

Assessing the Impact of Pulmonary Rehabilitation on Health Outcomes of Patients with Chronic Obstructive Pulmonary Disease: A Systematic Review

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HIGHLIGHTS

- Reviews barriers to implementing evidence-based practice in nursing settings
- Synthesises findings from empirical studies across multiple countries and contexts
- Identifies time constraints, limited support, and skill gaps as key challenges
- Highlights both individual and organisational factors affecting EBP uptake
- Discusses implications for strengthening evidence-informed nursing practice

ABSTRACT

Pulmonary rehabilitation (PR) is a core non-pharmacological intervention for chronic obstructive pulmonary disease (COPD), yet the optimal programme duration, the ideal timing and setting for starting pulmonary rehabilitation, factors driving programme completion and adherence remain unclear. This review was conducted to synthesize current evidence on effectiveness of pulmonary rehabilitation in improving exercise capacity and quality of life in patients with COPD, and to appraise the methodological strengths and weaknesses of the existing evidence base. Literature was analysed, including only peer-reviewed quantitative research papers published between January 2015 and December 2024, encompassing randomized controlled trials, cohort studies, quasi-experimental designs, and pilot studies. Critical Appraisal Skills Program (CASP) checklist for quantitative research was employed to evaluate each of the shortlisted papers, narrowing down to a final fifteen papers, for review. Pulmonary rehabilitation was consistently associated with improvements in exercise capacity, respiratory muscle strength, dyspnoea, and quality of life in individuals with COPD. Psychological advantages, such as reduced anxiety and depression, are also prevalent. Evidence indicates that exercise capacity improves within four weeks, eight-week pulmonary rehabilitation programs are equally successful as twelve-week programs, providing flexible alternatives, depending on patient needs, socio-economic context and availability of resources. Early initiation of pulmonary rehabilitation within two weeks of an exacerbation was associated with reduced hospital readmissions and reduced duration of hospital stays. Innovative rehabilitation methods such as Tai Chi, yoga, and singing therapy provide feasible alternatives. Phone supervised, home-based, and online interventions such as hybrid virtual coaching, and nurse-led initiatives have been studied at conceptual level with varying levels of physical and psychological improvements. Health economics, hospital admission rates, length of hospital stays and mortality need to be studied through long-term follow-up studies for rehabilitative interventions, with particular attention to improve long-term adherence and accessibility to PR. Certain studies indicate cognitive advantages when physical rehabilitation is integrated with cognitive training. Nonetheless, methodological constraints, like limited sample numbers and brief follow-up periods, underscore the necessity for more stringent studies. Future research must emphasize extensive, longitudinal controlled trials to enhance evidence and plan to introduce strategies to promote enduring adherence.

KEYWORDS

Chronic Obstructive Pulmonary Disease
Pulmonary Rehabilitation
Exercise Capacity
Quality of Life
Health Outcomes

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is an umbrella term for a group of lung diseases characterised by respiratory symptoms such as dyspnoea, cough and sputum production. These symptoms result from airway and/or alveolar abnormalities, leading to persistent, often progressive airflow limitation. Exacerbations and comorbidities negatively impact the severity of respiratory symptoms, impairment of health-related quality of life, lung function decline, health care utilization, and mortality risk (Global Initiative for Chronic Obstructive Lung Disease, 2026 GOLD Report and Pocket Guide). COPD is usually associated with chronic bronchitis and emphysema.

Additional to genetic, developmental and social factors, COPD is caused by air pollutants and inhaled particulate matter (Li et al., 2025). COPD is progressive, prevalent and is the third leading cause of death worldwide. COPDs can be severe, leading to hospitalization, premature mortality and significant healthcare expenditure. Thus, COPDs are a growing public health concern.

Identifying individuals at risk early in the course of disease, is essential to study risks, outcomes, and optimal interventions, before irreversible structural lung changes and co-morbidities are present (Yang et al., 2025). Studies continue to evaluate both pharmacological and non-pharmacological therapies for patients experiencing exacerbations of COPD (Dobler et al., 2019). Medication non-adherence remains a common challenge in COPD care, as many patients feel burdened by ongoing treatment obligations (Dobler et al., 2019). Non-pharmacological therapies, including smoking cessation and pulmonary rehabilitation (PR), are therefore vital elements of effective COPD management (Yawn & Kim, 2018).

Clinically supervised exercise training, education, and lifestyle counselling are the most commonly used PR techniques. The purpose of these programs is to strengthen cardiovascular and respiratory function, to self-manage symptoms and to improve overall quality of life of patients with a COPD. Evidence suggests that participation in PR programs improve health outcomes and reduces hospital readmission and mortality rates. For example, evaluation of an Education-Based Intervention Program (EBIP) versus standard care found a moderate improvement in dyspnoea and a significant improvement in chronic self-care management among COPD patients (Cevirme & Gokcay, 2020). However, not all patients benefit equally from pulmonary rehabilitation. Between 30% and half of patients who undergo PR are non-responsive. Despite improvements in exercise performance, their functional capacity, perceived sense of quality of life, and reduced symptoms of breathlessness and distress re-

main low, indicating that extrapulmonary treatable traits need addressing such as fatigue, depression, neuroticism, catastrophising and avoidance patterns (Volpato, 2026).

Programme completion itself remains a persistent problem, with higher completion rates when programmes are clinically supervised. A UK clinical evaluation found that only 42% of patients referred to PR completed the programme, with comparable difficulties reported internationally (Jones et al., 2017; Gilworth et al., 2024). Limited program availability, inadequate referral processes and low awareness of PR content and benefits are health system barriers, while knowledge and training of medical staff on PR can improve clinical outcomes for COPD patients (Wang et al., 2025).

The optimal duration of PR programmes, the ideal timing for initiation following an exacerbation, the environmental context of the PR program, impact of delivery mode and patient-related factors underlying poor programme completion and adherence are inconsistently addressed across the literature. Cochrane Review of 2015 defined PR as any programme of at least four weeks duration including exercise therapy with or without education and/or psychological support.

AIM AND OBJECTIVES

This systematic review seeks to consolidate quantitative evidence on the impact of pulmonary rehabilitation on the health outcomes of individuals with COPD, in order to inform improvements to current inpatient and outpatient PR practice, and to identify programme components (such as duration, timing of initiation, and delivery model) associated with improved clinical and functional results. Specifically, it evaluates the effects of pulmonary rehabilitation on exercise capacity, quality of life, symptom management, psychological well-being, and cognitive function, and appraises the methodological strengths and weaknesses of the existing evidence base.

Research question: What types of interventions are available, how are they delivered, and what is the impact of diverse PR interventions on health outcomes in COPD patients?

METHODS AND DESIGN

This research used a systematic review methodology, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria (Page et al., 2021). PubMed, CINHAL Plus, British Nursing database, and Google Scholar, were searched to identify peer-reviewed quantitative research articles published between January 2015 and December 2024. The primary

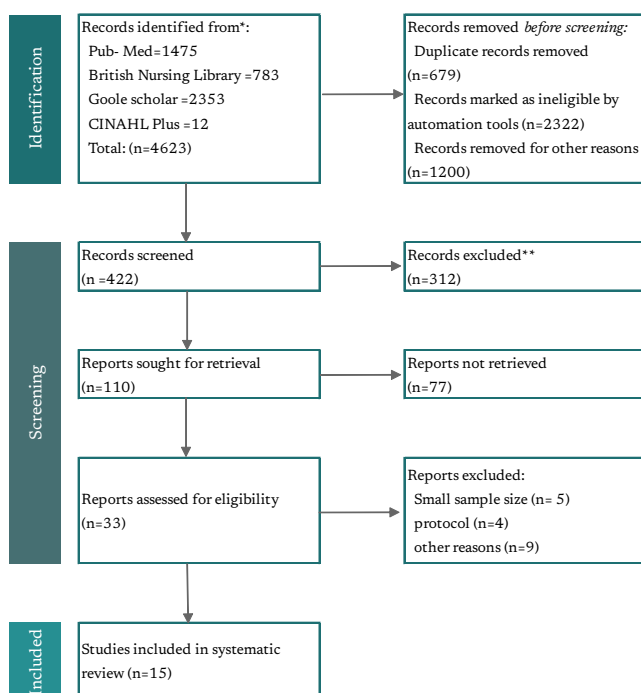
search terms used were “Chronic obstructive pulmonary disease”, “COPD”, “Chronic obstruction”, “Pulmonary Rehabilitation”, “Lung rehabilitation”, “Lung health program”, “Health outcome”, “Health status”, “Health effects” and “Health Impact”. Boolean operators, field codes like [tiab], and truncation * were used. For example, the search string used in PubMed search was "Chronic Obstructive Pulmonary Disease"[Mesh] OR "COPD"[tiab] OR "Chronic obstruction"[tiab]) AND ("Pulmonary Rehabilitation"[Mesh] OR "pulmonary rehabilitation"[tiab] OR "lung rehabilitation"[tiab]) AND ("Health Status"[Mesh] OR "health outcome"[tiab] OR "health status"[tiab] OR "quality of life"[tiab] OR "health-related quality of life"[tiab]).

The papers were reviewed shortlisting studies involving adult patients diagnosed with COPD, including all severities as classified by the Global Initiative for Chronic Obstructive Lung Disease, and were engaged in a pulmonary rehabilitation program that encompassed multiple elements, including fitness training, education, and psychosocial support.

Study Selection- PRISMA flow

Following the elimination of duplicate articles and the application of inclusion and exclusion criteria, a total of 33 articles were assessed through the evaluation of their titles, abstracts, and full texts. A total of 15 articles were chosen for data extraction.

Table 1. PRISMA Flow



Critical Appraisal

Critical Appraisal Skills Program (CASP) checklist for

quantitative research was employed to evaluate each paper. CASP was selected for its effective coverage of the requisite areas for critical appraisal. CASP indicated that ten studies selected for the review were high quality, and four were of medium quality. One was of weak quality, but we chose to include it as it focused on a low-cost community-based PR intervention, integrating PR into a community health and fitness centre. PR maintenance programs are successful when they are integrated within community groups and are clinically supervised (Blervaque et al., 2021). Table 2 and Table 3 shows the appraisal checklist outcomes for the selected fifteen studies.

Study authors were not contacted for missing data; this is acknowledged as a limitation of this review, and the review is not prospectively registered on any dedicated database.

Approach to synthesis: The narrative synthesis approach used in this study involved: (1) tabulating study characteristics, interventions, and outcomes in the data extraction form; (2) coding the reported outcomes and study characteristics inductively, with codes developed directly from the extracted data (e.g., “exercise capacity”, “respiratory muscle strength”, “anxiety/depression”, “programme duration”, “delivery mode”); (3) grouping related codes into candidate themes describing the domains and features of pulmonary rehabilitation most consistently linked to improved outcomes; and (4) reviewing and refining these candidate themes against the full data set. Coding was performed by the first author, with a sample independently checked by the second author; the resulting themes were discussed and finalised by consensus between both authors. Extracted data for the narrative synthesis is provided in Table 4 below.

RESULTS

Positive changes were most consistently observed in the six-minute walk distance (6MWD), respiratory muscle strength metrics (maximum inspiratory pressure, MIP, and maximum expiratory pressure, MEP), health-related quality of life (commonly measured with the St. George Respiratory Questionnaire, SGRQ), and dyspnoea scores. Where studies reported statistical testing, these improvements were generally statistically significant ($p < 0.05$). Together, these investigations point to multiple advantages of pulmonary rehabilitation spanning physiological, psychological, cognitive, and social domains, tailored to the specific requirements of the patient.

These varied studies, ranging from exercise training to mind-body practices and innovative exercise modalities, and community-based maintenance programs demonstrate significant advantages of customized pulmonary rehabilitation interventions in enhancing phys-

Table 2. Critical appraisal tool for quantitative studies (Articles 1-9)

Author/ Year	Kaasgaard et al., 2022		Chiu et al., 2020		Zhang et al., 2023		Liu et al., 2023		Butler et al., 2020		Bishop et al., 2024		Yu-Lin et al., 2024		Camillo et al., 2020		Jiang et al., 2023	
Did the study address a clearly focused question/issue?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Is the research method (study design) appropriate for answering the research question?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Is the method of selection of the research participants clearly described?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Could the way the sample was obtained prevent selection bias?	Can't tell	0	Can't tell	0	No	0	Can't tell	0	No	0	Yes	1	Can't tell	0	Yes	1	Yes	1
Was the study sample representative with regard to the population to which the findings will be referred?	Yes	1	Can't tell	0	Yes	1	Can't tell	0	No	0	Can't tell	0	Can't tell	0	Yes	1	No	0
Was the sample size based on pre-study considerations of statistical power?	Yes	1	Can't tell	0	Yes	1	Can't tell	0	No	0	Yes	1	Yes	1	Can't tell	0	Yes	1
Was satisfactory response rate achieved?	No	0	Can't tell	0	Yes	1	Can't tell	0	No	0	Can't tell	0	No	0	Yes	1	Yes	1
Are the measures (questionnaires) likely to be valid and reliable?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Was the statistical significance assessed?	Yes	1	Yes	1	Yes	1	Yes	1	Can't tell	0	Yes	1	Yes	1	Yes	1	Can't tell	0
Are confidence intervals given for the main results?	Yes	1	Can't tell	0	Yes	1	Yes	1	No	0	Yes	1	No	0	Yes	1	Yes	1

Author/ Year	Kaasgaard et al., 2022		Chiu et al., 2020		Zhang et al., 2023		Liu et al., 2023		Butler et al., 2020		Bishop et al., 2024		Yu-Lin et al., 2024		Camillo et al., 2020		Jiang et al., 2023	
Could there be confounding factors that haven't been accounted for?	Yes	1	Can't tell	0	Yes	1	Can't tell	0	No	0	No	0	Can't tell	0	Yes	1	Yes	1
Can the results be applied to your organisation?	Can't tell	0	Yes	1	Can't tell	0	Yes	1	Can't tell	0	Can't tell	0	Can't tell	0	Yes	1	Yes	1
Ethical approval?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Score Quality	10		7		10		8		5		9		7		12		11	

Yes = 1 Can't tell = 0, No = 0. Score quality rating: 1 to 5 = Low quality, 6 to 9 = Medium quality, and 10 to 13 = High quality

Table 3. Critical appraisal tool for quantitative studies (Articles 10-15)

Author/ Year	Tabka et al., 2023		Belloumi et al., 2024		Williams et al., 2023		Andrianopoulos et al., 2021		Phantayuth et al., 2024		Blervaque et al., 2021	
Did the study address a clearly focused question/issue?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Is the research method (study design) appropriate for answering the research question?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Is the method of selection of the research participants clearly described?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Could the way the sample was obtained prevent selection bias?	Yes	1	No	0	Yes	1	Can't tell	0	Can't tell	0	Can't tell	0
Was the study sample representative with regard to the population to which the findings will be referred?	Yes	1	Yes	1	Yes	1	Yes	1	Can't tell	0	Can't tell	0
Was the sample size based on pre-study considerations of statistical power?	Yes	1	Can't tell	0	Yes	1	Can't tell	0	Yes	1	Yes	1
Was satisfactory response rate achieved?	Yes	1	Yes	1	Can't tell	0	Yes	1	yes	1	Yes	1

Author/ Year	Tabka et al., 2023		Belloumi et al., 2024		Williams et al., 2023		Andrianopoulos et al., 2021		Phantayuth et al., 2024		Blervaque et al., 2021	
Are the measures (questionnaires) likely to be valid and reliable?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Was the statistical significance assessed?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Are confidence intervals given for the main results?	No	0	No	0	Yes	1	Can't tell	0	Yes	1	Yes	1
Could there be confounding factors that haven't been accounted for?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Can the results be applied to your organisation?	Yes	1	Yes	1	Yes	1	Yes	1	Can't tell	0	Can't tell	0
Ethical approval?	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1	Yes	1
Score Quality	12		10		12		10		10		10	

Yes = 1 Can't tell = 0, No = 0. Score quality rating: 1 to 5 = Low quality, 6 to 9 = Medium quality, and 10 to 13 = High quality

Table 4. Extracted data summary

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
1	To investigate the effectiveness of singing for lung health (SLH) as an alternative training modality within pulmonary rehabilitation for COPD patients Kaasgaard et al. (2022, Denmark)	A randomized controlled trial, with 270 COPD patients in eleven community-based PR services across Denmark comparing the effectiveness of Singing for Lung Health (SLH) training to standard physical exercise training (PEXT) in the control group. Intervention was conducted twice weekly for ten weeks (90 minutes /session), with additional weekly PR education sessions for both groups. 28% dropout rate showed comparable adherence to the program by both control and intervention groups.	Changes in QoL, measured by St George's Respiratory Questionnaire Anxiety and depression, measured using Hospital Anxiety and Depression Scale (HADS) Dyspnoea and lung function measured by forced expiratory volume in 1 s (FEV1) (in mL and as FEV1 % predicted), modified Medical Research Council (mMRC) dyspnoea scale and modified Borg category-ratio (Borg-CR10) dyspnoea scale; and adherence to PR.	SLH provided positive clinically relevant physiological and psychological changes in COPD patients, and SLH was non-inferior to PEXT in improving 6MWD post ten weeks in community-based PR settings. -Those who dropped out differed at baseline, showing poorer lung function, shorter 6MWD, higher prevalence and symptoms of current smoking. While SLH findings are comparable to other similar studies, improvement through SLH are lower than outcomes of PR in Cochrane Review, indicating PEXT used may have been not as effective as the one used in Cochrane Review	-study is a short-term proof-of-concept, and SLH require validation in a specialised PR centre As participants were blind to choice of group, outcomes from active choice by patients for SLH need to be investigated Key long-term outcomes such as hospital admission rates, mortality and health economics need investigating.

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
2	To investigate benefits of exercise training to improve respiratory muscle strength and exercise capacity in patients with chronic obstructive pulmonary disease and respiratory muscle weakness. Chiu et al. (2020, Taiwan),	A quasi-experimental study with ninety-seven patients from a hospital outpatient department. Patients were divided into four groups: 1 (normal MIP and MEP); 2 (low MIP); 3 (low MEP); and 4 (low MIP and MEP). Subjects underwent PR for 3 months; MIP, MEP, SGRQ, and CPET were evaluated post-PR.	Maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP), pulmonary function tests, the cardiopulmonary exercise test (CPET), and the St. George's Respiratory Questionnaire (SGRQ) were used.	Subjects with both poor MIP and MEP had the highest dyspnoea score, lowest exercise capacity, and poorest health-related quality of life (HRQoL). PR improved exercise capacity and HRQoL in all groups, with more improvement in MIP, MEP, tidal volume (on exercise), and dyspnea (at rest) in subjects with both low MIP and MEP. - Exercise training alone can enhance respiratory muscle strength, and supplementary inspiratory muscle training (IMT) may not provide further advantages regarding exercise capacity, health-related quality of life (HRQoL), or dyspnoea.	- sample size is small in group 2, 3 and 4. - no long term follows up - there is no control group
3	To assess the effects of a nurse-led, self-managed, home-based, family pulmonary rehabilitation intervention on quality of life and exercise capacity in rural patients with COPD. Zhang et al. (2023, China)	A non-randomized clinical trial of a thirteen-week intervention with 92 rural COPD patients and their families from two hospitals in China, with a follow up telephone supervised ten-month home-based intervention. Intervention included family-based exercise and strength training using pre-prepared manuals for family use. In the first week, intensive training in an education room at the hospital for both patients and their family members followed by weekly respiratory rehabilitation training and exercise training in comparison to routine nursing group who received hospital discharge, drug and rehabilitation guidance only. 20% dropout rate, with 54 males and 20 females completing	Compared SGRQ and 6MWD between the two groups before and after the intervention.	The family pulmonary rehabilitation intervention was safe and well-tolerated. It significantly improved the participants' exercise capacity and quality of life in comparison to the routine nursing intervention.	Sample size was small (74 completed) and was a short-term evaluation. The enthusiasm for PR by completers aged between 65 and 80 may have significantly impacted the outcome Duration and intensity of weekly self-training was not monitored. Intervention time was in autumn and winter which may have impacted participation and outcome. Study did not statistically verify the differences between the two groups before and after the pulmonary rehabilitation

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
4	To test if a combined program of Tai Chi and Conventional PR was more effective than Tai Chi or Conventional PR alone. Liu et al. (2023, China)	A randomized controlled clinical trial with a two-month hospital-based rehabilitation in a 1:1:1:1 ratio: usual care (control group), conventional PR with a total body recumbent stepper (TBRS) exercise (TBRS group), Tai Chi (TC) exercise (TC group), or combined Tai Chi and TBRS exercise (TBRS-TC group); followed by 10 months of home-based rehabilitation A 24-form Yang style, 30-minute Tai Chi exercise was conducted by certified instructors three times a week. Conventional PR was a seated training modality with a trained physiotherapist for 30 minutes thrice weekly. The combined group had 15 minutes of each for thirty minutes thrice weekly. 102 patients with mild to severe COPD were recruited, 85% completed the first two months and 68% completed the follow up home-based training for the next ten months.	The St George's Respiratory Questionnaire (SGRQ) as the primary endpoint was measured at baseline and every two months until the end of the follow-up. 6 min walk distance (6MWD), pulmonary function, the modified Medical Research Council Dyspnoea (mMRC) Scale, the COPD Assessment Test (CAT), the Hospital Anxiety and Depression Scale (HADS), the Berg Balance Scale (BBS) and the Borg scales. Spirometry was performed by using a hand-held spirometer (Medgraphics CPFS/D, USA) in line with American Thoracic Society guideline	All groups showed statistically and clinically significant improvements in exercise capacity. Integrated exercise group showed superior improvement in balance abilities, and decreased anxiety. The changes were significantly greater with TBRS-TC exercise than TBRS or TC alone TBRS exercise led to highest dyspnoea score than the other two exercise modalities. TC group presented a lower Borg fatigue score	Selection bias as those with very severe lung function impairment were excluded for safety and compliance reasons. Single blinded study

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
5	To determine the effectiveness of a post-rehabilitation, community-based maintenance program on exercise tolerance, functional capacity and quality of life. Butler et al. (2020, Canada)	Randomized controlled trial with 98 participants. Control group received standard home exercise instructions from their physical therapist following completion of PR. Intervention group received same instructions as control group with additional membership in a community centre, including enrolment in a community-based maintenance exercise program (endurance and resistance training), with twice weekly classes of one hour duration, with a COPD supervision trained instructor. 22% dropout rate in intervention group and 33% in control group	6MWD was measured at baseline and follow-ups in 2 months and 12 months. Duke Activity Status Index (DASI) was used to measure self-reported functional capacity, the Chronic Respiratory Disease Questionnaire (CRQ) to measure HRQoL, the 30-s chair stand test to infer lower extremity muscle strength and the COPD Self-Efficacy Scale (CSES)	The maintenance program helped to maintain exercise capacity in COPD patients who adhere to the community-based exercise program (attending at least half of the sessions) over one year, with no significant impact of the intervention on lower extremity muscle strength, self-efficacy, or quality of life compared to usual care. Strategies to improve program adherence are important for maximizing benefits, such as telerehabilitation support. Those who dropped out have lower scores on the DASI than those who completed the study ($p < 0.001$).	Higher motivation in individuals who volunteered for the study, even when randomized to the control group, may have positively influenced 6MWD maintenance over 1 year period. Only 39% in intervention program adhered to the community-based program, attending at least 50% of sessions. Age had a positive correlation with self-efficacy scores and all CRQ domains. Females were more likely to accomplish a higher number of sit-to-stands in 30 s, but less likely to be scored high on self-efficacy than males. Fatigue score also increased at 12 months across both groups.
6	To determine whether an 8-week PR programme was equivalent to a 12-week programme in improving endurance exercise capacity in people with COPD. Bishop et al. (2024, Australia)	A randomized controlled equivalence trial with 66 participants undergoing twice weekly supervised PR training by PR trained physiotherapists, at a hospital outpatient department. Training consisted of endurance and strength training with individualised self-management education. Between group comparisons were made at completion of each programme (i.e., week 8 or week 12), and at week 12, and at 6–12-month follow-up for both groups. 76% and 74% of participants completed programmes respectively	Endurance exercise capacity was measured using the endurance shuttle walk test (ESWT) time ¹⁷ with the speed determined by the participant's walking speed during the 6MWT. This was set as the baseline. Anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS)	The twice weekly, supervised, 8-week PR programme was equivalent to the 12-week PR programme at improving endurance exercise capacity at programme completion, week 12, and 6–12-month follow-up, though superiority of the 12-week group could not be excluded. At 6–12-month follow-up, there was a trend for the secondary outcomes to favour the 12-week group with functional exercise capacity and HRQoL being superior. Anxiety and depression were low at baseline for both groups and remained low.	COPD patients with a body mass index >35 kg/m ² ; using long term oxygen therapy (LTOT); musculoskeletal, cardiovascular or neurological conditions which would adversely affect ability to perform exercise was excluded in the study; hence findings are not generalizable to these patients. There was no standardization of assessment periods.

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
7	To evaluate the impact of early initiation of Volume Intensive Spirometry (VIS) on respiratory muscle strength in COPD patients. Yu-Lin et al. (2024, Malaysia).	Randomized prospective study with 34 patients in an acute care unit at a university medical centre. Both control and intervention groups commenced active cycle of breathing techniques (ACBT) and ground-based walking (GBW) training within 72 hours of admission, with thrice daily sessions, supervised by trained therapists. The intervention group received additional volume incentive spirometry (VIS) with requirements to perform 15 deep breaths thrice daily, using B-Spiro 5000. Upon discharge; thrice weekly, 15minutes daily exercise regimen for four weeks with weekly telephone follow-up.	Maximum inspiratory pressure (MIP), maximum expiratory pressure (MEP) and the 6-minute walk test (6-MWT) were used. Symptoms were assessed by the CAT score.	VIS significantly improved patient reported symptoms, and exercise capacity, as demonstrated by the increased 6-minute walk test distance. Starting PR at forty-eight hours post admission is safe, and introducing VIS to ACBT and ground-based walking significantly improved 6MWT	Small sample size, short duration and follow up. Limited blinding and potential bias
8	To compare the effect of pulmonary rehabilitation (PR) comprising downhill walking training (DT) to PR comprising level walking (conventional training (CT)) Camillo et al. (2020, Belgium)	Randomized controlled trial, with 35 patients in an outpatient PR unit at a university hospital for 12 weeks. DT group walked on a treadmill at 10% inclination while CT group walked on neutral inclination, assessed on duration and speed. Safety was assessed with serum creatine kinase levels at baseline and fortnightly.	Measured proportion of patients exceeding 30 metres in 6MWD and compared between groups using Analysis of Covariance adjusted for baseline levels.	Downhill walking on treadmill enhanced functional exercise tolerance, muscle function, symptoms, and quality of life compared to conventional walking training.	The study did not detect the expected benefit in patients who did not exhibit contractile muscle fatigue at baseline

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
9	To investigate the rehabilitative effects of pulmonary-based Qigong exercise (PQE) in stable patients with COPD. Jiang et al. (2023, China)	A randomized controlled assessor blinded clinical trial with 44 participants in a University Hospital of Traditional Chinese Medicine and Western Medicine. Control group received usual care for 3 months, and intervention group received usual care combined with 60 minutes PQE twice a day, every day, for three months PQE consisted of a rearranged programme for stable-COPD patients with nine characteristics: rise-up position, the “hu” and “si” sounds in Liu Zijue, “pushing up the sky to regulate the triple warmer” and “drawing a bow to shoot a vulture” in Ba Duanjin, “crane spread its wings and crane exercise of the crane flies” in Wuqinxi, and “cross-armed iron staff” in Yi Jinjing, restore position. 37 completed the programme	Forced vital capacity (FVC), forced expiratory volume in one second (FEV1), percentage of predicted values of FEV1 (FEV1%pred), FVC% pred, and FEV1/FVC % was measured using Master-screen-PFT, Jaeger, Germany. Skeletal muscle strength was measured with the isokinetic muscle strength test (CON-TREX, Physiomed, Germany) and symptoms of dyspnea are assessed using the Modified Medical Research Council (mMRC) Dyspnoea Scale. The quality of life is assessed using St. George's Respiratory Questionnaire (SGRQ).	PQE was found to be a safe, effective PR method in the family and community rehabilitation of COPD-stable patients. The three-month PQE intervention significantly enhanced exercise capacity, skeletal muscle strength, quality of life, lung function, and dyspnoea in stable COPD patients, indicating it can be used for clinical rehabilitation of COPD.	There was no follow-up, so it is difficult to assess the effect of PQE intervention long term. Women's participation was low hence, gender differences not known
10	To assess the impact of PR combined with cognitive training (CT) on exercise tolerance and cognitive functions, in men with severe COPD Tabka et al. (2023, Tunisia)	A randomized controlled trial with 39 male patients at a rehabilitation centre in a university hospital, with 36 compulsory sessions thrice weekly for 12 weeks. Both control and intervention group completed a structured PR program and education for COPD self-management. Intervention group received additional CT training focusing on attention, memory, concentration and language development	Pulmonary function was measured using a Spirometry Zan 100 (Inspire Health GmbH, Germany) to measure the forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC) and FEV/FVC Dyspnoea was measured using the Borg scale before the start and at the end of the 6MWT. Portable Spiropalm COSMED recorded heart rate (HR) and oxygen saturation (SpO2) continuously throughout the 6MWT. At the end of the 6MWT, the total covered distance was recorded. Cognitive function was assessed using the validated Arabic version of the Montreal Cognitive Assessment Test (MOCA).	There was significant improvement of the 6MWT distance after the rehabilitation period. Improvement in cognitive performance in both groups while latency of the P300 wave at Fz, Cz and Pz were greater in the intervention group indicating that combining CT with PR is feasible for patients with cognitive disorders	The absence of female patients in this study and exclusion of those selected who could not access transport, indicates necessity to consider inclusion strategies for hospital-based studies.

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
13	To identify differential responses to PR between cognitively impaired (CI) and cognitively normal (CN) COPD patients by assessing health status and exercise capacity. Andrianopoulos et al. (2021, Germany)	A pilot study of 3 weeks, with 66 inpatients attending, physician supervised 12 exercise sessions of fifty minutes duration, four times weekly, consisting of cycle ergometry, treadmill walking and resistance exercises, with time and workload progressively increased as tolerated. All patients received COPD self-management education and physical activity counselling. Adherence rate was 92%.	Self-completed HADS, CAT, CRQ, SF-36 questionnaires were explained till fully understood, and supported to complete all items. dyspnoea was assessed by mMRC, quality of life by SGRQ, related COPD symptoms by CAT. The MoCA cognitive test was used to categorize patients as CN or CI.	42% of patients had symptoms of cognitive impairment (CI). CI and CN patients improved their overall health status, global cognitive function, memory skills, and exercise capacity (6MWT and CET duration) Exercise training leads to small to moderate improvements in memory, cognitive performance, and quality of life The relationship between the changes in bodily pain in association with the disease burden (SGRQ impact) and the existence of cognitive impairment remained significant, and CI patients did not show any improvement in the SF-36 bodily pain domain following the PR program, unlike the CN patients.	The three week intense exercise study design indicates physician supervised short duration intense exercise training benefits COPD patients who are cognitively normal or have mildly impaired cognitive function. Perceptions of bodily pain maybe more prevalent in COPD patients with CI, and will require special consideration, in PR interventions.
14	To investigate the feasibility and potential benefits of combining Tai Chi and Yoga (TY combining) program on cardiorespiratory and lung functions, functional fitness, and QoL in older males diagnosed with COPD. (Phantayuth et al., 2024, Thailand)	Randomized controlled trial with 24 males. The TY combining group received a 70-min, thrice weekly program for 12 weeks, while the control group continued their usual routine. TY combined training included 20 forms of Dantien Salee Tai Chi program, 3 Pranayama Yoga techniques and 20 Asana Yoga poses, aimed to improve lower limb strength, balance, endurance, cardiovascular function, flexibility, and respiratory muscle strength.	Assessments were conducted at baseline and at week 12, including pulmonary function tests, quality of life measures, dyspnoea, and fatigue. Functional fitness tests were assessed at baseline, week 4, week 8, and week 12. Spirometry parameters included forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC), percentage of FEV1/FVC (FEV1/FVC%), and maximal voluntary ventilation (MVV).	The TY combining program significantly improved pulmonary function, functional fitness, quality of life, fatigue, and dyspnoea, with no reported adverse event, and was found to be safe and feasible.	The study's small sample size, homogeneity of participants, short intervention duration, lack of attention-matched activities, and limited pulmonary endpoints may limit its statistical power and generalizability. However, rapid improvements in functional fitness was observed within four weeks.

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
11	To evaluate feasibility of a home-designed RR program and analyse its medium-term impact on respiratory parameters and quality of life of rehabilitation adherent (RA) and rehabilitation non-adherent COPD patients Belloumi et al. (2023, Tunisia)	A prospective open label study by the pulmonology department at a respiratory medicine specialist hospital with 74 patients. The home designed program was a four-page written manual including stretching exercises, warm-up, endurance and limb strengthening exercises, water intake and hyper protein diet guidelines for lean patients, and a calendar to record dates when protocol was followed. At the start, patients were explained the protocol at hospital, after initial evaluation and selection for PR Program. A follow-up evaluation was done in four months, at the hospital.	Clinical evaluation of symptoms, using mMRC scale of dyspnoea, COPD assessment test (CAT) score for COPD symptoms, and then a spirometry, a 6-MWT, and a calculation of BODE index at the beginning of the study. BODE index included body mass index, decline of FEV1, severity of dyspnoea, and performance during exercise. Quality of life was assessed by the Arabic Tunisian version of short form 36 (SF-36)	48% of participants adhered to the program. 73% adhered to the prescribed medical treatment. Among 42 smokers, 19 quit smoking and 17 completed PR program Adherent patients had a dyspnoea score passing from 2.4 to 1.55 on average. Non-adherent patients had a dyspnoea score passing from 2.1 to 2.5 on average. CAT score in RA group dropped from 23 to 14.5 on average, the difference was statistically significant, while non-adherent patients CAT remained stable at 25 COPD exacerbations and hospitalizations decreased more in adherent individuals than non-adherent patients. There was a positive impact on quality of life after RR at home Program improved symptom control	Regular phone calls to patients and putting patients in groups could have improved adherence. Physician to Patient relationship has to be strong for home-based program adherence. Patients with heavy co-morbidities should be avoided for home-based rehabilitation. While home-based rehabilitation maybe a suitable alternative for women with low financial and transport access, gender of participants is not given in this study
12	To explore whether a comprehensive pulmonary rehabilitation program (CPRP) with Cognitive Behaviour Therapy for breathlessness or social group control (CPRP + SC) significantly improved health outcomes of COPD patients Williams et al. (2023, Australia)	A single centre randomized controlled trial with 101 patients with moderate obstructive airways. An 8-week intervention which included twice weekly, 45 minutes, group-based exercise sessions and two one-hour self-management education sessions each week; the CPRP+CBT group received an additional one-hour, group-based CBT session weekly, while the CPRP+SC group attended a weekly one-hour social group session to match time spent.	Using the six-minute walk test (6MWT), Hospital Anxiety and Depression scale (HADS-A and HADS-D), Multidimensional Dyspnoea Profile (MDP), Dyspnea-12 (D-12), Chronic Respiratory Disease Questionnaire (CRQ), accelerometry, and Multimedia Activity Recall for Adults and Children (MARCA).	Structured cognitive behavioural therapy intervention for breathlessness did not improve breathlessness beyond standard pulmonary rehabilitation (possibility that qualified PR trainers embed CBT automatically). The Control group who had an hour of social interaction recorded improvements in breathlessness sensation.	Single-Centre Design and Limited Generalizability

#	Aim of study, Author(s)/ Year/Country	Study design and setting	Data collection tools	Outcome of intervention	Limitations & recommendations
15	To assess the change in out-comes and survival probability for 1 to 5 years after PR pro-gram discharge in COPD patients following a medically super-vised PR maintenance pro-gram supported by com-munity-based self-help associations. Blervaque et al. (2021, France)	Data were prospectively collected from 144 COPD patients who followed a prag-matic multidisciplinary PR maintenance program for 1 to 5 years. Self-help patient associations provided a PR maintenance program comprising of (1) individualized exercise training (~ 42 sessions/year), (2) two annual health education classes of 6 hours duration per session, and (3) psy-chological support (~ 2.5 sessions/year).	The participants were assessed yearly for 6MWD, HRQoL (VQ11) and dyspnoea (MRC). The 5-year survival probability was compared to that of a control PR group without a maintenance program. Exercise ability, as assessed by the 6-minute walk distance, was sustained for up to 4 years in patients who had a favourable response to pulmon-ary rehabilitation.	Maintenance program patients showed significant PR benefits at 4 years for 6MWD and HRQoL (VQ11) and 5 years for MRC. The 5-year survival probability was higher than for PR patients without PR maintenance. Two clusters of response to long-term PR were identified, with re-sponders being the less severe COPD pa-tients.	Maintenance program sessions are clinic-ally supervised by healthcare professionals ensuring immediate constructive feedback and structured sessions. Self-help com-munities may provide long term exercise adherence through psychological support and group interactions.

ical function and exercise capacity in COPD patients. Traditional pulmonary rehabilita-tion exercises consistently improve lung function and exercise capacity in patients with COPD, serving as a fundamental advantage across diverse modalities (Tonga & Oliver, 2023). Integrating complementary exercise methods such as Pilates, Tai Chi including Liuzijue and Singing with traditional pulmonary rehabilitation produce greater im-provements in exercise capacity, fatigue reduction, balance, health-related quality of life, and anxiety reduction long-term, with improved lung function (Barbosa et al., 2024, Liu et al., 2024).

Pulmonary rehabilitation has also been studied alongside psychological therapies such as cognitive behavioural therapy (CBT) to reduce anxiety, depression, and stress in COPD patients when used as an adjuvant therapy; the present review's own included evidence does not confirm this, while it appears that cognitive function is improved by engaging in PR exercises. Further trials within a PR context are needed of how cognitive training, PR training and social engagement provided through these interventions inter-act and support patients' overall health and wellbeing and improve sensations of pain and breathlessness. Overall, this evidence supports a comprehensive COPD manage-ment approach that combines pulmonary rehabilitation with psychological and social support to improve quality of life and psychological well-being in this patient group, though the evidence for adjunctive CBT specifically remains mixed. Identifying indi-vidual personality traits, socio-emotional needs, neurological-sensory requirements and

adapting interventions for individualised support and coaching may be essential for those with specific cognitive, social, emotional, and sensory needs (Volpato, 2026).

Adaptable, flexible, personalized therapies, along with enduring adherence meth-ods, enhance results and maintain the advantages of pulmonary rehabilitation in COPD care. Chinese and Indian traditional breathing and movement exercises may also en-hance culturally sensitive approaches to low-impact therapy modalities enabling for wider patient preference inclusion in designing PR interventions without negative out-comes. Well-designed home-based rehabilitation programs with nurse-led weekly fol-low up, can result in sustained symptom management, decreased exacerbations, and en-hanced quality of life for compliant participants, rendering them a viable alternative in environments with constrained hospital resources or patient mobility issues. Yu-Lin et al. (2024) indicated that it is safe to start PR post 48 hours from hospital ad-mission for COPD exacerbation, using volume incentive spirometry (VIS) and active breathing strategies. Doing so improved symptoms, exercise capacity, and overall health status, with suggestions for prolonged application to fortify respiratory muscles. Bishop et al. (2024) discovered that programs of shorter duration (8 weeks) were equally bene-ficial as those of longer duration (12 weeks), enabling services to reconcile patient pref-erences, resource limitations, and healthcare expenditures while preserving therapeutic advantages. Andrianopoulos et al. (2021)'s model of clinically supervised, intense, tar-geted PR training of short duration, with additional pain management therapeutic sup-

port, can benefit both patients with mild cognitive impairment, often associated with COPDs, and those identified as cognitively normal.

Taken together, these studies indicate that each flexible modality addresses a distinct barrier to PR completion and adherence (Kaasgaard et al., 2022; Phantayuth et al., 2024); telephone supervised, home-based delivery addresses mobility and access barriers and was linked to better completion and reduced exacerbations among compliant participants (Belloumi et al., 2024); and clinically supervised short programmes address resource and time constraints with the additional benefits of developing physician doctor rapport, immediate feedback and medical support (Bishop et al., 2024). This pattern suggests that matching PR delivery format to a patient's specific barrier to participation, rather than offering a single standard programme, may be an important lever for improving adherence and completion.

Kaasgaard et al. (2022) recommended to explore long-term effects of PR on healthcare usage, hospital admission rates and mortality as health economics is a significant aspect which needs to be researched. Beyond the studies included in this review, broader systematic reviews and meta-analyses similarly report that early pulmonary rehabilitation improves exercise tolerance (e.g., 6MWD), quality of life, and dyspnoea, with no substantial adverse effects, and that initiating PR within the initial days to weeks following an exacerbation is associated with better functional recovery and clinical outcomes (Hsin-Yueh Lu et al., 2023). Exercise capacity improves by adding lower-limb strengthening exercises (Ward et al., 2025). These external reviews were not part of the 15 studies analysed here and are cited only as corroborating context.

Subsequent research indicates that substantial enhancements in endurance capacity and health-related quality of life (HRQoL) manifest during the initial four to eight weeks of pulmonary rehabilitation (PR), with the most pronounced benefits often observed early in the program. Consequently, shorter-duration regimens may provide the majority of benefits, particularly for individuals with mild to severe COPD (Bishop et al., 2024). Early pulmonary rehabilitation enhances exercise capacity metrics without prolonging hospital stay or elevating mortality risk. Furthermore, early pulmonary rehabilitation following exacerbation is associated with a reduced risk of hospital readmissions and enhanced functional outcomes, indicating its therapeutic efficacy and safety. Starting PR within the initial days to weeks following exacerbation is ideal to enhance recovery without extending stay (Kjærsgaard et al., 2020). This has implications for the practice of managing COPD. Medical staff should encourage early pulmonary rehabilitation after COPD exacerbations by

referring patients to PR Programs, and support patient adherence through education, psychosocial care, and flexible rehabilitation options like telephone supervised, home-based or culturally adapted programs. Monitoring exercise capacity, addressing mental health, and other medical needs are key clinical responsibilities, which need to be coordinated to ensure adherence.

The research confirms the benefits of pulmonary rehabilitation but also highlights several methodological limitations and shortcomings. Issues such as small sample sizes, short intervention periods, lack of control groups, and insufficient blinding may introduce bias. Sample composition was also a limitation: several included studies were male-only or not gender-balanced (e.g., Tabka et al., 2023, was conducted exclusively in male patients), which limits the generalisability of findings, particularly given that gender has itself been reported to influence PR outcomes (Spielmanns et al., 2016). Findings were further constrained by heavy reliance on within-group comparisons in some studies, and by heterogeneous and often short follow-up periods, meaning most reported benefits reflect short- to medium-term rather than confirmed long-term outcomes.

Recommendations from the reviewed articles for future studies include (1) Screen COPD patients for respiratory muscle weakness, and to provide exercise training to improve respiratory muscle strength in PR programs. Always measure change in exercise capacity from baseline to follow-up (2) Prioritize PR for COPD patients with severe respiratory muscle weakness, (3) Implement long term self-help, medically supervised, group based maintenance program, (4) Monitor patient regularly using planned long term assessments, (5) Encourage and support adherence through cognitive education, guidelines, minimal attendance requirements to at least 50% attendance and follow up, (6) Effective pain management during PR is essential, since it may restrict exercise ability. Screening for chronic knee pain or orthopaedic deformities is recommended. (7) Nurse led, home-based, self-managed PR with follow up telephone based weekly reviews works in rural settings with minimal access to health services. This model can work for those with moderate COPD and fewer co-morbidities, reducing long waitlists for clinician and therapist based supervised training in health centres, and reduce expenditure for long-duration PR, (8) Simple instructions and self-monitoring tools help, (9) Remote and virtual coaching may increase long-term advantages, (10) Pulmonary-based Qigong exercises can be used as an alternative exercise program for COPD-stable patients in family and community rehabilitation, (11) active choice for Singing based PR may provide significant outcomes, (12) Downhill walking may prove beneficial to those resistant to contractile muscle fatigue

(CMF) with standard training, and (13) consider patient preference and patient's cognitive, social, emotional, neurological needs, for the type of PR provided, and additional support.

Larger, longer-duration, gender-balanced, and rigorously controlled studies are necessary to strengthen the evidence supporting pulmonary rehabilitation interventions. Adherence to programs post four-month duration is low, making long-term impact difficult to assess. However, Blervaque et al. (2021)'s study in France indicates that self-help community-based maintenance programs can improve survival rate beyond five years for those who respond to PR.

CONCLUSION

This systematic review evaluated fifteen studies regarding the usefulness of pulmonary rehabilitation programs in enhancing health outcomes for individuals with Chronic Obstructive Pulmonary Disease (COPD). The data suggest that pulmonary rehabilitation is consistently associated with improvements in exercise capacity, physical function, quality of life, and psychological well-being. However, the included studies were heterogeneous in design, population, and intervention, and most reported outcomes over short to medium follow-up periods; these findings should therefore be interpreted as evidence of short-term benefit rather than confirmed long-term effectiveness. The need for long-term adherence and maintenance programs, and for larger, longer-duration controlled trials, is emphasized as essential for confirming and preserving the gains attained after early rehabilitation.

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AUTHOR CONTRIBUTIONS

Author one conceptualised the study, developed the methodology, conducted the literature search, screening, data charting, analysis and synthesis, and contributed to drafting and revising the manuscript. Author two contributed to the screening, data charting, interpretation of the findings, and critical revision of the manuscript. Both authors reviewed 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

The authors declare no conflict of interest.

ETHICS APPROVAL

Ethics approval was not required for this systematic review because it involved the review and synthesis of information from publicly available published literature and did not involve human participants, collection of personal data, or any intervention.

USE OF AI-ASSISTED TOOLS

Grammarly was used for grammar checking.