Received: 4 October 2016 | Revised: 19 May 2017 | Accepted: 26 June 2017

DOI: 10.1002/pon.4491

WILEY

PAPER

Feasibility of the mobile mindfulness-based stress reduction for breast cancer (mMBSR(BC)) program for symptom improvement among breast cancer survivors

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Funding information
The University of South Florida Research Initiative Account and in part by the National Cancer Institute, Grant/Award Number: 1R01CA131080-01A2

Abstract

Objective: The purpose of this pilot study was to test the feasibility of delivering the mobile mindfulness-based stress reduction for breast cancer (mMBSR(BC)) program using an iPad and to evaluate its impact on symptom improvement.

Methods: A single group, pre-posttest design was implemented among female stages 0-III breast cancer survivors (BCS) who completed treatment. Data were collected at baseline and week 6 on measures of psychological and physical symptoms and quality of life. The mMBSR(BC) program is a standardized, stress-reducing intervention that combines sitting and walking meditation, body scan, and yoga and is designed to deliver weekly 2-hour sessions for 6 weeks using an iPad.

Results: The mean age of the 15 enrolled BCS was 57 years; one participant was non-Hispanic black, and 14 were non-Hispanic white. Of the 13 who completed the study, there were significant improvements from baseline to 6 weeks post-mMBSR(BC) in psychological and physical symptoms of depression, state anxiety, stress, fear of recurrence, sleep quality, fatigue, and quality of life (P's < .05). Effect sizes for improvements of multiple symptoms ranged from medium to large.

Conclusions: These results provide preliminary support that the mMBSR(BC) program may be feasible and acceptable, showing a clinical impact on decreasing psychological and physical symptoms. This mobile-based program offers a delivery of a standardized MBSR(BC) intervention to BCS that is convenient for their own schedule while decreasing symptom burden in the survivorship phase after treatment for breast cancer.

KEYWORDS

breast cancer survivors, mobile-based, MBSR, quality of life, symptom managment

1 | BACKGROUND

Breast cancer survivors (BCS) comprise 41% of the cancer survivor population in the United States, outnumbering all other cancer survivors.[1] As treatments for breast cancer (BC) improve, survival rates are increasing and more BCS are living longer. Breast cancer survivors often suffer from many symptoms that may occur as a result of their disease and/or treatment such as pain, fatigue, sleep disturbances, numbness and tingling, psychological distress,[2] depression and anxiety,[3] and fears of cancer recurrence.[4] These symptoms may affect both daily functioning and quality of life (QOL).[5] Access to effective self-management interventions may reduce or ameliorate BCS' symptom burden and encourage social support; however, barriers such as distance, transportation, work, and limitations of cancer-related illnesses may prohibit participation. The use of mobile-based technologies offers an alternative format for the delivery of empirically tested psychosocial interventions.

Various forms of online behavioral health interventions exist in the literature, including cognitive behavior therapy and mindfulness-based

stress reduction (MBSR). Cognitive behavior therapy is the most common behavioral health intervention and has been adapted as a web-based intervention for cancer survivors. Improvements were reported in negative affect, helplessness/hopelessness, anxious preoccupation,[6] coping with cancer,[7] increase in fight spirit,[8] depression,[9] and insomnia.[10] A newer intervention, MBSR, is becoming more proliferative, and currently close to 80% of medical schools offer elements of mindfulness research and training[11]

Mindfulness-based stress reduction was developed by Jon Kabat-Zinn[12] and adapted for BCS.[13] MBSR holds promise for treating multiple symptoms experienced by cancer survivors. The traditional "in class" MBSR(BC) program has been found efficacious improving symptoms including fatigue severity and interference,[14] depression,[13,15] anxiety,[14,15] fear of recurrence (FOR),[13,16] and QOL.[13]

Although there is growing evidence supporting the effectiveness of the traditional 6- and 8-week MBSR program among cancer survivors, there is limited research adapting MBSR to a mobile-based or mobile format. An online mindfulness course including elements of MBSR and mindfulness-based cognitive therapy among 118 noncancer adults found significant improvements in levels of work-related rumination, fatigue, and sleep quality.[17] A nonrandomized study of an online mindfulness program also containing components of MBSR and mindfulness-based cognitive therapy among 273 adults found significant reductions in stress, anxiety, and depression at the course completion and at 1-month follow-up.[18]

For cancer survivors, a study by Zernicke et al[19] was identified that investigated the feasibility of the online mindfulness-based cancer recovery (MBCR) group program. Improvements in mood disturbance, stress symptoms, and spirituality and mindfully acting with awareness after MBCR were identified among 62 underserved distressed cancer survivor participants in the study.[19] Another study by Zernicke et al[20] on an online MBCR program found that younger participants showed more improvement in stress, spirituality, and nonreactivity to experience and males experienced more posttraumatic growth over time than females. In addition, the results suggested that online MBCR may improve energy while concurrently inducing relaxation.[20]

Currently, there is no evidence focusing specifically on BCS involving a mobile application of MBSR. This pilot study tested the feasibility and acceptability of the mobile MBSR for BC (mMBSR(BC)) program using a mobile-based technology platform (the iPad). We hypothesized that BCS using the mMBSR(BC) program would show improvements in psychological and physical symptoms of depression, anxiety, stress, FOR, cognitive functioning, sleep, fatigue, pain, and QOL.

2 | METHODS

2.1 | Sample and setting

Fifteen BCS were recruited from Moffitt Cancer Center, the USF Health Carol and Frank Morsani Center for Advanced Healthcare, and the Life Hope Medical Offices, all located in Tampa, Florida. Participants were also recruited from a larger randomized controlled trial (RCT) of a traditional 6-week MBSR(BC) program delivery format; patients that declined the traditional program because of scheduling conflicts and living too far were invited to participate. To be included in the study, participants were required to be aged ≥21 years with a diagnosis of stage 0-III BC, be able to speak and read English, and be within 2 weeks to 2 years posttreatment. Exclusion criteria included a diagnosis of stage IV BC, severe mental disorder, and/or BC recurrence.

2.2 | Procedures

2.2.1 | Study design, recruitment, and data collection procedures

A single-group, pretest-posttest design was implemented in this pilot study. The study protocol was approved by the Institutional Review Board at USF and Moffitt Cancer Center (IRB#: CR5_107408). A portion of patients who declined to participate in our larger R01 trial due to schedule conflicts or living too far away were contacted to participate. If BCS were interested and met inclusion criteria, informed consent was obtained. Baseline and 6-week follow-up assessments were performed, along with data collection of demographics and clinical history.

2.2.2 | mMBSR(BC) intervention

The mMBSR(BC) program was designed to deliver 6 weekly 2-hour sessions via the iPad. Participants received a user manual and orientation on how to use the iPad. The iPad allows for delivery flexibility while receiving the benefits of the traditional MBSR(BC) program. MBSR(BC) was adapted from Jon Kabat-Zinn's original 8-week program to address the needs of BCS by teaching self-regulation meditation techniques in stress reduction and symptom management.[12,13] Participants were asked to sequentially access the audio and video files through iBooks within the iPad for weekly content and training. Participants were guided through weekly modules in the iPad in formal meditative techniques (sitting meditation, walking meditation, body scan, and gentle Hatha yoga) via video files and lectured in informal meditative techniques (integrating mindfulness into daily life activities) via audio files, which were led through 1-way interaction by a clinical psychologist trained in MBSR. All content was arranged sequentially in the same manner as it was in our previous study's face-to-face MBSR(BC) program, since the intervention via iPad was designed to mirror the in-person MBSR(BC) sessions. Participants also received a physical manual to aid them in learning the formal and informal meditative techniques provided in the iPad. Formal meditative techniques included (1) sitting meditation (awareness of bodily sensations, thoughts, and emotions while focusing on the breath); (2) walking meditation (awareness of walking activity); (3) body scan (observing sensations in the body starting from the tips of the toes to the head, with focus on the breath); and (4) gentle Hatha yoga (postures and stretches that strengthen awareness, posture, and flexibility). Participants were asked to practice formally and informally for 15 to 45 minutes per day and to record practice time on the iPad. A research assistant contacted participants via telephone weekly to remind them to access the weekly modules on the iPad and to answer any questions they may have had or problems possibly encountered.

2.3 | Measurements

2.3.1 | Demographic and clinical history data

Demographic and clinical history data were completed at baseline and updated at 6 weeks. Demographic data included age, gender, ethnicity, education, and marital status. Clinical history data included cancer diagnosis, treatment, and family history.

2.3.2 | Physical symptoms

Fatigue was measured using the Fatigue Symptom Inventory,[21] which measures severity and perceived interference with QOL. The Fatigue Symptom Inventory has been found to have alpha coefficients above 0.90, suggesting good internal consistency.[21] Pain was measured using the Brief Pain Inventory,[22] which assesses pain severity and interference in daily living, with reliability coefficients from 0.82 to 0.95 reported.[22] Sleep quality was assessed using the Pittsburgh Sleep Quality Index. This instrument has proven adequately reliable (0.70-0.78) for measuring sleep quality, latency, duration, efficiency, disturbances, daytime sleep function, and the use of sleep medications.[23]

2.3.3 | Psychological symptoms

Depression was measured using the Center for Epidemiological Studies Depression Scale, which assesses frequency of depressive feelings and behaviors.[24] The Center for Epidemiological Studies Depression Scale was shown to have a reliability coefficient of 0.92 among BCS[24] and adequate validity in other populations.[25] State anxiety was measured using the State-Trait Anxiety Inventory, which has shown to be a reliable and valid tool to assess "state," or situational anxiety, with an internal consistency reliability[26] of 0.95. The Perceived Stress Scale was used to measure perceived stress and has a reported coefficient alpha reliability[27] ranging from 0.84 to 0.86. This instrument assesses the frequency of perceived "stressful" events experienced by the participants in the past month. Fear of recurrence was measured using the Concerns about Recurrence Scale, a reliable and valid tool with an overall internal consistency reliability of 0.87 for BC subjects. This tool consists of 2 subscales (overall FOR and nature of FOR) and measures both worry and FOR.[28]

2.3.4 | Cognition and mindfulness

The Everyday Cognition (ECog) assessed subjective change of everyday cognitive functioning in adults; it has one global factor and 6 subscales or domain-specific factors (Everyday Memory, Language, Visuospatial Abilities, Planning, Organization, and Divided Attention) with a reported reliability of 0.82 and adequate convergent and external validity.[29] Mindfulness was measured using the Five Facet Mindfulness Questionnaire, a reliable and valid tool for assessing mindfulness elements of observing, describing, acting with awareness, nonjudging of inner experience, and nonreactivity to inner experience.[30]

2.3.5 | Quality of life

Mental and physical health-related QOL was measured using the Medical Outcomes Studies Short-Form, which was shown to have reliability estimates from 0.62 to 0.94 in different populations, with a majority of scores greater than 0.80.[31]

2.3.6 | Acceptability and usability

Participants were asked to rate as follows: (1) how helpful the mMBSR (BC) program was in relieving their stress; (2) the ease of use of the program in completing the homework and practice techniques on a scale of 1 to 10 (1 = *very helpful*, 10 = *not helpful at all*); and (3) any additional thoughts or feelings about use of the program in an open-ended question.

2.4 | Statistical analysis

Outcomes of interest included psychological, physical, and cognitive symptoms, along with QOL. Within groups, data analytic comparisons between baseline and week 6 were made using the Wilcoxon signed-rank test on all outcome variables. Because this was a small pilot study (n = 13), a liberal nominal alpha of 0.10 was chosen to identify areas of promise. More importantly, in such a small study, effect sizes were estimated using Cohen *d*.

To validate how the mMBSR(BC) program might compare against a control group, the effect sizes from this pilot study were compared to the within groups effect sizes from an in-person MBSR(BC) program observed in our previous larger RCT.[16] The traditional MBSR(BC) program delivered in the R01 trial had the same program objectives and content and meditation practice techniques with the only difference being the medium of delivery (in-person vs electronic).

3 | RESULTS

3.1 | Sample characteristics

Of the 15 participants enrolled, a total of 13 (87%) completed the study. The mean age was 57, and most were married (80%) with some college education. A majority of the participants were non-Hispanic white (93%) with one participant who was non-Hispanic black (7%). Stage I BC was the most common diagnosis (40%), followed by stage II (27%), stage III (27%), and stage 0 (7%). Half of the participants received a mastectomy, 40% received lumpectomy, and 10% received no surgery. Over half (53%) of participants were treated with radiation and chemotherapy, followed by radiation only (20%), chemotherapy only (13%), and no chemotherapy or radiation treatment (13%). On average, the sample was about 10 months out of treatment for BC (mean = 317 days, SD = 237). See Table 1 for demographic and clinical characteristics.

3.2 | Results on outcome measures

Significant improvements were observed in psychological and physical symptoms, cognitive functioning, mindfulness, and QOL from baseline to 6 weeks post-mMBSR(BC) along with small to large effect sizes. See Tables 2A and 2B for outcome variable scores. Significant psychological improvements were evident in depression ($P < .01$), state anxiety ($P = .03$), perceived stress ($P = .004$), FOR overall ($P = .03$), and FOR problems ($P < .05$). Medium to large effect sizes were evident for these outcomes ($d = 0.60$-0.85). Significant improvements occurred in physical symptoms in less daytime sleep dysfunction ($P < .01$), with a medium effect size of $d = 0.65$. Improvements in fatigue symptoms

TABLE 1 Demographic and clinical characteristics of mMBSR(BC) participants

Characteristic	Statistic
Age, y	
Mean	57
SD	9
Race, % (n)	
White/non-Hispanic	93 (14)
Black/non-Hispanic	7 (1)
Marital status, % (n)	
Married	80 (12)
Divorced	13 (2)
Widowed	7 (1)
Education, % (n)	
High school graduate	13 (2)
Some college	47 (7)
College graduate	27 (4)
Graduate or professional school	13 (2)
BC stage at diagnosis, % (n)	
Stage 0	7 (1)
Stage I	40 (6)
Stage II	27 (4)
Stage III	27 (4)
Adjuvant treatment, % (n)	
Chemotherapy only	13 (2)
Radiation only	20 (3)
Radiation & Chemotherapy	53 (8)
No therapy	13 (2)
Surgery type, % (n)	
Lumpectomy	40 (6)
Mastectomy	60 (9)
Time since treatment, days	
Mean	317
SD	237

Abbreviations: BC, breast cancer; mMBSR(BC), mobile mindfulness-based stress reduction for breast cancer.

(P = .002) and fatigue interference (P = .03), with medium effect sizes (d = 0.47-0.60), were also observed. Multiple significant QOL improvements were identified: increased energy (P = .02), emotional well-being (P = .03), general health, (P < .01), and physical health (P = .03), with small to large effect sizes (d = 0.29-0.71).

Significant improvements were also observed in cognitive abilities (mindfulness and cognitive functioning). Improvements were observed in total Five Facet Mindfulness Questionnaire mindfulness scores (P < .01), nonjudging (P = 0.009) and nonreacting (P < .01), with medium to large effect sizes (d = 0.68-1.16), and improvements in language of ECog (P = .03), effect sizes (d = 0.90) with a trend towards improvements in memory (P = .07) and global scores (P = .06), with medium effect sizes (d = 0.50-0.66).

3.3 | Acceptability and usability

Eleven participants responded with qualitative feedback using open-ended questions to assess acceptability and usability of the program. This feedback generally reflected positive sentiments about the program. Some feedback lamented the amount of time to practice, preferred a group setting, or conveyed that the program did not add to what participants were already doing in their lives. Table 3 provides example comments from each of these 11 participants. The quantitative ratings supported an overall positive response. Twelve participants provided ratings at least once and 8 participants provided all 5 ratings. Multiple ratings across weeks were averaged for each participant to create a single rating for each participant. The mean ratings were 4.95 (range 2.2-8.0) for helpfulness to relieve stress and 4.68 (range 1.67-8.0) for ease of use of the program and practice techniques on a scale ranging from 1 to 10, with lower scores indicating more helpful. These mean ratings may have been skewed due to the fact that 3 participants reported that they had very little stress, limiting the ability to observe any improvements among these participants and lowering the overall mean scores for acceptability and usefulness. This also suggests that participants with low baseline stress may not have found the program as useful as those with higher baseline stress. For example, although one participant rated the program as 8.0 for both helpfulness and usability reported, they also reported that they had low stress in their life at this time.

3.4 | Compliance

The average practice time for all participants was 36 minutes per day. Five of 12 participants practiced greater than 45 minutes per day. Three participants practiced 20 to 45 minutes per day. Four participants practiced 1 to 19 minutes per day.

3.5 | Comparison of effect sizes

As a method of validating how mMBSR(BC) might compare against a control group, the effect sizes from this pilot study were compared to the within groups effect sizes from an in-person MBSR(BC) RCT program on the same outcome measures. For the 6 statistically significant outcomes observed in the larger R01 trial,[16] we examined and compared the 6-week within group effect sizes in this pilot study. Of these 6 outcomes, 5 of the effect sizes were larger in this pilot study (see Table 4).

4 | DISCUSSION

This pilot study aimed to test the feasibility of mMBSR(BC) delivered via an iPad and to evaluate its impact on improvement of physical and psychological symptoms and QOL among BCS. Results from this pilot study demonstrated that the mMBSR(BC) program may be feasible and acceptable to deliver in a larger clinical setting. The majority (87%) of the enrolled participants were able and willing to ultimately complete the program. The participants described the mMBSR(BC) program as convenient and easy to use and that the iPad facilitated content for learning and practice, indicating that the mode of delivery of mMBSR(BC) may be acceptable. The mobile format greatly enhances the user's experience of the program mainly for their convenience.

TABLE 2A Health status (quality of life) outcomes, cognitive, mindfulness outcome variables at baseline and 6 weeks after mMBSR(BC), and estimates of treatment effects

		Score (mean ± SD)		Effect Size and 95% CI			
Measure	Subdomain	Baseline mMBSR(BC)	6 weeks mMBSR(BC)	*d*	Lower	upper	*P* value
Health status (SF-36)	Physical functioning	66.33 (29.06)	69.23 (30.47)	0.10	−0.64	0.84	.15
	Role limitations-Physical	46.67 (42.12)	42.31 (42.55)	0.10	−0.64	0.84	.99
	Emotional	31.11 (38.76)	17.95 (32.25)	0.37	−0.38	1.12	.13
	Energy	49.33 (26.45)	57.69 (27.74)	0.31	−0.44	1.06	.02*
	Emotional well-being	67.80 (16.79)	78.15 (12.18)	0.71	−0.05	1.47	.03*
	Social functioning	42.80 (11.75)	41.08(15.37)	0.13	−0.61	0.87	.59
	Pain	66.17 (26.71)	70.19 (25.40)	0.15	−0.59	0.89	.44
	General health	60.67 (22.51)	73.46 (15.05)	0.68	−0.08	1.44	.01*
	Physical health	239.83 (57.08)	255.19 (47.82)	0.29	−0.45	1.03	.03*
	Mental health	191.04 (39.98)	194.87 (27.48)	0.11	−0.63	0.85	.58
Cognitive/mindfulness outcomes							
Mindfulness (FFMQ)	Observe	26.80 (4.74)	29.62 (4.07)	0.64	−0.12	1.40	.12
	Describe	29.27 (6.72)	30.15 (4.98)	0.15	−0.59	0.89	.29
	Awareness	27.47 (7.57)	30.84 (5.09)	0.53	−0.22	1.28	.13
	Nonjudging	28.67 (6.94)	35.31 (4.53)	1.16	0.36	1.96	.009**
	Non-reacting	22.00 (5.11)	25.15 (4.10)	0.68	−0.08	1.44	.01**
	FFMQ total	134.20 (25.23)	151.07 (15.45)	0.83	0.06	1.60	.01**
Everyday cognition (ECog)	Memory	1.40 (0.48)	1.21 (0.30)	0.50	−0.25	1.26	.07
	Language	1.24 (0.42)	1.02 (0.05)	0.90	0.13	1.68	.03*
	Visuospatial	1.09 (0.26)	1.03 (0.07)	0.38	−0.37	1.13	.48
	Planning	1.15 (0.27)	1.05 (0.09)	0.57	−0.19	1.32	.24
	Organization	1.33 (0.61)	1.21 (0.31)	0.28	−0.47	1.02	.42
	Divided attention	1.43 (0.63)	1.17 (0.37)	0.52	−0.23	1.27	.13
	Satisfaction	3.40 (1.30)	3.54(1.51)	0.10	−0.64	0.84	.46
	Global	1.27 (0.33)	1.11 (0.14)	0.66	−0.10	1.42	.06

Abbreviations: ECog, Everyday Cognition; FFMQ, Five Facet Mindfulness Questionnaire; MBSR(BC), mobile mindfulness-based stress reduction for breast cancer; SF-36, Medical Outcomes Short Form–36 items. *P* value is based on the Wilcoxon signed-rank test. Effect size is Cohen *d* for paired samples.

*$P < .05$.

**$P < 01$.

TABLE 2B Psychological and physical outcome variables at baseline and 6 weeks after mMBSR(BC) and estimates of treatment effects

Measure	Subdomain	Baseline mMBSR(BC)	6 weeks mMBSR(BC)	*d*	Lower	Upper	*P* Value
Psychological outcomes							
Depression (CESD)		7.47 (4.21)	4.79 (2.11)	0.85	0.07	1.62	.01**
State anxiety (STAI)		33.27 (14.01)	26.03 (6.10)	0.72	−0.04	1.48	.03*
Perceived stress (PSS)		14.33 (7.66)	9.08 (4.79)	0.84	0.07	1.62	.004**
Fear of recurrence (CARS)	Overall	12.00 (4.99)	9.00 (3.11)	0.74	−0.02	1.51	.03*
	Problems from concerns	41.80 (19.85)	29.67 (20.61)	0.60	−0.16	1.36	.05*
	Global	1.27 (0.33)	1.11 (0.14)	0.66	−0.10	1.42	.06
Physical outcomes							
Sleep quality (PSQI)	Sleep duration	0.60 (0.74)	0.46 (0.66)	0.20	−0.54	0.94	.50
	Sleep disturbances	1.60 (0.51)	1.20 (0.68)	0.68	−0.09	1.44	.06
	Latency to sleep onset	1.20 (0.86)	1.15 (1.07)	0.05	−0.69	0.79	.71
	Daytime dysfunction	1.20 (0.94)	0.69 (0.63)	0.65	−0.11	1.41	.01**
	Efficacy	0.73 (1.03)	0.61 (0.77)	0.13	−0.61	0.87	.95
	Total	7.93 (4.30)	6.54 (4.01)	0.34	−0.41	1.09	.28
Fatigue (FSI)	Symptom	15.20 (7.61)	10.77 (7.26)	0.60	−0.16	1.35	.002**
	Interference	26.20 (20.92)	17.31 (16.64)	0.47	−0.28	1.22	.03*
Pain (BPI)	Severity	8.93 (7.51)	8.69 (8.17)	0.03	−0.71	0.77	.62
	Interference	13.73 (16.18)	11.31 (15.07)	0.16	−0.59	0.90	.25

Abbreviations: BPI, Brief Pain Inventory; CARS, Concerns About Recurrence Scale; CESD, Center for Epidemiological Studies Depression Scale; FSI, Fatigue Symptom Inventory; MBSR(BC), mobile mindfulness-based stress reduction for breast cancer; PSS, Perceived Stress Scale; STAI-S, State scale of State Trait Anxiety Inventory; PSQI, Pittsburgh Sleep Quality Inventory. *P* value is based on the Wilcoxon signed-rank test. *P* value is based on the Wilcoxon signed-rank test. Effect size is Cohen *d* for paired samples.

*$P < .05$.

**$P < .01$.

The second major contribution of this study was symptom improvement. Improvements were observed in psychological and physical symptoms of depression, state anxiety, stress, FOR, sleep quality, fatigue, and QOL. We compared our study to 2 web-based

TABLE 3 Feedback from respondents to open-ended question about the program

Patient	Sentiment 1	Sentiment 2
1	Great program all patients should receive this information.	NA
2	All in all, I do not think I was the best subject for this program. My chemo is over a year in the past and I was left with no physical pain. I have very little stress in my life, somewhat by design in that since the cancer treatment ended, I have set my mind toward positivity. I did enjoy short periods of meditation, stretching and breathing, though. I did not do any of the exercises as often or as long as I am sure you would have liked me to, but I genuinely did the best I could.	NA
3	I think it is a good idea and a good opportunity to learn these techniques …. Not sure yet if I will apply or practice all or how much ….	NA
4	Needs a bit of improvement but overall is pretty good. It's helpful. I would not have sought out this help so the offer was very beneficial for me	I have experienced frustration at not knowing how long things would last for which kept me from starting on some days. The timing out of the iPad while doing formal work contained within the weeks activity was very disruptive.
5	Fun and interesting	I like the program. I wish it were longer. I worry that time is moving too fast and I don't always have the time to invest that I would like.
6	I feel it is very helpful. I am calmer when dealing with a stressful situation.	I continue to find it helpful. It has been harder for me to a lot time to do my meditation.
7	I think it would have been easier to have been trained in a group setting.	NA
8	I think that the meditation will be helpful since I am a very active person. I prefer gardening to body scan or yoga.	Since I have little stress in my life, the program has only been slightly useful.
9	I think it's a good idea and a good program. At first I was concerned with the time that it took to view the video, read the material and practice. I work FT go to school and have 4 busy children. Time is at a premium in my life. After speaking with to one of the researchers who clarified that I could practice at my own pace, I felt less pressure and found it easier to focus and schedule time, or not, to practice.	Good. Not sure if it reduces my stress but I can see the overall benefit of the program.
10	Still hard to stay in the present moment and relax. Important to be reminded of mindfulness every day.	NA
11	I am spiritual person, so I feel I am being asked to do something else seems like I do this already.	NA

Abbreviation: NA, no answer. Participants responded with up to 6 open-ended comments over the course of the study. These comments reflect the most positive and negative responses from the 11 participants who answered the open-ended question.

MBSR programs identified for noncancer survivors[17,18] and underserved cancer survivors.[19]

Similarly to our results, Krusche, Cyhlarova, and Williams[18] found improvements due an online MBSR intervention in "noncancer" adult participants,[18] in stress, ($P < .001$, $d = 1.20$), anxiety ($P \leq .001$, $d = 1.22$), and depression ($P < .005$, $d = 0.95$). Krusche, Cyhlarova, and Williams[18] study had higher effect sizes compared to our mMBSR(BC) results for depression ($P < .01$, $d = .83$), anxiety ($P < .03$, $d = 0.72$), and stress ($P = .004$, $d = 0.84$) postintervention. As in ours, their study had no control or comparison group. Querstret, Cropley, and Fife-Schaw[17] examined an online mindfulness course that included elements of MBSR among a noncancer population using a randomized waitlist control design and found significant improvements in work-related rumination, fatigue and sleep quality, and increased levels of mindfulness (acting with awareness). This study was similar to our mMBSR(BC) study for fatigue ($P = .002$, $d = 0.60$) and daytime sleep dysfunction ($P = .01$, $d = 0.65$).

Zernicke et al[19] found that cancer survivors that completed MBCR had significant reductions occurred in total mood scores ($P = .002$, $d = 0.44$), symptoms of stress ($P < .001$, $d = 0.49$), and mindfulness "acting with awareness" ($P = .004$, $d = 0.50$) compared to a waitlisted controlled group. These outcomes were similar to our mMBSR(BC) study for psychological symptoms of stress ($P = .004$, $d = 0.84$); however, we also observed significant differences for the mindfulness

TABLE 4 Within group effect size (Cohen *d*) comparison between recent large RCT[16] and current study

Measure	Lengacher et al[16] Within Group Effect Sizes	iPad Study Within Group Effect Sizes
Anxiety (STAI-S)	0.64	0.72
Fear of recurrence—Overall (CARS)	0.46	0.74
Fear of recurrence—Problems (CARS)	0.45	0.60
QOL—General health (MOS SF-36)	0.26	0.68
Fatigue—Severity (FSI)	0.50	0.60
Fatigue—Interference (FSI)	0.53	0.47

Abbreviations: CARS, Concerns About Recurrence Scale; FSI, Fatigue Symptom Inventory; MBSR(BC), mobile mindfulness-based stress reduction for breast cancer; MOS SF-36, Medical Outcomes Short Form–36 items; STAI-S, State scale of State Trait Anxiety Inventory. These measures were selected because MBSR (BC) participants showed statistically significant greater improvement than control participants in the Lengacher et al[16] randomized controlled trial (RCT).

factors of "nonjudging" ($P = .009$, $d = 1.16$), "nonreacting" ($P < .01$, $d = 0.68$), and "total mindfulness" ($P < .01$, $d = 0.83$).

Previous research using the practice of mindfulness provides further evidence of the benefits of applying mindful practices. In a pilot study by Wahbeh, Goodrich, and Oken[32] of an internet-based mindfulness meditation intervention for cognition and mood in an older adult noncancer sample, no differences existed between groups for the cognitive and mood outcomes. Compared to Wahbeh, Goodrich, and Oken,[32]our mMBSR(BC) program found significant improvements in mindfulness, language of ECog, and trends towards improvements in memory and global scores. Another RCT of a web-based mindfulness treatment for anxiety disorders in a noncancer population also found statistically significant improvements in anxiety ($P = .002$), depression ($P < .001$), and sleep outcomes ($P = .016$).[33] Future studies should explore the multiple effects of MBSR and mindfulness practices, especially in larger randomized clinical trials, as most of the studies we were able to compare results with were also small pilot studies.

4.1 | Limitations

There were limitations to this feasibility study. First, there was no control or comparison group. Future work should include randomization and benefit to an attention control group, matching the mMBSR(BC) group for time and attention. Although there were significant improvements in several outcomes, we cannot rule out other design effects (such as regression to the mean) that could lead to the observed intervention effects. Results from this pilot study will be used to inform the design of a larger clinical trial to enable a more robust examination of the effect sizes, namely, using a randomized waitlist control design. Second, the small sample size and short follow-up period limits the ability to make inferences about longer-term treatment effects. Prescreening patients for distress may benefit those who self-disclose distress related to cancer. Third, because the study included patients who elected to complete the program, there may have been self-selection bias. Lastly, most of our participants were white non-Hispanic with relatively high educational attainment, and our study population did not include late-stage cancer patients. Our findings are thus directly applicable to the larger R01 trial study population, which included stage 0-III BCS, with the majority having received a mastectomy and a combination of radiation and chemotherapy. Generalization of these findings to other groups will require a randomized design and analysis across other study populations.

4.2 | Clinical implications for cancer survivors

This study provides preliminary evidence supporting the clinical benefits of the mMBSR(BC) program as a flexible and user-friendly treatment that may assist with adverse symptom effects from cancer treatment and/or diagnosis. Through the use of the iPad, BCS will have the opportunity to benefit from a stress reduction program within the comfort of their homes, a valuable contribution after completion of treatment as they return to normal daily activities. This study also supports the feasibility of implementing a larger RCT and using this technology to reach BCS who may be economically disadvantaged and/or underserved to attend a regular MBSR class. Based on positive feedback regarding acceptability and usability, this evidence supports the delivery of this mobile-based intervention to patients not only after treatment but also while completing treatment.

In conclusion, this pilot study provides support for further evaluation of this delivery of the intervention among a larger diverse sample of cancer survivors. Results from this study provide preliminary evidence that mMBSR(BC) offers benefit for psychological and physical symptoms of depression, state anxiety, stress, FOR, sleep quality and fatigue, and QOL experienced by BCS who have recently completed cancer treatment.

ACKNOWLEDGEMENT

The project described was supported in part by a grant through the University of South Florida Research Initiative Account and by National Cancer Institute Award No. R01CA131080-01A2. The content is solely the responsibility of the authors. This study protocol was approved by the Institutional Review Boards at the University of South Florida and Moffitt Cancer Center to ensure the ethical treatment of participants.

CONFLICT OF INTEREST

The authors have no conflicts to report.

ETHICS APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors. Informed consent was obtained from all individual participants included in the study.

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How to cite this article: Lengacher CA, Reich RR, Ramesar S, et al. Feasibility of the mobile mindfulness-based stress reduction for breast cancer (mMBSR(BC)) program for symptom improvement among breast cancer survivors. *Psycho-Oncology*. 2018;27:524–531. https://doi.org/10.1002/pon.4491