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Systematic review and network meta-analysis of the improvement effect of psychological intervention on anxiety in patients with breast cancer

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Abstract: Objective: To analyze the improvement effect of anxiety state in breast cancer patients with malignant tumor after psychological intervention based on systematic review and network Meta-analysis. **Methods:** Randomized controlled trials (RCTs) on the effect of psychological intervention on anxiety of breast cancer patients were collected from CNKI, Wanfang database, VIP database and foreign Pubmed database, and the retrieval period was from the establishment of the database to 30 November 2025. The quality of the included studies was evaluated by Cochrane bias risk assessment tool. python software was used for network Meta-analysis. **Results:** A total of 11 studies involving 828 patients were included in this study, with 427 patients in the observation group and 401 patients in the control group. A total of 7 interventions were involved, including usual care, computerized cognitive behavioral therapy, Internet cognitive behavioral therapy, mindfulness-based cognitive therapy, positive psychological intervention based on PERMA model, acceptance and commitment therapy, and cognitive behavioral group therapy. Among them, the evaluation of anxiety improvement involved 12 studies, depression improvement involved 12 studies, and quality of life improvement involved 6 studies. The results of network Meta-analysis showed that mindfulness-based cognitive therapy was the best psychological intervention to improve anxiety, depression and quality of life in breast cancer patients, and the SUCRA probability was 100.00%. **Conclusion:** Mindfulness-based cognitive therapy has the best effect on improving anxiety, depression and quality of life in breast cancer patients, which can be prioritized for application.

Keywords: psychological intervention; anxiety state; systematic review; network meta-analysis; psychological nursing

1. Introduction

Breast cancer is one of the most common malignant tumors in women worldwide, and its incidence is increasing year by year, which has become an important disease [1] that seriously threatens women's health. According to the data of World Health Organization (WHO), the annual incidence of breast cancer continues to increase, especially in countries with rapid economic development, the prevalence of breast cancer shows a significant upward trend [2,3]. The diagnosis and treatment of breast cancer is often accompanied by a high psychological burden of patients. Anxiety, depression and other emotional problems are widely existed in patients. Studies have shown that patients with breast cancer are prone to more significant anxiety symptoms [4,5] in the short term after diagnosis, especially during treatment. These symptoms not only affect the patient's mental health, but also may adversely affect [6] the effect of treatment. Therefore, how to effectively relieve the anxiety of breast cancer patients

has become an important part of the comprehensive treatment of breast cancer.

In recent years, with the deepening of psychological research, psychological intervention has gradually become an important means to improve the mental health of breast cancer patients. A large number of clinical studies have shown that psychological intervention can effectively reduce the negative emotions such as anxiety and depression of breast cancer patients, help patients better adapt to the disease, and improve their treatment compliance and quality [7–9] of life. The existing psychological intervention methods mainly include cognitive behavioral therapy, group psychological support, relaxation training, etc., and these methods have achieved significant effects to a certain extent [10]. However, due to the individual difference of different interventions, as well as the diversity of research design, evidence about the effect of psychological intervention did not agree. Therefore, how to systematically evaluate the effect of different psychological interventions on the improvement of anxiety in breast cancer patients has become an urgent problem to be solved.

In this context, the aim of this study is to comprehensively compare the effects of various psychological interventions on anxiety in breast cancer patients by systematic review and network Meta-analysis. Network meta-analysis as a kind of advanced statistical analysis method, can integrate a variety of treatments of the comparison results at the same time, and provide the solution by indirect comparison between the relative effectiveness [11]. This method is gradually widely used in the research of psychological intervention, which can help to reveal the advantages and disadvantages of different psychological intervention methods and provide scientific basis for clinical practice [12]. However, previous systematic reviews have primarily focused on traditional psychological interventions, lacking network meta-analytic comparisons of emerging approaches—such as PERMA model-based positive psychological interventions and internet-delivered cognitive behavioral therapy [13 – 17]. In this context, the present study integrates the most up-to-date clinical trial evidence available up to 2025, incorporating and directly comparing multiple novel psychological interventions within a network meta-analysis framework. The aim is to provide updated, evidence-based guidance for clinicians to identify the optimal psychological support strategy [18 – 22]. We expect this work to offer a more objective and precise evaluation of intervention effectiveness for breast cancer patients, ultimately informing comprehensive treatment approaches and helping patients achieve better psychological support and clinical outcomes in the face of their disease.

2. Materials and methods

2.1. General information

Cnki, Wanfang database, VIP database and Pubmed were searched by computer, and the retrieval period was from the establishment of the database to November 30, 2025. The inclusion criteria of the literature were as follow: (1) study type: randomized controlled trial (RCT), whether blinded or not; (2) Study subjects: breast cancer patients confirmed by pathology, regardless of age, tumor stage and treatment stage; (3) Intervention measures: the specific intervention measures were based on the search

results of this study, and the control measures were routine nursing, blank control or other psychological intervention. (4) Outcome indicators: anxiety scores assessed by standardized scales (such as HAMA, SAS, GAD-7, etc.); (6) Publication language: Chinese and English. Exclusion criteria: (1) non-randomized controlled studies (such as reviews, case reports, observational studies, etc.); (2) subjects with other serious physical or mental diseases; (3) Non-psychological intervention (such as simple drugs, exercise, nutritional intervention, etc.); (4) incomplete data, unable to obtain full text or repeated publication; (5) conference abstracts, dissertations, unpublished grey literature.

2.2. Search strategy

Systematic search was carried out by combining subject words with free words. Chinese search terms included: “breast cancer” “breast cancer” “psychological intervention” “psychotherapy” “cognitive behavioral therapy” “mindfulness” “anxiety” “randomized controlled trial” etc. English search terms include: “breast neoplasms” “breast cancer” “psychological intervention” “psychotherapy” “cognitive behavioral therapy” “mindfulness” “anxiety” “randomized controlled trial”, etc. The search strategy was adjusted according to the characteristics of each database, supplemented by reference tracing and manual search.

2.3. Literature quality assessment

The quality of the literature was evaluated according to the Quality assessment tool for randomized Controlled Studies recommended by the Cochrane handbook. Seven core indicators were used to determine the included studies from the methodological dimension: (1) generation of random sequence (selection bias control); (2) Allocation concealment (selection bias control); (3) Blinded subjects and investigators (bias control); (4) Blinded outcome evaluation (measurement bias control); (5) Data integrity (loss to follow-up bias control); (6) Selective reporting (reporting bias control); (7) other potential bias. Each index was judged by three levels of “low risk”, “high risk” or “uncertain risk”, and “low risk” was considered as grade A; Partially satisfying “low risk” was defined as grade B; None of them meets “low risk” is grade C. The process of literature screening and quality assessment was carried out by two researchers independently, following the double-blind principle to avoid subjective bias. The specific procedures were as follows: First, researchers completed the literature screening and data extraction according to the prespecified criteria. The evaluation process did not interfere with each other. After the evaluation, the researchers compared their results. If the two researchers provide inconsistent evaluations, they will jointly re-examine the original documents and discuss until a consensus is reached. If disagreements persist, a third researcher will be invited to independently assess the material and make the final decision.

2.4. Statistical analysis

RevMan 5.3 and python software were used for data analysis. Continuous variables were expressed as mean difference (MD) and 95% confidence interval (CI). First, a traditional meta-analysis was performed to evaluate the difference in effect

between each intervention and the control group, and the I^2 statistic was used to assess the heterogeneity. If the inter-study heterogeneity was low ($I^2 \leq 50\%$), the fixed effect model was used. Otherwise, random-effects model was used. For the network meta-analysis, we adopted a Bayesian approach, selecting uninformative prior distributions. Three Markov chains were initiated, each undergoing 50,000 iterations with a 20,000 iteration burn-in period. Model convergence was judged by ensuring the PSRF converged to a value close to 1. The ranking probabilities of each intervention were assessed using cumulative surface under the cumulative ranking curve (SUCRA) plots. Publication bias was evaluated using funnel plots and Egger's test. The significance level was set at $\alpha = 0.05$.

3. Results

3.1. Literature search results 3315

A total of 3315 relevant articles were obtained. Duplicate and obviously irrelevant articles were excluded in the initial screening, and the research type, research object, intervention measures, outcome indicators and other research content were further screened in the second screening. The specific screening process is shown in **Figure 1**.

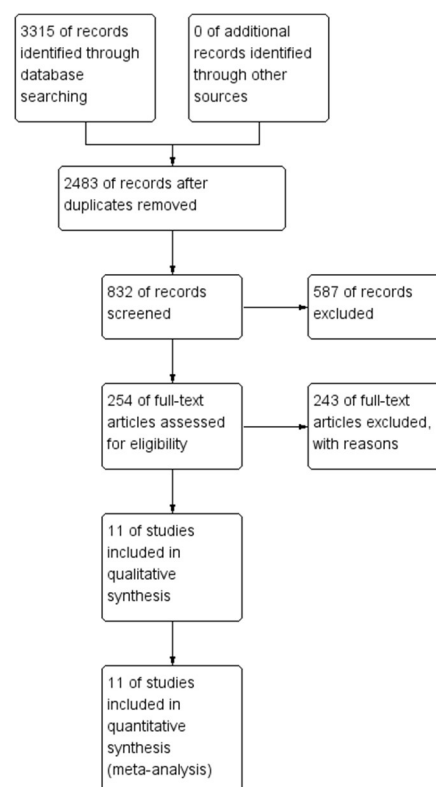


Figure 1. Flow chart of literature extraction.

3.2. Literature characteristics and methodological quality evaluation

After screening, a total of 11 RCTs were included, all of which were RCT studies. The total sample size was 828 cases, including 427 cases in the observation group and 401 cases in the control group. Seven interventions were involved, including routine

care, computerized cognitive behavioral therapy, Internet cognitive behavioral therapy, mindfulness-based cognitive therapy, positive psychological intervention based on PERMA model, acceptance and commitment therapy, and cognitive behavioral group therapy. The basic characteristics of the included studies are shown in **Table 1**. Of the 11 included studies, 1 was of grade A quality and 10 were of grade B. All of the studies explained the baseline data and comparability between the observation group and the control group. The risk of bias of the included literature is shown in **Figures 2** and **3**.

3.3. Convergence evaluation results

In the Bayesian model constructed in this study, the fluctuation of the Markov chain was small, the iteration trajectory tended to be stable, and the PSRF of the three outcome indicators were all 1, indicating that the model had converged to the target distribution, the model had good convergence, the iteration process had converged, and the number of iterations and annealing was sufficient, and no additional update was needed. Therefore, the model constructed in this study can effectively predict the data.

Table 1. Basic characteristics of the included studies.

Study subjects	Number of cases (T/C)	Interventions		Type of study	Main outcome measures
		Observation group	Control group		
Gong et al., (2021) [12]	37/37	Computerized cognitive behavioral therapy	Usual care	RCT study	SAI, PHQ-9
Hou et al., (2024) [13]	42/42	Internet-based Cognitive Behavioral Therapy (ICBT)	Usual care	RCT studies	SAS, SDS, FACT-B
Yao et al., (2020) [14]	48/48	Mindfulness-based stress reduction therapy	Usual care	RCT studies	SDS, SAS, and QLQ-BR53
Han et al., (2022) [15]	43/43	Mindfulness-based cognitive therapy	Usual care	RCT studies	SAS, SDS
Luo et al., (2022) [16]	60/60	Positive psychological interventions based on the PERMA model	Usual care	RCT studies	SAS, SDS, EORTCQLQ-C30
Fang et al., (2023) [17]	41/41	Positive psychological interventions based on the PERMA model	Usual care	RCT studies	SAS, SDS, FACT-B
Mirmahmoodi et al., (2020) [18]	22/22	Mindfulness-based stress reduction group counseling	Usual care	RCT studies	BAI, BDI-II
Shari et al., (2021) [19]	30/30	Brief Acceptance and Commitment Therapy (ACT)	Usual care	RCT studies	HADS
Mansouri et al., (2023) [20]	25/25	Cognitive-behavioral group therapy	Usual care	RCT studies	BAI, BDI-II
Akkol-Solakoglu et al., (2023) [21]	49/23	Internet-based cognitive behavioral therapy	Usual care	RCT studies	HADS, EORTC-QLQ
Ruan et al., (2025) [22]	30/30	Acceptance and commitment therapy	Usual care	RCT studies	SAS, SDS, FACT-B

Note: SAI stands for State Anxiety Scale; PHQ-9 stands for Patient Health Depression Questionnaire; SAS stands for self-rating anxiety Scale; SDS is self-rating depression scale; Functional Assessment of Cancer Therapy (FACT-B); QLQ-BR53 is a quality of life measurement scale for breast cancer patients. EORTCQLQ-C30 is the European Organization for Research and Treatment of Cancer Quality of Life questionnaire; BAI (Beck Anxiety Inventory); BDI stands for Beck Depression Inventory; HADS stands for Hospital Anxiety and Depression Scale.

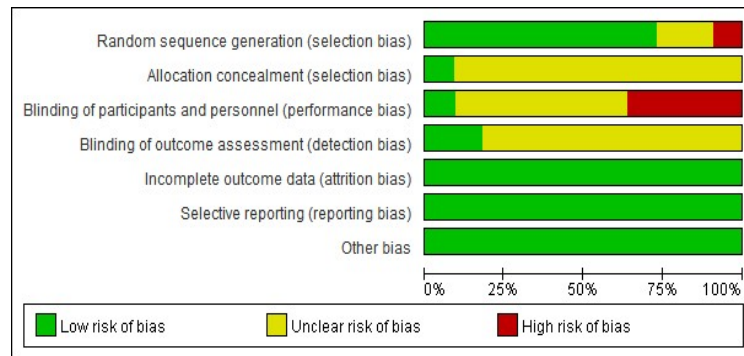


Figure 2. Risk of bias in the included literature.

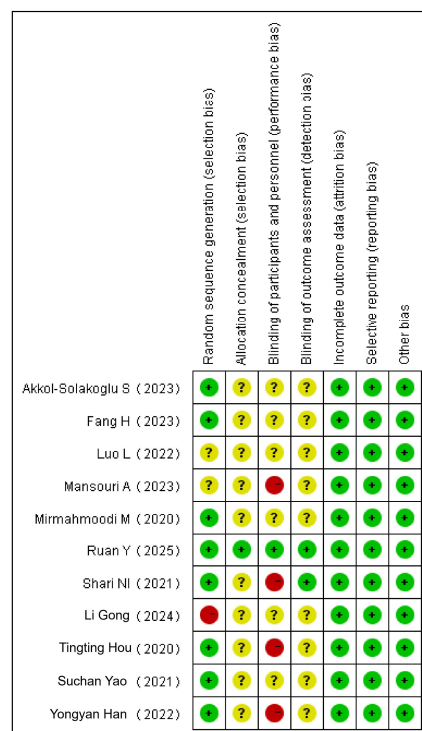


Figure 3. Quality of included literature.

3.4. Analysis of anxiety improvement effect

A total of 12 studies evaluated the effect of psychological intervention on anxiety of breast cancer patients, involving 7 measures. The results of inconsistency test showed that the direct and indirect evidence were in good agreement ($P = 0.8526$). The SUCRA probability ranking showed that mindfulness-based cognitive therapy had the highest probability of being the best intervention (100.0%), followed by computerized cognitive behavioral therapy (85.7%) and cognitive behavioral group therapy (71.4%). There was statistically significant difference in anxiety scores between mindfulness-based cognitive therapy and conventional nursing ($P < 0.05$). The difference between other interventions and routine nursing did not reach statistical significance ($P > 0.05$). The funnel plot distribution was roughly symmetrical, the Egger's test result showed a P -value of 0.325, suggesting that the possibility of publication bias was low. See **Table 2** and **Figures 4** and **5**.

Table 2. Analysis of the effect of anxiety improvement.

Interventions	Control measures	Sample size (intervention group)	Sample size (control group)	MD (mean)	MD standard error	95%CI
Positive psychological interventions based on the PERMA model	Usual care	101	101	2.675	3.43	(-4.0478, 9.3978)
Acceptance and commitment therapy	Usual care	60	60	2.46	3.76	(-4.9096, 9.8296)
Mindfulness-based cognitive therapy	Usual care	113	113	6.75	8.15	(9.2240, 22.7240)
Internet-based cognitive behavioral therapy	Usual care	91	65	3.905	6.405	(-8.6488, 16.4588)
Computerized cognitive behavioral therapy	Usual care	37	37	5.46	5.39	(-5.1044, 16.0244)
Cognitive-behavioral group therapy	Usual care	25	25	4.6	4.01	(-3.2596, 12.4596)

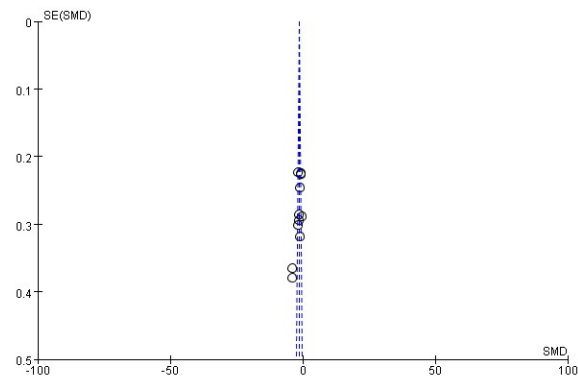


Figure 4. Funnel plot of anxiety scores in the two groups.

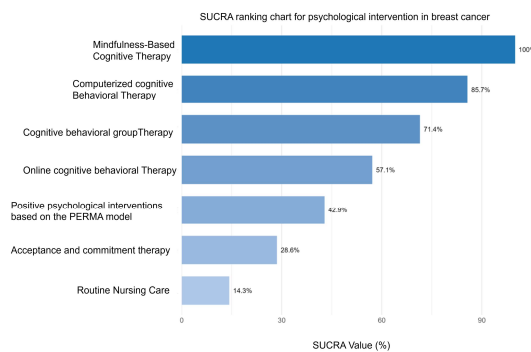


Figure 5. SUCRA ranking diagram of the effect of psychological intervention for breast cancer on anxiety state.

3.5. Analysis of improvement effect of depression

A total of 12 studies evaluated the effect of psychological intervention on depression in breast cancer patients, involving 7 interventions. The consistency test showed that the model had good consistency ($P = 0.9106$). The results of SUCRA ranking showed that mindfulness-based cognitive therapy ranked first (100.0%) in improving depressive symptoms, followed by cognitive behavioral group therapy (85.7%) and online cognitive behavioral therapy (71.4%). There was statistically

significant difference in depression scores between mindfulness-based cognitive therapy and conventional nursing intervention ($P < 0.05$). There was no statistically significant difference between other interventions and routine nursing ($P > 0.05$). The funnel plot distribution was roughly symmetrical, the Egger's test result showed a P -value of 0.418, suggesting that the possibility of publication bias was low. See **Table 3** and **Figures 6** and **7**.

3.6. Effect analysis of quality of life improvement

A total of 6 studies evaluated the effect of psychological intervention on improving the quality of life of breast cancer patients, involving 5 measures. The SUCRA ranking showed that mindfulness-based cognitive therapy (100%), internet-based cognitive behavioral therapy (80%) and positive psychological intervention based on the PERMA model (60%) ranked the top three. There was statistically significant difference in the quality of life score between mindfulness-based cognitive therapy and conventional nursing after intervention ($P < 0.05$). There was no statistically significant difference between other interventions and routine nursing ($P > 0.05$). The funnel plot distribution was roughly symmetrical, the Egger's test result showed a P -value of 0.286, suggesting that the possibility of publication bias was low. See **Table 4** and **Figures 8** and **9**.

Table 3. Depression improvement effect analysis.

Interventions	Control measures	Sample size (intervention group)	Sample Size (control group)	MD (mean)	MD standard error	95%CI
Positive psychological interventions based on the PERMA model	Usual care	101	101	1.695	3.43	(-5.0278, 8.4178)
Acceptance and commitment therapy	Usual care	60	60	2.215	3.76	(-5.1546, 9.5846)
Mindfulness-based cognitive therapy	Usual care	113	113	5.9167	8.15	(10.0573, 21.8907)
Internet-based cognitive behavioral therapy	Usual care	91	65	3.16	6.405	(-9.3938, 15.7138)
Computerized cognitive behavioral therapy	Usual care	37	37	2.22	5.39	(-8.3444, 12.7844)
Cognitive behavioral group therapy	Usual care	25	25	3.48	4.01	(-4.3796, 11.3396)

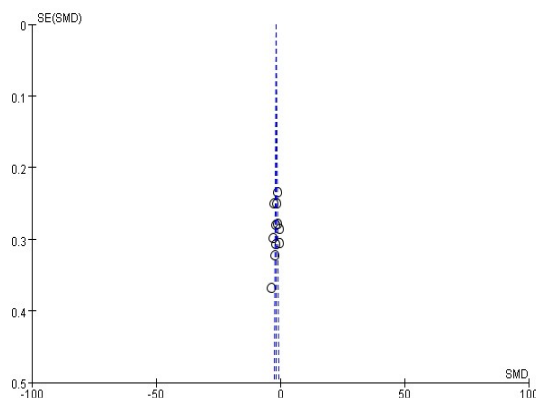


Figure 6. Funnel plot of depression scores in the two groups.

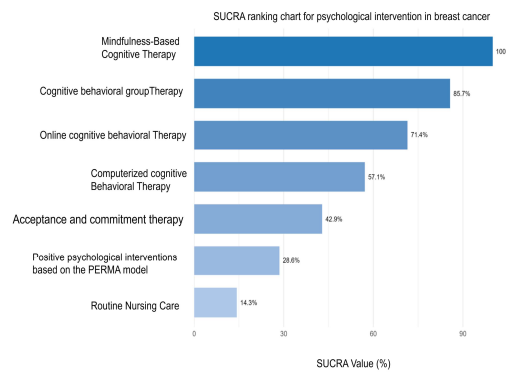


Figure 7. SUCRA ranking diagram of the effect of psychological intervention for breast cancer on depression status.

Table 4. Quality of life improvement effect analysis.

Interventions	Control measures	Sample size (intervention group)	Sample size (control group)	MD (mean)	MD standard error	95%CI
Positive psychological interventions based on the PERMA model	Usual care	101	101	4.355	3.94	(−3.3674, 12.0774)
Acceptance and commitment therapy	Usual care	30	30	1.87	1.71	(−1.4816, 5.2216)
Mindfulness-based cognitive therapy	Usual care	48	48	8.12	7.21	(6.0116, 22.2516)
Internet-based cognitive behavioral therapy	Usual care	91	65	5.295	4.555	(−3.6328, 14.2228)

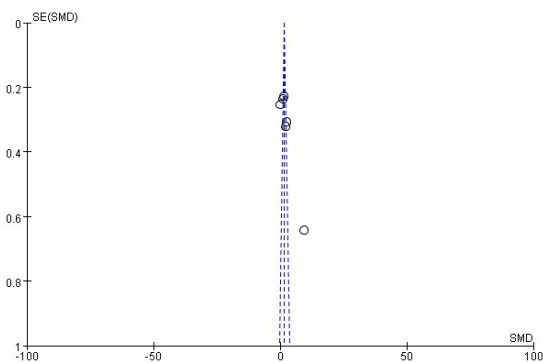


Figure 8. Funnel plot of quality of life scores in the two groups.

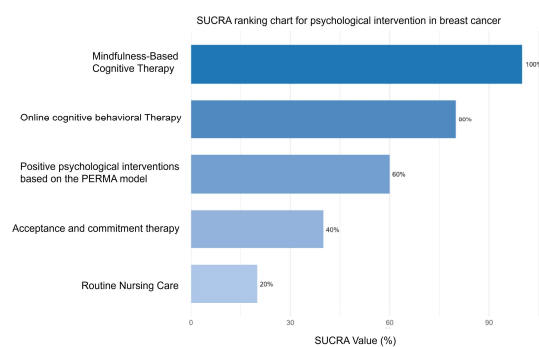


Figure 9. SUCRA ranking chart of effects of psychological intervention on QOL of breast cancer.

4. Discussion

The physical trauma and psychological stress faced by breast cancer patients in the process of diagnosis, treatment and rehabilitation make them a high risk group of anxiety. This negative emotion will not only aggravate physical discomfort, but also interfere with the neuro-endocrine-immune network, which will impair treatment tolerance and long-term prognosis [23]. At present, the clinical psychological intervention methods for breast cancer patients are diversified, but the efficacy of different intervention strategies lacks systematic quantitative comparison. Traditional meta-analysis is difficult to solve the problem of indirect comparison between interventions, while network meta-analysis provides a more comprehensive evidence-based basis for the accurate selection of clinical intervention programs by integrating direct and indirect evidence. This study employed Python for statistical analysis due to its strong flexibility in implementing Bayesian models, specifying custom prior distributions, and conducting convergence diagnostics. These capabilities make it well-suited for handling complex comparative structures involving multiple interventions and small sample sizes. Although software such as STATA and R is also commonly used for network meta-analysis, Python's programmability and extensibility provided greater autonomy for model customization in this research.

The results of this study showed that 11 randomized controlled trials involving a total of 7 psychological interventions were included. The results of network meta-analysis and SUCRA ranking showed that mindfulness-based cognitive therapy had the best effect on improving the anxiety state of breast cancer patients, followed by computerized cognitive behavioral therapy and cognitive behavioral group therapy. The results of network meta-analysis and SUCRA ranking showed that mindfulness-based cognitive therapy had the best effect on improving the anxiety state of breast cancer patients, and computerized cognitive behavioral therapy and cognitive behavioral group therapy were the next. There was no significant difference in the efficacy between the other interventions and routine care. At the same time, mindfulness-based cognitive therapy also showed outstanding advantages in improving depression and quality of life, indicating that the comprehensive efficacy of mindfulness-based cognitive therapy was more significant in the psychological intervention of breast cancer patients. The efficacy of different psychological interventions is heterogeneous, so it is necessary to combine its mechanism of action with the individual characteristics of patients to choose. From the perspective of psychopathological mechanism, the anxiety of breast cancer patients is mainly caused by excessive worry about disease progression, treatment side effects and life threat, accompanied by negative cognitive bias and decreased [24] emotional regulation ability. Mindfulness-based cognitive therapy is based on acceptance of the present and non-judgmental perception. It helps patients break the vicious cycle of worry and avoidance through systematic training, draw their attention back to real experience from catastrophic thinking, and cultivate the ability to accept negative emotions instead of confrontation, thereby reducing the intensity and duration [25,26] of emotional reactions from the root. Some studies have suggested that its potential neurobiological mechanism may be related to the regulation of the prefrontal cortex on the amygdala. By enhancing the executive control ability of the prefrontal cortex

and inhibiting the excessive activation of the amygdala, the physiological arousal and cognitive vigilance [27] related to anxiety can be reduced. The beneficial effects of MBCT on depression symptoms and quality of life may be attributed to a combination of mechanisms, including enhanced emotion regulation, increased psychological resilience, and improved cognitive diffusion resulting from mindfulness training. In contrast, while Computerized Cognitive Behavioral Therapy (cCBT) effectively corrects negative automatic thoughts [28], it appears weaker in terms of emotional acceptance. Although group Cognitive Behavioral Therapy can provide social support and group dynamics [29,30], its efficacy might be less stable, potentially influenced by factors such as group composition and facilitator expertise, compared to individualized mindfulness interventions. Interventions based on the PERMA model and Acceptance and Commitment Therapy did not show significant advantages in this study, which might be related to intervention duration, standardization levels, and the degree to which they aligned with the specific psychological needs of breast cancer patients.

This study has certain limitations. (1) The number of included articles was limited and mainly short and medium studies, and direct comparative evidence of some interventions was lacking, which may affect the stability of the results. (2) The routine care content varied across studies, and there was heterogeneity in intervention details (such as duration and frequency), which may have introduced clinical heterogeneity. (3) The wide CIs for the MD in some interventions (e.g., anxiety improvement with PERMA-based positive psychological interventions 95% CI: $-4.04789.3978$, and depression improvement with Acceptance and Commitment Therapy 95% CI: $-5.15469.5846$) suggest a degree of uncertainty in the estimated treatment effects. This phenomenon is likely attributable to the small sample sizes and variability in the fine details of intervention implementation across studies, leading to increased effect size variability. (4) The follow-up time was mainly after short-term intervention, and the long-term efficacy and recurrence prevention effect were not tracked, so the continuous benefit of intervention measures could not be evaluated. (5) The limited number of studies included for each type of intervention in this study (e.g., only two studies for Acceptance and Commitment Therapy) may affect the stability and generalizability of the ranking results. Future research with larger sample sizes is needed to further validate these findings.

In conclusion, mindfulness-based cognitive therapy shows the best effect on the improvement of anxiety in breast cancer patients, and can simultaneously improve the relief effect of depression and quality of life, which can be the first choice of clinical intervention. In clinical practice, psychological intervention strategies should be selected individually according to the cognitive characteristics, acceptance and access of patients. In the future, multi-center, large-sample and long-term follow-up randomized controlled trials are needed to further verify the long-term efficacy of mindfulness-based cognitive therapy and explore its combined application value with other interventions.

Author contributions: Conceptualization, YP and PD; methodology, KM; software, YP; validation, YP, PD and KM; formal analysis, YP; investigation, PD; resources, KM; data curation, YP; writing—original draft preparation, YP; writing—review and

editing, YP and PD; visualization, KM; supervision, PD; project administration, YP. All authors have read and agreed to the published version of the manuscript.

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Ethical approval: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Medical Ethics Review Board of Xuzhou Maternal and Child Health Care Hospital (Approval No. 202308015).

Informed consent statement: Informed consent was obtained from all subjects involved in the study.

Conflict of interest: The authors declare no conflict of interest.

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