Journal of Cardiovascular Nursing
Vol. 38, No. 2, pp. E55–E60 | Copyright © 2022 Wolters Kluwer Health, Inc. All rights reserved.

Brief Report

# Sleep, Stress, and Symptoms Among People With Heart Failure During the COVID-19 Pandemic

Meghan O'Connell, MPH; Sangchoon Jeon, PhD; Samantha Conley, PhD, RN; Sarah Linsky, MPH; Nancy S. Redeker, PhD, RN

**Background:** The COVID-19 pandemic raised concerns about the effects of stress on sleep and mental health, particularly among people with chronic conditions, including people with heart failure (HF). **Objective:** The aim of this study was to examine changes in sleep, sleep-related cognitions, stress, anxiety, and depression among people with HF who participated in a randomized controlled trial of cognitive behavioral therapy for insomnia before the COVID-19 pandemic. **Methods:** Participants self-reported sleep characteristics, symptoms, mood, and stress at baseline, 6 months after cognitive behavioral therapy for insomnia or HF self-management education (attention control), and during the pandemic. **Results:** The sample included 112 participants (mean age, 63 ± 12.9 years; 47% women; 13% Black; 68% New York Heart Association class II or III). Statistically significant improvements in sleep, stress, mood, and symptoms that occurred 6 months post treatment were sustained during the pandemic. **Conclusions:** Improving sleep and symptoms among people with HF may improve coping during stressful events, and cognitive behavioral therapy for insomnia may be protective.

**KEY WORDS: cognitive behavioral therapy, COVID-19, heart failure, sleep**

The COVID-19 pandemic raised concerns about the effects of stress on mental health and sleep deficiency. Studies throughout the world found decreases in sleep quality and increases in anxiety and depression during the early months of the pandemic.[1,2] People with chronic health conditions may be at an especially high risk for disturbed mood, stress, and sleep deficiency.[3]

The pandemic contributed to new sleep problems and worsening of preexisting sleep problems, especially among those with chronic medical conditions.[3] Eighteen to fifty-seven percent of respondents experienced poor sleep quality.[1,2] Sleep onset latency (minutes it takes to fall asleep) ($P < .001$), sleep efficiency (time asleep/time in bed × 100) ($P = .03$), sleep disturbances ($P < .001$), and daytime dysfunction ($P < .001$) worsened among Italians.[4] Poor sleep quality was associated with psychological distress.[5]

Among international groups, 35% to 69% of people in the early pandemic experienced anxiety and 14% to 31% experienced depression,[2,6] whereas 51% of people from 21 countries reported mild to severe anxiety symptoms, 59% experienced mild to extremely severe depression, and 57% experienced mild to extremely severe stress[7] during the pandemic. Notably, people with preexisting chronic conditions experienced more stress and anxiety during the pandemic, perhaps because of their increased susceptibility to the virus and higher risk of dying from it.[8] A UK survey of people with heart failure (HF) found

**Meghan O'Connell, MPH**
Program Manager, School of Nursing, University of Connecticut, Storrs, Connecticut.

**Sangchoon Jeon, PhD**
Senior Research Scientist/Biostatistician, Yale School of Nursing, West Haven, Connecticut.

**Samantha Conley, PhD, RN**
Nurse Scientist, The Mayo Clinic, Rochester, Minnesota.

**Sarah Linsky, MPH**
Research Assistant, Yale School of Nursing, West Haven, Connecticut.

**Nancy S. Redeker, PhD, RN**
Professor, School of Nursing, University of Connecticut, Storrs, Connecticut.

This work was supported by the National Institute of Nursing Research under grant R01NR016191.

The authors have no conflicts of interest to disclose.

**Correspondence**
Nancy S. Redeker, PhD, RN, School of Nursing, University of Connecticut, 231 Glenbrook Road, Unit 4026 Storrs, CT 06269-4026 (Nancy.Redeker@uconn.edu).

DOI: 10.1097/JCN.0000000000000906

high levels of pandemic-related anxiety that may be attributed to concern about HF treatment during the pandemic. For example, 65% reported canceled or postponed healthcare visits and procedures.[9] These findings are especially important because insomnia and sleep disturbance,[10] depression,[11] and stress[12] may worsen HF and daytime function and exacerbate symptoms. Cognitive behavioral therapy for insomnia (CBT-I) has been shown to improve sleep quality and insomnia severity, as well as anxiety and depression,[13] and may be protective during times of stress, including the COVID-19 pandemic.

Insomnia symptoms are common among people with chronic HF, and it is closely associated with daytime symptoms and functional performance.[10] To address this, we conducted a randomized controlled trial of the effects of CBT-I compared with HF self-management education (attention-control condition), the "HeartSleep Study."[13] The randomized controlled trial revealed clinically and statistically significant improvements in insomnia severity, sleep quality, sleep onset latency, sleep duration, and dysfunctional cognitions about sleep at 6 months post treatment that were sustained over 1 year.[13] Participants in the HF self-management group (attention-control condition) also improved on these outcomes, but the improvements were smaller overall in this group, and there were significant group-by-time effects favoring CBT-I.[13] Although both groups improved on anxiety and depression, the group-by-time effects were not statistically significant. Building on this work, the purpose of the current observational study was to examine changes in sleep, sleep-related cognitions, stress, anxiety, and depression from 6 months post intervention to the pandemic period.

## Materials and Methods

### Design

In this study, we used a repeated-measures design and included follow-up of participants in the HeartSleep Study, a randomized controlled trial of CBT-I, compared with HF self-management education among adults with stable HF (NCT 02660385).[13,14] We obtained approval from the human subjects' investigation committee and written informed consent from all participants.

### Setting

Participants resided in Connecticut, USA, a state under executive orders directing nonessential businesses to "prohibit all in-person functions" and undergoing phased reopening and lifting some restrictions during the data collection period (June–August 2020). We used electronic and mailed methods for data collection.

### Participants

Participants in the HeartSleep study were English-speaking adults 18 years or older with chronic HF and at least mild insomnia (score > 7 on the Insomnia Severity Index[15] [ISI]) who were concerned about sleep for at least 1 month. We included participants with no or no more than mild untreated sleep-disordered breathing and those treated with continuous positive airway pressure. We excluded people with seizure disorders, severe sleepiness, narcolepsy, end-stage renal failure, bipolar disorder, severe depression, current illicit drug use, restless leg syndrome, and/or more than mild untreated sleep apnea, and people working nights or shift work.[13,14]

### Procedures

Participants completed questionnaires to elicit sleep characteristics, daytime symptoms, mood, and stress at baseline and over 1 year after their participation in the intervention. In this report, we include baseline and 6-month data from variables measured during the pandemic period. Dependent on the date of enrollment in the 5-year study, the time between the 6-month follow-up and the pandemic period ranged from 6 months to 4 years. Except for a questionnaire on sleep habits designed to be administered during the pandemic, all measures were identical to the parent study. We programmed the questionnaires in REDCap,[16] and surveys were delivered electronically or via mail based on participant preference. We provided $25 electronic gift cards to all participants for completing the surveys during the pandemic period. Participants received honoraria for earlier phases of the study.[13,14]

#### Variables and Measures

##### Demographic and clinical characteristics

We collected demographic and clinical information for the parent study via self-report and medical records, including sex, age, race, ethnicity, educational attainment, marital status, work status, body mass index, New York Heart Association classification, ejection fraction, and health history, including medical and psychiatric comorbidities. We used the Charlson Comorbidity Index[17] to calculate comorbidity scores.

##### Sleep characteristics

We included self-report measures of sleep characteristics, including insomnia; sleep quality, duration, efficiency, latency, and impairment; and sleep-related beliefs and cognitions. The ISI[15] is internally consistent (0.74–0.88) and sensitive to treatment,[15] with scores ranging from 0 to 28. The scale has adequate reliability in our study ($\alpha$ = .89). Score levels indicate no (0–7), mild (8–14), moderate (15–21), and severe clinical (22–28) insomnia.

The Pittsburgh Sleep Quality Index was used to measure perceived sleep quality, efficiency, duration, and latency. Global sleep quality (total) ranges from 0 to 21. A global score greater than 5 is considered poor sleep quality (with higher score meaning poorer sleep quality). The Pittsburgh Sleep Quality Index has a diagnostic sensitivity of 89.6% and a specificity of 86.5% for

distinguishing "good" versus "poor" sleepers.[18] In this study, it had an α coefficient of .72.

We used the 8-item PROMIS Sleep Disturbance scale[19] as an indicator of sleep quality and the PROMIS Sleep Related Impairment scale, indicating daytime dysfunction associated with poor sleep. In this study, these measures had internal consistency levels of α = .94 and .90, respectively.

#### Sleep habits

We developed a set of 4 dichotomous questions (yes/no) to elicit information about changes in sleep habits experienced during the pandemic (changes in sleep, bedtime, wake time, wake during night). Participants who reported changes in sleep were asked up to 5 additional questions; for example, participants reporting changes related to waking during the night are then asked whether they wake more or less frequently than before the pandemic. One open-ended question elicits details about strategies used to try to improve sleep during the pandemic. We categorized the responses and counted the number of responses in each category.

We used 2 questionnaires to elicit dysfunctional sleep-related beliefs and cognitions. The Sleep Disturbance Questionnaire includes a 12-item scale with 4 factors that indicate attributions related to insomnia (restlessness/agitation, mental overactivity, consequences of insomnia, and lack of sleep readiness).[20] It is reliable and valid.[20] In our study, the α is .87. The Dysfunctional Beliefs and Attitudes About Sleep[21] was used to measure maladaptive beliefs about sleep. The items are measured on a 0- to 10-point numeric scale. A higher score reflects higher dysfunctional beliefs and attitudes about sleep. The scale is internally consistent and stable in general insomnia patients,[21] and in our study, α is .87.

#### Mood and stress

We used the 10-item Perceived Stress Scale[22] to measure the degree to which individuals perceive life events as stressful. Scores can be classified as low (0–13), moderate (14–26), and high (27–40). The scale has adequate reliability and validity in other populations[22] and our study (α = .91).

We used the 8-item PROMIS Anxiety and Depression scales, developed and tested with support from the US National Institutes of Health, to measure anxious and depressive symptoms. These scales are widely used and validated.[23] These 2 measures had internal consistency levels of α = .94 in this study.

### *Statistical Analysis*

We computed descriptive statistics for the study variables. We assessed patterns of missing responses on the instruments and imputed missing data using the Markov chain Monte Carlo algorithm. Missing data were rare and in no case exceeded 30% of questionnaire items. We performed Markov chain Monte Carlo imputation on individual missing items when the missing response rate was less than 30%, and all summary scores were calculated with observed and imputed data. We assessed the skewness of outcome variables. We did not use transformed scores because the normality assumption was satisfied. Changes in insomnia, sleep characteristics, daytime symptoms, and sleep-related cognitions from 6 months post CBT-I or attention control to the pandemic period were examined with paired *t* tests. We also examined the correlations between elapsed time from completion of the intervention and changes in the outcomes. With significant correlations, we examined the effect of the elapsed time on the outcomes at the pandemic period after adjusting for comorbid conditions and the outcomes at baseline and 6 months using the generalized linear model. Data gathered using the open-ended item on sleep behaviors from the Sleep Habits survey were categorized using 5 unique codes. We report frequencies for the occurrence of these codes.

## Results

One hundred twelve participants (74%) from the parent study (n = 152) agreed to participate. Among these, 52 (46%) completed the HF self-management group (attention-control condition) and 60 (54%) completed the CBT-I (intervention) group. The mean age was 63 (12.9) years. The sample includes 53% male and 13% Black/African American participants. Most had New York Heart Association class II or III HF with preserved ejection fraction, and comorbidities were prevalent. Approximately half were married or living with a partner (52%) and college educated (54%).

We compared demographic and clinical characteristics and changes in insomnia and sleep quality at 6 months between those who were included in this analysis and those who were not. There were no statistical differences in group assignment, age, sex, employment, education, New York Heart Association Functional classification, or ejection fraction (%). Furthermore, there were no significant differences in changes in insomnia and sleep quality (Pittsburgh Sleep Quality Index) at 6 months. However, those who were included in the analysis during the pandemic had lower body mass index (mean, 30.6 [7.7] vs 33.7 [9.0]) and less comorbidity (mean, 2.5 [1.8] vs 3.1 [2.0]) (Charlson Comorbidity Index).

Descriptive statistics for the sleep characteristics, stress, mood, and sleep-related beliefs and cognitions appear in the Table. At baseline, participants had clinical levels of insomnia (ISI > 15), poor sleep quality, prolonged sleep latency, and low sleep efficiency and scored over the *T* score of 50 (indicating scores worse than population norms) on sleep impairment and anxiety, but not depression. Stress was in the moderate range. There were no statistically significant differences between participants in the CBT-I, compared with the HF self-management

**TABLE Changes in Sleep, Sleep Cognitions, and Mental Health Between 6-Month Follow-up and the COVID Period (N = 112)**

| Variables | Baseline, Mean (SD) | 6 mo, Mean (SD) | COVID Survey, Mean (SD) | Δ From 6 mo to COVID |
|---|---|---|---|---|
| Insomnia and sleep characteristics | | | | |
| Insomnia severity (ISI) | 15.11 (4.87) | 10.08 (4.62) | 8.95 (6.00) | −1.05 (5.30)[a] |
| Sleep quality (PSQI) | 9.82 (3.84) | 7.59 (3.60) | 8.21 (3.95) | 0.53 (1.49) |
| Sleep latency (PSQI), min | 36.07 (41.32) | 23.82 (22.70) | 24.62 (23.80) | 2.02 (23.69) |
| Sleep efficiency (PSQI), % | 77.68 (14.64) | 81.41 (13.06) | 78.97 (20.51) | −2.96 (23.40) |
| Sleep duration (PSQI), h | 7.16 (2.01) | 7.57 (1.28) | 7.05 (2.17) | −0.59 (2.36) |
| Sleep disturbance *T* score (PROMIS) | 55.82 (7.53) | 51.72 (7.15) | 51.23 (9.81) | −0.09 (8.91) |
| Sleep impairment *T* score (PROMIS) | 53.49 (8.55) | 43.47 (10.76) | 50.05 (8.71) | 6.77 (10.41)[b] |
| Daytime symptoms | | | | |
| Perceived Stress Scale | 14.39 (7.19) | 12.51 (7.16) | 12.73 (7.57) | 0.25 (6.16) |
| Anxiety *T* score (PROMIS) | 51.30 (8.64) | 49.10 (9.25) | 50.29 (9.80) | 1.38 (7.94) |
| Depression *T* score (PROMIS) | 49.68 (8.10) | 48.45 (8.80) | 48.74 (8.99) | 0.32 (5.87) |
| Sleep-related cognitions | | | | |
| Sleep disturbance (SDQ) | 5.18 (1.52) | 4.56 (1.49) | 4.41 (1.55) | −0.16 (1.46) |
| Dysfunctional beliefs and attitudes about sleep | 2.92(0.70) | 2.55 (0.74) | 2.51 (0.70) | −0.02 (0.52) |

Significance of changed variables (Δ) are tested using a paired *t* test.
Abbreviations: DBAS, Dysfunctional Beliefs & Attitudes about Sleep Scale; ISI, Insomnia Severity Index; PROMIS, Patient Reported Outcomes Measurement System; PSQI, Pittsburgh Sleep Quality Index (a higher score indicates poorer sleep quality); SDQ, Sleep Disturbance Questionnaire.
[a] $P < .05$.
[b] $P < .001$.

group, on these variables during the pandemic (data not shown). Therefore, data from the treatment groups were combined for the analysis. From the 6-month follow-up to the pandemic, insomnia severity improved, whereas sleep duration became shorter (0.59 hours) and sleep impairment increased but remained at about the level of the population norm (50th percentile). The levels of sleep quality, latency, efficiency and disturbance, perceived stress, anxiety, depression, sleep disturbance, and dysfunctional beliefs about sleep remained consistent during the pandemic with 6-month levels (see Table).

The mean (SD) time elapsed between 6-month data collection and the pandemic period was 27.0 (11.2) months, and all participants were at least 8 months past the 6-month data collection during the pandemic period. There were no significant correlations between time elapsed and outcomes at the pandemic period, except for insomnia severity (ISI) and sleep cognitions (Sleep Disturbance Questionnaire). Longer elapsed time was associated with greater reductions in insomnia severity and sleep cognitions (ISI from 6 months [$r = -0.18$, $P = .1195$], Sleep Disturbance Questionnaire from 6 months [$r = -0.23$, $P = .0437$]). These relationships did not change when comorbidity was included in the prediction model.

Forty-three percent of participants (n = 48) reported changes in sleep habits during the pandemic. Among these, 37 (77%) reported changes in bedtime, with 73% (n = 27) going to bed later and 27% (n = 10) going to bed earlier. Thirty-one (65%) reported changes in wake time; among these, 61% (n = 19) and 39% (n = 12) had earlier and later wake times, respectively. Thirty-five participants (31%) reported using 1 or more strategies to improve their sleep during the pandemic as indicated in the open-ended responses. We categorized these responses as establishing a new routine (n = 10, 29%), sleep hygiene (n = 8, 23%), limiting/avoiding news coverage of the pandemic (n = 7, 20%), making dietary changes and/or exercising (n = 6, 17%), and using relaxation techniques (n = 5, 14%).

## Discussion

Our findings suggest that improvements in insomnia severity, sleep quality, latency, and efficiency, sleep-related cognitions and stress, anxiety, and depression after participation in CBT-I or an HF self-management class were sustained during the pandemic. These findings contrast with the results of several studies that documented high levels of stress, anxiety, depression, and sleep problems among broad segments of populations during the pandemic.[1,2] Despite larger changes in insomnia and fatigue in the CBT-I group in the overall sample in the parent study,[13] the lack of statistically significant differences between participants in either the CBT-I group or the HF self-management group (control condition) suggest that both interventions may have protective effects.

Authors of a previous study reported the stress-protective effects of a digital CBT-I program, which found significantly lower levels of insomnia, stress, and depressive symptoms and lower levels of "cognitive intrusions" and better global health over 3 to 4 years after treatment, a time that coincided with the pandemic.[24] On the basis of our findings, HF self-management education provided in the control group in our study that included health promotion content (eg, obtaining adequate exercise and diet, sleep hygiene) may also protect against decrements

## What's New and Important

- Contrary to research indicating that people with chronic medical conditions experienced new and worsening of existing sleep problems and population-based studies documenting high levels of stress, anxiety, and depression during the COVID-19 pandemic, people with HF who completed a CBT-I study before the pandemic did not experience changes in these outcomes during the pandemic.
- Improving sleep and symptoms among people with HF may contribute to coping with stressful events such as the pandemic.
- Cognitive behavioral therapy for insomnia may be protective; further research is needed.

in insomnia and mood. The group format for both interventions that included discussion, problem solving, and social support among the participants may also have contributed to these outcomes. Reports by almost a third of the sample that they used specific strategies during the pandemic to address sleep and stress also support the possible influence of these interventions, and some of them may have been learned during the intervention. It is also possible that study participants obtained mental health or other support services or used Web-based supports, although we do not have information about this.

Despite sustained or improved levels of most of the study outcomes, sleep duration decreased and sleep impairment increased during the pandemic compared with the 6-month follow-up. However, sleep duration at all times was within the 7- to 9-hour range of normal adult sleep,[25] and sleep impairment did not deteriorate below baseline and approximated the population norm of the 50th percentile.

Although participants reported changes in bedtime and wake-up time that may influence sleep duration, the reasons for these changes or the apparent discrepancy between the direction of changes in sleep duration and insomnia severity from 6 months to the pandemic are not completely known. They may be explained by the difference between the nature of insomnia and sleep duration and the focus of CBT-I. Chronic insomnia, a disorder of initiating and maintaining sleep and/or waking too early in the morning accompanied by daytime dysfunction,[26] is not defined by sleep duration, although short sleep duration may be present, and CBT-I is not specifically focused on extending sleep duration.

Strengths of the study include the well-characterized sample that was screened for specific sleep disorders and comorbidity, long-term follow-up, and use of standardized, reliable, and valid measures. Although the sample was overall representative of the larger sample from the parent study, it did not include all enrolled participants. Given the post hoc nature of this study, ability to detect group-related differences in the variables or changes in the variables over time may have been limited by insufficient power. Interventions provided for both CBT-I and HF self-management education consisted of 4 face-to-face meetings offered every other week and an intervening phone call, and these were completed within approximately 8 to 10 weeks of baseline, but aside from data collection, there was no intervention beyond that point. It is possible that further follow-up or "booster" strategies might provide further improvement. Although we addressed the varying duration of follow-up in this report, there were variable times, so this may have also influenced the results.

Our findings suggest that participants with HF and a history of chronic insomnia maintained or improved on posttreatment levels of insomnia severity, anxiety, depression, and stress. Although posttreatment levels of sleep impairment and sleep duration were not sustained, levels approximated normal levels during the pandemic. These finding confirm the clinical benefits of CBT-I for people with HF and comorbidities[13,27] and also suggest the potential benefits of HF self-management education. Given our findings, future prospective studies are needed to examine the extent to which these and other behavioral interventions improve the ability of people with HF to manage stressful events, such as the pandemic.

## Acknowledgments

The authors thank the following people for their contributions to this study: Henry Yaggi, Daniel Jacoby, Christopher Hollenbeak, Stephen Breazeale, Youri Hwang, Joanne Iennaco, Uzoji-Nwanaji-Enwerem, Lesa Moemeka, John C. Cline, Anna Sullivan, Andrea Knies, Jessica Kelly-Hauser, Lisa Finoia, Edward Gaiser III, James Darden IV, Joy Powell, Amanda Irion, Dawn Bickley, Patrick Richardson, Alice Tian, Beeba Mathew, Andrew Bessette, Radu Radulescu, Stephanie Cram, Garrett Ash, Jeffrey Turner, Maria Paulina Lopez, Jennifer Hichar, and Sherry Van Lange. The authors are also grateful to those who participated in this study.

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