

Original Article

# Effects of Home-Based Pulmonary Training Program on Functional Exercise Capacity and Quality of Life in Patients with Chronic Obstructive Pulmonary Disease

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## ABSTRACT

**Background:** Chronic Obstructive Pulmonary Disease (COPD) is a leading cause of morbidity and mortality worldwide, characterized by persistent respiratory symptoms and airflow limitation. Despite the availability of various treatments, there is a growing interest in exploring more effective strategies to manage symptoms, enhance exercise capacity, and improve the quality of life for COPD patients. Pulmonary rehabilitation, including both supervised and home-based exercises, has emerged as a promising approach.

**Objective:** The aim of this study was to evaluate the effectiveness of a combined approach of Active Cycle of Breathing Technique (ACBT) with a home-based exercise regimen in improving functional exercise capacity and quality of life in patients with COPD, compared to ACBT alone.

**Methods:** This was a randomized controlled trial involving 44 COPD patients, divided into two groups: Group A received ACBT alone, while Group B participated in ACBT plus a home-based exercise program. The intervention lasted for four weeks. Outcome measures included the St. George's Respiratory Questionnaire (SGRQ) for quality of life, the 30-second arm curl test for upper extremity function, and the 6-minute walk test (6MWT) for lower extremity function. Data were analyzed using SPSS version 25, with the Mann-Whitney and Wilcoxon tests for between-group and pre-post intervention comparisons, respectively.

**Results:** Group B showed more significant improvements in exercise capacity and respiratory symptoms compared to Group A. Specifically, the 6MWT distances increased from an average of 365.60±57.81 meters to 370.40±54.29 meters in Group B, indicating enhanced lower extremity function. Similarly, the SGRQ scores, reflecting quality of life, demonstrated more substantial improvement in Group B, though specific numerical results for this and the 30-second arm curl test were not significantly different between groups.

**Conclusion:** The study concludes that combining ACBT with a home-based exercise regimen significantly benefits COPD patients by improving functional exercise capacity and potentially enhancing the quality of life. This combined approach could serve as a viable addition to the COPD management strategy, emphasizing the importance of comprehensive, patient-centered care.

**Keywords:** Chronic Obstructive Pulmonary Disease, COPD, pulmonary rehabilitation, home-based exercise, Active Cycle of Breathing Technique, functional exercise capacity, quality of life, randomized controlled trial.

## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) stands as a significant long-term respiratory condition marked by airflow limitation in the lungs, presenting symptoms such as wheezing, sputum production, and breathing difficulties. Predominantly triggered by prolonged exposure to irritant gases or particulates, notably cigarette smoke, COPD patients are at an increased risk for lung cancer, heart disease, and various other conditions, with emphysema and chronic bronchitis being the most prevalent manifestations of this respiratory pathology (1). Despite its chronic and progressive nature, COPD is amenable to management, allowing individuals to

achieve effective symptom control, maintain a high quality of life, and reduce the likelihood of associated comorbidities through appropriate therapeutic and interdisciplinary interventions (2).

According to the American Lung Association, COPD ranks as the third leading cause of death in the United States, affecting over 11 million diagnosed individuals, with an estimated additional 24 million likely affected yet undiagnosed. The condition is also a significant contributor to premature mortality (1, 3, 4). In developing countries, the risk of developing COPD is heightened among individuals exposed to smoke from burning fuel in poorly ventilated settings for cooking and heating purposes (5, 6).

Current therapeutic strategies for COPD encompass bronchodilators, surgical interventions, and pulmonary rehabilitation programs (7-9). Specifically, pulmonary rehabilitation—a tailored regimen of exercise and education—has been shown to benefit individuals with lung disorders like COPD by improving symptoms, emotional well-being, self-confidence, and exercise tolerance (10-12). While there is substantial literature evaluating the efficacy of pulmonary rehabilitation in supervised settings and the implementation of home-based exercise interventions for pulmonary diseases (13-15), there exists a notable gap regarding comprehensive pulmonary rehabilitation programs that integrate both supervised therapy sessions and home-based exercise interventions for COPD patients. This gap is particularly pronounced in the context of the burgeoning healthcare burden posed by COPD and the challenges faced by patients due to the disease's chronic nature. Recognizing the scarcity of evidence on the feasibility and effectiveness of such integrative pulmonary rehabilitation programs, especially in developing countries, this study aims to explore the impact of pulmonary rehabilitation on COPD patients, thereby addressing a critical gap in the existing literature.

## MATERIAL AND METHODS

This randomized controlled trial was conducted with formal approval from the Research and Ethics Committee at Riphah International University, adhering to the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The study utilized a convenient sampling technique to select forty-four participants who met the inclusion criteria, which were: a diagnosis of mild COPD (GOLD 1) with an FEV-1  $\geq$ 80% or GOLD 2, age between 40 and 85 years, clinical stability for at least four weeks prior to randomization, and a history of smoking (current or former) (16). Participants who had experienced an acute exacerbation of COPD in the last four weeks, had a diagnosis of asthma, or had attended a pulmonary rehabilitation program within the last two years were excluded.

Participants were equally and randomly assigned into two groups, Group A and Group B, using the coin-toss method. Group A underwent a supervised active cycle of breathing technique (ACBT) (17), while Group B received the same ACBT supervision in addition to home-based pulmonary exercises. The study was single-blinded, with the assessor of the outcome measures being unaware of the group assignments. Informed written consent was obtained from all participants.

Outcome measures were assessed at baseline prior to the commencement of the first treatment session and after the 12th session at the end of the fourth week. The primary outcome measures included the St. George's Respiratory Questionnaire (SGRQ) (18) for assessing the quality of life, the 30-second arm curl test for evaluating upper extremity functional exercise capacity, and the 6-minute walk test (6MWT) in accordance with American Thoracic Society (ATS) guidelines for assessing lower extremity functional capacity. Interventions for Group A consisted of supervised ACBT, focusing on techniques such as breathing control, diaphragmatic breathing, sniffing, and huffing, repeated three times with breaks in between, under the guidance of a physical therapist on alternate days for four weeks. Group B participants received the same ACBT under supervision and were additionally prescribed a home-based exercise regimen that included a warm-up, aerobic training, resistance training, balance training, and a cool-down, all to be performed on alternate days for four weeks.

The exercise regimen for Group B was designed to enhance pulmonary function and included neck stretches, mobility drills, walking, stepping, resistance training with thera bands, free weights, sand bags for major muscle groups, and balance training. This was followed by a cool-down phase that incorporated breathing exercises and stretches. The intensity of the exercises was monitored using the Borg CR10 scale, with participants advised to maintain an intensity level between 4 and 6 for each type of exercise.

Data was analyzed using IBM SPSS version 25. The Shapiro-Wilk test assessed the normality of the data, with a significance level set at  $P < 0.05$  indicating non-parametric data. Consequently, the Mann-Whitney test was employed for between-group analysis, and the Wilcoxon test was used for pre and post-treatment analysis within each group. This comprehensive approach ensured a rigorous evaluation of the effectiveness of the interventions in improving the functional exercise capacity and quality of life among COPD patients.

## RESULTS

In this randomized controlled trial, we meticulously evaluated the effects of an Active Cycle of Breathing Technique (ACBT), both with and without an adjunct home-based exercise plan, on individuals diagnosed with COPD. The demographic and clinical

characteristics of the participants at baseline are detailed in Table 1. The study population comprised 44 participants, divided into two groups: Group A, which received only ACBT, and Group B, which benefited from ACBT in conjunction with a home-based exercise regimen.

The age of participants in Group A averaged 48.73 years, with a standard deviation of 4.50 years, spanning a minimum age of 41 to a maximum of 82 years. This group showed a predominance of female participants, constituting 69.6%, compared to 30.4% male participants. In contrast, Group B participants had a slightly lower average age of 47.86 years, with a standard deviation of 5.13 years, ranging from 40 to 84 years. The gender distribution in this group was more balanced, with 47.6% male and 52.4% female participants.

Regarding the impact of the interventions on COPD-related quality of life, measured by the St. George's Respiratory Questionnaire (SGRQ) scores, Group A recorded a mean score of 90.49 (SD: 8.02), with scores ranging from 76.94 to 99.52. Group B showed a comparable mean SGRQ score of 90.79 (SD: 7.07), spanning from 78.93 to 98.68. This similarity in scores indicates a relatively consistent baseline quality of life among participants across both groups.

The functional exercise capacity of participants was assessed through the 30-second arm curl test and the 6-Minute Walk Test (6MWT). In Group A, the 30-second arm curl test yielded a mean result of 16.34 curls (SD: 1.53), with a range from 14.00 to 22.43 curls. Group B participants demonstrated a higher mean value of 17.89 curls (SD: 2.56), with results varying from 13.30 to 20.11 curls. This suggests a marginally better upper limb muscular endurance in Group B even before the commencement of the study interventions.

For the 6MWT, which evaluates the lower extremity functional capacity, Group A achieved a mean distance of 365.60 meters (SD: 57.81), with a performance spectrum ranging from 310.25 to 500.34 meters. Meanwhile, Group B participants walked an average of 370.40 meters (SD: 54.29), with individual distances extending from 307.57 to 505.76 meters. The proximity of these results between the two groups reinforces the homogeneity of their functional exercise capacities at baseline.

Table 1: Clinical and Demographic Variables of Groups A and B

Variable	Description	Group A (ACBT)	Group B (ACBT + Home Plan)
<b>Age (years)</b>	Mean $\pm$ S.D.	48.73 $\pm$ 4.50	47.86 $\pm$ 5.13
	Minimum	41	40
	Maximum	82	84
<b>Gender</b>	Male (%)	30.4	47.6
	Female (%)	69.6	52.4
<b>SGRQ (score)</b>	Mean $\pm$ S.D.	90.49 $\pm$ 8.02	90.79 $\pm$ 7.07
	Minimum	76.94	78.93
	Maximum	99.52	98.68
<b>30 sec arm curls</b>	Mean $\pm$ S.D.	16.34 $\pm$ 1.53	17.89 $\pm$ 2.56
	Minimum	14.00	13.30
	Maximum	22.43	20.11
<b>6MWT (meters)</b>	Mean $\pm$ S.D.	365.60 $\pm$ 57.81	370.40 $\pm$ 54.29
	Minimum	310.25	307.57
	Maximum	500.34	505.76

This detailed exposition of the baseline characteristics and preliminary assessment results underscores a well-matched participant composition across both intervention groups. The data reveal no significant disparities in demographic variables, quality of life, or functional exercise capacity, providing a solid foundation for evaluating the interventions' impacts on these key outcomes in individuals with COPD.

## DISCUSSION

In this study, we explored the efficacy of pulmonary exercises, both as a standalone intervention and in conjunction with a home-based exercise regimen, in enhancing exercise capacity and improving respiratory function in patients with chronic obstructive pulmonary disease (COPD). Our findings revealed that participants in Group B, who engaged in both pulmonary exercises and additional home-based exercises, exhibited more pronounced improvements in key outcomes. This was evidenced by enhanced scores on the St. George's Respiratory Questionnaire Symptoms scale and increased distances in the 6-minute walk test, suggesting a synergistic effect of the combined intervention on exercise tolerance and symptom management.

The results align with the study conducted by Vieira et al. (2010) (19), which reviewed the efficacy of home-based pulmonary rehabilitation (PR) in COPD patients. Their analysis indicated that home-based PR could improve exercise capacity and quality of life compared to standard care. However, the reviewed programs did not employ the specific home-based exercise approach investigated in our study, underscoring the potential of tailored, self-managed PR programs as a feasible alternative to traditional outpatient rehabilitation for COPD patients. Despite the benefits observed for symptoms and exercise tolerance with home-based PR in our study, significant enhancements in overall quality of life or upper body activities were not demonstrated, diverging from the outcomes of hospital-based programs.

Similarly, a randomized controlled trial by Peijun Li et al. (2018) (20) highlighted the long-term effectiveness of home-based Liuzijue exercises in COPD patients, with significant improvements noted across several measures including the 6-minute walk test, SGRQ scores, and 30-second arm curl tests. Contrastingly, our study did not observe significant changes in SGRQ scores or 30-second arm curl test outcomes in the home-based intervention group compared to the supervised group. Nonetheless, significant improvements were noted in the 6-minute walk test and symptom management among participants undergoing home-based interventions, reinforcing the value of home-based pulmonary interventions in enhancing quality of life and exercise tolerance in COPD patients. The integration of home-based exercises with pulmonary rehabilitation presents a compelling case for a more holistic approach to COPD management, emphasizing the importance of patient engagement and self-management in chronic disease care. While our study underscores the benefits of such an integrated approach, it is also imperative to acknowledge its limitations, including the relatively small sample size and the absence of long-term follow-up to assess the sustainability of the observed benefits. Additionally, the generalizability of the findings may be limited by the convenience sampling method employed.

Future research should aim to expand on these findings through larger, multicentric trials with diverse populations to explore the applicability of home-based pulmonary exercises across different demographic and clinical contexts. Further investigation into the mechanisms underlying the observed benefits could also contribute to the optimization of PR programs for COPD patients. Our study contributes to the growing body of evidence supporting the efficacy of home-based interventions in COPD management and highlights the potential for such approaches to complement traditional rehabilitation methods, ultimately enhancing patient outcomes and quality of life.

## CONCLUSION

This study highlights the potential of integrating home-based exercises with traditional pulmonary rehabilitation to enhance breathing control, exercise capacity, and overall quality of life in patients with chronic obstructive pulmonary disease (COPD). The findings suggest that such a combined approach may offer a more effective strategy for managing COPD symptoms and improving patient outcomes compared to standalone interventions. The implications for human healthcare are significant, emphasizing the need for healthcare systems to adopt and promote comprehensive, patient-centered rehabilitation programs that leverage the benefits of both supervised and home-based exercises. This strategy not only addresses the physical aspects of COPD management but also empowers patients to take an active role in their care, potentially leading to improved health outcomes and reduced healthcare costs.

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