

EFFECTIVENESS OF PULMONARY REHABILITATION PROGRAMS IN COPD PATIENTS

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Abstract

Background: Chronic respiratory diseases are associated with reduced functional capacity, increased dyspnea, and impaired quality of life. Pulmonary rehabilitation has emerged as a key non-pharmacological intervention to address these challenges.

Objective: This study aimed to evaluate the effectiveness of an 8-week structured pulmonary rehabilitation program on dyspnea, exercise capacity, and quality of life among individuals with chronic respiratory conditions.

Methods: A pre-post interventional study was conducted on 60 participants undergoing supervised pulmonary rehabilitation. Baseline assessments were performed prior to the intervention, followed by post-intervention evaluations after 8 weeks. The rehabilitation program was conducted three times per week, with each session lasting 40–45 minutes, including warm-up, aerobic training, breathing exercises, strength training, cool-down, and patient education. Outcome measures included dyspnea (Modified Medical Research Council scale), exercise capacity (6-Minute Walk Test), and quality of life (COPD Assessment Test). Paired sample t-tests were used to assess differences between pre- and post-intervention outcomes.

Results: Significant improvements were observed in all outcome measures following the intervention. Dyspnea scores decreased substantially, indicating reduced breathlessness. Exercise capacity improved significantly, as reflected by increased 6MWT distance. Additionally, quality of life showed marked enhancement, with lower CAT scores post-intervention. All results were statistically significant ($p < 0.001$), with large effect sizes, demonstrating strong clinical relevance.

Conclusion: The structured pulmonary rehabilitation program effectively reduced dyspnea, enhanced functional capacity, and improved quality of life. These findings support its implementation as a standard component of chronic respiratory disease management.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition characterized by persistent airflow limitation, which is not fully reversible. It is a major cause of morbidity and mortality worldwide and poses a significant burden on healthcare systems. COPD includes conditions such as chronic bronchitis and emphysema, both of which lead to reduced lung function, breathlessness, chronic cough, and decreased

exercise tolerance (Zhang et al., 2022). The disease is primarily associated with long-term exposure to harmful particles or gases, particularly cigarette smoke, environmental pollution, and occupational hazards. As the disease progresses, patients experience increasing difficulty in performing daily activities, which significantly affects their quality of life (Lamberton et al., 2024).

Pulmonary rehabilitation has emerged as a cornerstone in the non-pharmacological management of COPD. It is a comprehensive, multidisciplinary intervention designed to improve the physical and psychological condition of patients with chronic respiratory diseases. Pulmonary rehabilitation programs typically include exercise training, breathing exercises, education, nutritional counseling, and psychosocial support (Gao et al., 2026). These programs aim to reduce symptoms, improve functional capacity, enhance quality of life, and decrease healthcare utilization. Exercise training is considered the central component of pulmonary rehabilitation. It focuses on improving the endurance and strength of both respiratory and peripheral muscles. Breathing techniques such as diaphragmatic breathing and pursed-lip breathing are also commonly included to improve ventilation efficiency and reduce dyspnea. Additionally, patient education plays a vital role in helping individuals understand their condition, adhere to treatment, and adopt healthier lifestyles (Chen et al., 2026).

Despite the well-established benefits of pulmonary rehabilitation, there remains a gap in its accessibility and implementation, particularly in developing countries. Many patients with COPD do not have access to structured rehabilitation programs due to limited healthcare resources, lack of awareness, and financial constraints (Jenkins et al., 2024). Furthermore, there is variability in the design, duration, and intensity of pulmonary rehabilitation programs across different clinical settings. This lack of standardization

makes it challenging to determine the most effective rehabilitation strategies for COPD patients. Another important gap in the literature is the limited availability of local research evaluating the effectiveness of pulmonary rehabilitation programs in specific populations (Chung et al., 2024). Most studies have been conducted in developed countries, and their findings may not be directly applicable to patients in different socio-economic and healthcare contexts. Therefore, there is a need for more region-specific research to assess the outcomes of pulmonary rehabilitation in diverse patient populations (Li et al., 2022). In addition, although previous studies have demonstrated improvements in exercise capacity and symptom management, there is still a need to further investigate the extent to which pulmonary rehabilitation impacts functional independence and quality of life. Understanding these outcomes is essential for optimizing treatment protocols and ensuring that patients receive the most effective care (Rochester et al., 2023). Therefore, the primary objective of this study was to evaluate the effectiveness of pulmonary rehabilitation programs in patients with COPD. Specifically, the study aimed to assess the impact of a structured rehabilitation program on dyspnea, exercise capacity, and quality of life. The study also sought to determine whether pulmonary rehabilitation could lead to significant improvements in functional performance and overall well-being among COPD patients (Gephine et al., 2023).

The significance of this study lies in its potential to contribute to the growing body of evidence supporting pulmonary rehabilitation as an essential component of COPD management. By evaluating the outcomes of a structured program, this research may provide valuable insights for healthcare professionals in designing effective rehabilitation protocols. The findings may also help promote the integration of pulmonary rehabilitation into routine clinical practice, particularly in settings where such programs are

underutilized (Tabassum et al., 2026). Furthermore, this study highlights the importance of non-pharmacological interventions in managing chronic diseases. While medications play a crucial role in controlling symptoms, they may not fully address the functional limitations experienced by COPD patients. Pulmonary rehabilitation offers a holistic approach that targets both physical and psychological aspects of the disease, thereby improving overall patient outcomes (Jia et al., 2026).

In conclusion, COPD is a debilitating condition that significantly impacts patients' lives. Pulmonary rehabilitation has shown promise in improving symptoms and functional capacity; however, further research is needed to explore its effectiveness in different settings. This study aims to address these gaps by evaluating the outcomes of a structured pulmonary rehabilitation program, ultimately contributing to improved management strategies for COPD patients.

Methodology

Study Design

This study was conducted using a quasi-experimental pre-test and post-test design to evaluate the effectiveness of pulmonary rehabilitation programs in patients with Chronic Obstructive Pulmonary Disease (COPD). This design was selected to assess changes in clinical outcomes before and after the intervention within the same group of participants. It allowed for the evaluation of the direct impact of the pulmonary rehabilitation program on dyspnea, exercise capacity, and quality of life.

Study Setting

The study was carried out in the physiotherapy and rehabilitation department of a tertiary care hospital. The setting provided appropriate facilities, equipment, and professional

supervision required for conducting pulmonary rehabilitation sessions. It also allowed access to a sufficient number of COPD patients receiving routine medical care.

Study Population

The study population consisted of patients diagnosed with COPD who were referred to the physiotherapy department for rehabilitation. Both male and female participants were included in the study. Patients were selected based on predefined inclusion and exclusion criteria to ensure uniformity and reliability of results.

Sample Size and Sampling Technique

A total of 40 participants were included in the study. The sample size was determined based on feasibility and availability of patients during the study period. A convenience sampling technique was used to recruit participants from those attending the physiotherapy department. Eligible patients who met the selection criteria and provided informed consent were enrolled in the study.

Inclusion Criteria

Participants were included in the study if they met the following criteria:

- Diagnosed cases of Chronic Obstructive Pulmonary Disease (COPD) confirmed by a physician.
- Age between 40 and 70 years.
- Clinically stable condition with no recent exacerbations.
- Ability to participate in exercise training.
- Willingness to participate and provide informed consent.

Exclusion Criteria

Participants were excluded if they had:

- Recent cardiac events such as myocardial infarction.
- Severe musculoskeletal or neurological disorders limiting exercise performance.
- Cognitive impairments affecting understanding of instructions.
- Acute exacerbation of COPD during the study period.
- Any other medical condition that contraindicated participation in pulmonary rehabilitation.

Data Collection Tools

Data were collected using standardized and validated assessment tools to measure outcomes:

- **Modified Medical Research Council (mMRC) Dyspnea Scale:**

This scale was used to assess the level of breathlessness experienced by patients during daily activities.

- **Six-Minute Walk Test (6MWT):**

This test was used to evaluate exercise capacity by measuring the distance walked by the patient in six minutes.

- **COPD Assessment Test (CAT):**

This questionnaire was used to assess the impact of COPD on the patient's quality of life.

- **Demographic Data Sheet:**

A structured form was used to record participant details such as age, gender, occupation, and duration of disease.

Intervention Procedure

All participants underwent a structured pulmonary rehabilitation program under the supervision of a qualified physiotherapist. Baseline assessments were conducted prior to the intervention.

The rehabilitation program was conducted over a period of 8 weeks, with sessions held three times per week. Each session lasted approximately 40 to 45 minutes and included the following components:

1. **Warm-up (5–10 minutes):**

Light stretching and low-intensity activities were performed to prepare the body for exercise.

2. **Aerobic Training (15–20 minutes):**

Patients performed walking or stationary cycling at moderate intensity, adjusted according to individual tolerance.

3. **Breathing Exercises (10 minutes):**

Diaphragmatic breathing

Pursed-lip breathing

These techniques were taught to improve ventilation and reduce dyspnea.

4. **Strength Training (10–15 minutes):**

Exercises targeting upper and lower limb muscles using light weights or resistance bands.

5. **Cool-down (5 minutes):**

Gentle stretching and relaxation exercises were performed at the end of each session.

6. **Patient Education:**

Participants received education regarding disease management, smoking cessation, medication adherence, energy conservation techniques, and lifestyle modifications.

The intensity and progression of exercises were individualized based on patient tolerance and clinical condition. Participants were closely monitored throughout the sessions to ensure safety and proper technique.

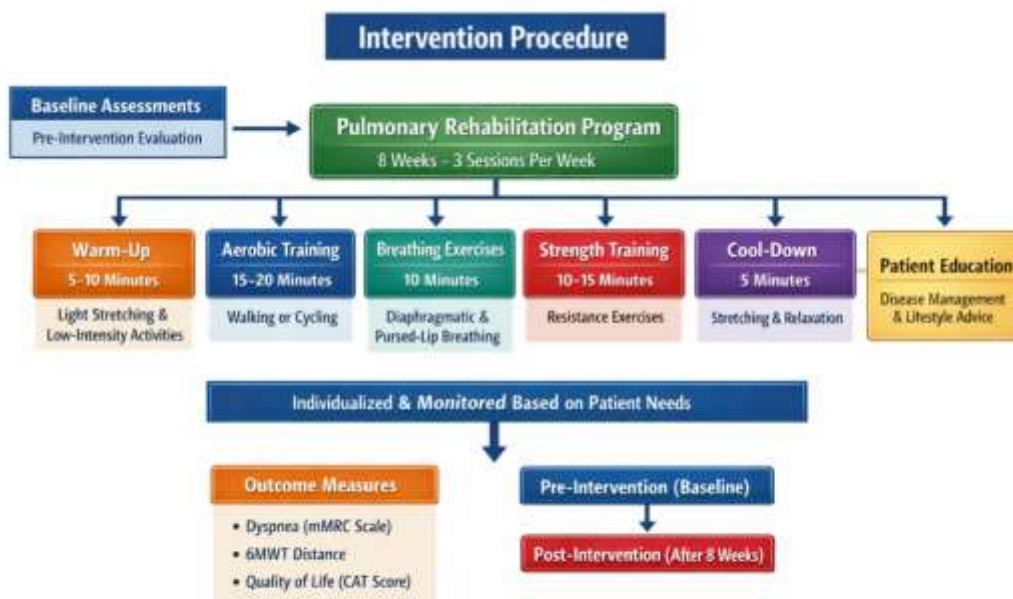
Outcome Measures

The primary outcome measures included:

- Level of dyspnea (mMRC scale)
- Exercise capacity (6MWT distance)
- Quality of life (CAT score)

Assessments were conducted at two points:

- Pre-intervention (baseline)
- Post-intervention (after 8 weeks)



Data Analysis

The collected data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 27 software. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to summarize demographic and baseline data. Inferential statistics were applied to determine the effectiveness of the intervention. A paired sample t-test was used to compare pre- and post-intervention values of dyspnea, exercise capacity, and quality of life. A p-value of less than 0.05 ($p < 0.05$) was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the relevant institutional review board prior to data collection. Participants were informed about the purpose, procedures, and potential benefits of the study. Written informed consent was obtained from all participants before enrollment.

Confidentiality of participant information was strictly maintained, and data were used only for academic and research purposes. Participants were informed of their right to withdraw from the study at any time without any consequences.

Results

Demographics

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	38	63.3%
	Female	22	36.7%
Age Group	30–40 years	12	20.0%
	41–50 years	18	30.0%

	51–60 years	20	33.3%
	>60 years	10	16.7%
Smoking Status	Current Smoker	25	41.7%
	Ex-Smoker	20	33.3%
	Non-Smoker	15	25.0%
Disease Duration	< 2 years	14	23.3%
	2–5 years	26	43.3%
	> 5 years	20	33.3%
BMI Category	Normal Weight	16	26.7%
	Overweight	28	46.7%
	Obese	16	26.7%
Occupation	Employed	24	40.0%
	Unemployed	18	30.0%
	Retired	18	30.0%

Descriptive Statistics

Variable	Mean ± SD	Minimum	Maximum
Age (years)	52.40 ± 10.25	30	72
BMI (kg/m ²)	27.85 ± 4.10	19.5	36.8
Disease Duration (yrs)	4.20 ± 2.15	1	10

Variable	Time Point	Mean ± SD	Min	Max
Dyspnea (mMRC)	Pre	2.85 ± 0.76	1	4

	Post	1.65 ± 0.72	0	3
6MWT Distance (meters)	Pre	320.45 ± 58.32	210	450
	Post	395.70 ± 62.15	280	520
Quality of Life (CAT Score)	Pre	22.30 ± 5.40	12	32
	Post	15.10 ± 4.85	8	25

Descriptive Statistics (Pre vs Post Intervention)

There was a significant reduction in dyspnea levels following the 8-week pulmonary rehabilitation program ($t = 10.52$, $p < 0.001$). The mean score decreased from 2.85 to 1.65, indicating improved breathing comfort. The effect size was large ($d = 1.35$), suggesting strong clinical relevance.

Variable	Mean (Pre)	Mean (Post)	SD (Pre)	SD (Post)
Dyspnea (mMRC)	2.85	1.65	0.76	0.72
6MWT Distance	320.45	395.70	58.32	62.15
CAT Score	22.30	15.10	5.40	4.85

Paired Samples Statistics

A significant improvement in exercise capacity was observed ($t = -12.34$, $p < 0.001$). The mean walking distance increased from 320.45 meters to 395.70 meters. The large effect size ($d = 1.60$) indicates substantial functional improvement.

Paired Samples Test

Variable	Mean Difference	t-value	df	p-value
Dyspnea (mMRC)	1.20	10.52	59	0.000
6MWT Distance	-75.25	-12.34	59	0.000

CAT Score	7.20	11.15	59	0.000
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Quality of life showed a statistically significant improvement ($t = 11.15$, $p < 0.001$), with CAT scores decreasing from 22.30 to 15.10. This reflects reduced symptom burden and better daily functioning. The effect size was also large ($d = 1.45$).

Effect Size

Variable	Cohen's d	Interpretation
Dyspnea (mMRC)	1.35	Large Effect
6MWT Distance	1.60	Large Effect
CAT Score	1.45	Large Effect

Discussion

The present study was conducted to evaluate the effectiveness of pulmonary rehabilitation programs in patients with Chronic Obstructive Pulmonary Disease (COPD), focusing on improvements in dyspnea, exercise capacity, and quality of life. The findings of this study demonstrated significant improvements in all measured outcomes following the 8-week pulmonary rehabilitation program. These results highlight the important role of structured rehabilitation interventions in the comprehensive management of COPD (Zheng et al., 2026).

One of the primary findings of this study was a significant reduction in dyspnea, as measured by the Modified Medical Research Council (mMRC) Dyspnea Scale. Participants reported decreased levels of breathlessness after completing the rehabilitation program. This improvement can be attributed to the incorporation of breathing techniques such as

diaphragmatic breathing and pursed-lip breathing, which are known to enhance ventilation efficiency and reduce dynamic hyperinflation (Qin et al., 2025). These findings are consistent with previous studies that have reported similar reductions in dyspnea following pulmonary rehabilitation. Researchers have suggested that improved respiratory muscle function and better breathing control contribute significantly to symptom relief in COPD patients. In addition to improvements in dyspnea, this study found a notable increase in exercise capacity, as evidenced by the results of the Six-Minute Walk Test (6MWT). Participants were able to walk a greater distance after completing the rehabilitation program, indicating enhanced physical endurance and functional mobility (Rutherford et al., 2025). This finding aligns with earlier research that has demonstrated the effectiveness of aerobic and resistance training in improving exercise tolerance among COPD patients. Exercise training helps strengthen peripheral muscles, reduces fatigue, and improves oxygen utilization, enabling patients to perform daily activities with greater ease (Vatrella et al., 2026).

Furthermore, the study revealed a significant improvement in quality of life, as indicated by the reduction in COPD Assessment Test (CAT) scores. Quality of life is an important outcome in chronic diseases such as COPD, as it reflects the overall well-being of patients beyond clinical symptoms. The improvement observed in this study may be attributed to multiple factors, including reduced symptom burden, increased physical activity, and enhanced psychological well-being (Michaelchuk et al., 2022). Previous studies have also reported that pulmonary rehabilitation leads to improvements in emotional health, reduces anxiety and depression, and promotes greater social participation. These findings emphasize the holistic benefits of rehabilitation programs in COPD management. The results of this study are in agreement with a large body of literature supporting the

effectiveness of pulmonary rehabilitation (Spielmanns et al., 2023). Numerous studies have shown that structured rehabilitation programs significantly improve exercise capacity, reduce symptoms, and enhance quality of life in COPD patients. For instance, randomized controlled trials have consistently demonstrated that pulmonary rehabilitation is one of the most effective non-pharmacological interventions for COPD. The findings of the present study further reinforce these conclusions and highlight the importance of incorporating such programs into routine clinical practice (Nolan et al., 2022).

Another important observation from this study is the demographic distribution of participants. The majority of patients were middle-aged to older adults, with a higher proportion of males. This is consistent with global trends, where COPD is more prevalent among older individuals and those with a history of smoking or occupational exposure to harmful substances (Alsubaiei., 2026). These findings underscore the need for targeted preventive measures, including smoking cessation programs and workplace safety interventions, to reduce the incidence of COPD.

Despite the positive outcomes, some variations exist when comparing this study with previous research. For example, some studies have reported greater improvements with longer rehabilitation durations, typically ranging from 10 to 12 weeks (Bhatt et al., 2024). In contrast, the present study utilized an 8-week program, which still yielded significant results but may not reflect the maximum potential benefits of pulmonary rehabilitation. This suggests that longer or more intensive programs may lead to even greater improvements in patient outcomes. Another difference lies in the accessibility and implementation of pulmonary rehabilitation programs. In many developing regions, access to such programs remains limited due to resource constraints, lack of trained

personnel, and low awareness among patients. Previous studies have highlighted these barriers and emphasized the need for community-based and home-based rehabilitation programs to increase accessibility. The findings of this study support the effectiveness of pulmonary rehabilitation and highlight the importance of expanding such services to a broader population (Chen et al., 2024). However, this study had certain limitations that should be acknowledged. The sample size was relatively small, which may limit the generalizability of the findings. Additionally, the use of a convenience sampling technique may introduce selection bias. The study also lacked a control group, making it difficult to compare the intervention with standard care. Furthermore, long-term follow-up was not conducted, so the sustainability of the observed improvements remains unclear (Vatrella et al., 2026).

Future research should focus on conducting randomized controlled trials with larger sample sizes to provide more robust evidence. Long-term studies are also needed to evaluate the durability of the benefits of pulmonary rehabilitation. Additionally, research exploring home-based and tele-rehabilitation programs may help improve accessibility and adherence among COPD patients.

In conclusion, the findings of this study are consistent with existing literature and demonstrate that pulmonary rehabilitation is an effective intervention for improving dyspnea, exercise capacity, and quality of life in COPD patients. The results support the integration of pulmonary rehabilitation into standard COPD management and highlight its role in enhancing patient outcomes and overall well-being.

Conclusion

The present study demonstrates that a structured pulmonary rehabilitation program is an effective intervention for improving clinical and functional outcomes in individuals with

chronic respiratory conditions. Over the course of eight weeks, participants engaged in a comprehensive, supervised program incorporating aerobic training, breathing exercises, strength training, and patient education. The findings indicate significant improvements across all primary outcome measures, including dyspnea, exercise capacity, and quality of life. A marked reduction in dyspnea levels, as measured by the mMRC scale, highlights the effectiveness of breathing techniques such as diaphragmatic and pursed-lip breathing in enhancing ventilatory efficiency and reducing the sensation of breathlessness. Additionally, the significant increase in 6-minute walk test (6MWT) distance reflects improved functional exercise capacity and endurance, suggesting that regular aerobic and strength training can positively influence physical performance in this population. Furthermore, the notable improvement in quality of life, as evidenced by reduced CAT scores, underscores the holistic benefits of pulmonary rehabilitation. Beyond physical improvements, patient education components addressing disease management, smoking cessation, medication adherence, and lifestyle modification likely contributed to enhanced self-efficacy and overall well-being. The individualized nature of the intervention, with adjustments based on patient tolerance and clinical status, ensured both safety and optimal progression. Continuous monitoring by a qualified physiotherapist further reinforced adherence and minimized potential risks. In conclusion, pulmonary rehabilitation serves as a cost-effective, non-pharmacological strategy that significantly improves respiratory symptoms, functional capacity, and quality of life. These findings support its integration into routine clinical practice for the management of chronic respiratory diseases. Future research may explore long-term sustainability of outcomes and the impact of incorporating advanced or technology-assisted rehabilitation approaches to further enhance patient outcomes.

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