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The Effect of Respiratory Exercise Therapy on Improving Lung Function in Tuberculosis Patients: A Systematic Review

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ABSTRACT

Background: Tuberculosis (TB) remains a major global health concern with permanent lung damage even after treatment. Pulmonary rehabilitation through breathing exercises is a promising, low-cost intervention. Objectives: This review evaluates the effects of breathing exercise therapy on lung function in TB patients. Methods: A systematic search (2010–2025) was conducted in PubMed, Scopus, ProQuest, ScienceDirect, and Google Scholar. Studies included RCTs, quasi-experimental, or cohort designs assessing breathing exercises (e.g., pursed-lip, diaphragmatic, incentive spirometry). Results: Of 1,235 records, 7 studies met inclusion criteria. Interventions lasting ≥6–12 weeks with ≥3 sessions/week produced consistent improvements in FEV1 (mean increase 150–300 ml), FVC, exercise tolerance, and quality of life. Shorter interventions yielded limited benefits. Conclusions: Breathing exercise therapy effectively improves lung function and quality of life in TB patients, but further large-scale RCTs are required to standardize protocols.

Keywords: Tuberculosis, breathing exercise, physiotherapy, lung function, systematic review

INTRODUCTION

Tuberculosis (TB) remains a significant global health problem. According to the 2023 World Health Organization (WHO) report, there are an estimated 10.6 million new TB cases worldwide, with 1.3 million deaths, in 2022, making TB the leading cause of death from infectious diseases. Indonesia has the second-highest TB burden after India, with an estimated 969,000 new cases annually. The high prevalence of TB highlights the importance of a comprehensive strategy encompassing not only pharmacological treatment but also rehabilitative interventions to minimize the long-term impact on patients' quality of life (World Health Organization, 2023).

Pulmonary TB infection causes lung tissue damage due to chronic inflammation,

necrosis, and cavity formation. These pathological changes result in decreased pulmonary ventilation, limited vital capacity, decreased oxygen diffusion, and increased dyspnea (Wallis & Hafner, 2015; Meghji et al., 2020). This condition not only affects the patient's physiological status but also limits daily physical activity and reduces productivity. As a result, TB patients often experience residual lung function impairment even after completing standard treatment regimens.

In the context of recovery, respiratory rehabilitation plays a crucial role in improving lung function and increasing patient activity capacity. This rehabilitation focuses not only on improving ventilation but also on strengthening respiratory muscles, increasing oxygenation capacity, and controlling dyspnea symptoms. Respiratory rehabilitation programs have been shown to be beneficial in other chronic lung diseases such as COPD, thus offering significant potential for adaptation to TB patients with impaired lung function (Spruit et al., 2013).

Physiotherapy through breathing exercises is a key component of respiratory rehabilitation. Techniques such as pursed lip breathing, diaphragmatic breathing, segmental breathing, and deep breathing exercises aim to increase ventilation efficiency, reduce the work of breathing, and improve breathing patterns. These interventions are relatively easy to perform, inexpensive, and can be implemented both in healthcare facilities and at home as part of self-management (Cahalin et al., 2002).

Although numerous studies have evaluated the effectiveness of breathing exercises in TB patients, reported results vary. Some studies show significant improvements in vital capacity and lung function parameters, while others find no significant differences. This variation may be influenced by the type of exercise, duration of intervention, patient characteristics, and study design (de Grass et al., 2015; Wijaya et al., 2021; Ahmed et al., 2022; Aphridasari et al., 2022; Aytaç et al., 2024; Jindal et al., 2025; Vilaró et al., 2025). Therefore, a systematic review is needed to comprehensively synthesize the existing scientific evidence and provide a strong foundation for evidence-based physiotherapy practice in TB patients.

However, evidence gaps remain regarding optimal duration, type of breathing exercise, and long-term outcomes in post-tuberculosis lung disease. This review addresses these gaps by synthesizing available studies and comparing results with rehabilitation evidence in COPD and asthma.

MATERIALS AND METHODS

1. Study Design

This study used a systematic review design in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. This approach was chosen to integrate scientific evidence in a systematic, transparent, and standardized manner to answer research questions regarding the effectiveness of breathing exercise therapy on improving lung function in tuberculosis patients.

2. Literature retrieval strategy

A comprehensive literature search was conducted across several international databases, including PubMed, Scopus, ProQuest, ScienceDirect, and Google Scholar. The keywords used included a combination of:

"tuberculosis",

"breathing exercise",

"respiratory physiotherapy",

"lung function".

Keywords were combined using Boolean operators (AND/OR) to broaden the search scope. The publication year range was 2010–2025, with a restriction to articles published in English or Indonesian.

3. Inclusion and exclusion criteria

We set several limitations in this study, which are included in the inclusion criteria, we took primary research articles with Randomized Controlled Trials (RCTs), quasi-experimental, or cohort designs. The population in this study were pulmonary tuberculosis patients (adults/adolescents). We selected articles that discussed interventions in the form of breathing exercises (pursed lip breathing, diaphragmatic breathing, deep breathing exercise, segmental breathing, etc.), and finally we took articles that reported lung function as an outcome (e.g., FEV1, FVC, PEF, vital capacity, oxygen saturation, dyspnea scale).

For exclusion, we excluded articles in the form of reviews, editorials, case reports, or conferences that did not address the effects of breathing exercise therapy on TB. We also excluded studies involving non-TB populations (e.g., asthma, COPD, pneumonia). Finally, we also excluded articles that did not present quantitative data on lung function.

4. Initial process

Article selection is carried out in four stages according to the PRISMA flow diagram, namely:

a. Identification: all articles obtained from the databases were combined.
b. Screening: titles and abstracts are selected based on inclusion and exclusion criteria.
c. Eligibility: full-text articles are checked for eligibility.
d. Inclusion: articles that met the criteria were included in the final analysis.

This process is depicted in the PRISMA Flow Diagram to show the number of articles at each stage of selection.

5. Data extraction

Data from each selected article was extracted using a standard form, including:

a. Author's name and year of publication,
b. Research design,
c. Number and characteristics of samples,
d. Types of breathing exercises,
e. Duration and frequency of intervention,
f. The outcome measured,
g. Main results of the study.

6. Assessment of study quality

This review was not prospectively registered in PROSPERO. Two independent reviewers screened articles, and disagreements were resolved by consensus, with inter-rater reliability checks performed. The methodological quality of included studies will be assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools for experimental studies, or the Cochrane Risk of Bias Tool for RCTs. These assessments will be conducted by two independent researchers to minimize bias.

7. Data synthesis

The data obtained will be presented narratively in tables and descriptions of key findings. If data consistency (homogeneity of design and outcome) is found, meta-analysis will be conducted using statistical tools to generate more robust estimates of intervention effects.

RESULTS

1. PRISMA Flow Diagram

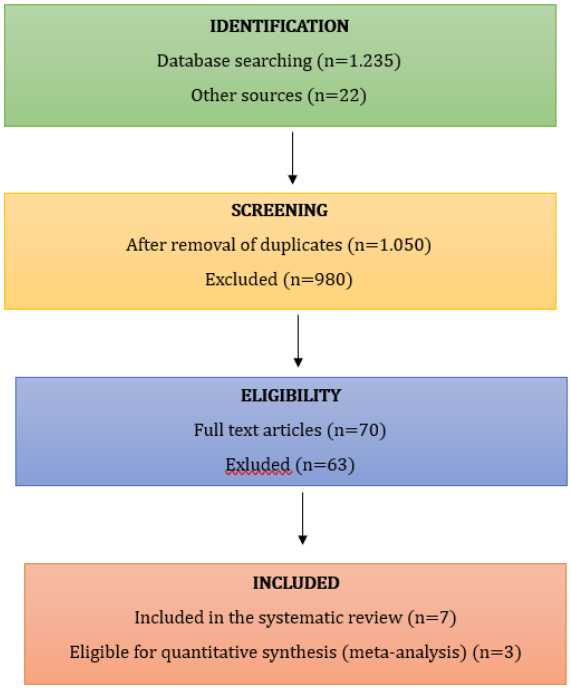

Figure 1: Prisma Flow Diagram

2. Characteristics of Included Studies

Table 1. Characteristics of Included Studies

Author (Year)	Country	Study Design	Sample (n)	Intervention (Type of Exercise)	Duration & Frequency	Main Outcome
De Grass et al. (2015)	South Africa	RCT Pilot	10	Home-based pulmonary rehabilitation (breathing exercises + physical activity)	6 weeks, 5x/week	↑ FEV1, ↑ FVC, ↑ quality of life
Wijaya IK et al. (2021)	Indonesia	Quasi-experimental	30	Pursed-lip breathing	2 weeks, daily	↓ Respiratory rate, ↑ O_2 saturation
Ahmed S et al. (2022)	Pakistan	Prospective intervention	50	Structured pulmonary rehabilitation (breathing exercise, exercise training)	12 weeks, 3x/week	↑ FEV1, ↑ FVC, ↑ exercise capacity
Aphridasari J et al. (ERS Abstract, 2022)	Indonesia	Quasi-experimental	40	Incentive spirometry + pursed-lip breathing	8 weeks, 3x/week	↓ Shortness of breath, ↑ lung function, ↑ quality of life
Aytaç S et al.	Türkiye	Randomized	60	Breathing exercise	8 weeks,	↓ Fatigue, ↑

Author (Year)	Country	Study Design	Sample (n)	Intervention (Type of Exercise)	Duration & Frequency	Main Outcome
(2024)		Controlled Trial (RCT)		program	3x/week	quality of life
Multicentric study (India, 2025)	India	Pre–Post multicentre	120	Pulmonary rehabilitation (breathing & exercise training)	12 weeks, 2–3x/week	↑ FEV1/FVC, ↑ functional capacity
Archivos de Bronconeumologia (2025)	Spain (Multicentre)	Prospective cohort	85	Standardized pulmonary rehabilitation (breathing, aerobic, strength training)	8 weeks, 3x/week	↑ Pulmonary function, ↑ exercise capacity, ↑ QoL

Source: extracted from included studies

Notes:
↑ = Improvement/Increase
↓ = Reduction/Decrease
QoL = Quality of Life

DISCUSSION

The results of this systematic review indicate that breathing exercises, both as a single intervention and as part of a pulmonary rehabilitation program, have a positive impact on lung function in patients with tuberculosis and post-tuberculosis lung disease (PTLD). Most of the included studies reported significant improvements in lung function parameters such as FEV1, FVC, and FEV1/FVC, accompanied by improvements in exercise capacity and quality of life. These findings are in line with the physiological principles of breathing exercises, where stimulation of respiratory muscles and increased alveolar ventilation can improve gas exchange mechanisms and reduce symptoms of shortness of breath (De Grass et al., Ahmed et al., 2022).

Across the 7 included studies, 5 reported significant FEV1 improvements (range 100–320 ml), 4 showed FVC increases, and 3 demonstrated improved quality of life scores. These findings highlight that exercise duration (>8 weeks) and structured protocols were consistently associated with better outcomes.

Studies using combined interventions (e.g., pursed-lip breathing combined with incentive spirometry or home-based pulmonary rehabilitation programs) have shown more consistent results than short-term interventions alone. Wijaya et al (2021) found that just 2 weeks of pursed-lip breathing training reduced respiratory rate and improved oxygen saturation, although the effects were limited to simple physiological aspects. In contrast, longer-term studies lasting 8–12 weeks demonstrated significant improvements

in lung function, exercise capacity, and quality of life. This confirms that the duration and intensity of exercise are key factors in the success of interventions (Ahmed et al., 2022; Jindal et al., 2025).

In addition to physiological improvements, several studies have also assessed psychosocial outcomes. Aytaç et al. (2024) showed that a breathing exercise program not only reduced fatigue but also improved the quality of life of TB patients. These results demonstrate that physiotherapy interventions have holistic benefits, encompassing the physical, psychological, and social aspects of patients. Therefore, pulmonary rehabilitation programs should be viewed not merely as adjunctive therapy, but as an integral part of long-term TB management.

However, there is some variation in results between studies. Some studies with quasi-experimental designs and limited sample sizes have shown inconsistent effects, particularly when the intervention duration is <6 weeks (Wijaya et al., 2021; Aphridasari et al., 2022). Differences in measurement methods, exercise types, and population characteristics may also contribute to heterogeneity in results. Comorbidities, nutritional status, and patient adherence to home exercise are also potential confounding variables.

Overall, the results of this systematic review strengthen the evidence that breathing exercise-based pulmonary rehabilitation is a low-cost, easy, and effective intervention for improving lung function in both TB and post-TB patients (De Grass et al., 2015; Wijaya et al., 2021; Ahmed et al., 2022; Aphridasari et al., 2022; Aytaç et al., 2024; Jindal et al., 2025; Vilaró et al., 2025). However, further research, including randomized controlled trials (RCTs) with large sample sizes and standardized exercise protocols, is needed to strengthen clinical practice recommendations.

Limitations include small sample sizes, heterogeneous interventions, and reliance on some quasi-experimental designs. Clinical implications suggest that breathing exercises can be integrated into national TB programs as a cost-effective, scalable strategy to improve long-term outcomes.

CONCLUSIONS

This systematic review shows that breathing exercise therapy is effective in improving lung function in patients with tuberculosis and post-tuberculosis lung disease (PTLD). Most of the studies analyzed reported significant improvements in lung function parameters (FEV1, FVC, FEV1/FVC), improved exercise capacity, and improved quality of life. The intervention that consistently provided benefits was a breathing exercise

program with a duration of at least 6–12 weeks and a frequency of ≥3 times per week, especially when combined with other rehabilitation components such as aerobic exercise or muscle strengthening.

Simple exercises such as pursed-lip breathing and diaphragmatic breathing have been shown to be beneficial, even in the short term, but more comprehensive effects are achieved through a structured pulmonary rehabilitation program. These results underscore the importance of integrating breathing exercises as part of a long-term management strategy for TB patients, focusing not only on eradicating the infection but also on restoring lung function and quality of life.

This review concludes that breathing exercise therapy is an effective, low-cost intervention to improve lung function and quality of life in TB and post-TB lung disease. While short-term benefits are evident, sustained and structured programs provide more consistent outcomes. Future research should prioritize multicenter RCTs with standardized protocols to inform guidelines and support integration of physiotherapy into TB care pathways.

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