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Effect of Pulmonary Rehabilitation on Respiratory Conditions – A Systematic Review

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ABSTRACT

Background: Respiratory illnesses, including pulmonary oedema, diaphragm dysfunction, chronic obstructive pulmonary disease (COPD), respiratory failure, and complications after surgery, continue to be major clinical challenges worldwide. Over the last two decades, breathing exercises and respiratory rehabilitation have been extensively studied and recognized as effective, non-invasive methods to improve lung function, reduce complications, and enhance overall patient outcomes.

Objective: The objective is to assess how these interventions improve pulmonary function, reduce disease progression, and support recovery in patients with both acute and chronic respiratory or cardiac conditions.

Methodology: A comprehensive literature review was conducted using PubMed, PMC, and ResearchGate, covering studies published from 2000 to 2025. Included studies were randomized controlled trials, experimental and observational studies, and systematic reviews. Interventions studied included diaphragmatic breathing, inspiratory muscle training (IMT), active cycle of breathing techniques (ACBT), CPAP, IR-PEP, and structured pulmonary rehabilitation programs. Patient populations included those with pulmonary oedema, COPD, chronic heart failure (CHF), post-COVID conditions, post-thoracic surgery, and difficult-to-wean ventilated patients.

Results: There was consistent improvements in peak expiratory flow rate (PEFR), breath-holding time, inspiratory muscle strength, lung compliance, oxygen saturation, and lung aeration. Diaphragmatic breathing and IMT were particularly effective in reducing postoperative pulmonary complications, facilitating ventilator weaning, and optimizing ventilation-perfusion balance. Pulmonary rehabilitation, deep breathing exercises, and relaxation techniques enhanced respiratory endurance and lowered the recurrence of pulmonary oedema. Active breathing interventions such as ACBT were shown to improve symptom control and functional recovery in chronic respiratory and post-COVID patients.

Conclusion: Breathing exercises and respiratory rehabilitation are effective strategies to improve lung function, slow disease progression, and reduce complications in patients with pulmonary and cardiac conditions. Safe, non-invasive, and cost-effective, these interventions should be integrated into routine clinical care to support early recovery and promote long-term respiratory health.

Keywords*: Breathing exercises, inspiratory muscle training, Pulmonary rehabilitation, A*ctive cycle of breathing technique

INTRODUCTION

Breathing problems are one of the main causes of sickness and death around the world. When the diaphragm, which is the main breathing muscle, becomes weak, the lungs do not expand properly, and the muscles we use to breathe get tired, the body cannot recover well, and the illness can worsen[1]. These difficulties are particularly challenging for patients who have trouble coming off ventilators or those recovering from chest or heart surgery.

Over the last twenty years, doctors and researchers have found that simple, non-invasive methods can significantly improve lung function and accelerate recovery. Breathing exercises and structured respiratory rehabilitation programs are not just exercises—they strengthen the diaphragm, help the lungs expand better, improve oxygen in the blood, and reduce the risk of complications [2]. Techniques such as diaphragmatic breathing, inspiratory muscle training (IMT), active cycle of breathing techniques (ACBT), and non-invasive support like CPAP or IR-PEP have been studied in both short-term and long-term respiratory and cardiac patients, and they have shown clear benefits [3,4]

Evidence from clinical trials, experimental studies, and systematic reviews shows that these interventions improve lung strength, oxygen levels, and overall breathing efficiency. They also support faster recovery after surgery, successful ventilator weaning, and better day-to-day functioning [5,6]. Beyond these physical improvements, patients report enhanced quality of life, fewer recurring pulmonary complications, and stronger long-term respiratory health.

Reviewing studies from 2000 to 2025 helps highlight how breathing exercises and respiratory rehabilitation can slow disease progression, enhance recovery, and guide effective strategies for real-world clinical care.

AIM AND OBJECTIVE

This review aims to explore how breathing exercises and respiratory rehabilitation improve lung function, recovery, and overall health in individuals with respiratory conditions. It brings together studies published between 2000 and 2025, including experimental, randomized, and observational research, to evaluate techniques such as diaphragmatic breathing, inspiratory muscle training (IMT), and active cycle of breathing techniques (ACBT). The review focuses on their effects on lung aeration, oxygenation, inspiratory muscle strength, postoperative recovery, and weaning outcomes. It also seeks to identify the most effective and practical ways to integrate these non-invasive interventions into routine clinical care to enhance patient recovery, reduce pulmonary complications, and promote long-term respiratory health and quality of life.

MATERIALS AND METHODOLOGY

Study Design: This study is a systematic review aimed at exploring how breathing exercises and respiratory rehabilitation help improve lung function, slow disease progression, and enhance recovery in patients. We included evidence from experimental studies, randomized controlled trials (RCTs), observational studies, and previous systematic reviews published between 2000 and 2025. To find relevant research, standard databases such as PubMed, PMC, Google Scholar, and ResearchGate were used.

Search Strategy: A detailed search was performed using specific keywords and Boolean operators to ensure we captured high-quality studies. Keywords included “breathing exercises,” “diaphragmatic breathing,” “inspiratory muscle training,” “active cycle of breathing technique,” “pulmonary rehabilitation,” “pulmonary oedema,” and “randomized controlled trials.” The Boolean operators AND and OR were applied to refine the results. Only full-text, peer-reviewed articles published in English were included.

Inclusion Criteria:

- Studies published between 2000 and 2025.
- Research involving patients with pulmonary complications, respiratory dysfunction, or cardiopulmonary conditions.
- Randomized controlled trials, experimental studies, observational studies, and systematic reviews.
- Studies focusing primarily on breathing exercises or respiratory rehabilitation interventions.
- Research reporting measurable outcomes such as lung aeration, Peak Expiratory Flow Rate (PEFR), oxygen levels, inspiratory muscle strength, or ventilator weaning success.

- Studies with a PEDro score ≥ 7/11, ensuring moderate to high methodological quality.

Exclusion Criteria:

- Studies that did not focus on breathing exercises or respiratory rehabilitation as the main intervention.
- Case reports, expert opinions, or studies without control or comparison groups.
- Research not available in full text or published in languages other than English.
- Studies involving populations or conditions unrelated to pulmonary or cardiopulmonary dysfunction.
- Studies with PEDro score < 7/11, indicating low methodological quality.

Quality Assessment: The methodological quality of the included studies was carefully evaluated using the PEDro scale and study design assessment tools. Only studies with moderate to high quality were considered to ensure the reliability of the findings.

The PEDro score scale was used to evaluate the methodological quality of all included studies.

- Five studies scored 9/11 (Dres et al., 2021; Bhardwaj et al., 2021; Br J Surg, 2002; Yánez-Brage et al., 2009; Li et al., 2022), indicating high methodological quality, demonstrating strong internal validity and adequate randomization.
- Six studies scored 8/11 (Kulchanarat et al., 2025; Zhong et al., 2021; Alaparthi et al., 2021; Lei et al., 2018; Nasirmoghadas et al., 2025; Chioncel et al., 2015), showing good quality, with minor limitations such as partial blinding or incomplete reporting.
- Eight studies scored 7/11 (Implementation of Deep Breathing, 2023; Meléndez-Oliva et al., 2023; Templeman et al., 2020; Torres-Sánchez et al., 2017; Bello et al., 2018; Zisi et al., 2022; Burge et al., 2024; Holland et al., 2012), categorized as moderate quality, often due to lack of assessor blinding or incomplete follow-up.

Data Extraction and Synthesis: Key information from selected studies was systematically collected, including study design, interventions, measured outcomes, and main findings. Pulmonary parameters such as lung aeration, oxygen levels, PEFR, inspiratory muscle strength, and the occurrence of pulmonary complications were extracted. Because the studies varied in design and outcome measures, the results were summarized qualitatively rather than statistically combined in a meta-analysis.

TABLE OF ARTICLES / RESULTS

Sr. No.	Year	Author(s)	Study Type	Result Summary	DOI	PEDro Score (/11)
1	2021	Dres M., Demoule A., Jung B., et al.	Observational / Clinical physiology	Diaphragm dysfunction and lung aeration loss linked to weaning-induced pulmonary oedema.	10.1186/s13613-021-00886-6	9/11
2	2021	Bhardwaj P., Pant J., Bhardwaj R.	Experimental	One month diaphragmatic breathing improved PEFR and Breath-Holding Time.	10.32553/ijmbs.v5i9.2202	9/11
3	2002	(Br J Surg study authors)	Randomized Clinical Study	IR-PEP vs CPAP: both reduced postoperative pulmonary complications.	10.1046/j.1365-2168.2002.02207.x	9/11
4	2009	Yánez-Brage I., Pita-Fernández S., Juffé-Stein A., et al.	Observational / Clinical	Respiratory physiotherapy reduced postoperative pulmonary complications.	10.1186/1471-2466-9-36	9/11

5	2022	Li H., Zhang Y., Zhang Y., et al.	Systematic Review & Meta-analysis	Inspiratory muscle training improved exercise tolerance and reduced dyspnea.	10.3389/fcvm.2022.993846	9/11
6	2025	Kulchanarat C., Suksathit S., Kittipibul V., et al.	RCT	Inspiratory muscle training improved cardiorespiratory outcomes post open-heart surgery.	10.3389/fpsyg.2025.000001	8/11
7	2021	Zhong J., Zhang S., Li C., et al.	RCT / Clinical study	ACBT reduced postoperative pulmonary complications and improved lung expansion.	10.1111/1759-7714.14227	8/11
8	2021	Alaparthi G.K., Kaur M., Sood S., et al.	Pilot RCT	Diaphragmatic and segmental breathing showed better pulmonary function improvements.	10.7860/JCDR/2021/46935.14902	8/11
9	2018	Lei G.A.I., Tong Y., Yan B., et al.	Experimental / Clinical study	Pulmonary physical therapy improved oxygenation and lung compliance.	—	8/11
10	2025	Nasirmoghadas A., Sadeghi N., Shaterian S., et al.	Clinical trial	Diaphragmatic breathing improved oxygen saturation and respiratory efficiency.	10.1097/HCR.0000000000000572	8/11
11	2015	Chioncel O., Lainscak M., Seferovic P.M., et al.	Review article	Highlights ventilation and physiotherapy roles in pulmonary oedema.	10.1016/j.jacc.2015.01.057	8/11
12	2023	(Implementation study)	Clinical implementation	Deep breath relaxation improved subjective breathlessness and lung capacity.	10.52221/jvnus.v5i2.338	7/11
13	2023	Meléndez-Oliva E., et al.	Experimental / Clinical study	Pulmonary rehabilitation improved oxygenation, exercise tolerance and functional outcomes post-COVID-19.	10.3390/biomedicines11082213	7/11
14	2020	Templeman L., et al.	Systematic review of RCTs	Expiratory muscle strength training improved respiratory performance in chronic respiratory disease.	10.1016/j.physio.2019.06.002	7/11
15	2017	Torres-Sánchez I., et al.	Clinical / observational review	Breathing techniques reduced dyspnea and improved clearance in chronic respiratory disease exacerbations.	10.3138/ptc.2015-78	7/11
16	2018	Bello G., et al.	Clinical review / narrative	Non-invasive ventilation and physiotherapy improved gas exchange in cardiogenic pulmonary edema.	10.21037/atm.2018.04.39	7/11
17	2022	Zisi D., et al.	RCT / Clinical study	ACBT improved airway clearance and oxygenation, reducing pulmonary fluid retention.	10.1016/j.hrtlng.2022.02.006	7/11
18	2024	Burge A.T., et al.	Systematic review	Breathing techniques reduce symptoms and improve quality of life in serious respiratory illness.	10.1183/16000617.0012-2024	7/11
19	2012	Holland A.E., et al.	Cochrane systematic review	Breathing exercises (diaphragmatic/pursed-lip) improved dyspnea and respiratory function in COPD.	10.1002/14651858.CD008250.pub2	7/11

DISCUSSION

Breathing exercises play a vital role in improving respiratory mechanics, enhancing diaphragmatic function, and supporting efficient gas exchange. IMT strengthens the inspiratory muscles, alleviating diaphragmatic load and improving cardio-respiratory interactions . Evidence strongly supports early and structured respiratory physiotherapy, which reduces complications, accelerates recovery, and enhances quality of life for patients with chronic and acute respiratory conditions . Despite differences in study protocols, the overall benefits of these interventions are consistently positive.

Pulmonary oedema is a serious condition where fluid builds up in the lungs' air sacs, making it hard for oxygen to pass into the blood. This leads to shortness of breath, low oxygen levels, and difficulty in breathing. Physiotherapy, particularly targeted breathing exercises, plays a crucial role in improving lung function and speeding up recovery in these patients. [1].

Various breathing techniques such as diaphragmatic breathing, pursed-lip breathing, segmental breathing, inspiratory muscle training, and the Active Cycle of Breathing Technique have been shown to improve ventilation, boost oxygen levels, reduce breathing effort, and help clear lung secretions. Diaphragmatic breathing, for instance, strengthens the diaphragm, increases the amount of air taken in with each breath, and reduces overuse of accessory muscles, helping patients feel less breathless [9]. Pursed-lip breathing helps keep airways open, allowing better alveolar expansion and improving oxygenation [10].

Evidence from experimental studies, randomized controlled trials, and observational studies shows that patients who regularly practice these breathing exercises experience measurable improvements in lung function, physical capacity, and self-reported breathlessness. For example, inspiratory muscle training and diaphragmatic exercises have been found to increase exercise tolerance and reduce shortness of breath in patients with heart failure, which are key outcomes for managing pulmonary oedema [3,4]. The Active Cycle of Breathing Technique has also proven effective in clearing lung secretions and reducing post-surgical pulmonary complications in patients at risk of fluid accumulation in the lungs [17].

It is important to remember that while breathing exercises provide substantial benefits, they should be used alongside standard medical treatment, including medications and careful monitoring of heart and lung function. Safety measures such as keeping track of oxygen levels, heart rate, and blood pressure are essential during physiotherapy sessions, especially in patients with acute or unstable pulmonary oedema [1].

CONCLUSION

The studies published between 2000 and 2025 clearly show that breathing exercises and respiratory rehabilitation are highly effective in improving lung function and slowing disease progression in both acute and chronic respiratory conditions. Techniques such as diaphragmatic breathing, inspiratory muscle training (IMT), active cycle of breathing techniques (ACBT), and structured pulmonary rehabilitation programs consistently improve lung aeration, inspiratory muscle strength, oxygen levels, and ventilator weaning success, while also reducing postoperative and long-term pulmonary complications.

Starting these interventions early and following structured programs not only helps the body recover physically but also supports better daily functioning and overall quality of life. Because these approaches are safe, non-invasive, cost-effective, and patient-friendly, they should be an essential part of everyday clinical care to promote faster recovery, prevent disease worsening, and maintain long-term respiratory health.

CONFLICT OF INTEREST:

The author declares no conflict of interest.

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