Received: 28 April 2021 | Revised: 12 July 2021 | Accepted: 14 July 2021

DOI: 10.1111/jsr.13450

Journal of Sleep Research

SHORT REPORT

# New-onset and exacerbated insomnia symptoms during the COVID-19 pandemic in US military veterans: A nationally representative, prospective cohort study

Elissa McCarthy[1] | Jason C. DeViva[2,3] | Peter J. Na[3] | Robert H. Pietrzak[2,3,4,5]

[1]US Department of Veterans Affairs National Center for PTSD, White River Junction, VT, USA

[2]Veterans Affairs Connecticut Health Care System, West Haven, CT, USA

[3]Department of Psychiatry, Yale School of Medicine, New Haven, CT, USA

[4]US Department of Veterans Affairs National Center for PTSD, VA Connecticut Healthcare System, West Haven, CT, USA

[5]Department of Social and Behavioral Sciences, Yale School of Public Health, New Haven, CT, USA

**Correspondence**
Elissa McCarthy, National Center for PTSD, VA Medical Center (116D), 215 North Main St White River Junction, VT 05009, USA.
Email: elissa.mccarthy@va.gov

## Summary

The COVID-19 pandemic has had a negative impact on physical and mental health worldwide. While pandemic-related stress has also been linked to increased insomnia, scarce research has examined this association in nationally representative samples of high-risk populations, such as military veterans. We evaluated pre- and pandemic-related factors associated with new-onset and exacerbated insomnia symptoms in a nationally representative sample of 3,078 US military veterans who participated in the National Health and Resilience in Veterans Study. Veterans were surveyed in the USA in 11/2019 (pre-pandemic) and again in 11/2020 (peri-pandemic). The Insomnia Severity Index was used to assess severity of insomnia symptoms at the pre- and peri-pandemic assessments. Among veterans without clinical or subthreshold insomnia symptoms pre-pandemic ($n$ = 2,548), 11.5% developed subthreshold (10.9%) or clinical insomnia symptoms (0.6%) during the pandemic; among those with subthreshold insomnia symptoms pre-pandemic ($n$ = 1,058; 26.0%), 8.0% developed clinical insomnia symptoms. Pre-pandemic social support (21.9% relative variance explained), pandemic-related stress related to changes in family relationships (20.5% relative variance explained), pre-pandemic chest pain (18.5% relative variance explained) and weakness (11.1% relative variance explained), and posttraumatic stress disorder (8.2% relative variance explained) explained the majority of the variance in new-onset subthreshold or clinical insomnia symptoms during the pandemic. Among veterans with pre-pandemic subthreshold insomnia, pandemic-related home isolation restrictions (59.1% relative variance explained) and financial difficulties (25.1% relative variance explained) explained the majority of variance in incident clinical insomnia symptoms. Taken together, the results of this study suggest that nearly one in five US veterans developed new-onset or exacerbated insomnia symptoms during the pandemic, and identify potential targets for prevention and treatment efforts.

KEYWORDS
COVID-19, insomnia symptoms, mental health, pandemic, veteran

## 1 | INTRODUCTION

One of the most common models of the development of insomnia (Spielman, Caruso, & Glovinsky, 1987) posits that precipitating factors, which include psychosocial stressors, changes in health or changes in routine, interact with predisposing factors (e.g. gender, arousal tendency) to insomnia to create short-term sleep problems that may persist over time. The COVID-19 pandemic could serve as a precipitant for insomnia symptoms in multiple ways (e.g. increased distress, changes in health or daily routine), and research has indicated that the pandemic period has been associated with increased incidence of insomnia (Killgore et al., 2020; Wu et al., 2021; Yuksel et al., 2021). Poorer pandemic sleep has been associated with female gender, employment, family responsibilities, chronic illness, consuming > 6 alcoholic beverages per week, higher stress levels, younger age, adverse changes in livelihood, and higher levels of stress (Killgore et al., 2020; Mandelkorn et al., 2021; Yuksel et al., 2021).

A recent meta-analysis found a higher prevalence of mental health problems during the pandemic, including insomnia (Wu et al., 2021). Individuals with insomnia symptoms before or after the pandemic may have increased stress, anxiety and depressive symptoms during the pandemic than those with no insomnia symptoms (Meaklim, Junge, Varma, Finck, & Jackson, 2021). A survey of the US adult population ($N$ = 1,013) during the pandemic revealed elevated rates of insomnia (subthreshold 30.6%; moderate range 19.8%; severe range 5.2%; Killgore et al., 2020). Further, a national survey ($N$ = 1,116) in China found that the COVID-19 pandemic was associated with increased prevalence of subthreshold and threshold insomnia symptoms relative to pre-pandemic rates (31.5% versus 24.8%, respectively; Sun, Qin, Basta, Chen, & Li, 2021). A second population-based survey in China ($N$ = 56,679) found that 23.5% ($N$ = 13,308) of participants had subthreshold insomnia symptoms, and 5.7% ($N$ = 3,256) had moderate/severe insomnia symptoms during the pandemic (Shi et al., 2020).

Military veterans are more likely than the general adult population to develop insomnia (Byrne, McCarthy, DeViva, Southwick, & Pietrzak, 2021). Given this increased predisposition, veterans may therefore be more likely to develop insomnia in response to a highly stressful precipitating event such as the COVID-19 pandemic. As insomnia symptoms are associated with an array of negative outcomes among veterans (Byrne et al., 2021; Department of Veterans Affairs & Department of Defense, 2019), determining whether the COVID-19 pandemic is associated with changes in the incidence of clinically significant insomnia symptoms has important implications for clinical practice and intervention strategies specific to this population.

Using data from a contemporary, nationally representative sample of US veterans, the purpose of the current study was twofold: (1) identify changes in the prevalence of clinical and subthreshold insomnia symptoms during the pandemic; and (2) evaluate pre- and peri-pandemic factors associated with new-onset and exacerbated insomnia symptoms in this population. Given the broad range of factors linked to insomnia (Killgore et al., 2020; Mandelkorn et al., 2021; Yuksel et al., 2021), we explored how a comprehensive array of pre- and peri-pandemic risk and protective factors related to new-onset and exacerbated insomnia symptoms. In addition, given the high prevalence of posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) in veterans (Armenta et al., 2019), as well as a strong association between these disorders and insomnia (Britton, McKinney, Bishop, Pigeon, & Hirsch, 2019), we additionally considered how these pre-existing psychiatric morbidities might influence pandemic-related changes in insomnia symptoms.

## 2 | METHODS

### 2.1 | Participants

Data were analysed from the 2019–2020 National Health and Resilience in Veterans Study (NHRVS), which surveyed a nationally representative sample of 4,069 US military veterans. Prior to the pandemic, a survey was conducted to assess the mental health of this population. This survey was fielded prior to the first documented cases of COVID-19 infection in China, and ended before the first documented COVID-19 case and implementation of COVID-19-related lockdowns in the USA (median completion date: 11/21/19). Peri-pandemic data were collected from 3,078 veterans (75.6% of the original sample) approximately 1 year later, during the 2020 fall and winter surge of COVID-19 cases (median completion date: 11/14/2020). Recruitment and sample details of the 2019–2020 NHRVS have been reported previously (Hill, Nichter, Loflin, Norman, & Pietrzak, 2021). Briefly, the sample was drawn from KnowledgePanel®, a survey research panel of more than 50,000 households maintained by Ipsos. Ipsos statisticians computed post-stratification weights to permit generalizability of results to the US veteran population using benchmark distributions from the Veterans Supplement of the most contemporaneous US Census Current Population Survey (U.S. Census Bureau, 2019). All participants provided informed consent. The study was approved by the Human Subjects Committee of the VA Connecticut Healthcare System, and carried out in accordance with the Declaration of Helsinki.

### 2.2 | Assessments

#### 2.2.1 | Insomnia symptoms

The Insomnia Severity Index (ISI; Morin, Belleville, Bélanger, & Ivers, 2011) was used to assess the severity of insomnia symptoms. The ISI is a 7-item self-report questionnaire that assesses the nature, severity and impact of insomnia over the past 2 weeks (Cronbach's $\alpha$ = 0.89 and 0.88 at pre- and peri-pandemic assessments, respectively). Total scores on the ISI range from 0 to 28, with scores of 0–7 indicative of no clinically significant insomnia symptoms; 8–14 subthreshold insomnia symptoms; 15–21 clinical

insomnia (moderate severity) symptoms; and 22–28 clinical insomnia (severe) symptoms. At both assessments in the current study, veterans were classified on the basis of total ISI scores into the following groups: no insomnia symptoms (score of 0–7); subthreshold insomnia symptoms (score of 8–14); and clinical insomnia symptoms (score of 15–28). For the purposes of this study, scores of 15 or higher were collapsed into a single clinical insomnia category, as this score threshold has been recommended for epidemiological studies (Morin et al., 2011).

#### 2.2.2 | Independent variables

Table 1 describes pre-pandemic and peri-pandemic factors that were examined in relation to new-onset and exacerbated insomnia.

### 2.3 | Data analysis

Data analyses proceeded in five steps. First, we computed descriptive statistics to identify the incidence of new-onset and exacerbated insomnia symptoms over the 1-year study period. Second, we conducted chi-squares and independent-samples *t*-tests to compare pre- and peri-pandemic factors in: (1) veterans with new-onset insomnia symptoms versus veterans without insomnia symptoms at both assessments; and (2) veterans with subthreshold insomnia symptoms at the pre-pandemic assessment who did and did not develop clinical insomnia symptoms at the peri-pandemic assessment. These analyses were used to help guide variable selection for the multivariable models. Third, we conducted two multivariable binary logistic regression analyses to identify pre-pandemic risk factors and peri-pandemic correlates associated with new-onset and exacerbated insomnia. Variables that differed by group at the $p < 0.05$ level in bivariate analyses were entered into these analyses. Fourth, planned post hoc analyses of composite variables (e.g. protective psychosocial characteristics) were conducted to identify specific aspects of these variables that were associated with new-onset and exacerbated insomnia symptoms; $\alpha$ was set to 0.01 in these analyses to reduce the likelihood of Type I error. Fifth, relative importance analyses were conducted to identify relative variance in new-onset and exacerbated insomnia symptoms explained by each significant variable identified in multivariable analyses.

## 3 | RESULTS

Among veterans without insomnia symptoms pre-pandemic ($n$ = 2,548), 11.5% developed subthreshold (10.9%) or clinical (0.6%) insomnia symptoms during the pandemic (these groups were combined for subsequent analyses due to the low incidence of clinical insomnia symptoms). Among veterans with subthreshold insomnia symptoms pre-pandemic ($n$ = 1,058; 26.0%), 8.0% developed clinical insomnia symptoms during the pandemic.

### 3.1 | Predictors of incident subthreshold/clinical insomnia symptoms in veterans without insomnia symptoms

Table 2 shows results of bivariate and multivariable analyses of pre- and peri-pandemic factors associated with new-onset insomnia symptoms. Results of a multivariable analysis revealed that greater adverse childhood experiences (ACEs), and pre-pandemic PTSD, somatic symptoms, disability in activities of daily living/instrumental activities of daily living (ADL/IADL), and lower social connectedness, as well as COVID-19 infection, and COVID-19-related social restriction stress and relationship difficulties were independently associated with the development of subthreshold or clinical insomnia symptoms during the pandemic.

Planned post hoc analyses revealed that physical abuse during childhood (odds ratio [OR] = 1.78, 95% confidence interval [CI] = 1.18–2.70), greater pre-pandemic chest pain (OR = 1.67, 95% CI = 1.20–2.34) and weakness (OR = 1.34, 95% CI = 1.10–1.64), lower perceived social support (OR = 0.95, 95% CI = 0.92–0.99), and greater pandemic-related stress related to changes in family relationships (OR = 1.42, 95% CI = 1.19–1.70) and changes in relationships with others (OR = 1.17, 95% CI = 1.06–1.30) were associated with this outcome.

Relative importance analyses indicated that pre-pandemic social support (21.9%), pandemic-related stress related to changes in family relationships (20.5%), pre-pandemic chest pain (18.5%), weakness (11.1%) and PTSD (8.2%) explained the majority of the variance in incident subthreshold or clinical insomnia symptoms, with pre-pandemic ADL/IADL disability (7.5%), childhood physical abuse (5.6%), pandemic-related changes in relationships with others (4.6%) and COVID-19 infection (2.1%) accounting for the remaining variance in this outcome.

### 3.2 | Predictors of incident clinical insomnia symptoms among veterans with subthreshold insomnia symptoms

Table 3 shows results of bivariate and multivariable analyses of pre-pandemic risk factors and peri-pandemic correlates of exacerbated insomnia symptoms in veterans with subthreshold insomnia symptoms at the pre-pandemic assessment. Results of a multivariable analysis revealed that greater ACEs and pandemic-related social restriction and financial stress were independently associated with incident clinical insomnia symptoms.

Planned post hoc analyses revealed that having a household member with mental illness or who attempted suicide during childhood (OR = 2.69, 1.40–5.16); pandemic-related stress related to home isolation restrictions (OR = 1.49, 95% CI = 1.09–2.04); and pandemic-related financial difficulties (OR = 1.51, 95% CI = 1.14–1.98) were associated with incident clinical insomnia symptoms.

Relative importance analyses indicated that pandemic-related home isolation restrictions explained the majority of variance in

**TABLE 1** Measures of psychiatric, sociodemographic, military and psychosocial variables, and COVID-19 infection and pandemic stressors

| | |
|---|---|
| Sociodemographic characteristics | Age (continuous), sex (male, female), race/ethnicity (white, non-white), education (college graduate or higher, up to high school diploma), marital status (married/living with partner, not), household income ($60,000 or more, less than $60,000), retirement status (retired, not), combat veteran status |
| Pre-pandemic risk factors | |
| ACEs | Adverse Childhood Experiences Questionnaire score (ACEQ; Finkelhor, Shattuck, Turner, & Hamby, 2015) |
| Total traumas | Total count of potentially traumatic events endorsed on Life Events Checklist for DSM-5 (LEC-5; Weathers, Blake, et al., 2013) |
| Lifetime MDD | Lifetime MDD was assessed according to DSM-5 diagnostic criteria using a modified self-report version of the MINI (Sheehan, 2016) |
| Lifetime PTSD | Lifetime PTSD was defined as a score of 33+ (Bovin et al., 2016) on the PCL-5 (Weathers, Litz, et al., 2013), which was modified to include lifetime ratings of all PTSD symptoms in relation to veterans' self-reported "worst" Criterion A trauma on the LEC-5 (Weathers, Blake, et al., 2013) |
| Lifetime AUD | Lifetime AUD was defined as meeting DSM-5 diagnostic criteria for AUD using a modified self-report version of the MINI (Sheehan, 2016) |
| Lifetime DUD | Lifetime DUD was defined as meeting DSM-5 diagnostic criteria for AUD using a modified self-report version of the MINI (Sheehan, 2016) |
| Loneliness | Score on 3-item measure adapted from the UCLA Loneliness Scale (Hughes, Waite, Hawkley, & Cacioppo, 2004) |
| Number of medical conditions | Sum of number of medical conditions endorsed in response to question: "Has a doctor or healthcare professional ever told you that you have any of the following medical conditions?" (e.g. arthritis, cancer, diabetes, heart disease, asthma, kidney disease); range: 0–24 conditions |
| Somatic symptoms | Score on Somatization Subscale of the Brief Symptom Inventory-18 (Derogatis, 2000) |
| Disability in any ADL/IADL | Any disability in ADL. The following question was asked: "At the present time, do you need help from another person to do the following?" (e.g. bathe; walk around your home or apartment; get in and out of the chair) Endorsement of any of these activities was indicative of having a disability with an ADL (Hardy & Gill, 2004) |
| Pre-pandemic psychosocial protective factors | |
| Protective psychosocial characteristics | Factor score using the following six indicators: score on Purpose in Life Test-Short Form (Schulenberg, Schnetzer, & Buchanan, 2011); score on Connor-Davidson Resilience Scale-10 (Campbell-Sills & Stein, 2007); rating (1 = strongly disagree to 7 = strongly agree) on single-item measure of optimism from Life Orientation Test-Revised ("In uncertain times, I usually expect the best"; Scheier, Carver, & Bridges, 1994); rating (1 = strongly disagree to 7 = strongly agree) on single-item measure of gratitude from Gratitude Questionnaire ("I have so much in life to be thankful for"; McCullough, Emmons, & Tsang, 2002); rating (1 = strongly disagree to 7 = strongly agree) on single-item measure of curiosity/exploration from Curiosity and Exploration Inventory-II ("I frequently find myself looking for new opportunities to grow as a person"; Kashdan et al., 2009); rating (1 = strongly disagree to 7 = strongly agree) on single item measuring perceived level of community integration ("I feel well integrated in my community") |
| Social connectedness | Factor score using the following three measures as indicators: score on 5-item Medical Outcomes Study Social Support Scale (Sherbourne & Stewart, 1991); size of social network as assessed by the question, "About how many close friends and relatives do you have (people you feel at ease with and can talk to about what is on your mind)?"; secure attachment style as measured by the Attachment Style Questionnaire (ASQ; Hazan & Shaver, 1987) |
| COVID-19 infection stressors | COVID-19 infection status (endorsement of: self-infected, know someone in household who was infected, know someone not in household who was infected, and know someone who died of COVID-19) was assessed using the Assessment of Exposure to COVID-19 scale developed by the National Center for PTSD |
| COVID-19 pandemic stressors | Questions from the Coronavirus Health Impact Survey (National Institute of Mental Health, 2020) were used to assess COVID-19-associated media consumption, and worries and concerns at the peri-pandemic assessment<br>Factor analysis revealed that these items loaded on five factors (eigenvalues = 1.01–4.94): COVID-19-related disease worries (e.g. "In the past month, how worried have you been about being infected with coronavirus?"); COVID-19 social restriction stress (e.g. "How stressful have these changes in social contacts been for you?"); COVID-19-associated socioeconomic stress (e.g. "In the past month, to what degree have changes associated to the pandemic created financial problems for you or your family?"); COVID-19-associated relationship difficulties (e.g. "Has the quality of the relationships between you and members of your family changed?"); and COVID-19-associated social engagement (e.g. "In the past month, how many people, from outside of your household, have you had an in-person conversation with?") |

ACEs, adverse childhood experiences; ADL, activities of daily living; AUD, alcohol use disorder; COVID-19, coronavirus disease 2019; DSM-5, Diagnostic and Statistical Manual of Mental Disorders, 5th edition; DUD, drug use disorder; IADL, instrumental activities of daily living; MDD, major depressive disorder; MINI, Mini Neuropsychiatric Interview; PTSD, posttraumatic stress disorder; UCLA, University of California, Los Angeles; VA, Veterans Affairs.

**TABLE 2** Sociodemographic, pre-pandemic risk factors, and peri-pandemic correlates of incident subthreshold or clinical insomnia symptoms in US military veterans

| | No insomnia symptoms *N* = 1,805 (88.5%) | Incident subthreshold or clinical insomnia symptoms *N* = 222 (11.5%) | Bivariate analyses | | Multivariable analysis |
|---|---|---|---|---|---|
| | *N* (weighted %) or weighted mean (SD) | *N* (weighted %) or weighted mean (SD) | Test of difference | *p* | OR (95% CI) |
| Sociodemographic variables | | | | | |
| Age | 65.9 (13.9) | 64.6 (14.0) | 1.32 | 0.19 | – |
| Male gender | 1,644 (93.2%) | 193 (90.4%) | 2.36 | 0.12 | – |
| White race/ethnicity | 1,531 (81.4%) | 191 (83.0%) | 0.32 | 0.57 | – |
| College graduate or higher education | 854 (33.8%) | 91 (31.2%) | 0.57 | 0.45 | – |
| Married/partnered | 1,347 (75.9%) | 165 (80.8%) | 2.58 | 0.11 | – |
| Household income $60K or higher | 1,120 (62.1%) | 137 (64.2%) | 0.38 | 0.54 | – |
| Retired | 1,069 (51.0%) | 113 (47.9%) | 0.71 | 0.40 | – |
| Combat veteran | 561 (30.5%) | 58 (27.5%) | 0.84 | 0.36 | – |
| Pre-pandemic risk factors | | | | | |
| ACEs | 1.0 (1.5) | 1.7 (2.1) | 5.66 | < 0.001 | 1.14 (1.04–1.24)** |
| Total traumas | 7.3 (6.8) | 8.7 (9.2) | 2.80 | 0.005 | 1.00 (0.98–1.03) |
| Lifetime MDD | 109 (5.7%) | 32 (16.4%) | 33.63 | < 0.001 | 1.65 (1.00–2.74) |
| Lifetime PTSD | 43 (2.2%) | 21 (11.6%) | 53.79 | < 0.001 | 2.47 (1.31–4.67)** |
| Lifetime AUD | 608 (34.2%) | 92 (46.9%) | 13.36 | < 0.001 | 1.11 (0.79–1.56) |
| Lifetime DUD | 115 (6.6%) | 29 (13.7%) | 14.34 | < 0.001 | 1.39 (0.84–2.31) |
| Loneliness | 4.0 (1.5) | 4.7 (1.8) | 5.90 | < 0.001 | 1.03 (0.91–1.17) |
| Number of medical conditions | 2.5 (1.9) | 3.1 (2.0) | 4.45 | < 0.001 | 1.06 (0.97–1.15) |
| Somatic symptoms | 1.7 (2.2) | 3.1 (2.8) | 8.17 | < 0.001 | 1.13 (1.07–1.20)*** |
| Any ADL and/or IADL disability | 124 (7.2%) | 33 (16.1%) | 20.26 | < 0.001 | 1.85 (1.13–3.04)* |
| Pre-pandemic psychosocial protective factors | | | | | |
| Protective psychosocial characteristics | 0.3 (0.8) | 0.0 (0.9) | 5.54 | < 0.001 | 0.88 (0.71–1.09) |
| Social connectedness | 0.3 (0.9) | −0.1 (0.9) | 4.81 | < 0.001 | 0.74 (0.62–0.88)** |
| COVID-19 infection stressors | | | | | |
| Infected with COVID-19 | 112 (6.0%) | 22 (13.6%) | 16.73 | < 0.001 | 1.99 (1.21–3.27)** |
| Someone in household infected with COVID-19 | 87 (5.3%) | 20 (9.8%) | 7.16 | 0.007 | 0.99 (0.47–2.07) |

(Continues)

TABLE 2 (Continued)

| | No insomnia symptoms $N = 1,805$ (88.5%) | Incident subthreshold or clinical insomnia symptoms $N = 222$ (11.5%) | Bivariate analyses | | Multivariable analysis |
|---|---|---|---|---|---|
| | *N* (weighted %) or weighted mean (SD) | *N* (weighted %) or weighted mean (SD) | Test of difference | *p* | OR (95% CI) |
| Know someone infected with COVID-19 | 697 (37.2%) | 91 (44.1%) | 3.81 | 0.051 | – |
| Know someone who died of COVID-19 | 87 (4.6%) | 9 (3.2%) | 0.90 | 0.34 | – |
| COVID-19 pandemic stressors | | | | | |
| COVID-19-related disease worries | −0.1 (1.0) | 0.2 (1.0) | 3.87 | < 0.001 | 1.16 (0.99–1.35) |
| COVID-19-related social restriction stress | −0.1 (0.9) | 0.1 (0.9) | 3.01 | 0.003 | 1.24 (1.06–1.46)** |
| COVID-19-related financial stress | −0.1 (0.8) | −0.1 (1.2) | 4.01 | < 0.001 | 1.13 (0.96–1.32) |
| COVID-19-related relationship difficulties | 0.0 (0.9) | 0.2 (0.9) | 3.96 | < 0.001 | 1.25 (1.06–1.47)** |
| Hours of COVID-19-related media per week | 1.5 (2.1) | 1.5 (1.7) | 0.04 | 0.97 | – |
| Positive screen for COVID-19-related PTSD | 155 (8.8%) | 32 (11.0%) | 1.06 | 0.30 | – |

Significant association: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

ACEs, adverse childhood experiences; ADL, activity of daily living; AUD, alcohol use disorder; CI, confidence interval; DUD, drug use disorder; IADL, instrumental activity of daily living; MDD, major depressive disorder; OR, odds ratio; PTSD, posttraumatic stress disorder.

**TABLE 3** Sociodemographic, pre-pandemic risk factors and peri-pandemic correlates of incident clinical insomnia symptoms among US military veterans with pre-pandemic subthreshold insomnia symptoms

| | No incident clinical insomnia symptoms *N* = 692 (92.0%) | Incident clinical insomnia symptoms *N* = 62 (8.0%) | Bivariate analyses | | Multivariable analysis |
|---|---|---|---|---|---|
| | *N* (weighted %) or weighted mean (SD) | *N* (weighted %) or weighted mean (SD) | Test of difference | *p* | OR (95% CI) |
| Sociodemographic variables | | | | | |
| Age | 61.0 (15.0) | 54.9 (13.8) | 3.06 | 0.002 | 0.98 (0.96–1.00) |
| Male gender | 606 (91.1%) | 50 (88.7%) | 0.41 | 0.52 | – |
| White race/ethnicity | 563 (78.8%) | 50 (74.2%) | 0.70 | 0.40 | – |
| College graduate or higher education | 315 (35.2%) | 30 (40.3%) | 0.66 | 0.42 | – |
| Married/partnered | 474 (71.9%) | 46 (79.0%) | 1.46 | 0.23 | – |
| Household income $60K or higher | 398 (58.5%) | 35 (58.1%) | 0.01 | 0.95 | – |
| Retired | 385 (43.0%) | 31 (37.1%) | 0.82 | 0.36 | – |
| Combat veteran | 279 (43.7%) | 22 (42.6%) | 0.03 | 0.87 | – |
| Pre-pandemic risk factors | | | | | |
| ACEs | 1.7 (2.1) | 2.8 (2.5) | 3.85 | < 0.001 | 1.16 (1.24–2.09)* |
| Total traumas | 11.3 (9.9) | 10.6 (9.1) | 0.56 | 0.58 | – |
| Lifetime MDD | 138 (20.1%) | 17 (24.6%) | 0.70 | 0.40 | – |
| Lifetime PTSD | 86 (12.8%) | 17 (29.1%) | 11.28 | 0.001 | 0.92 (0.43–1.98) |
| Lifetime AUD | 308 (47.0%) | 31 (50.8%) | 0.33 | 0.56 | – |
| Lifetime DUD | 113 (18.0%) | 13 (23.0%) | 0.92 | 0.34 | – |
| Loneliness | 5.0 (1.8) | 5.7 (2.1) | 2.84 | 0.005 | 1.02 (0.85–1.23) |
| Number of medical conditions | 3.4 (2.1) | 3.9 (2.5) | 1.66 | 0.097 | – |
| Somatic symptoms | 3.7 (3.2) | 4.2 (2.8) | 1.34 | 0.18 | – |
| Any ADL and/or IADL disability | 105 (13.9%) | 12 (18.0%) | 0.78 | 0.38 | – |
| Pre-pandemic psychosocial protective factors | | | | | |
| Protective psychosocial characteristics | −0.2 (1.0) | −0.5 (0.9) | 2.14 | 0.033 | |
| Social connectedness | −0.2 (1.0) | −0.3 (0.8) | 0.42 | 0.67 | – |
| COVID-19 infection stressors | | | | | |
| Infected with COVID-19 | 57 (8.7%) | 7 (11.3%) | 0.46 | 0.50 | – |
| Someone in household infected with COVID-19 | 53 (10.3%) | 3 (4.9%) | 1.84 | 0.17 | – |
| Know someone infected with COVID-19 | 317 (46.6%) | 32 (50.0%) | 0.26 | 0.61 | – |

(Continues)

TABLE 3 (Continued)

| | No incident clinical insomnia symptoms $N = 692$ (92.0%) | Incident clinical insomnia symptoms $N = 62$ (8.0%) | Bivariate analyses | | Multivariable analysis |
|---|---|---|---|---|---|
| | *N* (weighted %) or weighted mean (SD) | *N* (weighted %) or weighted mean (SD) | Test of difference | *p* | OR (95% CI) |
| Know someone who died of COVID-19 | 44 (6.2%) | 5 (8.1%) | 0.34 | 0.56 | – |
| COVID-19 pandemic stressors | | | | | |
| COVID-19-related disease worries | 0.1 (0.9) | 0.1 (0.9) | 0.47 | 0.64 | – |
| COVID-19-related social restriction stress | 0.1 (1.0) | 0.6 (1.1) | 3.88 | < 0.001 | 1.61 (1.24–2.09)*** |
| COVID-19-related financial stress | 0.0 (1.0) | 0.8 (1.5) | 5.52 | < 0.001 | 1.47 (1.19–1.82)*** |
| COVID-19-related relationship difficulties | 0.0 (1.1) | 0.1 (0.9) | 0.63 | 0.53 | – |
| Hours of COVID-19-related media per week | 1.6 (2.0) | 1.8 (2.1) | 0.41 | 0.68 | – |
| Positive screen for COVID-19-related PTSD | 99 (14.0%) | 20 (37.1%) | 22.78 | < 0.001 | 1.76 (0.86–3.60) |

Significant association: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

ACEs, adverse childhood experiences; ADL, activity of daily living; AUD, alcohol use disorder; CI, confidence interval; DUD, drug use disorder; IADL, instrumental activity of daily living; MDD, major depressive disorder; OR, odds ratio; PTSD, posttraumatic stress disorder.

incident clinical insomnia symptoms (59.1%), with pandemic-related financial difficulties (25.1%) and having a household member with mental illness or who attempted suicide during childhood (15.7%) explaining the remaining variance.

## 4 | DISCUSSION

Results of this nationally representative prospective cohort study indicate that nearly one in five US veterans developed new-onset or exacerbated insomnia symptoms during the pandemic, suggesting that the pandemic may have negatively impacted sleep in a significant proportion of US veterans, and underscoring the importance of assessing, monitoring and treating insomnia symptoms in the midst of this ongoing public health crisis.

Results of the current study are generally consistent with previous research identifying family dynamics, changes in activities/routines and financial/employment difficulties as related to sleep difficulties during the COVID-19 pandemic (Mandelkorn et al., 2021; Robillard et al., 2021; Yuksel et al., 2021). Specifically, our results revealed that lower pre-pandemic social connectedness and greater pandemic-related stress due to changes in family relationships were most strongly associated with the development of subthreshold or clinical insomnia symptoms during the pandemic. Somatic symptoms such as chest pain and weakness and pre-existing PTSD also emerged as significant predictors of new-onset insomnia symptoms. These findings are consistent with prior work suggesting a link between somatic symptoms, trauma and insomnia symptoms (Astill Wright et al., 2021), and suggest that veterans with pre-existing physical and mental health difficulties may be at increased risk for developing sleep difficulties during the pandemic.

Pandemic-related home isolation restrictions were most strongly associated with the development of clinical insomnia symptoms among veterans with subthreshold insomnia symptoms at the pre-pandemic assessment. Home isolation can limit activities, disrupt healthy schedules and increase unhealthy compensatory behaviours (e.g. sedentary activities, alcohol consumption), thus increasing risk for the development of insomnia symptoms (Mandelkorn et al., 2021; Robillard et al., 2021). Pandemic-related financial stress and having a family member with history of mental illness who may be more vulnerable to the negative impact of the pandemic (Yao, Chen, & Xu, 2020) could both function as additional sources of stress, which could in turn disrupt sleep (Mandelkorn et al., 2021; Robillard et al., 2021, Yuksel et al., 2021).

The current study has some noteworthy limitations. The NHRVS is a large epidemiological study and relied on self-report

questionnaires as opposed to structured clinical interviews. We also administered the ISI, which is not a diagnostic tool, to identify levels of insomnia symptoms. The use of a subjective sleep self-report instrument of insomnia symptoms also does not provide information about the specific nature of insomnia (e.g. initial, middle, late insomnia), and limits the ability to determine which specific aspects of sleep to target to improve insomnia symptoms among military veterans. Further, additional unmeasured sleep-related variables (e.g. frontline employees working longer shifts that led to changes in sleep–wake schedules; increased exposure to activating blue wavelength light with increased screen time for employment, education or assisting children with virtual learning; changes in cues for circadian sleep–wake rhythms, possibly including decreased morning light exposure and increased sedentary activities; decreased physical activity; increased opportunity for napping, which could decrease the drive for nighttime sleep) may have also contributed to insomnia symptoms. Additionally, the study design does not permit us to determine if new-onset or exacerbated insomnia symptoms are distinctly attributable to the pandemic (i.e. it is possible that the observed incidence of insomnia symptoms simply reflect normative fluctuations or incidence rates) or whether the results are specific to veterans. Further research using structured interviews and diagnostic assessments of insomnia-related disorders is needed to extend these results in veterans and other at-risk populations.

## 5 | CONCLUSIONS

The current study provides the first known population-based data on pre-to-peri-pandemic changes in insomnia symptoms in US military veterans. Results suggest that prevention and treatment efforts that target specific risk factors/subpopulations (e.g. low social connectedness, pre-existing physical and mental health issues), and that address pandemic-related social and financial stressors may help mitigate risk for the development or exacerbation of insomnia symptoms. Consistent with one of the most well-known models of insomnia development (Spielman et al., 1987), veterans have increased predisposing factors for insomnia, as well as a potential precipitating factor—pandemic-related stressors—that may collectively increase risk for the development of chronic insomnia symptoms. Sleep-related clinical practice guidelines (Department of Veterans Affairs & Department of Defense, 2019; Edinger et al., 2021) recommend cognitive behavioural therapy for insomnia as the gold-standard treatment for clinical insomnia. They further suggest that interventions to mitigate subthreshold insomnia, which can be delivered via telemedicine, may help prevent the development of more chronic and disabling sleep difficulties. Further research is needed to evaluate the efficacy of such interventions, as well as novel approaches such as the "Insomnia Coach" mobile app (https://www.ptsd.va.gov/appvid/mobile/insomnia_coach.asp), "COVID Coach" mobile app (https://www.ptsd.va.gov/appvid/mobile/COVID_coach_app.asp), "Path to Better Sleep" (Greene, Ulmer, Farrell-Carnahan, & Mackintosh, 2017) and other technology-based interventions, in mitigating insomnia symptoms in veterans and other populations whose sleep has been adversely impacted by the pandemic.

### CONFLICT OF INTEREST

Elissa McCarthy: no conflict of interest. Jason DeViva: no conflict of interest. Peter J. Na: no conflict of interest. Robert Pietrzak: no conflict of interest.

### AUTHOR CONTRIBUTION

Elissa McCarthy: writing – original draft. Jason DeViva: writing – review and editing. Peter J. Na: writing – review and editing. Robert Pietrzak: writing – review and editing.

### DATA AVAILABILITY STATEMENT

Data available on request from the authors.

### ORCID

*Elissa McCarthy* https://orcid.org/0000-0003-3022-0509

### REFERENCES

Armenta, R. F., Walter, K. H., Geronimo-Hara, T. R., Porter, B., Stander, V. A., & LeardMann, C. A. (2019). Longitudinal trajectories of comorbid PTSD and depression symptoms among U.S. service members and veterans. *BMC Psychiatry*, *19*(1), 396. https://doi.org/10.1186/s12888-019-2375-1

Astill Wright, L., Roberts, N. P., Barawi, K., Simon, N., Zammit, S., McElroy, E., & Bisson, J. I. (2021). Disturbed sleep connects symptoms of posttraumatic stress disorder and somatization: A Network Analysis Approach. *Journal of Traumatic Stress*, *34*(2), 375–383. https://doi.org/10.1002/jts.22619

Bovin, M. J., Marx, B. P., Weathers, F. W., Gallagher, M. W., Rodriguez, P., Schnurr, P. P., & Keane, T. M. (2016). Psychometric properties of the PTSD Checklist for Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition (PCL-5) in veterans. *Psychological Assessment*, *28*(11), 1379–1391. https://doi.org/10.1037/pas0000254

Britton, P. C., McKinney, J. M., Bishop, T. M., Pigeon, W. R., & Hirsch, J. K. (2019). Insomnia and risk for suicidal behavior: A test of a mechanistic transdiagnostic model in veterans. *Journal of Affective Disorders*, *245*, 412–418. https://doi.org/10.1016/j.jad.2018.11.044

Byrne, S. P., McCarthy, E., DeViva, J. C., Southwick, S. M., & Pietrzak, R. H. (2021). Prevalence, risk correlates, and health comorbidities of insomnia in U.S. military veterans: Results from the 2019–2020 National Health and Resilience in Veterans Study. *Journal of Clinical Sleep Medicine*, *17*(6), 1267–1277. https://doi.org/10.5664/jcsm.9182

Campbell-Sills, L., & Stein, M. B. (2007). Psychometric analysis and refinement of the Connor-Davidson Resilience Scale (CD-RISC): Validation of a 10-item measure of resilience. *Journal of Traumatic Stress*, *20*(6), 1019–1028. https://doi.org/10.1002/jts.20271

U.S. Census Bureau (2019). *Current Population Survey, August 2019 Veterans Supplement*. Technical Documentation CPS-19. https://www2.census.gov/programs-surveys/cps/techdocs/cpsaug19.pdf

Department of Veterans Affairs and Department of Defense (2019). *VA/DoD Clinical Practice Guideline for the Management of Chronic Insomnia and Obstructive Sleep Apnea*. Author. Retrieved from: https://www.healthquality.va.gov/guidelines/CD/insomnia/VADoDSleepCPGFinal508.pdf

Derogatis, L. R. (2000). *BSI-18: Brief Symptom Inventory 18 - Administration, scoring, and procedures manual*. NCS Pearson.

Edinger, J. D., Arnedt, J. T., Bertisch, S. M., Carney, C .E., Harrington, J. J., Lichstein, K. L., … Martin, J. L. (2021). Behavioral and psychological treatments for chronic insomnia disorder in adults: an American Academy of Sleep Medicine clinical practice guideline. *Journal of Clinical Sleep Medicine: JCSM : Official Publication of the American Academy of Sleep Medicine*, *17*(2), 255–262. https://doi.org/10.5664/jcsm.8986

Finkelhor, D., Shattuck, A., Turner, H., & Hamby, S. (2015). A revised inventory of Adverse Childhood Experiences. *Child Abuse & Neglect*, *48*, 13–21. https://doi.org/10.1016/j.chiabu.2015.07.011

Greene, C. J., Ulmer, C. S., Farrell-Carnahan, L., & Mackintosh, M. (2017). *Path to Better Sleep Course*. Retrieved from http://www.VeteranTraining.va.gov/insomnia

Hardy, S. E., & Gill, T. M. (2004). Recovery from disability among community-dwelling older persons. *JAMA*, *291*(13), 1596–1602. https://doi.org/10.1001/jama.291.13.1596

Hazan, C., & Shaver, P. (1987). Romantic Love Conceptualized as an Attachment Process. *Journal of Personality & Social Psychology*, *52*(3), 511–524. https://doi.org/10.1037/0022-3514.52.3.511

Hill, M. L., Nichter, B., Loflin, M., Norman, S. B., & Pietrzak, R. H. (2021). Comparative associations of problematic alcohol and cannabis use with suicidal behavior in U.S. military veterans: A population-based study. *Journal of Psychiatric Research*, *135*, 135–142. https://doi.org/10.1016/j.jpsychires.2021.01.004

Hughes, M. E., Waite, L. J., Hawkley, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Research on Aging*, *26*(6), 655–672. https://doi.org/10.1177/0164027504268574

Kashdan, T. B., Gallagher, M. W., Silvia, P. J., Winterstein, B. P., Breen, W. E., Terhar, D., & Steger, M. F. (2009). The Curiosity and Exploration Inventory-II: Development, factor structure, and psychometrics. *Journal of Research in Personality*, *43*(6), 987–998. https://doi.org/10.1016/j.jrp.2009.04.011

Killgore, W. D. S., Cloonan, S. A., Taylor, E. C., Fernandez, F., Grandner, M. A., & Dailey, N. S. (2020). Suicidal ideation during the COVID-19 pandemic: The role of insomnia. *Psychiatry Research*, *290*, 113134. https://doi.org/10.1016/j.psychres.2020.113134

Mandelkorn, U., Genzer, S., Choshen-Hillel, S., Reiter, J., Meira e Cruz, M., Hochner, H., … Gileles-Hillel, A. (2021). Escalation of sleep disturbances amid the COVID-19 pandemic: a cross-sectional international study. *Journal of Clinical Sleep Medicine: JCSM : Official Publication of the American Academy of Sleep Medicine*, *17*(1), 45–53. https://doi.org/10.5664/jcsm.8800

McCullough, M. E., Emmons, R. A., & Tsang, J.-A. (2002). The grateful disposition: A conceptual and empirical topography. *Journal of Personality and Social Psychology*, *82*(1), 112–127. https://doi.org/10.1037/0022-3514.82.1.112

Meaklim, H., Junge, M. F., Varma, P., Finck, W. A., & Jackson, M. L. (2021). Pre-existing and post-pandemic insomnia symptoms are associated with high levels of stress, anxiety and depression globally during the COVID-19 pandemic. *Journal of Clinical Sleep Medicine: JCSM : Official Publication of the American Academy of Sleep Medicine*. https://doi.org/10.5664/jcsm.9354

Morin, C. M., Belleville, G., Bélanger, L., & Ivers, H. (2011). The Insomnia Severity Index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep: Journal of Sleep and Sleep Disorders Research*, *34*(5), 601–608. https://doi.org/10.1093/sleep/34.5.601

National Institute of Mental Health (2020). *The CoRonavIruS Health Impact Survey (CRISIS)*. Retrieved January 11, 2021, from National Institute of Mental Health Intramural Research Program Mood Spectrum Collaboration, Child Mind Institute of the NYS Nathan S. Kline Institute for Psychiatric Research website: https://www.nlm.nih.gov/dr2/CRISIS_Adult_Self-Report_Baseline_Current_Form_V0.3.pdf

Robillard, R., Dion, K., Pennestri, M., Solomonova, E., Lee, E., Saad, M., … Kendzerska, T. (2021). Profiles of sleep changes during the COVID-19 pandemic: Demographic, behavioural and psychological factors. *Journal of Sleep Research*, *30*(1), e13231. https://doi.org/10.1111/jsr.13231

Scheier, M. F., Carver, C. S., & Bridges, M. W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*, *67*(6), 1063–1078. https://doi.org/10.1037/0022-3514.67.6.1063

Schulenberg, S., Schnetzer, L., & Buchanan, E. (2011). The purpose in life test-short form: Development and psychometric support. *Journal of Happiness Studies*, *12*(5), 861–876. https://doi.org/10.1007/s10902-010-9231-9

Sheehan, D. V. (1992– 2016). *Mini International Neuropsychiatric Interview*. English Version 7.0.2. For DSM-5. Copyright.

Sherbourne, C. D., & Stewart, A. L. (1991). The MOS social support survey. *Social Science & Medicine*, *32*(6), 705–714. https://doi.org/10.1016/0277-9536(91)90150-B

Shi, L., Lu, Z. A., Que, J. Y., Huang, X. L., Liu, L., Ran, M. S., … Lu, L. (2020). Prevalence of and Risk Factors Associated With Mental Health Symptoms Among the General Population in China During the Coronavirus Disease 2019 Pandemic. *JAMA Network Open*, *3*(7), e2014053. https://doi.org/10.1001/jamanetworkopen.2020.14053

Spielman, A. J., Caruso, L. S., & Glovinsky, P. B. (1987). A behavioral perspective on insomnia treatment. *Psychiatric Clinics of North America*, *10*, 541–553. https://doi.org/10.1016/S0193-953X(18)30532-X

Sun, Q., Qin, Q., Basta, M., Chen, B., & Li, Y. (2021). Psychological reactions and insomnia in adults with mental health disorders during the COVID-19 outbreak. *BMC Psychiatry*, *21*, https://doi.org/10.1186/s12888-020-03036-7

Weathers, F. W., Blake, D. D., Schnurr, P. P., Kaloupek, D. G., Marx, B. P., & Keane, T. M. (2013). *The Life Events Checklist for DSM-5 (LEC-5)*. Instrument Available from the National Center for PTSD at www.ptsd.va.gov

Weathers, F. W., Litz, B. T., Keane, T. M., Palmieri, P. A., Marx, B. P., & Schnurr, P. P. (2013). *The PTSD Checklist for DSM-5 (PCL-5)*. Scale Available from the National Center for PTSD at www.ptsd.va.gov

Wu, T., Jia, X., Shi, H., Niu, J., Yin, X., Xie, J., & Wang, X. (2021). Prevalence of mental health problems during the COVID-19 pandemic: A systematic review and meta-analysis. *Journal of Affective Disorders*, *281*, 91–98. https://doi.org/10.1016/j.jad.2020.11.117

Yao, H., Chen, J.-H., & Xu, Y.-F. (2020). Patients with mental health disorders in the COVID-19 epidemic. *The Lancet. Psychiatry*, *7*(4), e21. https://doi.org/10.1016/S2215-0366(20)30090-0

Yuksel, D., McKee, G. B., Perrin, P. B., Alzueta, E., Caffarra, S., Ramos-Usuga, D., … Baker, F. C. (2021). Sleeping when the world locks down: Correlates of sleep health during the COVID-19 pandemic across 59 countries. *Sleep Health*, *7*(2), 134–142. https://doi.org/10.1016/j.sleh.2020.12.008

**How to cite this article:** McCarthy, E., DeViva, J. C., Na, P. J., & Pietrzak, R. H. (2022). New-onset and exacerbated insomnia symptoms during the COVID-19 pandemic in US military veterans: A nationally representative, prospective cohort study. *Journal of Sleep Research*, 31, e13450. https://doi.org/10.1111/jsr.13450