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REVIEW ARTICLE

Effectiveness of mindfulness-based stress reduction (MBSR) on symptom variables and health-related quality of life in breast cancer patients—a systematic review and meta-analysis

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Abstract

Objective The purpose of this systematic review and meta-analysis was to evaluate the effectiveness of mindfulness-based stress reduction (MBSR) in breast cancer patients.

Methods A systematic search of Cochrane Library, Cochrane Central Register of Controlled Trials, PsycINFO database, Web of science, Medline, EMBASE, CNKI, and CBM database was carried out from February to May 2018, with no language restrictions. Trials examining the effects of MBSR versus control group on symptom variables and health-related quality of life were included. Data concerning studies, patient characteristics, and outcomes were extracted. Methodological quality of each included randomized controlled trials were assessed individually by two reviewers independently using criteria recommended in the Cochrane Handbook for Systematic Reviews of Interventions 5.1.0. Meanwhile, Newcastle-Ottawa Quality Assessment Scale (NOS) was used to evaluate methodological quality of non-randomized studies.

Results In all, 14 studies involving 1505 participants were included. Due to the effect of MBSR, statistically significant results were found on physiological function (SMD = 0.28, 95% CI [0.07, 0.049], $P = 0.008$), cognitive function (SMD = 1.48, 95% CI [0.34, 2.61], $P = 0.01$), fatigue (SMD = − 0.66, 95% CI [− 1.11, − 0.20], $P = 0.004$), emotional wellbeing (SMD = 1.01, 95% CI [0.35, 1.67], $P = 0.003$), anxiety (SMD = − 0.54, 95% CI [− 1.01, − 0.07], $P = 0.02$), depression (SMD = − 0.61, 95% CI [− 1.11, − 0.11], $P = 0.02$), stress (SMD = − 0.48, 95% CI [− 0.81, − 0.15], $P = 0.004$), distress (SMD = − 0.56, 95% CI [− 0.85, − 0.26], $P = 0.0002$) and mindfulness (SMD = 0.94, 95% CI [0.10, 1.79], $P = 0.03$). Although the effects on pain, sleep quality, and global QoL were in the expected direction, they were not statistically significant ($P > 0.05$) based on insufficient evidence.

Conclusions MBSR is worthy of being recommended to breast cancer patients as a complementary treatment or adjunctive therapy.

Keywords Mindfulness-based stress reduction · Breast cancer · Health-related quality of life · Meta-analysis

Introduction

Breast cancer is the most frequently diagnosed cancer and the leading cause of cancer death among females, accounting for 23% of the total cancer cases and 14% of the cancer deaths [1]. Currently, it is the most common cancer among women both in developed and developing countries. About 55% of the global burden is currently experienced in developed countries, but incidence rates are rapidly rising in developing countries [2]. The treatment for breast cancer has changed dramatically, with more effective early detection and improved diagnosis, which bring about increased survival rates. However, many women who survive breast cancer inevitably experience a range of disease and treatment-related problems that is always persistent throughout their lives, including significant

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psychosocial problems, decreased psychosocial function and health-related quality of life (HRQoL). The immediate and long-term sequelae often lead to anxiety, depression, fears of recurrence, sleep disturbances, or physical problems of pain and fatigue.

It is now well known that psychosocial interventions could improve emotional wellbeing and quality of life of cancer patients [3]. An integrative therapeutic psychosocial intervention that has become increasingly popular and that may hold promise in relieving cancer-related cognitive impairment is mindfulness-based stress reduction (MBSR) [4]. MBSR is an 8-week program consists of educational materials, practice sessions of four meditative techniques (sitting meditation, body scan, gentle Hatha yoga, and walking meditation) [5, 6]. The MBSR has been used in health care practice to deliver interventions.

Previous researches testing MBSR interventions in breast cancer patients have produced both positive [7–9] and negative [10, 11] results involving such aspects anxiety, depression, pain, sleep quality, and global or disease specific quality of life. Cecile A. Lengacher et al. demonstrated extended improvement for the MBSR group compared with usual care in both psychological symptoms of anxiety, fear of recurrence problems, and physical symptoms of fatigue [8]. Caroline J. Hoffman et al. have reported that MSBR improved mood, breast and endocrine-related quality of life, and wellbeing more effectively than standard care in stage 0 to III breast cancer women. These results persisted in 3 months [9]. However, Chung Eun Lee et al. showed that MBSR program had a mild effect of improving average pain and alleviating distress [12]. The study taken by Shelley A. Johns et al. showed that cancer-related fatigue interference was not significant at any time point under MBSR intervention [10].

Therefore, there has been much debate regarding the value of MBSR program in breast cancer women. As a result, the current meta-analysis aims to investigate whether MBSR is beneficial for symptom variables and HRQoL in breast cancer patients and survivors.

Methods

Search strategy

The electronic databases of Cochrane Library, Cochrane Central Register of Controlled Trials, PsycINFO database, Web of science, Medline, EMBASE, CNKI, and CBM database were searched from February to May 2018, with no language restrictions. The search terms used were related to breast cancer (key words: breast cancer, breast neoplasms, breast tumors, cancer of breast, human mammary carcinoma; MeSH term: breast neoplasm); mindfulness-based stress reduction (key words: mindfulness-based stress reduction, MBSR, mindfulness-based cognitive therapy, MBCT, mindfulness-based intervention; MeSH term: mindfulness-based stress reduction), in combination with the outcome measures anxiety, depression, stress, mindfulness, fatigue, pain, and global or disease-specific quality of life. Related systematic reviews and meta-analyses were also identified from these databases. The reference lists were checked as well as those articles, until no further studies were found. Those trials comparing MBSR intervention with a control group receiving no MBSR for breast cancer women were included. Publications without sufficient quantitative data to calculate the effect size and corresponding standard error were excluded. When results of one study were reported in several publications, only the most recent and complete data were considered.

Data extraction

The eligibility of trials was assessed by two reviewers independently (Fig. 1). Data concerning studies, patient characteristics, and outcomes were extracted by two authors. Discrepancies were resolved by agreement, and a third reviewer was consulted if necessary. Two authors extracted a range of data independently from each publication including (1) general information (e.g., first author's name, year of publication, and country where the study was conducted); (2) characteristics of the patient population (e.g., number of participants, breast cancer stage); (3) characteristics of the intervention (e.g., type, frequency, duration, and follow-up time); and (4) outcome measures. Quantitative data were extracted to calculate effect sizes. Data on effect size that could not be obtained directly were recalculated when possible.

Methodological quality assessment

Methodological quality of each included randomized controlled trials (RCTs) were assessed individually by two reviewers independently for major potential sources of bias using criteria recommended in the Cochrane Handbook for Systematic Reviews of Interventions 5.1.0 [13]. The domains related to risk of bias were assessed: (1) random sequence generation; (2) allocation concealment; (3) blinding of participants, clinical staff, and outcome assessors (performance bias, detection bias); (4) incomplete outcome data (attrition bias); (5) selective reporting (reporting bias); and (6) other bias. Meanwhile, Newcastle-Ottawa Quality Assessment Scale (NOS) was used to evaluate methodological quality of non-randomized studies based on three aspects: selection of study groups, comparability of study groups and ascertainment of either the exposure or outcome of interest [14]. When differences existed, a third reviewer was consulted, the results were reached through final consensus.

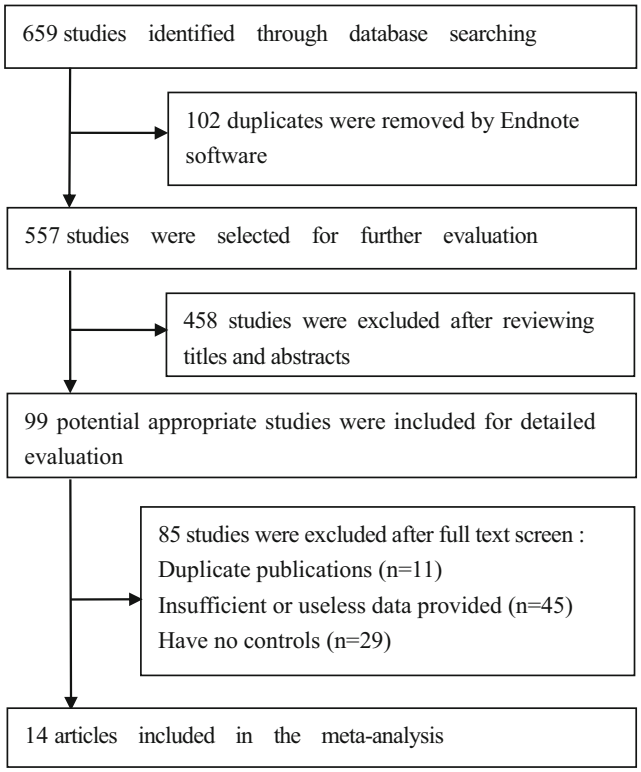


Fig. 1 Flow diagram of the study selection process

Data synthesis and statistical analysis

The scores on questionnaires were extracted as mean differences (MD) ± standard deviation (SD). MD and 95% confidence intervals (CI) were calculated for scores in each study eligible for the meta-analysis and combined by using fixed or random effects model according to DerSimonian and Laird [15]. Heterogeneity was assessed through Q and I^2 statistics for each comparison, and potential sources of heterogeneity were discussed where appropriate [16]. P value less than 0.05 was considered statistically significant, and I^2 values of 25%, 50%, and 75% were defined as low, moderate, and high estimates, respectively. Publication bias was not conducted as a result of small number (less than 10) of studies included in each analysis [17]. This meta-analysis was conducted by Stata 12.0 software and also had been registered on the systematic review database of PRPSPERO, the number is CRD 42018099195.

Results

Studies selection

As shown in Fig. 1, the literature search initially identified 659 articles, 645 were excluded after initial review for the following reasons. Among these, 102 duplicates were excluded by using Endnote software, and 458 articles were excluded after

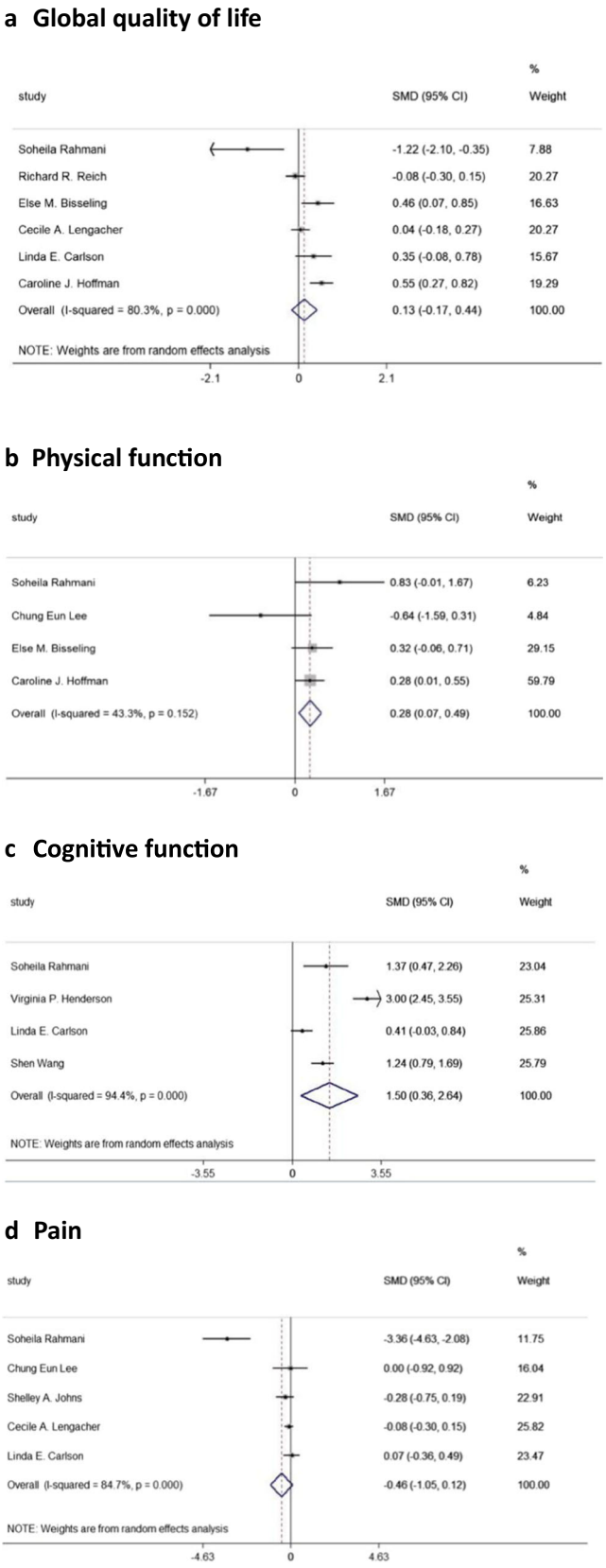


Fig. 1 Dimension analysis of total breast cancers. **a** Global quality of life. **b** Physical function. **c** Cognitive function. **d** Pain. **e** Fatigue. **f** Sleep quality. **g** Emotional wellbeing. **h** Anxiety. **i** Depression. **j** Stress. **k** Distress. **l** Mindfulness

Table 1 Characteristics of the included studies

Author	Year	Country	Stage	Age (year)	Sample size	Intervention		Intervention duration or follow-up time	Outcomes	Instruments	Study design
				Mean ± SD	Treatment/ control	Treatment group	Control group				
Soheila Rahmani	2014	Iran	I–III	43.25 ± 3.08	12/12	Treatment was implemented during 8 group sessions, once a week and for 2 h based on MBSR	Without MBSR intervention	2 months	QoL, physical function, emotion, social function, fatigue, and pain	QLQ-C30 and QLQ-BR23	RCT
Chung Eun Lee	2017	South Korea	Metastatic breast cancer	52	9/9	Offered once a week for 2 h each and continued for 8 weeks	Usual care	8 weeks	QoL, anxiety, depression, pain, and distress	FACT-B, HADS, WBPI, and distress thermometer scale	Non-RCT
JiaYuan Zhang	2016	China	I–III	48.67 ± 8.49	28/30	received weekly 2-h sessions conducted by psychologist	Usual care	3 months	Anxiety and stress	STAI and PSS	RCT
Virginia P. Henderson	2013	USA	Newly diagnosed	50 ± 8	53/58	completing the 8-week MBSR program plus 3 additional sessions	Usual care	8 weeks, 4 months, 1 year, and 2 years	Emotion, social function, anxiety, and depression	FACT-B, STAI, and SCL-90-R	RCT
Richard R. Reich	2016	USA	0–III	53.04 ± 8.72	155/148	6 weeks, 2 h per week sessions	Usual care	6 weeks, 12 weeks	Anxiety, depression, mindfulness, sleep quality, fatigue, pain, cognitive function, stress, and QoL	STAI, CESD, CAMS-R, PSQI, FSI, BPI, ECOG, PSS, and SF-36	RCT
Else M. Bisseling	2017	Netherland	0–III	51.7 ± 8.3	52/52	8 weekly group-based 2.5-h sessions, a 6-h silent day between sessions 6 and 7, and daily 45-min home practice	Usual care	8 weeks	Anxiety, depression, QoL, well-being, and mindfulness	HADS, QLQ-C30, WEMWBS, and FFMQ-SF	Non-RCT
Shelley A. Johns	2016	USA	0–III	56.9 ± 9.9	35/36	MBSR intervention	Psychoeducation and support	6 months	Fatigue, vitality, QoL, anxiety, and sleep quality	FSI,SF-36, PHQ-8, GAD-7, and ISI	RCT
Cecile A. Lengacher	2016	USA	0–III	56.5 ± 10.2	152/147	6-week MBSR	Usual care	6 weeks, 12 weeks	Pain, fatigue, QoL, anxiety, depression, and stress	BPI, CESD, STAI, PSS, and MOS	RCT

Table 1 (continued)

Author	Year	Country	Stage	Age (year)	Sample size	Intervention		Intervention duration or follow-up time	Outcomes	Instruments	Study design
				Mean ± SD	Treatment/ control	Treatment group	Control group				
Linda E. Carlson	2002	Canada	0–II, early stage	54.5 ± 10.9	42/42	8-week MBSR	Without intervention	8 weeks	QoL, mood, stress, fatigue, and sleep quality	EORTC, QLQ-C30, POMS, SOSI, and symptom-scales	Non-RCT
Caroline J. Hoffman	2012	UK	0–III	49 ± 9.26	103/111	8-week MBSR	Usual care	8 weeks, 12 weeks	Anxiety, depression, emotion, fatigue, vigor, physical function, and social well-being	POMS, FACT-B, FACT-ES, and WHO-5	RCT
Shen Wang	2017	China	I–III	40.67 ± 4.58	45/46	8-week MBSR	Usual care	3 months	Fatigue, cognitive function, emotion, and sleep	PFS-R and PSQI	RCT
Patricia L. Dobkin	2007	Canada	Unclear	54	13/13	8-week MBSR	Without intervention	8 weeks	Depression, stress, and mindfulness	CES-D, PSS, and MAAS	Non-RCT
Yaowarat Matchim	2010	Thailand	0–II,early stage	56.87	15/17	8-week MBSR	Without MBSR intervention	4 weeks, 8 weeks	Mood, stress, and mindfulness	POMS, C-SOSI, and FFMQ	Non-RCT
Rose H. Matousek	2010	Canada	I–II	55.9 ± 10.8	33/33	8-week MBSR	Without MBSR intervention	8 weeks	Depression and stress	CESD and PSS	Non-RCT

SD, standard deviation; *QoL*, quality of life; *HADS*, hospital anxiety and depression scale; *WBPI*, Wisconsin brief pain inventory; *RCT*, randomized clinical trial; *STAI*, state trait anxiety inventory; *PSS*, perceived stress scale; *FACT-B*, functional assessment of cancer therapy-breast; *SCL-90-R*, symptom checklist 90-revised; *CESD*, center for epidemiologic studies-depression; *CAMS-R*, cognitive and affective mindfulness scale-revised; *PSQI*, Pittsburgh sleep quality index; *FSI*, fatigue symptom inventory; *BPI*, brief pain inventory; *ECOG*, everyday cognition scale; *WEMWBS*, Warwick-Edinburgh mental wellbeing scale; *FFMQ-SF*, short form of the five facet mindfulness questionnaire; *PHQ-8*, patient health questionnaire 8-item depression scale; *GAD-7*, 7-item generalized anxiety disorder scale; *ISI*, the 7-item insomnia severity index; *MOS*, medical outcomes study short form; *EORTC*, European organization for research and treatment of cancer quality of life questionnaire; *POMS*, profile of mood states; *SOSI*, symptoms of stress inventory; *FACT-ES*, functional assessment of cancer therapy-endocrine symptoms; *WHO-5*, WHO five-item well-being questionnaire; *PFS-R*, revised piper fatigue scale; *MAAS*, mindful attention awareness scale; *C-SOSI*, Calgary symptoms of stress inventory; *FFMQ*, five facet mindfulness questionnaire

Table 2 Risk of bias assessment of the included randomized clinical trials

Study	Adequate sequence generation	Allocation concealment	Performance bias	Detection bias	Attrition bias	Reporting bias	Other bias	Overall bias
Soheila Rahmani	Uclear	Uclear	Yes	No	Yes	No	No	High
Jia Yuan Zhang	Uclear	Uclear	No	No	No	No	No	Moderate
Virginia P. Henderson	Uclear	Uclear	No	No	Yes	No	No	Moderate
Richard R. Reich	Yes	Uclear	No	No	No	No	No	Low
Shelley A. Johns	Yes	Uclear	No	No	No	No	No	Low
Cecile A. Lengacher	Yes	Yes	No	No	No	No	No	Low
Caroline J. Hoffman	Yes	Yes	No	No	No	No	No	Low
Shen Wang	Yes	Uclear	No	No	No	No	No	Low

initial screening because the subjects and interventions were not related to the MBSR program. Ninety-nine full-text articles were maintained for further screening. Of these studies, 85 were excluded for the following reasons: duplicate publications ($n = 11$); have no controls ($n = 29$); insufficient data provided, and authors were not reachable ($n = 45$). Finally, 14 articles were included in this meta-analysis [7–12, 18–25]. References cited in published original and review articles were examined until no further studies were found.

Characteristics of included studies

The characteristics of studies included in the meta-analysis were presented in Table 1. The combined sample size across 14 included studies was 1505 participants. Among the included studies, 4 were performed in America, 1 in Iran, 1 in South Korea, 1 in Netherland, 1 in the UK, 1 in Thailand, 3 in Canada, and 2 in China. The majority of patient samples consisted of patients with non-metastatic breast cancer, whereas 1 study [12] included metastatic breast cancer patients. The median of mean ages was 48.17 years [range 40.67–56.90] and the sample size of patients with breast cancer ranged from 9 to 153. All studies compared MBSR intervention with usual care or no MBSR control condition. Although these studies used various forms of MBSR intervention, mainly consisted of educational materials, practice sessions of four meditative techniques (sitting meditation, body scan, gentle Hatha yoga, and walking meditation). The intervention programs and follow-up time ranged from 4 weeks to 24 months.

The risk of bias assessment of included studies were shown in Tables 2 and 3. The overall RCTs had unclear selection bias, performance bias, and detection bias, with relative high risk of reporting bias. But they had low risk of attrition bias and other bias. And overall, there was a mean Newcastle-Ottawa scale score of 6 out of 9 (range, 5–7), which indicated that those non-RCTs in our meta-analysis had good quality generally.

Effectiveness of interventions

There were 14 studies that compared MBSR interventions with usual care or "no interventions" control condition. The data measured at post-intervention were used for the outcomes. Results in these studies involved participants included by the researchers in their analyses, many of whom excluded participants for many reasons, including dropouts or uncollected data. Statistical heterogeneity was tested for each outcome. A negative direction for MD or SMD of bad outcomes indicates that the intervention

Table 3 Risk of bias assessment of included non-randomized clinical trials

Study	Selection				Comparability	Outcome			Total score
	Exposed cohort	Non-exposed cohort	Ascertainment of exposure	Outcome of interest		Assessment of outcome	Length of follow-up	Adequacy of follow-up	
Chung Eun Lee	–	*	*	–	**	*	–	–	5
Else M. Bisseling	–	*	*	*	**	*	*	–	7
Linda E. Carlson	–	*	*	*	**	*	*	–	7
Patricia L. Dobkin	–	*	*	*	**	*	–	–	6
Yaowarat Matchim	–	*	*	–	**	*	–	–	5
Rose H. Matousek	–	*	*	*	**	*	–	–	6

condition produces more improvement in outcomes than the control condition, and vice versa. Figure 2 provides a summary of the results of the overall meta-analysis for each of dimensions.

Global quality of life

Six studies [7–9, 11, 18, 19] involving 1024 participants examined the impact of MBSR on quality of life. Heterogeneity analyses revealed substantial heterogeneity across studies ($P = 0.0002$, $I^2 = 80\%$), and therefore, a random-effects model was used. The results of meta-analysis revealed that no significant difference was observed between MBSR interventions and the control groups (SMD = 0.14, 95% CI [− 0.16, 0.44], $P = 0.37$; Fig. 2a).

Physiological function

Four studies [9, 12, 18, 19] reported physiological function involving 359 participants. A fixed-effects model was used, because the heterogeneity test showed an I^2 of 38% among the studies ($P = 0.18$, $I^2 = 38\%$). MBSR had a positive effect on physiological function compared with control conditions; this effect was statistically significant (SMD = 0.28, 95% CI [0.07, 0.049], $P = 0.008$; Fig. 2b).

Cognitive function

Four studies [11, 18, 20, 21] reported cognitive function involving 310 participants. A random-effects model was used, because the heterogeneity test showed substantial heterogeneity among studies ($P < 0.00001$, $I^2 = 94\%$). The results of meta-analysis revealed that MBSR had a positive effect on cognitive function compared with control conditions; this effect was statistically significant (SMD = 1.48, 95% CI [0.34, 2.61], $P = 0.01$; Fig. 2c).

Pain

Five studies [8, 10–12, 18] reported pain involving 496 participants. A random-effects model was used, because the heterogeneity test showed substantial heterogeneity among studies ($P < 0.00001$, $I^2 = 83\%$). No significant difference was observed between MBSR and control groups (SMD = − 0.43, 95% CI [− 0.99, 0.13], $P = 0.13$; Fig. 2d).

Fatigue

Seven studies [7–11, 18, 21] reported fatigue involving 1082 participants. A random-effects model was used, because the heterogeneity test showed substantial heterogeneity among the studies ($P < 0.00001$, $I^2 = 91\%$). MBSR had a positive effect on fatigue compared with control conditions; this

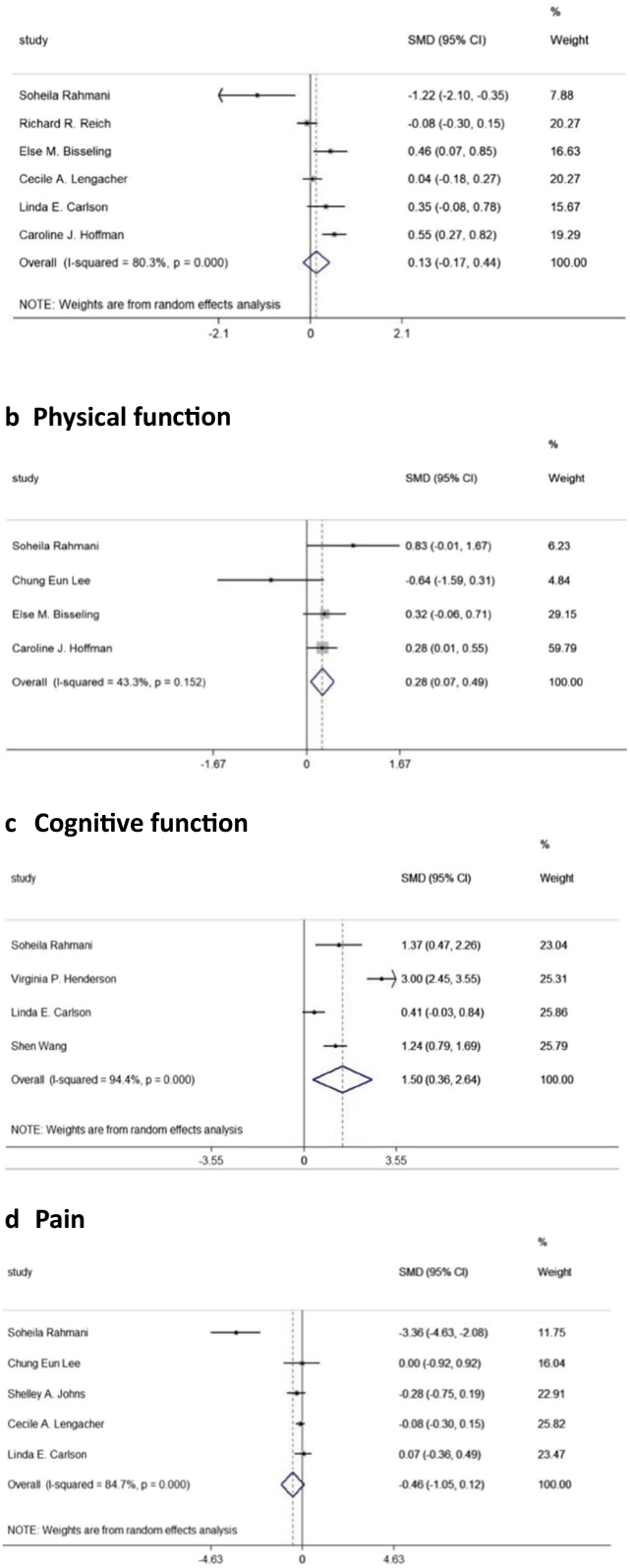
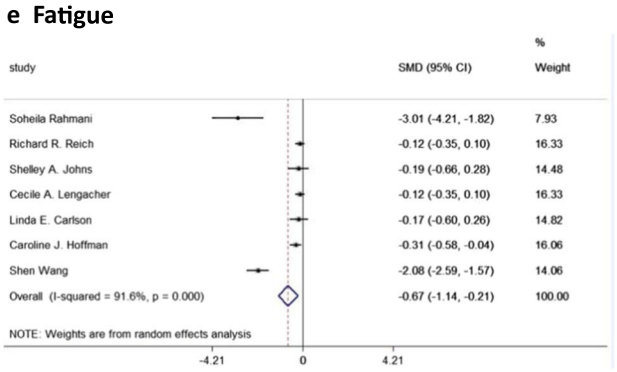
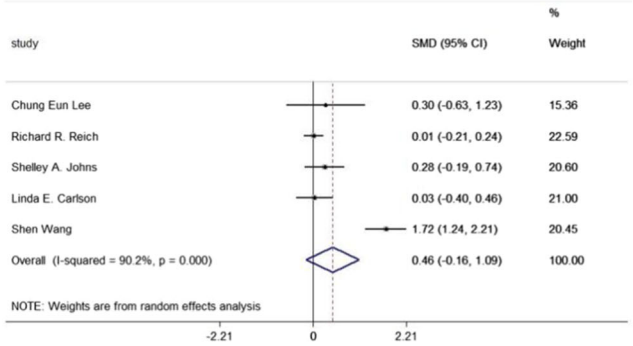
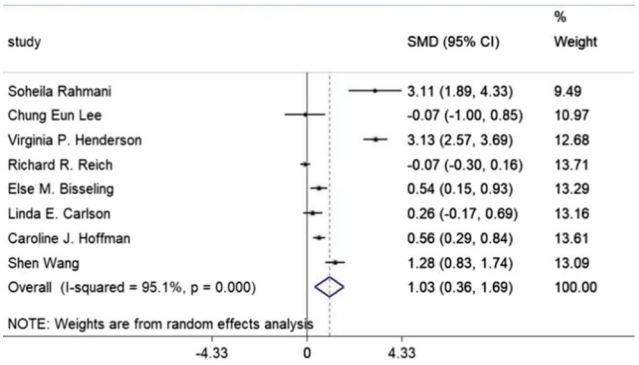
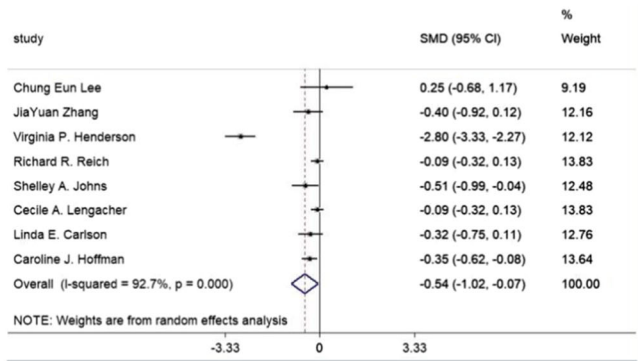


Fig. 2 Dimension analysis of total breast cancers. **a** Global quality of life. **b** Physical function. **c** Cognitive function. **d** Pain. **e** Fatigue. **f** Sleep quality. **g** Emotional wellbeing. **h** Anxiety. **i** Depression. **j** Stress. **k** Distress. **l** Mindfulness









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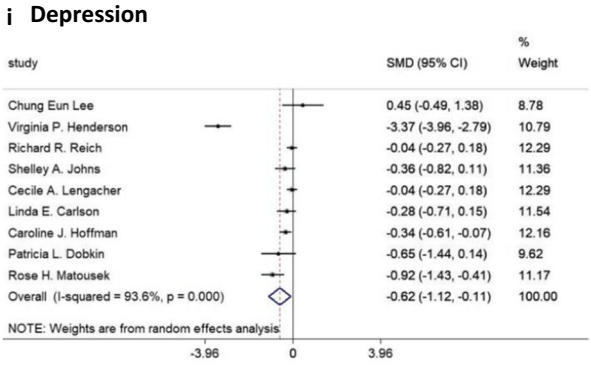

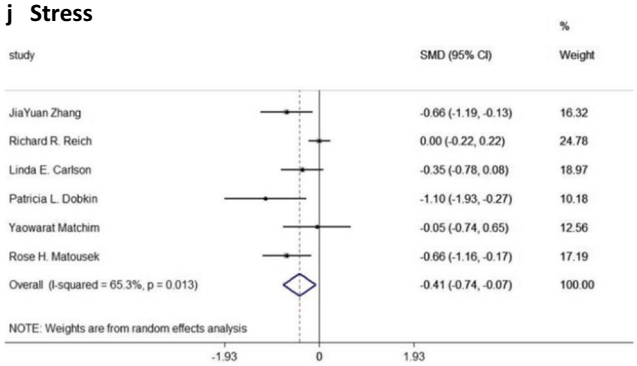

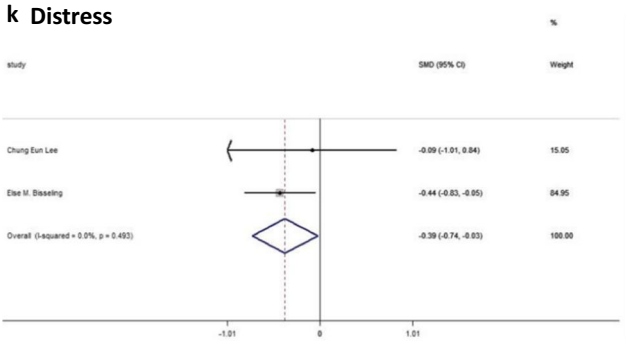

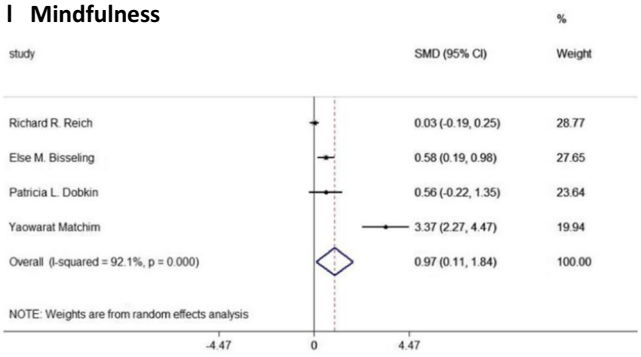

Fig. 2 (continued)

effect was statistically significant (SMD = − 0.66, 95% CI [− 1.11, − 0.20], $P = 0.004$; Fig. 2e).

Sleep quality

Five studies [7, 10–12, 21] reported sleep quality involving 559 participants. A random-effects model was used, because

the heterogeneity test showed substantial heterogeneity among studies ($P < 0.00001$, $I^2 = 90\%$). No significant difference was observed between MBSR and control groups (SMD = 0.46, 95% CI [− 0.16, 1.08], $P = 0.15$; Fig. 2f).

Emotional wellbeing

Eight studies [7, 9, 11, 12, 18–21] reported emotional wellbeing involving 942 participants. A random-effects model was used, because the heterogeneity test showed substantial heterogeneity among studies ($P < 0.00001$, $I^2 = 95\%$). The results of meta-analysis revealed that MBSR had a positive effect on emotional wellbeing compared with control conditions; this effect was statistically significant (SMD = 1.01, 95% CI [0.35, 1.67], $P = 0.003$; Fig. 2g).

Anxiety

Eight studies [7–12, 20, 22] reported anxiety involving 1162 participants. A random-effects model was used, because the heterogeneity test showed substantial heterogeneity among studies ($P < 0.00001$, $I^2 = 93\%$). The results of the meta-analysis revealed that MBSR had a positive effect on anxiety compared with control conditions; this effect was statistically significant (SMD = − 0.54, 95% CI [− 1.01, − 0.07], $P = 0.02$; Fig. 2h).

Depression

Nine studies [7–12, 20, 23, 25] reported depression involving 1196 participants. A random-effects model was used, because the heterogeneity test showed substantial heterogeneity among studies ($P < 0.00001$, $I^2 = 94\%$). MBSR had a positive effect on depression compared with control conditions; this effect was statistically significant (SMD = − 0.61, 95% CI [− 1.11, − 0.11], $P = 0.02$; Fig. 2i).

Stress

Six studies [7, 11, 22–25] reported stress involving 641 participants. A random-effects model was used, because the heterogeneity test showed relative large heterogeneity among studies ($P = 0.003$, $I^2 = 70\%$). The results of meta-analysis revealed that MBSR had a positive effect on stress compared with control conditions; this effect was statistically significant (SMD = − 0.48, 95% CI [− 0.81, − 0.15], $P = 0.004$; Fig. 2j).

Distress

Two studies [12, 19] reported distress involving 188 participants. A fixed-effects model was used, because the heterogeneity test showed an I^2 of 37% among the studies ($P = 0.20$, $I^2 = 37\%$). MBSR had a positive effect on distress compared with control conditions; this effect was statistically significant (SMD = − 0.56, 95% CI [− 0.85, − 0.26], $P = 0.0002$; Fig. 2k).

Mindfulness

Four studies [7, 19, 23, 24] reported mindfulness involving 478 participants. A random-effects model was used, because the heterogeneity test showed substantial heterogeneity among studies ($P < 0.00001$, $I^2 = 92\%$). The results of meta-analysis revealed that MBSR had a positive effect on mindfulness compared with control conditions; this effect was statistically significant (SMD = 0.94, 95% CI [0.10, 1.79], $P = 0.03$; Fig. 2l).

Discussion

This meta-analysis provides a comprehensive summary of studies exploring the effectiveness of MBSR interventions, during and after treatment, on outcomes such as global quality of life, physical function, cognitive function, pain, fatigue, sleep quality, emotional wellbeing, anxiety, depression, stress, distress, and mindfulness in breast cancer patients or survivors. Statistically significant, results were found for the effect of MBSR on physical function, cognitive function, fatigue, emotional wellbeing, anxiety, depression, stress, distress, and mindfulness, with stronger effects found on relieving distress, stress, and fatigue. Although there was such a trend that MBSR could play a role in improving global quality of life, sleep quality and relieving pain. No significant effects were observed in pooled results. In our meta-analysis, only one study [18] assessed the effect on sexual function and body image, thus a summary effect size could not be calculated.

Breast cancer diagnosis and treatment could result in highly stressful experience. Patients continues to exist high levels of stress, anxiety, depression, fear of disease recurrence, insomnia, and fatigue, which have serious impact on global QoL [26]. Consequently, how to help breast cancer patients maintain maximal function has become the priority of rehabilitation. An innovative intervention in cancer patients is MBSR, which consists of 8 weekly group-based 2.5-h sessions, a 6-h silent day between sessions 6 and 7, and daily 45-min home practice. Mindfulness is defined as intentionally paying attention to present-moment experiences in an accepting and non-judgmental way [5, 6]. Previous systematic reviews and meta-analyses concluded that mindfulness-based interventions were effective in decreasing psychological disorder of cancer patients [27, 28]. However, the meta-analysis specifically for breast cancer patients are limited. A recent systematic review [29] reported large effect sizes for MBSR in improving anxiety and perceived stress in breast cancer, but only for uncontrolled trials. Moreover, there is limited evidence that MBSR

can affect pain, fatigue, sleep quality, psychological disorders, health-related quality of life (HRQOL), and other dimensions. Therefore, the aim of this meta-analysis was to assess whether MBS is effective in improving HRQOL and other dimensions among breast cancer survivors.

MBSR intervention is known to have been associated with reduction in symptoms, especially negative emotions in psychological disorders. In the current meta-analysis, no statistically significant effects were observed from pooling data on pain, social function, and sleep quality. As expected, there was a tendency toward decreases in these dimensions at post-intervention. The minimal impact on these outcomes may be explained by several factors, the difference between individual and group sessions, different stage of disease, different measures used across the studies, and insufficient data provided in some studies [30–33]. Würtzen et al. [31] reported that a significant effect of MBSR on the burden of somatic symptoms post-intervention and after 6 months' follow-up. Witekjanusek et al. [32] found that women enrolled in MBSR program had improved QoL and coping effectiveness compared to Non-MBSR group. Andersen et al. [34] showed that MBSR had a statistically significant effect on sleep quality between baseline and post-intervention. However, these studies we mentioned above do not have continuous data (mean ± standard deviation), which were excluded by us. Consequently, studies with minor or positive results could be missed. Additionally, in terms of pain, the different stage of the disease counts. Chung Eun Lee et al. [12] reported MBSR program had a mild effect of alleviating average pain, which recruited metastatic breast cancer. A recent meta-analysis showed that the sooner after diagnosis psychological help was offered, the higher the uptake [35]. Furthermore, recently, qualitative studies [36, 37] gave more supports for the use of MBSR in reducing psychological issues among breast cancer patients. The MBSR group expressed a series of positive effects including increased calm, energy, and less physical pain.

To our knowledge, this is the first study employing a meta-analysis of RCTs and non-RCTs that has examined the effects of MBSR interventions on pain, fatigue, sleep quality, psychological disorders, HRQOL, and other dimensions for breast cancer patients and survivors. However, certain limitations of the current studies and this meta-analysis should be addressed. First, heterogeneity existed in the pooling of almost all outcome measures. As a consequence, random effect analyses were used, resulting in wider confidence intervals and relatively more weight being given to smaller studies. Second, we could not identify any significant sources of heterogeneity of outcomes in the randomized controlled trials. A potential explanation for this is the variation in difference between individuals and varying measures used among the studies, further research should be conducted to clarify this matter. Furthermore, since there was no detailed information about usual care in articles, we regret not being able to elaborate or to make subgroup analysis. Finally, some well-designed RCTs were excluded because of inadequate data reported. Therefore, the conclusions must be interpreted with caution. Further, well-designed and high-quality studies are needed to evaluate the effects.

Conclusions

The results of this meta-analysis revealed that MBSR had a positive effect on relieving anxiety, depression, fatigue, stress, distress and improving mindfulness, cognitive function, emotional wellbeing, physical function, and overall QoL among breast cancer patients or survivors. This beneficial program is worthy of being recommended to breast cancer patients as a complementary treatment or adjunctive therapy to make them enjoy better quality of life.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

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