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WORLDVIEWS ON EVIDENCE-BASED NURSING

REVIEW ARTICLE

The use of mHealth apps to improve hospital nurses' mental health and well-being: A systematic review

Cynthia Moore MBOE, BSN[1] | Stephanie Kelly PhD, RN[2] | Bernadette Mazurek Melnyk PhD, APRN-CNP, EBP-C, FAANP, FNAP, FAAN[3,4,5]

[1]College of Nursing, The Ohio State University, Columbus, Ohio, USA

[2]College of Nursing, University of Arizona, Gilbert, Arizona, USA

[3]Evidence-Based Practice, College of Nursing, Columbus, Ohio, USA

[4]Pediatrics and Psychiatry, College of Medicine, Columbus, Ohio, USA

[5]College of Nursing, The Helene Fuld Health Trust National Institute for EBP, Columbus, Ohio, USA

Correspondence
Cynthia Moore, College of Nursing, The Ohio State University, 1577 Neil Avenue, Columbus, OH 43210, USA.
Email: cindimoore@hotmail.com

Abstract

Background: Nursing well-being has become a heightened focus since the COVID-19 pandemic. Nurses are leaving the profession early in their careers or retiring sooner than expected. Those who remain in the workforce report higher levels of burnout, anxiety, depression, and exhaustion. There is concern that there may be a shortage of at least half a million nurses by 2030.

Aims: This systematic review aimed to investigate the evidence of using a mental health promotion mHealth app to improve the mental health of hospital nurses.

Methods: A systematic search was conducted in CINAHL Plus with Full Text, MEDLINE with Full Text, Professional Development Collection, Psychology and Behavioral Sciences Collection, Sociological Collection, PsycInfo, Embase, and PubMed with search dates of January 2012–November 15, 2022. The mHealth intervention needed to be asynchronously delivered through a smartphone with hospital nurse participants to be included in this review.

Results: Of the 157 articles screened for this review, six were included. Primary outcome variables were anxiety, burnout, coping, depression, self-efficacy, stress, well-being, and work engagement. Intervention types included mindfulness-based interventions (MBIs), cognitive behavioral therapy (CBT), stress inoculation therapy (SIT), psychoeducation, and stress management. Anxiety, depression, well-being, and burnout improved with MBIs; depression improved with CBT; and anxiety and active coping improved with SIT.

Linking evidence to action: This review demonstrated promising findings in using mHealth apps to improve the mental health of hospital nurses. However, more randomized controlled trials with larger sample sizes may reveal which type of mHealth app and how much exposure to the intervention is more effective in improving specific mental health symptoms. Longitudinal follow-up is also recommended to study sustainability of the mental health improvements.

KEYWORDS
anxiety, burnout, mental health, mHealth app, mindfulness-based intervention, nurses, review, smartphone, stress, well-being

INTRODUCTION

Nurses are reporting more negative mental health symptoms than ever before, especially those who care for patients in the hospital setting. Post-pandemic studies found that 68% of nurses reported high levels of stress, 59% reported exhaustion, 45% reported anxiety, 38% felt burnout, and over 50% reported thoughts of leaving their job in the next 6 months (American Nurses Association [ANA], 2022). These findings have negative implications not only for the personal well-being of nurses but also for the stability of the nursing workforce and the ability to deliver quality healthcare to our communities in the near future. Zhang et al. (2017) estimate that by 2030, the United States will have a nursing workforce shortfall of over half a million nurses. Supporting the mental health of hospital nurses is one way to help build a healthy nursing workforce that can meet future healthcare demands.

Nurses who feel supported by their organization by taking part in mental health promotion programs are more likely to succeed in achieving better health (Melnyk et al., 2021). There are numerous randomized controlled trials (RCTs) that have demonstrated sustained positive health effects in healthcare workers from interventions designed to improve mental health, well-being, resilience, lifestyle habits, and physical activity (Mistretta et al., 2018; Spinelli et al., 2019; Stratton et al., 2017). Many interventions like these have been carried out in settings that require attendance to a web-based activity or in-person seminar, lasting over an hour or more, with regular follow-up activity (Melnyk et al., 2021). Nurses often find it difficult to attend a class or participate in scheduled events, whether because of personal obligations, work schedules, or lengthy work commute (Ross et al., 2019). Access to mental health promotion programs can be facilitated by delivering the intervention through a smartphone, commonly referred to as a mobile health (mHealth) app (Lewis et al., 2014).

The World Health Organization defines an mHealth app as any health promotion program that is delivered using mobile phone technology (Hassen, 2020). Since the onset of the COVID-19 pandemic, the market growth of mental health mHealth apps has more than doubled and is expected to continue to grow at a rate of about 20% year after year until 2030 (Grand View Research [GVR], 2023). Apps for depression, anxiety, meditation, and stress dominate the market shares of mental health apps, and stress management (SM) is predicted to have the most rapid expansion in the coming years (GVR, 2023). There is growing evidence that the recent technological advancements in mHealth apps are consistently producing positive outcomes at a clinical level and will continue to improve to meet the health needs of the users (Olsen, 2021). However, researchers are unable to show consistent effectiveness of the apps on sustained improvement in common mental health disorders, such as depression and anxiety in diverse populations (Goldberg et al., 2022; Lu et al., 2022; Tsai et al., 2022). This systematic review aimed to investigate the evidence that using a mental health promotion mHealth app could improve the mental health of hospital nurses, compared to nurses who received a single session, a different mHealth intervention, or nothing at all. Specifically, intervention approaches used in each mHealth app, occupational and mental health outcomes measures within and between groups, and sustainability of the outcomes were assessed.

METHODS

This systematic review followed recommendations by the Centre for Reviews and Dissemination guidance for undertaking reviews in health care (Centre for Review and Dissemination, 2008) and is registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42023384846).

Search strategy

Keyword searches were completed using the following databases: CINAHL Plus with Full Text, MEDLINE with Full Text, Professional Development Collection, Psychology and Behavioral Sciences Collection, Sociological Collection; PsycInfo; Embase; and PubMed. We used a lower date boundary of January 2012, when smartphones were being developed, and limiters of "all adult" and "adulthood." MeSH terms and Boolean operations were used to develop a comprehensive, nested search list (Table 1). Relevant article reference lists were hand-searched, but no new articles were found. One author (CM) performed this search and exported all available articles. Two authors (CM and SK) reviewed titles and abstracts to assess for eligibility for the review. The last search was performed on November 15, 2022 to ensure new literature was not overlooked.

TABLE 1 Search terms.

(nurse* OR nurses OR nursing OR "nursing student*" OR "nurse, registered" OR "registered nurse*" OR "nursing personnel" OR "new grad*" OR "newly graduated nurse*" OR "nursing staff*")
AND
(mindfulness OR meditation OR "mindfulness meditation*" OR CBT or "cognitive behavioral therapy*" or "cognitive behavioral*" OR "stress management*" OR "well being" OR "well-being*" OR resilience OR coping OR "guided imagery*" OR "mindfulness-based intervention*" OR "mind–body therapy*" OR "self-care" OR "self care*" OR "self-help")
AND
("mhealth app*" OR "ehealth app*" OR "mobile phone*" OR "cell phone*" OR "m-health" or "e-health" OR smartphone* OR "mobile phone*" OR "app, mobile" OR "application, mobile" OR "digital health" OR phone* OR "mobile health")
AND
("compassion fatigue*" OR burnout OR "career burnout" OR "work burnout" OR "emotional distress" OR "emotional stress" OR "job stress*" OR "occupational stress*" OR "job stress*" OR "mental strain" OR "mental fatigue" OR "work stress*" OR "work-related stress*" OR "workplace stress*")
NOT
Patient

Eligibility criteria

Three inclusion criteria were used: (1) direct patient care hospital nurses, nurse practitioners (NPs), and nursing or NP students; (2) intervention must be delivered solely by smartphone; and (3) intervention can be accessed asynchronously. Six exclusion criteria were used: (1) any technology-based intervention that did not use a smartphone; (2) any intervention that offered supplemental

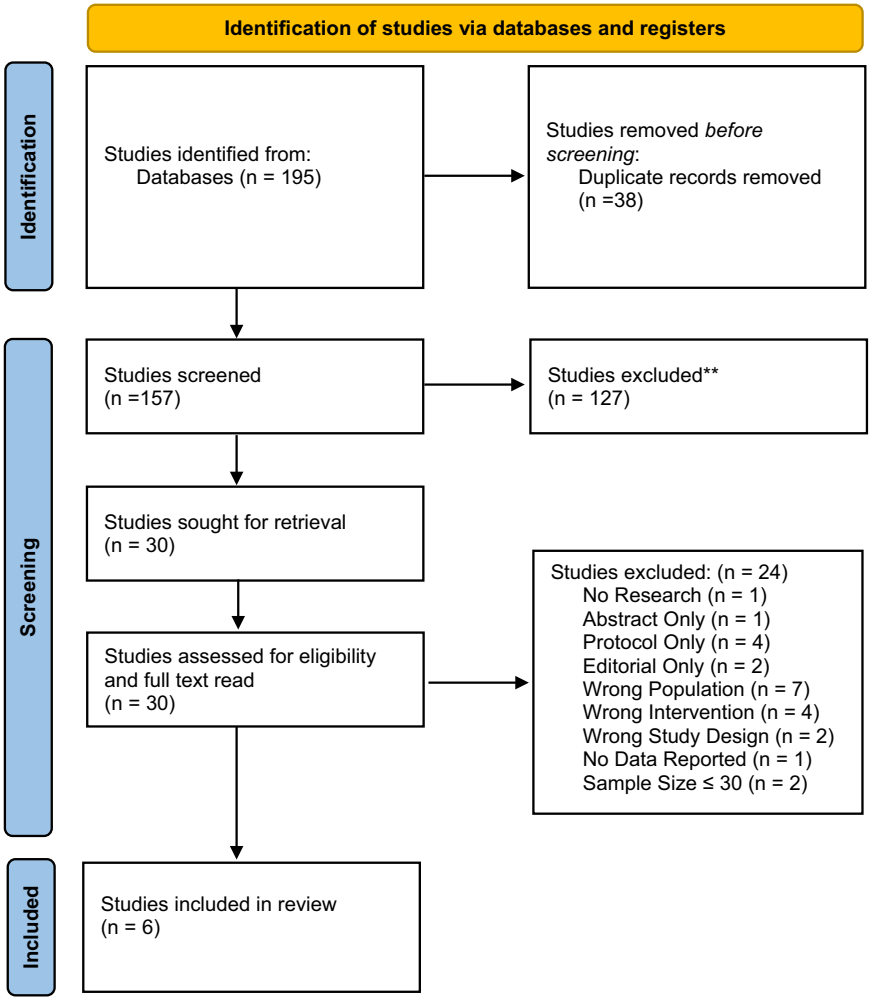

FIGURE 1 Flowchart of study identification/PRISMA guidelines (Page et al., 2021).

TABLE 2 JBI critical appraisal checklist tool for RCT studies.

	Was true randomization used for assignment of participants to treatment groups?	Was allocation to treatment groups concealed?	Were treatment groups similar at the baseline?	Were participants blind to treatment assignment?	Were those delivering treatment blind to treatment assignment?	Were outcomes assessors blind to treatment assignment?
Villani 2013	U	U	U	U	U	U
Hwang	Y	U	N	Y	NA	U
Imamura	Y	N	U	N	N	N
Sasaki	Y	N	U	N	N	N

Note: Green indicates was met. Yellow indicates unclear. Red indicates not met.

Abbreviations: JBI, Joanna Briggs Institute; N, No; NA, not applicable; U, unclear; Y, Yes.

coaching, even if the primary intervention was delivered by smartphone; (3) any in-person class delivery of the intervention; (4) any intervention that required access to a computer; (5) any intervention that required synchronous participation in a group setting; and (6) any study that included any other healthcare workers.

Operational definitions of excluded terms were: (1) *Smartphone* is any mobile phone that is capable of executing a software application; (2) *Technology-based* intervention is any program that is primarily designed to be delivered by signing into a website from a desktop or laptop computer; (3) *Supplemental coaching* is any written or verbal interaction with another person whose role is to provide counseling or advice to a participant in the study; and (4) *In-person class* is any program that requires attendance at a specified time, usually in a group setting.

Study selection

All relevant articles were exported into Zotero© and then into Covidence©. Duplicate articles were automatically removed. Two authors (CM and SK) applied eligibility criteria to independently select articles for inclusion in screening and full-text review and discussed and resolved any disagreements.

Data extraction and quality evaluation

An extraction template was developed to collect the following: (1) study title, date, and first author; (2) country; (3) conceptual model; (4) study setting and population description; (5) aim of the study; (6) study design; (7) demographic variables; (8) intervention description, dose, and time span; (9) mhealth app name; and (10) outcome variables and measures. Quality was assessed using Joanna Briggs Institute (JBI) critical appraisal tools for RCTs and cohort studies (Moola et al., 2020; Tufanaru et al., 2020). Extraction and quality assessment were performed independently by two authors (CM and SK) and any disagreements were discussed until an agreement was reached.

Data analysis

Pooled statistical analysis was not possible because outcome variables in the included studies were measured using different scales, and sample sizes amongst the majority of the studies were small, either by design or attrition. Reported significance, based on an alpha of 0.05, was descriptively compared.

RESULTS

Search results

The initial search resulted in 195 articles, of which 38 were duplicates. Initial screening resulted in 127 articles being excluded. Of the remaining 30 articles, only nine met eligibility criteria (Figure 1). Full-text review demonstrated that three of the nine studies (Hommelson, 2022; Jakel et al., 2016; Villani et al., 2012) either did not report data or did not have a large enough sample size (≥30) to produce data suitable for statistical analysis (Gliner et al., 2017, p. 153). These were removed from the study selection, leaving six studies for the review.

Study quality

The results of the JBI RCT and cohort critical appraisals are in Tables 2 and 3. Of the four RCTs, one met three of the 13 criteria (Villani et al., 2013), and three met seven of the 13 criteria (Hwang & Jo, 2019; Imamura et al., 2021; Sasaki et al., 2021). Of the two non-RCTs, one met five of the 11 criteria (Knill et al., 2021) and one met four of the 11 criteria (Foley & Lanzillotta-Rangeley, 2021). Because

Were treatment groups treated identically other than the intervention of interest?	Was follow up complete and if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Were participants analyzed in the groups to which they were randomized?	Were outcomes measured in the same way for treatment groups?	Were outcomes measured in a reliable way?	Was appropriate statistical analysis used?	Was the trial design appropriate, and any deviations from the standard RCT design accounted for in the conduct and analysis of the trial?
U	U	U	U	Y	Y	Y
N	Y	N	Y	Y	Y	Y
N	Y	Y	Y	Y	Y	Y
N	Y	Y	Y	Y	Y	Y

TABLE 3 JBI critical appraisal checklist tool for cohort studies.

	Were the two groups similar and recruited from the same population?	Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Was the exposure measured in a valid and reliable way?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Were the outcomes measured in a valid and reliable way?	Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	Were strategies to address incomplete follow up utilized?	Was appropriate statistical analysis used?
Foley	NA	NA	Y	U	NA	U	Y	Y	U	U	Y
Knill	NA	NA	Y	Y	N	U	Y	Y	N	U	Y

Note: Green indicates was met. Yellow indicates unclear. Red indicates not met.

Abbreviations: JBI, Joanna Briggs Institute; N, No; NA, not applicable; U, unclear; Y, Yes.

these two studies had only one experimental group and no control group (Foley & Lanzillotta-Rangeley, 2021; Knill et al., 2021), two of the 11 criteria related to comparing the experimental group with the control group were not applicable.

Characteristics of selected studies

Six studies were selected for inclusion in this review (Foley & Lanzillotta-Rangeley, 2021; Hwang & Jo, 2019; Imamura et al., 2021; Knill et al., 2021; Sasaki et al., 2021; Villani et al., 2013). Three were RCTs, one was a secondary analysis of one of the selected RCTs, one was pre-experimental, and one was an evidence-based-practice quality improvement project (Table 4). All participants were hospital clinical nurses, with sample sizes ranging from 30 to 949. Of the studies that reported gender and level of education, 86% of participants were female, 23.2% had an associate degree or diploma, 70.8% had a bachelor's degree, and 6% had a graduate degree or were in a graduate degree program.

Findings

All six studies had significant findings using an alpha of 0.05 in their statistical analysis. One study showed improvement in well-being and burnout in nurses and NPs at 30, 60, and 90 days when the groups were pooled (Knill et al., 2021), and one showed improvement in stress and self-efficacy within the experimental group at 4 weeks (Hwang & Jo, 2019). However, both of these studies note that the participants had normal baseline scores of well-being, burnout (Knill et al., 2021), anxiety, and depression (Hwang & Jo, 2019) at the start of the study, potentially decreasing the effects of the interventions. Imamura et al. (2021) showed a decrease in depression at 3 months in the intervention group that used CBT modules in a fixed order over a 6-week period, but only for those whose baseline depression was ≤10 on the Depression Anxiety Stress Scale-21, and these changes were not significant at 7 months. Sasaki et al. (2021) reported an increase in work engagement in the intervention group that used a fixed order of CBT modules, but changes were not significant at 7 months. Foley and Lanzillotta-Rangeley (2021) demonstrated a decrease in depression, anxiety, and stress. Lastly, one study had improvement in anxiety and coping at 4 weeks (Villani et al., 2013).

Attrition was problematic for two of the six studies. Foley and Lanzillotta-Rangeley (2021) reported a completion rate of 40%. Knill et al. (2021) reported attrition in both groups, resulting in a completion rate of 58% by the nurse group and 42% by the NP group.

A common feature of mHealth apps is the ability to analyze user engagement and ongoing use of the app by tracking the number of modules accessed, number of minutes a program is used, and how often the app is accessed (Fleming et al., 2018). Three of the studies in this review reported the mHealth app usage metrics in their studies. Foley and Lanzillotta-Rangeley (2021) showed that

the nurse anesthesia students completed an average of 6.5 sessions out of the 10, averaging 51.2 min of meditation over the 10-day period. Knill et al. (2021) reported that the oncology nurses and NPs meditated for a combined 16,010 min; app usage by nurses dropped from 58% at day 30 to 39% at day 90, and NP app usage dropped from 72% at day 30 to 46% at day 90. The nurses reported group use of the app while at work, so only one user was tracked, which made the individual usage rate appear lower. The most used program by all the participants combined was sleep hygiene (Knill et al., 2021). Imamura et al. (2021) and Sasaki et al. (2021) reported a module completion rate of >83% for all six modules of programs A and B, and a survey completion rate of >90% for programs A and B and the control group at 3 and 7 months. Villani et al. (2013) reported 100% completion for all eight videos. Hwang and Jo (2019) did not report app usage history.

Primary interventions (aim 1)

Two studies used the mindfulness-based intervention (MBI) app, Headspace™ (Foley & Lanzillotta-Rangeley, 2021; Knill et al., 2021). Headspace™ was developed in 2012 by a Buddhist monk, Andy Puddicombe. Features of Headspace™ include guided meditations, breathing exercises, and psychoeducation to improve stress and anxiety. Over 2100 businesses have partnered with Headspace™ to offer free access to their employees, and over 70 million people have downloaded the app (Headspace, n.d.; Curry, 2023). Headspace™ has been shown to reduce stress and increase mindfulness and well-being in research studies (Economides et al., 2018; Flett et al., 2018; Howells et al., 2014). Headspace™ has a Mobile Application Rating Score of 4.6 out of 5, making it one of the best-rated apps available (Wang et al., 2021). Headspace™ offers a 10 day program at no charge (Headspace, n.d.). Hwang and Jo (2019) used an un-named proprietary stress-management app to deliver modules for meditation, breathing, yoga, healing music, physical fitness, and diet education. Imamura et al. (2021) and Sasaki et al. (2021) used a proprietary CBT app, ABC SM, to deliver educational modules in varying combinations on behavioral activation, problem solving, CBT techniques, coping, assertiveness, job crafting, and self-compassion. Villani et al. (2013) used Mobile-stress inoculation therapy (SIT), using muscle relaxation exercises, autogenic training, and calming video scenes prior to delivering video with stress-inducing images.

Instrumentation, occupational, and mental health outcomes (aim 2)

Few studies used the same measurement tools to evaluate the effects of the mHealth app interventions (Table 5). Occupational health outcomes included work engagement, perceived stress, job stress, emotional labor, and burnout. Mental health outcomes included anxiety, depression, self-efficacy, well-being, and coping.

Sustainability of outcomes (aim 3)

Of the six studies reviewed, four measured outcomes within the boundaries of the intervention length (Table 4). Imamura et al. (2021) and Sasaki et al. (2021) were the only studies to evaluate outcomes after the intervention ended, at 3 and 7 months. They demonstrated a decrease in depression and an increase in work engagement, respectively, at 3 months, but no significant effect was observed at 7 months.

DISCUSSION

The purpose of this review was to evaluate existing evidence of the effects of mHealth interventions in the hospital inpatient nurse population. Improvement in stress, anxiety, depression, well-being, and burnout was seen with the MBIs, which is in agreement with prior research showing that MBIs improve stress, depression, and anxiety in the nursing population (Green & Kinchen, 2021). A meta-analysis of 23 studies by Stratton et al. (2017) reported that MBIs delivered by tablet, computer, or smartphone improved overall well-being (depression, stress, and anxiety), with the largest effect size seen in decreasing stress.

Use of a CBT SM app for 6 weeks in this review decreased depression, but only in those whose baseline depression was ≤10 (mild) on the Depression Anxiety Stress Scale-21. This finding agrees with a meta-analysis of mHealth apps used to treat depression, which found that those with mild to moderate depression showed significant improvement in symptoms compared to those with major depression (Firth et al., 2017).

Regarding the length of mHealth app interventions in this review, five of the six studies lasted 6 weeks or less, and one lasted 12 weeks. Two systematic reviews found that CBT-based mHealth apps might have some effect on depression or anxiety if the length of intervention is at least 6 weeks, but the varying quality of the existing evidence limits solid predictive analytics (Hrynyschyn & Dockweiler, 2021; Lu et al., 2022).

SIT decreased anxiety and improved coping. There is a dearth of literature discussing the use of SIT to reduce anxiety in nurses; however, two studies have used SIT for nurses to decrease stress. Both studies reported no significant effects of SIT on stress (Khatoni et al., 2020; Suryanto & Alfian, 2020). A 2016 systematic review examining the effects of SIT on post-traumatic stress disorder (PTSD) found that SIT improved PTSD symptoms initially, but this waned over a 3-month period (Lee et al., 2016).

Effect sustainability of a SM mHealth app reported in two of the included studies demonstrated a loss of positive effects between the 3- and 7-month follow-up surveys (Imamura et al., 2021; Sasaki 2021). In a meta-review of meta-analyses of mHealth apps for mental health, Lecomte et al. (2020) found lasting benefits from 6 to 11 weeks post-intervention for anxiety and 7 to 11 weeks post-intervention for depression. The included RCTs studied mHealth app outcomes on anxiety and depression in various populations,

TABLE 4 Study characteristics.

First author and year	Study conceptual model	Study design	Study setting	Population description	Sample size pre/post	mHealth app description	mHealth intervention instructions
Villani 2013	Karasek's Job Strain Model	RCT	Medical oncology wards in Milan, Italy	Oncology nurses F—30; M—0	30/30	Mobile SIT	2 15-minute videos twice weekly for 4 weeks
Foley 2021	Lazarus Theory of Stress, Coping, and Adaptation	Pre-experimental (one-group design)	University DNP anesthesia program (SRNAs)	DNP Anesthesia students F—n/a; M—n/a	53/33	Mindfulness-based Intervention	1 module daily for 10 days
Hwang 2019	None	RCT	College hospitals in metropolitan Seoul, Korea	Hospital nurses F—53; M—3	60/56	Proprietary stress management app using music, yoga, and metal healthcare educations	Twice weekly for at least 10 minutes a day for 4 weeks
Knill 2021	None	Evidence-based practice quality improvement project	Inpatient BMT units in a Midwest hospital	BMT nurses and nurse practitioners F—n/a; M—n/a	67/37	Mindfulness-based Intervention	10 minutes daily, 7 days/week for 12 weeks
Imamura 2021	Cognitive behavioral therapy	RCT	Large general hospital in Hanoi, Vietnam	Hospital nurses F—806; M—143	949/873	Proprietary cognitive behavioral therapy stress management programs	Program A—1 module weekly for 6 weeks, in any order; Program B—1 module weekly for 6 weeks in prescribed order
Sasaki 2021	Secondary analysis of work engagement	RCT	Large general hospital in Hanoi, Vietnam	Hospital nurses F – 806;M –143	949/873	Proprietary cognitive behavioral therapy stress management programs	Program A – 1 module weekly for 6 weeks, in any order; Program B—1 module weekly for 6 weeks in prescribed order

Abbreviations: BMT, bone marrow transplant; DNP, Doctor of Nursing Practice; F, female; M, male; SIT, stress inoculation therapy; RCT, randomized controlled trial.

TABLE 5 Study measures and follow-up.

First author	Baseline self-report measures	Measurement tools/scales	First follow-up measure	Last follow-up measure
Foley 2021	Anxiety Depression stress	DASS-21—Depression, Anxiety, Stress scales	10 days	NA
Villani 2013	Active coping Denial Job latitude, Psychological Job demand, Social support at work Perceived stress Anxiety, State; Anxiety, Trait	COPE—Brief Coping Orientation to Problems Experienced JCQ- Job Content Questionnaire MSP—Mesure du Stress Psychologique STAI—State Trait Anxiety Index	Before and after each 5 min video, twice weekly for total of 8 measurements over 4 weeks	NA
Hwang 2019	Anxiety Depression Perceived stress Well-being Job stress Emotional labor Self-efficacy	GAD-7—Generalized Anxiety Disorder-7q PHQ-9—Personal Health Questionnaire-9q PSS-Perceived Stress Scale WHO-5-Well-Being Index-5q Korean Occupational Stress Scale (KOSS) Korean-Emotional Labor scale Self-Efficacy Likert scale	4 weeks	NA
Imamura 2021	Anxiety depression	DASS-21—Depression, Anxiety, Stress scales	12 weeks	28 weeks
Knill 2021	Burnout Well-being	Burnout—one question WBI—Well-being Index	4 weeks	12 weeks
Sasaki 2021	Work engagement	UWES—90 Utrecht Work Engagement Scale–9q	12 weeks	28 weeks

Abbreviations: NA, not applicable.

including healthcare workers, college students, people with chronic illness, and veterans (Lecomte et al., 2020).

While the app usage rates in Knill et al. (2021) may appear low, they are higher than the range of usage rates of similar mHealth apps used by the public, which range from less than 1% to 28% of people either completing app programs or using the app on a regular basis (Fleming et al., 2018). Imamura et al. (2021) and Sasaki et al. (2021) reported that their high participation rate might have resulted from reminder emails and texts sent to participants who were nearing the deadline for completion. Reminders and messaging can be helpful to increase engagement in app use; however, it can also be a source of irritation to the app user and contribute to disengagement if the frequency or content of the reminders increases the user's stress or anxiety (Szinay et al., 2020).

Limitations

Strengths of the studies in this review are the RCT designs of four studies, a 7-month follow-up in two studies, app usage rates in two studies, and module completion rates in three studies. However, sample sizes in all but two of the studies were less than 60 at the study end, either by design or by attrition. Two studies reported that many participants' baseline measures were in the normal range, which would lessen the overall effects of the interventions. All the post-intervention measures were self-reported, which could introduce response bias. Study duration did not extend beyond 12 weeks for any of the included studies and follow-up in all but two of the studies did not extend beyond the study period. Therefore, the sustainability of the positive effects found with the mHealth app usage discussed in this review cannot be determined. Lastly, the studies used many different measures to evaluate outcomes, making pooled analysis of the data problematic.

There are some limitations in our review. We only included studies that measured effects of mHealth apps on hospital nurses. This search restriction limits the ability to compare the effectiveness of mHealth apps used in other healthcare professionals (e.g., physicians, pharmacists). However, we also recognize that hospital nurses may face different stressors and demands than other healthcare workers and may interact with mHealth app interventions differently. Another limitation is that we excluded studies that incorporated coaching, regular check-ins, or peer support as we were interested in the effectiveness of a self-guided mental health mHealth app that does not rely on other integrated interventions for success.

Linking evidence to action

- This review demonstrated promising findings in using mHealth apps to improve the mental health of hospital nurses.
- More RCTs with larger sample sizes may reveal which type of mHealth app and how much exposure to the intervention is more effective in improving specific mental health symptoms.
- Longitudinal follow-up is also recommended to study sustainability of the mental health improvements.

CONCLUSION

From this systematic review, there are very little data available that indicate the dosage of mHealth mental health interventions required to appreciate a change in mental health and well-being outcome variables. Future research should focus on determining a minimum amount of intervention needed for substantial change to be noted. Rigorous longitudinal RCTs are needed to provide valuable evidence regarding both short- and long-term effects of mHealth interventions with nurses who practice in hospital and healthcare settings.

CONFLICT OF INTEREST STATEMENT

None of the authors have conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Cynthia Moore https://orcid.org/0000-0002-8720-1379
Bernadette Melnyk https://orcid.org/0000-0002-4704-1198

REFERENCES

American Nurses Association. (2022, July 26). *COVID-19 survey series: Workplace impact survey*. ANA. https://www.nursingworld.org/practice-policy/work-environment/health-safety/disaster-preparedness/coronavirus/what-you-need-to-know/covid-19-survey-series-anf-2022-workplace-survey/

Centre for Reviews and Dissemination. (2008). *Systematic reviews* (2009th ed.). University of York NHS Centre for Reviews & Dissemination.

Curry, D. (2023, August 16). *Headspace revenue and usage statistics (2023)*. Business of Apps. https://www.businessofapps.com/data/headspace-statistics/

Economides, M., Martman, J., Bell, M. J., & Sanderson, B. (2018). Improvements in stress, affect, and irritability following brief use of a mindfulness-based smartphone app: A randomized controlled trial. *Mindfulness*, *9*(5), 1584–1593. https://doi.org/10.1007/s12671-018-0905-4

Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., & Sarris, J. (2017). The efficacy of smartphone-based mental health interventions for depressive symptoms: A meta-analysis of randomized controlled trials. *World Psychiatry*, *16*(3), 287–298. https://doi.org/10.1002/wps.20472

Fleming, T., Bavin, L., Lucassen, M., Stasiak, K., Hopkins, S., & Merry, S. (2018). Beyond the trial: Systematic review of real-world uptake and engagement with digital self-help interventions for depression, low mood, or anxiety. *Journal of Medical Internet Research*, *20*(6), e199. https://doi.org/10.2196/jmir.9275

Flett, J. M., Hayne, H., Riordan, B. C., Thompson, L. M., & Conner, T. S. (2018). Mobile mindfulness meditation: A randomised controlled trial of the effect of two popular apps on mental health. *Mindfulness*, *10*(5), 863–876. https://doi.org/10.1007/s12671-018-1050-9

Foley, T., & Lanzillotta-Rangeley, J. (2021). Stress reduction through mindfulness meditation in student registered nurse anesthetists. *AANA Journal*, *89*(4), 284–289.

Gliner, J. A., Morgan, G. A., & Leech, N. L. (2017). *Research methods in applied settings* (3rd ed.). Routledge.

Goldberg, S. B., Lam, S. U., Simonsson, O., Torous, J., & Sun, S. (2022). Mobile phone-based interventions for mental health: A systematic meta-review of 14 meta-analyses of randomized controlled trials. *PLOS Digital Health*, *1*(1), e0000002. https://doi.org/10.1371/journal.pdig.0000002

Grand View Research. (2023). *Mental health apps market size, share & trends analysis report by platform type (Android, iOS), by application type (depression and anxiety management, stress management), by region, and segment forecasts, 2023–2030*. https://www.grandviewresearch.com/industry-analysis/mental-health-apps-market-report#

Green, A. A., & Kinchen, E. V. (2021). The effects of mindfulness meditation on stress and burnout in nurses. *Journal of Holistic Nursing*, *39*(4), 356–368. https://doi.org/10.1177/08980101211015818

Hassen, D. (2020). Mobile-aided diagnosis systems are the future of health care. *Eastern Mediterranean Health Journal*, *26*(9), 1135–1140. https://doi.org/10.26719/emhj.20.042

Headspace. (n.d.). *Be kind to your mind*. www.headspace.com

Hommelson, T. (2022). *Mindfulness meditation to decrease stress in pediatric nurses* [Doctoral dissertation, University of Missouri-Kansas City]. MoSpace. https://mospace.umsystem.edu/xmlui/handle/10355/90015

Howells, A., Ivtzan, I., & Eiroa-Orosa, F. (2014). Putting the 'app' in happiness: A randomised controlled trial of a smartphone-based mindfulness intervention to enhance wellbeing. *Journal of Happiness Studies*, *17*(1), 163–185. https://doi.org/10.1007/s10902-014-9589-1

Hrynyschyn, R., & Dockweiler, C. (2021). Effectiveness of smartphone-based cognitive behavioral therapy among patients with major depression: Systematic review of health implications. *JMIR mHealth and uHealth*, *9*(2), e24703. https://doi.org/10.2196/24703

Hwang, W., & Jo, H. (2019). Evaluation of the effectiveness of mobile app-based stress-management program: A randomized controlled trial. *International Journal of Environmental Research and Public Health*, *16*(21), 4270. https://doi.org/10.3390/ijerph16214270

Imamura, K., Tran, T., Nguyen, H., Sasaki, N., Kuribayashi, K., Sakuraya, A., Bui, T., Nguyen, A., Nguyen, Q., Nguyen, N., Nguyen, K., Nguyen, G., Tran, X., Truong, T., Zhang, M., Minas, H., Sekiya, Y., Watanabe, K., Tsutsumi, A., & Kawakami, N. (2021). Effect of smartphone-based stress management programs on depression and anxiety of hospital nurses in Vietnam: A three-arm randomized controlled trial. *Scientific Reports*, *11*(1), 11353. https://doi.org/10.1038/s41598-021-90320-5

Jakel, P., Kenney, J., Ludan, N., Miller, P., McNair, N., & Matesic, E. (2016). Effects of the use of the provider resilience mobile application in reducing compassion fatigue in oncology nursing. *Clinical Journal of Oncology Nursing*, *20*(6), 611–616. https://doi.org/10.1188/16.cjon.611-616

Khatoni, S., Teymouri, F., Pishgooie, S. A., & Khodabakhsh, M. R. (2020). Determining the effectiveness of stress inoculation training on nurses' job stress at selected military hospitals. *Military Caring Sciences*, *7*(1), 26–34. https://doi.org/10.29252/mcs.7.1.26

Knill, K., Warren, B., Melnyk, B., & Thrane, S. (2021). Burnout and well-being: Evaluating perceptions in bone marrow transplantation nurses using a mindfulness application. *Clinical Journal of Oncology Nursing*, *25*(5), 547–554. https://doi.org/10.1188/21.cjon.547-554

Lecomte, T., Potvin, S., Corbière, M., Guay, S., Samson, C., Cloutier, B., Francoeur, A., Pennou, A., & Khazaal, Y. (2020). Mobile apps for mental health issues: Meta-review of meta-analyses. *JMIR mHealth and uHealth*, *8*(5), e17458. https://doi.org/10.2196/17458

Lee, D. J., Schnitzlein, C. W., Wolf, J. P., Vythilingam, M., Rasmusson, A. M., & Hoge, C. W. (2016). Psychotherapy versus pharmacotherapy for posttraumatic stress disorder: Systemic review and meta-analyses to determine first-line treatments. *Depression and Anxiety*, *33*(9), 792–806. https://doi.org/10.1002/da.22511

Lewis, T., Boissaud-Cooke, M., Aungst, T., & Eysenbach, G. (2014). Consensus on use of the term "app" versus "application" for reporting of mhealth research. *Journal of Medical Internet Research*, *16*(7), e174. https://doi.org/10.2196/jmir.3460

Lu, S.-C., Xu, M., Wang, M., Hardi, A., Cheng, A. L., Chang, S.-H., & Yen, P.-Y. (2022). Effectiveness and minimum effective dose of app-based mobile health interventions for anxiety and depression symptom reduction: Systematic review and meta-analysis. *JMIR Mental Health*, *9*(9), e39454. https://doi.org/10.2196/39454

Melnyk, B., Tan, A., Hsieh, A., Gawlik, K., Arslanian-Engoren, C., Braun, L. T., Dunbar, S., Dunbar-Jacob, J., Lewis, L. M., Millan, A., Orsolini, L., Robbins, L. B., Russell, C. L., Tucker, S., & Wilbur, J. (2021). Critical care nurses' physical and mental health, worksite wellness support, and medical errors. *American Journal of Critical Care*, *30*(3), 176–184. https://doi.org/10.4037/ajcc2021301

Mistretta, E. G., Davis, M. C., Temkit, M., Lorenz, C., Darby, B., & Stonnington, C. M. (2018). Resilience training for work-related stress among health care workers. *Journal of Occupational & Environmental Medicine*, *60*(6), 559–568. https://doi.org/10.1097/jom.0000000000001285

Moola, S., Munn, Z., Tufanaru, C., Aromataris, E., Sears, K., Sfetcu, R., Currie, M., Qureshi, R., Mattis, P., Lisy, K., & Mu, P.-F. (2020). Systematic reviews of etiology and risk. In E. Aromataris, & Z. Munn (Eds.), *JBI Manual for Evidence Synthesis*. https://synthesismanual.jbi.global

Olsen, E. (2021, August 4). Digital health apps balloon to more than 250,000 available on the market, according to IQVIA report. *Mobi Health News*. https://www.mobihealthnews.com/news/digital-health-apps-balloon-more-350000-available-market-according-iqvia-report

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … McKenzie, J. E. (2021). Prisma 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. *BMJ*, *372*, n160. https://doi.org/10.1136/bmj.n160

Ross, A., Touchton-Leonard, K., Perez, A., Wehrlen, L., Kazmi, N., & Gibbons, S. (2019). Factors that influence health-promoting self-care in registered nurses. *Advances in Nursing Science*, *42*(4), 358–373. https://doi.org/10.1097/ans.0000000000000274

Sasaki, N., Imamura, K., Tran, T., Nguyen, H., Kuribayashi, K., Sakuraya, A., Bui, T., Nguyen, Q., Nguyen, N., Nguyen, G., Zhang, M., Minas, H., Sekiya, Y., Watanabe, K., Tsutsumi, A., Shimazu, A., & Kawakami, N. (2021). Effects of smartphone-based stress management on improving work engagement among nurses in Vietnam: Secondary analysis of a three-arm randomized controlled trial. *Journal of Medical Internet Research*, *23*(2), e20445. https://doi.org/10.2196/20445

Spinelli, C., Wisener, M., & Khoury, B. (2019). Mindfulness training for healthcare professionals and trainees: A meta-analysis of randomized controlled trials. *Journal of Psychosomatic Research*, *120*, 29–38. https://doi.org/10.1016/j.jpsychores.2019.03.003

Stratton, E., Lampit, A., Choi, I., Calvo, R. A., Harvey, S. B., & Glozier, N. (2017). Effectiveness of ehealth interventions for reducing mental health conditions in employees: A systematic review and meta-analysis. *PLoS ONE*, *12*(12), e0189904. https://doi.org/10.1371/journal.pone.0189904

Suryanto, A. P., & Alfian, I. N. (2020). The effectiveness of stress inoculation training in reducing stress on intensive care nurses. In R. Ardi, & P. Chobthamkit (Eds.), *Proceedings of the 3rd International Conference on Psychology in Health, Educational, Social, and Organizational Settings (ICP-HESOS 2018) – Improving Mental Health and Harmony in Global Community* (pp. 168–173). Science and Technology Publications.

Szinay, D., Jones, A., Chadborn, T., Brown, J., & Naughton, F. (2020). Influences on the uptake of and engagement with health and well-being smartphone apps: Systematic review. *Journal of Medical Internet Research*, *22*(5), e17572. https://doi.org/10.2196/17572

Tsai, Z., Kiss, A., Nadeem, S., Sidhom, K., Owais, S., Faltyn, M., & Lieshout, R. (2022). Evaluating the effectiveness and quality of mobile applications for perinatal depression and anxiety: A systematic review and meta-analysis. *Journal of Affective Disorders*, *296*, 443–453. https://doi.org/10.1016/j.jad.2021.09.106

Tufanaru, C., Munn, Z., Aromataris, E., Campbell, J., & Hopp, L. (2020). Systematic reviews of effectiveness. In E. Aromataris, & Z. Munn (Eds.), *American Journal of Medical Quality*. https://synthesismanual.jbi.global

Villani, D., Grassi, A., Cognetta, C., Cipresso, P., Toniolo, D., & Riva, G. (2012). The effects of a mobile stress management protocol on nurses working with cancer patients: A preliminary controlled study. *Studies in Health Technology and Informatics*, *173*, 524–528.

Villani, D., Grassi, A., Cognetta, C., Toniolo, D., Cipresso, P., & Riva, G. (2013). Self-help stress management training through mobile phones: An experience with oncology nurses. *Psychological Services*, *10*(3), 315–322. https://doi.org/10.1037/a0026459

Wang, X., Markert, C., & Sasangohar, F. (2021). Investigating popular mental health mobile application downloads and activity during the covid-19 pandemic. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *65*(1), 50–61. https://doi.org/10.1177/0018720821998110

Zhang, X., Tai, D., Pforsich, H., & Lin, V. W. (2017). United States registered nurse workforce report card and shortage forecast: A revisit. *American Journal of Medical Quality*, *33*(3), 229–236. https://doi.org/10.1177/1062860617738328

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