



Mindfulness-based interventions for breast cancer patients in China across outcome domains: a systematic review and meta-analysis of the Chinese literature

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Abstract

Objective This study aims to evaluate the treatment effect of a mindfulness-based intervention for Chinese breast cancer patients across outcome domains, including symptom-related, psychosocial, and quality of life outcomes.

Methods Following the Cochrane Systematic Review guideline, we searched across five electronic databases, reference lists of eligible studies, professional websites, and major academic journals in Chinese. Publication bias was assessed using funnel plot and Vevea and Woods sensitivity analysis, and risk of bias was evaluated using the revised Cochrane risk of bias tool for randomized trials and risk of bias in non-randomized studies of interventions. A meta-analysis of Hedges' *g* was conducted using meta-regression with robust variance estimation.

Results Final analysis included a total of 45 controlled trials containing 286 effect size estimates. Across outcome domains, studies reported an overall large and statistically significant treatment effect, $d = 0.921$, 95% CI (0.805, 1.040), $p < 0.001$. Subgroup analyses of specific domains of outcome reported overall significant treatment effects for (1) symptom-related outcomes, $d = 0.885$, 95% CI (0.657, 1.110), $p < 0.001$; (2) psychosocial wellness outcomes, $d = 0.984$, 95% CI (0.879, 1.090), $p < 0.001$; and (3) quality of life, $d = 0.990$, 95% CI (0.776, 1.200), $p < 0.001$. Moderator analysis did not identify any significant moderator.

Conclusion Chinese literature reported an overall statistically significant and large treatment effect of a mindfulness-based intervention for breast cancer patients in China. Except for physical symptom outcomes, e.g., nausea/vomiting and pain, a mindfulness-based intervention was effective across outcome domains among Chinese breast cancer patients.

Keywords Breast cancer · Mindfulness-based intervention · Systematic review and meta-analysis

Breast cancer is the most common cancer and cause of cancer-related death among women internationally [1]. There were over 2 million newly diagnosed breast cancer patients worldwide in 2018, including 626,679 associated deaths [2].

Medical treatments for breast cancer have advanced significantly over the past decade, resulting in major improvements in breast cancer patients' 5-year survival rate [3–5]. However, psychosocial and symptom-related outcomes among breast cancer patients remain poorly addressed both during and after patients' cancer treatment [6–8]. Breast cancer patients, especially those receiving ongoing treatment, often suffer from physical side effects such as nausea/vomiting, sleep disturbance, chronic pain, shortness of breath, among others [9, 10]. Although most of these physical symptoms are prominent during active cancer treatment, many patients continue to endure physical late effects for many years after treatment completion [11, 12].

Additionally, breast cancer patients often encounter a high level of psychosocial challenges throughout their disease trajectory including, but not limited to, depression, anxiety, mood disorders, and psychological distress [13–15]. Meta-analyses of the global prevalence of psychiatric disorders

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revealed an average rate of 32.2% and 41.9% for breast cancer patients, respectively [16, 17]. Notably, rates of depression and anxiety among breast cancer patients were reported at least two times higher in developing countries than developed countries, underscoring the mental health disparities and unmet psychosocial needs among breast cancer patients from developing countries.

Finally, unaddressed physical symptoms and psychosocial challenges may lead to patients' compromised wellbeing such as decreased self-efficacy, increased risk of substance use, and reduced quality of life. For example, studies have found that breast cancer patients' quality of life was the lowest before postoperative chemotherapy, increased after the second chemotherapy, then lowered again after the fourth and fifth rounds of chemotherapy [18]. The quality of life trajectory among breast cancer patients continues to fluctuate throughout their post-treatment survivorship care, highlighting the needs for ongoing surveillance and interventions to address breast cancer patients' biopsychosocial challenges [19]. Therefore, it is essential for health and mental health providers to have a thorough understanding of existing psychosocial interventions to support breast cancer patients.

Mindfulness-based interventions for breast cancer patients

Mindfulness-based interventions represent a unique form of psychotherapeutic and/or supportive intervention that warrants attention for cancer patients, including those diagnosed with breast cancer. In this study, a mindfulness-based intervention is defined as any form of psychotherapeutic and/or supportive intervention that uses mindfulness as the core treatment component. This study operationalizes mindfulness using two features: (1) mindfulness grounds attention and awareness in one's present moment experience and (2) mindfulness posits that adopting an attitude of openness or acceptance toward one's experience is critical [20]. Unlike most didactic psychotherapies (e.g., cognitive behavioral therapy or problem-solving therapy), mindfulness-based interventions do not have a structured change process/mechanism but, instead, focus on attention to the present, acceptance, and emotion regulation [21, 22]. This is particularly important for cancer patients because many didactic psychotherapies do not sufficiently address patients' cognitive structure and emotional response to a cancer diagnosis and its treatment [22–24]. When facing a cancer diagnosis, many cognitive patterns and emotional responses generally considered maladaptive are now normalized. For example, fear of death is typically considered as an irrational or exaggerated thought for most individuals who have health and/or death anxiety. However, fear of death is a reasonable and expected thought among breast cancer patients. As a result, traditional approaches of

“modifying” or “intervening” fear of death would not work effectively among cancer patients. On the other hand, mindfulness-based interventions focusing on acceptance and emotion regulation when facing distressful thoughts and emotions, like death anxiety, may effectively target cancer patients' concerns. Finally, changes in body image, self-perception, and sexuality among breast cancer patients also highlight the unique relevance of mindfulness-based interventions that focus on acceptance, inner reflection, and emotion regulation. In summary, mindfulness-based interventions provide a mechanism of change that addresses the unique physical and psychosocial challenges experienced by women with breast cancer. It is essential for psycho-oncology providers, e.g., cancer psychologists, oncology social workers, and oncology nurses, to better understand the effectiveness of mindfulness-based interventions for breast cancer patients.

Existing reviews and gap in the literature

To our knowledge, seven systematic reviews and/or meta-analysis studies published in English focused on mindfulness-based interventions for breast cancer patients. Specifically, four studies [25–28] focused on Mindfulness-Based Stress Reduction for breast cancer patients' psychological outcomes, quality of life, and symptom-related outcomes. The number of included studies was small in general (2 reviews included 3 randomized controlled trials (RCTs); 1 review included 9 RCTs and 1 review included 14 RCTs). In addition, three studies [29–31] evaluated the effectiveness of mindfulness-based interventions for breast cancer patients' physical, psychosocial, and quality of life outcomes. The size of these three reviews remains relatively small with six, ten, and seven included RCTs. Across the seven published reviews, findings were consistent in supporting mindfulness-based interventions for breast cancer patients across outcome domains, i.e., symptom-related outcomes, psychosocial outcomes, and quality of life. Most reported effect size estimates were moderate to large ranging from $d = 0.31$ to $d = 1.48$.

However, several important gaps remain in the existing literature. First, most published reviews included fewer than 10 studies, which reduces the level of confidence regarding their meta-analytic findings. Second, only three out of seven studies broadly focused on mindfulness-based interventions and four studies narrowly focused on mindfulness-based stress reduction. While all these reviews are highly valuable to our understanding of mindfulness-based interventions for breast cancer patients, research synthesis studies regarding various mindfulness-based interventions for breast cancer patients remain limited. Third, most existing reviews focused on a confined set of outcome domains rather than being inclusive of physical, psychosocial, and quality of life outcomes. While a confined review would provide greater conceptual clarity,

most breast cancer patients suffer from a combination of biopsychosocial challenges. Therefore, a comprehensive review that includes multiple outcome domains may provide a holistic picture for psycho-oncology providers when considering treatment options for breast cancer patients. Finally, over 80% of RCTs included in existing reviews were conducted in developed countries, e.g., North America and Europe, which limited their implications to developing countries as well as racial/ethnic minority immigrants in developed countries. This is problematic especially given the health and mental health disparities among racial/ethnic minority breast cancer patients, including breast cancer patients who are Chinese.

Asian Americans have the third-highest rate of breast cancer incidence internationally [32] and the highest rate of increase in breast cancer incidence despite the overall stable trend across racial/ethnic groups [32, 33]. Studies have consistently reported disparities among Asian breast cancer patients [34], especially those pertaining to psychosocial support. Significantly greater disease burdens were identified among Asian breast cancer patients in comparison to other racial/ethnic groups due to poor access to evidence-based psychosocial interventions [35, 36]. In other words, while there are evidence-based psychosocial interventions for breast cancer patients in general, limited attention has focused on the effectiveness of these interventions on breast cancer patients of Chinese descent. Most importantly, published systematic reviews and meta-analysis studies (between 2012 to 2019) identified only *two* clinical trials published in English delivering mindfulness-based interventions for breast cancer patients in China, leaving few empirical evidence supporting the use of a mindfulness-based intervention for breast cancer patients of Chinese descent.

Therefore, the purpose of this study is to evaluate the effectiveness of mindfulness-based intervention for breast cancer patients that are published in the Chinese literature. Acknowledging the complex biopsychosocial challenges confronting Chinese breast cancer patients, this review is inclusive of various domains of outcomes including physical, psychosocial, and quality of life outcomes. Specifically, we evaluate the following hypotheses: (1) mindfulness-based interventions are overall effective for Chinese breast cancer patients and (2) explore possible factors, e.g., treatment modality (individual versus group intervention) or treatment approach (mindfulness as a therapeutic intervention versus as a behavioral skill), moderate the treatment effect.

Methods

Search strategy A total of 5 electronic databases were searched in this study. Three electronic databases, including China Academic Journals Full-Text Database; China Academic Journals Electronic Publishing House; and China

Academic Journal Network Publishing Database were searched using the China National Knowledge Infrastructure (CNKI). The other two datasets were (1) WanFang Data Knowledge Service Platform which integrates over 15 types of databases and (2) China Science and Technology Journal Databases, which includes medical journals. The literature search occurred on August 1, 2020, and a list of initial articles was obtained on August 3. Search terms included “mindfulness” (zheng nian) or “meditation” (ming xiang) or “Zen” (chan xiu) or “inner reflection” (nei guan) to capture mindfulness-related studies and “breast cancer” (ru xian ai) or “breast oncology” (ru xian liu) or “breast malignancy” (ru xian zhong liu) to capture studies related to breast cancer. There was no time limit for studies included in this review. A gray literature search involved (1) screening reference lists of eligible studies; (2) searching relevant professional websites: China Anti-Cancer Association, Chinese Society of Clinical oncology, and Shanghai Cancer Institute; and (3) searching major academic journals: Chinese Journal of Cancer Research and the Chinese Journal of Cancer.

Study eligibility Studies were included if they (1) evaluated a mindfulness-based intervention; (2) used a controlled trial with or without random assignment; (3) targeted breast cancer patients; (4) written and/or published in the Chinese language; and (5) focused on physical, psychosocial, quality of life, and mindfulness-related outcomes.

Study screening and data extraction Two independent researchers utilized an Excel database to track study screening, first based on title and abstract and then, based on full text. Between screener, reliability was 84% for title and abstract screening and 97% for full-text screening. When there was a disagreement, the two reviewers met to resolve discrepancies, and when not successful, a third reviewer read the article and made a final decision. Study characteristics (e.g., sample size, gender, intervention modality, outcomes) and effect size data were extracted for each study included in the review. Study coding followed a pre-defined coding sheet to facilitate systematic data extraction. Publication bias was visually assessed using a funnel plot by plotting observed treatment effect size estimates against their standard errors and then statistically using Vevea and Woods [37] sensitivity analysis using an a priori weight function. Risk of bias was assessed using Version 2 of the Cochrane risk of bias tool for randomized trials (RoB 2) [38] for randomized controlled trials and the Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) [39] for controlled trials without random assignment.

Meta-analytic procedures Data analysis used R software. In addition to descriptive statistics describing study characteristics, treatment effect size estimates were calculated for each

individual study to determine treatment effect magnitude. All study outcomes were continuous in nature and, therefore, effect sizes were calculated using the between-groups standardized mean difference (SMD) to obtain Hedges' g [40]. Following the best practice, we further bias corrected the g statistic using a J function [40] to obtain an unbiased estimation of treatment effect size, noted as d in this study.

Meta-analysis and moderator analysis were conducted using meta-regression with robust variance estimation (RVE) [41, 42]. An intercept-only meta-regression model offers an overall average of treatment effect sizes across studies. The addition of a covariate to the meta-regression model, i.e., univariate meta-regression, allows for evaluating the effect of potential moderators on treatment effect sizes. Meta-regression is considered a superior method than many other meta-analysis methods primarily for two reasons. First, meta-regression with RVE effectively handles dependent effect sizes in a meta-analysis that is when more than one effect size estimates are being reported in a study and all reported (thus dependent) effect size estimates are being included in the meta-analysis [41, 42]. Second, meta-regression with RVE produces robust statistical inference regardless of a model's variance modeling strategy [41, 42]. In other words, it is *not* necessary to determine if a fixed- or random-effects model is appropriate.

Results

Search results Figure 1 presents detailed steps and results of the literature search. An initial pool of 393 articles (from both

electronic database search and manual search) was identified for initial screening after duplicates were removed. Of the 393 articles, 266 were excluded based on title and abstract review, resulting in 127 articles for full-text review. The full-text evaluation further eliminated 82 studies, leading to an analytical sample of 45 studies including 286 effect sizes in the final meta-analysis.

Risk of bias This was assessed using RoB 2 and ROBINS-I [38, 39] for randomized controlled trials (RCT) and controlled trials without random assignment, respectively. Included studies overwhelmingly reported low risk of bias (Table 1), with only one controlled trial without randomization reported moderate risk for missing data analysis and six RCTs reported some concern for missing data analysis and one RCT reported some concern for measurement used.

Publication bias This was assessed using funnel plot and Vevea and Woods sensitivity analysis using a priori weight functions (Fig. 2). The visual inspection found the funnel plot reasonably symmetric, which supported the absence of publication bias. Such a conclusion was further affirmed by the Vevea and Woods sensitivity analysis. An observed line of treatment effect size (in red) was plotted next to a theoretical line of treatment effect size (in blue) assuming the funnel plot is perfectly symmetric. Although the observed treatment effect size was slightly greater than the theoretical effect size, the difference was not statistically significant, suggesting the absence of publication bias.

Fig. 1 PRISMA flowchart of literature search

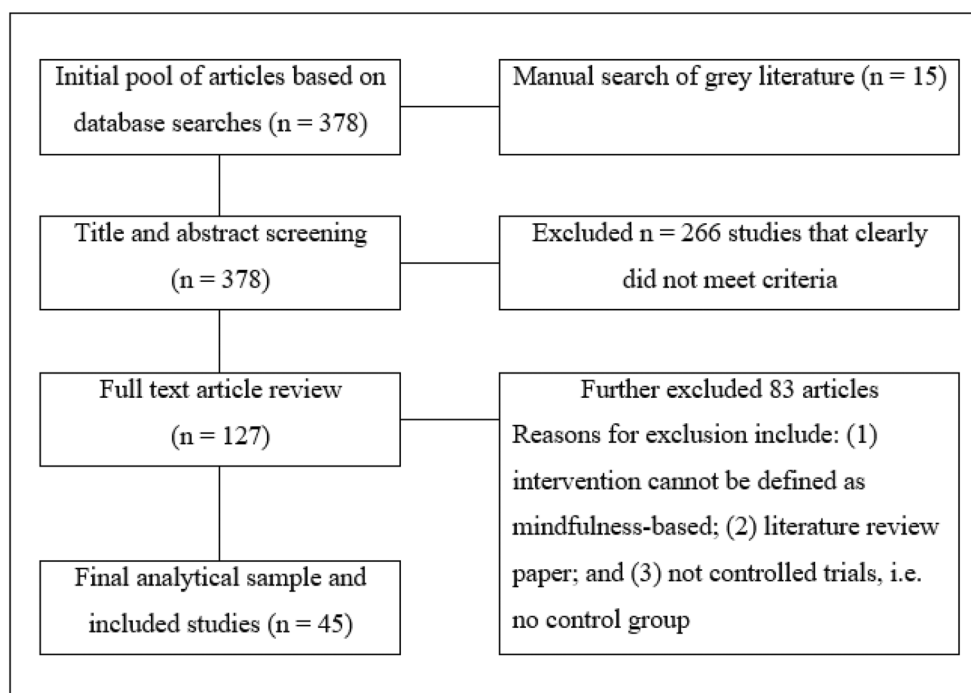


Table 1 Risk of bias of included studies

Study info	Pre-intervention bias		At intervention bias		Post-intervention bias		Selection of reported results
	Confounding	Participants selection	Classifications of intervention	Deviation	Missing data	Measurement of outcome	
Risk of bias for controlled trials without randomization							
Cao et al. (2016)	LR	LR	LR	LR	LR	LR	LR
Lin et al. (2014)	LR	LR	LR	LR	LR	LR	LR
Miao (2015)	LR	LR	LR	LR	LR	LR	LR
Qiao (2018)	LR	LR	LR	LR	LR	LR	LR
Qu et al. (2019)	LR	LR	LR	LR	MR	LR	LR
Wei et al. (2018)	LR	LR	LR	LR	LR	LR	LR
Zeng et al. (2020)	LR	LR	LR	LR	LR	LR	LR
Zhang et al. (2015)	LR	LR	LR	LR	MR	LR	LR
Zhang & Tang (2019)	LR	LR	LR	LR	LR	LR	LR
Zhao et al. (2016)	LR	LR	LR	LR	LR	LR	LR
Risk of bias for randomized controlled trials							
Study info.	Domain 1 (randomization)		Domain 2 (deviation)	Domain 3 (missing outcome)	Domain 4 (measurement)	Domain 5 (selective reporting)	Overall
Chen (2019)	LR	LR	LR	LR	LR	LR	LR
Chen (2019)	LR	LR	LR	LR	LR	LR	LR
Chen (2017)	LR	LR	LR	LR	LR	LR	LR
Chen et al. (2019)	LR	LR	LR	LR	LR	LR	LR
Ding et al. (2017)	LR	LR	LR	LR	LR	LR	LR
Dong et al. (2019)	LR	LR	LR	LR	LR	LR	LR
Du et al. (2016)	LR	LR	LR	LR	LR	LR	LR
Hao et al. (2019)	LR	LR	LR	SC	LR	LR	LR
Hou (2019)	LR	LR	LR	LR	LR	LR	LR
Li (2019)	LR	LR	LR	LR	LR	LR	LR
Li et al. (2020)	LR	LR	LR	LR	LR	LR	LR
Liang et al. (2018)	LR	LR	LR	LR	LR	LR	LR
Liu et al. (2018)	LR	LR	LR	SC	LR	LR	LR
Liu et al. (2016)	LR	LR	LR	LR	LR	LR	LR
Liu et al. (2018)	LR	LR	LR	LR	LR	LR	LR
Lu et al. (2019)	LR	LR	LR	LR	LR	LR	LR
Luo (2018)	LR	LR	LR	LR	LR	LR	LR
Shan et al. (2019)	LR	LR	LR	SC	LR	LR	LR
Shen (2018)	LR	LR	LR	LR	LR	LR	LR
Wang & Liu (2016)	LR	LR	LR	LR	SC	LR	LR
Wang et al. (2017)	LR	LR	LR	SC	LR	LR	LR
Wang et al. (2019)	LR	LR	LR	SC	LR	LR	LR
Wang et al. (2019)	LR	LR	LR	LR	LR	LR	LR
Xu et al. (2019)	LR	LR	LR	LR	LR	LR	LR
Xu & Wang (2020)	LR	LR	LR	LR	LR	LR	LR
Yang et al. (2018)	LR	LR	LR	LR	LR	LR	LR
Yao et al. (2020)	LR	LR	LR	LR	LR	LR	LR

Table 1 (continued)

Study info	Pre-intervention bias		At intervention bias		Post-intervention bias		Measurement of outcome	Selection of reported results
	Confounding	Participants selection	Classifications of intervention	Deviation	Missing data			
Zhang et al. (2020)		LR	LR	LR	LR	LR	LR	LR
Zhang et al. (2018)		LR	LR	LR	LR	LR	LR	LR
Zhang (2017)		LR	LR	LR	LR	LR	LR	LR
Zhao et al. (2017)		LR	LR	LR	LR	LR	LR	LR
Zhu et al. (2020)		LR	LR	LR	LR	LR	LR	LR
Zhu et al. (2020)		LR	LR	LR	LR	LR	LR	LR
Zhu et al. (2018)		LR	LR	LR	LR	LR	LR	LR
Zou et al. (2020)		LR	LR	LR	LR	LR	LR	LR

LR, low risk of bias; MR, moderate risk; SC, some concerns

Study characteristics (Online supplemental Table 1) All included studies were peer-reviewed articles in academic journals, including a total of 4,280 participants. Forty-three studies reported an average age of 46.02 years old and all were female participants. All but one study ($n = 44$) focused on breast cancer patients who were receiving active cancer treatment, and 12 out of 16 studies reported participants' cancer stages and included breast cancer patients in both early and middle stage of treatment. Out of the 39 studies reporting patients' cancer treatment, 21 (53.85%) studies reported chemotherapy only, leaving 18 studies reporting a mixture of chemotherapy, targeted drugs, surgery, and stem cell transplant. Thirty-two studies were randomized controlled trials and the remainder were controlled trials without random assignment. Twenty-two studies used individual-based mindfulness interventions and 23 studies delivered mindfulness-based interventions in a group format.

Thirty-five studies (77.78%) delivered mindfulness-based interventions as psychotherapeutic treatments, meaning these interventions were delivered purposefully to reduce breast cancer patients' psychological disorders such as depression, anxiety, and mood disorders. Ten studies delivered mindfulness-based interventions as supportive treatments, meaning mindfulness was used to support breast cancer patients' stress reduction, distress alleviation, and self-management of disease (e.g., behavioral training). Most studies ($n = 39$, 86.67%) delivered mindfulness-based interventions as an independent treatment, which means that mindfulness was the only treatment component in the intervention. Six studies delivered mindfulness-based interventions with mindfulness being the primary treatment component, but in conjunction with other components, e.g., mindfulness plus psychoeducation, or mindfulness plus behavioral modification. Thirty-two studies utilized mindfulness as an active ingredient during treatment to alleviate symptoms and 13 studies taught mindfulness to participants as a method for them to self-practice and alleviate their own symptoms.

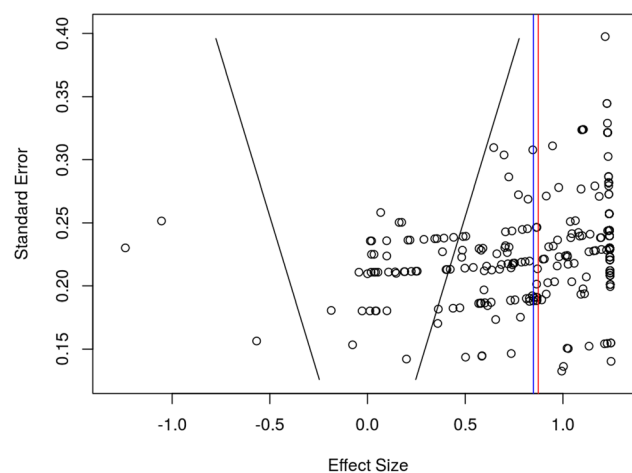


Fig. 2 Publication bias

Forty-one studies reported an average treatment frequency of 11.5 sessions per month, ranging from 2 to 30 sessions monthly. Individual session lengths averaged at 1.40 h per session, ranging from 30 min to 2.5 h per session. Providers of mindfulness-based interventions included mental health professionals (e.g., psychologists, social workers, and nurses). Sixteen studies used manualized mindfulness-based treatment, whereas 29 studies did not use a treatment manual to monitor intervention fidelity.

Treatment outcomes largely included (1) physical; (2) psychosocial; and (3) quality of life. Physical outcomes included sleep wellness-related outcomes (11 studies and 36 effect sizes), fatigue outcomes (6 studies and 20 effect sizes), and other types of physical symptoms (5 studies and 26 effect sizes). Psychological wellness outcomes included depression and anxiety (31 studies and 65 effect sizes) and other general psychosocial outcomes (17 studies 73 effect sizes), such as self-efficacy, and stress, among others.

Meta-analytic results (Table 2) Heterogeneity was assessed using multi-level modeling and revealed a significant amount of heterogeneity between effect sizes, $Q(285) = 1199.53, p < 0.001$. Across outcome domains, an overall treatment effect of mindfulness-based interventions for breast cancer patients was statistically significant, $d = 0.921, 95\% \text{ CI } (0.805, 1.040), p < 0.001$. This finding indicated a statistically significant large treatment effect of mindfulness-based interventions for Chinese breast cancer patients. Chinese breast cancer patients receiving mindfulness-based interventions on average are expected to report 0.921 standard deviations higher score (i.e., improvement) than their counterparts in the treatment-as-usual group. Subgroup analyses further indicated statistically significant treatment effects of mindfulness-based interventions for Chinese breast cancer patients to improve their (1) symptom-related outcomes, $d = 0.885, 95\% \text{ CI } (0.657, 1.110), p < 0.001$; (2) psychosocial wellness outcomes, $d = 0.984, 95\% \text{ CI } (0.879, 1.090), p < 0.001$; and (3) quality of life, $d = 0.990, 95\% \text{ CI } (0.776, 1.200), p < 0.001$. It was not feasible to meta-analyze mindfulness-related outcomes because only one study including 6 effect sizes reported this type of outcomes.

Additional subgroup analyses within symptom outcomes and psychosocial wellness outcomes identified statistically significant treatment effects for Chinese breast cancer patients' sleep wellness, $d = 0.939, 95\% \text{ CI } (0.678, 1.200), p < 0.001$; fatigue, $d = 1.082, 95\% \text{ CI } (0.833, 1.320), p < 0.001$; but *not for* other types of physical symptoms such as nausea, vomiting, or pain, $d = 0.589, 95\% \text{ CI } (-0.212, 1.390), p = 0.111$.

In addition to subgroup analyses based on outcome domains, statistically significant treatment effects were observed among other subgroups. First, an overall significant treatment effect was observed among randomized controlled trials, $d = 0.942, 95\% \text{ CI } (0.799, 1.080), p < 0.001$ and controlled trials

without random assignment, $d = 0.870, 95\% \text{ CI } (0.642, 1.100), p < 0.001$. Second, treatment effects were statistically significant for Chinese cancer patients receiving chemotherapy only, $d = 0.863, 95\% \text{ CI } (0.685, 1.040), p < 0.001$ and patients receiving multiple cancer treatments, $d = 0.971, 95\% \text{ CI } (0.808, 1.130), p < 0.001$. Thirdly, both individual-based interventions and group-based interventions reported overall statistically significant treatment effects, $d = 0.942, 95\% \text{ CI } (0.768, 1.120), p < 0.001$ for individual-based interventions and $d = 0.901, 95\% \text{ CI } (0.733, 1.070), p < 0.001$ for group-based interventions. Fourth, both therapeutic and supportive interventions reported statistically significant treatment effects, $d = 0.957, 95\% \text{ CI } (0.860, 1.050), p < 0.001$, and $d = 0.784, 95\% \text{ CI } (0.353, 1.210), p < 0.001$, respectively. Finally, interventions with mindfulness as the only treatment component reported statistically significant treatment effects, $d = 0.904, 95\% \text{ CI } (0.778, 1.030), p < 0.001$, as well as for interventions with mindfulness in conjunction with other treatment components, $d = 1.030, 95\% \text{ CI } (0.638, 1.430), p < 0.001$

Moderator analysis and sensitivity analysis Given the significant amount of heterogeneity among effect size estimates, moderator analyses were conducted to evaluate if any moderator explained away variances among effect sizes. Moderators examined included (1) outcome types (symptom outcomes, versus psychosocial wellness, versus quality of life); (2) study design (randomized controlled trial versus controlled trials without random assignment); (3) current treatment (chemotherapy only versus multiple treatment components); (4) treatment modality (individual- versus group-based treatment); (5) treatment nature (psychotherapeutic versus supportive intervention); and (6) treatment integrity (independent mindfulness only interventions versus interventions with mindfulness in conjunction with other treatment components). Univariate meta-regression, however, did not identify any significant moderator. Sensitivity analyses using only studies with a low risk of bias did not reveal any change in findings. Therefore, only findings with the full analytical sample are presented in this paper.

Discussion

Despite existing systematic review and meta-analysis studies supporting the effectiveness of mindfulness-based interventions for breast cancer patients, little is known about the treatment effect of mindfulness-based interventions for Chinese breast cancer patients. To our knowledge, this study is the first systematic review and meta-analysis of Chinese literature on mindfulness-based interventions for Chinese breast cancer patients. Across domains of outcomes, we identified an overall large treatment effect of mindfulness-based interventions for

Table 2 Meta-analysis results

	Estimates	<i>r</i> (df)	<i>K/N</i> *	95% CI	<i>p</i> value
Overall effect	0.921	16 (43.6)	45/286	[0.805, 1.040]	< 0.001
Outcome types					
Symptom Outcomes	0.885	8.18 (17.9)	19/82	[0.657, 1.110]	< 0.001
<i>Sleep wellness</i>	0.939	8.01 (9.93)	11/36	[0.678, 1.200]	< 0.001
<i>Fatigue</i>	1.082	11.6 (4.64)	6/20	[0.833, 1.320]	< 0.001
<i>Physical symptoms</i>	0.589	2.04 (3.99)	5/26	[-0.212, 1.390]	= 0.111
Psychosocial wellness	0.984	19.1 (34.2)	36/138	[0.879, 1.090]	< 0.001
<i>Depression and anxiety</i>	0.971	17 (29.3)	31/65	[0.854, 1.090]	< 0.001
<i>General psychology</i>	0.969	12.6 (15.8)	17/73	[0.805, 1.130]	< 0.001
Quality of life	0.990	10.5 (8.88)	10/60	[0.776, 1.200]	< 0.001
Mindfulness**	0.637	--	1/6	--	--
Design					
RCT	0.942	13.4 (30.7)	32/212	[0.799, 1.080]	< 0.001
nRCT	0.870	8.31 (11.9)	13/74	[0.642, 1.100]	< 0.001
Current treatment					
Chemotherapy only	0.863	10.1 (19.8)	21/159	[0.685, 1.040]	< 0.001
Multi-treatment	0.971	12.3 (22.8)	24/127	[0.808, 1.130]	< 0.001
Treatment modality					
Individual treatment	0.942	11.2 (20.8)	22/151	[0.768, 1.120]	< 0.001
Group treatment	0.901	11.1 (21.8)	23/135	[0.733, 1.070]	< 0.001
Treatment nature					
Psychotherapeutic	0.957	20.1 (32.8)	35/221	[0.860, 1.050]	< 0.001
Supportive	0.784	4.12 (8.99)	10/65	[0.353, 1.210]	< 0.001
Treatment integrity					
Independent intervention	0.904	14.5 (37.6)	39/259	[0.778, 1.030]	< 0.001
Combined intervention	1.030	6.71 (4.97)	6/27	[0.638, 1.430]	= 0.001

**K*, number of studies; *N*, number of effect sizes

**Mindfulness-related outcomes were only reported by 1 study including 6 effect sizes; therefore, subgroup analysis was not feasible

breast cancer patients. Such findings were consistent with Western literature that generally report moderate to large treatment effects.

It was also encouraging that subgroup analyses overall identified large and statistically significant treatment effects of mindfulness-based interventions for physical, psychosocial, and quality of life outcomes. When compared with existing reviews, findings on psychosocial outcomes were similar between Western and Chinese literature, $d = 1.01$ and $d = 0.98$, respectively. Furthermore, Chinese literature reported overall large treatment effects for physical and quality of life outcomes ($d = 0.89$ and $d = 0.99$, respectively), whereas Western literature reported small to moderate treatment effects, $d = 0.21$ and $d = 0.42$, respectively. Although this study did not formally evaluate the difference in treatment effects between Western and Chinese literature for these outcomes, it is reasonable to infer that Chinese breast cancer patients may benefit more from mindfulness-based interventions than their Western counterparts for symptom and quality

of life-related outcomes. This was possibly due to the compatibility between mindfulness and Eastern culture/philosophy [43]. Considering the importance of cultural compatibility between psychosocial interventions and patients' cultural background, it would be interesting for future research to untangle if differences in treatment effect size of mindfulness-based interventions for Western breast cancer patients versus their counterparts who are Asian descendants who migrated to Western countries, e.g., North America or Australia.

Although this study revealed an overall large and statistically significant treatment effect for mindfulness-based interventions among Chinese breast cancer patients' physical outcomes, further analyses suggested that mindfulness-based interventions were effective for sleep-related outcomes ($d = 0.94$, $p < 0.001$), fatigue ($d = 1.08$, $p < 0.001$) but not for other physical symptoms ($d = 0.59$, $p = 0.111$), like nausea/vomiting, dizziness, or pain. It is possible that many patients with intensive symptoms of nausea/vomiting, dizziness, or pain are still receiving invasive cancer treatment or are

recently off treatment. Therefore, the treatment effect of mindfulness-based interventions may be hindered for these treatment-related physical symptoms. This finding has important practice implications for psycho-oncology providers when supporting Chinese breast cancer patients for physical outcomes using mindfulness-based interventions. To improve patients' physical outcomes, mindfulness-based interventions can be regarded as empirically supported interventions for sleep problems and fatigue but not for other symptoms.

Subgroup analyses further revealed that mindfulness-based interventions were overall effective among both randomized controlled trials and controlled trials without random assignment, for breast cancer patients receiving only chemotherapy and for those receiving multiple treatments, and when delivered in individual and group formats. Findings revealed that mindfulness-based interventions were overall effective when delivered as a psychotherapeutic intervention and as a supportive intervention. Similarly, mindfulness-based interventions were effective when delivered on their own or in conjunction with other interventions. All of these subgroup analyses further endorsed the effectiveness of mindfulness-based interventions for Chinese breast cancer patients when being delivered in a variety of formats, e.g., individual versus group format or delivered on their own versus in a combined format.

Limitations and recommendation for future research The current meta-analysis has several strengths including a comprehensive literature search, inclusion of published and gray literature, a large number of included studies ($n = 45$), and the use of advanced statistical methods which allowed meta-analyzing 286 effect sizes to increase statistical power. A further strength was this study's focus on multiple domains of outcomes while also conducting subgroup and domain-specific analyses to deliver findings with informative implications to clinical practice.

Limitations of this study include the possibility that we could have missed eligible studies even though we used a rigorous and comprehensive search process. In addition, while a set of moderators were tested to account for the significant amount of heterogeneity across effect sizes, none of them was identified as a significant moderator. Third, given the already heavy content of this review, further moderator analyses within each outcome domains were not conducted. Future studies should report on additional moderator analyses specific to each domains of outcomes. Finally, this review only included Chinese studies in the Chinese language, thus preventing formal comparison between the Western and Chinese literature. It would be valuable to have a cross-cultural and interdisciplinary team to conduct a comparative systematic review and meta-analysis of the Western and Chinese literature on this topic to formally compare the treatment effect of mindfulness-based interventions for breast cancer patients.

Conclusion

The present review, to our knowledge, is the first to synthesize the effects of mindfulness-based interventions for Chinese breast cancer patients (and published in Chinese literature) across domains of outcomes, i.e., physical, psychosocial, and quality of life outcomes. Results suggest that mindfulness-based interventions are overall effective for Chinese breast cancer patients with large treatment effects across outcome domains except for physical outcomes, e.g., nausea/vomiting, dizziness, and pain. These findings have important implications for psycho-oncology providers when supporting Chinese breast cancer patients using mindfulness-based interventions. Results also point to similarities and differences of mindfulness-based interventions for breast cancer patients in the Chinese literature versus the Western literature, which are important for psycho-oncology providers supporting Chinese breast cancer patients.

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Availability of data and material Data can be made available upon request from the corresponding author.

Code availability Code can be made available upon reasonable request from the corresponding author.

Author contribution Shijie Jing: conceptualization; data curation; investigation; project administration; supervision; validation; writing the original manuscript

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Declaration

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