UC Irvine
UC Irvine Previously Published Works

Title

Testing the Effectiveness of a Mindfulness- and Acceptance-Based Smartphone App for Nurses Traumatized by the COVID-19 Pandemic: A Pilot Study.

Permalink

https://escholarship.org/uc/item/0861k8d3

Journal

Issues in Mental Health Nursing, 45(10)

Authors

Reyes PhD Msn Rn, Andrew

Fudolig PhD, Miguel

Sharma Mbbs PhD McHes, Manoj

et al.

Publication Date

2024-10-01

DOI

10.1080/01612840.2024.2385571

Peer reviewed

Testing the Effectiveness of a Mindfulness- and Acceptance-Based Smartphone App for Nurses Traumatized by the COVID-19 Pandemic: A Pilot Study

Andrew Thomas Reyes, PhD, MSN, RN[a], **Miguel Fudolig, PhD**[b], **Manoj Sharma, MBBS, PhD, MCHES**[c], **Lorraine S. Evangelista, PhD, RN, FAAN**[d]

[a]School of Nursing, University of Nevada Las Vegas, Las Vegas, Nevada, USA

[b]School of Public Health, University of Nevada Las Vegas, Las Vegas, Nevada, USA

[c]Department of Social & Behavioral Health, University of Nevada Las Vegas, Las Vegas, Nevada, USA

[d]Mountain West Clinical & Translational Infrastructure Network, University of Nevada Las Vegas, Las Vegas, Nevada, USA

Abstract

A significant proportion of frontline nurses developed post-traumatic stress disorder (PTSD) symptoms as a result of working during the COVID-19 pandemic. This study aimed to determine the efficacy of a mindfulness- and acceptance-based smartphone app intervention among nurses traumatized by the COVID-19 pandemic. This was a two-arm, randomized controlled trial. We randomly assigned 60 frontline nurses working in various clinical settings in the United States during the pandemic to either the intervention group (i.e. participants used the mindfulness app for 6 wk) or the wait-list control group. We assessed the app's efficacy through outcome measures of PTSD symptom severity, experiential avoidance, rumination, mindfulness, and resilience, measured at pre-, mid-, and post-intervention periods and a 1-month follow-up. Intervention satisfaction and perceived usability of the app were assessed within the intervention group. There was strong evidence of within-between interaction for PTSD, experiential avoidance, and rumination, implying significant improvement of these outcomes for the intervention group as compared to the control group. We only found a within-group interaction effect for mindfulness, indicating significant improvement of mindfulness within the intervention group only. Participants in the intervention group reported high satisfaction levels and perceived usability with the app. Findings highlight that mindfulness- and acceptance-based smartphone apps can improve PTSD symptoms of nurses traumatized by the pandemic. Healthcare organizations should provide nurses with accessible interventions (e.g. mindfulness apps) to treat and prevent secondary behavioral consequences of the pandemic, such as PTSD.

✉**CONTACT** Andrew Thomas Reyes andrewthomas.reyes@unlv.edu School of Public Health, University of Nevada Las Vegas, 4505 S. Maryland Parkway, Box 453018, Las Vegas, NV 89154-9900, USA.

Introduction

Post-traumatic stress disorder (PTSD) has been a significant secondary behavioral consequence of the COVID-19 global pandemic. Several population groups continue to be afflicted with PTSD even though the public health emergency ended in 2023. The unprecedented number of COVID-19 infections, the fear of contracting the disease, and the direct and indirect experience of witnessing deaths have been significant sources of traumatic exposures triggering post-traumatic stress among various population groups (Marvaldi et al., 2021). Healthcare workers treating patients infected with COVID-19 comprised one of the major population groups particularly affected by PTSD symptoms during the pandemic (Allan et al., 2020). Evidence also shows that healthcare workers indirectly working with COVID-19 patients (e.g. those working in clinical areas other than COVID units, dealing with families of infected patients) have also been exposed to traumatic stressors and can develop PTSD symptoms (Hou et al., 2020; Johnson et al., 2020).

Nurses, especially, are significant frontline healthcare workers at risk for pandemic-related PTSD symptoms. Because of their closer and more frequent contact with infected patients and their professional and moral obligations to report to work during the height of the pandemic, nurses were more exposed to pandemic-associated traumatic stressors than other healthcare workers (Benfante et al., 2020; Riedel et al., 2021). Due to witnessing an unprecedented number of patient deaths, caring for families of patients who could not be with their dying loved ones, having anxieties about infecting their own families and close companions, coping with changing workplace policies, or dealing with the lack of protective equipment, nurses became more vulnerable to repeated traumatic exposures (Bani Issa et al., 2022; Leng et al., 2021; Levi & Moss, 2022). Consequently, these traumatic stressors placed nurses at higher risk for developing PTSD symptoms or exacerbating the post-traumatic stress they already had (Moon et al., 2021; Song et al., 2020).

In a meta-analysis, the prevalence of PTSD developed during the pandemic among nurses was 28.22% compared to 17.34% for the general population (Yunitri et al., 2022). Because PTSD may develop several months or years after the initial traumatic exposure (Galatzer-Levy et al., 2018; North & Oliver, 2013), a higher prevalence of nurses developing delayedonset PTSD is predicted months and years following the pandemic (Al Falasi et al., 2021; Benfante et al., 2020; Geng et al., 2021). More specifically, it is assessed that about 10% to 40% of healthcare workers will develop PTSD symptoms 1 to 3 years after the pandemic (Preti et al., 2020). Therefore, this emphasizes the significance of developing a tailored strategy to improve nurses' mental health and aid in their recovery from traumatic situations.

An increasing number of studies have been conducted in the last 2 decades on the effect of mindfulness-based interventions on the improvement of PTSD symptoms (Boyd et al., 2018; Zhang et al., 2021). Many of these mindfulness-based interventions have been delivered online and digitally to broaden access to care (Rodriguez-Paras et al., 2017); consequently, technology-based mindfulness interventions have been increasingly applied in COVID-related PTSD, including those targeted at healthcare workers affected by the pandemic (Fiol-DeRoque et al., 2021; Keng et al., 2022). This trend is beneficial because

evidence shows that nurses are increasingly accessing self-help online tools to cope with their traumatic experiences from the pandemic (Kang et al., 2020). However, based on a systematic review, the effectiveness of mindfulness-based interventions for healthcare workers with PTSD remains unclear and limited (Hoedl et al., 2024; Ramachandran et al., 2023; Sun et al., 2021). Additionally, while there is a growing number of PTSD apps approved by the U.S. Food and Drug Administration (FDA), there remains limited evidence of how these apps apply to healthcare workers with PTSD (Phan et al., 2023).

This study examines the feasibility and acceptability of a mindfulness smartphone app for nurses traumatized by the COVID-19 pandemic. The app was based on the principles of Acceptance and Commitment Therapy (ACT; Hayes, 2016), a third-wave cognitive behavior therapy focused on "mindfulness, emotions, acceptance, the relationship, values, goals, and meta-cognition" (Hayes & Hofman, 2017, p. 245), which encourages participants to engage with the present moment (e.g. mindfulness and acceptance), clarify their values, and cultivate committed action to a value-based life (Hayes et al., 2006). ACT-based interventions have shown preliminary evidence in improving PTSD symptoms among different population groups (Kelly et al., 2022; Meyer et al., 2018; Wharton et al., 2019). However, there is limited evidence and inconsistent findings on ACT-based interventions for healthcare workers psychologically impacted by the global pandemic (Weiner et al., 2020).

Methods

Design

This pilot study employed a quasi-experimental pretest and posttest design with a comparison group (wait-list control).

Setting and sample

The study was conducted in the United States from October 2021 to October 2022. The study included frontline nurses, specifically registered nurses (RNs) and licensed practical nurses (LPNs), who were either presently or formerly employed in healthcare facilities in the United States. The study employed the following inclusion criteria: 1) be at least 18 years of age; 2) be employed as a frontline nurse (RN or LPN) within the United States; 3) obtain a score of 33 or higher on the PTSD Checklist for DSM-5 (PCL-5), which serves as the threshold for a provisional diagnosis of PTSD according to Weathers et al. (2013); and 4) possess an Android smartphone or iPhone (iOS 13 or later). The study's exclusion criteria encompassed the following conditions: 1) individuals presently using another mindfulness application; 2) individuals currently participating in a mindfulness program during the study's duration; 3) individuals experiencing psychotic symptoms during the study; and 4) individuals with impairments, such as blindness or deafness, that could hinder their ability to perceive information on the application and engage with the audio-guided mindfulness meditations integrated within the application.

Instruments

Participants from the intervention and control groups completed surveys of outcome measures (i.e. PTSD symptom severity, experiential avoidance, rumination, mindfulness,

and resilience) at multiple periods (i.e. pre-intervention, mid-intervention, post-intervention, and follow-up) through a Qualtrics link. Intervention group participants also completed an intervention satisfaction survey (Levin et al., 2015) and a System Usability Scale (Tullis & Albert, 2008) during the post-intervention period through a Qualtrics link.

PTSD symptom severity—The severity of PTSD symptoms was measured using the PTSD Checklist for DSM-5 (PCL-5, Weathers et al., 2013), which contains 20 components, each reflecting a PTSD symptom. The PCL-5 scale ranges from 0 to 80, with higher scores indicating greater severity of symptoms. Participants were asked to rate each item on a scale ranging from 0 (i.e. *not at all* bothered by the symptoms) to 4 (i.e. *extremely* bothered by the symptoms). The PCL-5 has a high internal consistency ($\alpha = 0.94$) and test–retest reliability ($r = 0.82$; Blevins et al., 2015).

Experiential avoidance—We used the 7-item Acceptance and Action Questionnaire-II (AAQ-II, Bond et al., 2011) to measure experiential avoidance, which refers to an individual's unwillingness to experience unacceptable emotions and thoughts (Hayes et al., 1996). AAQ-II scores ranged from 7 to 48, with higher scores indicating greater levels of experiential avoidance. In a previous study, the AAQ-II was reported to have a good internal consistency ($\alpha = 0.84$) and a test–retest reliability of 0.81 at 3 months and 0.79 at 12 months (Hayes et al., 1996).

Rumination—The Rumination Response Scale (RRS; Treynor et al. 2003) was used to assess the participant's level of rumination, which refers to passively focusing on negative emotions and repetitively thinking about the causes, consequences, and experience of such negative emotional states (Nolen-Hoeksema et al., 2008; Treynor et al. 2003). The 22-item RRS was rated on a scale from 1 (*almost never*) to 4 (*almost always*) to different statements about ruminative thinking. RRS scores ranged from 22 to 48, with higher scores indicating greater use of rumination as a coping strategy for negative emotions. The RRS was previously reported to have a strong internal consistency ($\alpha = 0.90$; Treynor et al. 2003).

Mindfulness—We used the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) to measure the level of mindfulness, which is defined as "open or receptive awareness of and attention" to the present moment (Brown & Ryan, 2003, p. 822). Each item (i.e. statements about the everyday experience) was rated on a scale from 1 (*almost always*) to 6 (*almost never*). MAAS scores ranged from 1 to 6, with higher mean scores indicating higher levels of mindfulness. In Brown and Ryan (2003) factor analyses and reliability assessment, the MAAS showed a good internal consistency ($\alpha = 0.82$) and test–retest reliability (intraclass correlation coefficient of 0.81).

Resilience—The 25-item Connor-Davidson Resilience Scale (CD-RISC) was employed to assess the level of resilience, defined as the "personal qualities that enable one to thrive in the face of adversity" (Connor & Davidson, 2003, p. 76). Participants rated each item on a scale from 0 (*not true at all*) to 4 (*true nearly all the time*); total scores range from 0 to 100, with higher scores indicating greater resilience. The CD-RISC was reported to have a good internal consistency ($\alpha = 0.89$) and test–retest reliability (intraclass correlation coefficient of 0.87; Connor & Davidson, 2003).

Intervention satisfaction—We used the satisfaction items that Levin et al. (2015) developed to evaluate a web-based ACT program they tested. We modified the wording of the items to fit with assessing participants' satisfaction with the ACT-based app. Each item was rated on a 6-point scale, with higher mean scores (ranging from 1 to 6) indicating higher levels of satisfaction with the app in the areas of overall satisfaction, perceived helpfulness, comprehension, intentions to use, and perceived fit.

Perceived usability of the app—The 10-item System Usability Scale (SUS; Tullis & Albert, 2008) was used to evaluate the perceived usability of the app. Following specific procedures for the calculation of SUS scores, the SUS yields a number (ranging from 0 to 100) representing a reliable and valid composite measure of the overall usability of a program or intervention (Bangor et al., 2008). A reliability analysis of the SUS was conducted and revealed an acceptable level of reliability with Cronbach's alpha of 0.911 (Bangor et al., 2008). SUS scores ranging from 75 to 90 are considered good to excellent products, while scores below 70 mean that such products or programs require further scrutiny and improvement (Bangor et al., 2008).

Procedures

We used sponsored Facebook advertisements to publicize the study and recruit participants. The screening questionnaire was included in the Facebook ad. Researchers contacted participants using the email addresses they provided on the screening form. After providing consent to participate in an introductory session for the study via Zoom, eligible participants were randomly assigned in a 1:1 ratio to either the intervention or control group using the online program www.randomizer.org. During the research orientation, the investigator explained the study procedure, answered queries, obtained informed consent, and assisted participants with installing the app on their smartphones.

Two groups were in the randomized controlled trial: the intervention group (who used the app for 6 wk) and the wait-list control group (who did not use the mindfulness app but were offered to use it after the follow-up period). Participants in both intervention and control groups completed measures of PTSD, experiential avoidance, rumination, mindfulness, and resilience at four time points: Week 1 (baseline, during the orientation to the study), Week 3 (mid-intervention), Week 6 (post-intervention), and Week 10 (follow-up, which is 1 month after the intervention period). Participants obtained the link to the Qualtrics-based surveys through their email. Additionally, participants in the intervention group completed two Qualtrics surveys to determine their perceived satisfaction with the app and its usability. All study steps were conducted according to the CONSORT reporting guidelines (Schulz et al., 2010). Figure 1 shows the CONSORT flow diagram.

The intervention

The smartphone application comprised a series of daily mindfulness exercises and weekly learning materials (i.e. videos and reflection journals) based on ACT principles outlined by Hayes (2016). More specifically, the app incorporated seven distinct mindfulness meditations accompanied by audio guidance, which were sourced from various ACT workbooks authored by Harris (2019), Hayes and Smith (2005), and Stoddard and Afari

(2014). Participants were advised to practice at least one daily audio-guided mindfulness meditation, watch the weekly videos at their leisure, and write brief reflections on their thoughts, insights, and learned knowledge from the weekly videos. Reflections were directly written in the app's journaling section. Participants also received weekly phone calls from the research team to follow up on technical problems with the app.

The app was hosted by MetricWire, an online mobile assessment platform designed to provide ecological momentary assessments, customized push notifications, interactive app components, and secure database integration. MetricWire was available to both Android and iOS smartphones.

Sample size

The pilot nature of this study was the basis for determining the sample size of $N = 60$. This pilot study was proposed as a first step to a more extensive grant application and to determine the issues in delivering the study protocol. More particularly, the sample size was based on addressing two targets: (1) to obtain pilot data on recruitment, retention, adherence, and acceptability of the intervention and (2) to estimate the potential effects of the app-based intervention in reducing PTSD among frontline nurses. Hence, the main emphasis of determining the improvement of outcomes was to estimate the effect size rather than testing for statistical significance. Therefore, the sample size of 60 was based on the feasibility of the number of participants to recruit within the limited time frame of the study and the recommendations for optimal sample sizes in pilot studies (Hertzog, 2008). The sample size was based on the precision of estimates as determined by a 95% confidence interval (Moore et al., 2011). We expected an attrition rate of 20% based on the sample size, allowing the lowest final sample size of 48. In the current study, all 60 participants completed the study except one participant in the control group who did not complete the follow-up measures.

Data analyses

The statistical analysis software SAS Version 9.4 was used to conduct all data analyses. The demographic data, perceived satisfaction with the intervention, and app usability were analyzed using descriptive statistics. To examine the variations in outcomes (namely, PTSD symptom severity, experiential avoidance, rumination, mindfulness, and resilience) between the intervention and control groups, we performed a two-tailed t-test at each time point. Subsequently, the generalized estimated equations (GEE) approach for repeated measures analysis was used to test for an interaction effect between treatment and time and ascertain disparities in outcomes across time between the two cohorts. The compound symmetry structure was used to characterize the GEE framework's variance and correlations between different time points. The Bonferroni adjustment was applied to the raw p value to address the possible inflation of the type I error due to multiple comparisons in the simple effect analyses. All participants in both groups completed all measures at the designated periods, except one from the control group who did not complete the follow-up assessment at Week 10 (see Figure 1). The Kenward-Roger degrees of freedom adjustment was implemented to account for the multi-level analysis and imbalanced sample resulting from missing data (specifically, one missing data point in the control group at the 1-month follow-up).

Ethical considerations

The Office of Research Integrity—Human Subjects, the institutional research ethics board of the University of Nevada Las Vegas (UNLV), approved the study (IRB Approval #1760618-FB). Informed consent was obtained from all participants. Participants were also reassured of complete anonymity and confidentiality of their data, including their names and any other identifiable information. To ensure that participants obtain needed psychiatric services in crisis situations, participants who were receiving any other forms of psychiatric treatment other than mindfulness programs (e.g. cognitive behavior therapy, mental health counseling, pharmacotherapy) were not excluded from the study. During the orientation of the study, participants were also encouraged to seek appropriate urgent or emergency psychiatric services if they ever experienced some psychiatric crises during the study period.

Results

Participant demographics

The study included 60 participants, with 30 assigned to the intervention group and another 30 to the control group. The study had 10 males and 20 females in each group. The intervention group's average age in years was 36.4 ($SD = 8.22$), whereas the control group's average age was 34.3 ($SD = 8.54$). A statistical study also found no statistically significant difference in average age between the two groups ($t = 868$, $p = 0.392$). Table 1 shows the demographic characteristics of the sample. Furthermore, the chi-square tests performed on the two groups revealed no statistically significant differences in the demographic data: race ($X^2 = 4.440$, $p = 0.880$), employment ($X^2 = 0.330$, $p = 0.988$), licensure status ($X^2 = 0.231$, $p = 0.631$), and marital status ($X^2 = 1.500$, $p = 0.221$).

Intervention satisfaction and usability of the app

Perceived satisfaction and usability of the app were assessed with the intervention group only. Satisfaction with the intervention ranged between 5.57 and 5.80 on a 6-point scale (e.g. 4 = *slightly agree*, 5 = *agree*, and 6 = *strongly agree*). The mean SUS rating was 92.25 (SD = 9.24).

Differences in outcomes

The outcomes of PTSD, experiential avoidance, rumination, mindfulness, and resilience were analyzed separately using GEE models. We tested for a significant interaction between time and treatment for each outcome using the Type III tests of fixed effects from the corresponding GEE model. The Kenward-Roger method was used to approximate the appropriate degrees of freedom for the fixed effects test in the GEE model. When the interaction between time and treatment was significant, we implemented a simple effect analysis to test for treatment effects and adjusted the resulting *p* value using the Bonferroni correction. We used a significance level of 0.05 throughout the analysis. Cross-sectional statistics and the effect sizes between the treatment and control groups of these outcomes are listed in Table 2.

PTSD (PCL-5)

The within-between interaction was determined to be significant ($F(3,173.2) = 14.97$, $p < 0.001$). In Week 1, there was no evidence of a difference between the two groups ($p = 0.443$, $d = 0.199$). The intervention group was recorded to have a significantly lower average PCL-5 score compared to the control group in Week 3 ($p = 0.02$, $d = 0.586$). This trend was also observed in Weeks 6 ($p < 0.001$, $d = 1.678$) and 10 ($p < 0.001$, $d = 1.119$). PCL-5 findings indicate significant improvement across three timepoints in the intervention group as compared to the control group.

Experiential avoidance (AAQ)—A significant within-between interaction was observed between the intervention and time for the AAQ scores ($F(3, 173.1) = 7.52$, $p < 0.001$). There was no evidence of any difference in AAQ scores between the intervention and control group at baseline ($p = 0.434$, $d = 0.178$) and mid-intervention ($p = 0.757$, $d = 0.089$). We observed a significant difference between the two groups during the post-intervention ($p < 0.001$, $d = 0.906$) and the follow-up ($p = 0.003$, $d = 0.824$) assessments. Findings show that improvement in experiential avoidance was significant for the intervention group as compared to the control group at Week 6 (post-intervention) and Week 10 (follow-up period).

Rumination (RRS).: The interaction effect was also found to be significant for the RRS scores ($F(3,173.2) = 6.77$, $p < 0.001$). Before completing the intervention, the two groups experienced similar levels of rumination. Similar to the PCL-5 and AAQ scores, the difference in RRS scores between the two groups changed over time. However, significant differences were only observed in Weeks 6 ($p < 0.001$, $d = 1.043$) and 10 ($p = 0.004$, $d = 0.821$). Findings demonstrate that improvement in rumination was significant for the intervention group as compared to the control group at Weeks 6 and 10.

Mindfulness (MAAS).: Unlike the previous outcomes discussed in this section, the interaction between the intervention and time for the MAAS scores was not significant at the 0.05 level ($F(3, 173.2) = 1.69$, $p = 0.171$).

The Type III tests of fixed effects also yielded a nonsignificant intervention effect. However, the results of the fixed effects tests showed a significant time effect ($F(3, 173.2) = 6.72$, $p < 0.001$). On average, the participants from both groups showed increased mindfulness levels after the intervention period ended. In the intervention group, the MAAS scores were recorded to increase significantly from Week 3 to Week 6 ($p = 0.045$, $d = 0.700$) and maintained this increase at Week 10 ($p = 0.010$, $d = 0.828$). Findings show that while there was no significant difference in improvements of mindfulness over time between the intervention and control groups, mindfulness levels within the intervention group significantly improved from Week 3 to Week 6 to Week 10.

Resilience (CD-RISC).: The interaction between the intervention and time for the CD-RISC scores was not significant ($F(3, 173.2) = 0.47$, $p = 0.707$). The Type III tests of fixed effects yielded a nonsignificant intervention main effect ($F(3, 58.1) = 0.44$, $p = 0.511$). Although the

intervention did not increase the CD-RISC scores in the participants, there was no evidence that the scores decreased compared to the control group.

Discussion

Principal findings

This study assessed the effects of an ACT-based mobile app on PTSD symptoms, experiential avoidance, rumination, mindfulness, and resilience among nurses traumatized by the COVID-19 pandemic. We also explored the app's acceptability by evaluating the system's usability and participant satisfaction with the app.

First, we compared the effects of the app on PTSD symptom severity. Results of the GEE model revealed a significant interaction between treatment and time for PTSD symptom severity (PCL-5 scores). These results imply that the difference between the intervention and the control groups changed over time. The results also mean that both groups started with the same level of PTSD severity; however, the intervention group had significantly lower PCL-5 scores than the control group at mid-intervention. The significant difference in PCL-5 scores continued to be observed post-intervention and at follow-up visits (Week 10, or 4 wk after using the app). The PTSD symptom severity was the only outcome in the study in which the app demonstrated early (i.e. at mid-intervention) and sustained improvement.

Second, we examined the effects of experiential avoidance. Although a significant interaction was observed between treatment and time for experiential avoidance (AAQ scores), significant differences in AAQ scores between the two groups were only observed during post-intervention (Week 6) and follow-up periods (Week 10). These findings imply that the effects of the intervention on experiential avoidance might only be observable at the end of the intervention. The decrease in experiential avoidance level was still observed in the follow-up visit, which supports the conclusion that the effects of the intervention were sustained even after the intervention.

Third, similar to experiential avoidance, significant differences between groups for rumination (RRS scores) were observed at Week 6 (post-intervention) and Week 10 (follow-up period). These findings imply that the individuals in the treatment group recorded lower levels of rumination only after the intervention period. Therefore, these findings mean that the effects of rumination might only be observable at the end of the intervention. Our findings on the significant decrease in rumination levels in the follow-up visit support the sustainability of the effects of the intervention.

Fourth, we found no significant interaction effect between treatment and time for mindfulness (MAAS scores). Additionally, the nonsignificant intervention effect from the fixed effects tests indicates that the intervention did not perform differently from the control in changing mindfulness levels. However, the significant increase in MAAS scores from Week 3, Week 6, and Week 10 within the intervention group provides strong evidence that the mindfulness app encourages its users to be more receptive and aware of their present situation.

The fifth measure we investigated was resilience. Results of the Type III tests of fixed effects for resilience (CD-RISC scores) yielded a nonsignificant main effect of the intervention, which led to the conclusion that the intervention did not have a different effect between groups. Overall, neither group's CD-RISC scores increased or decreased during the intervention, indicating that the intervention did not influence resilience over time.

Finally, we explored the system's usability and satisfaction with the app. As reported above, the mean SUS rating was 92.25 (SD = 9.24). An SUS rating of 72.75 is considered "good" and 85.58 as "excellent" (Bangor et al., 2008); therefore, the app was perceived to be highly usable and user-friendly. Based on ratings of satisfaction with the app, participants in the intervention group were generally satisfied with the app, with general ratings between "agree" and "strongly agree" in the following areas: overall satisfaction, perceived helpfulness, comprehension, intentions to use, and perceived fit.

Comparison with prior work

We previously tested this mindfulness/acceptance-based app among military veteran college students; however, it had a shorter duration of intervention, such as 4 wk instead of 6 (Reyes et al., 2020). Results from this single-arm study of military veterans showed consistent improvement in PTSD symptoms, experiential avoidance, and rumination across assessment time points (Reyes et al., 2020). Similarly, in the current study, PTSD symptoms consistently improved across assessment time points, including a significant decline in PTSD symptom severity in the intervention group as compared to the control group. However, while the current study demonstrated consistent improvement of experiential avoidance and rumination, significant differences in these two measures between groups were only shown at post-intervention and follow-up, suggesting that improvement of experiential avoidance and rumination requires more mindfulness and acceptance training. Similar to the previous study, which demonstrated significant improvement in mindfulness (Reyes et al., 2020), the current study results showed improvement in mindfulness within the intervention group across all assessment time points. However, based on the current study's findings, there was no significant difference in the improvement of mindfulness between the two groups, warranting more research in this area. Finally, the lack of significant findings on resilience in the current study is also consistent with the weak effects of resilience in the pilot study with military veteran college students (Reyes et al., 2020).

The study findings regarding significant improvement of PTSD, experiential avoidance, and rumination are consistent with previous research on mindfulness apps (Davis et al., 2023; Reyes et al., 2022; Webb et al., 2021). Our findings highlight that training with developing mindfulness and acceptance, which pertains to nonjudgmental awareness of traumatizing internal experiences by recognizing the transient nature of thoughts and feelings (Vujanovic et al., 2011), contribute to the improvement of PTSD symptoms, experiential avoidance, and rumination. Individuals with PTSD are distressed by recurring traumatizing memories (Ehlers, 2010), which results in coping by suppressing or avoiding these unwanted internal experiences (Vujanovic et al., 2011). However, such avoidant coping has been shown in multiple studies to maintain the severity of PTSD symptoms (Ruiz-Párraga & López-Martínez, 2015; Short et al., 2018; Thompson et al., 2011; Weaver et al., 2020). In contrast,

the app-based intervention, leveraging the principles of ACT, allows users to develop mindfulness and acceptance skills by creating alternative contexts in which unwanted and intrusive thoughts and feelings are observed without judgment (Hayes et al., 2006). For example, the app contained audio-guided exercises to meditate on the function rather than the content of thoughts (i.e. thoughts are thoughts, and feelings are feelings rather than the external objective reality) and to observe the transient nature of thoughts, such as visualizing thoughts like the passing leaves on a river stream (Hayes, 2016).

Our limited significant difference in mindfulness levels is consistent with other studies that tested the effects of short-term use of mindfulness apps on the same mindfulness measure (i.e. MAAS) used in the current study (Egami & Highfield, 2023; McGuire & Zhen, 2019). On the other hand, significant changes in MAAS scores were observed with intervention rather than control groups in longer-term use of mindfulness apps (Bear et al., 2022; Hendricks et al., 2020). Although our findings show a significant change in mindfulness levels within the intervention group at post-intervention and follow-up periods, our findings imply that 6 wk of mindfulness training may be inadequate to effect significant differences between the intervention and control groups. However, unlike these studies, as mentioned earlier, participants in the current study had high levels of PTSD symptom severity, which could have also been attributed to the lack of significant findings on mindfulness levels. Training programs to improve mindfulness among individuals with PTSD symptoms may require more time and focus. More particularly, the phenomenon of avoidance, which is conceptually opposite to mindfulness (Brem et al., 2017), is the hallmark of PTSD (Weaver et al., 2020). In PTSD, these avoidant behaviors (e.g. thought suppression and denial of unwanted and recurring traumatic memories, thoughts, and feelings) become pervasive in one's life, and such behaviors eventually develop into maladaptive coping strategies (Akbari et al., 2022). Hence, interventions aimed to facilitate mindfulness and acceptance (i.e. the willingness to remain in contact with unwanted internal experiences) among individuals with rigid patterns of avoidance may require more time to effect such positive outcomes (e.g. increased mindfulness levels).

Therefore, a more nuanced examination of mindfulness must address the study's need for significant differences in mindfulness levels. For example, in a mindfulness intervention for military veterans with PTSD, Stephenson et al. (2017) found that certain aspects of mindfulness (i.e. nonreactivity and acting with awareness) were associated with improvement in PTSD; in contrast, the observing aspect of mindfulness worsened PTSD symptoms. Therefore, using a mindfulness measure that demonstrates the nuanced aspects of mindfulness (i.e. the Five Facet Mindfulness Questionnaire [FFMQ], Baer et al., 2006) in addition to the single-factor MAAS (Brown & Ryan. 2003) is recommended for future research. Our recommendation is concurred by Duffy et al. (2022) conclusions in their psychometric comparison study that FFMQ and MAAS measure different aspects of mindfulness. Clinical trials should not use either of the measures as outcomes alone (Duffy et al., 2022).

Our lack of significant difference in improvement in resilience is consistent with other studies of mindfulness interventions. Clarkson et al. (2019) found a significant improvement in resilience in the intervention group but no significant difference in improvement in

resilience when compared to the control group. Additionally, no significant improvement in resilience was demonstrated in single-arm mindfulness intervention studies (Fortney et al., 2013; Kemper et al., 2015) and in an ACT-based intervention for nurses who provided care to COVID-19 patients (Han et al., 2022). While resilience is often conceptualized as one's capability to cope positively with adversities (Connor & Davidson, 2003), the adversities referred to within this definition usually pertain to significant life events (Clarkson et al., 2019). The traumatic events during the COVID-19 pandemic that exposed frontline nurses may be considered major life events; however, the probable reason why resilience did not demonstrate significant improvement in the intervention as compared to the control group was the repeated exposure to traumatic events associated with COVID-19. During the pandemic, many nurses were obliged to come to work or fulfill their duties as critically essential healthcare workers (Bergman et al., 2021). Since additional trauma reactivates PTSD symptoms (Fossion et al., 2015), daily exposure to various traumatic scenarios heightened the anxiety and psychological distress that the nurses were already experiencing (Benfante et al., 2020; Orrù et al., 2021). Additionally, the mean resilience of the participants in the current study was generally higher compared to studies (i.e. involving nurses during the COVID-19 pandemic) that also used the 25-item CD-RISC (Afshari et al., 2021; Han et al., 2022; Li et al., 2021; Zakeri et al., 2021). Similar to Clarkson et al. (2019) conclusion regarding the lack of significant difference in resilience between treatment groups, our participants demonstrated a good level of resilience from the outset, and the intervention did not differentiate between groups.

Limitations of the study

The first limitation of the study was the use of convenience sampling. Our primary recruitment process was through the Facebook ad, and the sample was drawn from the nurses who responded to the ad. Therefore, our sample may not be representative of the population at large. However, we intended to maximize internal validity and employed random assignment to the intervention or control group.

The second limitation of the study was related to the sample and sample size. First, we had very few participants of Hispanic and Asian origins. The majority of our participants were White and African Americans. Hence, our analysis of the outcomes based on the major racial groups in the United States was limited. Second, the study's sample size of 60 may be considered small for a randomized controlled trial. The focus of the pilot study was to determine the acceptability of the intervention and the feasibility of the study protocol rather than the investigation of the efficacy of the intervention. Therefore, we based our sample size on recommendations for optimal sample sizes in pilot studies (Hertzog, 2008).

The third limitation was the use of self-report measures, particularly for measuring PTSD symptom severity. We did not use a clinician-administered instrument to measure PTSD symptoms but rather the self-administered PCL-5. Participants could have exaggerated or minimized their perceptions of their covert PTSD symptoms (e.g. intrusive memories, avoidance of internal experiences). An advantage of using scales such as the Clinician-Administered PTSD scale (CAPS; Blake et al., 1995) is the person administering the scale can clarify symptoms attributed to other disorders, such as depression (Kramer et al., 2023).

While both PCL-5 and CAPS have varying degrees of diagnostic discordance (Kramer et al., 2023), a few studies have demonstrated that the scores of PCL-5 and CAPS are strongly associated (Blanchard et al., 1996; Forbes et al., 2001) and have moderate diagnostic consistency (Hansen et al., 2023). Participants should be instructed to read each question more carefully, particularly in their first scale completion, to maximize interpretable PCL-5 scores (Kramer et al., 2023).

Finally, privacy issues related to using Facebook ads to recruit potential participants were a possible study limitation. Potential participants could have perceived the risks of losing their privacy when interacting with Facebook. Some of these privacy risks include the fear of being tagged by a friend who may think they may be interested, fear of being visible if they like the ad, and fear of receiving user-related links (i.e. through Facebook algorithms) once they click the ad (Akers & Gordon, 2018). These concerns are valid, particularly the high prevalence of perceived shame, guilt, and moral injury related to developing PTSD symptoms from the pandemic among frontline healthcare workers (Amsalem et al., 2021). Hence, to protect the privacy of potential participants, we used a Facebook dark post (also called a sponsored post), which is only posted to a selected target audience (e.g. frontline nurses in the U.S.). A sponsored post does not appear on the advertiser's timeline nor the page of the advertiser's followers; instead, the post only shows on the target audience's timeline. We also included a nonhypertext URL to the study so that potential participants could access the study by copying and pasting the URL to a new browser tab rather than directly clicking the ad. However, Facebook ads are not devoid of the possibility of breaching privacy; therefore, researchers must abide by ethical guidelines for protecting users' privacy during social media recruitment. Researchers must also be aware that the ad requirements of these social media platforms change frequently (Akers & Gordon, 2018). Finally, early discussions and planning within the research team are required to determine if recruiting through social media platforms is the most optimal way of recruiting participants (Akers & Gordon, 2018).

Conclusions

The findings from this study make several contributions to the current literature. The study's development and feasibility testing of a smartphone app based on ACT realizes essential contributions to technology and mental health care in the context of the COVID-19 pandemic. The pandemic has been associated with secondary behavioral consequences, including PTSD, particularly among frontline workers such as nurses. The positive findings of the study, including the high satisfaction and usability rates of the app, provide foundational evidence for future research in further testing of ACT-based apps for PTSD among nurses whom the pandemic has psychologically impacted. The study's findings also provide evidence for healthcare organizations to consider delivering online and digital interventions for employee mental health assistance and support. Hence, nurses can be provided with digital interventions to complement the mental health care they already receive, access psychological support amid their demanding work schedules, obtain confidential mental health support, and receive preventive care for post-traumatic stress exacerbation and re-traumatization.

The findings of the study provide various insights for future research. First, based on our limited significant difference in mindfulness and resilience, we recommend further testing the app using randomized controlled trial (RCT) designs with larger sample sizes. Second, adding another mindfulness measure to the single-factor mindfulness measure we used (i.e. MAAS) could shed further insights into the app's effect on different aspects of mindfulness. Third, enhancing the racial and ethnic diversity of the sample can highlight the impact of several social determinants of health on e-mental health, an approach intended to leverage online and digital technologies to address the gaps in mental health promotion and treatment. Fourth, we plan to integrate the multi-theory model (Sharma, 2015, 2022), a fourth-generation intervention framework for health behavior change, into the delivery model of the app to enhance the initiation and maintenance of healthy behaviors associated with PTSD (e.g. mindfulness and acceptance as opposed to avoidant coping). Finally, future research should also focus on testing the effects of ACT-based and mindfulness apps in preventing PTSD and promoting mental health among nurses, and not only in treating PTSD. Therefore, collaborations among multiple sites of healthcare organizations are required to determine the application and testing of digital psychological support for nurses, particularly considering the practical contexts of implementing theory-driven research and controlled designs such as RCTs.

Funding

References

Afshari D, Nourollahi-Darabad M, & Chinisaz N (2021). Demographic predictors of resilience among nurses during the COVID-19 pandemic. Work (Reading, Mass.), 68(2), 297–303. 10.3233/WOR-203376 [PubMed: 33492260]

Akbari M, Seydavi M, Hosseini ZS, Krafft J, & Levin ME (2022). Experiential avoidance in depression, anxiety, obsessive-compulsive related, and posttraumatic stress disorders: A comprehensive systematic review and meta-analysis. Journal of Contextual Behavioral Science, 24, 65–78. 10.1016/j.jcbs.2022.03.007

Akers L, & Gordon JS (2018). Using Facebook for large-scale online randomized clinical trial recruitment: Effective advertising strategies. Journal of Medical Internet Research, 20(11), e290. 10.2196/jmir.9372 [PubMed: 30409765]

Al Falasi B, Al Mazrouei M, Al Ali M, Al Dhamani M, Al Ali A, Al Kindi M, Dalkilinc M, Al Qubaisi M, Campos LA, Al Tunaiji H, & Baltatu OC (2021). Prevalence and determinants of immediate and long-term PTSD consequences of coronavirus-related (CoV-1 and CoV-2) pandemics among healthcare professionals: A systematic review and meta-analysis. International Journal of Environmental Research and Public Health, 18(4), 2182. 10.3390/ijerph18042182 [PubMed: 33672257]

Allan SM, Bealey R, Birch J, Cushing T, Parke S, Sergi G, Bloomfield M, & Meiser-Stedman R (2020). The prevalence of common and stress-related mental health disorders in healthcare workers based in pandemic-affected hospitals: A rapid systematic review and meta-analysis. European Journal of Psychotraumatology, 11(1), 1810903. 10.1080/20008198.2020.1810903 [PubMed: 33244359]

Amsalem D, Lazarov A, Markowitz JC, Naiman A, Smith TE, Dixon LB, & Neria Y (2021). Psychiatric symptoms and moral injury among US healthcare workers in the COVID-19 era. BMC Psychiatry, 21(1), 546. 10.1186/s12888-021-03565-9 [PubMed: 34740357]

Baer RA, Smith GT, Hopkins J, Krietemeyer J, & Toney L (2006). Using self-report assessment methods to explore facets of mindfulness. Assessment, 13(1), 27–45. 10.1177/1073191105283504 [PubMed: 16443717]

Bangor A, Kortum PT, & Miller JT (2008). An empirical evaluation of the System Usability Scale. International Journal of Human-Computer Interaction, 24(6), 574–594. 10.1080/10447310802205776

Bani Issa W, Al Nusair H, AlTamimi A, Rababa M, Saqan R, Hijazi H, Al-Marzouqi A, Abdul Rahman H, & Naing L (2022). Posttraumatic stress disorders and influencing factors during the COVID-19 pandemic: A cross-sectional study of frontline nurses. International Nursing Review, 69(3), 285–293. 10.1111/inr.12734 [PubMed: 34878183]

Bear KA, Barber CC, & Medvedev ON (2022). The impact of a mindfulness app on postnatal distress. Mindfulness, 13(11), 2765–2776. 10.1007/s12671-022-01992-7 [PubMed: 36189185]

Benfante A, Di Tella M, Romeo A, & Castelli L (2020). Traumatic stress in healthcare workers during COVID-19 pandemic: A review of the immediate impact. Frontiers in Psychology, 11, 569935. 10.3389/fpsyg.2020.569935 [PubMed: 33192854]

Bergman L, Falk AC, Wolf A, & Larsson IM (2021). Registered nurses' experiences of working in the intensive care unit during the COVID-19 pandemic. Nursing in Critical Care, 26(6), 467–475. 10.1111/nicc.12649 [PubMed: 33973304]

Blake DD, Weathers FW, Nagy LM, Kaloupek DG, Gusman FD, Charney DS, & Keane TM (1995). The development of a Clinician-Administered PTSD Scale. Journal of Traumatic Stress, 8(1), 75–90. 10.1007/BF02105408 [PubMed: 7712061]

Blanchard EB, Jones-Alexander J, Buckley TC, & Forneris CA (1996). Psychometric properties of the PTSD Checklist (PCL). Behaviour Research and Therapy, 34(8), 669–673. 10.1016/0005-7967(96)00033-2 [PubMed: 8870294]

Blevins CA, Weathers FW, Davis MT, Witte TK, & Domino JL (2015). The Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5): Development and initial psychometric evaluation. Journal of Traumatic Stress, 28(6), 489–498. 10.1002/jts.22059 [PubMed: 26606250]

Bond FW, Hayes SC, Baer RA, Carpenter KM, Guenole N, Orcutt HK, Waltz T, & Zettle RD (2011). Preliminary psychometric properties of the Acceptance and Action Questionnaire–II: A revised measure of psychological inflexibility and experiential avoidance. Behavior Therapy, 42(4), 676–688. 10.1016/j.beth.2011.03.007 [PubMed: 22035996]

Boyd JE, Lanius RA, & McKinnon MC (2018). Mindfulness-based treatments for posttraumatic stress disorder: A review of the treatment literature and neurobiological evidence. Journal of Psychiatry & Neuroscience: JPN, 43(1), 7–25. 10.1503/jpn.170021 [PubMed: 29252162]

Brem MJ, Shorey RC, Anderson S, & Stuart GL (2017). Experiential avoidance as a mediator of the relationship between dispositional mindfulness and compulsive sexual behaviors among men in residential substance use treatment. Sexual Addiction & Compulsivity, 24(4), 257–269. 10.1080/10720162.2017.1365315 [PubMed: 30740011]

Brown KW, & Ryan RM (2003). The benefits of being present: Mindfulness and its role in psychological well-being. Journal of Personality and Social Psychology, 84(4), 822–848. 10.1037/0022-3514.84.4.822 [PubMed: 12703651]

Clarkson M, Heads G, Hodgson D, & Probst H (2019). Does the intervention of mindfulness reduce levels of burnout and compassion fatigue and increase resilience in pre-registration students? A pilot study. Radiography (London, England: 1995), 25(1), 4–9. 10.1016/j.radi.2018.08.003 [PubMed: 30599829]

Connor K, & Davidson JRT (2003). Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). Depression and Anxiety, 18(2), 76–82. 10.1002/da.10113 [PubMed: 12964174]

Davis JP, Pedersen ER, Borsari B, Bowen S, Owen J, Sedano A, Fitzke R, Delacruz J, Tran DD, Buch K, Saba S, Canning L, & Bunyi J (2023). Development of a mobile mindfulness smartphone app for post-traumatic stress disorder and alcohol use problems for veterans: Beta test results and study protocol for a pilot randomized controlled trial. Contemporary Clinical Trials, 129, 107181. 10.1016/j.cct.2023.107181 [PubMed: 37059261]

Duffy JR, Thomas ML, Bormann J, & Lang AJ (2022). Psychometric comparison of the Mindful Attention Awareness Scale and the Five Facet Mindfulness Questionnaire in veterans treated for posttraumatic stress disorder. Mindfulness, 13(9), 2202–2214. 10.1007/s12671-022-01948-x

Egami S, & Highfield MEF (2023). The effect of a mindfulness phone application on NICU nurses' professional quality of life. Advances in Neonatal Care: Official Journal of the National Association of Neonatal Nurses, 23(3), E70–E78. 10.1097/ANC.0000000000001064 [PubMed: 37036941]

Ehlers A (2010). Understanding and treating unwanted trauma memories in posttraumatic stress disorder. Zeitschrift Fur Psychologie, 218(2), 141–145. 10.1027/0044-3409/a000021 [PubMed: 22095462]

Fiol-DeRoque MA, Serrano-Ripoll MJ, Jiménez R, Zamanillo-Campos R, Yáñez-Juan AM, Bennasar-Veny M, Leiva A, Gervilla E, García-Buades ME, García-Toro M, Alonso-Coello P, Pastor-Moreno G, Ruiz-Pérez I, Sitges C, García-Campayo J, Llobera-Cánaves J, & Ricci-Cabello I (2021). A mobile phone-based intervention to reduce mental health problems in health care workers during the COVID-19 pandemic (PsyCovidApp): Randomized controlled trial. JMIR mHealth and uHealth, 9(5), e27039. 10.2196/27039 [PubMed: 33909587]

Forbes D, Creamer M, & Biddle D (2001). The validity of the PTSD checklist as a measure of symptomatic change in combat-related PTSD. Behaviour Research and Therapy, 39(8), 977–986. 10.1016/s0005-7967(00)00084-x [PubMed: 11480838]

Fortney L, Luchterhand C, Zakletskaia L, Zgierska A, & Rakel D (2013). Abbreviated mindfulness intervention for job satisfaction, quality of life, and compassion in primary care clinicians: A pilot study. Annals of Family Medicine, 11(5), 412–420. 10.1370/afm.1511 [PubMed: 24019272]

Fossion P, Leys C, Kempenaers C, Braun S, Verbanck P, & Linkowski P (2015). Beware of multiple traumas in PTSD assessment: The role of reactivation mechanism in intrusive and hyper-arousal symptoms. Aging & Mental Health, 19(3), 258–263. 10.1080/13607863.2014.924901 [PubMed: 24927132]

Galatzer-Levy IR, Huang SH, & Bonanno GA (2018). Trajectories of resilience and dysfunction following potential trauma: A review and statistical evaluation. Clinical Psychology Review, 63, 41–55. 10.1016/j.cpr.2018.05.008 [PubMed: 29902711]

Geng S, Zhou Y, Zhang W, Lou A, Cai Y, Xie J, Sun J, Zhou W, Liu W, & Li X (2021). The influence of risk perception for COVID-19 pandemic on post-traumatic stress disorder in healthcare workers: A survey from four designated hospitals. Clinical Psychology & Psychotherapy, 28(5), 1146–1159. 10.1002/cpp.2564 [PubMed: 33592682]

Han J, Zhang L, Liu Y, Zhang C, Zhang Y, Tang R, & Bi L (2022). Effect of a group-based acceptance and commitment therapy programme on the mental health of clinical nurses during the COVID-19 sporadic outbreak period. Journal of Nursing Management, 30(7), 3005–3012. 10.1111/jonm.13696 [PubMed: 35666250]

Hansen M, Vaegter HB, Ravn SL, & Andersen TE (2023). Validation of the Danish PTSD Checklist for DSM-5 in trauma-exposed chronic pain patients using the Clinician-Administered PTSD Scale for DSM-5. European Journal of Psychotraumatology, 14(1), 2179801. 10.1080/20008066.2023.2179801 [PubMed: 36892217]

Harris R (2019). ACT made simple: An easy-to-read primer on Acceptance and Commitment Therapy (2nd ed.) New Harbinger Publications.

Hayes SC (2016). Acceptance and Commitment Therapy, Relational Frame Theory, and the third wave of behavioral and cognitive therapies – Republished article. Behavior Therapy, 47(6), 869–885. 10.1016/j.beth.2016.11.006 [PubMed: 27993338]

Hayes SC, & Hofmann SG (2017). The third wave of cognitive behavioral therapy and the rise of process-based care. World Psychiatry: Official Journal of the World Psychiatric Association (WPA), 16(3), 245–246. 10.1002/wps.20442 [PubMed: 28941087]

Hayes SC, Luoma JB, Bond FW, Masuda A, & Lillis J (2006). Acceptance and commitment therapy: Model, processes and outcomes. Behaviour Research and Therapy, 44(1), 1–25. 10.1016/j.brat.2005.06.006 [PubMed: 16300724]

Hayes SC, & Smith S (2005). Get out of your mind and into your life: The new acceptance and commitment therapy. New Harbinger.

Hayes SC, Wilson KG, Gifford EV, Follette VM, & Strosahl K (1996). Experiential avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. Journal of Consulting and Clinical Psychology, 64(6), 1152–1168. 10.1037//0022-006x.64.6.1152 [PubMed: 8991302]

Hendricks DS, Lavery MR, Bouillon LE, & Gotfried RS (2020). Evaluating the effectiveness of a mindfulness app among academic advisors. Journal of Technology in Behavioral Science, 5(2), 149–155. 10.1007/s41347-019-00122-w

Hertzog MA (2008). Considerations in determining sample size for pilot studies. Research in Nursing & Health, 31(2), 180–191. 10.1002/nur.20247 [PubMed: 18183564]

Hoedl M, Osmancevic S, Thonhofer N, Reiter L, & Schoberer D (2024). Psychosocial interventions for healthcare workers during the COVID-19 pandemic: Rapid review and meta-analysis. Wiener Medizinische Wochenschrift (1946), 174(3–4), 79–86. 10.1007/s10354-023-01013-9 [PubMed: 37191933]

Hou T, Zhang R, Song X, Zhang F, Cai W, Liu Y, Dong W, & Deng G (2020). Self-efficacy and fatigue among non-frontline health care workers during COVID-19 outbreak: A moderated mediation model of posttraumatic stress disorder symptoms and negative coping. PloS One, 15(12), e0243884. 10.1371/journal.pone.0243884 [PubMed: 33301523]

Johnson SU, Ebrahimi OV, & Hoffart A (2020). PTSD symptoms among health workers and public service providers during the COVID-19 outbreak. PloS One, 15(10), e0241032. 10.1371/journal.pone.0241032 [PubMed: 33085716]

Kang L, Ma S, Chen M, Yang J, Wang Y, Li R, Yao L, Bai H, Cai Z, Xiang Yang B, Hu S, Zhang K, Wang G, Ma C, & Liu Z (2020). Impact on mental health and perceptions of psychological care among medical and nursing staff in Wuhan during the 2019 novel coronavirus disease outbreak: A cross-sectional study. Brain, Behavior, and Immunity, 87, 11–17. 10.1016/j.bbi.2020.03.028 [PubMed: 32240764]

Kelly MM, Reilly ED, Ameral V, Richter S, & Fukuda S (2022). A randomized pilot study of Acceptance and Commitment Therapy to improve social support for veterans with PTSD. Journal of Clinical Medicine, 11(12), 3482. 10.3390/jcm11123482 [PubMed: 35743552]

Kemper KJ, Lynn J, & Mahan JD (2015). What is the impact of online training in mind-body skills? Journal of Evidence-Based Complementary & Alternative Medicine, 20(4), 275–282. 10.1177/2156587215580882 [PubMed: 25962637]

Keng SL, Chin JWE, Mammadova M, & Teo I (2022). Effects of mobile app-based mindfulness practice on healthcare workers: A randomized active controlled trial. Mindfulness, 13(11), 2691–2704. 10.1007/s12671-022-01975-8 [PubMed: 36160038]

Kramer LB, Whiteman SE, Petri JM, Spitzer EG, & Weathers FW (2023). Self-rated versus clinician-rated assessment of posttraumatic stress disorder: An evaluation of discrepancies between the PTSD Checklist for *DSM-5* and the Clinician-Administered PTSD Scale for *DSM-5*. Assessment, 30(5), 1590–1605. 10.1177/10731911221113571 [PubMed: 35915927]

Leng M, Wei L, Shi X, Cao G, Wei Y, Xu H, Zhang X, Zhang W, Xing S, & Wei H (2021). Mental distress and influencing factors in nurses caring for patients with COVID-19. Nursing in Critical Care, 26(2), 94–101. 10.1111/nicc.12528 [PubMed: 33448567]

Levi P, & Moss J (2022). Intensive care unit nurses' lived experiences of psychological stress and trauma caring for COVID-19 patients. Workplace Health & Safety, 70(8), 358–367. 10.1177/21650799211064262 [PubMed: 35112605]

Levin ME, Pistorello J, Hayes SC, Seeley JR, & Levin C (2015). Feasibility of an Acceptance and Commitment Therapy adjunctive web-based program for counseling centers. Journal of Counseling Psychology, 62(3), 529–536. 10.1037/cou0000083 [PubMed: 25961755]

Li X, Zhou Y, & Xu X (2021). Factors associated with the psychological well-being among front-line nurses exposed to COVID-2019 in China: A predictive study. Journal of Nursing Management, 29(2), 240–249. 10.1111/jonm.13146 [PubMed: 32890453]

Marvaldi M, Mallet J, Dubertret C, Moro MR, & Guessoum SB (2021). Anxiety, depression, trauma-related, and sleep disorders among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. Neuroscience and Biobehavioral Reviews, 126, 252–264. 10.1016/j.neubiorev.2021.03.024 [PubMed: 33774085]

McGuire JM, & Zhen T (2019). Use of a mindfulness smartphone app in an advanced psychiatry elective for pharmacy students. Innovations in Pharmacy, 10(3), 13. 10.24926/iip.v10i3.1346

Meyer EC, Walser R, Hermann B, La Bash H, DeBeer BB, Morissette SB, Kimbrel NA, Kwok OM, Batten SV, & Schnurr PP (2018). Acceptance and commitment therapy for co-occurring posttraumatic stress disorder and alcohol use disorders in veterans: Pilot treatment outcomes. Journal of Traumatic Stress, 31(5), 781–789. 10.1002/jts.22322 [PubMed: 30338561]

Moon DJ, Han MA, Park J, & Ryu SY (2021). Post-traumatic stress and related factors among hospital nurses during the COVID-19 outbreak in Korea. The Psychiatric Quarterly, 92(4), 1381–1391. 10.1007/s11126-021-09915-w [PubMed: 33788071]

Moore CG, Carter RE, Nietert PJ, & Stewart PW (2011). Recommendations for planning pilot studies in clinical and translational research. Clinical and Translational Science, 4(5), 332–337. 10.1111/j.1752-8062.2011.00347.x [PubMed: 22029804]

Nolen-Hoeksema S, Wisco BE, & Lyubomirsky S (2008). Rethinking rumination. Perspectives on Psychological Science: A Journal of the Association for Psychological Science, 3(5), 400–424. 10.1111/j.1745-6924.2008.00088.x [PubMed: 26158958]

North CS, & Oliver J (2013). Analysis of the longitudinal course of PTSD in 716 survivors of 10 disasters. Social Psychiatry and Psychiatric Epidemiology, 48(8), 1189–1197. 10.1007/s00127-012-0639-x [PubMed: 23269398]

Orrù G, Marzetti F, Conversano C, Vagheggini G, Miccoli M, Ciacchini R, Panait E, & Gemignani A (2021). Secondary traumatic stress and burnout in healthcare workers during COVID-19 outbreak. International Journal of Environmental Research and Public Health, 18(1), 337. 10.3390/ijerph18010337 [PubMed: 33466346]

Phan P, Mitragotri S, & Zhao Z (2023). Digital therapeutics in the clinic. Bioengineering & Translational Medicine, 8(4), e10536. 10.1002/btm2.10536 [PubMed: 37476062]

Preti E, Di Mattei V, Perego G, Ferrari F, Mazzetti M, Taranto P, Di Pierro R, Madeddu F, & Calati R (2020). The psychological impact of epidemic and pandemic outbreaks on healthcare workers: Rapid review of the evidence. Current Psychiatry Reports, 22(8), 43. 10.1007/s11920-020-01166-z [PubMed: 32651717]

Ramachandran HJ, Bin Mahmud MS, Rajendran P, Jiang Y, Cheng L, & Wang W (2023). Effectiveness of mindfulness-based interventions on psychological well-being, burnout and post-traumatic stress disorder among nurses: A systematic review and meta-analysis. Journal of Clinical Nursing, 32(11–12), 2323–2338. 10.1111/jocn.16265 [PubMed: 35187740]

Reyes AT, Bhatta TR, Muthukumar V, & Gangozo WJ (2020). Testing the acceptability and initial efficacy of a smartphone-app mindfulness intervention for college student veterans with PTSD. Archives of Psychiatric Nursing, 34(2), 58–66. 10.1016/j.apnu.2020.02.004 [PubMed: 32248935]

Reyes AT, Song H, Bhatta TR, & Kearney CA (2022). Exploring the relationships between resilience, mindfulness, and experiential avoidance after the use of a mindfulnessand acceptance-based mobile app for posttraumatic stress disorder. Perspectives in Psychiatric Care, 58(2), 776–784. 10.1111/ppc.12848 [PubMed: 34018197]

Riedel B, Horen SR, Reynolds A, & Hamidian Jahromi A (2021). Mental health disorders in nurses during the COVID-19 pandemic: Implications and coping strategies. Frontiers in Public Health, 9, 707358. 10.3389/fpubh.2021.707358 [PubMed: 34765579]

Rodriguez-Paras C, Tippey K, Brown E, Sasangohar F, Creech S, Kum HC, Lawley M, & Benzer JK (2017). Posttraumatic stress disorder and mobile health: App investigation and scoping literature review. JMIR mHealth and uHealth, 5(10), e156. 10.2196/mhealth.7318 [PubMed: 29074470]

Ruiz-Párraga GT, & López-Martínez AE (2015). The role of experiential avoidance, resilience and pain acceptance in the adjustment of chronic back pain patients who have experienced a traumatic event: A path analysis. Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine, 49(2), 247–257. 10.1007/s12160-014-9654-3 [PubMed: 25236672]

Schulz KF, Altman DG, & Moher D (2010). CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials. BMJ (Clinical Research ed.), 340(mar23 1), c332–c332. 10.1136/bmj.c332

Sharma M (2015). Multi-theory model (MTM) for health behavior change. WebmedCentral, 6(9), WMC004982.

Sharma M (2022). Theoretical foundations of health education and health promotion (4th ed.) Jones and Bartlett Learning.

Short NA, Boffa JW, Clancy K, & Schmidt NB (2018). Effects of emotion regulation strategy use in response to stressors on PTSD symptoms: An ecological momentary assessment study. Journal of Affective Disorders, 230, 77–83. 10.1016/j.jad.2017.12.063 [PubMed: 29407542]

Song X, Fu W, Liu X, Luo Z, Wang R, Zhou N, Yan S, & Lv C (2020). Mental health status of medical staff in emergency departments during the Coronavirus disease 2019 epidemic in China. Brain, Behavior, and Immunity, 88, 60–65. 10.1016/j.bbi.2020.06.002 [PubMed: 32512134]

Stephenson KR, Simpson TL, Martinez ME, & Kearney DJ (2017). Changes in mindfulness and posttraumatic stress disorder symptoms among veterans enrolled in mindfulness-based stress reduction. Journal of Clinical Psychology, 73(3), 201–217. 10.1002/jclp.22323 [PubMed: 27152480]

Stoddard JA, & Afari N (2014). The big book of ACT metaphors: A practitioner's guide to experiential exercises and metaphors in Acceptance and Commitment Therapy. New Harbinger Publications.

Sun Z, Yu C, Zhou Y, & Liu Z (2021). Psychological interventions for healthcare providers with PTSD in life-threatening pandemic: Systematic review and meta-analysis. Frontiers in Psychiatry, 12, 697783. 10.3389/fpsyt.2021.697783 [PubMed: 34393858]

Thompson RW, Arnkoff DB, & Glass CR (2011). Conceptualizing mindfulness and acceptance as components of psychological resilience to trauma. Trauma, Violence & Abuse, 12(4), 220–235. 10.1177/1524838011416375

Treynor G, Gonzalez R, & Nolen-Hoeksema S (2003). Rumination reconsidered: A psychometric analysis. Cognitive Therapy and Research, 27(3), 247–259. 10.1023/A:1023910315561

Tullis T, & Albert W (2008). Measuring the user experience: Collecting, analyzing, and presenting usability metrics. Morgan Kaufmann.

Vujanovic AA, Niles B, Pietrefesa A, Schmertz SK, & Potter CM (2011). Mindfulness in the treatment of posttraumatic stress disorder among military veterans. Professional Psychology: Research and Practice, 42(1), 24–31. 10.1037/a0022272

Weathers FW, Litz BT, Keane TM, Palmieri PA, Marx BP, Schnurr PP (2013). The PTSD Checklist for DSM-5 (PCL-5). http://www.ptsd.va.gov/professional/assessment/adult-sr/ptsd-checklist.asp

Weaver SS, Kroska EB, Ross MC, Sartin-Tarm A, Sellnow KA, Schaumberg K, Kiehl KA, Koenigs M, & Cisler JM (2020). Sacrificing reward to avoid threat: Characterizing PTSD in the context of a trauma-related approach–avoidance conflict task. Journal of Abnormal Psychology, 129(5), 457–468. 10.1037/abn0000528 [PubMed: 32437204]

Webb CA, Swords CM, Murray L, & Hilt LM (2021). App-based mindfulness training for adolescent rumination: Predictors of immediate and cumulative benefit. Mindfulness, 12(10), 2498–2509. 10.1007/s12671-021-01719-0 [PubMed: 35432625]

Weiner L, Berna F, Nourry N, Severac F, Vidailhet P, & Mengin AC (2020). Efficacy of an online cognitive behavioral therapy program developed for healthcare workers during the COVID-19 pandemic: The REduction of STress (REST) study protocol for a randomized controlled trial. Trials, 21(1), 870. 10.1186/s13063-020-04772-7 [PubMed: 33087178]

Wharton E, Edwards KS, Juhasz K, & Walser RD (2019). Acceptance-based interventions in the treatment of PTSD: Group and individual pilot data using Acceptance and Commitment Therapy. Journal of Contextual Behavioral Science, 14, 55–64. 10.1016/j.jcbs.2019.09.006

Yunitri N, Chu H, Kang XL, Jen HJ, Pien LC, Tsai HT, Kamil AR, & Chou KR (2022). Global prevalence and associated risk factors of posttraumatic stress disorder during COVID-19 pandemic: A meta-analysis. International Journal of Nursing Studies, 126, 104136. 10.1016/j.ijnurstu.2021.104136 [PubMed: 34856503]

Zakeri MA, Hossini Rafsanjanipoor SM, Zakeri M, & Dehghan M (2021). The relationship between frontline nurses' psychosocial status, satisfaction with life and resilience during the prevalence of COVID-19 disease. Nursing Open, 8(4), 1829–1839. 10.1002/nop2.832 [PubMed: 33675182]

Zhang D, Lee EKP, Mak ECW, Ho CY, & Wong SYS (2021). Mindfulness-based interventions: An overall review. British Medical Bulletin, 138(1), 41–57. 10.1093/bmb/ldab005 [PubMed: 33884400]
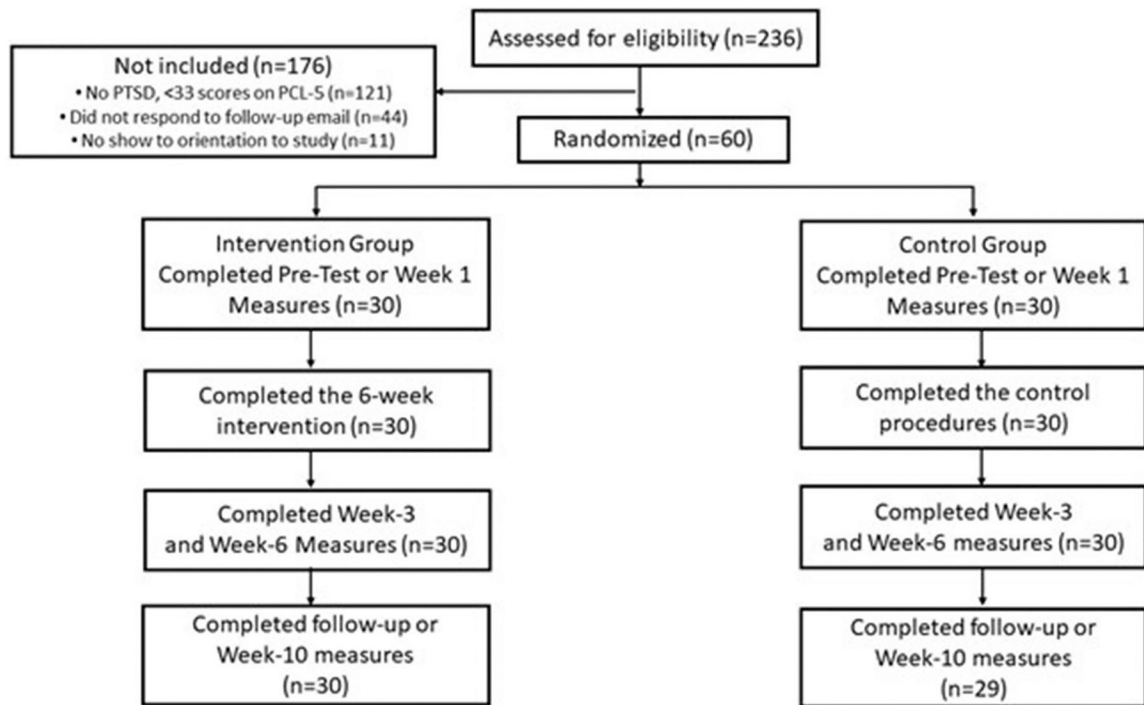
Figure 1.
CONSORT flow diagram.

Table 1.

Participant demographics by group.

Variable	Intervention ($n = 30$)	Control ($n = 30$)
Age	36.4 ($SD = 8.22$)	34.3 ($SD = 8.54$)
Gender		
Female	20	20
Male	10	10
Race		
White	14	15
African American	14	13
Asian	1	1
Hispanic	1	1
Employment		
Full-time	28	26
Part-time, Per Diem, Casual	1	3
Unemployed	1	1
Licensure Status		
Registered Nurse	26	25
Licensed Practical nurse	4	5
Marital Status		
Married/In a long-term Relationship	25	24
Single/Divorced	5	6

Table 2.

Cross-sectional comparison of outcomes using GEE standard errors.

Variable	Intervention Group Mean score (SD)	Control Group Mean score (SD)	t	p*	Cohen's d
PTSD Symptoms					
PCL-5 Week 1	57.77 (SD = 13.18)	55.23 (SD = 12.24)	.772	.443	.199
PCL-5 Week 3	33.20 (SD = 13.01)	41.70 (SD = 15.86)	2.34	.020*	.586
PCL-5 Week 6	20.20 (SD = 12.29)	43.80 (SD = 15.64)	6.499	<.001*	1.678
PCL-5 Week 10	23.20 (SD = 13.66)	39.90 (SD = 16.11)	4.298	<.001*	1.119
Rumination					
RRs Week 1	57.93 (SD = 12.06)	57.53 (SD = 11.92)	.129	.898	.033
RRs Week 3	52.53 (SD = 8.88)	56.87 (SD = 11.31)	1.651	.104	.426
RRs Week 6	44.80 (SD = 11.83)	56.93 (SD = 11.43)	4.040	<.001*	1.043
RRs Week 10	45.50 (SD = 11.34)	54.10 (SD = 9.50)	3.153	.003*	.821
Experiential Avoidance					
AAQ Week 1	30.10 (SD = 7.22)	28.50 (SD = 10.42)	.691	.492	.178
AAQ Week 3	28.60 (SD = 7.46)	29.23 (SD = 6.81)	.343	.733	.089
AAQ Week 6	23.37 (SD = 7.86)	30.37 (SD = 7.60)	3.508	<.001*	.906
AAQ Week 10	22.17 (SD = 7.46)	28.48 (SD = 7.87)	3.165	.002*	.824
Resilience					
CD-RISC Week 1	67.77 (SD = 13.62)	64.10 (SD = 17.19)	.916	.364	.236
CD-RISC Week 3	63.70 (SD = 11.53)	62.50 (SD = 15.99)	.333	.740	.086
CD-RISC Week 6	70.07 (SD = 11.72)	66.87 (SD = 13.92)	.963	.339	.249
CD-RISC Week 10	66.93 (SD = 14.63)	67.48 (SD = 15.48)	.140	.889	.037
Mindfulness					
MAAS Week 1	3.29 (SD = 1.12)	3.31 (SD = 0.71)	.104	.917	.027
MAAS Week 3	3.39 (SD = 0.92)	3.20 (SD = 0.73)	.900	.372	.232
MAAS Week 6	3.83 (SD = 0.97)	3.46 (SD = 0.72)	1.702	.094	.439
MAAS Week 10	3.91 (SD = 1.14)	3.45 (SD = 0.81)	1.794	.078	.824

*
Significance level at $p < 0.05$; note: Week 1 (baseline); Week 3 (mid-intervention); Week 6 (post-intervention); and Week 10 (follow-up). Cohen's d (small = 0.3, moderate = 0.5, large = 0.8). Intervention group had $N = 30$ for Weeks 1 to 10 and Control group had $N = 30$ for Weeks 1,3, and 6 and $N = 29$ for Week 10.