BMC Pulmonary Medicine

RESEARCH

Open Access

Effects of pulmonary rehabilitation program in a community based hospital in California

Baljit Ubhi[1,2], Razaz Shaheen[2], Kristin Ireland[2,3] and Abdullah Alismail[2,4,5*]

Abstract

Introduction The purpose of this study was to evaluate the effectiveness of a community based pulmonary rehabilitation program in central California.

Method This was a retrospective study approved by the institutional review board at Community Regional Medical Centers Fresno. Data were extracted from a pulmonary rehabilitation clinic at a Community Based Hospital in Fresno, CA, USA from 2016 to 2023. The program was designed as follows: patients completed a six-week program, two hours, twice/week. The program included the following: stretching, breathing, and personalized training/exercise. Main outcomes were the following data: six-minute walk tests (6MWT), shortness of breath questionnaire (SOB-Q), Patient Health Questionnaire (PHQ-9), quality of life (QoL), and satisfaction level.

Results The study included 381 participants, comprising 186 males and 195 females. Our findings demonstrated significant improvements post-program, including increased six-minute walk test (6MWT) distances (633 ± 316 to 925 ± 311 m, $p < 0.001$), reduced shortness of breath scores (52.28 ± 22.36 to 41.87 ± 20.9, $p < 0.001$), improved PHQ-9 depression scores (7.83 ± 5.46 to 4.70 ± 4.42, $p < 0.001$), and higher quality of life scores (16.0 ± 5.88 to 19.00 ± 6.15, $p < 0.001$). Patient satisfaction was high, with consistent positive feedback on program design and delivery.

Conclusion Our results showed that the program was effective in improving patients' quality of life, shortness of breath, and 6MWT. In addition, patients were satisfied with the program upon completion. Further longitudinal studies in different regions are strongly recommended to confirm and validate our findings.

Keywords Rehabiliation, 6MWT, Community hospital, Quality of Life, Pulmonary rehabilitation, Six minute walk test

Introduction

Patients with pulmonary diseases may experience shortness of breath during any exertion, which can decrease physical activity and cause muscle weakness. Consequently, their overall quality of life is impaired. Pulmonary rehabilitation (PR) is a nonpharmaceutical approach aimed at increasing muscular strength to provide an improved quality of life for patients with pulmonary disease [1]. Originally, PR was believed to be a therapy for chronic obstructive pulmonary disease (COPD) [2]. Currently, PR is approved for treating several lung diseases, including but not limited to interstitial lung disease, Pulmonary Hypertension, Asthma, Bronchitis, Bronchiectasis, and long Covid [3–11]. PR is the main component

*Correspondence:
Abdullah Alismail
aalismail@llu.edu
[1] Community Regional Medical Centers, Fresno, CA, USA
[2] Department of Cardiopulmonary Sciences, School of Allied Health Professions, Loma Linda University, Loma Linda, CA, USA
[3] FOAMfrat, Wauwatosa, WI, USA
[4] Department of Medicine, School of Medicine, Loma Linda University, Loma Linda, CA, USA
[5] Department of Cardiopulmonary Sciences, College of Health Sciences, Rush University, Chicago, IL, USA

in managing chronic pulmonary and pulmonary vascular diseases long-term [3, 4, 12–15]. PR also demonstrates substantial differences in reducing symptoms, enhancing functional capacity, and improving health-related quality of life. A PR program typically involves a combination of education and exercise. Educational interventions and physical activity have been shown to improve symptoms and minimize hospital readmissions in patients with chronic pulmonary disease [3, 5, 12, 16]. The concept of PR is not new; it originated in the eighteenth century [2, 17].

In addition, one of the key reported outcomes for PR program success is reduced emergency room visits [18–20]. Patients with pulmonary diseases are more likely to visit the emergency department (ED) due to acute exacerbations that may progress to respiratory failure. ED visits remain a significant challenge for patients and healthcare systems. As a result, reducing ED visits for patients with chronic respiratory failure has become a key objective for most hospitals [21–24]. In fact, a recent study that analyzed Medicare beneficiaries of COPD patients who survived at least 30 days post-hospital discharge reported a significant reduction and lower risk of readmission 1 year post-PR [24].

Therefore, PR is recognized as a Medicare benefit; however, it remains unpopular in healthcare settings due to the challenge of obtaining appropriate reimbursement amounts and access [1]. Community-based pulmonary rehabilitation refers to structured exercise and education programs conducted in non-healthcare facilities, designed to improve symptoms and quality of life while reducing barriers to attendance such as long travel distances [25]. According to the literature, pulmonary rehabilitation remains unpopular in healthcare settings due to inadequate reimbursement by insurers and healthcare systems, which jeopardizes program viability, with pulmonary rehabilitation being reimbursed at approximately half the rate of cardiac rehabilitation despite requiring similar personnel and resources [26]. The efficacy of community-based hospital pulmonary rehab has been the subject of only a handful of studies. The purpose of this study was to evaluate the effectiveness of a pulmonary rehabilitation (PR) program in a community-based hospital in Fresno, California, before, during, and after the COVID-19 pandemic.

Methods

The Institutional Review Board at Community Regional Medical Centers, Fresno, approved the Study. This was a retrospective study where data was extracted from a PR clinic in a community-based hospital in central California of patients who completed the program from 2016 to 2023. Program design was focused on an interdisciplinary team approach to meet patient specific needs. The program was composed of six weeks; patients attended twice a week for two hours each visit. The interdisciplinary team consisted of physicians, respiratory therapists, pharmacists, social services, and nutritionists. The program included stretching, breathing, and personalized training/exercise. All patients completed the following exercise and training program: walking on a treadmill, stationary bike, upper body ergometer, rowing (machine or bands), flexibility training, resistance training (weights, sports cords, or bands), relaxation training (meditation, yoga). Patients completed pre- and post-program six-minute walk tests (6MWT), shortness of breath questionnaire (SOB-Q), Patient Health Questionnaire (PHQ-9), quality of life (QoL), and satisfaction level. The educational component of the program included items on disease awareness and self-management techniques on a variety of topics such as: disease process, bronchial hygiene, breathing techniques [pursed lip and diaphragmatic breathing], diet and nutrition, psycho/social modifications such as relaxation techniques, inhaler instructions, and medication compliance. Supplement file 1.

Main outcomes

The following questionnaires were completed by patients during their visit and the responses were used as outcome measures in the study:

SOBQ: The University of California, San Diego Shortness Of Breath Questionnaire (SOBQ) was used before and after pulmonary rehab [27]. Improvement in SOB and shortness of breath was evaluated to determine the patient's physical conditioning. The patients were provided with a questionnaire to index their shortness of breath before and after the program. The results were compared to determine if there was an improvement in the index after the program.

PHQ-9 is an evidence-based Patient Health Questionnaire used in Pulmonary Rehab outcomes to identify patients who may be depressed [28]. Pulmonary rehabilitation focuses on psychological, emotional, and social problems and physical ability. Our patients were provided with a questionnaire to measure their depression level before and after the program. The results were evaluated to determine if there was a reduction in their depression score after the program.

Knowledge test: Before and after the program, the patient was given a health questionnaire with ten questions that pointed to specific scenarios of living with pulmonary disease. The results of the test ques-

tionnaire were compared to determine whether the patient gained knowledge during the program. Supplement file 2.

Ferrans and Powers Quality Of Life: Patients completed this questionnaire before and after their PR visit. It measures QOL in four domains: health and functioning, socioeconomic, psychological/spiritual, and family [29–32].

Satisfaction: Patients complete a patient satisfaction survey specific to Pulmonary Rehab. The survey grades on a 5-point scale. Areas evaluated: Facility/Staff, Exercise Program, Education Program, and Counseling Program, which helps to identify the opportunity for improvement. Supplement file 3.

The program used and applied the minimal clinically important difference on two of the main outcome variables: 6MWT and the PHQ-9. Both numbers were very ambitious compared to what the literature reports. For the 6MWT, the program goal was 115 feet, which is higher than what is reported in the literature, 87 feet, respectively [33–36]. Another measurement was used as a goal in the 6MWT, which is a 30% improvement by program completion. For the other variables, the MCID was as follows: PHQ-9 = 5 points and/or 25% improvement, QoL = 2 points and/or 60% improvement, Shortness of Breath = 5 points and/or 60%, and a reduction of ED visits of more than 50%.

Data analysis

Data were analyzed using SPSS software. Descriptive statistics were used to summarize demographic and clinical characteristics. Paired t-tests were conducted to compare pre- and post-program outcomes, including six-minute walk test (6MWT), shortness of breath scores (SOB-Q), PHQ-9 depression scores, quality of life (QoL) scores, and emergency department visit frequency. Statistical significance was set at $p < 0.05$.

Results

A total of $N = 381$ patients were analyzed, as outlined in Table 1. The gender distribution comprised 48.6% males (186) and 50.9% females (195), indicating a sample reflective of gender representation, which may enhance the generalizability of the study's findings across genders. Patients had a mean age of 67.19 ± 12.176.

Over the period from 2016 to 2023, there was an upward trend in study completions, peaking in 2019 with 64 patients (16.7%) completing the program, followed by a decline to the lowest point in 2023 with 31 patients (8.1%). This variation could reflect external influences affecting patient recruitment, such as the COVID-19 period.

Table 1 Demographic and clinical profile of respiratory health study patients, $N = 381$

Variables	N	%
Gender		
Male	186	48.8
Female	195	51.2
Year of Completion		
2016	51	13.3
2017	53	13.9
2018	57	15.0
2019	62	16.3
2020	39	10.2
2021	51	13.4
2022	37	9.7
2023	31	8.1
Diagnosis		
COPD	114	29.9
Emphysema	73	19.2
Bronchitis	14	3.7
Shorntess of Breath	46	12.1
ILD/IPF	39	10.2
PH/PAH	15	3.9
Asthma	10	2.6
COVID-19	22	5.8
RF	10	2.6
Other PD	31	8.1
Bronchectasis	4	1.0
Lung Transplant	3	0.8

Abbreviation: *COPD* Chronic Obstructive Pulmonary Disease, *ILD/IPF* Interstitial Lung Disease/ Idiopathic Pulmonary Fibrosis, *PH/PAH* Pulmonary Hypertension/ Pulmonary Arterial Hypertension, *RF* Respiratory Failure, *PD* Pulmonary Disease

Diagnosis data showed a notable prevalence of respiratory conditions, with Chronic Obstructive Pulmonary Disease (COPD) as the most prevalent, affecting 29.8% of patients (114 individuals), followed by Emphysema at 19.1% (73 patients), and Shortness of Breath (SOB) at 12.0% (46 patients).

Table 2 demonstrates significant improvements across all examined health metrics post-intervention, with noteworthy enhancements in 6MWT (distances increased from 633 to 925 m), patient knowledge (scores improved from 6.50 to 9.50), and symptom management (SOB and ED visits decreased to 41.8 and 0.29, respectively). Furthermore, Quality of Life scores improved to 19.00, and PHQ9 depression scores decreased to 4.70, all with highly significant p-values (< 0.001), underlining the intervention's comprehensive benefits. Table 2 also shows that post program completion variables met or exceeded the MCID goals.

Table 2 Comparative outcomes pre- and post-intervention in respiratory health parameters

Variables	N[a]	Pre	Post	Mean Difference	% Improvement	*P* value
6MWT	378	633 ± 316	925 ± 311	292	% 46.13	< 0.001
Knowledge Test # of Correct Responses	114	6.50 ± 1.87	9.50 ± 0.95	3	% 46.15	< 0.001
SOB	381	52.28 ± 22.36	41.87 ± 20.90	10.41	% 19.91	< 0.001
ED visits	319	0.92 ± 1.79	0.26 ± 0.71	0.66	% 71.74	< 0.001
QOL	381	16.0 ± 5.88	19.00 ± 6.15	2.97	% 18.75	< 0.001
PHQ9	381	7.83 ± 5.46	4.70 ± 4.42	3.1	% 39.97	< 0.001

Abbreviation: *6MWT* six minute walk

SOB Shortness of Breath

QOL Quality of Life

PHQ9 Patient Health Questionnaire-9

[a] there are missing data in some of the variables where some patients did not complete some of the questionnaires such as the knowledge test

Discussion

The objective of this study was to evaluate the effectiveness of a PR program in a community-based hospital in central California. Overall, the results indicate that the program was successful in terms of the primary outcome measures and emergency department visits.

In the present study, we have included a diverse array of pulmonary diagnoses in the patient population. We have 381 patients who completed pulmonary rehabilitation in our facility between 2016 and 2023, with the majority having COPD. There were more female participants than males. While this finding contrasts with research indicating that women may face greater barriers to PR participation, such as depression or work-related conflicts, it highlights the potential effectiveness of the program's design or outreach strategies in engaging female patients [37]. Research suggests that gender differences, such as higher rates of depression among women and employment conflicts, may influence PR participation and outcomes [37]. Women, particularly those under 60, may face barriers like class timing or lack of social support, which can hinder their ability to engage with PR programs. This raises questions about whether certain program characteristics, such as timing, accessibility, or emotional support components, contributed to higher female participation and warrants further investigation. Current research indicates that older females with COPD may experience more significant improvements in exercise capacity compared to their male peers, as evidenced by more remarkable Δ6MWT outcomes in some studies [38]. This highlights the potential for targeted PR strategies that address specific demographic needs, particularly for older women, to enhance program effectiveness and outcomes.

This retrospective study assesses the benefits of pulmonary rehab for patients with chronic pulmonary diseases. The participants exhibited significant improvement post PR in their six-minute walk distance, shortness of breath, PHQ9 questionnaire, quality of life questionnaire, knowledge test, and emergency department visits, consistent with the literature findings. For example, 6MWT showed statistically significant improvement in pre vs post-rehab programs in our clinic, similar to other programs [39–42]. Lastly, when looking at the 6MWT and PHQ9 results, our findings show that patients have exceeded the MCID values of 85 ± 6 feet as reported by Vinan-Vega and colleagues' study [33]. This supports the notion that PR is effective in non-academic community-based settings [43].

Moreover, our study shows a reduction in shortness of breath (SOB), and patients' SOB improved post-PR. This improvement also confirms that pulmonary rehab is well known for its physiological benefits [44, 45]. Data also shows that patients' knowledge of post-rehab pulmonary disease also improved. Although not all patients have completed the knowledge test, the significant improvement can highlight program engagement and effectiveness from an evaluation perspective. Adding this with the other data, such as functional status and quality of life, results suggest that participating in PR has helped patients with pulmonary disease improve their quality of life by significantly reducing ED visits. The success of our PR program thus far adds to the limited literature on PR in low-resource settings (i.e., community-based hospitals). Furthermore, all the MCID set values and goals were met, where some were even exceeded. Therefore, we support the call and need for more studies of PR programs in low-resource settings to validate our findings and possibly explore higher MCID values for each tracked outcome [43].

When looking at modern PR programs, such as tele-pulmonary rehab, they have shown promise and

effectiveness in many studies [46–52]. For instance, Selzler et al. (2018) highlight the success of telehealth PR in improving exercise capacity and quality of life while addressing the accessibility challenges faced by rural and urban populations alike. By standardizing PR content and integrating telemonitoring, teleconsultations, and tele-education, this program demonstrates the feasibility of scaling PR programs across diverse settings while maintaining clinical standards and patient outcomes [53]. One common challenge reported is the need for stronger and longer studies from an evidence-based medicine standpoint [54, 55]. Therefore, future studies should consider a longitudinal approach that includes community-based hospitals and limited or low-resource setting facilities.

In addition, evaluating pulmonary diseases other than COPD has been suggested as a need, since most studies have focused on COPD [52]. While the Canadian study focuses on COPD, expanding the scope of PR programs to include conditions such as pulmonary fibrosis, bronchiectasis, and asthma could provide valuable insight [53]. Investigating PR's effectiveness in these populations would help determine whether benefits like improved exercise capacity and reduced healthcare utilization can be achieved across a broader spectrum of pulmonary diseases.

Limitations

Our study has some limitations. First, it is a single-centered study at a community-based hospital. Therefore, we cannot generalize our data to other geographical areas. Second, our data is limited to the six-week sessions and lacks long-term data. In addition, there were missing data in some key variables, such as the knowledge questionnaire, where only 30% of the sample completed it. This could be due to various reasons, such as not being interested in taking the questionnaire. However, we still noticed a significant difference between the pre- and post-questionnaire in those who completed the knowledge test. Furthermore, we believe that not having key data of comorbidities, oxygenation status, smoking status, other chronic diseases, and lung function might not give a complete picture of the program's effectiveness. Further studies from community-based hospitals should consider conducting longitudinal studies, including pulmonary function tests, evaluating long-term effectiveness, and looking into their patients' comorbidities.

Conclusion

In this retrospective study, our community-based pulmonary rehabilitation program has shown its effectiveness in improving patients' quality of life, 6MWT, and shortness of breath. Our findings have met and exceeded our set MCID goals. Therefore, these findings support the current literature of PR effectiveness in low-resource settings similar to high-resource and/or academic settings. Future studies are needed to validate our findings in broader regions, countries, and environments. More specifically, we strongly recommend prospective longitudinal studies to validate our findings.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12890-025-03714-w.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Acknowledgements
N/A.

Authors' contributions
BU: literature review, study design, data collection, and writing of original draft. RS: Data analysis and statistician. KI: Literature review and manuscript writing. AA: Study design, literature review, study design, data analysis. All authors contributed to the writing and review of this manuscript.

Funding
N/A.

Data availability
The datasets in this study are not publicly available due to confidentiality, but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study adheres to the Declaration of Helsinki where the Institutional Review Board at Community Regional Medical Centers Fresno approved the Study under 45 CFR 46.111 and 21 CFR 56.111 (IRB# 2023041 Ref #: 001611296). Consent is waived under 45 CFR 46.117 (c)(1)(i, ii, or iii)/21 CFR 56.109(c)1.

Consent for publication
N/A.

Competing interests
The authors declare no competing interests.

Received: 25 November 2024 Accepted: 8 May 2025
Published online: 21 May 2025

References

1. Troosters T, Janssens W, Demeyer H, Rabinovich RA. Pulmonary rehabilitation and physical interventions. Eur Respir Rev Off J Eur Respir Soc. 2023;32:220222.
2. Casaburi R. A brief history of pulmonary rehabilitation. Respir Care. 2008;53:1185–9.
3. Dowman LM, Holland AE. Pulmonary rehabilitation in idiopathic pulmonary fibrosis. Curr Opin Pulm Med. 2024;30:516–22.
4. Menson KE, Dowman L. Pulmonary rehabilitation for diseases other than COPD. J Cardiopulm Rehabil Prev. 2024;44:425–31.
5. Rochester CL, Alison JA, Carlin B, Jenkins AR, Cox NS, Bauldoff G, et al. Pulmonary rehabilitation for adults with chronic respiratory disease: an

official American thoracic society clinical practice guideline. Am J Respir Crit Care Med. 2023;208:e7-26.
6. Spruit MA, Singh SJ, Garvey C, ZuWallack R, Nici L, Rochester C, et al. An official American thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. Am J Respir Crit Care Med. 2013;188:e13-64.
7. Zampogna E, Paneroni M, Cherubino F, Pignatti P, Rudi M, Casu G, et al. Effectiveness of a pulmonary rehabilitation program on persistent asthma stratified for severity. Respir Care. 2019;64:1523–30.
8. Annoni S, Bellofiore A, Repossini E, Lazzeri M, Nicolini A, Tarsia P. Effectiveness of chest physiotherapy and pulmonary rehabilitation in patients with non-cystic fibrosis bronchiectasis: a narrative review. Monaldi Arch Chest Dis Arch Monaldi Mal Torace. 2020;90.
9. Ora J, Prendi E, Ritondo BL, Pata X, Spada F, Rogliani P. Pulmonary rehabilitation in noncystic fibrosis bronchiectasis. Respir Int Rev Thorac Dis. 2022;101:97–105.
10. Xiong T, Bai X, Wei X, Wang L, Li F, Shi H, et al. Exercise rehabilitation and chronic respiratory diseases: effects, mechanisms, and therapeutic benefits. Int J Chron Obstruct Pulmon Dis. 2023;18:1251–66.
11. Hockele LF, Affonso JVS, Rossi D, Eibel B. Pulmonary and functional rehabilitation improves functional capacity, pulmonary function and respiratory muscle strength in post COVID-19 patients: pilot clinical trial. Int J Environ Res Public Health. 2022;19:14899.
12. Daynes E, Mills G, Hull JH, Bishop NC, Bakali M, Burtin C, et al. Pulmonary rehabilitation for people with persistent symptoms after COVID-19. Chest. 2024;166:461–71.
13. Tao W, Huang J, Jin Y, Peng K, Zhou J. Effect of pulmonary rehabilitation exercise on lung volume and respiratory muscle recovery in lung cancer patients undergoing lobectomy. Altern Ther Health Med. 2024;30:90–6.
14. Nici L. Pulmonary rehabilitation: mechanisms of functional loss and benefits of exercise. Respir Care. 2024;69:640–50.
15. Moy ML. Maintenance pulmonary rehabilitation: an update and future directions. Respir Care. 2024;69:724–39.
16. Martínez-Pozas O, Meléndez-Oliva E, Rolando LM, Rico JAQ, Corbellini C, Sánchez Romero EA. The pulmonary rehabilitation effect on long covid-19 syndrome: a systematic review and meta-analysis. Physiother Res Int J Res Clin Phys Ther. 2024;29:e2077.
17. MacIntyre NR. Pulmonary rehabilitation: a look back, a look forward. Respir Care. 2024;69:633–9.
18. Raskin J, Spiegler P, McCusker C, ZuWallack R, Bernstein M, Busby J, et al. The effect of pulmonary rehabilitation on healthcare utilization in chronic obstructive pulmonary disease: the Northeast pulmonary rehabilitation consortium. J Cardiopulm Rehabil Prev. 2006;26:231.
19. Nguyen HQ, Harrington A, Liu I-LA, Lee JS, Gould MK. Impact of pulmonary rehabilitation on hospitalizations for chronic obstructive pulmonary disease among members of an integrated health care system. J Cardiopulm Rehabil Prev. 2015;35:356.
20. Sahin H, Varol Y, Naz I, Aksel N, Tuksavul F, Ozsoz A. The effect of pulmonary rehabilitation on COPD exacerbation frequency per year. Clin Respir J. 2018;12:165–74.
21. Lindenauer PK, Stefan MS, Pekow PS, Mazor KM, Priya A, Spitzer KA, et al. Association between initiation of pulmonary rehabilitation after hospitalization for COPD and 1-year survival among medicare beneficiaries. JAMA. 2020;323:1813–23.
22. Moore E, Palmer T, Newson R, Majeed A, Quint JK, Soljak MA. Pulmonary rehabilitation as a mechanism to reduce hospitalizations for acute exacerbations of COPD: a systematic review and meta-analysis. Chest. 2016;150:837–59.
23. Özmen İ, Yıldırım E, Öztürk M, Ocaklı B, Yıldız R, Aydın R, et al. Pulmonary rehabilitation reduces emergency admission and hospitalization rates of patients with chronic respiratory diseases. Turk Thorac J. 2018;19:170.
24. Stefan MS, Pekow PS, Priya A, ZuWallack R, Spitzer KA, Lagu TC, et al. Association between initiation of pulmonary rehabilitation and rehospitalizations in patients hospitalized with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2021;204:1015–23.
25. Cecins N, Landers H, Jenkins S. Community-based pulmonary rehabilitation in a non-healthcare facility is feasible and effective. Chron Respir Dis. 2017;14:3–10.
26. Nici L, Singh SJ, Holland AE, ZuWallack RL. Opportunities and challenges in expanding pulmonary rehabilitation into the home and community. Am J Respir Crit Care Med. 2019;200:822–7.
27. Chen T, Tsai APY, Hur SA, Wong AW, Sadatsafavi M, Fisher JH, et al. Validation and minimum important difference of the UCSD shortness of breath questionnaire in fibrotic interstitial lung disease. Respir Res. 2021;22:202.
28. Kroenke K, Spitzer RL, Williams JBW. The PHQ-9. J Gen Intern Med. 2001;16:606–13.
29. Rannestad T, Rustøen T. Ferrans and Powers Quality of Life Index. In: Maggino F, editor. Encyclopedia of Quality of Life and Well-Being Research. Cham: Springer International Publishing; 2023. p. 2490–3.
30. Ferrans CE. Development of a quality of life index for patients with cancer. Oncol Nurs Forum. 1990;17(3 Suppl):15–9 (discussion 20-21).
31. Ferrans CE, Powers MJ. Psychometric assessment of the quality of life index. Res Nurs Health. 1992;15:29–38.
32. Ferrans CE, Powers MJ. Quality of life index: development and psychometric properties. ANS Adv Nurs Sci. 1985;8:15–24.
33. Vinan-Vega M, Mantilla B, Yang S, Nugent K. The effect of pulmonary rehabilitation on physical performance and health related quality of life in patients with chronic lung disease. Respir Med. 2021;186:106533.
34. Polkey MI, Spruit MA, Edwards LD, Watkins ML, Pinto-Plata V, Vestbo J, et al. Six-minute-walk test in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2013;187:382–6.
35. Kiley JP, Sri Ram ,J, Croxton ,Thomas L, and Weinmann GG. Challenges Associated with Estimating Minimal Clinically Important Differences in COPD—The NHLBI Perspective. COPD J Chronic Obstr Pulm Dis. 2005;2:43–6.
36. Holland AE, Hill CJ, Rasekaba T, Lee A, Naughton MT, McDonald CF. Updating the minimal important difference for six-minute walk distance in patients with chronic obstructive pulmonary disease. Arch Phys Med Rehabil. 2010;91:221–5.
37. Early F. The impact of gender on access to pulmonary rehabilitation for people with Chronic Obstructive Pulmonary Disease. 2018.
38. Maestri R, Vitacca M, Paneroni M, Zampogna E, Ambrosino N. Gender and age as determinants of success of pulmonary rehabilitation in individuals with chronic obstructive pulmonary disease. Arch Bronconeumol. 2023;59:174–7.
39. Vitacca M, Paneroni M, Spanevello A, Ceriana P, Balbi B, Salvi B, et al. Effectiveness of pulmonary rehabilitation in individuals with chronic obstructive pulmonary disease according to inhaled therapy: the Maugeri study. Respir Med. 2022;202:106967.
40. Hayden MC, Limbach M, Schuler M, Merkl S, Schwarzl G, Jakab K, et al. Effectiveness of a three-week inpatient pulmonary rehabilitation program for patients after COVID-19: A prospective observational study. Int J Environ Res Public Health. 2021;18:9001.
41. Zhang H, Hu D, Xu Y, Wu L, Lou L. Effect of pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis of randomized controlled trials. Ann Med. 2022;54:262–73.
42. Beaumont M, Mialon P, Le Ber C, Le Mevel P, Péran L, Meurisse O, et al. Effects of inspiratory muscle training on dyspnoea in severe COPD patients during pulmonary rehabilitation: controlled randomised trial. Eur Respir J. 2018;51:1701107.
43. Habib GM, Rabinovich R, Divgi K, Ahmed S, Saha SK, Singh S, et al. Systematic review of clinical effectiveness, components, and delivery of pulmonary rehabilitation in low-resource settings. Npj Prim Care Respir Med. 2020;30:1–14.
44. Moazeni SS, Ghaljeh M, Navidian A. The Effect of Pulmonary Rehabilitation on Fatigue and Quality of Life in Patients with Chronic Obstructive Pulmonary Disease: A Quasi-Experimental Study. Med - Surg Nurs J. 2020;9.
45. Aljazeeri J, Almusally R, Wert Y, Abdelhalim M, Klinger C, Ramesh N, et al. Pulmonary rehabilitation for Post-COVID-19. J Cardiopulm Rehabil Prev. 2023;43:438.
46. Reychler G, Piraux E, Beaumont M, Caty G, Liistro G. Telerehabilitation as a form of pulmonary rehabilitation in chronic lung disease: a systematic review. Healthcare. 2022;10:1795.
47. Tsutsui M, Gerayeli F, Sin DD. Pulmonary rehabilitation in a post-COVID-19 world: telerehabilitation as a new standard in patients with COPD. Taylor Francis. 2021;19:379–91.
48. Hansen H, Bieler T, Beyer N, Kallemose T, Wilcke JT, Østergaard LM, et al. Supervised pulmonary tele-rehabilitation versus pulmonary rehabilitation in severe COPD: a randomised multicentre trial. Thorax. 2020;75:413–21.

49. Burge AT, Cox NS, Holland AE, McDonald CF, Alison JA, Wootton R, et al. Telerehabilitation compared to center-based pulmonary rehabilitation for people with chronic respiratory disease: economic analysis of a randomized, controlled clinical trial. Ann Am Thorac Soc. 2024. https://doi.org/10.1513/AnnalsATS.202405-549OC.
50. Zanaboni P, Dinesen B, Hoaas H, Wootton R, Burge AT, Philp R, et al. Long-term telerehabilitation or unsupervised training at home for patients with chronic obstructive pulmonary disease: a randomized controlled trial. Am J Respir Crit Care Med. 2023;207:865–75.
51. Zhang L, Maitinuer A, Lian Z, Li Y, Ding W, Wang W, et al. Home based pulmonary tele-rehabilitation under telemedicine system for COPD: a cohort study. BMC Pulm Med. 2022;22:284.
52. Cox NS, Corso SD, Hansen H, McDonald CF, Hill CJ, Zanaboni P, et al. Telerehabilitation for chronic respiratory disease - Cox, NS - 2021 | Cochrane Library.
53. Selzler A-M, Wald J, Sedeno M, Jourdain T, Janaudis-Ferreira T, Goldstein R, et al. Telehealth pulmonary rehabilitation: A review of the literature and an example of a nationwide initiative to improve the accessibility of pulmonary rehabilitation. Chron Respir Dis. 2018;15:41–7.
54. Rochester CL, Spruit MA, Holland AE. Pulmonary Rehabilitation in 2021. JAMA. 2021;326:969–70.
55. Holland AE, Cox NS, Houchen-Wolloff L, Rochester CL, Garvey C, ZuWallack R, et al. Defining modern pulmonary rehabilitation. An official american thoracic society workshop report. Ann Am Thorac Soc. 2021;18:e12-29.

Publisher's Note