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REVIEW

The effect of music therapy on anxiety, depression, pain and sleep quality of lung cancer patients: a systematic review and meta-analysis

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Abstract

Purpose Music Therapy (MT) is reported to alleviate anxiety and depression in patients with lung cancer, but there is a lack of conclusive studies on the effects of MT. The purpose of this study is to explore the effects of MT on anxiety, depression, pain, sleep quality, and quality of life in lung cancer patients.

Methods We searched seven databases, such as PubMed, Embase, Web of Science, Cochrane Library, CNKI, China VIP, and WanFang from their inception to 31 December 2023. And we searched for Randomized Controlled Trials (RCTs) on the effects of MT on anxiety, depression, pain, and quality of life in lung cancer patients. The Cochrane Risk of Bias (ROB) tool assessed the quality of the included studies, while the GRADE system evaluated the evidence's certainty. Meta-analysis was conducted using RevMan 5.3 and Stata 18.0 software.

Results Our analysis comprised 16 trials, assessing 1991 patients. When compared to routine treatment, MT can significantly decrease the levels of anxiety (SMD = -1.43, 95% CI = -2.07 to -0.78, $P < 0.0001$), depression (SMD = -1.49, 95% CI = -1.91 to -1.07, $P < 0.00001$), pain (SMD = -1.58, 95% CI = -3.08 to -0.08, $P < 0.05$) and improve sleep quality (MD = -3.02, 95% CI = -4.47 to -1.57, $P < 0.0001$), quality of life (SMD = 1.50, 95% CI = 0.73 to 2.28, $P < 0.05$).

Conclusion MT can relieve anxiety, depression, pain, promote sleep and life quality in lung cancer patients. Meanwhile, engaging in MT for 30 min, 1 to 2 times per day, over a duration of 2 weeks to 3 months, could potentially alleviate anxiety more effectively.

Keywords Lung cancer · Music therapy · Anxiety · Depression · Pain · Systematic review

Introduction

Lung cancer is the second most commonly diagnosed cancer globally. This disease is diagnosed in more than 2 million people every year [1] and is the leading cause of cancer-related deaths. Lung cancer is often difficult to detect in its early stages. Consequently, most patients are clinically diagnosed at an advanced stage, which can cause significant anxiety [2]. The main treatments for lung cancer include chemotherapy and surgery, with both interventions adversely affecting patients' physical and psychosocial well-being [3, 4]. Psychological symptoms such as anxiety, nervousness, and poor sleep may occur in mild cases, whereas depression and suicidal risk may arise in severe cases [5, 6]. A study demonstrated that lung cancer was associated with severe depression, and when the scope of analysis was broadened to include symptoms of anxiety and depression, this proportion increased to 44% [7]. Anxiety in patients with lung cancer is not only a psychological issue, but it is also linked to disease progression. Moreover, severe cases of anxiety and depression can even lead to patient mortality [8]. Therefore, the impact of lung cancer on the physical and psychological well-being of patients should be addressed to alleviate anxiety and depression in this population.

Lung cancer is treated with surgery and chemotherapy, both of which have side effects [9]. Approximately 25% to 50% of lung cancer patients experience psychological issues following chemotherapy [4]. Postoperative pain and psychological trauma pose significant challenges for lung cancer patients, affecting their recovery and quality of life. Studies have shown that 15% to 40% cancer patients experience

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anxiety and depression during treatment [10]. Additionally, anxiety, depression and pain levels in patients with cancer continue to increase even after treatment [11]. This elevation in anxiety and depression can impair immune and endocrine functions, as well as reduce the patient's quality of life. Therefore, the impact of cancer on the physical and psychosocial needs of patients should be assessed to improve their quality of life. Furthermore, identifying an efficient complementary methodology to ameliorate pain and anxiety in patients with lung cancer is crucial for achieving long-term health outcomes.

Music Therapy (MT) is the clinical and evidence-based use of music interventions by a credentialed professional who has completed an approved music therapy program, with the aim of accomplishing individualized goals within a therapeutic relationship [12]. MT is highly recommended for patients with lung cancer who are undergoing any invasive clinical procedure [13], providing effective alleviation of the psychological problems associated with preoperative and postoperative surgical interventions. The application of music intervention in disease treatment has been reported in Western countries from the 18th to the nineteenth century with numerous clinicians considering it a valuable addition to their treatment methods [14]. Subsequently, MT has developed rapidly in the twentieth century and has become a widely used complementary treatment in developed countries such as the USA, the UK and Japan [15]. Currently, MT is considered an effective complementary treatment for alleviating psychosomatic illnesses [16]. MT has been employed to improve anxiety, depression and pain in patients [17]. This therapy has also rapidly gained popularity in China, with Western and the five elements theory of Traditional Chinese Medicine (TCM)-related MT approaches being utilized to treat patients with lung cancer. The five elements theory-based MT draws on the TCM theory of internal organs, which applies music to regulate qi flow and enhance psychological well-being. Patients with tumors who undergo TCM-based MT, which integrates the five organs, elements, and tones, effective regulation of emotions, optimal emotional well-being, alleviation of somatic symptoms, and enhancement of immune function [18]. And, personalized MT is the process by which music therapists facilitate patients to achieve their individualized goals within a therapeutic relationship. Thus, MT can alleviate depression and enhance life quality [19].

MT influences the physiological and psychological aspects of the human body by altering activity in brain areas rich in receptors related to anxiety, depression, and pain through neurotransmitters such as endogenous opioids [20], GABA [21], and dopamine [22]. Earlier research indicates that the pleasurable response to music may be mediated by endogenous opioid activity, while strong pleasurable responses are linked to dopamine release in the striatal system [23]. Additionally, music responses have been found to be linked to increased regional cerebral blood flow (rCBF) in the ventral striatum and dorsomedial midbrain, but decreased rCBF in the hippocampus and amygdala [24]. Although studies tentatively suggest that the role of endogenous opioids in the PAG may be influenced by oxytocin, this interaction remains largely unexplored [20]. Moreover, MT may mitigate stress in patients with cancer by reducing salivary cortisol levels [25]. All these evidence-based findings support that the efficacy of MT for pain, anxiety and depression. Thus, MT can enhance patient comfort and diminish pain and distress [26].

Several systematic reviews have shown that the Western approach-based MT and MT based on the five elements of TCM may alleviate anxiety and depression in patients with cancer [27, 28]. In contrast, other studies have reported that MT is ineffective in improving emotions and provides inconsistent pain relief in individuals with lung cancer [29]. Furthermore, the optimal duration of MT interventions for patients with lung cancer remains unclear. Therefore, our study, combines the findings from recently published randomized clinical trials with our research outcomes in terms of anxiety, depression, pain, sleep quality, and life quality to provide a more comprehensive evaluation of MT efficacy in patients with lung cancer. In this evaluation, we determined the optimal duration, frequency, and session length of MT interventions for patients' anxiety and depression, thereby establishing a reliable and robust evidence-based foundation for the effective application of MT in future clinical practices for patients with lung cancer.

Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) was adhered to in reporting this systematic review and meta-analysis. Subsequently, our review has been registered with PROSPERO (CRD42024483618).

Data sources and search strategy

A comprehensive search of seven electronic databases, including PubMed, Cochrane Library, Embase, Web of Science, China National Knowledge Infrastructure (CNKI), Wanfang, and China VIP, was conducted from their inception to December 31, 2023. The search strategies and methodologies are detailed below: ('music' OR 'music therapy' OR 'singing') AND ('lung cancer' OR 'tumor') AND ('negative emotions' OR 'anxiety' OR 'depression' OR 'pain' OR 'sleep quality'). For the full search algorithm, refer to the Supplementary Table.

Selection process

After eliminating duplicate documents, the studies were autonomously screened by two researchers (Li and Tao), using the literature management system Endnote Version X9. In the initial phase, they eliminated irrelevant articles based on the abstracts and titles. Using the criteria for inclusion and exclusion, two researchers autonomously examined the entire texts of the remaining research in the second phase. Any differences of opinion will be addressed and settled with Zhang, the third researcher.

Inclusion and exclusion criteria

In the analysis, we included RCTs evaluating MT as an intervention for individuals with lung cancer.

Inclusion criteria: (a) Participants: the patients diagnosed with lung cancer, including those hospitalized for chemotherapy, radiotherapy, or surgery, who are at least 18 years of age, and have a life expectancy of more than 3 months; (b) Interventions: the interventional group implemented MT, including music of Chinese Medicine, Personalized music based on standard care; (c) Comparison: the control group implemented usual treatment, such as usual care, supportive treatment, standard nursing, and regular treatment; (d) Outcomes: The following indicators were used to measure anxiety(Self-Rating Anxiety Scale, SAS; Numeric Visual Analog Anxiety Scale, NVAAS), depression (Self-Rating Depression Scale, SDS; Hamilton Depression Scale, HAMD), pain(Visual Analog Scale, VAS, Brief Pain Inventory, BPI), sleep quality(Pittsburgh Sleep Quality Index, PSQI) and life quality(FACT-G, EORTC QLQ-C30, FACT-L); (e) Type of studies: Randomized controlled trials.

Exclusion criteria: (a) Duplicate study reports; (b) Complete data not provided, including protocols, conference proceedings, and abstracts; (c) Multiple interventions of a study.

Data extraction

Relevant data was extracted by two researchers autonomously. The data below were retrieved from 16 individual pieces of literature using an Excel standardized spreadsheet: (a) Study and baseline characteristics: name of the first author, year published, country, sample size, age (mean age). (b) Intervention characteristics: intervention type, duration, single session, frequency. (c) Outcome: Primary outcome: anxiety, depression. Secondary outcomes: pain, sleep quality, quality of life. Means and standard deviation values for the outcome markers of both the intervention group and the routine care group were recorded at the end of the intervention. When the included studies reported only differences in outcome indicators, we used the baseline and change data to calculate the endpoint values.

Risk of bias and quality assessment

In this study, we utilized a risk of bias analysis to evaluate the methodology and quality of the included literature by employing the risk of bias criteria provided by the Cochrane Collaboration and the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system to determine the certainty of the evidence. Two evaluators independently extracted information and judged the overall risk of bias based on the most frequently cited risks across seven categories.

Data synthesis

This meta-analysis was conducted using RevMan version 5.3 and Stata 18.0 software. In cases where the reviewed literature utilized varied instruments to measure the same parameter, the results were combined using the standardized mean difference (SMD) and 95% confidence interval (CI). A p-value of < 0.05 in the combined results was considered statistically significant. Additionally, heterogeneity was investigated using I-squared (I^2), where $I^2 \geq 50\%$ indicated heterogeneity. Random or fixed-effects models were applied in these heterogeneity tests. Sensitivity analysis was also conducted to evaluate the robustness of the results after excluding any individual study. Finally, funnel plots were used to evaluate publication bias.

Results

Study selection

The literature selection is displayed in Fig. 1. Following the identifying of 926 relevant research, 499 of the studies had to be removed due to duplication. While 427 studies' titles and abstracts were examined, 362 were found to be ineligible because the inclusion criteria were not satisfied. After retrieving the whole texts of the remaining 65 literature for a closer inspection, 49 items were eliminated from the study. Ultimately, 16 RCTs—4 English literature and 12 Chinese literature—suited our requirements for inclusion.

Study characteristics

In total, we included 16 studies. A total of 1991 patients were evaluated, with 990 in the routine care group and 1001 in the MT intervention group. The single treatment time of median was 30 min (range 30 to 60 min). In addition, the median duration was 2 weeks to 3 months (range 1 week to 3 months), and the median frequency was 2 times per day (range 1 to 3 times per day). For detailed features of the works of literature and interventions, see Table 1.

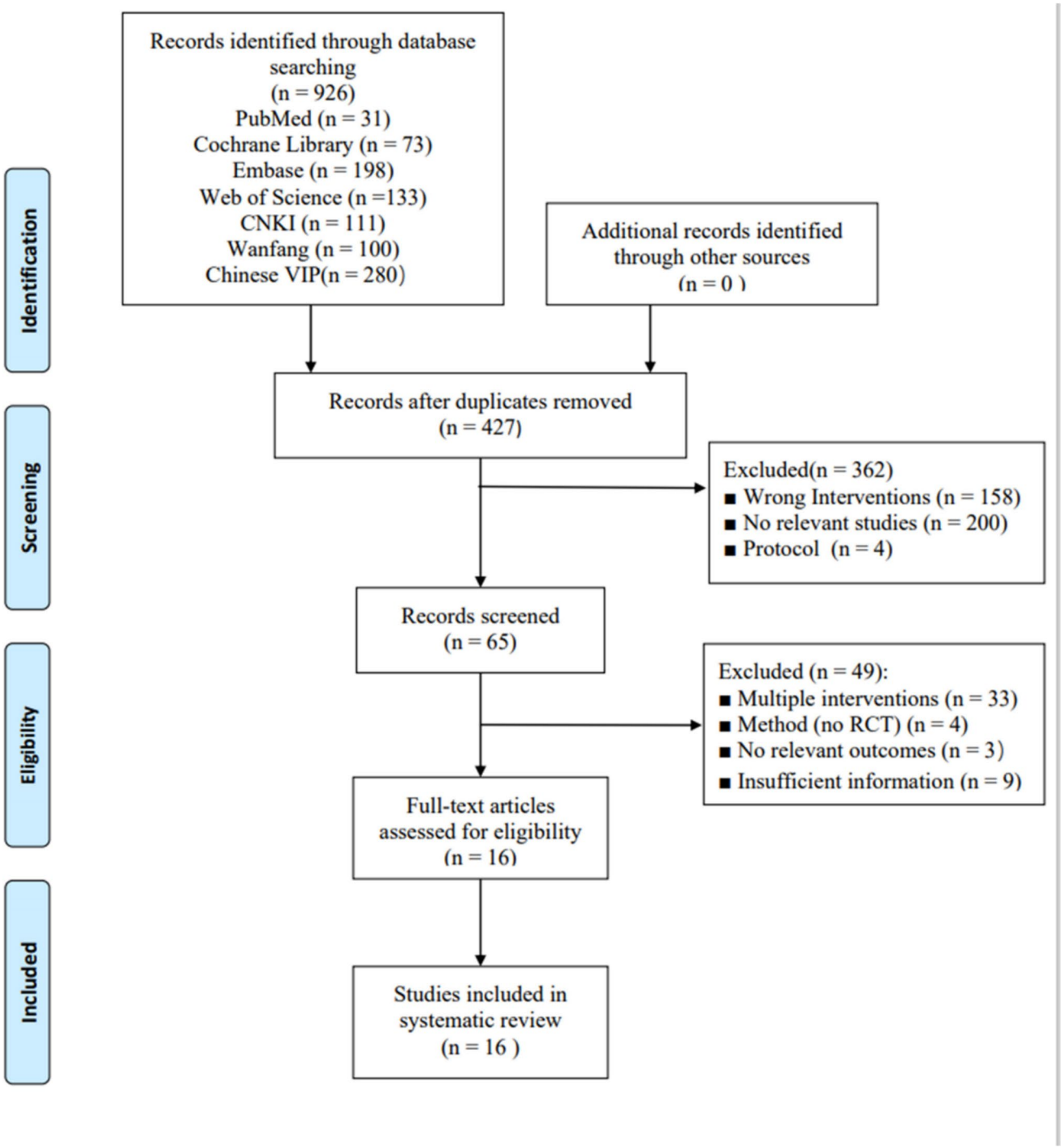

Fig. 1 PRISMA flow diagram of included studies in the review and meta-analysis

Risk of bias and quality assessment in studies

The risk of bias evaluation for the 16 papers is below. The evaluation of the random sequence generation analysis (Fig. 2) reported that over 75% (12/16) of the studies described a low risk. There was a high risk of bias in outcome assessment blinding by 6 trials [30–35], and 14 trials [30, 32, 34–45] had a high risk of bias in terms of the following blinding of participants. 4 trials [35, 37, 41, 45] described methods of distribution concealment using sealed opaque envelopes, and 4 trials [30, 38–40] were high-risk in their selective data reporting. No other bias was found in 11 trials [30, 32, 34–37, 39, 40, 42, 44, 46].

Table 1 Characteristic information

Study/Year	Country	Age	Sample size	Gender(M/F)	Type of intervention	Intervention group	Control group	Frequency, duration of intervention	Outcomes and scales
Zhang et al.(2017)	China	**C**:67.46 ± 7.64 **I**: 66.95 ± 7.38	23/23	**I**: = 14/9 C: = 15/8	Chemotherapy or Surgery (Hospitalized patients)	Personalized music with standard care (Hospital implementation)	Standard care	**Frequency**: 2x per day for 60 min **Duration**: 2 months	Pain(VAS)
Sha et al.(2013)	China	**C**:55.69 ± 7.94 **I**:56.48 ± 8.81	107/112	**I**: = 71/36 **C**: = 75/37	Surgery (Hospitalized patients)	Personalized music with standard care (Hospital implementation)	Standard care	**Frequency**: 2x per day for 60 min **Duration**: 1 week	Sleep quality(PSQI) Pain(BPI)
Jiang et al.(2015)	China	**C**:55.9 ± 7.9 **I**:56.5 ± 8.8	112/116	**I**: = 74/38 **C**: = 77/39	Surgery (Hospitalized patients)	Personalized music with standard care (Hospital implementation)	Standard care	**Frequency**: 2x per day for 60 min **Duration**: 3 months	Anxiety(SAS) Depression(SDS) Sleep quality(PSQI)
Cao et al.(2015)	China	**C**:36–75 **I**:36–72	27/30	**I**: = 17/10 **C**: = 19/11	Chemotherapy (Hospitalized patients)	Five-elements music with standard care (Hospital implementation)	Standard care	**Frequency**: 2x per day for 30 min **Duration**: 4 weeks	Sleep quality(PSQI)
Hu et al.(2022)	China	**C**:61.44 ± 5.45 **I**:60.84 ± 5.39	50/50	**I**: = 32/18 **C**: = 30/20	Chemotherapy (Hospitalized patients)	Five-elements music with standard care (Hospital implementation)	Standard care	**Frequency**: 2x per day for 30 min **Duration**: 3 months	Anxiety(SAS) Depression(SDS) Quality of life(EQRTC QLQ-C30)
Deng et al.(2011)	China	31–76	39/39	59/19	Chemotherapy or Surgery (Hospitalized patients)	Music therapy with routine treatment (Hospital implementation)	Routine treatment	**Frequency**: 2x per day for 60 min **Duration**: 10 days	Anxiety(SAS) Depression(SDS)
Wang et al.(2006)	China	**C**:55.0 ± 11.9 **I**:58.22 ± 12.8	20\10	**I**: = 15/5 **C**: = 7/3	Surgery (Hospitalized patients)	Music therapy with standard care (Hospital implementation)	Standard care	**Frequency**: 2x per day for 30 min **Duration**: 1 week	Anxiety(SAS) Depression(SDS)
Liu et al.(2013)	China	**C**:M 59 **I**:M 60	44/42	**I**: = 28/16 **C**: = 25/17	Surgery (Hospitalized patients)	Five-elements music with routine treatment (Hospital implementation)	Routine treatment	**Frequency**: 1x per day for 30 min **Duration**: 2 weeks	Anxiety(SAS) Depression(SDS)
Sun et al.(2015)	China	57.65 ± 11.35	47/43	62/28	Chemotherapy (Hospitalized patients)	Five-elements music with routine treatment (Hospital implementation)	Routine treatment	**Frequency**: 3x per day for 60 min **Duration**: 2 weeks	Anxiety(SAS) Depression(SDS) Sleep quality(PSQI)

Table 1 (continued)

Study/Year	Country	Age	Sample size	Gender(M/F)	Type of intervention	Intervention group	Control group	Frequency, duration of intervention	Outcomes and scales
Lin et al.(2018)	China	C:56.78 ± 5.34 I:56.99 ± 5.56	34/33	I: = 20/14 C: = 19/14	Surgery (Hospitalized patients)	Personalized music with standard care (Hospital implementation)	Standard care	**Frequency**: 2x per day for 30 min **Duration**: 1 week	Sleep quality(PSQI)
Lin et al.(2012)	China	**C**:68.90 ± 9.52 **I**:67.52 ± 8.35	58/60	**I**: = 34/24 **C**: = 38/22	Surgery (Hospitalized patients)	Five-elements music with standard care (Hospital implementation)	Standard care	**Frequency**: 1x per day for 30 min **Duration**: 1 week	Anxiety(SAS) Depression(SDS)
Liu et al.(2019)	China	**C**:M 58.1 **I**:M 58.7	44/44	**I**: = 17/27 **C**: = 16/28	Chemotherapy or Surgery (Hospitalized patients)	Five-elements music with standard care (Hospital implementation)	Standard care	**Frequency**: 1x per day for 30 min **Duration**: 4 weeks	Depression(HAMD) Sleep quality(PSQI)
Duan et al.(2023)	China	**C**:65.70 ± 8.905 **I**:66.10 ± 8.890	80/73	**I**: = 70/10 **C**: = 63/10	Chemotherapy or Surgery (Hospitalized patients)	Music therapy with routine nursing care (Hospital implementation)	Routine nursing care	**Frequency**:30 min **Duration**: 3 months	Anxiety(SAS) Quality of life(FACT-G)
Mou et al.(2020)	China	**C**:57.63 ± 10.38 **I**:56.99 ± 9.84	150/150	**I**: = 119/31 **C**: = 122/28	Chemotherapy (Hospitalized patients)	Passive music with standard care (Hospital implementation)	Standard care	**Frequency**: 2x per day for 30 min **Duration**: —	Anxiety(NVAAS)
Tang et al.(2021)	China	**C**:54.28 ± 5.18 **I**:54.28 ± 5.59	50/50	**I**: = 31/19 **C**: = 30/20	Surgery (Hospitalized patients)	Six steps to music with routine treatment (Hospital implementation)	Routine treatment	**Frequency**: 2x per day for 30 min **Duration**: 5 days	Anxiety(SAS) Pain(VAS) Sleep quality(PSQI)
Du et al.(2020)	China	**C**:66.89 ± 8.42 **I**:67.26 ± 6.69	116/115	—	Chemotherapy (Hospitalized patients)	Vocal music therapy with routine treatment (Hospital implementation)	Routine treatment	**Frequency**: Online:1x per day for 30 min Offline: 1x per week for 30 min **Duration**: 12 months	Quality of life(FACT-L)

Note: *I,* Intervention group; *C,* Control group; *SAS,* Self-Rating Anxiety Scale; *NVAAS,* Numeric Visual Analog Anxiety Scale; *SDS,* Self-Rating Depression Scale; *HAMD,* Hamilton Depression; *VAS,* Visual analog scale; *BPI,* Brief Pain Inventory; *PSQI,* Pittsburgh Sleep Quality Index; *EORTC QLQ-C30,* European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30; *FACT-L,* Functional Assessment of Cancer Therapy-Lung; *FACT-G,* Functional Assessment of General

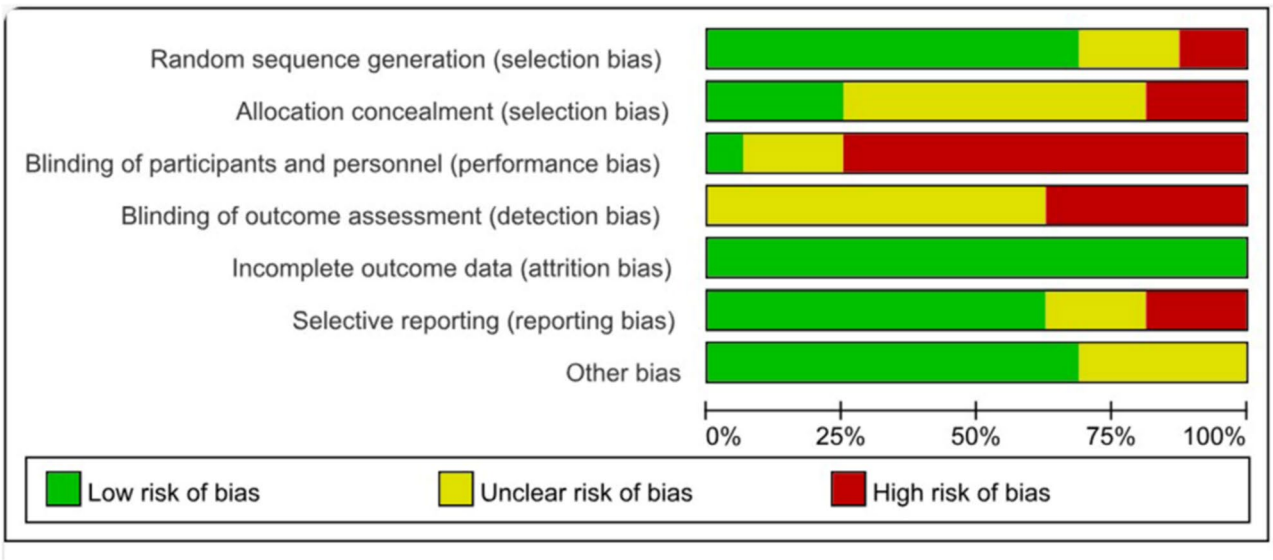

Fig. 2 Risk of bias graph for included studies (n = 16)

Quality assessment using the GRADE criteria revealed that most studies were of low quality. This was due to the lack of blinding, small participant numbers, and high heterogeneity. Consequently, the quality of evidence was low across all analysis, with no separate categorization of subgroups (Table 2).

Results of syntheses

Anxiety

Ten trials [32, 34–36, 38, 41, 43, 45–47], covering 1283 patients, assessed the efficacy of MT for treating anxiety in individuals with lung cancer. Our meta-analysis results (Fig. 3) reported MT significantly reduced the anxiety levels of lung cancer patients (SMD = −1.43, 95% CI = −2.07 to −0.78, $P < 0.0001$, $I^2 = 96\%$).

Depression

Eight trials [34, 36, 38, 40, 43, 46, 47], covering 818 patients assessed the efficacy of MT as a therapeutic method for depression in individuals with lung cancer. According to the outcomes of our meta-analysis (Fig. 4), there was a remarkable combined influence on how depression changes in patients with lung cancer (SMD = −1.49, 95% CI = −1.91 to −1.07, $P < 0.00001$, $I^2 = 85\%$).

Sleep quality

Seven trials [30, 34, 35, 38–40, 42] covering 721 patients, estimated the efficacy of MT as a therapeutic method for improving sleep quality in individuals with lung cancer. Our results revealed that the MT significantly enhances sleep quality among individuals with lung cancer. (Fig. 5) (MD = −3.02, 95% CI = −4.47 to −1.57, $P < 0.0001$, $I^2 = 97\%$).

Pain

Three trials [35, 42, 44] covering 365 patients, estimated the efficacy of MT as a therapeutic method for pain in individuals with lung cancer. It showed that there was a significant effect of MT on reducing pain in patients (Fig. 6) (SMD = −1.58, 95% CI = −3.08 to −0.08, $P < 0.05$, $I^2 = 97\%$).

Overall QoL

Two trials [38, 45], covering 253 patients, evaluated changes in overall quality of life scores post-MT. Our study (Fig. 7) showed a significant influence on promoting the life quality for individuals affected by lung cancer (SMD = 1.50, 95% CI = 0.73 to 2.28, $P < 0.05$, $I^2 = 86\%$).

Sensitivity analysis and publication bias

Because of the insufficient number of studies, we only discussed the funnel plot of anxiety, shown in Fig. 8. We excluded any single study from the sensitivity analysis, which confirmed the stability of the combined results across these studies. Meanwhile, the results of the Egger's test indicated that our findings were not affected by publication bias. Materials were presented in the Supplementary Table.

Table 2 GRADE analysis

		Certainty Assessment				Certainty Assessment	No. of patients			Effect	Certainty
	Study Design	Risk Of Bias	Inconsistency	Indirectness	Imprecision	Other Considerations	Extraction	None-Extraction	Relative	Absolute	
Anxiety	10RCTs	serious[a]	not serious[b]	serious[c]	not serious[d]	none[e]	650	663	-	SMD 1.43 lower (2.07 to 0.78 lower)	LOW
Depression	8RCTs	serious[f]	not serious[b]	serious[c]	not serious[d]	none[e]	414	404	-	SMD 1.49 lower (1.91 to 1.07 lower)	LOW
Pain	3RCTs	serious[g]	not serious[b]	serious[c]	serious[h]	none[e]	180	185	-	SMD 1.58 lower (3.08 to 0.08 lower)	VERY LOW
Sleep quality	7RCTs	serious[i]	not serious[b]	serious[c]	not serious[d]	none[e]	359	362	-	MD 3.02 lower (4.47 to 1.57 lower)	LOW
Quality of Life	2RCTs	serious[j]	not serious[b]	not serious	very serious[k]	none[4]	130	123	-	SMD 1.5 higher (0.73 to 2.28 higher)	VERY LOW

Note: [a]Nine studies were randomized correctly without blinding and allocation concealment and one study correctly randomized the method and assigned the concealment scheme without blinding. [b]A random effects model was used; Confidence intervals overlap. [c]Different age pooled on the same estimate without a subgroup analysis for adults or the elderly. [d]Larger sample size, narrower confidence intervals. [e]No risk of publication bias as different sources were searched. [f]Eight studies were randomized correctly, without blinding and allocation concealment. [g]Three studies were randomized correctly, without blinding and allocation concealment. [h]Smaller sample size, wider confidence intervals. [i]Seven studies were randomized correctly, without blinding and allocation concealment. [j]Two studies were randomized correctly, without blinding and allocation concealment. [k]Large differences in populations; Smaller sample size, wider confidence intervals

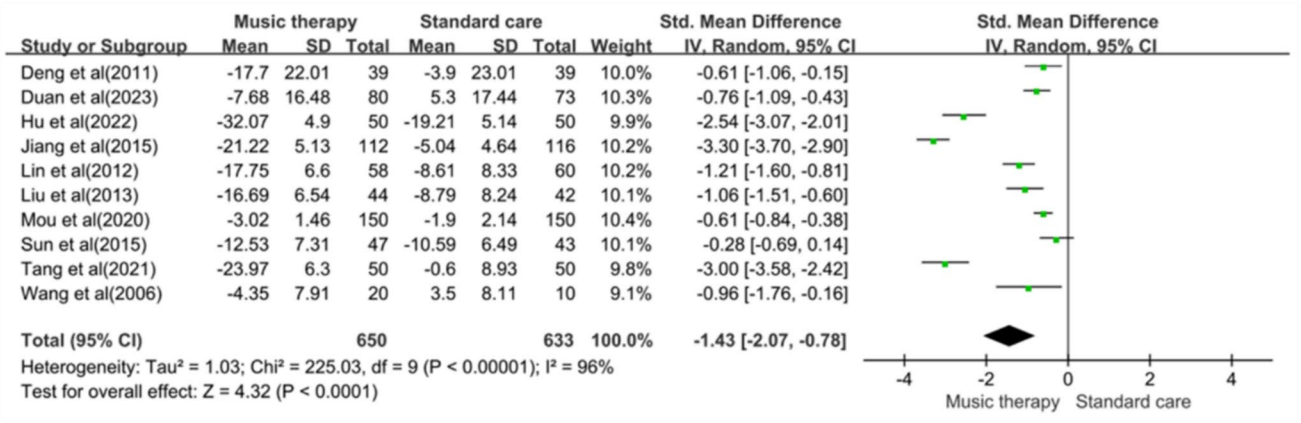

Fig. 3 Effect sizes forest plots for music therapy on the anxiety of patients with lung cancer

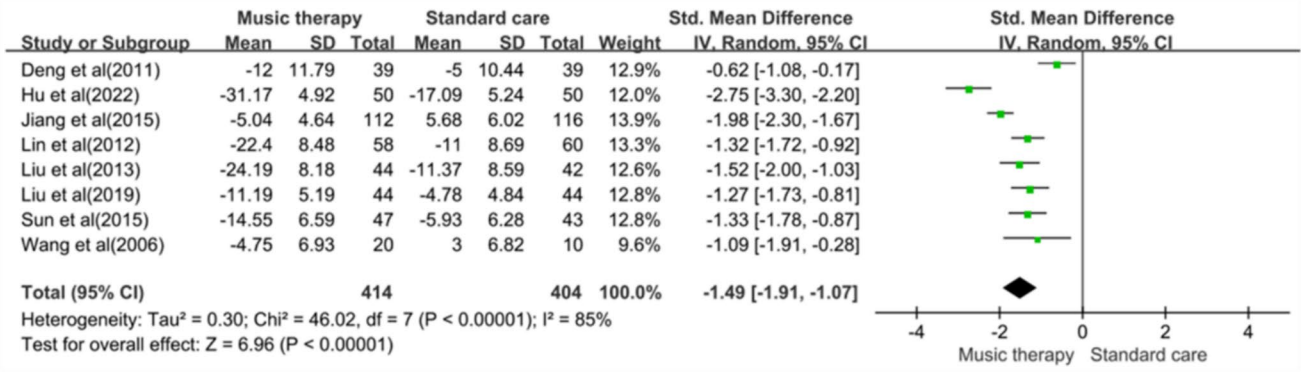

Fig. 4 Effect sizes forest plots for music therapy on the depression of patients with lung cancer

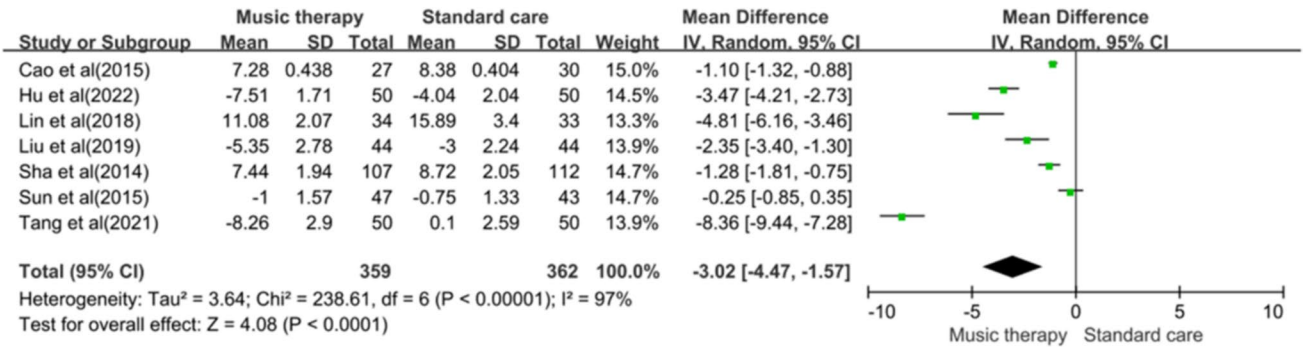

Fig. 5 Effect sizes forest plots for music therapy on the sleep quality of patients with lung cancer

Subgroup analysis

Anxiety

Duration The subgroup analysis based on the duration of MT intervention mainly, included 10 trials [32, 34–36, 38, 41, 43, 45–47], covering 1283 patients, and reporting the length of time for MT intervention. Our subgroup analysis (Fig. 9) showed that there was a significant influence only when the intervention duration was the 2 weeks to 3 months (SMD = −2.02, 95% CI = −3.14 to −0.91, $P = 0.0004$, $I^2 = 96\%$).

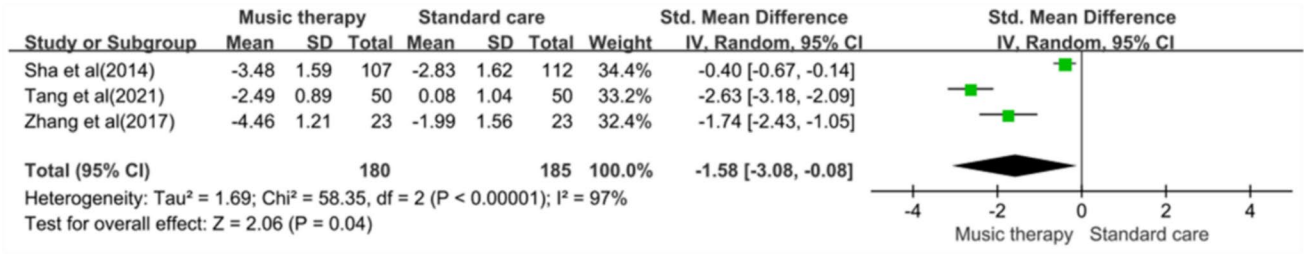

Fig. 6 Effect sizes forest plots for music therapy on the pain of patients with lung cancer

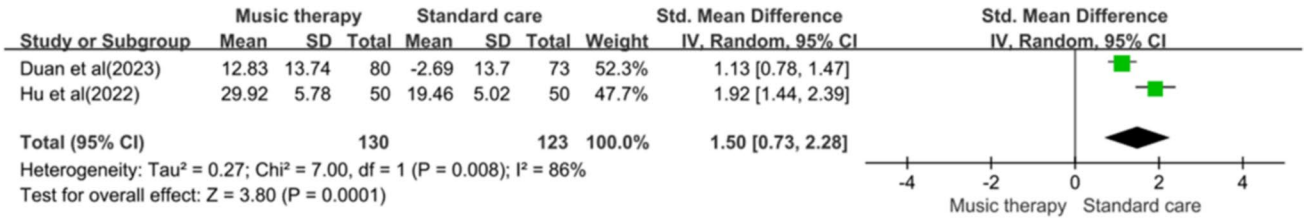

Fig. 7 Effect sizes forest plots for music therapy on the Overall QoL of patients with lung cancer

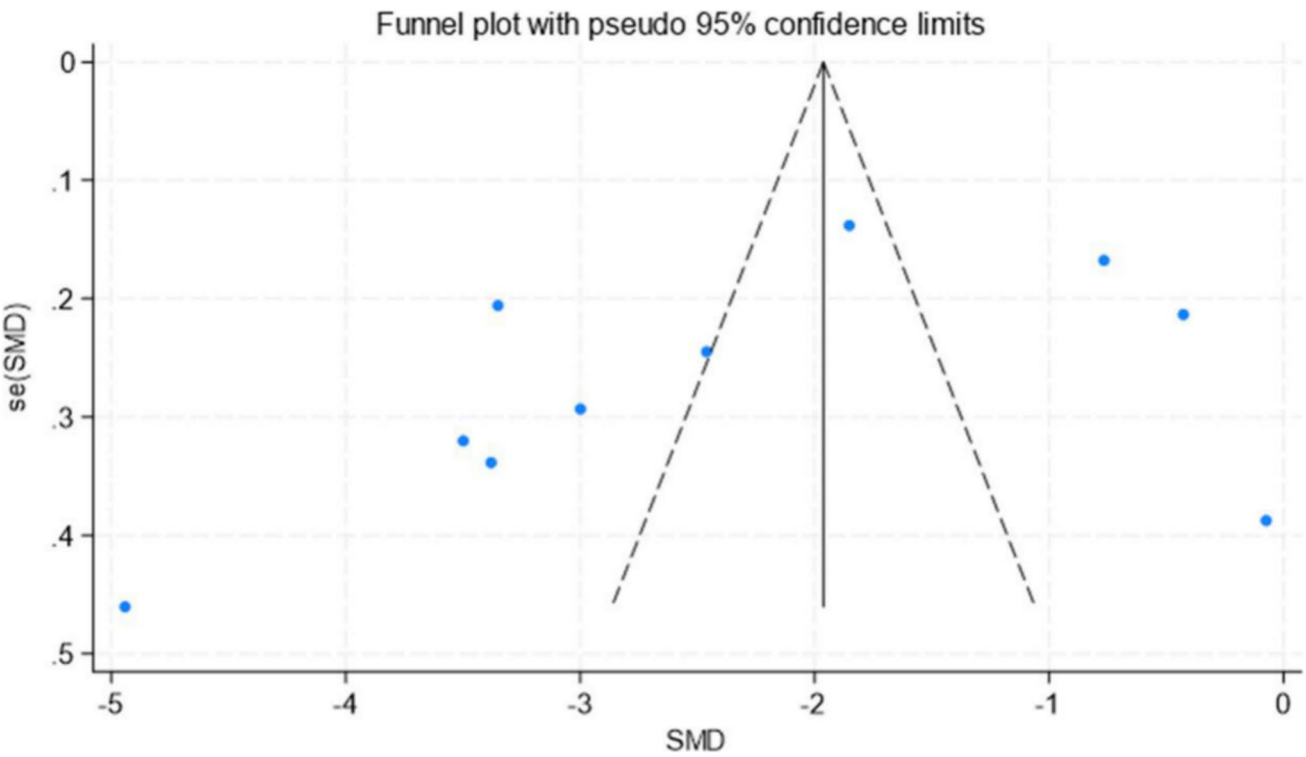

Fig. 8 The funnel plot of anxiety

Single times 10 studies reported a single session of MT in individuals with lung cancer. The results (Fig. 10) showed that only when the single intervention time was 30 min, there was a significant pooled efficacy in associating with routine care and the interventional groups (SMD = −1.28, 95% CI = −1.84 to −0.72, $P < 0.00001$, $I^2 = 93\%$).

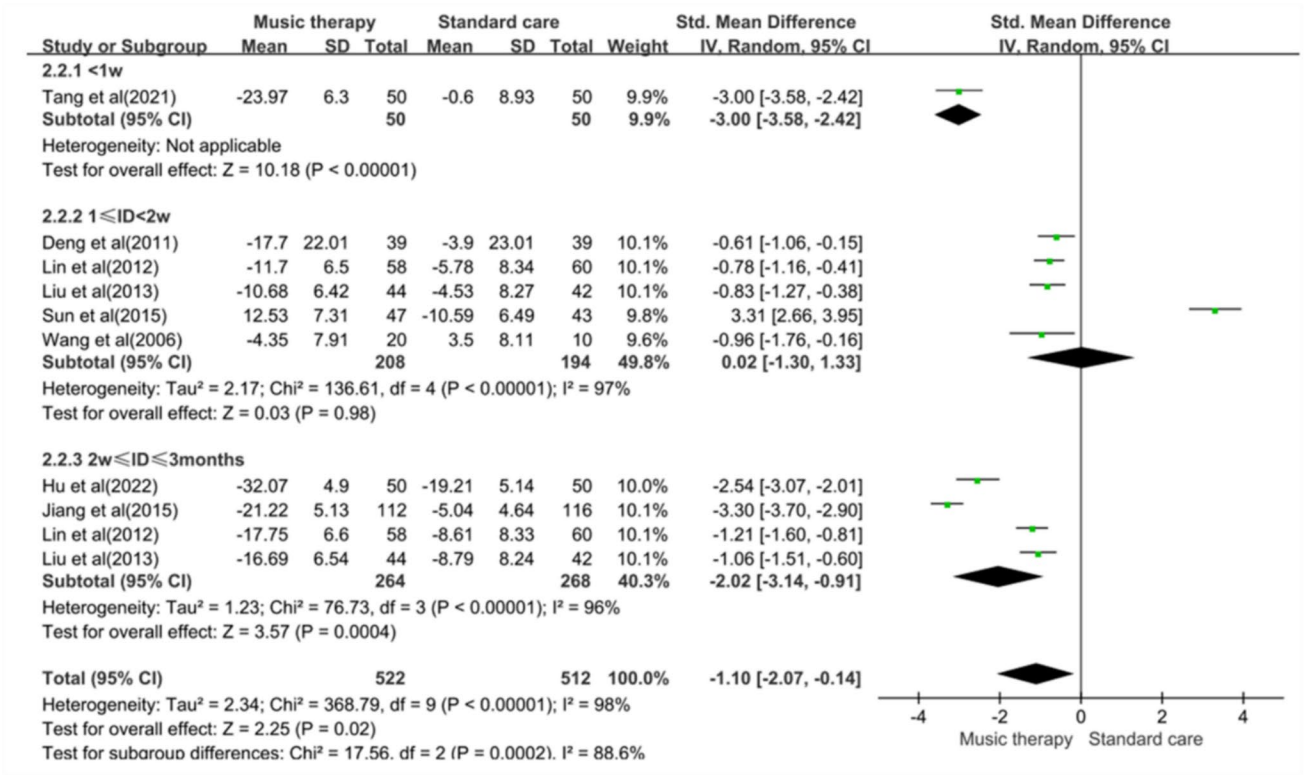

Fig. 9 Effect sizes forest plots for music therapy of different durations on anxiety of patients with lung cancer

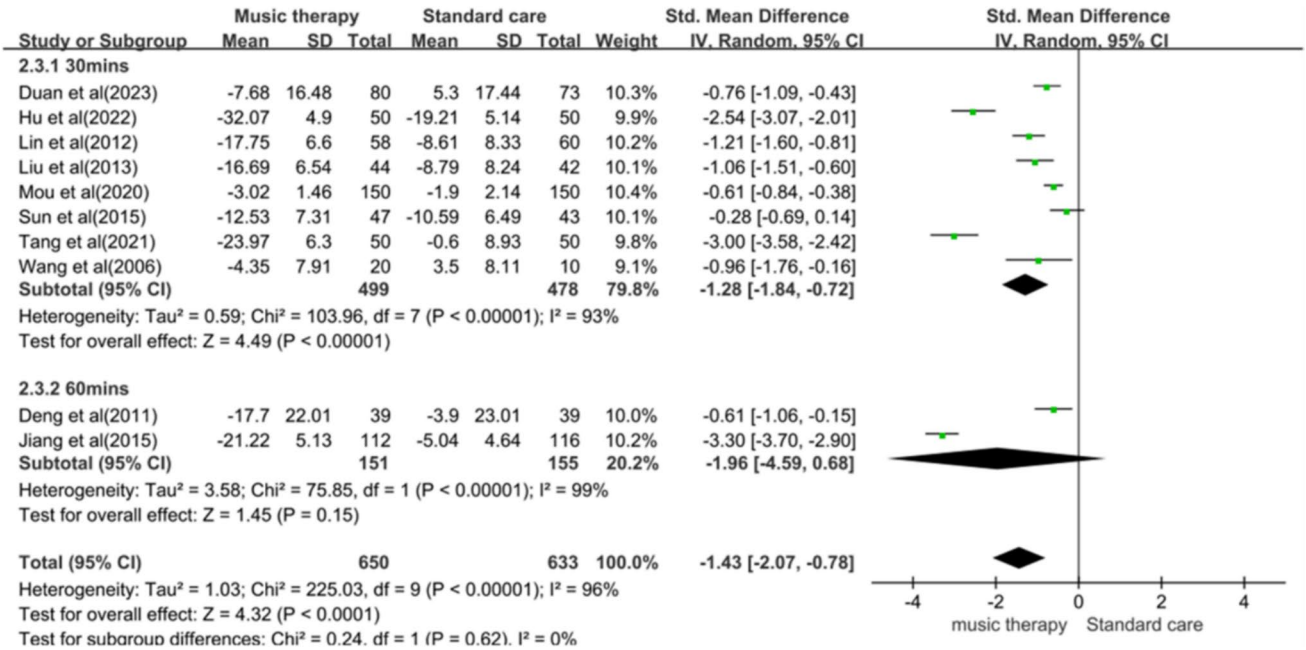

Fig. 10 Forest plot of effect size of different single music therapy sessions on anxiety in lung cancer patients

Frequency A subgroup analysis of different times of intervention on anxiety in patients with lung cancer (Fig. 11) reported that there was a remarkable impact in associating with routine care and the interventional groups when MT was performed on lung cancer patients once a day and twice a day (SMD = −1.14, 95% CI = −1.44 to −0.84, $P < 0.00001$,

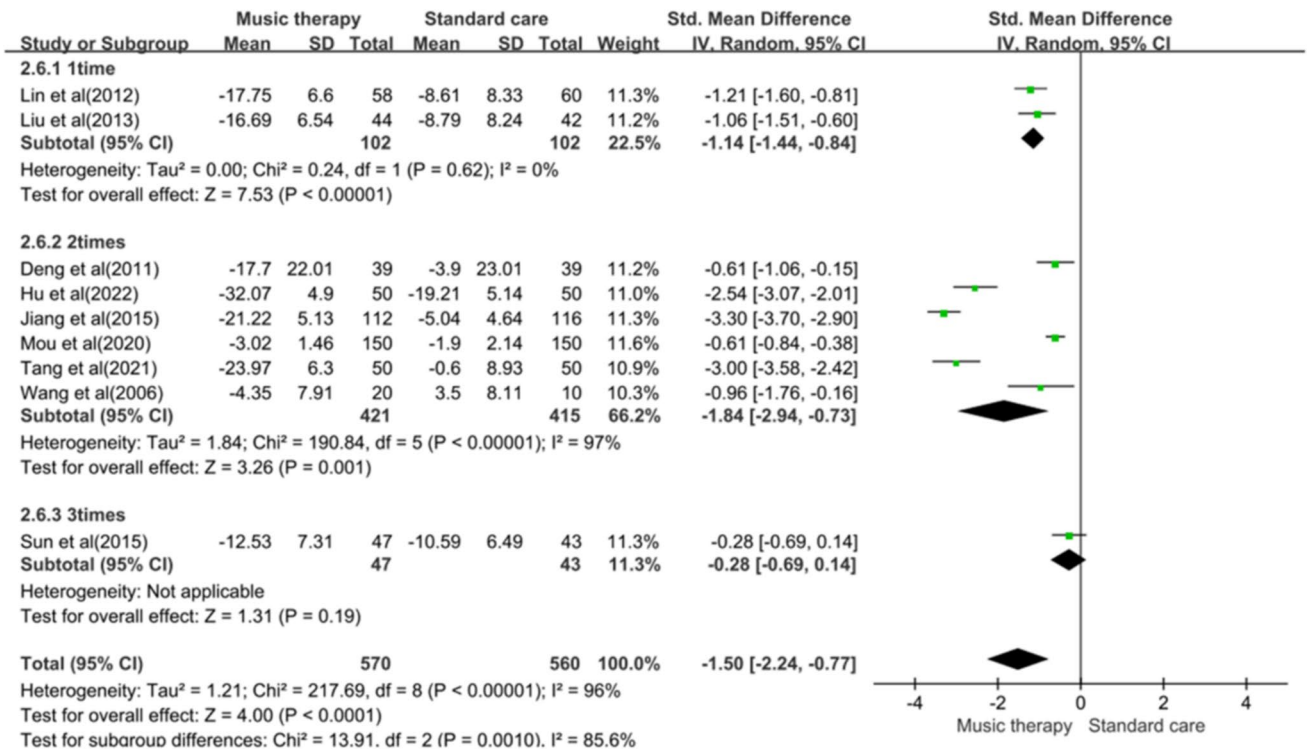

Fig. 11 Forest plot of effect size of different frequency music therapy on anxiety in lung cancer patients

$I^2 = 0\%$), (SMD = −1.84, 95% CI = −2.94 to −0.73, $P < 0.05$, $I^2 = 97\%$).

Periods A subgroup analysis of music intervention on different states of anxiety in individuals with lung cancer during the cancer period (Fig. 12) showed that in the chemotherapy period (SMD = −1.74, 95% CI = −2.92 to −0.56, $P < 0.05$, $I^2 = 96\%$), perioperative period (SMD = −1.84, 95% CI = −3.14 to −0.26, $P < 0.05$, $I^2 = 97\%$), cancer period (SMD = −0.71, 95% CI = −0.98 to −0.44, $P < 0.00001$, $I^2 = 0\%$), peripheral catheterization period, there was a remarkable efficacy in associating with routine care and the interventional groups (SMD = −0.61, 95% CI −0.84 to −0.38, $P < 0.00001$, $I^2 = 96\%$).

Depression

Duration The subgroup analysis (Fig. 13) derived from the duration of MT intervention mainly included eight trials [34, 36, 38, 40, 43, 46, 47], covering 818 patients and reporting the length of time for MT intervention. The results (Table 3) showed that when the intervention duration were 1 week to 2 weeks and 2 weeks to 3 months, there was a remarkable efficacy in associating with routine care and the interventional groups (SMD = −1.28, 95% CI = −1.69 to −0.87, $P < 0.00001$, $I^2 = 70\%$), (SMD = −1.75, 95% CI = −2.23 to −1.28, $P < 0.00001$, $I^2 = 84\%$).

Single times A subgroup analysis of different durations for a single MT session (Fig. 14) indicated that only when the session lasted 30 min was there a significant pooled efficacy among the routine care and intervention groups (SMD = −1.55, 95% CI = −1.99 to −1.11, $P < 0.00001$, $I^2 = 78\%$).

Frequency and periods A subgroup analysis of different intervention frequencies for depression in patients with lung cancer (Fig. 15) revealed that MT administered once, twice, or three times daily significantly impacted lung cancer patients. Subgroup analysis of MT interventions for varying degrees of depression in individuals with lung cancer showed significant effects between routine care and intervention groups, particularly during chemotherapy, perioperative periods, and throughout the cancer journey (Fig. 16).

Discussion

A sum total of 16 RCTs in this research, which covered 1991 patients to evaluate the efficacy of MT on anxiety, depression, pain, sleep quality, and life quality in individuals with lung cancer. The combined results showed that MT can alleviate anxiety, depression, pain and promote sleep quality and quality of life. Compared with currently published literature, our study expands on a large number of studies

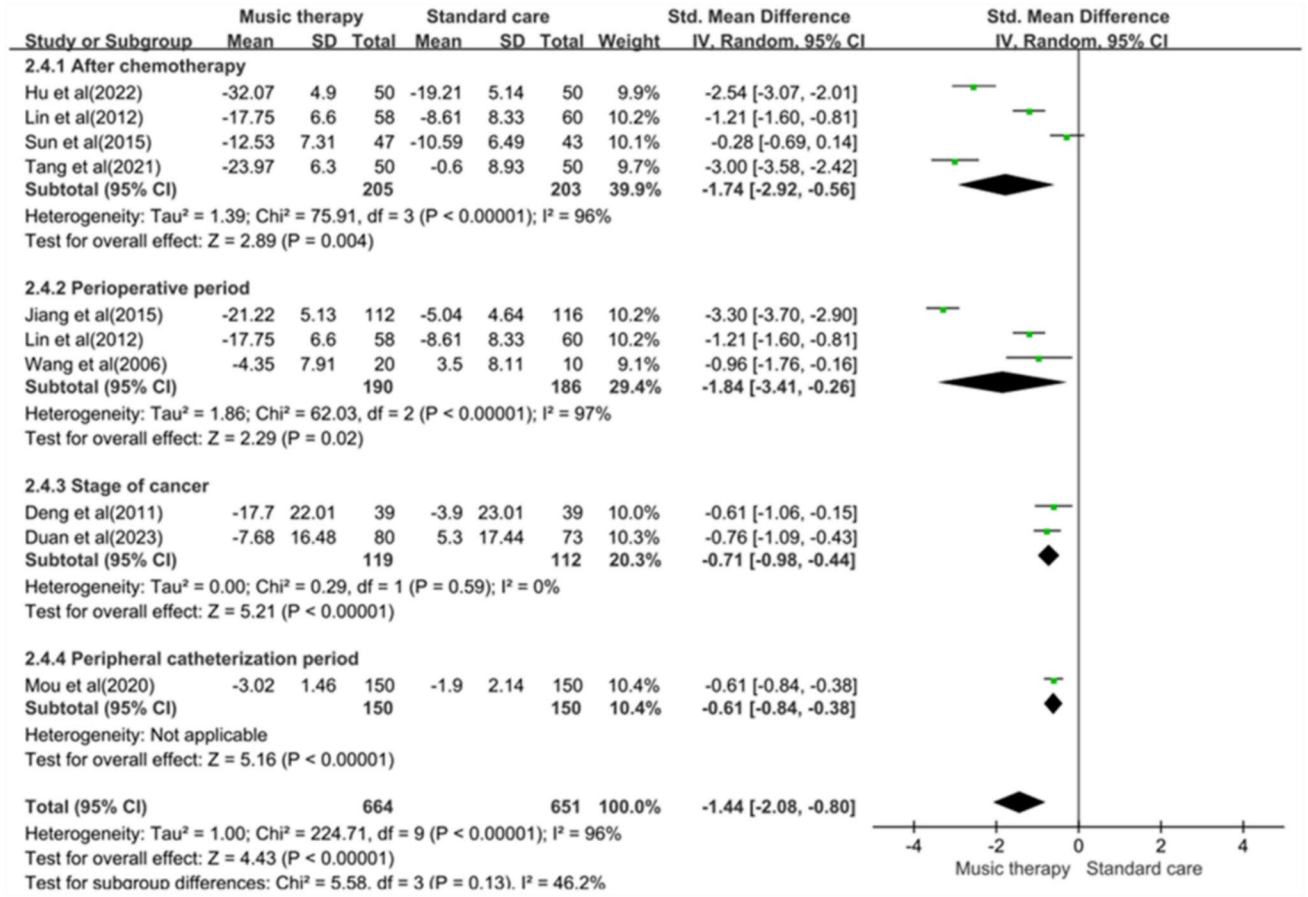

Fig. 12 Effect sizes forest plots for music therapy of different periods on anxiety of patients with lung cancer

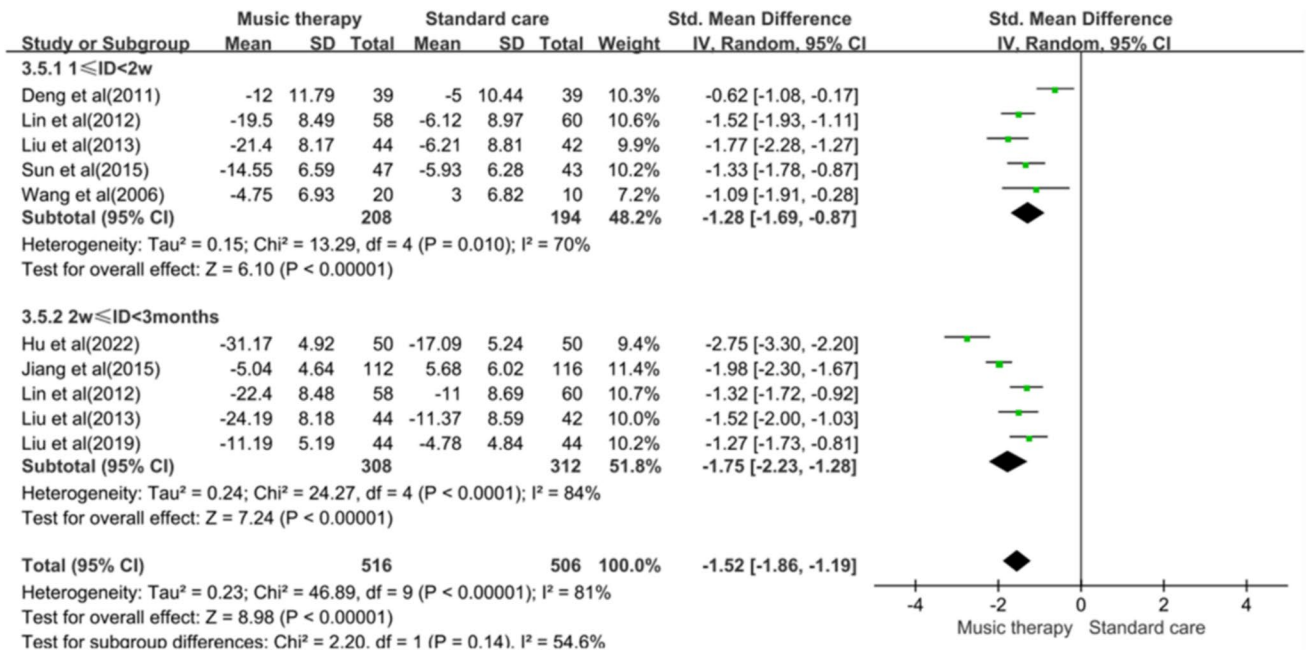

Fig. 13 Effect sizes forest plots for music therapy of different durations on depression of patients with lung cancer

Table 3 Results of meta-analysis

Subgroups		Include studies	Effect model	95%CI	*P*-Value	I^2%
Duration	1w ≤ ID < 2w	5	Random	−1.28(−1.69, −0.87)	< 0.00001#	70
	2w ≤ ID < 3 m	5	Random	−1.75(−2.23, −1.28)	< 0.00001#	84
Frequency	1time per day	2	Random	−1.40(−1.71, −1.09)	< 0.00001#	0
	2times per day	4	Random	−1.62(−2.53, −0.72)	0.0004#	93
	3times per day	2	Random	−1.30(−1.62, −0.97)	< 0.00001#	0
Single times	30 min	6	Random	−1.55(−1.99, −1.11)	< 0.00001#	78
	60 min	2	Random	−1.31(−2.65, 0.02)	0.05*	96
Periods	chemotherapy period	3	Random	−1.78(−2.63, 0.93)	< 0.0001#	90
	Perioperative period	3	Random	−1.53(−2.09, −0.97)	< 0.00001#	77
	Stage of cancer	2	Random	−0.94(−1.57, −0.31)	0.003#	74

Note: ID: Intervention Duration; w:week or weeks; m: months;*: $P = 0.05$, No statistically significant difference; #: $P < 0.05$, Statistically significant difference

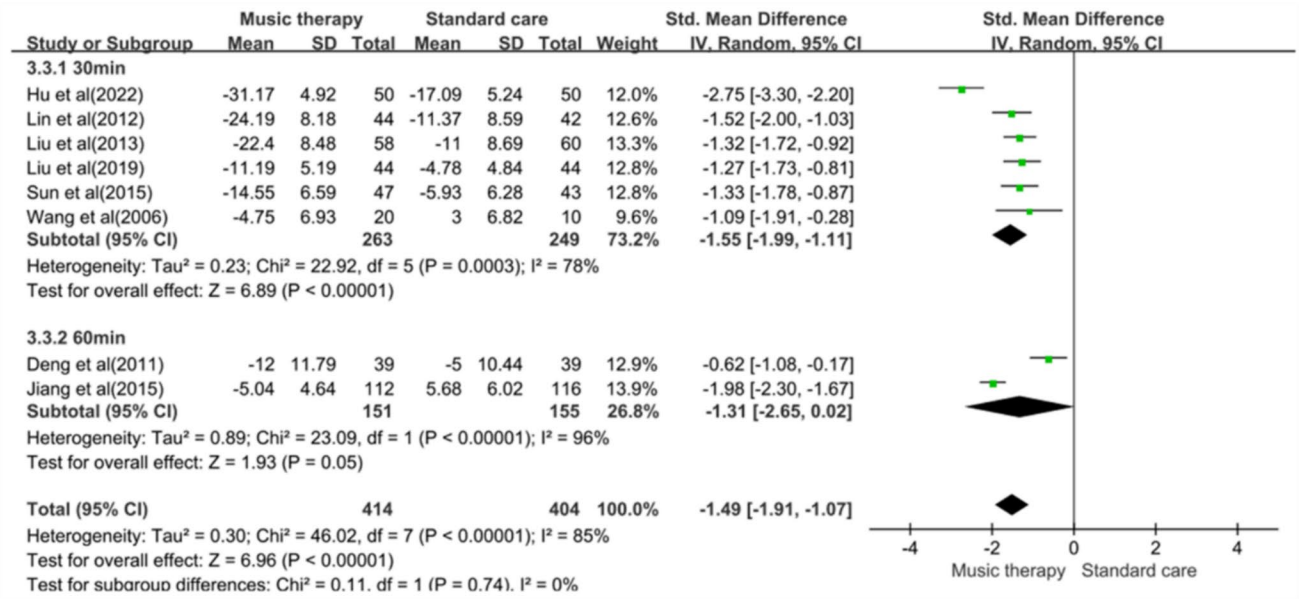

Fig. 14 Forest plot of effect size of different single music therapy sessions on depression in lung cancer patients

and thorough subgroup analysis to explore the optimal intervention time, single session, and frequency of MT in the therapeutic management of anxiety and depression in patients with lung cancer. Our study aims to provide a basis for MT as an adjuvant therapeutic method for patients with lung cancer in the future.

Our study showed that MT significantly improved anxiety and depression in individuals with lung cancer, a finding that is consistent with our results [48]. The effects of MT are associated with the physiology and psychology of the human body. This therapy utilizes rhythms and sounds to stimulate the production of certain endogenous substances, which alleviate negative psychological states, including tension, anxiety, and depression, triggered by psychological and social factors and enhance stress resilience [49]. Furthermore, personalized MT integrates the therapist's guidance with the patient's individual preferences and goals to facilitate a collaborative session, thereby effectively improving anxiety and depression [12]. TCM emphasizes the unity of body and spirit, as well as the harmony and unity between humans and nature, and between individuals and society, aligning with the "bio-psycho-social model" of modern Western medicine [50]. The five elements-based MT affects the rhythm of physiological fluctuation in the body through the rhythm of external music sound vibrations, thus reducing the anxiety and depression of patients with lung cancer [51].

Our results of subgroup analysis suggested that MT for 2 weeks to 3 months may be a better alternative for

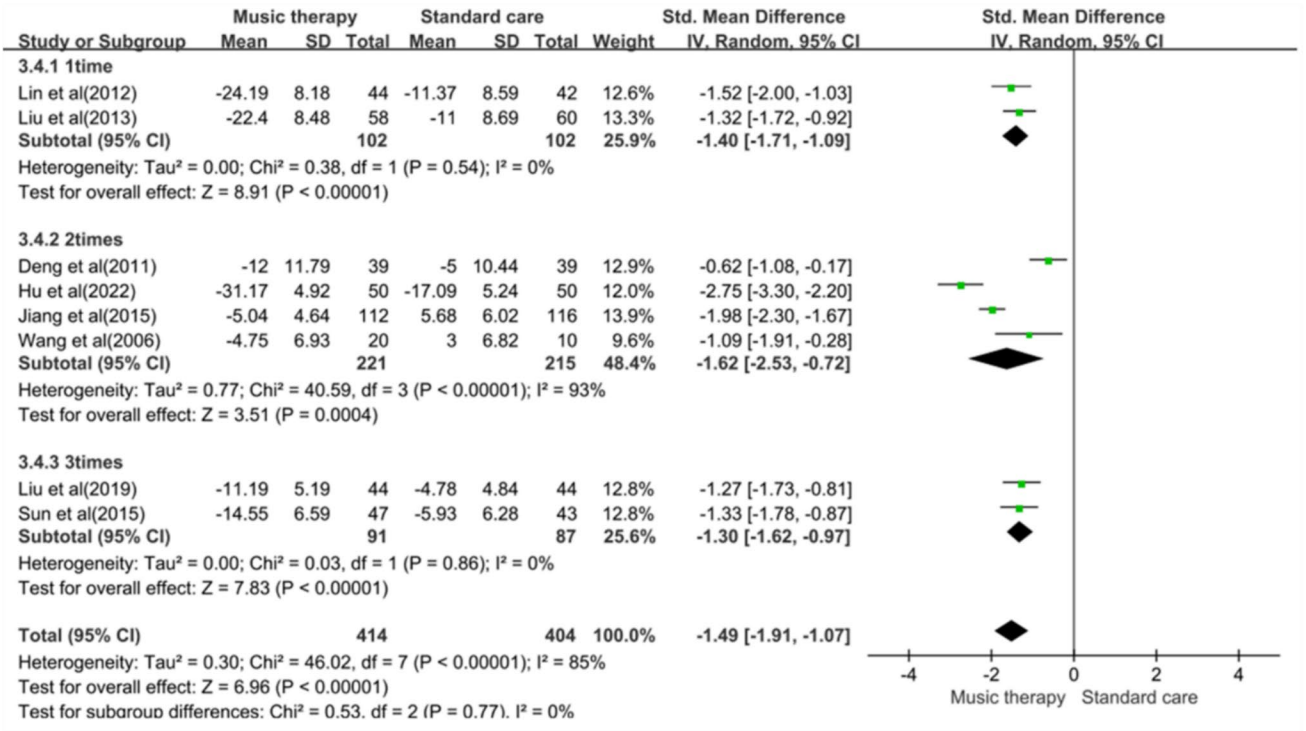

Fig. 15 Forest plot of effect size of different frequency music therapy on depression in lung cancer patients

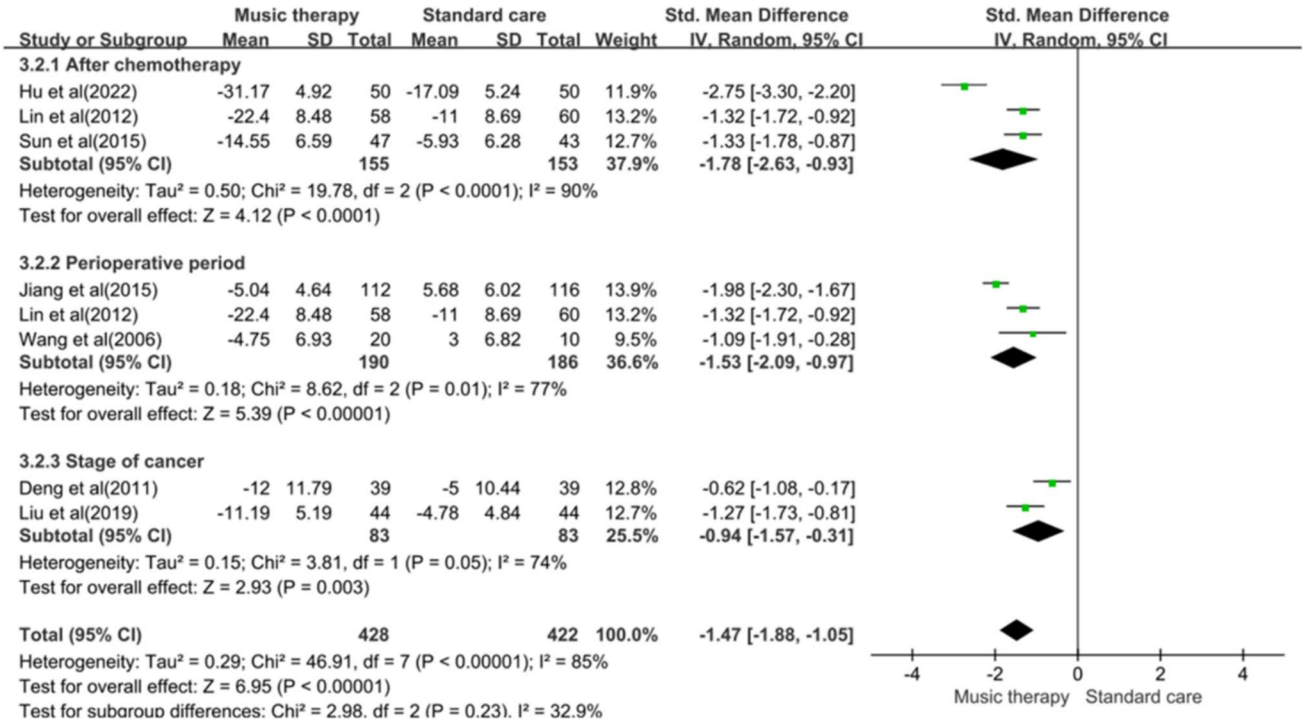

Fig. 16 Effect sizes forest plots for music therapy of different periods on depression of patients with lung cancer

managing anxiety in patients with lung cancer. Furthermore, practicing MT 1 to 2 times a day for 30 min each session is an intervention program that is easy to accept for individuals with lung cancer and has a positive effect on

anxiety. Researchers have shown that [52], endorphins are released after 20–30 min of exercise, usually within 20 min. However, the excessive secretion of endorphins can cause fatigue, while prolonged euphoria may induce insomnia and other adverse reactions. These outcomes indicate that the frequency and duration of MT interventions should be regulated, but the timing mechanism of endorphin release in MT has not been elaborated. Hence, based on the mechanism of endorphin release in exercise and our study results of an intervention time of 30 min, was suggested to effectively improve anxiety [53, 54]. In summary, our research results align with both theory and practice, offering practical insights for therapeutic approaches in patients with lung cancer.

Patients with lung cancer also frequently experience severe depression, which can affect the therapeutic methods, hinder recovery, and decrease quality of life [10]. However, reliable evidence supporting the implementation of MT for chronic and persistent psychological disorders such as depression is still lacking [8]. Our study results demonstrated that MT could improve depression in patients with lung cancer, consistent with the findings of Li et al [55]. Additionally, MT exhibited a similar therapeutic mechanism for anxiety and depressive symptoms in patients with lung cancer by promoting the release of neurotransmitters (e.g., dopamine) in the brain. The depressive state of patients is more effectively addressed via the pleasurable effects of the MT mechanism, which potentially augments its therapeutic effectiveness on depression.

Pain is strongly related to negative emotions, sleep, and quality of life in individuals with lung cancer [56], highlighting that relieving pain in this patient population is a crucial issue. The results of the present study revealed that MT could palliate pain in patients with lung cancer. Moreover, pleasurable auditory stimulation through music has been suggested to inhibit pain transmission in the center nervous system, ultimately achieving analgesic effects and improving pain tolerance [57]. However, several factors can affect postoperative pain; therefore, the efficacy of MT for postoperative pain still needs further in-depth research. Furthermore, we did not conduct a subgroup analysis because of an insufficient volume of evidence. Thus, additional research exploring this topic is essential in the future.

It is also particularly significant to pay attention to the impact of MT on sleep quality and life quality in individuals with lung cancer. The present study summarized the efficacy of applying MT on sleep and quality of life in lung cancer patients, with an effective outcome. The study by Li et al. [55] reported that MT improves sleep and life quality for lung cancer patients. A decline in sleep quality is known to have a serious impact on the psychological condition, physical recovery, and quality of life of patients [58]. However, relatively fewer studies have been conducted on the sleep quality of patients with lung cancer who undergo MT. In light of the current study findings, future research can be expanded to provide a basis for the systematic therapeutic application of MT in patients with lung cancer.

Limitation and prospects

Our article has three limitations. One of the potential sources of bias in the present study was that despite our comprehensive search of Chinese and international databases for the most relevant studies, some noteworthy original trials might have been omitted from our analysis. Moreover, related bias might have occurred because the full text of a study (such as ongoing studies, conference proceedings, and abstracts) was not available or some articles were published in languages other than Chinese or English. Regional bias might have also occurred because all the studies in this meta-analysis utilized single-center data from the Chinese population. Furthermore, our study results should be cautiously interpreted because the analyzed studies contained a risk of bias.

The current study did not explore the objective indicators of the effects of MT on patients with lung cancer. Additionally, we observed that no studies had summarized MT efficacy in patients with lung cancer across different age groups and genders. Hence, future large-sample studies should assess the objective indicators of MT efficacy in patients with lung cancer according to age and gender stratification. The refinement of the evaluation indexes of MT and the comparison of treatment efficacy across various population characteristics may assist researchers in optimizing MT effectiveness and further reducing the disease burden of this patient group.

Conclusion

MT is an effective complementary therapy that can improve anxiety, depression, pain, sleep quality, and quality of life in individuals who experienced cancer of the lung. Significantly, we found that the best intervention time to improve anxiety in patients is 2 weeks to 3 months, 1 to 2 times per day, 30 min each time; the best time to improve depression is 1 week to 3 months, 1 to 3 times per day, 30 min each time. However, future research also requires long-term clinical trials with larger samples to prove more precise conclusions. Moreover, in-depth research is needed to enhance communication between music therapists and patients, ultimately ensuring that the MT approach is scientific and that the objectivity of the MT effect is maintained.

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Author contribution Yang Li: Conceptualization, Methodology, Software, Writing-Original Draft, Investigation Yanmin Tao: Writing-Revie &Editing, Data Curation Hongyan, Wang: Funding acquisition Zhifei Wen: Writing-Revie &Editing Shuyang Ji: Writing-Revie &Editing Linfeng Liu: Funding acquisition Xiangeng Zhang: Supervision, Project administration, Writing-Revie &Editing.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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