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Effects of mindfulness-based cognitive therapy on self-efficacy and mental health in lung cancer patients undergoing radiotherapy: A randomized controlled trial

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ABSTRACT

Background: This study aimed to evaluate the effectiveness of Mindfulness-Based Cognitive Therapy (MBCT) in improving self-efficacy, quality of life, and mental health outcomes in patients with lung cancer undergoing radiotherapy. ***Materials and Methods:*** A randomized controlled trial was conducted involving 60 patients diagnosed with lung cancer and scheduled to receive radiotherapy between January 2024 and February 2025. Patients were randomly assigned to either the intervention group (IG, n=30), which received MBCT in addition to standard oncological care, or the control group (CG, n=30), which received standard oncological care alone. The MBCT program was delivered over eight weekly sessions during the radiotherapy course. Outcome measures included quality of life (QoL), self-efficacy (SE), cancer-related fatigue, and levels of depression and anxiety. Assessments were conducted at baseline, one day after completing radiotherapy, and seven days post-treatment. ***Results:*** Compared to baseline, patients in the intervention group showed significant improvements in QoL, self-relaxation, positive attitude, decision-making confidence, and overall self-efficacy ($P<0.05$). These improvements were significantly greater than those observed in the control group at both follow-up points. Furthermore, the intervention group exhibited markedly reduced symptoms of depression, anxiety, and cancer-related fatigue-particularly emotional and cognitive fatigue-seven days post-treatment ($P<0.05$). ***Conclusion:*** MBCT significantly enhances self-efficacy and mental health outcomes in lung cancer patients undergoing radiotherapy. These findings support the integration of MBCT as a complementary psychosocial intervention in radiotherapy care to improve patients' psychological resilience and quality of life.

INTRODUCTION

Lung cancer remains one of the most prevalent and deadly malignancies worldwide, with a high burden of physical and psychological complications throughout the treatment course [1]. Radiotherapy, a cornerstone in the management of lung cancer, is often associated with substantial side effects including fatigue, pain, and physical discomfort, which can severely impact patients' psychological well-being and quality of life [2, 3].

A growing body of evidence indicates that cancer patients-particularly those with lung cancer-frequently experience mental health disorders such as depression, anxiety, emotional distress, and reduced self-efficacy during and after treatment [3, 4]. These psychological disturbances may stem from a combination of factors including fear of disease progression, physical suffering, social isolation, and uncertainty about the future. Importantly, radiotherapy itself, while life-saving, can exacerbate feelings of helplessness, loss of control, and emotional fatigue due to its cumulative physical burden and treatment-related limitations on daily life [5-7].

Mindfulness-based cognitive therapy (MBCT) is a structured psychotherapeutic approach that integrates principles of cognitive-behavioral therapy with mindfulness training. It has shown promise in enhancing emotional regulation, reducing rumination, and improving psychological resilience in various clinical populations [8]. MBCT may be particularly well-suited for cancer patients undergoing stressful treatments, as it empowers individuals to observe distressing thoughts and sensations without judgment, thereby potentially improving self-efficacy and mental health outcomes [9].

Despite increasing interest in psychosocial interventions for cancer patients, few studies have specifically evaluated the application of MBCT in individuals undergoing radiotherapy for lung cancer-

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a population known to face high levels of psychological vulnerability. To our knowledge, this is one of the first randomized controlled trials assessing the effect of MBCT on self-efficacy, mental health status, and fatigue in lung cancer patients during radiotherapy.

Therefore, the aim of this study was to evaluate the effectiveness of MBCT in improving self-efficacy, reducing depression and anxiety, and alleviating cancer-related fatigue among lung cancer patients undergoing radiotherapy. The novelty of this work lies in its focus on integrating a structured psychological intervention into routine radiotherapy care to address unmet mental health needs in this high-risk population.

MATERIALS AND METHODS

Study design and ethical approval

This randomized controlled trial was conducted at the Radiotherapy Ward 3 of Hangzhou Cancer Hospital, between January 2024 and February 2025. The study was approved by the Institutional Ethics Committee of Hangzhou Cancer Hospital (Approval No: HZCH2021-RT-097, approved on August 13, 2021), and registered in the Chinese Clinical Trial Registry (Registration No: ChiCTR2200065348). All participants provided written informed consent prior to enrollment.

Participants

A total of 60 patients with histologically confirmed lung cancer who were scheduled to receive radiotherapy were enrolled in the study. Participants were randomly assigned to either the intervention group (IG, n=30), which received Mindfulness-Based Cognitive Therapy (MBCT) in addition to routine care, or the control group (CG, n=30), which received routine care alone. Randomization was performed using a computer-generated random number table.

Eligible participants were between 18 and 65 years of age, had an Eastern Cooperative Oncology Group (ECOG) performance status of 0 to 2, were able to operate smartphones and communicate verbally, and had adequate literacy to complete self-administered assessments. They were expected to survive for at least three months. Patients with pre-existing psychiatric illness, alcohol or substance abuse, prior radiotherapy or chemotherapy, cognitive impairment, or participation in other concurrent psychological trials were excluded. Participants were withdrawn from the study if they violated the study protocol, showed poor compliance, had incomplete data, or chose to voluntarily withdraw at any stage.

Radiotherapy and chemotherapy protocols

All participants received radiotherapy using either three-dimensional conformal radiotherapy (3D -CRT) or intensity-modulated radiotherapy (IMRT) delivered by the Elekta Axesse™ linear accelerator system (Elekta AB, Sweden). Radiotherapy was prescribed at a total dose of 60 to 66 Gy, administered in 30 to 33 fractions over six to seven weeks, five sessions per week. Treatment planning was performed using the Monaco Treatment Planning System (Elekta, Sweden). No patients received chemotherapy during the study period in order to isolate the psychological effects of MBCT during radiotherapy.

Sample size estimation

The sample size was calculated based on an empirical formula that considers the number of questionnaire dimensions. Using the formula: sample size = [maximum number of dimensions × (15 to 20)] × [1 + 20% for anticipated dropout], and assuming a maximum of five dimensions, the required minimum sample size was estimated to be 60 participants.

Intervention protocols

The intervention group received MBCT in addition to routine care. A six-member intervention team was established, consisting of a licensed psychotherapist, a radiation oncologist, a psychologist, and four nurses, all of whom completed training in MBCT techniques. The MBCT program followed the structured model developed by Segal, Williams, and Teasdale. Sessions were conducted once per week over eight consecutive weeks in a dedicated consultation room at Hangzhou Cancer Hospital. Each session lasted approximately 60 minutes and was delivered in small groups. Remote access was also facilitated using Zoom Pro software (Zoom Video Communications, USA).

The eight-week MBCT curriculum included the following core components: cultivating awareness of automatic pilot behavior through mindful eating; body scan and breathing practices; mindfulness of present-moment experiences; recognizing habitual avoidance patterns; acceptance of unpleasant thoughts and emotions; cognitive defusion techniques; strategies for self-care and pleasure engagement; and planning for long-term integration of mindfulness into daily life.

The control group received eight weekly psychoeducational sessions, each lasting 60 minutes, which provided information on lung cancer risk factors, symptoms, treatment options, lifestyle recommendations, emotional communication techniques, and simple relaxation strategies. These sessions were delivered by trained staff and supplemented by follow-up text messages via the WeChat platform (Tencent Holdings Ltd., China).

Assessment instruments

Primary and secondary outcomes were assessed

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at three time points: prior to radiotherapy, one day after the final session, and seven days after completion of radiotherapy. Psychological and behavioral outcomes were evaluated using standardized and validated Chinese-language instruments.

The World Health Organization Quality of Life-BREF (WHOQOL-BREF) scale was used to assess overall quality of life across physical, psychological, social, and environmental domains. Self-efficacy was measured using the Strategies Used by People to Promote Health (SUPPH) scale, which includes dimensions of self-relaxation, positive attitude, and decision-making confidence. Cancer-related fatigue was assessed using the Cancer Fatigue Scale (CFS), which evaluates physical, emotional, and cognitive fatigue. Depression and anxiety symptoms were evaluated using the Hamilton Depression Scale (HAMD-17) and the Hamilton Anxiety Scale (HAMA-14), respectively. All scales were administered and scored by two trained clinical psychologists blinded to group allocation. Statistical analysis was performed using SPSS version 22.0 software (IBM Corp., USA).

Observational indicators

Baseline demographic and clinical characteristics, including age, gender, height, weight, smoking and alcohol history, cancer type and stage, were recorded at enrollment. Psychological measures and fatigue scores were collected at all three time points. Additionally, patient satisfaction with the intervention was documented and categorized as "very satisfied," "satisfied," or "dissatisfied," with overall satisfaction rates calculated accordingly.

Statistical analysis

Quantitative data were tested for normality and expressed as mean ± standard deviation. Between-group comparisons were analyzed using independent -samples t-tests or Mann–Whitney U tests, depending on distribution. Repeated-measures analysis of variance (ANOVA) was used to assess changes over time within and between groups. Categorical variables were analyzed using the chi-square test. All statistical analyses were conducted using SPSS version 22.0 (IBM Corp., USA), and a p-value of less than 0.05 was considered statistically significant.

RESULTS

Baseline data of subjects

In the IG, there were 19 men and 11 women (55.06±8.14), height of 162.64±10.78 cm, weight of 58.92±6.52 kg. The pathological types included 14 cases of adenocarcinoma, 10 of squamous cell carcinoma, and 6 of small cell carcinoma. The pathological staging included 17 cases of stage II, 9 of stage III, and 4 of stage IV. There were 21 cases with a smoking history and 11 with a drinking history. The CG had 18 men and 12 women (53.57±6.72), height of 159.75±12.56 cm, weight of 60.84±7.18 kg. The pathological types included 13 subjects of adenocarcinoma, 10 of squamous cell carcinoma, and 7 of small cell carcinoma. The pathological staging included 18 subjects of stage II, 8 of stage III, and 4 of stage IV. There were 22 subjects with a smoking history and 10 with a drinking history. The comparison of the number of males and females, age, height, weight, pathological type, pathological staging, smoking history, and drinking history in the subjects suggested no visible distinctions (P >0.05) (figure 1).

QoL score of subjects

One day and seven days after CT, the QoL scores of the subjects were both visibly higher as against before CT; the scores of the IG were visibly higher as against the CG (P <0.05) (figure 1).

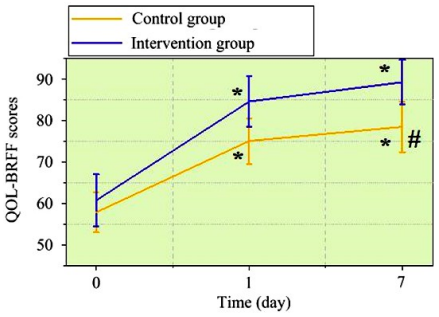


Figure 1. QoL score contrast of subjects before and after CT. Note: * as against that before CT, # as against the IG, P <0.05

SE level of subjects

One day and seven days after CT, the self-relaxation, positive attitude, self-decision scores, and SE total score of the subjects were both visibly higher as against before CT; those of the IG were visibly higher as against the CG (P <0.05) (figure 2).

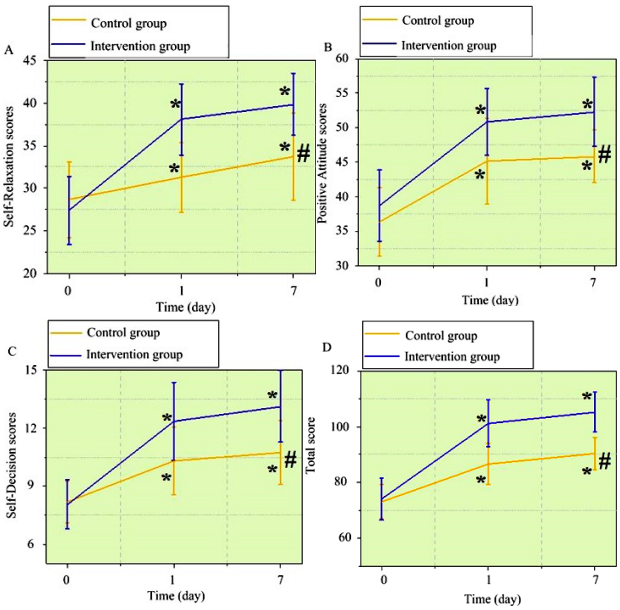


Figure 2. Contrast of SE level of subjects before and following CT. (**A-D** are self-relaxation, positive attitude, self-decision, and total SE scores, respectively). Note: * as against that before CT, # as against the IG, P <0.05

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Anxiety and depression scores of subjects

One day and seven days following CT, the depression and anxiety scores of the subjects were both visibly lower as against before CT; the scores of the IG were markedly lower as against the CG (P <0.05) (figure 3).

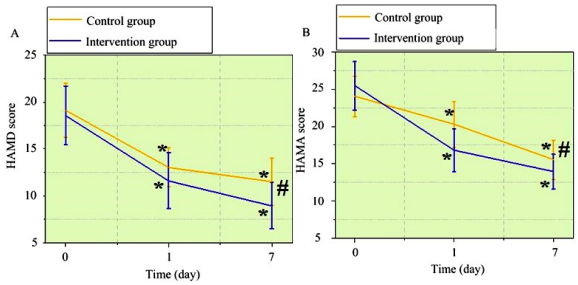


Figure 3. Contrast of anxiety and depression scores of subjects before and following CT. (**A:** depression; **B:** anxiety). Note: * as against that before CT, # as against the IG, P<0.05

Cancer fatigue score of subjects

One day and seven days after the completion of radiotherapy, the scores for physiological fatigue, emotional fatigue, cognitive fatigue, and total cancer-related fatigue in the intervention group (IG) were significantly lower compared to baseline levels. Furthermore, these scores were significantly lower in the IG compared to the control group (CG) at both time points (P < 0.05) (figure 4).

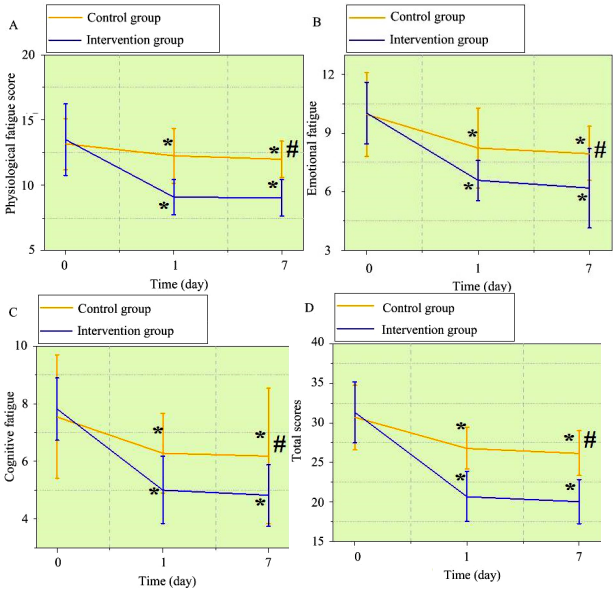


Figure 4. Contrast of cancer-related fatigue scores of subjects. (**A-D**: physiological fatigue, emotional fatigue, cognitive fatigue, and cancer fatigue total scores). Note: * as against that before CT, # as against the IG, P <0.05.

Satisfaction degree of subjects

In the IG, there were 16 cases of very satisfaction, 11 cases of satisfaction, and 3 cases of dissatisfaction, with a satisfaction rate of 90%; in the CG, there were 10 cases of very satisfaction, 13 cases of satisfaction, and 7 cases of dissatisfaction, with a satisfaction rate of 76.67%. The satisfaction rate of the IG was markedly higher in contrast to the CG (P <0.05) (figure 5).

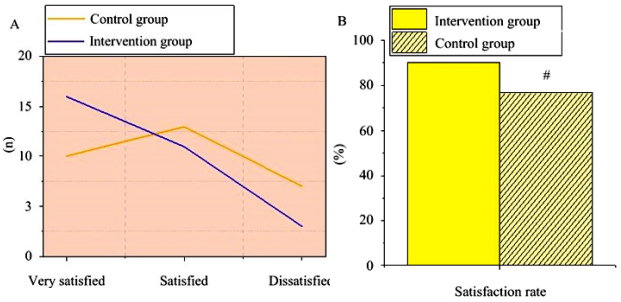


Figure 5. Contrast of subjects' satisfaction rate. (A is the number of very satisfied, satisfied, and dissatisfied cases; B is the satisfaction rate). Note: # as against the IG, P<0.05.

Radiotherapy treatment and side effects

All patients in the study received radiotherapy as part of their treatment for lung cancer. The average number of radiotherapy sessions administered to the subjects was 30 sessions, with a total treatment duration of 6 weeks. Radiotherapy was targeted based on tumor location and stage, following standard treatment protocols for lung cancer. A range of side effects related to radiotherapy was observed in the patients, which included fatigue, skin irritation at the treatment site, difficulty swallowing, and nausea. These side effects were most pronounced in the first few days after radiotherapy and improved by the seventh day following treatment. The table below summarizes the frequency of side effects observed in the IG and CG, as well as the severity reported.

Table 1. Radiotherapy side effects between groups.

Side Effect	IG (%)	CG (%)	P-value
Fatigue (Mild to Severe)	30 (60%)	35 (70%)	0.045
Skin Irritation	15 (30%)	22 (44%)	0.038
Difficulty Swallowing	10 (20%)	15 (30%)	0.071
Nausea	8 (16%)	12 (24%)	0.108

The IG showed a statistically significant reduction in fatigue and skin irritation compared to the CG (P < 0.05), while other side effects such as difficulty swallowing and nausea did not show a significant difference between the two groups. By the seventh day following radiotherapy, patients in both groups showed improvement in fatigue and other side effects. However, the IG reported a faster recovery, with 50% of patients experiencing mild or no fatigue by day seven, compared to 30% in the CG. The reduction in side effects and faster recovery in the IG group could be attributed to the psychological benefits of mindfulness-based cognitive therapy (MBCT), which helped improve stress management and emotional regulation.

DISCUSSION

Patients with lung cancer (LC) undergoing radiotherapy frequently experience profound psychological distress, including depression, anxiety, and diminished self-efficacy. These emotional challenges are not only driven by the disease burden

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and uncertainty about prognosis, but also by the physical side effects and psychological toll of treatment itself [10, 11]. Radiotherapy, though a central modality in LC treatment, often contributes to feelings of helplessness, fear of disease progression, and a sense of lost control-all of which negatively affect patients' mental health and QoL [12, 13].

In this randomized controlled trial, we evaluated the impact of MBCT on the self-efficacy, emotional well-being, fatigue, and QoL of LC patients receiving radiotherapy. The baseline characteristics between the IG and CG were statistically similar, affirming the comparability of groups and reinforcing the attribution of post-intervention effects to the MBCT program itself.

Our findings demonstrate that MBCT significantly improved patients' QoL across multiple domains shortly after completion of radiotherapy. This is consistent with previous studies indicating that MBCT enhances emotional resilience and daily functioning in patients with chronic illnesses and cancer [14, 15]. Notably, the intervention group exhibited marked improvements in self-relaxation, positive attitude, and decision-making-dimensions closely associated with psychological coping and treatment compliance.

Furthermore, this study observed significant reductions in anxiety and depression symptoms among patients who received MBCT. These outcomes align with prior clinical evidence supporting the effectiveness of mindfulness-based interventions in reducing psychological distress in cancer populations, including those undergoing chemotherapy and hematologic treatments [16, 17]. In particular, MBCT may exert its therapeutic benefits by altering maladaptive cognitive patterns and increasing patients' ability to remain present and non-reactive to distressing thoughts, which is especially relevant for individuals coping with cancer-related uncertainty [18].

Another key finding was the significant reduction in cancer-related fatigue, including physical, emotional, and cognitive domains, in the MBCT group. Fatigue is one of the most debilitating symptoms reported by radiotherapy recipients and is known to persist long after treatment in many cases [19]. Previous research has shown that mindfulness practices improve energy perception, reduce mental exhaustion, and promote restorative behaviors among cancer survivors [19]. Our results further support the integration of MBCT as a non-pharmacological strategy to mitigate fatigue during active oncologic treatment.

The present study contributes to a growing body of literature by focusing specifically on LC patients undergoing radiotherapy-a population less frequently addressed in mindfulness research, which often focuses on breast or colorectal cancer. By tailoring MBCT sessions to this group, the intervention addressed disease-specific psychological burdens such as fear of breathlessness, disease recurrence, and treatment side effects. These tailored applications may have enhanced the program's relevance and effectiveness.

Despite these promising results, this study has limitations. The sample size was modest (n=60), potentially limiting the statistical power and generalizability of the findings. Additionally, the follow-up period was short, with outcomes assessed only up to seven days post-radiotherapy, precluding any analysis of long-term psychological or functional benefits. Moreover, potential confounding variables such as social support systems, coping styles, or comorbid psychiatric conditions were not controlled for, which may have influenced psychological outcomes. The intervention was also delivered in a single center, and cultural or regional factors may affect replicability in other settings.

Future studies should address these limitations by employing larger, multicenter designs with extended follow-up durations. It would also be valuable to examine the synergistic effects of MBCT when combined with other psychosocial interventions, such as cognitive-behavioral therapy or family-based support programs.

In conclusion, this study demonstrates that MBCT is a feasible and effective intervention for improving self-efficacy, reducing psychological distress, and alleviating cancer-related fatigue in LC patients undergoing radiotherapy. These findings support the integration of MBCT into routine oncology care as a complementary strategy to improve psychological resilience and enhance treatment outcomes. Further research is warranted to confirm these findings and explore their long-term implications in diverse cancer populations.

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Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this article. The study was conducted without any external financial support or involvement from organizations that may have influenced the research outcomes.

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***Ethical Approval*:** This study was approved by the Ethics Committee of Hangzhou Cancer Hospital. All participants provided written informed consent before participating in the study, and the research was conducted in accordance with ethical standards set by the institution.

***Author Contributions*:** B.X. and X.M. contributed equally to the conception and design of the study, data collection, analysis, and manuscript writing. B.X. was responsible for overseeing the clinical aspects of the intervention and statistical analysis. X.M. assisted with the methodology and data interpretation. Both authors approved the final manuscript.

***Data Availability*:** The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

***Possible use of AI*:** Artificial intelligence tools were not used in the generation, analysis, or interpretation of data in this study.

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