ORIGINAL RESEARCH

Evaluating the efficacy of a mindfulness mobile app for stress reduction in nurses

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ABSTRACT

Objective: All Nurses experience work stress that can take their focus away from patient care. Healthcare organizations strive to identify successful, cost-effective stress reduction programs. Mindfulness Based Stress Reduction (MBSR) training is a validated approach to stress reduction, usually in a class format. However, financial and time constraints make it inaccessible to most practicing nurses. Alternatively, mobile mindfulness apps offer an approach to mindfulness that can reach large populations, are available 24/7, anonymous, and cost effective.
Methods: This prospective, study evaluated the efficacy of a mindfulness mobile app for stress reduction in nurses utilizing Whil, a Mobile App that offers mindfulness training specifically geared towards health professionals. Eight hundred and fifty-two nurses were recruited from twelve sites (71 per site) within a large Health Care System in the Northeast United States.
Results: Two scales were used to test results. Nurses Stress Scale (NSS) results indicated that nurses experienced a reduction in stress level with use and time spent in the app. Nurses in the 31-40 age range and nurses on 12-hour shifts experienced greater stress levels.
Conclusions: Significant differences were seen in the Subscales Conflict with Physicians, Conflict with other Nurses, and Lack of Support. There was no change in the Mindfulness Attention Awareness Scale (MAAS) over time. Spearman's correlation showed a significant and negative correlation between NSS and MAAS scores. The Whil Mobile App is effective for stress reduction in practicing nurses on all shifts and is cost effective.

Key Words: Nurse, Stress, Mindfulness, Mobile app

1. INTRODUCTION

There are over 4.3 million nurses in the United States making up the biggest constituent of the healthcare professions.[1] Health systems are not sustainable without nurses. Nursing is an extremely high stress, physically and emotionally draining profession. The dynamic nature of the profession leads to stress stemming from caring for sick and dying patients and their families, coordinating care, challenging coworkers, feelings of powerlessness, striving to meet and exceed outcome metrics, and constantly changing regulatory requirements. This stress impacts nurses job performance, personal lives and may adversely affect patient care outcomes and lead to burnout, turnover and even leaving the profession. According to the World Health Organization,[2] burnout occurs from chronic workplace stress and the WHO recommends that organizations promote and sustain a healthy work environment to mitigate its harmful effects. The mounting evidence of stressors, burnout, and the resulting exodus from the nursing

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profession is a call to action for leaders.

1.1 Importance of problem

Stress reduction in practicing nurses is a national concern. The Triple Aim was developed by the Institute for Healthcare Improvement (IHI) as a framework for optimizing health system performance with a focus on providing the best possible care at the lowest cost while enhancing the patient experience.[3] The Quadruple aim added the goal of improving the staff experience recognizing the importance of improving the work life of health care providers. Without a focus on staff, achieving triple aim goals becomes more difficult to achieve. Burnout, a phenomenon not new to nursing, occurs in over 35% of nurses and is linked with quality of patient care and safety.[4]

Staff satisfaction and retention hinges on creating healthy work environments that include stress reduction programs accessible to practicing nurses both at work and after work. Relaxation and behavior modification techniques have been studied as components of stress management programs for nurses with some success. Many of these involve the guidance of an instructor, in person attendance, scheduled time commitments, and may be expensive.

1.2 Review of the literature

In reviewing the literature, Mindfulness Based Stress Reduction (MBSR) developed by Jon Kabat-Zinn[5] in the 1970s, was frequently cited as an effective methodology for stress reduction and improving well-being in multiple studies with patients with physical illness, disease, and mental disorders as well as healthy people.[6]

The fundamental premise of MBSR is "mindfulness," defined as being fully present to one's experience without judgment or resistance. MBSR is an 8-week, in person program that includes weekly time commitments and one daylong retreat. Practice is required at least 6 days of the week. Meditation, yoga, and body scan meditations are essential components of MBSR.

In a quantitative and qualitative Randomized Controlled Trial (RCT) study, researchers at a hospital in the Northeast United States offered MBSR to their nurses as an approach to mitigating stress and burnout.[7–9] The measurement tools used were the Maslach Burnout Inventory, the Brief Symptom Inventory (BSI) and the Mindfulness Attention Awareness Scale (MAAS). Results suggest a significant decrease in the Maslach Burnout Inventory and self-reported improvements in relaxation and self-care. Difficulty with edginess, discomfort, and unpleasant emotions were reported.

In a novel approach for providing MBSR training, live attendance was substituted with group telephonic sessions (tMBSR).[10] A nonrandomized pre–post intervention included thirty-six nurses who were measured at three time points on various measures of health. The results showed improvements in stress, burnout, and wholeness. These findings suggest that the tMBSR is a viable alternative.

Recognizing the time constraints posed by in person programs, Hersch & colleagues conducted a RCT with 104 nurses to test the use of the Web based BREATHE: Stress Management for Nurses program.[11] Seven universal modules and management tools on the impact of stress were created by conducting information gathering sessions with nurses. Nurses who participated in the BREATHE program demonstrated a positive change in their stress levels measured by the Nursing Stress Scale (NSS). The results included improvements in working relationships with doctors and nurses as well as being able to cope with grief and the unknown.

1.3 Web-based stress reduction

There is mounting evidence that web-based programs can be effective and cost-effective approaches to workforce health promotion. Web-based programs can be accessed by individuals at their convenience requiring only remote access. The Mobile Applications Rating Score (MARS) is a twenty-three-item rating system used to evaluate the quality of mobile apps based on a 5-point scale ranging from inadequate to excellent. Additionally, it rates engagement, functionality, aesthetics, and information quality. In a Systematic Review, mindfulness -based iPhone apps were rated utilizing the MARS.[12] Findings concluded that although many apps claim to be mindfulness related, most were guided meditation apps, timers, or reminders. The Headspace app scored the highest, receiving a 4.0.

In another RCT evaluating the use of Headspace[13] the research question was aimed at determining if finishing the introductory phase of the Headspace Mindfulness app could impact stress. Beginning meditators were randomized into an introductory phase while the control group received an alternative meditation program. The results suggest that participating in the introductory sessions had a beneficial impact on stress and well-being. This RCT did not study nurses.

To address the mental health needs of Korean nurses, researchers developed an app and conducted a RCT comparing fifty-six nurses. Participants were measured before and after receiving the mobile app. Variables included depression, stress, anxiety, emotional labor, self-efficacy, and well-being[14] Those in the study group were required to use the app at least two days out of seven for a minimum of ten minutes duration. The control group had no intervention. Mea-

surement scales included the modified Perceived Stress Scale (PSS), and the Korean Occupational Stress Scale (KOSS). Results suggest that those using the app demonstrated an improvement in mental health. At Posttest, the experimental groups' stress, depression, anxiety, and emotional labor improved. Moreover, the positive index of well-being and self-efficacy level increased. Limitations of this Pilot study include small sample size and short duration time.

Since the completion of this study, a further review of the literature identified other studies evaluating the use of mobile apps. In a systematic review[15] researchers provide a summary of interventions used for stress management by nurses and identified the measurement tools used to evaluate nurses' stress level. Measurement tools used most frequently to measure stress were the Perceived Stress Scale (PSS) and the Nurse Stress Scale (NSS). Moreover, the researchers stress the importance of developing and implementing interventions that are easily available to nurses in the workplace. Limitations include the diversity of the interventions hindering comparisons between interventions or meta-analysis.

In a RCT conducted in Singapore,[16] members of the health care team were randomly assigned to Headspace or a control group. This pre-post design includes self report measures, and the results suggest that Headspace can be beneficial in decreasing stress and improving the overall health of the healthcare team.

Nurses working on a cardiac step-down unit were given access to a Headspace meditation application created to improve compassion satisfaction, compassion fatigue, and mindfulness.[17] Study participants were required to complete a meditation exercise four out of seven days, lasting a minimum of ten minutes for two months. Participation was validated by submission of calendars attesting to use. Seventy-five percent participation compliance was accepted, and qualifying participants were eligible to win a gift card. Results indicated that participant baseline scores were lower than the adult average, however, they improved post-intervention. Limitations of this study include a small sample size of eight nurse working in a cardiac stepdown unit.

Lastly, in a meta-analysis aimed at investigating the effect of using mobile applications for stress reduction in nurses, six reported RCTs were shown to have a significant reduction in stress and job burnout after using the mobile app interventions.[18] The highest effect size was observed for the Headspace app usage, which reduced stress ($p = 0.01$).

This review of the literature summarizes the far-reaching use and availability of mobile apps for stress reduction in nurses. Therefore, the aim of this study was to expand on the existing body of knowledge , specifically, evaluating the Whil Mobile App for stress reduction in practicing nurses.

Whil is a Mobile App that offers a mindfulness training program specifically geared towards healthcare professionals that can be accessed on a desktop or mobile device. The program includes Compassionate Caregiving "Taking care of yourself" (4-week Program) and Compassionate Caregiving "Taking care of Others" (4-week program).

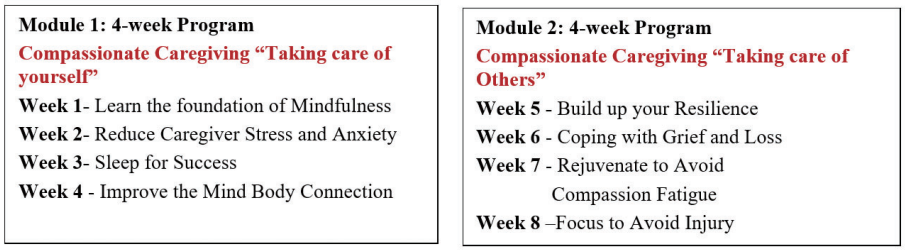

Figure 1. Whil Module 1: 4-week program & Module 2: 4-week program

The program invites participating nurses to invest 5 minutes a day with the goal of reducing stress and improving the ability to focus. It has been used in healthcare settings but never studied as a stress reduction modality for practicing nurses as is the aim of this study. The Whil App offers reporting tools that allow administrators access to data such as frequency of use, sessions completed, and time of use, all valuable information in selecting an app for the nursing population.

Research questions:

1) Does participating in the Whil 8-week mindfulness training program utilizing a mobile app designed for health care providers decrease stress in nurses as measured by the Nurse Stress Scale (NSS)?
2) Does participating in an 8-week mindfulness training program utilizing a mobile app designed for health care providers increase mindfulness as measured by the Mindfulness Attention Awareness Scale (MAAS)?
3) Will the decrease in stress level and the increase in mind-

fulness be maintained at the 3-month post intervention measurement point?

Hypotheses:

Hypothesis 1-Nurses who use the Whil 8-week mindfulness training program utilizing a mobile app designed for healthcare providers will demonstrate a decrease in stress as measured by the Nurse Stress Scale (NSS).

Hypothesis 2-Nurses who use the Whil 8-week mindfulness training program utilizing a mobile app designed for healthcare providers will demonstrate an increase in mindfulness as measured by the Mindfulness Attention Awareness Scale (MAAS).

Hypothesis 3-The decrease in stress level and increase in mindfulness will be maintained at the 3-month post intervention point.

2. METHOD

This prospective study included twelve individual freestanding facilities within this large Healthcare System; each assigned a Site Principal Investigator (PI). Endorsement from the site Chief Nursing Officer was obtained by the Study PI and a contract to use the Whil app was signed granting the nurses access to the app once they met the inclusion criteria and signed a consent form. IRB approval was granted in November of 2019.

Definition of Key Terms:

Job Stress: Job stress is defined as the harmful physical and emotional response that occurs when the perceived job demands exceed the workers' perceived capabilities and resources (Lazarus & Folkman 1984).

Mindfulness: Mindfulness could be defined as the ability to observe thoughts, bodily sensations, or feelings in the present moment with an open and accepting orientation towards one's experiences. Mindfulness is awareness and attention training that helps you create daily habits to calm and focus your mind and relax your central nervous system.

2.1 Participant characteristics

The participants were registered nurses, able to access the Whil app via a mobile device, who understood and spoke English, consented to participate in the study, agreed to have data accessed from the Whil app for analyses, and had access to a private space for conducting mindfulness practices.

2.2 Sampling procedure

Participants for this study were recruited via flyers that described the study and linked the participant to an information letter detailing the study process. Flyers were emailed and posted throughout all participating sites by the site PI's. One thousand and seventeen invitations were emailed to potential participants. One thousand respondents consented and agreed to participate in the study.

2.3 Measurement tools

The Nursing Stress Scale (NSS) measures potential stress sources originating from the physical, psychological, and social environment. There are thirty-four questions with responses on a 4-point scale. There are seven subscales identifying specific sources of stress. Total possible scores for the NSS range from 34 to 136, with higher scores indicating more frequent stress experienced by nurses. Two estimates of the reliability of the NSS were determined: test-retest and internal consistency. The test-retest coefficient for the total scale was 0.81. Four measures of internal consistency were obtained: a Spearman-Brown coefficient of 0.79, a Guttman split-half coefficient of 0.79, a coefficient α of 0.89, and a standardized item α of 0.89. All four measures indicated a satisfactory level of consistency among items.

The validity of the NSS was determined by correlating total score from the NSS with measures of trait anxiety, job satisfaction, and nursing turnover hypothesized to be related to stress.

2.4 The mindfulness attention awareness scale (MAAS)

The Mindful Attention Awareness Scale is a 15-item scale designed to assess individual differences in the frequency of mindful states over time. Awareness and attention to what is happening in the present moment is measured using a 6-point Likert-type response scale ranging from 1 (almost always) to 6 (almost never). The MAAS shows strong psychometric properties and has been validated with college, community, and cancer patient samples. Correlational, quasi-experimental, and laboratory studies have shown that the MAAS recruits a unique quality of consciousness that is related to, and predictive of, a variety of self-regulation and well-being constructs. The measure takes 10 minutes or less to complete. The final score is a mean of the fifteen items. Higher scores reflect higher levels of dispositional mindfulness.

2.5 Sample size, power

A power analysis determined the sample size to be 852 (71 at each of 12 sites) nurses accounting for a moderate effect size and a 50% drop out rate.

2.6 Research procedure

This was a multisite study including twelve facilities that are part of a large healthcare organization in the Northeast United States. Eligible participants were administered both NSS and MAAS surveys at baseline. Then, the participants

were given access to the mindfulness training courses on the Whil app in period 1 and the two surveys were administered at the end of period 1 (5 weeks from baseline). Participants were entered to the second set of the mindfulness training courses on the Whil app in period 2 and the two surveys were administered at the end of period 2 (9 weeks from baseline). The access to the Whil app was terminated at the end of period 2. The two surveys were administered 3 months from the end of the second period.

Data Collection Point	Timeframe	Activity
1	Baseline Consent and enroll in study	• Demographic Form • Complete two surveys (NSS & MAAS)
2	After week five using the app	• Complete two surveys (NSS & MAAS)
3	After week nine using the app	• Complete two surveys (NSS & MAAS) • After week 9 no access to app
4	3 months post completion	• Complete two surveys (NSS & MAAS)

Figure 2. The Data collection points, timeframes and actions required

2.7 Statistical analysis

Descriptive statistics (frequency distribution for categorical variables and mean, standard deviation, median, interquartile range, minimum, and maximum for continuous variables) were calculated. Multivariable linear mixed regression was used to screen variables (age, gender, race, ethnicity, shift, degree, prior training, and practicing mindfulness. Survey time window and the total cumulative Whil app usage time were retained in the model at each selection step. Hierarchical data structure, and multiple subjects within a site, were considered in the models. Spearman correlation analysis was performed to determine the correlation between NSS and MAAS scores at each time point.

3. Results

3.1 Participants

Among the 1,000 respondents, 857 completed the mindful attention awareness scale and met the eligibility criteria. The response rate was 85.7%. Among the 857 participants, 304 did not have data on the time spent on the Whil App and were excluded from the analysis. Thus, there were 553 participants among the 12 sites (see Figure 3).

SHIFT	EDUCATION	AGE	SEX	RACE	PRIOR TRAINING	PRACTICING MINDFULNESS
52 % - 12-hour shift 29%- 8-hour shift 16%- 10-hour shift	94% Baccalaureate degree or above	87% Under 60 y/o	93% Female	74% White 85% non-Hispanic or Latino	78% No prior training	76% Not practicing mindfulness

Figure 3. Demographics for the 553 participants

For the NSS survey, 552 out of the 553 participants answered at baseline. Among the 553 participants, 276 participants completed the survey at the second time point, the dropout rate was 50%. The dropout rate for the third and the fourth time points were 63% and 66%, respectively, with reference to the 553 participants. The dropout rate for the MAAS survey at the second, third, and the fourth time points was 57%, 65%, and 69%, respectively.

The median Whil App use time in Period 1 was 178 minutes (IQR = 48-401), in Period 2 was 154 minutes (IQR = 52-327), and the total use time was 183 minutes (IQR = 50-460).

As shown in Figure 4, time spent in Whil app over time.

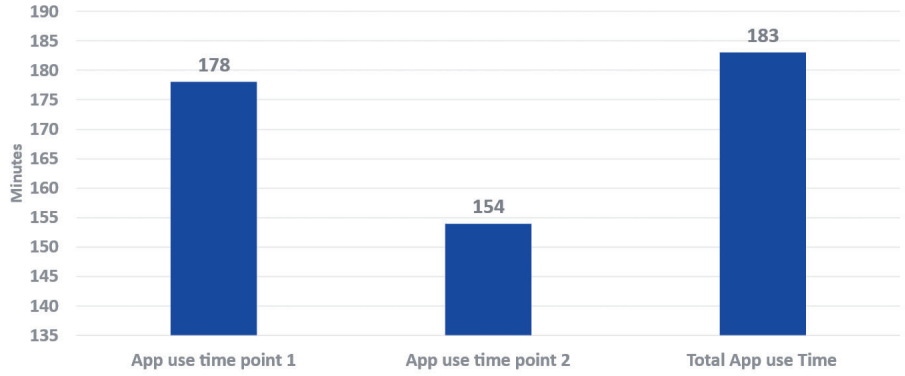

Figure 4. The time spent in Whil App over time

3.2 Hypothesis testing

The following results were found as part of the hypothesis testing:

3.2.1 *Change in the total NSS score over time*

The average NSS score at each time point was 1.98 ± 0.43 at baseline, 1.90 ± 0.41 at the second time point, 1.81 ± 0.41 at the third time point, and 1.83 ± 0.39 at follow-up. The average MAAS score at each time point was 3.86 ± 1.02 at baseline, 3.97 ± 0.96 at the second time point, 4.15 ± 0.97 at the third time point, and 4.05 ± 0.99 at follow-up.

The results showed that there was a statistically significant change in the total NSS score over time after adjusting for total app use time, shift, and age, p=0.0071. Pairwise comparisons showed that, on average, the total NSS score at baseline was 10.8% greater than at the third time point, p=0.0031. The total NSS score at the second time point, on average, was 7.3% greater than at the third time point, p=0.0446 (see Figure 5).

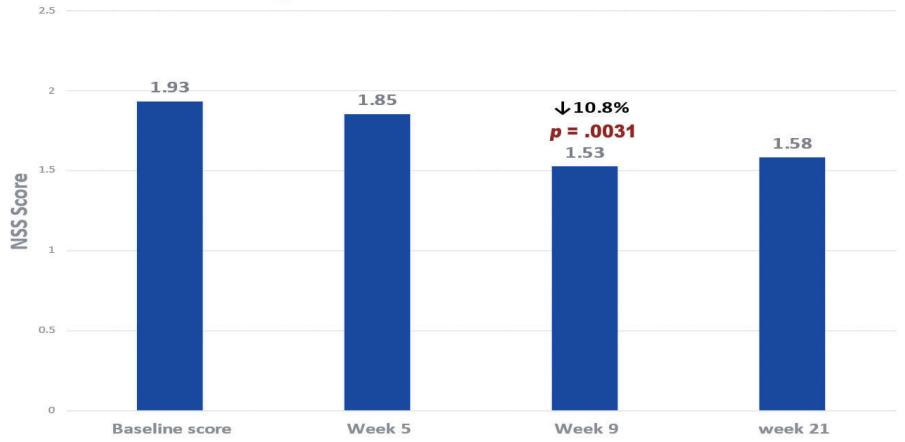

Figure 5. Changes in Total Mean NSS Score

3.2.2 *Changes in NSS Subscales over time*

The analysis of the seven subscales showed a significant reduction in specific areas of nursing stress including Conflict with physicians, Lack of support, and Conflict with other nurses.

1) Conflict with physicians

The analysis determined that there was a statistically significant change in Conflict with physicians' subscale over time after adjusting for total app use time, shift, age, race, and practicing mindfulness, $p < .0001$. Pairwise comparison showed that the Conflict with physicians' subscale at baseline (first time point) was 7.2% greater than that at the second time point, $p = .0036$, and was 16.4% greater than the third time point, $p < .0001$. The second time point was 8.6% greater than the third time point, $p = .0481$.

2) Lack of support

The analysis determined that there was a statistically significant change in Lack of support subscale over time after adjusting for total app use time, shift, and race, $p = .0024$. Pairwise comparison showed that baseline Lack of support

subscale was 6.8% greater than the second time point, p = .0220, and was 14.9% greater than the third time point, p = .0027.

3) Conflict with other nurses

The analysis determined that there was a statistically significant change in Conflict with other nurses' subscale over time after adjusting for total app use time, shift, age, and practicing mindfulness, p = .0001. Pairwise comparison showed that the baseline Conflict with other nurses' subscale was 3.7% greater than the third time point, p < .0001, and was 11.8% greater than the fourth time point, p = .0237. The Conflict with other nurses' scale at the second time point was 12.4% greater than the third time point, p = .0025.

The analysis of the seven subscales showed that there was no significant change over time in four subscales: Death and dying, Inadequate preparation, Workload, Uncertainty concerning treatment.

3.2.3 *Changes in MAAS scores over time*

The analysis showed that there was no change in the MAAS scale over time after adjusting for total app use time, age, and race, p = .3089 (see Figure 6).

As shown in Figure 6, MAAS scores change over time.

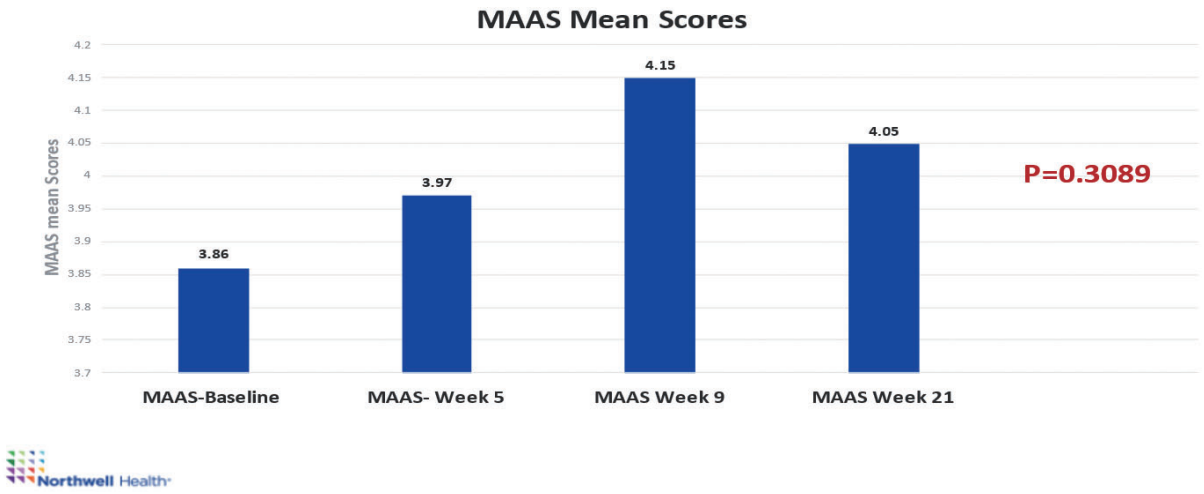

Figure 6. MAAS Scores change over time

The analysis determined that the decrease in stress level was maintained over the 3-month period, however, the MAAS scores dropped in the final measurement at 3 months.

3.2.4 *Correlation between NSS score and MAAS*

Spearman's correlation showed that there was a significant and negative correlation between NSS and MAAS scores at all points; baseline (ρ = -0.39138, p < .0001), at the second time point (ρ = -0.39891, p < .0001), at the third time point (ρ =-0.55919, p < .0001), and at the fourth time point (ρ = -0.42555, p < .0001).

4. Discussion

The purpose of this research study, conducted during the Covid pandemic, was to examine the efficacy of the Whil Mindfulness Mobile App for stress reduction in practicing nurses. The results provide promising evidence that the Whil Mobile App, when used regularly by practicing nurses, can decrease stress and increase mindfulness.

The review of the literature on stress reduction for nurses suggested that while MBSR programs are effective, they are difficult for nurses to attend due to the time investment and cost,.[7–10] A modified version of the MBSR program added a telephonic component to reduce the in-person requirement with some success.[10]

Most of these programs required actual presence, a requirement that is especially problematic for nurses whose schedules and patient care responsibilities make it exceedingly difficult to leave point of care areas for even short periods of time to attend mandatory education programs such as skills fairs and grand rounds.

The use of Mobile Apps for Stress reduction in nurses continues to be studied[15–17] with further validation of the efficacy of mobile applications as an alternative to in person programs that are costly, and not accessible to large populations such as our work force of over 4.3 million nurses practicing in the United States. The accessibility and convenience of the Whil Mobile App suggest that it is a valuable tool for stress reduction in nurses.

H1: The findings from this study support H1. On average,

the total NSS score at baseline was 10.8% higher than at the third time point after adjusting for app use time, shift, and age, $p = .0031$.

The intent of the study design was to make the mobile app accessible and easy to use by practicing nurses at the time and location of their choosing. However, the results indicate that some nurses did not use the app often despite it being free and accessible on any mobile device at any time leading me to conclude that regular use of mobile apps for stress reduction requires effort, motivation, and perhaps additional incentives such as earning points towards a reward or a gift card. Those nurse that used it more often, scored lower on the stress scale.

H2: The finding from this study did not support H2. The final model showed that there was no change in the MAAS scale over time after adjusting for total app use time, age, and race, $p = .3089$ (see Figure 4).

As seen in Figure 5, the Mindfulness score did increase at timepoint 2 (5 weeks) and timepoint 3 (9 weeks) and dropped at timepoint 4 (21 weeks). It is important to note that although not significant, the final Mindfulness (4.05) score was higher than the baseline score (3.86) indicating that the effects were somewhat maintained.

H3: The findings from this study partially support H3. The NSS at the 3-month mark was lower than the baseline scores and the MAAS scores at the 3-month point were higher than at baseline.

An important finding from this study is that nurses in the 31-40 age range and nurses working 12 hour shifts experienced greater stress levels indicating the need to target this population when planning stress reduction strategies. Moreover, mobile apps must be conveniently accessible to all nurses, both in the workplace, and after work.

In summary, the Whil Mobil App can be a valuable strategy for mitigating stress and burnout that will in turn ultimately improve patient care outcomes.

4.1 Study limitation

The first limitation of this study was that recruitment began three months prior to the Covid-19 pandemic which resulted in a health system wide "enrollment pause". Once lifted, an extension was granted by Whil, and all twelve sites were able to recruit seventy-one nurses.

Because of Covid restrictions, consents could not be obtained in person and required multiple steps electronically. Participants had the option to ask questions of the PI electronically prior to signing. Signed consents had to be co-signed by the Site PI. The participant would then gain access to the Whil app for a nine-week period. Based on feedback, accessing the Whil app was not user friendly and required several clicks to get to the mindfulness modules. This may have led to the large dropout rate.

A limitation is that demographic data on job role/position, and years of experience were not captured in the RedCap survey limiting the ability to examine nurse stress level in these categories.

An additional limitation was that there was no control group for comparison of findings.

A strength of this multisite study is that all the twelve participating sites recruited seventy-one nurses, the number required for power. Each site received an individualized analysis allowing them to customize stress reduction interventions based on their demographics and findings.

In summary, this study contributes to and expands on what are successful stress reduction modalities for nurses, a worldwide problem affecting the largest segment of the healthcare team. Nurse leaders can apply these findings to strategically plan programs at their organization.

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AUTHORS CONTRIBUTIONS

Myrta Rabinowitz, Ph.D was responsible for writing this manuscript with Tung Ming Leung, Ph.D contributing the statistical analysis.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

INFORMED CONSENT

Obtained.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

DATA SHARING STATEMENT

No additional data are available.

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