#### **ORIGINAL ARTICLE**



## The effects and mechanism of mindfulness intervention on posttraumatic growth in breast cancer patients: A randomized controlled trial

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#### ABSTRACT

While the benefits of mindfulness training in enhancing posttraumatic growth (PTG) are well-documented, its underlying mechanisms remain unclear. This randomized controlled trial explored whether reduced fear of cancer recurrence (FCR) mediates the effect of mindfulness on PTG in breast cancer patients. Ninety participants from a cancer center in southeast China were randomly assigned to either an eight-week mindfulness training group (n = 46) or a routine care control group (n = 44). Assessments of PTG, FCR, and psychosocial adaptation (PSA) were conducted before and after the intervention. Repeated measures ANOVA revealed significant group-by-time interactions for PTG and FCR. Further, mediation analysis showed that reductions in FCR mediated the positive effect of mindfulness training on PTG. These findings suggest that FCR may be a key mechanism through which mindfulness promotes PTG, highlighting the value of targeting FCR in psychosocial interventions for breast cancer patients.

Key words: mindfulness, posttraumatic growth, breast cancer, fear of cancer recurrence

## INTRODUCTION

According to the recent cancer report by the World Health Organization (WHO), breast cancer has emerged as a significant global health concern, with 2.261 million cases reported in 2020, surpassing lung cancer as the most prevalent cancer worldwide (IARC, 2020). Particularly in China, the incidence rate of breast cancer among women remains substantially high, approximately five times the global average annual incidence rate, with an annual increase of 2.5% (Siegel *et al.*, 2021). Upon diagnosis, breast cancer patients typically undergo multifaceted treatment regimens involving surgery, radiotherapy, chemotherapy, and endocrine therapy (Rubovszky *et al.*, 2023). However, this treatment

journey is accompanied by not only physical challenges but also considerable psychological distress (Kuswanto *et al.*, 2023).

However, research indicates that certain patients undergoing treatment for lung cancer may display positive behaviors. These positive psychological, cognitive, and emotional changes resulting from overcoming difficulties and setbacks have been referred to as posttraumatic growth (PTG) (Austin *et al.*, 2024; Tedeschi & Calhoun, 1996). Increased levels of PTG benefit patients by enabling them to approach their illness with a constructive mindset, enhancing their psychological and social adaptability, improving psychological well-being, and promoting healthy behaviors,

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thus facilitating disease recovery and enhancing the overall quality of life (Ang et al., 2023; Wang *et al.*, 2024). Notably, studies with Chinese breast cancer patients also indicate that they tend to exhibit lower levels of PTG compared to the average, indicating significant potential for improvement (Peng *et al.*, 2019). Enhancing PTG through evidence-based interventions is imperative for promoting the recovery and well-being of breast cancer survivors.

The effects of mindfulness interventions on breast cancer patients are well-documented and include psychological benefits such as reduced anxiety and depression, as well as enhanced PTG (Zhu et al., 2025). Physiological benefits include stress reduction and improved immune function (Zhang et al., 2022). These interventions promote an overall improvement in the quality of life (Dahabre et al., 2024). These effects provide a strong rationale for incorporating mindfulness practices into supportive care for cancer patients. Central to mindfulness training are sustained attention to awareness and consciousness and the acceptance of new experiences without emotional judgment (Creswell & Mindfulness, 2017). Given the longstanding presence of Buddhist philosophy in Chinese society, mindfulness practices may be particularly well-suited for Chinese patients (Zhang et al., 2017). However, the precise mechanisms underlying the impact of mindfulness interventions on PTG in breast cancer patients require further investigation. Mindfulness intervention may operate through two pathways: alleviating negative emotions and cognition or enhancing positive awareness of strength and potential. Thus, both negative and positive mediating pathways are plausible contributors to PTG among breast cancer patients undergoing mindfulness interventions.

Among the negative psychological factors affecting breast cancer patients, fear of cancer recurrence (FCR) stands out, characterized by apprehension and worry about the possibility of cancer returning or progressing (Liu et al., 2019). Studies suggest that 60% to 99% of breast cancer patients experience varying degrees of FCR (Ellegaard et al., 2017), which correlates negatively with PTG. FCR is also positively associated with depression among breast cancer survivors experiencing high levels of PTG (Kuswanto et al., 2020), impacting their quality of life and treatment outcomes (Nahm et al., 2021). Recent surveys suggest that reducing FCR may mediate improvements in PTG among both native and overseas Chinese breast cancer survivors (An et al., 2023; Liu et al., 2018; Yeung & Lu, 2018). However, this mediation pathway requires further validation through randomized controlled trials to establish causality.

On the other hand, mindfulness practices are commonly thought to enhance psychosocial adaptation (PSA), although PSA remains vaguely defined. Attributes defining PSA include change, process, continuity, interaction, and influence (Londono & McMillan, 2015). For breast cancer patients, positive PSA can be attributed to good forms of coping style, such as support and self-control, and, to a less diverting and denial (Heim et al., 1997), aligning closely with the principles of mindfulness. Studies have shown a positive correlation between mindfulness interventions and PSA in breast cancer patients (Hwang et al., 2023; Iannopollo et al., 2022). Additionally, research demonstrates a significant positive relationship between PSA and PTG among various cancer survivors (Cheng et al., 2020; Roepke, 2015; Shakespeare-Finch & Barrington, 2012; Silva et al., 2012). Hence, it is possible to conjecture that mindfulness training facilitates PTG by fostering psychosocial adaptions in Chinese breast cancer patients.

This study, employing a randomized controlled design, examines the potential mediating role of FCR and PSA in the impact of mindfulness training on enhancing PTG among breast cancer patients. We hypothesized that an eight-week mindfulness training intervention would increase PTG and PSA while decreasing FCR compared to the control group (CG). This study follows a typical parallel mediating model, where FCR and PSA act as negative and positive mediators, respectively, in the relationship between mindfulness intervention and PTG among breast cancer patients. Specifically, we hypothesized that changes in FCR and PSA from pre- to post-test would significantly mediate the intervention's effect on changes in PTG during the same period.

## **METHOD**

## Ethical statement

The study was approved by the Medical Ethics Committee of Affiliated People's Hospital of Ningbo University (2021-077). Informed consent was gained from each participant before their participation.

## **Participants**

Breast cancer patients treated at the Cancer Treatment Center of the Affiliated People's Hospital of Ningbo University from October to December 2021 were enrolled. Inclusion criteria for eligible participants were: (1) Women aged 18-65; (2) Confirmed pathological diagnosis of breast cancer; (3) Willingness to participate and capacity to comprehend their condition; (4) Clear cognitive awareness and ability to express intentions. Exclusion criteria were: (1) Severe heart and lung dysfunction or concurrent cancers; (2) Receipt of similar psychological interventions within the past 6 months; (3) Failure to provide informed consent.

Sample size estimation using G\* Power for repeated-

measures analysis of variance (ANOVA) indicated that 84 participants (42 per group) are required to detect a small to medium effect size (f = 0.25) with an  $\alpha$  error probability of 0.05 and a power of 0.80. Ninety eligible participants were included in this study and randomly assigned to either the mindfulness training group (MTG) or the routine care CG, with 46 in the MTG and 44 in the CG. All 90 participants completed the baseline assessment. Sociodemographic characteristics are presented in Table 1, and participant flow is illustrated in Figure 1.



Figure 1. Flow diagram for sampling and recruitment.

## Measures

The Posttraumatic Growth Inventory (PGI), initially developed by Tedeschi and Calhoun in 1996 (Tedeschi & Calhoun, 1996), underwent modification and translation by Wang *et al.* (2011) in 2011 to suit the Chinese context. It assesses individual levels of PTG across five dimensions: personal strength, relating to others, appreciation of life, spiritual change, and new possibilities, comprising 20 items. Utilizing a Likert 6-point scoring method, the total score ranges from 0 to 105 points, with higher scores indicating greater levels of PTG. The Cronbach's  $\alpha$  for the PGI was 0.80. Cheng *et al.* (2017) evaluated PTG among patients with chronic diseases, confirming high reliability across all five dimensions of the scale.

The Fear of Progress Questionnaire Short Form (FoP-Q-SF) was developed by Mehnert *et al.* (2006) of Germany in 2006 and later translated into Chinese by Wu *et al.* (2015) This scale comprises 2 dimensions and 12 items, focusing on physiological health and social/family aspects. Responses are rated on a Likert with 5 levels, yielding a total score ranging from 12 to 60 points. Higher scores indicate greater FCR, with a total score of  $\geq$  34 points indicating psychological

dysfunction. The scale demonstrates a Cronbach's  $\alpha$  of 0.883.

The Psycho-Social Adaptation Questionnaire (PSAQ) for Breast Cancer Patients was developed by Cheng and Wang in 2010 (Cheng & Wang, 2010). It comprises 44 items across 5 dimensions: anxiety/depression (8 items), self-esteem and self-acceptance (10 items), attitude (8 items), self-control and self-efficacy (9 items), and sense of belonging (9 items). Responses are scored on a Likert with 5 levels, resulting in a total score ranging from 44 to 220 points. Higher scores indicate better levels of PSA ability. A score of  $\geq$  175 suggests a high level of adaptation, < 132 indicates a low level, and 132-175 indicates a moderate level. The Cronbach's  $\alpha$  for the whole scale is. 945, with coefficients for each dimension ranging from 0.743 to 0.818.

#### Procedure

#### Pre-test

Eligible participants were randomly assigned to either the MTG or the CG after providing informed consent. Subsequently, they completed demographic information including age, residence, educational level, diagnosis time, surgical method, and clinical staging, along with measures such as the PGI, FoP-Q-SF, and PSAQ.

#### Eight-week mindfulness training program

This program is based on cognitive therapy as outlined by Modinos *et al.* (2010) in the United States. It consists of eight weekly, supervised group training sessions, each lasting 40 min. Participants are also encouraged to engage in daily home training tailored to their needs. Six nursing staff, trained as psychologists with extensive mindfulness exercise experience, oversee and guide the daily training sessions. The working group conducts inperson group lectures to instruct patients in mindfulness training. For patients unable to attend in person, video guidance is provided.

The specific steps of mindfulness training are as follows: (1) Mindful eating of raisins. The patient places a raisin in their palm and brings it to eye level, focusing on the raisin. Using the thumb and index finger of the other hand, they slowly rotate the raisin, carefully observing its outer surface and every crease. Next, they move the raisin under their nose to smell its scent, paying attention to each action. This exercise continues for ten minutes. (2) Conscious breathing. The patient finds a quiet and comfortable environment, sitting on a sofa or chair without leaning on the backrest. They place both hands on the lower abdomen and focus on the breathing process. They observe the sensation of air passing through the nasal cavity, throat, and chest, feeling the abdomen expand, and then contract as air exits through the chest, throat, and nasal cavity. Throughout the

| Sociodemographic characteristics                           | Mindfulness training group ( $n = 46$ ) | Control group<br>(n = 44) | χ <b>²</b> | Р     |
|--|---|---------------------------|------------|-------|
| Age  |   |                           | 1.344      | 0.511 |
| $\leq 40 \ (n = 12)$                                       | 5 (5.56)                                | 7 (7.78)                  |            |       |
| > 40-60 ( <i>n</i> = 73)                                   | 38 (42.22)                              | 35 (38.89)                |            |       |
| > 60 (n = 5)   | 3 (3.33)                                | 2 (2.22)                  |            |       |
| Residence  |   |                           | 0.134      | 0.714 |
| urban areas ( $n = 65$ )                                   | 34 (37.78)                              | 31 (34.44)                |            |       |
| countryside ( $n = 25$ )                                   | 12 (13.33)                              | 13 (14.44)                |            |       |
| Educational level  |   |                           | 0.146      | 0.986 |
| college or above $(n = 23)$                                | 12 (13.33)                              | 11 (12.22)                |            |       |
| high school or vocational school ( $n = 21$ )              | 11 (12.22)                              | 10 (11.11)                |            |       |
| middle school ( $n = 31$ )                                 | 16 (17.78)                              | 15 (16.67)                |            |       |
| primary school and below $(n = 15)$                        | 7 (7.78)                                | 8 (8.89)                  |            |       |
| Diagnosis time   |   |                           | 2.119      | 0.347 |
| $\leq 3 \text{ months } (n = 5)$                           | 1 (1.11)                                | 4 (4.44)                  |            |       |
| > 3-6 months ( <i>n</i> = 16)                              | 8 (8.89)                                | 8 (8.89)                  |            |       |
| > 6 months ( $n = 69$ )                                    | 37 (41.11)                              | 32 (35.56)                |            |       |
| Surgical method  |   |                           | 2.653      | 0.266 |
| Radical mastectomy ( $n = 35$ )                            | 21 (23.33)                              | 14 (15.56)                |            |       |
| Breast preservation surgery $(n = 54)$                     | 25 (27.78)                              | 29 (32.22)                |            |       |
| Breast reconstruction after radical mastectomy ( $n = 1$ ) | 0                                       | 1 (1.11)                  |            |       |
| Clinical Staging   |   |                           | 1.961      | 0.375 |
| stage I $(n = 36)$   | 19 (21.11)                              | 17 (18.89)                |            |       |
| stage II $(n = 31)$  | 18 (20)                                 | 13 (14.44)                |            |       |
| stage III $(n = 23)$                                       | 9 (10)                                  | 14 (15.56)                |            |       |

#### Table 1: Sociodemographic characteristics of participants by group

Data were presented as N (%).

exercise, the patient remains relaxed, repeating the inhalation and exhalation process for ten minutes. (3) Sitting meditation. The patient adopts a comfortable posture, closes their eyes, and adjusts their breathing rhythm. They silently recite simple words or monosyllabic sounds, fostering a relaxed and positive mindset while experiencing bodily relaxation. Music may be played appropriately during this process, which lasts for twenty minutes.

#### Post-test

Following the eight-week training period, participants completed PGI, FoP-Q-SF, and PSA once more.

#### Data analyses

We utilized IBM SPSS Statistics 24.0 for the statistical analyses in our study. A significance level of  $\alpha = 0.05$  was applied. Initially, *Chi-square* tests were conducted to assess baseline equivalence between the two groups regarding sociodemographic data.

If baseline group differences were detected on any variables, pre-test scores for those variables were controlled for in all subsequent analyses. Otherwise, separate two-way mixed ANOVA tests (between-subject variable: mindfulness training *vs.* control; within-subject variable: pre- *vs.* post-test) were conducted for the mediators and dependent variables. Following the approach outlined by Xu *et al.* (2016), if a significant group × time interaction was observed, simple effect analyses were performed to examine the time effect within each group individually. Effect sizes for interaction and simple effect analyses were assessed using partial eta squared ( $\eta_p^2$ ) (Cohen, 1988).  $\eta_p^2$  values of 0.01, 0.06, and 0.14 correspond to small, medium, and large effect sizes, respectively.

To determine whether the impact of mindfulness training on PTG was mediated by FCR or PSA, the parallel mediational model was tested using Model 4 from the PROCESS Macros for SPSS (Montoya & Hayes, 2017). This type of multiple mediator model allows for examination into whether the causal effects operate through one or more mechanisms simultaneously. For all models, simple deviation scores (*i.e.*, change scores) between pre and post-tests were calculated for each of the mediators. Bootstrapping analyses with 95% confidence intervals (CIs) and 5, 000

resamples were conducted.

To assess whether mindfulness training's impact on PTG was mediated by FCR or PSA, parallel mediational models were tested using Model 4 from the PROCESS Macros for SPSS (Montoya & Hayes, 2017). This approach enables the examination of whether causal effects operate through one or more mechanisms simultaneously. Simple deviation scores (*i.e.*, change scores) between pre and post-tests were calculated for each mediator. Bootstrapping analyses with 95% CI and 5000 resamples were conducted.

## RESULTS

## **Baseline characteristics**

The sociodemographic information of the participants showed that the majority of the participants were aged 41-60 years (n = 73, 81.1%), residing in urban areas (n = 65, 72.2%), with a junior high school education level (n = 35, 38.9%), diagnosed for 6 months or more (n = 71, 78.89%), underwent breast-conserving surgery (n = 51, 56.7%), and had a clinical stage of stage I (n = 36, 40%). Chi-square test analyses showed that there were no significant differences between the intervention and CG on any sociodemographic variables or baseline measurements (all P > 0.05) (Table 1).

## Treatment effect of the mindfulness training

Repeated measures ANOVA revealed a significant group × time interaction for PTG: F(1, 87) = 4.151, P = 0.006,  $\eta_p^2 = 0.003$  (Table 2). Subsequent simple effects analyses demonstrated that the MTG exhibited significantly higher PTG at post-test compared to the pre-test (P < 0.001), whereas no significant differences in PTG were observed within the CG between pre-and post-test (P = 0.280) (Figure 2). Additionally, there were no significant differences in PTG between the mindfulness intervention group and the CG, either at pre-test (P = 0.846) or post-test (P = 0.113).

Additionally, repeated measures ANOVA revealed significant group × time interactions for FCR: *F* (1, 87) = 5.83, P = 0.018,  $\eta_p^2 = 0.004$  (Table 2). Subsequent simple effects analyses within the MTG indicated that post-test scores on the FoP-Q-SF were lower than pretest scores (P = 0.011). Conversely, no difference was observed in the CG before and after intervention (Figure 3). There were no significant differences in FCR between the mindfulness intervention group and the CG, either at pre-test (P = 0.538) or post-test (P = 0.348).

Furthermore, repeated measures ANOVA showed no significant group × time interactions for PSA: *F* (1, 87) = 0.03, P = 0.052,  $\eta_p^2 < 0.001$  (Table 2).



Figure 2. Changes in PTG pre and post-test during mindfulness training by group. MTG, mindfulness training group; CG, control group.

## **Mediation analyses**

Table 3 presents the results of the mediation analyses. The mediation models, with mindfulness training as the independent variable and changes in FCR and PSA as mediators, are depicted in Figure 4. The findings indicate that the total effect of the model approached marginal significance, with t = -1.885, P = 0.063, and an effect size of 0.392. The mediating effect of FCR was significant at a 95% confidence interval (95% CI = [-0.431, -0.037]), with an effect size of 0.157, while the mediating effect of PSA was not significant (95% CI = [-0.205, 0.179]). After controlling for FCR, the effect of grouping on PTG was not significant (95% CI = [-0.607, 0.137]). Hence, the reduction in FCR is the mechanism through which mindfulness intervention enhances PTG.

## DISCUSSION

This study demonstrates that an 8-week mindfulness training intervention enhances PTG among breast cancer patients while reducing their FCR. Furthermore, FCR serves as a mediating factor between mindfulness training and PTG levels.

Prior research indicates that participants undergoing 2.0 to 2.5 h of mindfulness training often struggle to maintain wakefulness and focus, experiencing issues such as drowsiness, fatigue, or disorders (Yu & Zhang, 2013). In our study, we adjusted the content and duration of mindfulness training sessions to 40 min per class, aiming to better accommodate the physical conditions of breast cancer patients and enhance intervention feasibility. This modification allows patients to engage in training at their convenience without requiring specialized equipment, ensuring intervention continuity.

This study corroborates prior findings suggesting that mindfulness training interventions can enhance PTG among breast cancer patients. However, compared to the CG, the observed improvement is modest.

| Tabl | e 2: | Descriptive | statistics | and | between-g | group | outcomes | results |
|------|------|-------------|------------|-----|-----------|-------|----------|---------|
|------|------|-------------|------------|-----|-----------|-------|----------|---------|

| 0                                       | PGI             |                 | FoP-Q-SF      |               | PSAQ          |                 |
|---|-----------------|-----------------|---------------|---------------|---------------|-----------------|
| Group                                   | Pre-test        | Post-test       | Pre-test      | Post-test     | Pre-test      | Post-test       |
| Mindfulness training group ( $n = 46$ ) | $3.68 \pm 1.00$ | $4.10\pm0.96$   | $2.41\pm0.67$ | $2.25\pm0.69$ | $3.40\pm0.29$ | $3.34 \pm 0.23$ |
| Control group ( $n = 44$ )              | $3.62 \pm 1.07$ | $3.75 \pm 1.11$ | $2.32\pm0.67$ | $2.38\pm0.56$ | $3.30\pm0.37$ | $3.23\pm0.32$   |
| F                                       | 4.15            |                 | 5.83          |               | 0.03          |                 |
| Р                                       | 0.006           |                 | 0.018         |               | 0.052         |                 |
| $\eta_p^{\ 2}$                          | 0.003           |                 | 0.004         |               | < 0.001       |                 |

Data were presented as Mean ± SD. PGI, Posttraumatic Growth Inventory; FoP-Q-SF, Fear of Progress Questionnaire Short Form; PSAQ, Psycho-Social Adaptation Questionnaire.

| Parameter | FCR                         |       |       |               | PSA                         |       |               | PTG                          |         |  |
|-----------|-----------------------------|-------|-------|---------------|-----------------------------|-------|---------------|------------------------------|---------|--|
|           | coeff                       | SE    | Р     | coeff         | SE                          | Р     | coeff         | SE                           | Р       |  |
| MT        | -0.495                      | 0.205 | 0.018 | 0.037         | 0.212                       | 0.862 | 0.235         | 0.187                        | 0.213   |  |
| FCR       | -                           | -     | -     | -             | -                           | -     | -0.353        | 0.098                        | 0.001   |  |
| PSA       | -                           | -     | -     | -             | -                           | -     | -0.478        | 0.095                        | < 0.001 |  |
| Constant  | 0.737                       | 0.323 | 0.025 | -0.055        | 0.333                       | 0.869 | 0.350         | 0.293                        | 0.236   |  |
|           | $R^2 = 0.062$               |       |       | $R^2 = 0.003$ |                             |       | $R^2 = 0.289$ | 1                            |         |  |
|           | F(1, 88) = 5.814, P = 0.018 |       |       | F(1, 88) =    | F(1, 88) = 0.031, P = 0.862 |       |               | F(3, 86) = 11.666, P < 0.001 |         |  |

MT, mindfulness training; FCR, fear of cancer recurrence; PSA, psychosocial adaptation; PTG, posttraumatic growth



**Figure 3.** Changes in FCR pre and post-test during mindfulness training by group. MTG, mindfulness training group; CG, control group.

Mindfulness practices, such as meditation and deep breathing, reduce stress by promoting relaxation and lowering cortisol levels. This stress reduction enhances overall well-being and fosters a more positive outlook, facilitating PTG (Wenzel *et al.*, 2020). Mindfulness helps individuals observe their thoughts and feelings without judgment, improving emotional regulation and enabling more constructive trauma processing, thus contributing to PTG. The implications of this enhancement are extensive, affecting psychological well-being, physical health, and interpersonal relationships. Research indicates that high levels of PTG in cancer patients are associated with effective stress management and sustained positive emotions, leading to a more hopeful



**Figure 4.** Mediating effect of FCR on the impact of MT on PTG. \*, P < 0.05; \*\*, P < 0.01; MT, mindfulness training; FCR, fear of cancer recurrence; PSA, psychosocial adaptation; PTG, posttraumatic growth.

outlook on disease management and improved treatment adherence (Chen *et al.*, 2019). The limited disparity between the MTG and the CG may be attributed to several factors: First, PTG is influenced by various factors, and while mindfulness training addresses some of these factors, its impact may be constrained. Second, participants in our study exhibited relatively high levels of PTG upon enrollment, with 41.11% being retired individuals and 87.78% being medical insurance workers. These groups typically possess stable lifestyles and incomes, exhibiting resilience to traumatic events or experiencing minimal disruption to their lives from such events.

This study found that mindfulness intervention led to a

reduction in FCR among breast cancer patients; however, the difference compared to the CG was not statistically significant. Patients often associate the loss of a breast with their cancer experience, triggering negative emotions and fear of recurrence. Mindfulness intervention has been shown to effectively alleviate this fear (Peng et al., 2022). Studies indicate that mindfulness exercises can enhance the prefrontal cortex, a brain region associated with emotion and emotional regulation (Nakamura et al., 2021). Participants in the intervention group gradually developed a positive outlook on stressful events through mindfulness training, contributing to reduced FCR. The lack of significant difference between the CG and intervention group may be explained by the higher proportion of breastconserving surgeries in this study (56.67% of total surgeries), Exceeding the average level of Tianjin hospitals in recent years (16.8%) (Liu et al., 2022). Consequently, participants in this study exhibited milder symptoms, earlier cancer staging, smaller surgical wounds, quicker recovery, and less FCR.

Mindfulness interventions have minimal impact on the PSA of breast cancer patients. Possible reasons include: (1) The broad scope and varied content of psychosocial factors limit the effectiveness of mindfulness interventions alone. Some factors, such as social discrimination against breast cancer patients, are not entirely within the patient's control. This suggests that effective PSA requires a multifaceted approach. (2) The process of psychological and social adaptation necessitates continuous self-evaluation and adjustment by patients. This is a gradual and progressive improvement process. The short interval between measurements may explain the absence of significant differences observed.

This study reveals a significant mediating effect of FCR (0.157) in the mechanism of mindfulness intervention on PTG among breast cancer patients. Mindfulness interventions enhance self-awareness and emotional regulation, thereby alleviating the FCR. Emotional states profoundly influence PTG, and mindfulness training aids in better managing negative emotions and fostering growth (Nik Jaafar *et al.*, 2022). FCR emerges as a proximal factor impacting PTG. Future research can explore strategies to mitigate patients' FCR, improve emotional well-being, and facilitate a higher quality of life for breast cancer patients.

This study has several limitations. Firstly, the 8-week duration of the mindfulness intervention may be insufficient to observe sustained impacts, potentially leading to incomplete manifestation of mindfulness effects and insignificant differences in PTG and FCR between the intervention and CGs. Some studies have shown that a 12-week mindfulness intervention can effectively improve outcome indicators for breast cancer patients compared to a CG (Gok Metin *et al.*, 2019). Future research should extend the intervention duration to twelve weeks or longer and observe the sustained impact post-intervention. Secondly, the study employed a single-center design, limiting sample diversity to one medical institution. Variations in cultural background, treatment plans, and psychological characteristics among breast cancer patients may affect the generalizability and representativeness of the results. Future research should consider multi-center studies across regions or countries to enhance the robustness and universality of findings.

## CONCLUSION

This study illustrates the efficacy of an eight-week mindfulness training program in augmenting PTG levels and alleviating the FCR among breast cancer patients. Further mediation analysis suggests that the decrease in FCR acts as a pathway by which mindfulness training impacts PTG. These results enrich our comprehension of how mindfulness interventions foster PTG and improve the well-being of breast cancer patients.

## DECLARATION

## Author contributions

Lyu XK and Yang TT: Conceptualization, Writing— Original draft preparation, Writing—Reviewing and Editing. Zhengyang Xu ZY: Conceptualization, Supervision, Writing—Original draft preparation. Han Y and He XL: Supervision, Project administration.

## Ethical approval

The study was approved by the Medical Ethics Committee of Affiliated People's Hospital of Ningbo University (2021-077). Informed consent was gained from each participant before their participation.

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## **Conflict of interest**

Lyu XK is the editorial board member of the journal. The article was subject to the journal's standard procedures, with peer review handled independently of the editor and the affiliated research groups.

# Use of large language models, Al and machine learning tools

None declared.

## Data availability statement

All datasets are available in the main text and will be available from the corresponding author upon request.

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