Literature Review

Preferences For Pulmonary Exercises In Lung Cancer Patient: A Systematic Review

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Abstract

Lung cancer survivors often experience persistent physical limitations after treatment. Recent evidence indicates that structured exercise after lung cancer treatment is safe and beneficial, improving cardiorespiratory fitness, muscle strength, symptom control, and psychosocial well-being. However, exercise remains underutilized in post-treatment care, highlighting the need to strengthen its integration into lung cancer survivorship programs. This systematic review based on 4 data bases (ScienceDirect, Pubmed, EBSCO, Nature anda SAGE), included clinical trial, observational study and pilot study, articles were published between 2021-2025 in English, and available in full-text. Papers, which not met the inclusion criteria, will be excluded. Keywords used in this study are 'Lung Cancer Patient'' AND OR 'cancer Survivor' AND ' lung exercise OR "Pulmonary Rehabilitation" AND 'Lung Capacity'. This paper provided various exercises for lung cancer survivor based on procedure, baseline measurement and duration exercise.

Keywords: Lung Cancer; Lung Exercise; Pulmonary Rehabilitation

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INTRODUCTION

Lung cancer remains one of the leading causes of cancer-related morbidity and mortality worldwide (Siegel et al., 2024). Advances in early detection and multimodal treatments—including surgery, chemotherapy, radiotherapy, targeted therapy, and immunotherapy—have significantly improved survival outcomes among individuals with lung cancer (Sung et al., 2021; Thai et al., 2021). Consequently, the population of lung cancer survivors continues to increase. Despite improved survival, many survivors experience persistent physical and psychological impairments following treatment, such as cancer-related fatigue, dyspnea, reduced exercise capacity, muscle weakness, impaired pulmonary function, anxiety, and decreased quality of life (Granger et al., 2022; Peddle-McIntyre et al., 2023).

Cancer treatments, particularly thoracic surgery, chemotherapy, and radiotherapy, frequently contribute to physical deconditioning and functional decline. Periods of reduced physical activity during and after treatment can further exacerbate these impairments, leading to delayed recovery and increased risk of long-term comorbidities, including cardiovascular disease, sarcopenia, and metabolic dysfunction (Schmitz et al., 2021; Stene et al., 2022). Historically, individuals with lung cancer were often advised to restrict physical activity due to concerns regarding symptom exacerbation and safety. However, contemporary evidence supports that exercise, when appropriately prescribed and supervised, is both safe and feasible for this population (Campbell et al., 2022).

Exercise interventions—including aerobic training, resistance exercise, and respiratory muscle training—have demonstrated beneficial effects on cardiorespiratory fitness, muscle strength, pulmonary function, fatigue, and functional capacity in lung cancer survivors (Granger et al., 2022; Peddle-McIntyre et al., 2023). In addition, regular physical activity has been associated with improved symptom control, enhanced psychosocial well-being, and better health-related quality of life (Singh et al., 2023). Exercise also supports functional independence and facilitates return to daily activities, which are central goals of survivorship care and long-term recovery (Campbell et al., 2022).

Despite these well-documented benefits, exercise remains underutilized in post-treatment lung cancer care. Key barriers include the lack of standardized, lung cancer–specific exercise guidelines, limited referral to rehabilitation services, patient-related concerns such as fear of dyspnea, and insufficient integration of exercise programs within oncology care pathways (Granger et al., 2022; Singh et al., 2023). Moreover, heterogeneity in exercise modality, intensity, duration, timing, and level of supervision across existing studies underscores the need for clearer, evidence-based recommendations tailored specifically to lung cancer survivors (Peddle-McIntyre et al., 2023).

Therefore, a comprehensive understanding of the role of exercise following lung cancer treatment is essential to optimize physical recovery, mitigate long-term treatment-related complications, and enhance overall survivorship outcomes. This article aims to examine current evidence regarding exercise interventions in lung cancer survivors and to highlight their potential role as an integral component of comprehensive post-treatment care..

RESEARCH METHOD

This research used an integrative research review design using a structured literature review procedure consisting of five stages. The stages included problem formulation, literature search and data collection, data evaluation, data analysis, and presentation of the findings. The research question of this study was to explore the various of lung exercise or pulmonary rehabilitation on lung cancer survivor to improve lung capacity or function capacity. A comprehensive literature search was performed using four electronic databases: (Science direct, Pubmed, Ebsco, Nature and SAGE Journals. The inclusion criteria for this study were articles published between 2022 and 2025, written in English, and available as full-text publications. The selected study designs included clinical trials or studies that had been tested in the form randomized controlled trials (RCTs). Literature

quality assessment was conducted using the Jadad score (Jadad et al., 1996). The article selection process according to the study stages is presented in the PRISMA flow diagram in Figure 1.

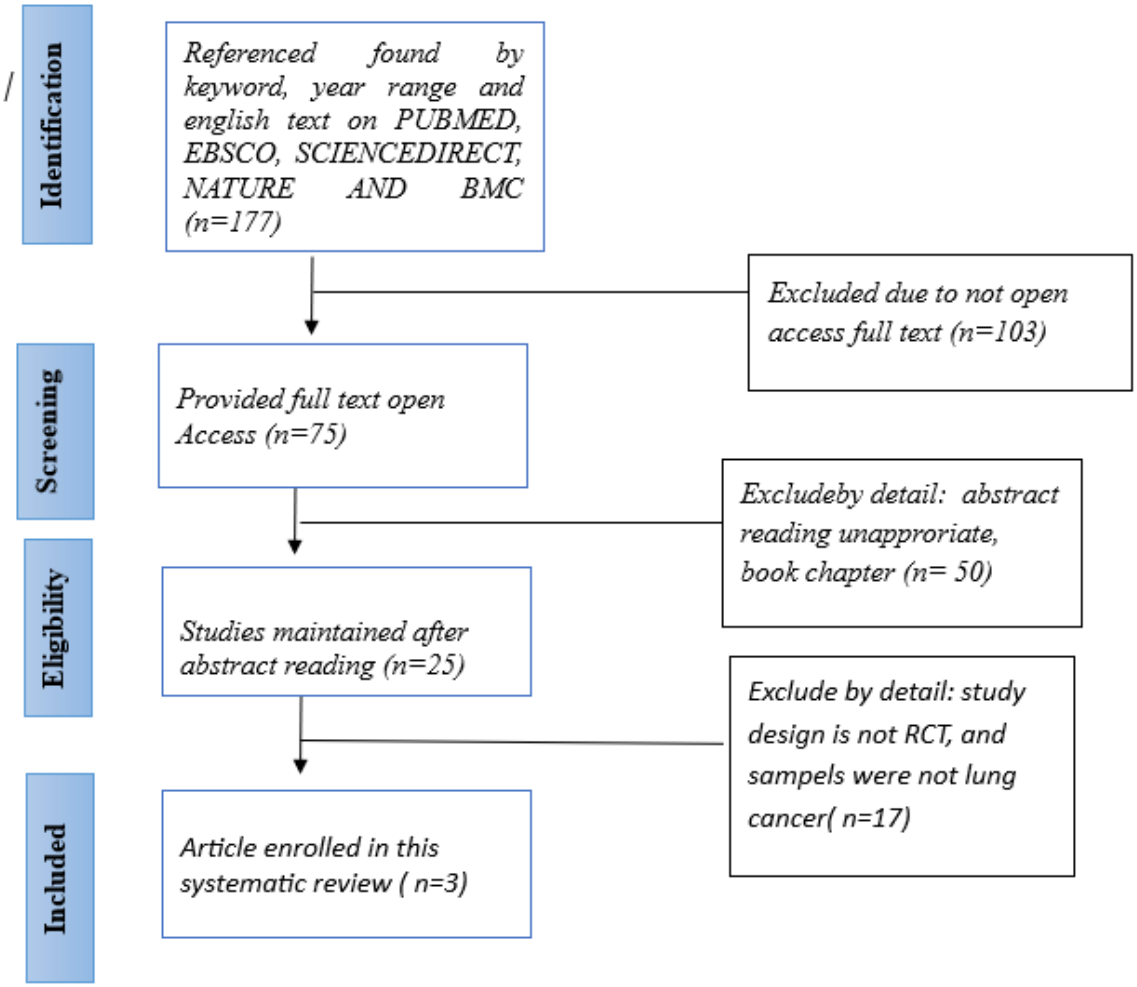


Figure 1: PRISMA Diagram flow

RESULTS

1. Type of Cancer

The included studies primarily involved patients with lung cancer, with one study also including patients with head and neck cancer. Two studies exclusively enrolled patients with non-small cell lung cancer (NSCLC) undergoing surgical treatment. Chen et al. (2023) included patients with stage I–IIIA NSCLC in the perioperative period, while Guo et al. (2025) focused on patients undergoing thoracoscopic radical lung cancer surgery. These populations are characterized by a high risk of postoperative pulmonary complications (PPCs), impaired lung function, and prolonged recovery. One study expanded the cancer spectrum to include patients with lung cancer or head and neck cancer receiving active oncological treatment (Grigoletto et al., 2023). This broader inclusion reflects shared functional and psychosocial challenges across cancer types, including deconditioning, fatigue, anxiety, and reduced health-related quality of life.

2. Type of Exercise

Three main categories of exercise interventions were identified across the included studies are respiratory physiotherapy–based exercises, respiratory exercises combined with adjunctive modalities, and multimodal aerobic and resistance exercise programs.Respiratory-based exercises were the most frequently reported interventions, particularly in perioperative lung cancer populations. Standard Active Cycle of

Table 1: Summary Articles

Title	Design	Participants	Intervention	Outcome	Result	Jadad Score
Chen et al. (2023) Comparative efficacy of different combinations of acapella, active cycle of breathing technique, and external diaphragmatic pacing in perioperative patients with lung cancer: a randomised controlled trial”	RCT and Prospective with assessor -blinded. The participants were	365 lung cancer patients with I to IIIA stage non-small cell lung carcinoma The participant were divided into 3 groups which are	• **Control Group (ACBT)** Participants received standard Active Cycle of Breathing Technique (ACBT) treatment, consisting of 3-5 breath controls, 3-4 thoracic expansion exercises, and 2-3 forced expiratory techniques. The full course involved five sessions, with training provided on the day of admission, day before surgery, and postoperative days (POD) 1-3. Each session lasted approximately 20-30 minutes. • **Acapella plus ACBT Group**: Participants received a five-session combined ACTs program aimed at facilitating airway clearance. This included active inspiration, exhaling through an Acapella device (with gradually adjusted frequency/resistance dial), and controlled breathing (eight repetitions), followed by forced expiratory technique (huffing) to clear airways. The treatment was considered complete when no longer expectorating sputum or when the participant was too fatigued, lasting a maximum of 30 minutes • **EDP plus ACBT Group**: Participants received both ACBT and External Diaphragm Pacemaker (EDP) treatment. EDP involved stimulating the phrenic nerve through body surface low-frequency pulse electrical stimulation, with a pacing frequency of 15 times per minute, pulse frequency of 40 Hz, and gradually increasing stimulation intensities. Two pairs of electrode sheets	• functional capacity, measured by the 6-minute walk test (6MWT). • Forced Vital Capacity (FVC%) • Forced Expiratory Volume in 1 Second (FEV1%):	the study found that both Acapella plus ACBT and EDP plus ACBT significantly improved functional capacity and lung function in perioperative lung cancer patients compared to ACBT alone. The EDP plus ACBT combination was particularly effective, showing superior outcomes in functional capacity and lung function, as well as reducing PPCs, drainage tube removal time, and hospital stays.	JADAD SCORE: Based on 5 indicators, a score of 3 was obtained, which is categorized as high.

			were attached to specific points on the neck and chest. The EDP treatment lasted an average of 30 minutes. Both combined intervention groups received treatment on the day of admission, day before surgery, and POD 1-3 in the ward			
Grigoletto et al (2023) Effects of Semisupervised Exercise Training on Health Outcomes in People With Lung or Head and Neck Cancer: Protocol for a Randomized Controlled Trial	Protocol for a Randomized Controlled Trial	Lung cancer or head and neck cancer	• **Training Group** (TG): Participants in the TG received semisupervised home-base resistance and aerobic exercise training throughout their cancer treatment, starting one week before treatment commencement and continuing for two weeks post treatment completion. - Resistance training involves elastic bands twice a week, targeting elbow flexors, knee flexors, and knee extensors (2 sets of 10 repetitions, progressing to 3 sets of 10-15 repetitions). Aerobic training consists of brisk walking outdoors for at least 20 minutes daily, aiming for 150 minutes weekly. - **Aerobic Training:** Participants will perform a brisk walk outdoors for at least 20 minutes daily, aiming for 150 minutes weekly, maintaining a Borg dyspnea score between 4 and 6. A pedometer will be provided for feedback. Intensity is progressed by increasing walking speed if weekly aerobic training exceeds 150 minutes. - Semisupervision includes an exercise diary, daily SMS text messages, and phone calls every 7 to 14 days. • **Control Group (CG):** Participants in the CG will receive usual cancer treatment without any formal exercise prescription and will be instructed to maintain their routine activities. They will also receive phone calls every 15 days to discuss treatment-related issues	• Characteristics of the participants • Functional Capacity (6-minute walk test, time and go test, 1-minute sit-to-stand test) • International Physical Activity Questionnaire. • HADS: Hospital for Anxiety and Depression Scale. • HRQoL: health-related quality of life. • EORTC QLQ-30: European Organization for Research and Treatment of Cancer Core Quality of Life Questionnaire. • MSAS-BR: Memorial Symptom Assessment Scale (Portuguese version)	This exercise training as a complementary treatment for patients with cancer is likely to promote positive effects on the health outcomes assessed, over and above any change in the CG, and prevent the reduction of initial cancer treatment dose prescribed. If these positive effects are shown, they will likely impact long-term outcomes such as hospitalizations and 12-month survival	JADAD SCORE: Based on 5 indicators, a score of 3 was obtained, which is categorized as high.

Guo et al (2025) Effect of position management combined with active cycle of breathing techniques on reducing postoperative pulmonary complications in lung cancer patients	a randomized controlled trial	213 radical lung cancer patient on undergoing surgery thoracoscopic	• **Control Group:** Received routine treatment and nursing care, including guidance for deep breathing exercises three times daily for 15-30 minutes each session, for 5 days post-surgery • **Experimental Group 1:** Received routine care plus Active Cycle of Breathing Techniques (ACBT) [5]. The ACBT protocol included Breathing Control (BC), Thoracic Expansion Exercises (TEE), and Forced Expiration Technique (FET), performed three times daily for 15-30 minutes each session for 5 consecutive days • **Experimental Group 2:** Received routine care plus ACBT combined with position management. Position management involved specific postoperative positioning (e.g., head-down, flat-lying with head raised 30-45° initially, then semi-sitting or seated positions) and postural drainage tailored to the surgical site and sputum status. ACBT procedures were the same as in Experimental Group 1	• Incidence of postoperative pulmonary complications (PPCs), including pulmonary infection and atelectasis . • Duration of chest tube placement, length of hospital stay, postoperative oxygen saturation (SpO2) levels from days 1 to 5, and patient satisfaction with rehabilitation care	• There was a statistically significant difference in PPC incidence among the groups (χ^2 = 10.058, P=0.007) • Repeated measures ANOVA showed significant differences in SpO2 across groups (P < 0.001), time points (P < 0.001), and their interaction (P < 0.001) Experimental Group 2 showed the highest SpO2 levels. • Significant differences were found in both chest tube retention time and hospital stay among the groups (P < 0.05) . Experimental Group 2 had significantly shorter retention time and hospital stay compared to both the control group and Experimental Group 1.	JADAD SCORE: Based on 5 indicators, a score of 3 was obtained, which is categorized as high.

Breathing Technique (ACBT) was used as a baseline intervention in two studies (Chen et al., 2023; Guo et al., 2025). ACBT protocols consistently included breathing control, thoracic expansion exercises, and forced expiratory techniques, delivered multiple times daily during hospitalization.

3. **Type of Exercise**

Three main categories of exercise interventions were identified across the included studies are respiratory physiotherapy–based exercises, respiratory exercises combined with adjunctive modalities, and multimodal aerobic and resistance exercise programs.Respiratory-based exercises were the most frequently reported interventions, particularly in perioperative lung cancer populations. Standard Active Cycle of Breathing Technique (ACBT) was used as a baseline intervention in two studies (Chen et al., 2023; Guo et al., 2025). ACBT protocols consistently included breathing control, thoracic expansion exercises, and forced expiratory techniques, delivered multiple times daily during hospitalization.

Two studies evaluated enhanced respiratory exercise approaches. Chen et al. (2023) combined ACBT with either an Acapella oscillatory positive expiratory pressure device or External Diaphragmatic Pacing (EDP), while Guo et al. (2025) combined ACBT with postoperative position management and postural drainage. These adjunctive strategies were designed to optimize airway clearance, diaphragmatic activation, and ventilation–perfusion matching. In contrast, Grigoletto et al. (2023) implemented a semisupervised home-based exercise program combining aerobic walking and resistance training using elastic bands, delivered throughout active cancer treatment.

This intervention emphasized longer-term functional conditioning rather than short-term perioperative respiratory recovery. Overall, the findings indicate substantial heterogeneity in exercise type, ranging from short-term, inpatient respiratory interventions to longer-duration, outpatient multimodal exercise programs

4. **Recommended Duration of Exercise**

Across the included studies, the recommended duration of exercise interventions varied according to treatment phase and exercise modality, ranging from short-term intensive perioperative programs to longer-term, semisupervised training during active cancer treatment. In perioperative lung cancer patients, respiratory exercise interventions were implemented over a short but intensive duration. Chen et al. (2023) delivered ACBT-based interventions, with or without Acapella or External Diaphragmatic Pacing (EDP), over five sessions spanning the day of hospital admission, the day before surgery, and postoperative days 1–3. Each session lasted approximately 20–30 minutes, with the total intervention period limited to the early postoperative phase. Similarly, Guo et al. (2025) applied ACBT alone or combined with position management for five consecutive postoperative days, with sessions conducted three times daily for 15–30 minutes.

In contrast, Grigoletto et al. (2023) implemented a longer-duration exercise program targeting patients undergoing active cancer treatment. The intervention began one week prior to cancer treatment initiation and continued until two weeks after treatment completion, resulting in a total duration of approximately 6–8 weeks, depending on treatment length. Aerobic exercise was prescribed at ≥150 minutes per week, while resistance training was conducted twice weekly, reflecting international exercise oncology recommendations.

Overall, short-term interventions (≤1week) were primarily used to address acute postoperative pulmonary dysfunction, whereas longer-duration programs (≥6 weeks) aimed to preserve or improve functional capacity, physical activity levels, and psychosocial outcomes during and after cancer treatment.

5. **Effect of Exercise**

All included studies reported beneficial effects of exercise interventions compared with routine care or standard breathing exercises alone. In perioperative lung cancer patients, enhanced respiratory exercise interventions led to

significant improvements in functional capacity and pulmonary function.

Chen et al. (2023) demonstrated that both Acapella plus ACBT and EDP plus ACBT significantly improved 6-minute walk distance, FVC%, and FEV1% compared with ACBT alone, with the EDP plus ACBT group showing the greatest improvements. This group also experienced fewer PPCs, shorter chest drainage duration, and reduced length of hospital stay.Similarly, Guo et al. (2025) found that combining ACBT with position management significantly reduced the incidence of PPCs, improved postoperative oxygen saturation (SpO_2), and shortened chest tube retention time and hospital stay compared with ACBT alone and routine care.

In patients undergoing active cancer treatment, the semisupervised aerobic and resistance exercise program reported by Grigoletto et al. (2023) was associated with favorable trends in functional capacity, physical activity levels, psychological outcomes (anxiety and depression), and health-related quality of life, compared with usual care. The intervention was also suggested to help prevent reductions in prescribed cancer treatment dose. Taken together, the results indicate that exercise interventions positively influence physiological outcomes, clinical recovery, and patient-reported outcomes, with the magnitude of benefit depending on exercise type and treatment phase.

DISCUSSION

This systematic review demonstrates that exercise-based interventions play a critical role in improving functional, respiratory, and clinical outcomes in patients with lung cancer across perioperative and treatment phases. The consistent benefits observed across all included studies reinforce growing evidence that exercise is not only safe but also therapeutically valuable for lung cancer patients, challenging historical assumptions that physical exertion should be limited in this population (Cavalheri & Granger, 2020; Campbell et al., 2022).

In perioperative non-small cell lung cancer (NSCLC) patients, multimodal respiratory interventions combining Active Cycle of Breathing Technique (ACBT) with adjunctive devices such as Acapella and External Diaphragm Pacemaker (EDP) produced significantly greater improvements in functional capacity and pulmonary function than ACBT alone. These findings align with previous research showing that oscillatory positive expiratory pressure devices enhance secretion mobilization and reduce airflow obstruction, thereby improving ventilation efficiency and exercise tolerance (Barker et al., 2020). The superior outcomes observed in the EDP plus ACBT group suggest that diaphragmatic neuromuscular stimulation provides an added physiological advantage by improving diaphragmatic excursion, tidal volume, and oxygen delivery (Chen et al., 2023).

Importantly, reductions in postoperative pulmonary complications (PPCs), chest drainage duration, and length of hospital stay highlight the clinical relevance of combining respiratory muscle activation with airway clearance strategies. PPCs remain a major contributor to postoperative morbidity following lung cancer surgery, and evidence increasingly supports early, targeted pulmonary rehabilitation as a preventive strategy (Guo et al., 2021; Peddle-McIntyre et al., 2022). Improved pulmonary function parameters (FVC% and FEV1%) observed in combined intervention groups further indicate enhanced lung mechanics and recovery.

The integration of position management with ACBT also demonstrated significant benefits, including higher postoperative oxygen saturation (SpO_2) and lower PPC incidence. Positioning techniques facilitate gravity-assisted drainage, improve ventilation–perfusion matching, and reduce atelectasis risk—mechanisms that are particularly important in the immediate postoperative period (Cavalheri & Granger, 2020). These findings support a multimodal rehabilitation approach that addresses both mechanical and physiological aspects of pulmonary recovery.

Beyond the surgical context, this review highlights the effectiveness of semisupervised home-based aerobic and resistance exercise programs during active cancer treatment. Improvements in functional capacity, physical activity levels, psychological outcomes, and health-related quality of life (HRQoL) are consistent with current oncology exercise literature (Granger et al., 2021; Campbell et al., 2022). Notably, the use of behavioral support strategies—such as exercise diaries, SMS reminders, and periodic follow-up—likely contributed to improved adherence, addressing a well-recognized barrier to exercise participation among cancer patients.

The Study Novelty

The key novelty of this systematic review lies in its comparative synthesis of multimodal exercise strategies across different phases of lung cancer care, highlighting that combined and technology-assisted interventions (e.g., EDP, Acapella, position management) yield greater benefits than single-modality or conventional breathing exercises alone. Unlike previous reviews that focused primarily on aerobic or resistance training, this review demonstrates that integrating respiratory muscle stimulation and airway clearance techniques with exercise produces superior functional and clinical outcomes, particularly in reducing PPCs and hospitalization duration. Additionally, this review underscores the continuum of exercise benefits from the perioperative period to active cancer treatment, reinforcing the concept that exercise should not be limited to survivorship but initiated early and adapted throughout the treatment trajectory.

CONCLUSION

Exercise interventions provide meaningful benefits for patients with lung cancer, particularly perioperative NSCLC, by improving pulmonary function, functional capacity, and clinical recovery. Short-term intensive respiratory physiotherapy effectively reduces postoperative pulmonary complications and hospital stay, while longer-duration aerobic and resistance programs enhance physical, psychological, and quality-of-life outcomes during active treatment. These findings support a phase-specific, multimodal exercise approach as an integral component of comprehensive cancer care

LIMITATION

The evidence is based on a small number of studies, largely focused on surgically treated lung cancer patients, limiting generalizability to other cancer types and stages. Substantial heterogeneity in exercise modalities, duration, and outcome measures also restricts direct comparison and synthesis of findings.

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