ORIGINAL ARTICLE

IJPHY

Integrating Virtual Reality into Pulmonary Rehabilitation in Chronic Obstructive Pulmonary Disease: A Narrative Review

*[1]Neha Vyas
[2]Ajeet Kumar Saharan
[3]Madhu Teotia
[4]Neha Kashyap

ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition that is characterized by airway obstruction, inflammation, and impaired pulmonary function. Pulmonary rehabilitation (PR) is a well-established therapeutic intervention for COPD management. However, patient adherence to a traditional pulmonary rehabilitation program is often limited by accessibility, self-motivation, and financial constraints. Virtual Reality (VR) has emerged as an innovation that enhances PR by providing interactive, engaging, and patient-centric tailored rehabilitation experiences. This narrative review synthesizes existing evidence on the effectiveness of VR-enhanced PR in improving physical dimensions, functional mobility, pulmonary function, and health-related quality of life (HRQoL) among individuals with COPD.

Methods: A comprehensive search on databases, including PubMed, PEDro, and ScienceDirect, was conducted from January 2019 to November 2025. The review included randomized controlled trials (RCTs) that evaluated VR-based PR intervention compared to traditional PR. Inclusion criteria required studies to focus on COPD patients using VR to enhance their physical and cardiac capacity. Data extraction was performed independently, and findings were synthesized descriptively.

Results: A total of 17,052 studies were identified, and only 10 met the inclusion criteria; these included 726 participants with stable COPD. The studies incorporated VR technologies alongside traditional PR. VR-enhanced PR demonstrated improvements in exercise tolerance, functional mobility, pulmonary function, and HRQoL. Patient engagement and adherence were also reported to be higher in VR based interventions compared to traditional PR.

Conclusion: VR-enhanced PR offers an alternative to traditional pulmonary rehabilitation by providing engaging, accessible care for patients with COPD. The current evidence supports its short-term effectiveness and broader implementation.

Keywords: Functional mobility, Physical fitness, Health-related quality of life, Virtual reality, Pulmonary Rehabilitation.

Received 25th May 2025, accepted 05th April 2026, published 09th June 2026

www.ijphy.com

DOI : 10.15621/ijphy/2026/v13i2/2195

[2]Professor and principal, Nims College of Physiotherapy and Occupational Therapy, Nims University, Jaipur. India. Email: ajeetphysio@gmail.com
[3]Assistant Professor, University of Engineering and Management, Jaipur. India.
Email: madhuteotia811@gmail.com
[4]Assistant Professor, School of Allied Health Sciences, Galgotias University, Greater Noida, India.
Email: Nehabcip1121@gmail.com

CORRESPONDING AUTHOR

***[1]Neha Vyas**

Ph.D. Scholar, Nims College of Physiotherapy and Occupational Therapy, Nims University, Jaipur. India.
Email: nehavyas555@gmail.com

INTRODUCTION

Chronic Obstructive Pulmonary Rehabilitation is a progressive and reversible obstructive respiratory condition with less air flow due to obstruction and an inflammatory response in the lungs. There are several causes of COPD, such as cigarette smoking, long-term exposure to gases, and noxious elements. Most cigarette smokers have chronic inflammation in the lungs. COPD is marked by significant difficulty in breathing because of obstruction, respiratory failure, cardiovascular risk, and cancer. Recently, COPD has become a highly prevalent disease with a prevalence rate of 10.6% worldwide, with 2.7 million patients per year. The literature states that due to a sedentary lifestyle, smoking, air pollution, and other risk factors, the prevalence will increase by 2.3% in 2050, and it will be more common in women, and it will be the third most common disease by 2030 [1,2]. In COPD, the lungs' response can increase mucus production, worsen bronchitis, accelerate emphysema, and disrupt normal tissue repair and immune defense. This is largely driven by inflammation of the small airways and bronchioles [3]. Several pathological changes will occur as a result of increased resistance to airflow in the small airways, increased lung regulatory adherence, air retention, gradual airflow limitation, and pulmonary function decline [4]. The pathological changes found in COPD involve cellular and molecular mechanisms. The changes in the proximal cartilaginous airway, where the diameter is >2mm, show an increased number of macrophages as well as CD8 T lymphocytes, fewer neutrophils and eosinophils, which increase with progression of disease, enlargement of submucosal bronchial gland, global cell metaplasia, cellular infiltration of bronchial glands, airway epithelial squamous metaplasia, and ciliary dysfunction [5]. The changes in peripheral non-cartilaginous airway with <2mm diameter show an increased number of macrophages and T lymphocytes (CD8 will be more than CD4), early-stage bronchiolitis, luminal and inflammatory exudate, pathological extension of global cells, and squamous metaplasia in the peripheral airway and airway narrowing [6].

The main clinical features are dyspnea, cough, wheezing, and mucus secretion. The systemic features of COPD are cachexia, disuse muscle atrophy, and elevated risk of cardiovascular disease, osteoporosis, depression, and anxiety. With advancing disease, the patient may experience severe pulmonary distension, including a barrel-shaped chest [7]. All these features experienced by patients result in reduced endurance and limited participation in activities of daily living (ADLs), which, overall, impact patients' quality of life. These have adverse effects on the wider aspect of a patient's health [8]. Owing to a sedentary lifestyle, comorbidities, and frequent exacerbations, the quality of life of younger patients with COPD significantly worsens. Few studies claim that the burden of COPD has reduced due to the strategies used in recent years, like a ban on tobacco use, public awareness about the hazardous effects of tobacco, self-care, and prevention of disease [9, 10].

Pulmonary rehabilitation (PR) is an evidence-based, non-pharmacological, and conservative method used in the management of COPD. It is a comprehensive approach that includes thorough assessment, tailored interventions, and self-care education for patients, which can change patients' behavior and long-term adherence to the program, improving physical and mental fitness [11]. Long-standing PR program includes supervised exercise training, including aerobic, resistance, and strengthening training, flexibility, and breathing exercises; patient and family education and counseling-based protocol and guidance provided to patients for 8 weeks or more, with a minimum of 2 sessions per week. PR is always recommended for the initial stages of COPD, from hospital admission to 6-8 weeks, with the help of a multidisciplinary team, including medical staff, physiotherapists, and nursing staff [12, 13].

Studies have suggested that PR is an essential and effective component of COPD management, resulting in improved health-related quality of life, physical fitness, and exercise tolerance, and reduced dyspnea [14]. There are persistent barriers to patient participation, attendance, and completion of their treatment protocol in traditional PR. These barriers include lack of concordance, accessibility issues, financial challenges, transportation issues, lack of motivation among patients and family members, disinterest, and limited perceived value [15, 16].

Since COVID-19, there has been a surge in home-based pulmonary rehabilitation programs incorporating modern technologies such as tele-rehabilitation, non-invasive vibration, web-based models, and virtual reality (VR) [17]. It has been suggested that home-based PR can serve as a substitute model to enhance treatment utilization and access. Studies have also reported that home PR is secure and can mitigate health consequences with modest resources [18]. Most studies have shown particular interest in newer technologies, such as virtual reality, and their use in rehabilitation. Virtual reality refers to a computer-generated environment that people can interact with. VR can be non-immersive, immersive, or semi-immersive, and can be projected in 2D or 3D on a screen, allowing interaction with objects using joysticks and keyboards [19]. A few studies state that VR in PR can promote patient participation and support an active lifestyle for patients with COPD, as it can be tailored to individual needs. It has been documented to impose a high training load, which can help us create a suitable training load for the most fragile patients [20].

The literature contains numerous studies assessing the effects of VR on chronic respiratory conditions. Although studies that included only COPD were a handful, the inclusion of all types of experimental and quasi-experimental studies limited the evidence and its generalizability [21]. This review aims to synthesize the available data on the effects of VR on physical fitness, functional mobility, pulmonary function, and health-related quality of life in patients with COPD.

METHODS

Search Strategies

The search was conducted in the following online databases: PubMed, PEDro, and ScienceDirect, from January 2019 to November 2025, and included only randomized controlled trials (RCTs). Throughout this, the following keywords were used: "Virtual Reality" AND "Pulmonary Rehabilitation" AND "Chronic Obstructive Pulmonary Disease" OR "COPD" OR "Physical Fitness" OR "Functional Fitness" OR "Pulmonary Function" OR "Functional Mobility", to create different search strategies.

The bibliographical search was conducted independently by one author using multiple search strategies. For the Cochrane Collaboration to search the participant population, intervention, comparison, outcomes, and research design were used to create more impactful search strategies. We have scrutinized the population with COPD, with interventions of VR and PR, functional capacity, pulmonary function, and HRQOL as outcomes. For greater specificity and sensitivity, only the intervention and population were used.

Eligibility Criteria

The selection process was conducted by one of the authors, who independently retrieved all articles from the database using titles and abstracts. In addition, the acceptance and rejection of the articles were handled by the second author. The criteria for inclusion were as follows: (a) the population should be COPD patients, (b) the study design should be RCT and pilot RCT, the experimental group should have VR devices to improve physical capacity and breathing exercises, (c) the non-experimental group should receive traditional PR, including aerobic, resistance, breathing exercises, and relaxation exercises. The studies will be excluded from the review if (a) the samples with mixed respiratory conditions/ pulmonary conditions were included, or (b) they do not consist of traditional PR protocols.

Data Extraction and Quality Assessment

A scrupulous review of the title and abstract has been conducted in the selection database. The studies were fully analyzed when they met the inclusion and exclusion criteria. Additionally, all the reference articles were thoroughly examined for any possibly relevant articles in English. During data extraction, the author used a worksheet to compile data from all studies. The selected data was extracted from among all included articles: authorship, date of publication, type of study, number of groups, total sample size, age, gender, and time since diagnosis, level of immersive, type of intervention, duration of intervention in weeks, number of sessions per week, frequency of each session in minutes whether it was being used individually or along with traditional PR, PR including exercises program based on FITT.

Data Synthesis and Analysis

A narrative review was conducted to summarize the effectiveness of VR training on physical fitness, functional mobility, pulmonary functions, and health-related quality of life. Studies were not considered centered on follow-up time points, as all studies analyzed the short-term effectiveness of VR training by comparing pre- and post-intervention differences within groups.

This narrative review synthesized the data descriptively and thematically according to the outcomes of interest, including physical fitness, functional mobility, pulmonary function, and health-related quality of life, among COPD patients who received VR- or PR-based interventions. VR and PR were compared in terms of their efficacy and therapeutic potential for COPD management.

RESULTS

Identification of Studies

Through electronic database research, we identified 17,052 records. After removal of duplicates (n=11,064), 5,988 studies were sought for retrieval, from which 2,647 studies were not retrieved, and a total of 3,341 studies were evaluated for eligibility. Then, based on titles and abstracts, we omitted studies that did not include COPD participants, non-VR interventions, or studies written in languages other than English (n=3,331). Hence, a total of 10 studies were included in this review [4, 8, 11, 13, 18, 20-24]. A detailed flowchart is shown in Figure 1 below.

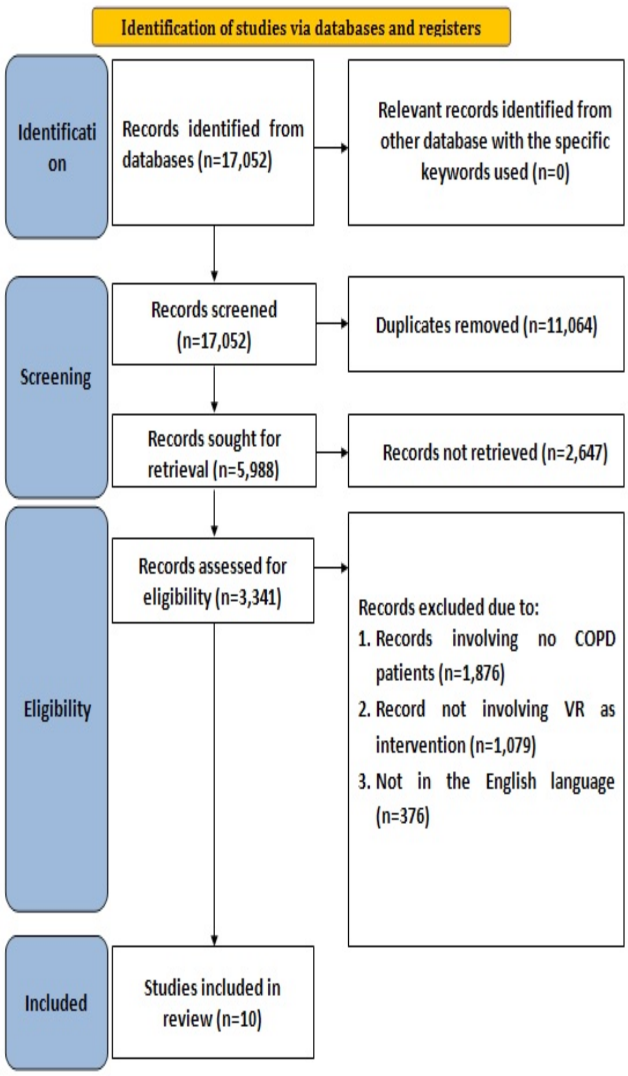

Figure 1: PRISMA flow diagram

Description of Studies

The number of participants in the included studies in this narrative review was 726. All participants presented with stable COPD. All included studies have an additional VR component to the usual PR treatment for COPD patients. Table 1 provides the characteristics of the studies included. The studies incorporated various VR technologies, including somatosensory interactive games, Kinect systems, Wii Fit videogames, immersive head-mounted displays, and cycling simulations, as an adjunct or alternative to traditional PR. VR-enhanced PR demonstrated superior or equivalent improvements in exercise tolerance, functional mobility, pulmonary function, symptom burden, psychological status (anxiety, depression, and stress), cognitive function, ADL, and health-related quality of life. Patient engagement and adherence were consistently higher with VR-based interventions compared with traditional PR [4,8,11,13,18,20-24].

Table 1: Characteristics of the studies included in the narrative review.

Study	Sample Size	Intervention Group	Control Group	Results
Rutkowski et al. (2019) [13]	68 (34/group)	Group II (n=34) Standard 2-week inpatient PR and daily 20-min Kinect VR (4 mini-games: strength, endurance, balance)	Group I (n=34) Standard 2-week inpatient PR only	Both improved SFT scores. VR group superior in Sit and Reach and Up and Go tests. VR enhanced mobility and fitness.
Sutanto et al. (2019) [22]	23 randomized → 20 completed (10/group)	EG (n=10) Standard PR (cycle ergometer 30 min, 3×/week × 6 weeks) and 30-min daily Wii Fit videogame program (yoga, strength, aerobic games)	CG (n=10) Standard PR (cycle ergometer) only	Both groups improved 6MWD, TDI, SGRQ. No significant between-group difference in clinical outcomes. Wii Fit was feasible but more expensive and added no extra benefit.
Rutkowski et al. (2020) [21]	106 completed (ET 34; ETand VR 38; VR 34)	ET and VR (n=38): Traditional PR and endurance training and daily VR (Kinect 4 games). VR-only (n=34): Traditional PR and daily VR (no endurance training)	ET (n=34): Traditional PR and endurance training (no VR)	All improved SFT. ET and VR superior to ET in 6/6 tests. VR-only superior to ET in Arm Curl, Chair Stand, and 6MWT. VR supplementation (or replacement) yielded superior fitness gains.
Jung et al. (2020) [8]	10	VR group (n=10) 8-week home-based immersive VR PR program (Pico Goblin headset and PR in VR app; education and seated exercises led by 3D avatar; ~20 min/day) with remote supervision	No intervention	11 qualitative themes: increased compliance/engagement, physical and psychological improvements, improved HRQoL/confidence. Quantitative: significant gains in physical measures. Feasible remote alternative to traditional PR.
Rutkowski et al. (2021) [4]	50 (25/group)	VR group (n=25) Standard 2-week inpatient PR and 10 × 20-min immersive VR sessions (VR TierOne – Virtual Therapeutic Garden, Ericksonian psychotherapy)	Control (n=25) Standard 2-week inpatient PR and 10 × 20-min Schultz autogenic training	Significant reductions in stress (PSQ), depression and anxiety (HADS) only in VR group (strong effect sizes). VR provided additional mood and psychological benefits.
Liu et al. (2021) [20]	100 (50/group)	Study group (n=50) Conventional drugs and health education and respiratory training and 12-week VR lung rehab (BioMaster system – cycling simulation)	Control (n=50) Conventional drugs, health education, respiratory training, and routine limb exercises	Study group superior in lung function (%FEV_1 and FEV_1/FVC at 8–12 weeks), 6MWD, CAT (reduced dyspnea), MoCA (improved cognition), and ADL ($P < 0.05$). VR improved physical, cognitive, and medication adherence outcomes.
Jin et al. (2023) [23]	80 (40/group)	SIG and PRP (n=40) Standard PRP (30 min daily: postural/limb/breathing exercises) and 20-min daily somatosensory interactive games (3 games: Kitchen Sharp Knife, Swimming Master, Table Tennis Master) for 6 weeks	PRP only (n=40) Standard PRP alone for 6 weeks	Significant time × group interaction for 6MWD & Brief-BESTest ($P < 0.001$). Intervention group superior at all follow-ups (peaking at 3 months and sustained through 12 months). Safe and feasible; no difference in inflammation or readmissions.
Shirodkar et al. (2024) [18]	72 (36/group)	Experimental (n=36) Conventional diaphragmatic breathing and VR goggles (5 min daily × 6 days)	Control (n=36) Conventional diaphragmatic breathing alone (5 min daily × 6 days)	Both groups improved PEFR, SpO_2, and QOL (SGRQ). No statistically significant between-group differences. VR was feasible and produced equivalent effects.
Kizmaz et al. (2024) [11]	50 hospitalized (25/group)	VR and PR (n=25) Traditional PR (daily until discharge, incl. pedaling) and VR cycling simulation in forest environment	Traditional PR (n=25) Standard PR (daily pedaling exercises) only	VR and PR showed greater improvements in 1-min STST ($p=0.037$), CAT ($p=0.003$), depression/HADS ($p<0.05$), and LCADL ($p<0.05$). VR was safe and added benefits during acute exacerbation.
Alsharif et al. (2025) [24]	50 (25/group)	VR and PR group Standard PR and immersive VR training component	Standard PR group Standard PR alone	VR group demonstrated superior gains in functional capacity, symptom reduction, and psychological outcomes vs standard PR (consistent with pattern in similar trials).

6MWD / 6MWT: 6-Minute Walk Distance / 6-Minute Walk Test; ADL: Activities of Daily Living; Brief-BESTest: Brief Balance Evaluation Systems Test; CAT: COPD Assessment Test; COPD: Chronic Obstructive Pulmonary Disease; EG / CG: Experimental Group / Control Group; ET: Endurance Training ; FEV_1: Forced Expiratory Volume in 1 Second; FVC: Forced Vital Capacity; HADS: Hospital Anxiety and Depression Scale; HRQoL: Health-Related Quality of Life; LCADL: London Chest Activity of Daily Living; MCI: Mild Cognitive Impairment; MoCA: Montreal Cognitive Assessment; mMRC: modified Medical Research Council (dyspnea scale); PEFR: Peak Expiratory Flow Rate; PR / PRP: Pulmonary Rehabilitation / Pulmonary Rehabilitation Program; PSQ: Perception of Stress Questionnaire; QOL / SGRQ: Quality of Life / St. George's Respiratory Questionnaire; SIG: Somatosensory Interactive Games; SFT: Senior Fitness Test; SpO_2: Peripheral Oxygen Saturation; STST: 1-Minute Sit-to-Stand Test; TDI: Transitional Dyspnea Index; VR: Virtual Reality

DISCUSSION

This narrative review synthesizes evidence from 10 RCTs involving 726 participants and evaluates the integration of VR and interactive gaming technologies into PR programs for patients with COPD. Overall, the results demonstrate that VR-enhanced PR consistently provides superior or equivalent improvements compared to traditional PR alone across multiple key outcomes. These outcomes include exercise tolerance, pulmonary function, functional capacity, symptom burden, psychological status, and health-related quality of life (HRQoL). Patient engagement, adherence, and satisfaction were also notably higher with VR interventions, effectively addressing common barriers to traditional PR, such as low motivation, accessibility issues, and exercise monotony [4, 8, 11, 13, 18, 20-24].

Jin et al. (2023) reported that adding somatosensory interactive games to standard PR produced significant time-by-group interactions for the measured 6-minute walk distance and balance. The benefits peaked at three months and persisted up to twelve months. The intervention was safe and feasible, with no difference in inflammation markers or hospital readmissions [23]. Shirodkar et al. (2024) found comparable improvements in peak expiratory flow rate, peripheral oxygen saturation, and HRQoL between VR-based and conventional diaphragmatic breathing exercises over six days, confirming the feasibility of VR and its equivalent short-term efficacy [18]. Sutanto et al. (2019) showed that adding Wii Fit video games to PR was feasible but did not yield statistically superior clinical outcomes (6-minute walk distance, transitional dyspnea index, and St. George's Respiratory Questionnaire scores) compared with standard PR. However, it was more expensive [22].

Jung et al. (2020) demonstrated high feasibility and acceptability of an 8-week home-based immersive VR-PR program using the Pico Goblin headset. Qualitative analysis revealed eleven themes highlighting increased compliance, engagement, physical and psychological improvements, and better HRQoL. Quantitative measures showed significant pre-to-post gains in physical function [8]. Rutkowski et al. (2019) found that daily Kinect VR training, added to a 2-week inpatient PR program, produced superior improvements in balance and mobility compared with standard PR alone [13]. In a three-arm RCT, Rutkowski et al. (2020) reported that both VR-supplemented PR (with endurance training) and VR-only PR were superior to endurance training alone across multiple components, including the 6-minute walk test [21]. Rutkowski et al. (2021) further showed that adding immersive VR therapy using the Virtual Therapeutic Garden (based on Ericksonian psychotherapy) to standard PR significantly reduced stress, anxiety, and depression beyond traditional autogenic training, with strong effect sizes [4].

Liu et al. (2021) specifically studied patients with COPD and mild cognitive impairment. They demonstrated that a 12-week VR lung rehabilitation program using the BioMaster system was superior to routine limb exercises in lung function, exercise capacity, reducing dyspnea, improving cognition, and ADL[20]. Kizmaz et al. (2024) evaluated VR during acute COPD exacerbation. They found that VR combined with PR produced greater improvements in the 1-minute sit-to-stand test, dyspnoea, depression, anxiety, and ADL compared to traditional PR alone [11]. Finally, Alsharif et al. (2025) confirmed that immersive VR training, added to standard PR, yielded superior gains in functional capacity, symptom reduction, and psychological outcomes compared with standard VR [24].

In summary, VR technology offers an engaging, accessible, and patient-centered adjunct or alternative to traditional VR. Clinically, integrating VR into PR programs can overcome key barriers such as low motivation and poor adherence, improve physical and psychological outcomes in both stable and acute COPD settings, and potentially reduce healthcare burden through better long-term self-management. Future large-scale, long-term trials should evaluate cost-effectiveness, optimal virtual reality protocols, and sustainability to support broader clinical implementation.

Limitations and Future Studies

Despite its advantages, VR-enhanced PR is not without limitations. The high cost of VR equipment and the need for technical ability to set up and support the systems may pose barriers to widespread adoption of the technology. The long-term sustainability of VR-enhanced PR interventions and their impact on COPD progression could not be assessed due to the short-term nature of the studies included in this narrative review. Future studies should aim to address these gaps identified in the current evidence base. In the future, studies should also explore the cost-effectiveness of VR interventions in reducing healthcare costs by improving patient outcomes and reducing hospital readmissions.

CONCLUSION

This narrative review underscores the promising role of

VR technology in advancing pulmonary rehabilitation for patients with COPD. VR-enhanced PR offers a novel, patient-centered approach that addresses both physical and psychosocial challenges by combining the benefits of immersive environments with evidence-based rehabilitation protocols.

REFERENCES

[1] Sharma BB, Singh V. Pulmonary rehabilitation: An overview. Lung India. 2011;28(4):276-84.

[2] Liu Y, Du Q, Jiang Y. The effect of virtual reality technology in exercise and lung function of patients with chronic obstructive pulmonary disease: A systematic review and meta-analysis. Worldviews Evid Based Nurs. 2024;21(3):307-17.

[3] Patsaki I, Avgeri V, Rigoulia T, Zekis T, Koumantakis GA, Grammatopoulou E. Benefits from incorporating virtual reality in pulmonary rehabilitation of COPD patients: A systematic review and meta-analysis. Adv Respir Med. 2023;91(4):324-36.

[4] Rutkowski S, Szczegielniak J, Szczepańska-Gieracha J. Evaluation of the efficacy of immersive virtual reality therapy as a method supporting pulmonary rehabilitation: A randomized controlled trial. J Clin Med. 2021;10(2):352.

[5] Chai X, Wu L, He Z. Effects of virtual reality-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: A meta-analysis. Medicine (Baltimore). 2023;102(52):e36702.

[6] Alabdulmohsen DM, Alabdulmohsen SM. Virtual reality for chronic obstructive pulmonary disease: insights from a scoping review. Int J Adv Med. 2025;12:242-9.

[7] Obrero-Gaitán E, Chau-Cubero CY, Lomas-Vega R, Osuna-Pérez MC, García-López H, Cortés-Pérez I. Effectiveness of virtual reality-based therapy in pulmonary rehabilitation of chronic obstructive pulmonary disease. A systematic review with meta-analysis. Heart Lung. 2024;65:1-10.

[8] Jung T, Moorhouse N, Shi X, Amin MF. A virtual reality-supported intervention for pulmonary rehabilitation of patients with chronic obstructive pulmonary disease: mixed methods study. J Med Internet Res. 2020;22(7):e14178.

[9] Pittara M, Matsangidou M, Pattichis CS. Virtual reality for pulmonary rehabilitation: comprehensive review. JMIR Rehabil Assist Technol. 2023;10:e47114.

[10] Gabriel AS, Tsai TY, Xhakli T, Finkelstein J. Patient perceptions of a virtual reality-based system for pulmonary rehabilitation: a qualitative analysis. Stud Health Technol Inform. 2023;305:406-9.

[11] Kizmaz E, Telli Atalay O, Çetin N, Uğurlu E. Virtual reality for COPD exacerbation: a randomized controlled trial. Respir Med. 2024;230:107696.

[12] Colombo V, Aliverti A, Sacco M. Virtual reality for COPD rehabilitation: a technological perspective. Pulmonology. 2022;28(2):119-33.

[13] Rutkowski S, Rutkowska A, Jastrzębski D, Racheniuk H, Pawełczyk W, Szczegielniak J. Effect of virtual reality-based rehabilitation on physical fitness in patients with chronic obstructive pulmonary disease. J Hum Kinet. 2019;69:149-57.

[14] Xie X, Fan J, Chen H, Zhu L, Wan T, Zhou J, Fan D, Hu X. Virtual reality technology combined with comprehensive pulmonary rehabilitation on patients with stable chronic obstructive pulmonary disease. J Healthc Eng. 2021;2021:9987200.

[15] Li Y, Jiang H, Lyu Z. Virtual reality as an adjunct to pulmonary rehabilitation of patients with chronic obstructive pulmonary disease: a protocol for systematic review and meta-analysis. BMJ Open. 2023;13(12):e074688.

[16] Colombo V, Mondellini M, Gandolfo A, Fumagalli A, Sacco M. Usability and acceptability of a virtual reality-based system for endurance training in elderly with chronic respiratory diseases. In: International Conference on Virtual Reality and Augmented Reality; 2019. Cham: Springer International Publishing; 2019. p. 87-96.

[17] Moorhouse N, Jung T, Shi X, Amin F, Newsham J, McCall S. Pulmonary rehabilitation in virtual reality for COPD patients. In: Augmented reality and virtual reality: the power of AR and VR for business; 2019. Cham: Springer International Publishing; 2019. p. 277-90.

[18] Shirodkar S, Deo M. A comparative study between conventional diaphragmatic breathing exercise and virtual reality-based diaphragmatic breathing exercise on quality of life in chronic obstructive pulmonary disease patients: a randomized control trial. Arch Med Health Sci. 2024;12(2):171-5.

[19] Chen Y, Zhang Y, Long X, Tu H, Chen J. Effectiveness of virtual reality–complemented pulmonary rehabilitation on lung function, exercise capacity, dyspnea, and health status in chronic obstructive pulmonary disease: systematic review and meta-analysis. J Med Internet Res. 2025;27:e64742.

[20] Liu H, Yang X, Wang X, Yang X, Zhang X, Li Q. Study on adjuvant medication for patients with mild cognitive impairment based on VR technology and health education. Contrast Media Mol Imaging. 2021;2021(1):1187704.

[21] Rutkowski S, Rutkowska A, Kiper P, Jastrzebski D, Racheniuk H, Turolla A, Szczegielniak J, Casaburi R. Virtual reality rehabilitation in patients with chronic obstructive pulmonary disease: a randomized controlled trial. Int J Chron Obstruct Pulmon Dis. 2020;15:117-24.

[22] Sutanto YS, Makhabah DN, Aphridasari J, Doewes M, Suradi, Ambrosino N. Videogame assisted exercise training in patients with chronic obstructive pulmonary disease: a preliminary study. Pulmonology. 2019;25(5):275-82.

[23] Jin X, Jin M, Zhang B, Niu ME, Han Y, Qian J. The association of conventional therapy associated with somatosensory interactive game enhances the effects of early pulmonary rehabilitation for patients with

acute exacerbation of chronic obstructive pulmonary disease: a randomized controlled trial. Games Health J. 2025;14(2):127-35.
[24] Alsharif AA, Obaya HE, Elyazed TI, Ali SM. Effect of virtual reality-based training on pulmonary functions and quality of life in patients with COPD. Egypt J Hosp Med. 2025;101(1).

Abbreviations

1	**ADLs**	Activities of Daily Living
2	**COPD**	Chronic Obstructive Pulmonary Disease
3	**CRQ**	Chronic Respiratory Questionnaire
4	**CG**	Control Group
5	**EG**	Experimental Group
6	**EG vs CG**	Comparison between Experimental Group and Control Group
7	**FEV1%**	Forced Expiratory Volume in 1 Second (percentage predicted)
8	**FIT**	Frequency, Intensity, Time, and Type (used in exercise prescription)
9	**HRQoL**	Health-Related Quality of Life
10	**PR**	Pulmonary Rehabilitation
11	**RCT**	Randomized Controlled Trial
12	**SD**	Standard Deviation
13	**VR**	Virtual Reality
14	**6MWT**	6-Minute Walk Test