), and 913 participants were allocated to the No Insomnia Symptoms group (with 741 meeting the stricter Good Sleeper group criteria).

Overall, 27% of the sample was previously diagnosed with a mental health condition, with depression being the most common diagnosis (15%). The top 5 countries with the highest number of participants were the United Kingdom, South Africa, Australia, India, and Ireland. Most participants reported being under lockdown in their country of residence at the time of completing the survey, which was also reflected in OxCGRT scores. Participants' demographics are provided in **Table 1**.

### Insomnia symptoms and sleep characteristics between groups

For individuals with post-pandemic insomnia symptoms, 77% believed that factors surrounding the pandemic triggered their insomnia symptoms. For individuals with pre-existing insomnia symptoms, 59% reported changes in their insomnia symptoms since the pandemic began, with most reporting a worsening of insomnia symptoms (72%) during the pandemic and some reporting improvements in sleep (28%). A range of previous insomnia experiences were reported by individuals with pre-existing insomnia, with most reporting trouble sleeping on and off for

**Table 1**—Participant demographics (n = 2,724).

Demographics	Mean ± SD (Range) or n (%)		
	Post-Pandemic Insomnia (n = 1,007)	Pre-existing Insomnia (n = 804)	No Insomnia Symptoms (n = 913)
Age (n = 2,415), y	43.5 ± 12.9 (18–77)	44.5 ± 14.8 (18–87)	46.9 ± 13.6 (18–81)
Sex: female (n = 2,693)	761 (76.6)	559 (70.4)	674 (74.4)
Marital status (n = 2,465)			
Married	419 (48.4)	316 (45.8)	488 (53.7)
Single	280 (32.3)	211 (30.6)	217 (23.9)
Other	167 (19.3)	163 (23.6)	204 (22.4)
Country of residence (n = 2,724)			
United Kingdom	209 (20.8)	202 (25.1)	544 (59.6)
South Africa	214 (21.3)	152 (18.9)	46 (14.2)
Australia	143 (14.2)	164 (20.4)	58 (6.4)
India	106 (10.5)	73 (9.1)	130 (14.2)
Ireland	61 (6.1)	51 (6.3)	29 (3.2)
Other	274 (27.2)	162 (20.1)	106 (11.6)
Currently in lockdown (n = 2,544)			
Yes	952 (94.5)	743 (92.4)	849 (93.0)
OxCGRT scores	81.8 ± 8.4 (57-100)	80.3 ± 8.8 (40-100)	77.9 ± 6.9 (50-100)
Currently employed (n = 2,702)	764 (76.6)	548 (68.9)	690 (75.8)
College educated (n = 2,300)	670 (79.6)	496 (73.8)	651 (82.8)
Employment impacted during COVID-19 (n = 2,101)	383 (29.0)	270 (33.6)	242 (26.5)
Finances impacted during COVID-19 (n = 2,701)	601 (59.7)	474 (59.0)	407 (38.0)
Shift worker (n = 1,986)			
Yes	64 (8.4)	65 (11.9)	44 (6.5)
Currently working overnight shifts	16 (1.6)	13 (1.6)	14 (1.5)
Caring for someone (n = 2,281)			
Yes	187 (18.6)	126 (15.7)	138 (15.1)
Elderly parent	97 (9.6)	70 (8.7)	71 (7.8)
Partner	16 (1.6)	11 (1.4)	17 (1.9)
Diagnosed with a physical health condition (n = 2,386)	113 (11.2)	103 (12.8)	82 (9.0)
Diagnosed with mental health condition (n = 2,311)	236 (28.0)	230 (34.0)	53 (19.3)
Depression	151 (15)	150 (18.7)	97 (10.6)
Anxiety	94 (9.3)	112 (13.9)	61 (6.7)
PTSD	24 (2.4)	25 (3.1)	9 (1.0)
Bipolar disorder	18 (1.8)	11 (1.4)	2 (0.2)
Other	42 (4.2)	31 (3.9)	24 (2.6)
Psychological support for mental health (n = 2,015)	70 (7.0)	71 (8.8)	22 (2.4)
Currently taking sleep medications (n = 2,724)	109 (10.8)	128 (15.9)	19 (2.1)

COVID-19 = coronavirus disease 2019, OxCGRT = Oxford COVID-19 Government Response Tracker, PTSD, post-traumatic stress disorder, SD = standard deviation.

years (42%), others having trouble sleeping the majority of the time (26%), and some only having trouble sleeping occasionally (12%). Interestingly, 12% reported that, despite having insomnia in the past, they had been sleeping better prior to the pandemic. For individuals with no history of insomnia symptoms, 86% considered themselves to be good sleepers.

Self-reported sleep quality across the groups from immediately before to during the COVID-19 pandemic is displayed in **Figure 2**. Participants with post-pandemic insomnia symptoms reported the most dramatic changes in sleep quality across this period. Further, both the Pre-existing and Post-Pandemic Insomnia Symptoms groups had significantly lower scores on the SCI than the No Insomnia Symptom group ( $P < .001$ ), indicating more severe insomnia symptoms (**Table S1** in the supplemental material). The Post-Pandemic Insomnia Symptoms group reported a median duration of insomnia symptoms on the SCI of 1–2 months, compared with more than 1 year for the Post-Pandemic Insomnia Symptoms group, supporting participants’ self-selected categories. Participants in both the Pre-existing and Post-Pandemic Insomnia Symptoms groups reported significantly greater cognitive arousal, somatic arousal, sleep effort, and sleep reactivity than those in the No Insomnia Symptoms group (all  $P < .001$ ). Post hoc tests indicated no significant

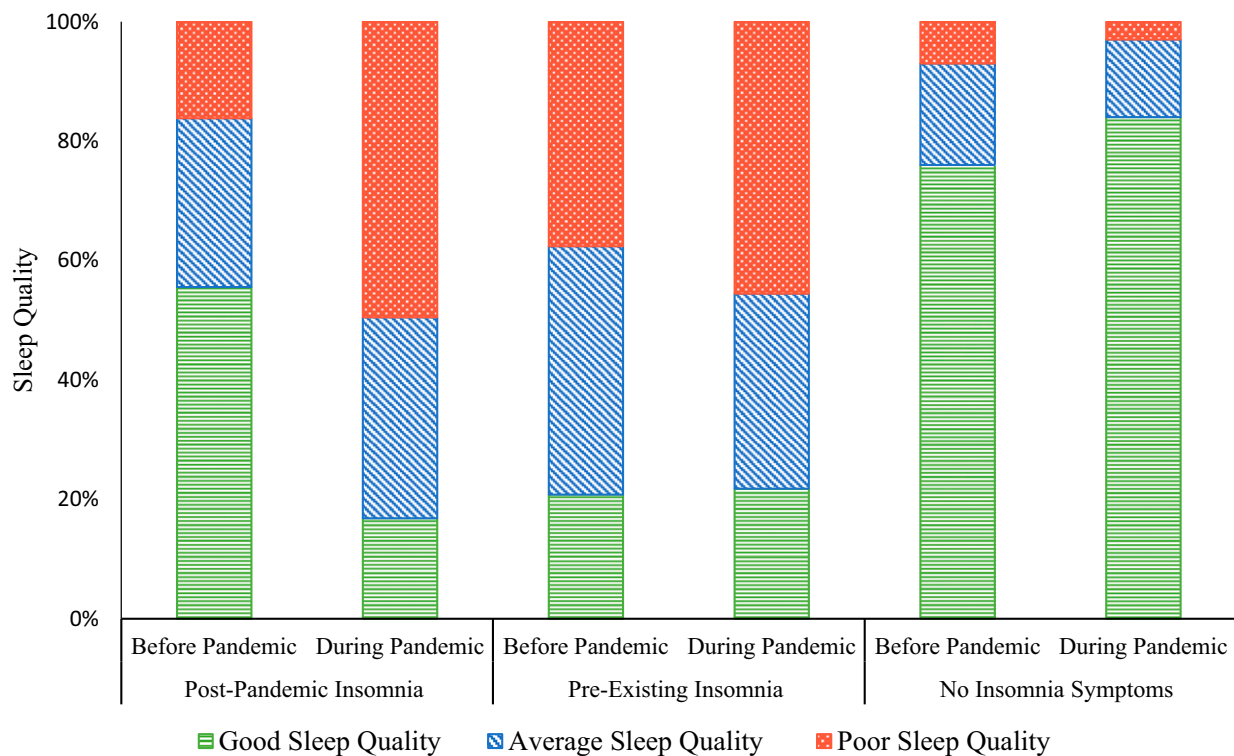
differences in sleep and insomnia measures between the Pre-existing and Post-Pandemic Insomnia Symptoms groups (all  $P > .011$ ).

**Stress, anxiety, and depression between groups**

Significant differences in perceived stress, state anxiety, and depression were observed between insomnia groups (all  $P < .001$ ). Across all mental health measures, those with post-pandemic insomnia symptoms reported significantly higher levels of perceived stress, anxiety, and depression than those with pre-existing insomnia symptoms or no insomnia symptoms (all  $P < .001$ ) (**Table 2A**). Additionally, participants who had pre-existing insomnia symptoms experienced significantly higher levels of stress, anxiety, and depression than those with no insomnia symptoms ( $P < .001$ ). Further, over 25% of participants in both of the insomnia symptoms groups reported experiencing suicidal ideation as reported on item 9 of the PHQ-9, a significantly higher proportion than for participants without insomnia symptoms ( $P < .001$ ) (**Table S2**).

The subanalysis on participants who likely met the criteria for Acute Insomnia and Insomnia Disorder revealed a similar pattern of results with larger effect sizes (**Table 2B**). Those with probable Acute Insomnia reported the highest levels of stress, anxiety, and depression during the COVID-19 pandemic, compared with

**Figure 2**—Changes in self-reported sleep quality from immediately before (eg, December 2019) to during the COVID-19 pandemic for those with post-pandemic insomnia symptoms (n = 1007), pre-existing insomnia symptoms (n = 804), and no insomnia symptoms (n = 913).



The 2 “poor” and “good” categories were collapsed into one for easier interpretation in the figure (eg, very poor and poor = poor; very good and good = good). COVID-19 = coronavirus disease 2019.

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**Table 2**—One-way ANCOVA examining the effect of insomnia group on the perceived stress, anxiety, and depression (adjusted mean  $\pm$  SE).

Variable	Post-Pandemic Insomnia (1)	Pre-existing Insomnia (2)	No Insomnia Symptoms (3)	F	df	P	Partial $\eta^2$	Post Hoc Comparison
<b>(A)</b>								
Stress (PSS-10)	21.42 $\pm$ .24	19.74 $\pm$ .27	15.31 $\pm$ .25	153.85	2, 2,041	<.001*	.13	1 > 2*, 1 > 3*, 2 > 3*
Anxiety (STAI-6)	46.51 $\pm$ .49	43.34 $\pm$ .55	34.42 $\pm$ .51	148.79	2, 2,043	<.001*	.13	1 > 2*, 1 > 3*, 2 > 3*
Depression (PHQ-9)	11.14 $\pm$ .20	9.97 $\pm$ .22	5.07 $\pm$ .21	237.35	2, 2,043	<.001*	.19	1 > 2*, 1 > 3*, 2 > 3*
	Probable Acute Insomnia (1)	Probable Insomnia Disorder (2)	Good Sleepers (3)	F	df	P	Partial $\eta^2$	Post Hoc Comparison
<b>(B)</b>								
Stress (PSS-10)	22.74 $\pm$ .36	21.36 $\pm$ .32	14.35 $\pm$ .27	210.29	2, 1,264	<.001*	.25	1 > 2*, 1 > 3*, 2 > 3*
Anxiety (STAI-6)	49.90 $\pm$ .72	45.83 $\pm$ .64	32.70 $\pm$ .53	210.14	2, 1,262	<.001*	.25	1 > 2*, 1 > 3*, 2 > 3*
Depression (PHQ-9)	12.74 $\pm$ .29	11.68 $\pm$ .26	4.14 $\pm$ .21	372.35	2, 1,262	<.001*	.37	1 > 2*, 1 > 3*, 2 > 3*

Adjusted means and SEs account for age, sex, education, employment, finances impacted, use of sleep medications and stringency of government COVID-19 restrictions (OxCGRT). **(A)**  $n = 2,052$ . **(B)** Subanalysis of participants ( $n = 1,273$ ) meeting probable diagnostic criteria for Acute Insomnia and Insomnia Disorder based on Sleep Condition Indicator scores and symptom duration. \* $P < .01$ . ANCOVA = analysis of covariance, COVID-19 = coronavirus disease 2019, OxCGRT = Oxford COVID-19 Government Response Tracker, PSS-10 = Perceived Stress Scale, PHQ-9 = 9-item Patient Health Questionnaire, SE = standard error, STAI-6 = 6-item State Trait Anxiety Inventory.

those with probable Insomnia Disorder and Good Sleepers (all  $P < .005$ ). Additionally, those with likely Insomnia Disorder reported significantly higher levels of stress, anxiety, and depression than did Good Sleepers (all  $P < .001$ ).

### Does a previous diagnosis of a mental health condition matter?

Given that 27% of the sample reported a previous diagnosis of a mental health condition, we reran the analysis separating individuals with and without a self-reported mental health condition diagnosis before the pandemic. A significant main effect for a previous mental health condition diagnosis was observed for stress [ $F(1, 2,034) = 38.56, P < .001$ ; partial  $\eta^2 = 0.02$ ], anxiety [ $F(1, 2,036) = 36.38, P < .001$ ; partial  $\eta^2 = 0.02$ ], and depression [ $F(1, 2,036) = 48.32, P < .001$ ; partial  $\eta^2 = 0.02$ ] (**Figure 3**). Individuals who reported a previous diagnosis of a mental health condition reported significantly higher levels of stress, anxiety, and depression than those who did not disclose a previous diagnosis (all  $P < .001$ ; **Figure 3**).

In addition, significant main effects for insomnia group were still observed across stress [ $F(1, 2,034) = 143.21, P < .001$ ; partial  $\eta^2 = 0.12$ ], anxiety [ $F(2, 2,036) = 139.76, P < .001$ ; partial  $\eta^2 = 0.12$ ], and depression [ $F(2, 2,036) = 224.24, P < .001$ ; partial  $\eta^2 = 0.18$ ]. Consistent with the primary analysis, those with post-pandemic insomnia symptoms had significantly higher scores on stress and mental health measures than those with pre-existing insomnia symptoms and those with no insomnia symptoms (all  $P < .001$ ). Those with pre-existing insomnia symptoms scored significantly higher on mental health measures than did those with no insomnia symptoms (all  $P < .001$ ).

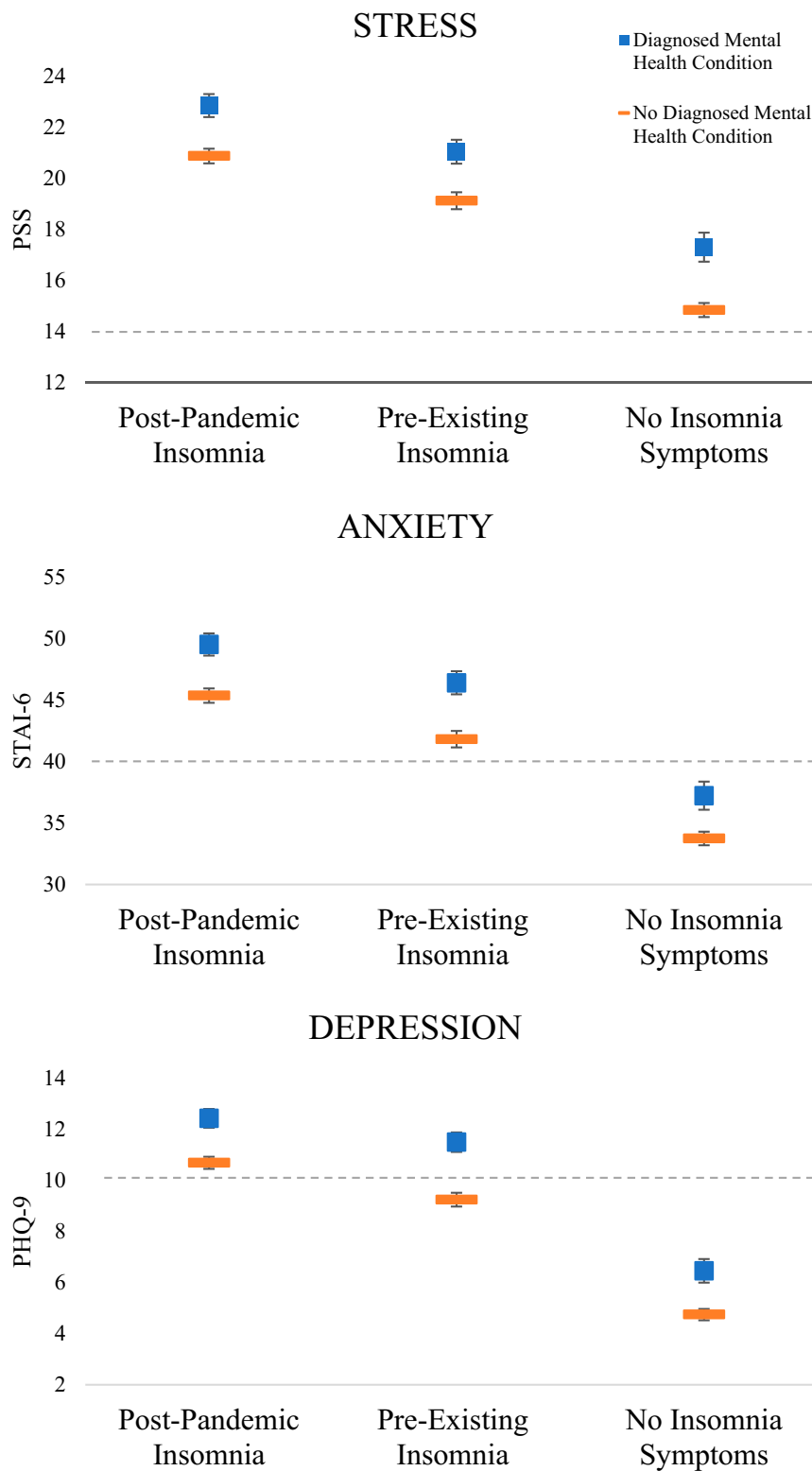
### Country differences in stress, anxiety, and depression symptoms

Significant main effects for country of residence were found across stress, anxiety, and depression (all  $P < .001$ ); however, effect sizes were small (all partial  $\eta^2$ s  $< .03$ ). Participants from South Africa displayed significantly higher stress, anxiety, and depression symptoms compared with all other countries (all  $P < .004$ ), except for participants from India for anxiety ( $P = .237$ ). There was no significant interaction effect between insomnia group and country of residence for stress ( $P = .013$ ), anxiety ( $P = .103$ ), or depression ( $P = .101$ ). After adjusting for covariates, however, no significant main effects were observed for country of residence for perceived stress ( $P = .047$ ), anxiety ( $P = .047$ ), or depression ( $P = .039$ ; see **Table 3**). Importantly, however, the main effects of insomnia group across stress, anxiety, and depression remained after adjusting for covariates (all  $P < .001$ ).

## DISCUSSION

The results of this study indicate that, globally, individuals experiencing pre-existing or post-pandemic insomnia symptoms experienced worse stress, anxiety, and depressive symptoms during the early stages of the COVID-19 pandemic than did people without insomnia symptoms. These results were observed even after controlling for factors known to influence insomnia and mental health during the pandemic, such as age, employment status, and government COVID-19 restrictions. Additionally, both Post-Pandemic and Pre-existing Insomnia Symptoms groups reported higher levels of suicidal ideation than those without insomnia symptoms, supporting the link between insomnia severity and elevated suicidal ideation during the pandemic.<sup>21</sup>

**Figure 3**—Stress, anxiety, and depression scores (adjusted means  $\pm$  SE) for individuals with and without a previous mental health condition diagnosis across insomnia groups.



Dotted lines denote cutoff scores for moderate stress, clinical anxiety, and clinical depression. PHQ-9 = 9-item Patient Health Questionnaire, PSS = Perceived Stress Scale, PSS-10 = 10-Item Perceived Stress Scale, STAI-6 = 6-item State-Trait Anxiety Inventory.

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**Table 3**—Cross-country differences in stress, anxiety, and depression across insomnia groups (unadjusted and adjusted analyses).

	Unadjusted						Adjusted					
	Mean ± SD			ANOVA F			Mean ± SE			ANOVA F		
	Post-Pandemic Insomnia	Pre-existing Insomnia	No Insomnia Symptoms	Insomnia (I)	Country (C)	I × C	Post-Pandemic Insomnia <sup>a</sup>	Pre-existing Insomnia <sup>a</sup>	No Insomnia Symptoms <sup>a</sup>	Insomnia (I)	Country (C)	I × C
Stress				101.32*	14.03*	2.25				135.44*	2.25	1.75
Australia	20.97 ± 6.68	18.98 ± 7.18	14.09 ± 6.91				21.88 ± 0.59	19.21 ± 0.56	14.54 ± 0.91			
UK	21.66 ± 6.73	17.94 ± 7.12	13.90 ± 6.54				22.01 ± 0.52	18.77 ± 0.53	14.72 ± 0.32			
India	21.13 ± 6.11	20.94 ± 7.12	16.51 ± 7.60				21.28 ± 0.82	20.52 ± 0.96	16.43 ± 0.74			
SA	23.03 ± 6.72	23.15 ± 7.24	18.93 ± 7.41				21.28 ± 0.55	21.70 ± 0.68	18.33 ± 1.11			
Ireland	21.53 ± 5.12	18.87 ± 7.03	14.07 ± 6.83				22.04 ± 0.94	19.28 ± 1.14	15.64 ± 1.37			
Other	21.50 ± 6.50	20.36 ± 6.88	15.47 ± 7.09				21.36 ± 0.47	20.00 ± 0.62	15.41 ± 0.70			
Anxiety				97.24*	12.16*	1.59				130.93*	2.25	1.49
Australia	47.58 ± 14.04	41.53 ± 13.37	33.14 ± 11.83				47.61 ± 1.20	42.24 ± 1.12	33.98 ± 1.85			
UK	45.41 ± 13.67	39.59 ± 13.12	32.10 ± 11.07				46.37 ± 1.05	40.95 ± 1.07	33.33 ± 0.66			
India	49.27 ± 15.29	47.85 ± 15.26	35.62 ± 13.11				47.80 ± 1.67	47.42 ± 1.93	35.25 ± 1.50			
SA	48.39 ± 14.18	49.22 ± 15.26	39.67 ± 17.81				45.35 ± 1.11	46.63 ± 1.37	38.23 ± 0.24			
Ireland	44.67 ± 11.36	41.21 ± 15.26	32.69 ± 12.54				45.43 ± 1.90	41.67 ± 2.28	34.36 ± 2.77			
Other	47.51 ± 14.01	44.95 ± 14.28	35.02 ± 14.26				47.58 ± 0.96	44.33 ± 1.26	35.28 ± 1.40			
Depression				142.73*	15.06*	1.60				209.14*	2.34	1.99
Australia	11.49 ± 6.09	9.62 ± 6.07	4.22 ± 4.71				11.56 ± 0.48	9.62 ± 0.45	4.35 ± 0.75			
UK	10.48 ± 6.00	8.74 ± 5.89	3.97 ± 3.89				11.06 ± 0.42	9.49 ± 0.43	4.71 ± 0.27			
India	11.51 ± 5.85	11.13 ± 6.24	5.20 ± 5.34				11.27 ± 0.67	10.37 ± 0.78	4.92 ± 0.61			
SA	12.43 ± 6.09	13.33 ± 6.82	8.18 ± 7.22				11.05 ± 0.45	12.07 ± 0.55	7.76 ± 0.90			
Ireland	10.31 ± 6.03	10.23 ± 5.88	4.11 ± 4.25				10.93 ± 0.77	10.01 ± 0.92	5.31 ± 1.12			
Other	11.49 ± 5.98	9.86 ± 5.75	5.40 ± 5.25				11.37 ± 0.39	9.20 ± 0.51	5.35 ± 0.57			

<sup>a</sup>Adjusted analysis included the covariates age, sex, employment, education, sleep medication use, and finances impacted (OxCGRT not included as a covariate in this analysis). \*P < .01. ANOVA = analysis of variance, OxCGRT = Oxford COVID-19 Government Response Tracker, SA = South Africa, SD = standard deviation, SE = standard error, UK = United Kingdom.

Together, these findings are consistent with pre-pandemic research, indicating that those with insomnia symptoms, either more acute or chronic, are at increased risk of stress, anxiety, depression, and suicidal ideation than those who sleep well.<sup>18–20,24,25,27</sup> Sleeping well may therefore be a protective factor for mental health during the COVID-19 pandemic.

Duration of insomnia symptoms, previous mental health diagnoses, and country of residence were also associated with worse stress and mental health symptoms during the pandemic. Individuals with insomnia symptoms that developed post-pandemic reported higher levels of stress, anxiety, and depression during the early stages of the pandemic than those with pre-existing insomnia symptoms. Also, meeting probable criteria for Acute Insomnia was associated with higher levels of stress, anxiety, and depression than meeting likely criteria for Insomnia Disorder. Additionally, individuals reporting previous mental health condition diagnoses reported more stress, anxiety, and depressive symptoms than those without a diagnosis and this finding was consistent across insomnia groups. Last, small cross-country differences in stress, anxiety, and depression were found across insomnia groups, with individuals from South Africa being the most affected. However, after controlling for age, sex, employment, education, sleep medication use, and the financial impact of the COVID-19 pandemic, these cross-country differences were no longer statistically significant.

Our findings indicate that individuals with post-pandemic insomnia symptoms had significantly worse stress and mental health symptoms than those with pre-existing insomnia symptoms, despite similarities in insomnia severity, presleep arousal, sleep reactivity, and sleep effort. Both of these insomnia groups also reported similar pre-pandemic mental health diagnoses. Our findings support emerging pandemic research that suggests that more-acute insomnia symptoms share a stronger relationship with anxiety and depression during the COVID-19 pandemic than pre-existing insomnia symptoms.<sup>30</sup> One possible explanation is that, unlike individuals with pre-existing insomnia symptoms, those with post-pandemic insomnia symptoms may not have yet developed coping skills to manage poor sleep and are therefore prone to experiencing heightened negative affect. Notably, some participants in the Pre-existing Insomnia Symptoms group reported improvements in sleep during the pandemic ( $n = 98$ ; 12%). Improvement in this group's insomnia symptoms during the pandemic may explain their lower scores on measures of stress, anxiety, and depression. Overall, however, our results suggest the COVID-19 pandemic took a greater toll on mental health for those experiencing post-pandemic insomnia symptoms than for individuals with pre-existing insomnia symptoms. Additional research exploring the factors associated with the development of insomnia symptoms during the pandemic, as well as factors responsible for improving sleep for some individuals with chronic insomnia, is required.

As sleep and mental health share a bidirectional relationship, increases in stress, anxiety, and depressive symptoms during the COVID-19 pandemic may have triggered insomnia symptoms. Notably, individuals across all groups with previously diagnosed mental health conditions reported higher levels of stress, anxiety, and depression than those without a previous diagnosis, consistent with prior research.<sup>58</sup> Difficulty sleeping in times of

stress is natural and possibly adaptive.<sup>40</sup> However, poor sleep, especially for extended periods, can worsen stress tolerance, anxiety, and mood; therefore, poor sleep can precipitate and perpetuate mental health problems.<sup>18–20</sup> While this cross-sectional study cannot determine the direction of causality, it is clear that people experiencing insomnia with and without previous mental health diagnoses had higher levels of stress, anxiety, and depression during the initial phase of the pandemic. Tracking people with insomnia symptoms over time and identifying whether they continue to experience insomnia and mental health challenges as the pandemic progresses would be of benefit.

The study also highlights slight differences in insomnia and mental health differences across countries. For instance, individuals from South Africa showed the highest levels of stress and depression compared with other countries. This was an interesting finding as previous research has suggested that South Africa has a lower prevalence of insomnia symptoms and lifetime depression than other countries.<sup>33,34</sup> Pre-pandemic prevalence estimates of insomnia and depressive symptoms in South Africa may be underestimated. However, it is important to note that differences across countries in mental health and insomnia severity were minimal and reduced after controlling for covariates. Variance in mental health and insomnia scores between countries may reflect different political, societal, economic, health care, and welfare systems, which was beyond the scope of the current study. Also, country-specific stressors and differences in disseminating health information may have played a role in mental health symptoms between countries. Further research should explore the reasons behind the variation in insomnia and mental health symptoms across countries and provide more sleep and mental health resources to countries most affected during the COVID-19 pandemic.

To support mental health during the pandemic, the results of this study indicate that health care providers should assess and potentially manage patients' insomnia. There is strong evidence suggesting that treating insomnia with either in-person or digital Cognitive Behavioral Therapy for Insomnia (CBT-I) improves both sleep and mental health.<sup>60–66</sup> Emerging research during the pandemic has also indicated that previous insomnia treatment using digital CBT-I has been linked to lower insomnia symptoms, stress, and depressive symptoms and greater health resilience during the pandemic.<sup>16</sup> Therefore, treating insomnia, either face-to-face or with digital treatments, may be crucial for improving both sleep and mental health during the COVID-19 pandemic.

### Strengths and limitations

The strengths of this study include the use of a large, global sample from 67 countries. As some countries may be underrepresented by mental health and sleep research, this study provides important insights into the worldwide impact of the COVID-19 pandemic on insomnia and mental health symptoms. Also, this study provides a novel overview of the differences in mental health between individuals who developed insomnia symptoms during the pandemic compared with pre-existing insomnia symptoms. Other studies have mostly reported all insomnia symptomology together and may be missing vital information regarding the relationship between insomnia subtypes and mental health. Also, we recruited participants based on their sleep and insomnia

symptoms, which may have reduced bias in people responding with mental health symptoms. We used the newly developed OxCGRT to control for the impact of different government responses to COVID-19 on insomnia and mental health symptoms. Last, this study was conducted in the early phase of the pandemic, allowing us to continue to follow participants as the pandemic progresses while monitoring sleep and mental health changes.

The limitations of the study include convenience sampling rather than probability sampling methods. As we were not estimating population prevalence, a convenience sample was deemed adequate, although this may lead to potential response bias. As there are currently no validated measures to assess acute insomnia, this study relied on participants' self-report of when insomnia symptoms started and applying the SCI cutoff score for Insomnia Disorder ( $\leq 16$ ), but with less than 3 months of symptom duration. Also, definitions of Acute Insomnia are inconsistent.<sup>39–41,67,68</sup> Future research needs to reach a consensus on the diagnostic criteria for Acute Insomnia and develop validated tools to differentiate Acute Insomnia from Insomnia Disorder. In addition, including participants from an extensive range of countries may have introduced more variability into the sample. However, we only found small differences in insomnia and mental health symptoms between countries, which was reduced even further after controlling for covariates. Last, we do not have pre-pandemic data to refer to in this study. Therefore, we cannot determine cause-effect relationships between sleep and mental health during the pandemic. Tracking insomnia and mental health symptoms longitudinally during the pandemic will shed more light on cause-effect relationships.

## CONCLUSIONS

This study found that post-pandemic insomnia symptoms were associated with the highest levels of stress, anxiety, and depression during the COVID-19 pandemic, compared with pre-existing insomnia symptoms or no insomnia symptoms. Pre-existing insomnia symptoms were also associated with higher stress, anxiety, and depressive symptoms than no insomnia symptoms. This pattern of results was observed for both individuals with and without a previous mental health condition diagnosis, with only small differences between countries found. Thus, internationally, post-pandemic insomnia symptoms may indicate poorer mental health during the COVID-19 pandemic. This may be particularly true for individuals who meet likely criteria for Acute Insomnia or who had a previous mental health condition diagnosis. Accordingly, related public health initiatives should include targeting sleep issues with in-person or online CBT-I treatment to improve sleep and mental health outcomes.

## ABBREVIATIONS

COVID-19, coronavirus disease 2019  
OxCGRT, Oxford COVID-19 Government Response Tracker  
PHQ-9, 9-item Patient Health Questionnaire  
PSAS, Pre-Sleep Arousal Scale

PSS-10, Perceived Stress Scale  
SCI, Sleep Condition Indicator

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## ACKNOWLEDGMENTS

The authors thank the participants for the time and energy they have given to participate in this study during this challenging time. The authors thank Tony Cunningham, who inspired us to undertake this sleep research project at the beginning of the pandemic. The authors thank those who assisted with participant recruitment, including Dr David Cunnington, Dr Julia Stone, and Ms Helen Burdette. They also

thank their family and friends, who shared study advertisements on social media, and Stephen Ghosh and Shelley Webb, who assisted with data cleaning and coding. The also thank A/Prof Sean W. Cain, Prof David J. Berlowitz, and Dr Bei who provided feedback and valuable advice on this project.

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## SUBMISSION & CORRESPONDENCE INFORMATION

**Submitted for publication December 24, 2020**

**Submitted in final revised form April 14, 2021**

**Accepted for publication April 15, 2021**

## DISCLOSURE STATEMENT

All authors have seen and approved the manuscript. Work for this study was performed at the School of Psychological Sciences, Monash University. The authors report no conflicts of interest.