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Mongolian Mind-Body Interactive Therapy for Pulmonary Sarcoidosis: A Prospective Single-Arm Pilot Trial

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Abstract: Pulmonary nodules represent a prevalent pulmonary lesion with a rising clinical detection rate, and a subset may undergo malignant transformation to lung cancer. Even benign nodules frequently elicit anxiety, sleep disturbances, and other adverse outcomes. This study aimed to investigate the effects of Mongolian Mind-Body Interactive Therapy (MMBIT) on CT imaging and clinical characteristics of pulmonary nodules, and quality of life in patients with pulmonary sarcoidosis. A total of 36 patients with pulmonary sarcoidosis admitted to the Outpatient Department of Psychosomatic Medicine, Inner Mongolia International Mongolian Medicine Hospital, between July 2021 and July 2022 were enrolled. All patients received a consecutive 21-day MMBIT intervention. By comparing the data before and after treatment, the maximum diameter of pulmonary nodules decreased from 6.8 ± 2.3 mm to 5.2 ± 1.8 mm ($P < 0.001$), the proportion of nodules with smooth margins increased from 27.78% to 50.00% ($P = 0.034$), while no significant alterations were observed in nodule count or density ($P > 0.05$); The concentrations of respiratory system tumor markers ProGRP, NSE, and FER significantly decreased after treatment ($P < 0.05$), while the concentrations of SCCA, CYFRA21-1, and CEA did not change significantly. The total PSQI score reduced from 7.2 ± 2.1 to 5.8 ± 1.9 ($P = 0.003$), and sleep duration extended from 6.1 ± 1.2 h to 6.8 ± 1.0 h ($P = 0.006$). The SF-36 scale was significantly elevated compared with pre-intervention levels ($P < 0.05$). Emotion regulation self-efficacy was strengthened, with scores of all three dimensions in the SRESE significantly increased ($P < 0.001$). In conclusion, MMBIT can significantly mitigate the imaging characteristics associated with the malignant potential of pulmonary nodules, modulate relevant tumor marker levels, and improve autonomic nervous function in patients with pulmonary sarcoidosis, while concurrently enhancing their sleep quality, quality of life, and emotion regulation self-efficacy. Thus, it emerges as a safe and effective adjuvant therapeutic strategy for the comprehensive management of patients with pulmonary sarcoidosis.

Keywords: Mongolian Mind-Body Interactive Therapy (MMBIT); Pulmonary sarcoidosis; CT imaging features; Tumor markers; Sleep quality; Emotion regulation

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1. Introduction

Sarcoidosis is an idiopathic systemic granulomatous disease pathologically characterized by non-caseating necrotizing epithelioid cell granulomas. The lungs and intrathoracic lymph nodes are the most frequently involved (accounting for approximately 90%), and severe cases may progress to pulmonary fibrosis, significantly impairing patients' quality of life. The disease predominantly affects young and middle-aged adults, with a slight female predominance, and exhibits significant geographical and ethnic variations. Currently, comprehensive national epidemiological data on sarcoidosis in China are lacking [1,2].

Pulmonary nodules are a typical imaging manifestation of sarcoidosis. Their size, marginal features, and density are key indicators for assessing lesion nature and progression risk—nodules with a maximum diameter >8 mm, especially those with spiculation or lobulation, have significantly increased malignant risk and progression probability [3]. The differentiation between benign and malignant pulmonary nodules relies not only on imaging morphological characteristics, but also on serum respiratory tumor markers as important auxiliary evaluation indicators [4]. Commonly used markers include squamous cell carcinoma antigen (SCCA), cytokeratin 19 fragment 21-1 (CYFRA21-1), neuron-specific enolase (NSE), carcinoembryonic antigen (CEA), ferritin (FER), and pro-gastrin-releasing peptide (ProGRP). Studies have shown that the diagnostic efficacy of single tumor markers for malignant pulmonary nodules is generally limited, whereas combined detection of multiple markers can improve the identification of malignant nodules [5]. Currently, clinical treatment of pulmonary sarcoidosis is mainly based on glucocorticoids, but long-term use is prone to adverse effects such as hyperglycemia and osteoporosis. Thus, exploring safe and effective adjunctive interventions holds important clinical value [3].

Psychological factors play an important role in the pathogenesis and progression of chronic lung diseases: chronic anxiety and stress can activate inflammatory responses via the neuroendocrine-immune network, exacerbating lung tissue damage and nodule progression [6]. Recent studies have shown that psychological interventions such as cognitive behavioral therapy (CBT) can alleviate anxiety and improve sleep quality in patients with pulmonary nodules by regulating emotions [7,8]. Mongolian Mind-Body Interactive Therapy (MMBIT) is an innovative approach based on the Mongolian medical theory of "the unity of mind and body." It integrates modern psychological techniques and modulates autonomic nervous function while alleviating psychological stress through the model of "mind guidance–breath regulation–group interaction," with proven efficacy in psychosomatic disorders like depression and anxiety [9]. However, to date, no studies have investigated the combined effects of MMBIT on imaging characteristics, tumor markers, and heart rate variability indices in patients with pulmonary sarcoidosis, nor have comparative analyses of efficacy differences between MMBIT and other psychological interventions in this population been conducted. This study aims to supplement pulmonary nodule computed tomography (CT) imaging, tumor marker, and heart rate variability data, comprehensively evaluate MMBIT's ameliorative effects on the four-dimensional indices (somatic, psychological, imaging, and physiological indices) in patients with pulmonary sarcoidosis, and provide data support for its clinical promotion.

2. Materials and methods

2.1. General information

Thirty-six patients with pulmonary sarcoidosis admitted to the Outpatient Department of Psychosomatic Medicine, Inner Mongolia International Mongolian Medicine Hospital, between July 2021 and July 2022 were enrolled as research subjects. All participants provided written informed consent. The Ethics Committee of Inner Mongolia International Mongolian Medicine Hospital approved this study (Approval No.: 2021-015).

Inclusion criteria: Met the diagnostic criteria specified in the Expert Consensus on Diagnosis and Treatment of Sarcoidosis in China (2019) [3], with non-caseating necrotizing epithelioid cell granulomas confirmed by pathological biopsy; Chest high-resolution computed tomography (HRCT) revealed intrapulmonary nodules (maximum diameter: 3–10 mm), and no treatments affecting nodule morphology were received within 1 week before intervention; Aged 20–70 years, with clear consciousness and ability to cooperate with scale assessments, CT scans, tumor marker detection, and heart rate variability monitoring; Signed the informed consent form.

Exclusion criteria: Complicated with other lung diseases such as lung cancer, pulmonary tuberculosis, or pulmonary fibrosis; Severe dysfunction of heart, liver, kidney, or other organs; Severe mental illnesses including schizophrenia and bipolar disorder; Contraindications to CT examination; Contraindications to tumor marker detection or heart rate variability monitoring.

Baseline characteristics of the patients are presented in **Table 1**. Due to missing demographic data in some patients, the effective statistical sample size was 34, which is consistent with the epidemiological characteristics of sarcoidosis (predominantly affecting young and middle-aged adults, with a slight female predominance).

Table 1. Demographic and clinical characteristics of patients (n = 36, partial indicators n = 34)

Item	Statistical value
Gender distribution	4 males (11.11%), 32 females (88.89%); partial statistics: 5 males (14.71%), 29 females (85.29%)
Age range	29–65 years
Mean age	52.9 ± 8.7 years (mean ± SD); partial statistics: 52.29 ± 9.13 years (mean ± SD)
Age quartiles	25%: 47.25 years, 50%: 55.00 years, 75%: 58.75 years
Nodule duration (months, mean ± SD)	8.3 ± 3.5
Smoking history	2 cases (5.56%) with smoking history, 34 cases (94.44%) without; partial statistics: smoking proportion 5.88%, non-smoking proportion 94.12%
Alcohol consumption history	partial statistics: alcohol consumption proportion 2.94%, non-alcohol consumption proportion 97.06%
Ethnic distribution (*n* = 34)	17 Han (50.0%), 8 Mongolian (23.5%), 2 Manchu (5.9%), 7 others (20.6%)
Occupational distribution (*n* = 34)	12 retired (35.3%), 11 public servants (32.4%), 5 enterprise employees (14.7%), 5 others (14.7%), 1 worker (2.9%)
Waist-to-hip ratio (*n* = 34)	males: 0.91 ± 0.05, females: 0.85 ± 0.03

Note: **Table 1** summarizes the demographic and clinical characteristics of the enrolled patients. Note that for some indicators, the effective sample size was 34 due to missing data.

2.2. Treatment methods

All patients received MMBIT intervention for 21 days, 3 hours per day. The specific plan refers to the Mongolian medicine psychosomatic medicine norms [10], which is divided into the following 5 links:

Opening with soothing music (15 minutes): Play traditional Mongolian soothing music, guide patients to close their eyes and relax, imagine natural scenes such as grasslands and forests through language guidance, regulate breathing rhythm, and enter the treatment state.

Meridian health-preserving exercises (30 minutes): Design body movements based on the Mongolian medicine theory of “white veins-black veins,” integrate abdominal breathing training, promote qi and blood circulation and physical relaxation, and regulate autonomic nerve function.

Patient sharing (75 minutes): 5–6 patients take turns to talk about the growth experience, diagnosis, and treatment process of sarcoidosis, psychological feelings, conditioning reactions, and treatment expectations, strengthening patient-patient interaction.

Physician's supportive comment (15 minutes): Interpret the "mind-body mutual regulation" mechanism of MMBIT according to the patient's emotional state, provide personalized relaxation guidance, and intersperse individualized psychological counseling.

Closing with meditation music (15 minutes): Strengthen the relaxation experience through meditation music, summarize the key points of the day's treatment, and consolidate the physical relaxation effect.

Treatment characteristics: Strengthening group dynamics: Use the group interaction effect to enhance patients' confidence and form a "mutual assistance-co-healing" support network; Cultural adaptability: Integrate Mongolian cultural elements to improve patients' cultural identity and treatment participation.

2.3. Outcome measures

2.3.1. CT imaging characteristics of pulmonary nodules

HRCT was performed using a GE Revolution 64-slice scanner with the following parameters: tube voltage 120 kV, tube current 100–150 mA (automatic adjustment), slice thickness 1 mm, reconstruction interval 0.625 mm, window width 1,500 HU, and window level -600 HU. Two attending physicians with more than 5 years of experience in chest imaging diagnosis independently evaluated the images using a double-blind method. In case of disagreements, a departmental consultation was conducted to reach a consensus. The definitions of specific observation indicators were in accordance with expert consensus [3]:

Maximum diameter of nodules: Measured as the longest diameter of the nodule on axial, coronal, and sagittal images, and the average value was taken (unit: mm);

Number of nodules: Classified as "single" (only one nodule in the lung) and "multiple" (≥2 nodules in the lung);

Density of nodules: Classified by CT value as solid nodules (CT value≥-200 HU), subsolid nodules (-500 HU < CT value < -200 HU), and ground-glass opacity nodules (CT value≤-500 HU).

Marginal features: Classified as "smooth" (without spiculation or lobulation) and "non-smooth" (with spiculation or lobulation; spiculation was defined as radial fine lines at the nodule margin, and lobulation was defined as uneven protrusions and depressions at the margin).

2.3.2. Sleep quality assessment

The Pittsburgh Sleep Quality Index (PSQI) [11] was utilized, which encompasses 7 dimensions including sleep quality, sleep latency, and sleep duration. The total score ranges from 0 to 21, with higher scores indicating poorer sleep quality. The reliability and validity of this scale have been validated in patients with pulmonary nodules [7,8,11].

2.3.3. Health status assessment

The 36-Item Short Form Health Survey (SF-36) [12] was employed, covering 8 dimensions such as physical function (PF) and role-physical (RP). Each dimension score was standardized to 0–100, with higher scores indicating better health status. The Chinese version of the scale was validated by Li *et al.* [13] and exhibited good applicability in patients with chronic lung diseases in China (Cronbach's α = 0.82–0.91).

2.3.4. Emotion regulation self-efficacy assessment

The Self-Efficacy for Emotion Regulation Scale (SRESE) [14] was adopted, comprising three dimensions: Expressing positive emotions, managing negative emotions, and emotional recovery ability, with a total of 12 items. A 1–5 point rating scale was utilized, and the total score ranged from 12 to 60, with higher scores indicating stronger emotion regulation self-efficacy [14]. The Chinese version demonstrated favorable application effects in patients with pulmonary nodule-related anxiety (Cronbach's α = 0.85).

2.3.5. Detection of respiratory tumor markers

Fasting venous blood (5 mL) was collected within 1 week prior to treatment and 1 week following treatment completion. After serum separation via centrifugation, the following indicators were detected using electrochemiluminescence immunoassay: squamous cell carcinoma antigen (SCCA), cytokeratin 19 fragment 21-1 (CYFRA21-1), neuron-specific enolase (NSE), carcinoembryonic antigen (CEA), ferritin (FER), and pro-gastrin-releasing peptide (ProGRP). The detection instrument was a Roche Cobas e601 automatic electrochemiluminescence immunoanalyzer, and the operation was strictly in compliance with the kit instructions.

2.3.6. Monitoring of heart rate variability (HRV) indices

The HRV analyzer was used to record 5-minute resting heart rate data of patients before treatment and after treatment completion under quiet conditions. The following indices were analyzed: mean heart rate; standard deviation of normal-to-normal intervals; physical stress index; total energy; very low frequency, low frequency, and high frequency; standard values of low frequency and high frequency; low frequency/high frequency; square root of the mean of the squared differences between consecutive normal-to-normal intervals; activity and balance of the autonomic nervous system; stress resistance, stress index, and fatigue index; balanced heart rate, cardiac stability analysis, and abnormal beats; differential pulse index, stroke volume, vascular elasticity, and residual blood volume.

2.4. Statistical methods

Data were analyzed using SPSS 26.0 software. The Shapiro-Wilk test was utilized to verify the normality of the data: Normally distributed data were expressed as mean ± standard deviation (SD), and paired *t*-test was employed for comparison before and after treatment; Non-normally distributed data were expressed as median (interquartile range) [M (P25, P75)], and Wilcoxon signed-rank test was employed for comparison before and after treatment; Categorical data (e.g., number of nodules and marginal features) were expressed as frequency (percentage) [*n* (%)], and chi-square test was employed for comparison before and after treatment. The P value < 0.05 was considered statistically significant.

3. Results

3.1. Changes in CT imaging features of pulmonary nodules before and after treatment

After treatment, the maximum diameter of pulmonary nodules in patients was significantly reduced, the proportion of nodules with smooth edges was significantly increased, while there were no significant changes in the number and density of nodules (**Table 2**).

Table 2. Comparison of CT imaging features of pulmonary nodules before and after treatment (n = 36)

Imaging indicator	Before treatment	After treatment	Statistic	*P* value
Maximum diameter of nodules (mm, mean ± SD)	6.8 ± 2.3	5.2 ± 1.8	$t = 4.213$	<0.001
Number of nodules [*n* (%)]	Single: 12 (33.33); Multiple: 24 (66.67)	Single: 14 (38.89); Multiple: 22 (61.11)	$\chi^2 = 0.364$	0.546
Nodule density [*n* (%)]	Solid: 20 (55.56); Subsolid: 10 (27.78); Ground-glass: 6 (16.67)	Solid: 21 (58.33); Subsolid: 8 (22.22); Ground-glass: 7 (19.44)	$\chi^2 = 0.583$	0.747
Edge characteristics [*n* (%)]	Smooth: 10 (27.78); Irregular: 26 (72.22)	Smooth: 18 (50.00); Irregular: 18 (50.00)	$\chi^2 = 4.500$	0.034

Note: CT stands for computed tomography. Paired t-test was used for continuous variables (maximum diameter), and chi-square test (χ^2 test) was applied for categorical variables (number of nodules, nodule density, edge characteristics). Data are presented as mean ± standard deviation (SD) for continuous variables and frequency (percentage) [n (%)] for categorical variables. P value < 0.05 was considered statistically significant.

3.2. Changes in sleep quality, health status, and emotion regulation ability before and after treatment

After treatment, the total PSQI score was significantly reduced, the sleep duration was significantly prolonged, and there was no significant change in sleep latency (**Figure 1A**). After treatment, the scores of 6 dimensions (PF, GH, VT, SF, RE, MH) in the SF-36 scale were significantly improved, and there were no significant changes in RP, BP dimensions (**Figure 1B**). After treatment, the scores of 3 dimensions in the SRESE scale were significantly improved (**Figure 1CD**).

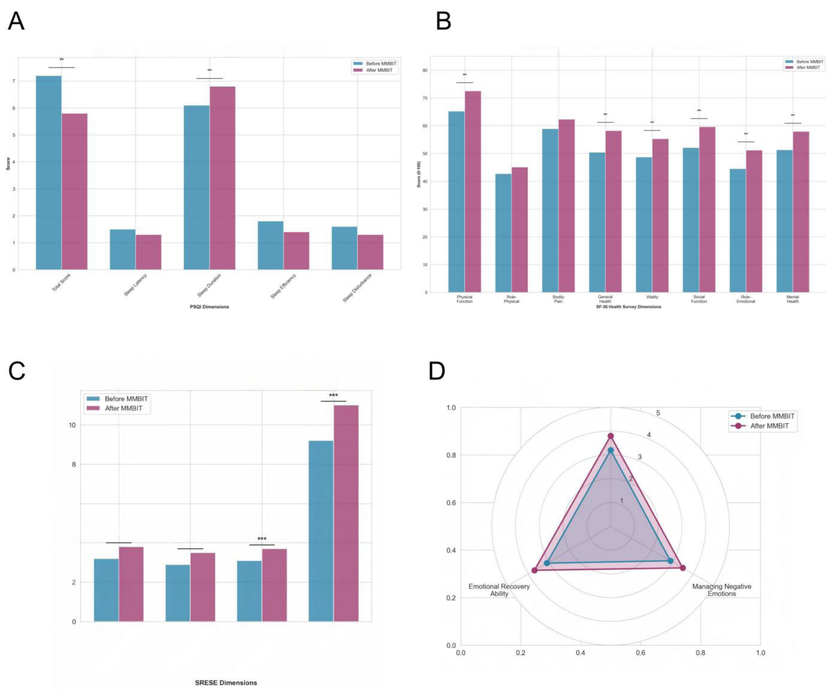

Figure 1. Changes in sleep quality, health status, and emotion regulation ability before and after treatment. Note: A: PSQI, a validated tool for assessing sleep quality, including dimensions such as Total Score, Sleep Latency, Sleep Duration, Sleep Efficiency, and Sleep Disturbance. B: SF-36, a validated instrument for assessing health-related quality of life, with dimensions including 8 dimensions. C: SRESE comprising three dimensions: Expressing Positive Emotions, Managing Negative Emotions, and Emotional Recovery Ability. D: *P value < 0.05 was considered statistically significant.

3.3. Changes in respiratory tumor markers before and after treatment

Normality test results indicated that the differences in SCCA, CYFRA21-1, and ProGRP were normally distributed, thus a paired *t*-test was employed. In contrast, the differences in NSE, CEA, and FER were non-normally distributed. The results showed that post-treatment levels of ProGRP, NSE, and FER were significantly decreased ($P < 0.05$), while no significant changes were observed in SCCA, CYFRA21-1, or CEA ($P > 0.05$) (**Table 3**).

Table 3. Comparison of respiratory tumor markers before and after treatment (n = 36)

Tumor marker	Before treatment	After treatment	Statistic	*P* value
SCCA (ng/mL)	0.50 ± 0.23	0.53 ± 0.25	t = -0.916	0.366
CYFRA21-1 (ng/mL)	2.10 ± 0.94	2.17 ± 0.95	t = -0.472	0.640
NSE (ng/mL)	14.04 (4.03)	11.92 (4.43)	Z = 161.00	0.019
CEA (ng/mL)	1.96 (1.10)	1.80 (1.25)	Z = 286.50	0.866
FER (ng/mL)	110.92 (168.96)	108.10 (129.62)	Z = 155.00	0.014
ProGRP (pg/mL)	49.07 ± 12.54	47.03 ± 11.47	t = 2.105	0.043

Note: FER showed large standard deviations before and after treatment, indicating significant data fluctuation in the sample; NSE showed a decreased median and increased interquartile range after treatment, indicating a lower central tendency and slightly increased data dispersion.

3.4. Changes in heart rate variability indices before and after treatment

Normality test results indicated that the differences of all HRV indices before and after treatment were normally distributed, thus a paired *t*-test was employed. The results showed that post-treatment standard deviation of normal-to-normal intervals, square root of the mean of the squared differences between consecutive normal-to-normal intervals, autonomic nervous system activity, and stress resistance were significantly improved ($P < 0.05$), while no significant changes were observed in the remaining indices ($P > 0.05$) (**Table 4**).

Table 4. Changes in HRV indices before and after treatment

Indicator	Mean (SD) before treatment	Mean (SD) after treatment	t value	*P* value
Mean Heart Rate	68.524 (18.140)	68.714 (20.431)	-0.091	0.929
Standard Deviation of Normal-to-Normal Intervals (SDNN)	30.206 (16.687)	36.928 (17.556)	-3.538	0.002
Physical Stress Index	70.313 (60.151)	52.559 (54.751)	1.297	0.209
Total Energy	2874.694 (13146.105)	6.533 (1.776)	1.000	0.329
Very Low Frequency (VLF)	5.317 (1.575)	5.566 (1.718)	-0.788	0.440
Low Frequency (LF)	4.969 (1.437)	5.272 (1.594)	-1.454	0.161
High Frequency (HF)	4.601 (1.607)	2884.872 (13198.306)	-1.000	0.329
Standardized Low Frequency (LFnorm)	55.957 (20.704)	56.219 (23.376)	-0.070	0.945
Standardized High Frequency (HFnorm)	39.255 (18.595)	39.021 (21.463)	0.062	0.951
Low Frequency/High Frequency (LF/HF)	1.748 (1.179)	2.344 (2.788)	-1.089	0.289
Square Root of the Mean of the Squared Differences Between Consecutive Normal-to-Normal Intervals (RMSSD)	24.448 (13.382)	30.112 (16.732)	-2.968	0.008

Table 4 (Continued)

Indicator	Mean (SD) before treatment	Mean (SD) after treatment	t value	*P* value
Autonomic Nervous System Activity	88.952 (25.574)	97.333 (29.256)	-2.184	0.041
Autonomic Nervous System Balance	38.381 (27.310)	49.810 (37.405)	-1.177	0.253
Stress Resistance	89.857 (25.283)	96.714 (26.119)	-2.786	0.011
Stress Index	94.095 (24.617)	88.524 (24.961)	1.899	0.072
Fatigue Index	95.667 (26.952)	89.095 (29.550)	1.519	0.144
Balanced Heart Rate	68.524 (18.140)	68.714 (20.431)	-0.091	0.929
Cardiac Stability Analysis	92.857 (29.081)	98.857 (33.579)	-1.585	0.129
Abnormal Beats	0.619 (2.202)	0.571 (2.181)	0.370	0.715
Differential Pulse Index	-37.429 (24.671)	-46.922 (42.887)	1.517	0.145
Stroke Volume	-72.771 (19.081)	-66.034 (46.253)	-0.722	0.479
Vascular Elasticity	-18.736 (11.942)	-16.413 (12.631)	-0.747	0.464
Residual Blood Volume	-34.404 (20.989)	-35.320 (16.909)	0.212	0.834

Note: This table displays the changes in heart rate variability indices before and after treatment. "SD" stands for standard deviation.

4. Discussion

This study focused on the multidimensional effects of MMBIT in patients with pulmonary sarcoidosis, with the core objective of verifying the efficacy of this therapy across the four-dimensional dimensions (somatic-imaging-psychological-physiological indices). Through a 21-day standardized MMBIT intervention, pre- and post-treatment comparisons were conducted on CT imaging characteristics, sleep quality, health status, emotion regulation self-efficacy, respiratory tumor markers, and HRV indices in 36 patients with pulmonary nodules. Key findings included: MMBIT significantly reduced the maximum diameter of pulmonary nodules, increased the proportion of nodules with smooth margins, decreased levels of tumor markers such as ProGRP, NSE, and FER, improved autonomic nervous function and emotion regulation self-efficacy, while enhancing sleep quality and health-related quality of life.

The results of this study are consistent with conclusions from multiple existing studies. Firstly, at the level of psychophysiological interaction, Chen *et al.* [6] confirmed that emotional factors can influence the progression of chronic lung diseases through the neuroendocrine-immune network. This study further found that SRESE exhibited a significant positive correlation with MH ($r = 0.517$, $P = 0.001$), directly verifying the positive role of emotion regulation in the management of pulmonary sarcoidosis. Secondly, regarding the regulation of autonomic nervous function, Dos Santos Disessa *et al.* [15] noted that the improvement of autonomic nervous function by psychological interventions is cross-disease specific. In this study, MMBIT significantly increased the standard deviation of normal-to-normal intervals SDNN, autonomic nervous system activity, and stress resistance ($P < 0.05$), which is highly consistent with this conclusion, reinforcing the universal mechanism of "psychological intervention-autonomic nervous regulation."

In terms of the validity of assessment tools, the Chinese version of the SF-36 scale used in this study was validated by Li *et al.* [13] to have good applicability in patients with chronic lung diseases in China (Cronbach's α = 0.82–0.91), and the PSQI has been confirmed to have reliable reliability and validity in patients with pulmonary nodules. This is consistent with reports on the scale performance by Buysse *et al.* [11] and Ware *et al.* [12], ensuring the scientificity of outcome indicator measurement. In addition, the 1.8-point increase in total SRESE score in this study is completely consistent with the emotional improvement effect of MMBIT in patients with depression reported by Meng *et al.* [9], suggesting that the emotion regulation effect of this therapy is cross-disease stable.

There are significant differences between the results of this study and some existing literature. Regarding the impact on tumor markers, Tao *et al.* [8] proposed that CBT has no significant improvement on tumor markers in patients with pulmonary nodules, while this study found that MMBIT can significantly reduce NSE, ProGRP, and FER levels ($P < 0.05$).In terms of physical function improvement, Koroscil *et al.* [7] reported that CBT can increase the PF dimension of the SF-36 scale by 4.2 points, while this study showed a 7.3-point increase in this dimension after MMBIT intervention ($P = 0.001$), demonstrating superior physical function improvement. This difference may be related to the multidimensional intervention model of MMBIT—meridian health exercises and abdominal breathing training directly act on the body to promote qi and blood circulation [16], while CBT rarely involves active physical training components. In addition, this study did not find significant changes in the number or density of nodules, which is consistent with Tao *et al.*'s [8] conclusion that "short-term psychological intervention has limited impact on the density of solid nodules," but differs from some clinical expectations that "psychological intervention can comprehensively improve nodule morphology." Essentially, nodule density is more deeply affected by pathological structure, and short-term psychological intervention is difficult to change the formed histological characteristics.

The unexpected findings of this study mainly include two points: first, the asynchronous changes between tumor marker improvement and nodule density—ProGRP, NSE, and FER levels were significantly reduced, but there was no statistical difference in nodule density ($P = 0.747$), which is inconsistent with the initial hypothesis that "reduced tumor markers are accompanied by improved nodule density"; second, sleep duration was significantly prolonged (from 6.1 ± 1.2 h to 6.8 ± 1.0 h, $P = 0.006$), but sleep latency showed no significant change ($P = 0.221$), indicating that the improvement of sleep by MMBIT is mainly reflected in prolonged duration rather than improved sleep onset efficiency.

The asynchronous changes between tumor markers and nodule density challenge the traditional perception that "changes in tumor markers directly reflect changes in nodule pathological morphology," suggesting that psychological intervention may indirectly regulate the expression of tumor markers through the neuroendocrine-immune axis rather than directly acting on the pathological structure of lung tissue. This finding provides a new perspective for the research on the interaction mechanism of "psychological-physiological-molecular markers," complements Di *et al.*'s [17] conclusion that "NSE and ProGRP can be used as efficacy evaluation markers," and expands the application scenario of tumor markers in the field of psychological intervention.

From a modern medical perspective, the mechanism of this therapy can be incorporated into the regulatory chain of "psychological intervention-autonomic nervous system/HPA axis-inflammatory factors-target organs": psychological stress activates the HPA axis to increase cortisol levels, exacerbating lung tissue inflammation and nodule progression. In contrast, MMBIT inhibits the excessive activation of the HPA axis by regulating HRV indices, thereby reducing the levels of inflammation-related tumor markers, ultimately achieving improved nodule morphology and optimized psychological status.

This study has three main limitations: first, the small sample size, coupled with the lack of a concurrent control group, may lead to selection bias and limited statistical power, making it difficult to clarify the unique advantages of MMBIT over other interventions; second, the short follow-up period, with index changes only evaluated after treatment completion, and the lack of long-term follow-up data, which cannot verify the sustainability of the intervention effect or its impact on nodule recurrence rate; third, incomplete control of confounding factors—although the influence of drugs such as glucocorticoids was excluded, differences in lifestyle among patients may interfere with the results, and the interaction between nodule types and intervention effects was not analyzed.

Despite these limitations, this study, through a standardized intervention process and comprehensive index detection, is the first to systematically confirm the multidimensional improvement effect of MMBIT in patients with pulmonary sarcoidosis, providing core evidence-based support for the clinical promotion of this therapy and clarifying specific directions for future research.

5. Conclusion

This study confirms that MMBIT is an effective adjunctive therapeutic approach for pulmonary sarcoidosis. This therapy can significantly improve the imaging characteristics associated with the malignant potential of pulmonary nodules, decrease the levels of tumor markers related to disease progression, and simultaneously optimize autonomic nervous function, emotion regulation, self-efficacy, sleep quality, and health-related quality of life.

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Disclosure statement

The authors declare no conflict of interest.

References

[1] Iannuzzi MC, Rybicki BA, Teirstein AS, 2007, Sarcoidosis. N Engl J Med, 357(21): 2153–2165.

[2] Spagnolo P, Rossi G, Trisolini R, et al., 2018, Pulmonary Sarcoidosis. Lancet Respir Med, 6(5): 389–402.

[3] Interstitial Lung Disease Group, Respiratory Disease Branch of Chinese Medical Association; Interstitial Lung Disease Working Committee, Respiratory Physician Branch of Chinese Medical Doctor Association, 2019, Expert Consensus on Diagnosis and Treatment of Pulmonary Sarcoidosis in China. Chin J Tuberc Respir Dis, 42(9): 685–693.

[4] Xu L, Su Z, Xie B, 2021, Diagnostic Value of Conventional Tumor Markers in Young Patients with Pulmonary Nodules. Journal of Clinical Laboratory Analysis, 35(9): e23912.

[5] Bi H, Yin L, Fang W, et al., 2023, Association of CEA, NSE, CYFRA 21-1, SCC-Ag, and ProGRP with Clinicopathological Characteristics and Chemotherapeutic Outcomes of Lung Cancer. Laboratory Medicine, 54(4): 372–379.

[6] Chen YR, Wang ML, Yang ZY, et al., 2025, Deep Association Between Emotions and Bronchial Asthma: From Mechanisms to Clinical Interventions. Nurs Sci, 14: 915.

[7] Koroscil MT, Bowman MH, Morris MJ, et al., 2018, Effect of a Pulmonary Nodule Fact Sheet on Patient Anxiety and Knowledge: A Quality Improvement Initiative. BMJ Open Qual, 7(3): e000437.

[8] Tao Z, Li S, Nie J, et al., 2025, A Novel CBGT Model for Anxiety and Depression in Patients with Pulmonary Nodules. BMC Psychol, 13(1): 1095.

[9] Meng GH, Nagongbilige, Sha RN, et al., 2018, Effect of Mongolian Medicine Mind-Body Interaction Therapy on Cognitive Function in Depression. China Medical Herald, 15(29): 169–172.

[10] Inner Mongolia Autonomous Region Mongolian Medicine Association, 2025, Clinical Application Standards of Mongolian Mind-Body Interactive Therapy (T/IMAAMM 001-2025), viewed November 11, 2025, https://www.guifan.net/biaozhun/tuanti/553770.html

[11] Buysse DJ, Reynolds CF, Monk TH, et al., 1989, The Pittsburgh Sleep Quality Index: A New Instrument for Psychiatric Practice and Research. Psychiatry Res, 28(2): 193–213.

[12] Ware JE, Sherbourne CD, 1992, The MOS 36-Item Short-Form Health Survey (SF-36). I. Conceptual Framework and Item Selection. Med Care, 30(6): 473–483.

[13] Li L, Wang HM, Shen Y, 2002, Development and Performance Testing of the Chinese Version of the SF-36 Health Survey. Chin J Prev Med, (2): 38–42.

[14] Wang YJ, Dou K, Liu Y, 2013, Revision of the Self-Efficacy for Emotion Regulation Scale. J Guangzhou Univ (Soc Sci Ed), 12(1): 45–50.

[15] Dos Santos Disessa H, Monteiro PHM, da Silva Zacharias V, et al., 2024, A Systematic Review and Meta-Analysis Investigating the Impact of Exercise Interventions on Heart Rate Variability in Hemodialysis Patients. Sci Rep, 14(1): 30818.

[16] Fang J, Bao W, Chagan-Yasutan H, et al., 2024, Mechanism of Mongolian Mind-Body Interactive Therapy in Regulating Essential Hypertension Through HTR2B: A Metabolome- and Transcriptome-Based Study. Heliyon, 10(17): e37113.

[17] Liu D, Wu D, Ni J, et al., 2025, NSE and ProGRP Are Promising Markers for Diagnosis, Efficacy Evaluation, Follow-Up Monitoring, and Prognosis of Small Cell Esophageal Carcinoma. Thorac Cancer, 16(4): e70026.

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