

Active Cycle of Breathing Technique for Airway Clearance in COPD: A Systematic Review

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is characterized by persistent airflow limitation accompanied by impaired mucociliary clearance and sputum retention, contributing to dyspnea, reduced pulmonary function, and decreased quality of life. Active Cycle of Breathing Technique (ACBT) is widely used in pulmonary rehabilitation to facilitate airway clearance; however, evidence regarding its effectiveness in COPD remains inconsistent.

Objective: To synthesize evidence from randomized controlled trials (RCTs) regarding the effectiveness of ACBT in improving airway clearance among adults with COPD.

Methods: A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guideline. PubMed, ScienceDirect, Cochrane Library, and Google Scholar were searched for RCTs published between 2020 and 2025. Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) Scale, and risk of bias was evaluated using the Cochrane Risk of Bias 2 tool.

Results: Four RCTs involving 189 participants were included. Compared with usual care, ACBT significantly increased 24-hour sputum production ($p=0.025$), improved FEV_1/FVC ($p<0.0001$), and increased oxygen saturation ($p=0.003$). Combined interventions demonstrated greater improvements in FEV_1 ($p=0.004$) and FVC ($p=0.023$) than ACBT alone. Both ACBT and Buteyko Breathing Technique improved dyspnea and quality of life, although the latter showed greater post-treatment improvement.

Conclusion: Evidence from four RCTs suggests that ACBT provides potential benefits for improving airway clearance and selected respiratory outcomes in adults with COPD. Nevertheless, the certainty of evidence remains limited because of the small number of studies, methodological heterogeneity, and combination interventions that preclude isolation of the independent effect of ACBT.

Keywords:

Chronic Obstructive Pulmonary Disease; Pulmonary Rehabilitation; Physical Therapy Modalities; Respiration; Airway Management.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder characterized by persistent airflow limitation resulting from structural abnormalities of the airways and alveoli, primarily caused by prolonged exposure to harmful particles or gases.¹ The disease is accompanied by chronic airway inflammation, mucus hypersecretion, destruction of lung parenchyma, and impaired mucociliary clearance, all of which contribute to progressive respiratory dysfunction.² According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2025 report, COPD remains the third leading cause of death worldwide and continues to impose a substantial clinical, economic, and social burden because of frequent exacerbations, repeated hospitalizations, and long-term disability. Although pharmacological management plays an essential role in symptom control and exacerbation prevention, international guidelines consistently recommend pulmonary rehabilitation as a key component of comprehensive COPD management because of its proven benefits in improving functional capacity and health-related quality of life.^{3,4}

Among the clinical manifestations of COPD, excessive mucus production and impaired airway clearance are particularly common in patients with chronic bronchitis and during acute exacerbations.² Retained airway secretions increase airflow resistance, promote ventilation-perfusion mismatch, impair gas exchange, and increase the work of breathing, ultimately worsening dyspnea, exercise intolerance, and quality of life.² Persistent mucus retention also facilitates bacterial colonization and recurrent respiratory infections, thereby increasing the frequency of exacerbations and accelerating disease progression.⁵ Consequently, effective airway clearance has become an important therapeutic target within pulmonary rehabilitation to improve respiratory mechanics and reduce symptom burden.²

Active Cycle of Breathing Technique (ACBT) is one of the most frequently implemented airway clearance techniques in respiratory physiotherapy because it is inexpensive, easy to perform, and does not require specialized equipment.⁶ The intervention consists of three sequential components, namely breathing control, thoracic expansion exercises, and the forced expiratory technique (FET).⁷ These components work synergistically to mobilize bronchial secretions from peripheral to central airways, facilitating sputum expectoration while minimizing dynamic airway collapse and excessive respiratory effort.⁷ Through these physiological mechanisms, ACBT is expected to improve airway patency, optimize ventilation, reduce dyspnea, and enhance respiratory efficiency.⁸ Previous evidence has also suggested that airway clearance techniques may improve mucus transport and respiratory outcomes in selected patients with COPD, particularly those with excessive sputum production.^{2,9}

Several randomized controlled trials (RCTs) have evaluated the effectiveness of ACBT in patients with COPD; however, the findings remain inconsistent.⁸ Gulati et al. reported that ACBT combined with autogenic drainage improved sputum expectoration more effectively than conventional physiotherapy, whereas improvements in dyspnea were comparable between groups. Shen et al. demonstrated that ACBT significantly increased 24-hour sputum production, improved the FEV_1/FVC ratio, and enhanced oxygen saturation compared with usual care in hospitalized patients with COPD.⁸ Conversely, Baig et al. found that although ACBT

significantly improved dyspnea and health-related quality of life, Buteyko Breathing Technique produced greater post-intervention improvements.¹⁰ Similarly, Sabir et al. observed superior improvements in pulmonary function when ACBT was combined with the Acapella device compared with ACBT alone. These findings suggest that the magnitude of treatment benefit may depend on comparator interventions, treatment protocols, and patient characteristics.¹¹

Despite the growing body of evidence, important methodological limitations remain.² Existing RCTs differ considerably in sample size, intervention duration, treatment frequency, comparator interventions, disease severity, and outcome measures.¹¹ Moreover, several studies evaluated ACBT in combination with other airway clearance techniques, making it difficult to isolate the independent therapeutic effect of ACBT.¹¹ Such clinical and methodological heterogeneity complicates direct comparison across studies and limits the certainty of evidence available for clinical decision-making.^{2,12} Furthermore, previous reviews have generally evaluated multiple airway clearance techniques collectively or included heterogeneous respiratory disorders, providing limited evidence specifically focused on ACBT in patients with COPD.¹³

Therefore, an updated systematic review restricted to randomized controlled trials is warranted to provide a comprehensive synthesis of the current evidence regarding the effectiveness of ACBT in COPD. By focusing exclusively on randomized studies and incorporating recent evidence published between 2020 and 2025, this review aims to provide a more rigorous evaluation of airway clearance, pulmonary function, dyspnea, oxygen saturation, functional capacity, and health-related quality of life. The findings are expected to support evidence-based physiotherapy practice, assist clinicians in selecting appropriate airway clearance interventions, and identify priorities for future research in pulmonary rehabilitation.

Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Statement to identify, critically appraise, and synthesize evidence regarding the effectiveness of the Active Cycle of Breathing Technique (ACBT) for improving airway clearance in patients with Chronic Obstructive Pulmonary Disease (COPD). The review protocol was developed before the literature search but was not prospectively registered in PROSPERO or the Open Science Framework (OSF), which should be considered a methodological limitation.¹⁴

A systematic literature search was conducted between January and June 2026 using four electronic databases: PubMed, ScienceDirect, Cochrane Library, and Google Scholar. Eligible studies were published between January 2020 and December 2025 in either English or Indonesian. The search strategy combined Medical Subject Headings (MeSH) and free-text terms using Boolean operators. The principal search syntax was ("Active Cycle of Breathing Technique" OR ACBT) AND ("Chronic Obstructive Pulmonary Disease" OR COPD) AND ("Airway Clearance" OR "Sputum Clearance") AND ("Randomized Controlled Trial" OR randomized OR RCT). The search strategy was adapted according to the indexing system of each database, and the reference lists of all eligible studies were manually screened to identify additional relevant publications.

Study eligibility was determined using the Population, Intervention, Comparator, Outcome, and Study Design (PICOS) framework. Studies were included if they employed a randomized controlled trial design, involved adults diagnosed with COPD, evaluated ACBT either as a standalone intervention or in combination with another physiotherapy intervention, compared ACBT with usual care, conventional physiotherapy, or another airway clearance or breathing intervention, and reported at least one outcome related to airway clearance, pulmonary function, dyspnea, oxygen saturation, functional capacity, or health-related quality of life. Studies were excluded if they were systematic reviews, meta-analyses, conference abstracts, editorials, letters, study protocols, duplicate publications, non-randomized studies, animal studies, or involved respiratory diseases other than COPD.

All retrieved citations were exported into Mendeley Desktop for duplicate removal. Two reviewers independently screened titles and abstracts, followed by full-text assessment according to the predefined eligibility criteria. Any disagreement regarding study eligibility was resolved through discussion until consensus was achieved. The study selection process followed the PRISMA 2020 guideline and is presented in Figure 1.

Data extraction was independently performed by two reviewers using a standardized data extraction form developed before the review commenced. Extracted information included author, publication year, country, participant characteristics, sample size, intervention protocol, comparator intervention, treatment duration, outcome measures, principal findings, methodological quality, and risk of bias. Any discrepancies identified during data extraction were resolved through discussion until agreement was reached. Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) Scale, which was specifically developed to evaluate randomized controlled trials in physiotherapy research. The PEDro Scale consists of 11 items, with Items 2–11 contributing to a maximum score of 10 points. Studies scoring 9–10 were classified as excellent quality, 6–8 as good quality, 4–5 as fair quality, and ≤3 as poor quality.⁸ Risk of bias was evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool across five domains: bias arising from the randomization process, deviations from intended interventions, missing outcome data, outcome measurement, and selection of reported results. Each study was classified as having low risk of bias, some concerns, or high risk of bias according to the RoB 2 guidance.⁹

Because substantial heterogeneity was identified across participant characteristics, intervention protocols, comparator interventions, treatment duration, and outcome measures, statistical pooling was considered inappropriate. Therefore, the findings were synthesized using a narrative synthesis approach. The direction and consistency of treatment effects were compared across studies while considering methodological quality and risk of bias. Greater emphasis was placed on findings from studies with higher PEDro scores and lower risk of bias to provide a balanced interpretation of the available evidence.^{8,9}

Results

A comprehensive literature search was performed across four electronic databases (PubMed, ScienceDirect, Cochrane Library, and Google Scholar). Following duplicate removal, titles and abstracts were screened according to the predefined eligibility criteria, after which potentially relevant articles underwent full-text assessment. Ultimately, four randomized controlled trials (RCTs) involving 189 participants fulfilled all inclusion criteria and were included in the qualitative synthesis. The complete study selection process is illustrated in Figure 1 (PRISMA 2020 Flow Diagram), which summarizes the identification, screening, eligibility assessment, reasons for exclusion, and final study inclusion.

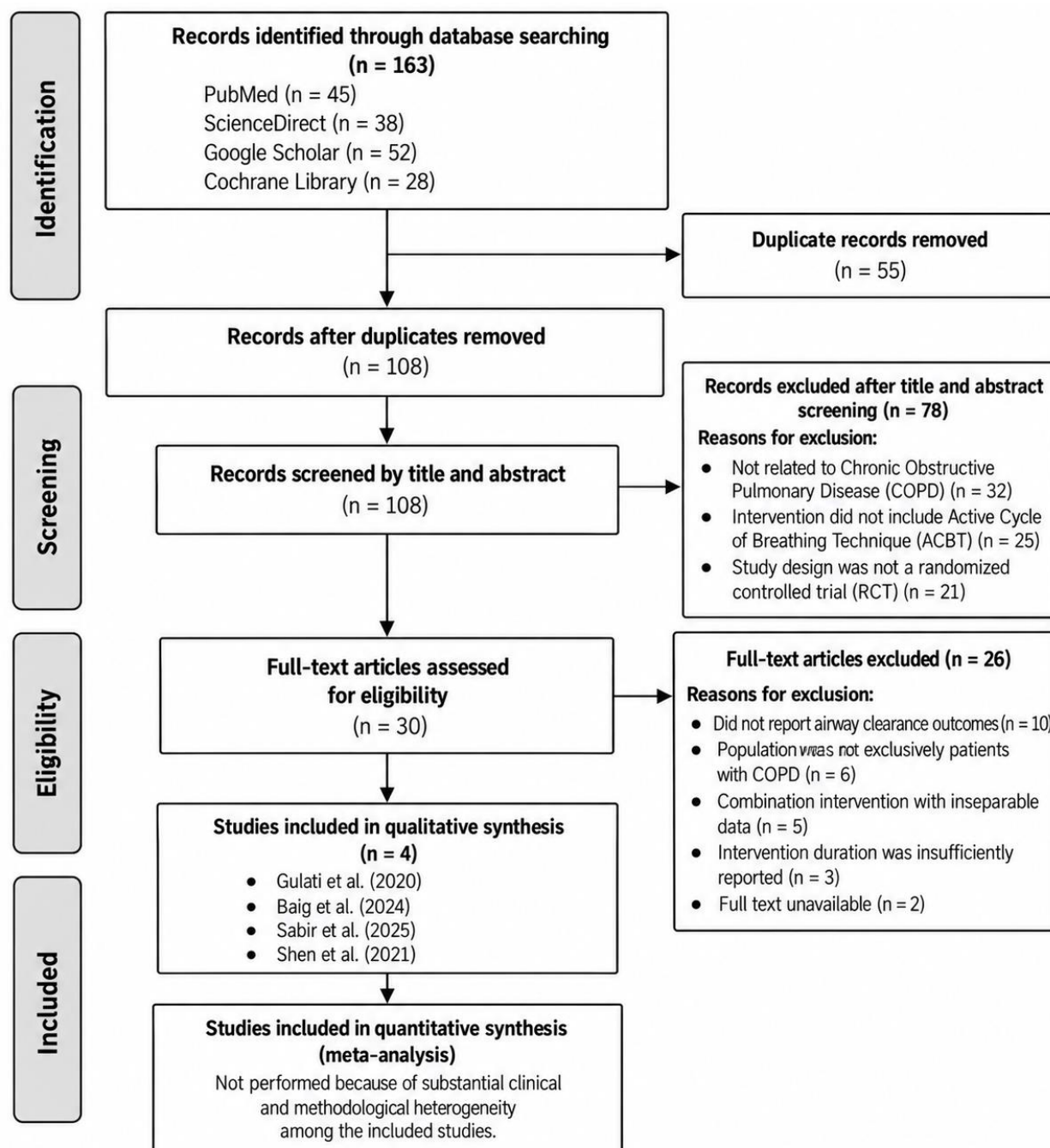


Figure 1. PRISMA 2020 Flow Diagram

The four included randomized controlled trials comprised a total of 210 participants with COPD and were conducted in India, China, and Pakistan between 2020 and 2025. Sample sizes ranged from 20 to 96 participants. All studies evaluated ACBT either as a standalone intervention or in combination with another airway clearance technique. Comparator interventions included conventional physiotherapy, usual care, the Buteyko breathing technique, and ACBT alone. Intervention duration varied considerably, ranging from an immediate treatment session to six weeks. The primary outcomes included sputum expectoration, pulmonary function, dyspnea, oxygen saturation, health-related quality of life, and symptom severity. Overall, all included studies reported beneficial effects of ACBT on one or more clinical outcomes, although the magnitude of improvement differed according to the intervention protocol and comparator. The characteristics of the included studies are summarized in Table 1.

Table 1. Characteristics and methodological quality of the included studies.

Author (Year)	Country	Participants	Intervention	Comparator	Duration	Outcome Measures	Main Findings	PEDro (/10)	Overall RoB 2
Gulati et al. (2020)	India	20 patients with COPD (40–70 years)	ACBT + Autogenic Drainage	Conventional physiotherapy	Immediate (single treatment session)	Sputum production, dyspnea	Both groups improved, but ACBT combined with autogenic drainage resulted in greater sputum clearance.	6	Some concerns
Shen et al. (2021)	China	96 hospitalized patients with acute exacerbation of COPD	ACBT	Usual care	1 week	FEV ₁ /FVC, SpO ₂ , CAT score, sputum clearance	ACBT significantly improved sputum clearance, pulmonary function, oxygen saturation, and symptom scores compared with usual care.	8	Low
Baig et al. (2024)	Pakistan	40 patients with stable COPD	ACBT	Buteyko Breathing Technique	6 weeks	Dyspnea, quality of life (SGRQ)	Both interventions improved outcomes, although the Buteyko Breathing Technique demonstrated greater improvements in dyspnea and quality of life.	6	Some concerns
Sabir et al. (2025)	Pakistan	54 patients with COPD	ACBT + Acapella	ACBT alone	4 weeks	FEV ₁ , FVC, dyspnea	The combination of ACBT and Acapella produced greater improvements in pulmonary function and dyspnea than ACBT alone.	6	Some concerns

Overall methodological quality was moderate to good based on the Physiotherapy Evidence Database (PEDro) Scale. PEDro scores ranged from 6 to 8 out of a possible 10 points. One study achieved a score of 8, indicating good methodological quality, whereas the remaining three studies scored 6, reflecting moderate methodological quality. Common methodological limitations included the absence of concealed allocation, lack of blinding of participants and therapists, and limited use of intention-to-treat analysis. Despite these limitations, all studies reported between-group comparisons and appropriate statistical analyses, supporting the overall reliability of the findings. The detailed PEDro assessment is presented in Table 2.

Table 2. Methodological quality assessment using the PEDro Scale.

PEDro Criteria	Gulati et al. (2020)	Shen et al. (2021)	Baig et al. (2024)	Sabir et al. (2025)
Eligibility criteria*	✓	✓	✓	✓
Random allocation	✓	✓	✓	✓
Concealed allocation	X	✓	X	X
Baseline comparability	✓	✓	✓	✓
Blinding of participants	X	X	X	X
Blinding of therapists	X	X	X	X
Blinding of assessors	X	✓	X	X
Adequate follow-up (>85%)	✓	✓	✓	✓
Intention-to-treat analysis	X	✓	X	X
Between-group statistical comparison	✓	✓	✓	✓
Point estimates and variability	✓	✓	✓	✓
Total PEDro Score (/10)	6	8	6	6

The risk of bias assessment using the Cochrane Risk of Bias 2 (RoB 2) tool indicated that one study was judged to have a low overall risk of bias, whereas the remaining three studies were classified as having some concerns. Most concerns were related to the randomization process and deviations from the intended interventions, while the domains of missing outcome data, outcome measurement, and selective reporting were generally considered to present a low risk of bias. No study was judged to have a high overall risk of bias. These findings suggest that the available evidence is generally reliable, although several methodological limitations should be considered when interpreting the results. The detailed risk of bias assessment is presented in Table 3.

Table 3. Risk of bias assessment using the Cochrane RoB 2 tool.

Study	Randomization Process	Deviations from Intended Interventions	Missing Outcome Data	Measurement of Outcome	Selection of Reported Results	Overall Risk
Gulati et al. (2020)	Some concerns	Some concerns	Low	Low	Low	Some concerns
Shen et al. (2021)	Low	Some concerns	Low	Low	Low	Low
Baig et al. (2024)	Some concerns	Some concerns	Low	Low	Low	Some concerns
Sabir et al. (2025)	Some concerns	Some concerns	Low	Low	Low	Some concerns

Narrative synthesis demonstrated that ACBT consistently improved airway clearance by facilitating sputum expectoration across the included studies. Improvements in pulmonary function, including forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), and the FEV₁/FVC ratio, were also reported, although the magnitude of improvement varied among studies. Several trials additionally demonstrated reductions in dyspnea severity, improvements in oxygen saturation, and better health-related quality of life following ACBT interventions. Studies evaluating combined interventions suggested that integrating ACBT with other

airway clearance techniques, such as Acapella therapy or autogenic drainage, may produce greater clinical benefits than ACBT alone. Conversely, one study reported that the Buteyko breathing technique produced greater improvements in dyspnea and quality of life than ACBT, indicating that treatment effectiveness may depend on intervention objectives and patient characteristics. Collectively, the available evidence supports the clinical usefulness of ACBT as an airway clearance intervention for individuals with COPD, while highlighting the need for larger, high-quality randomized controlled trials employing standardized intervention protocols and outcome measures.

Discussion

This systematic review synthesized evidence from four randomized controlled trials evaluating the effectiveness of the Active Cycle of Breathing Technique (ACBT) for airway clearance in patients with COPD. Overall, the included studies demonstrated that ACBT provides beneficial effects on sputum expectoration, pulmonary function, dyspnea, oxygen saturation, and health-related quality of life. Although the magnitude of these improvements varied across studies because of differences in intervention protocols, treatment duration, disease severity, and comparator interventions, the overall findings support the clinical value of ACBT as an airway clearance technique in COPD management. These findings are consistent with current recommendations emphasizing airway clearance techniques as adjunctive interventions for selected patients with excessive sputum production or impaired mucus clearance.²

The primary therapeutic benefit of ACBT lies in its ability to facilitate mucus mobilization and expectoration through a sequence of breathing control, thoracic expansion exercises, and forced expiratory techniques.¹⁵ This combination enhances collateral ventilation, promotes airflow behind retained secretions, and improves mucus transport toward the central airways, thereby facilitating expectoration. The present review demonstrated consistent improvements in sputum clearance across all included studies, regardless of whether ACBT was applied alone or combined with other physiotherapy techniques. These findings support previous evidence indicating that airway clearance interventions improve respiratory mechanics and reduce airway obstruction in patients with chronic sputum retention.

Improvements in pulmonary function were observed in several studies, particularly in forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), and the FEV₁/FVC ratio. These physiological improvements are likely attributable to enhanced airway patency following secretion removal, leading to improved ventilation and gas exchange.¹⁶ However, improvements in spirometric parameters were not consistently reported across all studies, possibly because pulmonary function in COPD is influenced by multiple factors beyond mucus retention, including airway remodeling, emphysematous changes, and disease severity. Consequently, airway clearance interventions such as ACBT should be considered complementary treatments rather than interventions capable of reversing structural pulmonary impairment.

In addition to pulmonary function, several studies reported reductions in dyspnea severity and improvements in health-related quality of life following ACBT. Reduced airway obstruction and improved ventilation may decrease respiratory muscle workload and alleviate the sensation of breathlessness during daily activities. However, one included study demonstrated that the Buteyko Breathing Technique produced greater improvements in dyspnea and quality of life than ACBT.¹⁷ This finding suggests that different breathing interventions may target distinct physiological mechanisms and clinical outcomes. While ACBT primarily focuses on secretion clearance, breathing retraining approaches such as the Buteyko technique may more effectively optimize breathing patterns and reduce ventilatory inefficiency in selected patient populations.

Two studies evaluated ACBT in combination with adjunctive airway clearance techniques, including autogenic drainage and Acapella therapy. Both studies reported greater clinical improvements than ACBT alone or conventional physiotherapy, suggesting that combining complementary airway clearance techniques may enhance secretion mobilization through different physiological mechanisms.¹⁵ Autogenic drainage facilitates secretion movement by modulating airflow at different lung volumes, whereas Acapella therapy combines positive expiratory pressure with airway oscillation to loosen retained mucus.^{18,19} These combined approaches may therefore provide additive therapeutic effects, particularly in patients with substantial mucus accumulation.

The methodological quality of the included studies was generally moderate to good, with PEDro scores ranging from 6 to 8. Three studies demonstrated some methodological concerns, primarily related to concealed allocation and blinding procedures, whereas one study was judged to have a low overall risk of bias. These findings reflect common methodological challenges in physiotherapy trials, where blinding participants and therapists is frequently impractical because of the nature of the intervention. Nevertheless, the absence of studies with a high risk of bias strengthens confidence in the overall findings, although the available evidence should still be interpreted with appropriate caution.¹⁷

Several limitations should be considered when interpreting the findings of this review. First, only four randomized controlled trials met the eligibility criteria, limiting the overall strength of the available evidence. Second, substantial heterogeneity in intervention duration, comparator interventions, participant characteristics, and outcome measures precluded quantitative meta-analysis. Third, several studies investigated ACBT in combination with other airway clearance techniques, making it difficult to isolate the independent therapeutic effect of ACBT. Finally, the review protocol was not prospectively registered, and no formal certainty-of-evidence assessment, such as the GRADE approach, was performed. These limitations should be considered when interpreting the conclusions and highlight the need for further high-quality randomized controlled trials employing standardized intervention protocols and clinically relevant outcome measures.

Overall, the findings of this review support the incorporation of ACBT as part of comprehensive pulmonary rehabilitation and respiratory physiotherapy for patients with COPD, particularly those with excessive sputum production or impaired airway clearance. Future research should include larger multicenter randomized controlled trials with standardized intervention protocols, longer follow-up periods, and consistent outcome measures to determine the long-term effectiveness of ACBT and identify patient populations most likely to benefit from this intervention.⁸

Conclusion

The findings of this systematic review indicate that the Active Cycle of Breathing Technique (ACBT) is an effective airway clearance intervention for patients with Chronic Obstructive Pulmonary Disease (COPD). Across the included randomized controlled trials, ACBT consistently improved sputum expectoration and demonstrated favorable effects on pulmonary function, dyspnea, oxygen saturation, and health-related quality of life. Although the magnitude of improvement varied according to intervention protocols and comparator treatments, the overall evidence supports the incorporation of ACBT into respiratory physiotherapy and pulmonary rehabilitation programs, particularly for patients with excessive sputum production. Nevertheless, the limited number of available randomized controlled trials and the heterogeneity of interventions and outcome measures warrant cautious interpretation. Future

well-designed multicenter randomized controlled trials with standardized intervention protocols and longer follow-up periods are needed to strengthen the evidence regarding the long-term effectiveness of ACBT in COPD management.

Author Contribution

I Made Satya Surya Diputra conceived and designed the study, developed the methodology, conducted the literature search, performed data extraction, interpreted the findings, and drafted the original manuscript.

Laila Nurindah Sari contributed to data analysis, data interpretation, visualization, manuscript drafting, and critical revision of the manuscript.

Anak Agung Sagung Ratih Dwi Yanthi Putri contributed to methodology validation, quality assessment of the included studies, and manuscript review.

I Komang Alit Manacika contributed to interpretation of findings, critical revision of the manuscript, and scientific editing.

Luh Putu Ayu Vitalisyawati contributed to supervision, resource provision, project administration, manuscript review, and approval of the final manuscript for publication.

I Gusti Putu Martha Kusuma contributed to study supervision, project administration, and final manuscript review.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Conflict of Interest Statement

The authors declare that they have no competing interests or conflicts of interest related to this study.

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Ethics Statement

Ethical approval was not required because this study is a systematic review based exclusively on previously published studies and did not involve direct participation of human subjects, collection of identifiable personal data, or experimental interventions. The review was conducted in accordance with the PRISMA 2020 reporting guideline.

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