Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Kinesiophobia and Its Response to Nurse-Led Pulmonary Rehabilitation in Patients with Chronic Obstructive Pulmonary Disease: A Cross-Sectional and Prospective Controlled Study

Yali Peng
Three Gorges University, China Three Gorges University
Chunyan Li
Three Gorges University, China Three Gorges University
Jinxia Zhang
Three Gorges University, China Three Gorges University
Gan Luo
Three Gorges University, China Three Gorges University
Shuang Wu
Three Gorges University, China Three Gorges University
Donglan Xiong
Three Gorges University, China Three Gorges University
Lin Yang
Affiliated Renhe Hospital of China Three Gorges University, China Three Gorges University
Zhiwen Huang
Three Gorges University, China Three Gorges University
Tingting Chen
Xinjiang Tarim Vocational Technical College
Huaiyan Liu
Three Gorges University, China Three Gorges University
Hao Qiaorong
China Three Gorges University
Mozhen Chi
380217463@qq.com

Three Gorges University, China Three Gorges University

Article

Keywords: Pulmonary Disease, Chronic Obstructive, Kinesiophobia, Pulmonary Rehabilitation, Nursing Care, Patient Care Management, Risk Assessment, Predictive Models

Posted Date: November 4th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10677858/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Kinesiophobia and Its Response to Nurse-Led Pulmonary Rehabilitation in Patients with Chronic Obstructive Pulmonary Disease: A Cross-Sectional and Prospective Controlled Study

Running title: Kinesiophobia and pulmonary rehabilitation in COPD

Authors:

Yali Peng[1], Chunyan Li[1], Jinxia Zhang[1], Gan Luo[1], Shuang Wu[1], Donglan Xiong[1], Lin Yang[2], Zhiwen Huang[1], Tingting Chen[3,4], Huaiyan Liu[1,4], Hao Qiaorong[4], Mozhen Chi[1*]

Affiliations:

[1] Department of Respiratory and Critical Care Medicine, Affiliated Renhe Hospital of China Three Gorges University, The Second College of Clinical Medical Science, China Three Gorges University, No. 410 Yiling Road, Yichang 443001, Hubei, China;

[2] Department of General Practice, Affiliated Renhe Hospital of China Three Gorges University, The Second College of Clinical Medical Science, China Three Gorges University, Yichang 443001, Hubei, China;

[3] Xinjiang Tarim Vocational Technical College, Xinjiang, China;

[4] College of Health Science, China Three Gorges University, Yichang, Hubei, China.

Corresponding author: Mozhen Chi, Department of Respiratory and Critical Care Medicine, Affiliated Renhe Hospital of China Three Gorges University, No. 410 Yiling Road, Yichang 443001, Hubei, China. Email: 380217463@qq.com

Abstract

Objective: To investigate the prevalence and associated factors of kinesiophobia in hospitalized patients with chronic obstructive pulmonary disease (COPD), develop a practical prediction model, and evaluate the response of kinesiophobia and respiratory-related outcomes to nurse-led pulmonary rehabilitation.

Methods: The cross-sectional phase was conducted from January to June 2025. Of 340 questionnaires distributed, 300 were valid (valid response rate, 88.2%). A prospective controlled intervention phase was conducted from August 2025 to January 2026 and included 100 patients, with 50 receiving nurse-led pulmonary rehabilitation and 50 receiving routine care. Kinesiophobia was assessed using the 17-item Tampa Scale for Kinesiophobia (TSK-17), and a total score >37 was defined as the presence of kinesiophobia. Logistic regression was used to

identify independent associated factors and construct a prediction model. The intervention incorporated cognitive-behavioral support, breathing training, graded exercise, symptom self-management, and follow-up supervision. Outcomes were assessed over 8 weeks.
Results: Kinesiophobia was identified in 199 of 300 patients with COPD (66.3%). Older age, more frequent acute exacerbations in the previous year, and higher modified Medical Research Council dyspnea scores were independently associated with kinesiophobia. The prediction model showed good discrimination, with an area under the curve of 0.915. In the intervention phase, patients receiving nurse-led pulmonary rehabilitation showed greater improvements in TSK-17 score, dyspnea, health status, arterial blood gas indices, and pulmonary function-related outcomes than those receiving routine care.
Conclusion: Kinesiophobia is common among hospitalized patients with COPD and is associated with age, exacerbation frequency, and dyspnea severity. A simple clinical prediction model may help identify patients at risk, and nurse-led pulmonary rehabilitation may reduce kinesiophobia and improve respiratory-related outcomes.
Keywords: Pulmonary Disease, Chronic Obstructive; Kinesiophobia; Pulmonary Rehabilitation; Nursing Care; Patient Care Management; Risk Assessment; Predictive Models

Introduction

Chronic obstructive pulmonary disease (COPD) is a major global respiratory disorder characterized by persistent airflow limitation, progressive symptoms, recurrent exacerbations, and substantial functional decline. Contemporary epidemiological analyses and international expert recommendations emphasize that COPD remains a growing public-health burden requiring earlier recognition and comprehensive long-term management [1,2]. Current GOLD guidance therefore supports multidimensional care that integrates pharmacological treatment with symptom assessment, risk reduction, physical activity, and non-pharmacological interventions [3]. Pulmonary rehabilitation is a central component of this approach and is recommended for symptomatic patients and after acute exacerbations because it can improve exercise capacity, dyspnea, and health-related quality of life [4,5].

One important but often underrecognized barrier to rehabilitation is kinesiophobia, in which patients avoid physical activity because they interpret breathlessness, fatigue, or cardiopulmonary discomfort as evidence of harm. The Tampa Scale for Kinesiophobia is widely used to quantify

fear of movement and avoidance behavior, and recent psychometric evidence supports its clinical use across chronic disease populations [6]. In COPD, dyspnea-related kinesiophobia is associated with reduced physical activity and maladaptive beliefs about breathlessness, potentially creating a cycle of avoidance, deconditioning, and further symptom amplification [7,8].

Recent evidence also suggests that nurse-led disease-management strategies and interventions combining cognitive guidance with breathing training can improve patient engagement and clinical outcomes in COPD [9,10]. However, evidence remains limited on how to integrate risk-factor identification, practical prediction modeling, and a structured nurse-led intervention within one clinically usable framework for kinesiophobia. Therefore, this study aimed to assess the prevalence and determinants of kinesiophobia in hospitalized patients with COPD, develop a clinically applicable prediction model, and evaluate the response to a nurse-led pulmonary rehabilitation intervention.

Methods

Study design and participants

This two-phase, single-center clinical study consisted of a cross-sectional analysis and a prospective controlled intervention study. The cross-sectional phase was conducted from January to June 2025 to investigate the prevalence of kinesiophobia and its associated clinical factors in hospitalized patients with COPD. The prospective controlled phase was conducted from August 2025 to January 2026 to evaluate the response of kinesiophobia and related respiratory outcomes to a nurse-led pulmonary rehabilitation intervention. All participants were recruited from the Department of Respiratory and Critical Care Medicine, Affiliated Renhe Hospital of China Three Gorges University, Yichang, China. The study protocol was approved by the Ethics Committee of Affiliated Renhe Hospital of China Three Gorges University on November 27, 2024 (approval no. RH-2024-31), and written informed consent was obtained from all participants.

Participants

During the cross-sectional phase, 340 questionnaires were distributed to hospitalized patients with COPD and 300 valid questionnaires were returned, corresponding to a valid response rate of 88.2%. Forty questionnaires were excluded because more than 20% of items were missing (n=22), logical inconsistencies were identified (n=11), or patterned responses were detected (n=7). COPD was diagnosed according to relevant clinical criteria based on respiratory

symptoms, exposure history, and pulmonary function findings. Patients were eligible if they were hospitalized in the respiratory department, had a confirmed diagnosis of COPD, were clinically able to complete questionnaire assessment and pulmonary function testing, and agreed to participate. Patients were excluded if they had severe cardiovascular or cerebrovascular disease, cognitive impairment, severe motor dysfunction, severe psychiatric disease, inability to cooperate with pulmonary rehabilitation or follow-up, or incomplete key clinical outcome data.

For the prospective intervention phase, 100 eligible patients were enrolled, of whom 50 received nurse-led pulmonary rehabilitation in addition to routine care and 50 received routine care alone. Baseline demographic and clinical characteristics were compared to evaluate group comparability before intervention. Both groups were followed according to the same assessment schedule to reduce differential follow-up bias.

Assessment of kinesiophobia and clinical variables

Kinesiophobia was assessed using the 17-item Tampa Scale for Kinesiophobia (TSK-17), a commonly used instrument for evaluating fear of movement and avoidance behavior. Each item is scored on a 4-point Likert scale, with a total score ranging from 17 to 68. Higher scores indicate greater fear of movement or exercise-related avoidance. In the primary analysis, a TSK-17 total score >37 was defined as the presence of kinesiophobia.

Dyspnea severity was assessed using the modified Medical Research Council (mMRC) dyspnea scale, and health status was assessed using the COPD Assessment Test (CAT). Pulmonary function indices included forced expiratory volume in 1 second/forced vital capacity (FEV_1/FVC), percentage of predicted forced expiratory volume in 1 second (FEV_1% predicted), maximal voluntary ventilation, inspiratory peak flow, and peak expiratory flow. Arterial blood gas indices included partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), and arterial pH. Demographic and clinical variables included age, sex, educational level, disease duration, smoking status, number of acute exacerbations in the previous year, length of hospital stay, and self-care ability. All clinical information was obtained from medical records and standardized patient assessment forms.

Development of the nurse-led pulmonary rehabilitation intervention

The nurse-led pulmonary rehabilitation program was developed according to established clinical rehabilitation principles for COPD and refined through expert consultation. The expert consultation process included two rounds. The authority coefficient was 0.86 in the first round

and 0.88 in the second round. Kendall's coefficient of concordance increased from 0.216 in the first round to 0.412 in the second round, indicating improved agreement among experts after revision. The preliminary intervention framework was developed based on evidence-based principles and the fear-avoidance model, with consideration of clinical practice, patient preferences, and multidisciplinary discussion. It was subsequently refined through two rounds of Delphi consultation involving 15 experts in related fields to establish the final intervention protocol.

The final intervention consisted of five components: admission assessment and individualized planning, cognitive-behavioral guidance within 48 hours after admission, confidence-building and rehabilitation education from day 3, structured pulmonary rehabilitation from day 4 when safety criteria were met, and discharge preparation with post-discharge follow-up. Before initiating rehabilitation training, patients were required to meet predefined safety criteria, including heart rate between 40 and 120 beats/min, systolic blood pressure between 90 and 180 mmHg, diastolic blood pressure ≤110 mmHg, respiratory rate ≤25 breaths/min, and oxygen saturation ≥90%.

The intervention included cognitive-behavioral guidance, breathing training, graded exercise training, symptom self-management education, and follow-up supervision. Cognitive-behavioral guidance focused on correcting misconceptions that exercise-induced breathlessness necessarily indicated disease deterioration. Breathing training included pursed-lip breathing and diaphragmatic breathing. Graded exercise training progressed from bed activity and resistance exercise to bedside walking and aerobic activity according to individual tolerance. Exercise intensity and duration were adjusted according to symptoms, vital signs, oxygen saturation, and perceived exertion. Patients were instructed to stop exercise immediately if marked dyspnea, chest tightness, dizziness, palpitations, excessive fatigue, abnormal respiratory rate, excessive heart rate, blood pressure >180/110 mmHg, or blood pressure <90/60 mmHg occurred. After discharge, follow-up supervision was provided at weeks 1, 2, 4, and 8 through telephone or online communication to monitor home-based rehabilitation, reinforce adherence, and address patient concerns.

Control conditions

Patients in both groups received routine COPD medical and nursing care, including condition monitoring, medication guidance, oxygen therapy guidance when needed, smoking cessation

education, dietary advice, and general health education. Patients in the intervention group received the additional nurse-led pulmonary rehabilitation program described above, whereas patients in the control group received routine care only. The same follow-up time points were used in both groups.

Outcomes

In the cross-sectional phase, the primary outcome was the presence of kinesiophobia, defined as a TSK-17 total score >37. The main purpose of this phase was to describe the prevalence of kinesiophobia and identify associated clinical factors. In the intervention phase, the primary outcome was the change in TSK-17 score from baseline to week 8. Secondary outcomes included changes in mMRC score, CAT score, PaO2, PaCO2, FEV1/FVC, FEV1% predicted, and peak expiratory flow. Outcomes were assessed at baseline and at weeks 1, 2, 4, and 8. All assessments were performed by trained clinical staff using standardized procedures.

Data quality control

To reduce measurement bias, all questionnaire assessments were performed using uniform instructions, and pulmonary function and arterial blood gas measurements were conducted according to routine clinical standards. Data were checked for completeness and consistency before analysis. When inconsistencies were identified, the original medical records were reviewed. Patients with missing key outcome data that could not be verified were excluded from the corresponding analysis. Data entry and statistical analysis were performed using de-identified datasets.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation or median with interquartile range according to distribution. Categorical variables were expressed as number and percentage. Between-group comparisons were performed using the independent-samples t-test or Mann–Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate.

Spearman correlation analysis was used to examine associations between TSK-17 score and clinical variables. Univariable logistic regression was first performed to identify candidate factors associated with kinesiophobia. Variables with $p<0.10$ in univariable analysis and clinical relevance were considered for multivariable logistic regression. To reduce overfitting and collinearity, the final prediction model retained age, number of acute exacerbations in the

previous year, and mMRC score. Model discrimination was evaluated using the receiver operating characteristic curve and area under the curve. Model calibration was assessed using a calibration plot, in accordance with common reporting principles for prediction modeling studies. For the intervention phase, within-group changes from baseline and between-group differences in change scores were calculated. Mixed-effects models including group, time, and group-by-time interaction were used to evaluate intervention effects over time. A significant group-by-time interaction indicated that the trajectory of change differed between the intervention and control groups. All statistical tests were two-sided, and $p < 0.05$ was considered statistically significant. Statistical analyses were performed using SPSS version 26.0 and R software, as appropriate.

Results

Status of kinesiophobia and associated clinical characteristics

Of 340 questionnaires distributed during the cross-sectional phase, 300 were valid and included in the analysis. The mean TSK-17 score was 42.73 ± 8.29, with a median of 42.0 (interquartile range, 36.0-48.0), indicating that fear-related avoidance was common in this inpatient population. Using the predefined cut-off of >37 points, 199 patients (66.3%) were classified as having kinesiophobia (Figure 1). Compared with patients without kinesiophobia, those with kinesiophobia were markedly older (74.73 ± 6.02 vs 63.53 ± 6.36 years, $p<0.001$), had longer disease duration (11.44 ± 8.25 vs 8.91 ± 7.46 years, $p=0.005$), more acute exacerbations in the previous year (2.37 ± 1.45 vs 1.46 ± 0.73, $p<0.001$), and longer hospital stay (9.55 ± 4.27 vs 7.46 ± 3.04 days, $p<0.001$). Symptom burden was also substantially higher in patients with kinesiophobia, as reflected by higher CAT scores (16.39 ± 5.37 vs 11.10 ± 4.47, $p<0.001$) and a clear shift toward higher mMRC grades ($p<0.001$). In contrast, sex distribution and smoking status were similar between groups. Respiratory performance showed a consistent but not uniform pattern: PaO2, MVV, PIF, and PEF were lower in patients with kinesiophobia, whereas PaCO2, FEV1/FVC, and FEV1% predicted did not differ significantly. These findings suggest that kinesiophobia was more closely related to age, recent clinical instability, dyspnea burden, and functional respiratory performance than to spirometric obstruction alone (Table 1).

Table 1. Cross-sectional characteristics according to kinesiophobia status

Variable	No kinesiophobia (n=101)	Kinesiophobia (n=199)	p value
Age	63.53 ± 6.36	74.73 ± 6.02	<0.001
Disease duration	8.91 ± 7.46	11.44 ± 8.25	0.005
Exacerbations in previous year	1.46 ± 0.73	2.37 ± 1.45	<0.001
Hospital stay	7.46 ± 3.04	9.55 ± 4.27	<0.001
pH	7.39 ± 0.05	7.41 ± 0.04	<0.001
PaO2	80.65 ± 16.66	75.93 ± 15.95	0.005
PaCO2	43.09 ± 8.68	43.51 ± 8.45	0.386
CAT	11.10 ± 4.47	16.39 ± 5.37	<0.001
Self-care score	84.31 ± 9.77	81.33 ± 11.17	0.021
FEV1/FVC	55.60 ± 15.92	54.26 ± 15.56	0.376
FEV1% predicted	52.48 ± 24.36	51.12 ± 21.69	0.895
MVV	46.49 ± 26.65	37.85 ± 19.80	0.026
PIF	3.29 ± 1.30	2.76 ± 1.08	<0.001
PEF	3.52 ± 1.89	2.83 ± 1.32	0.002
TSK-17 score	33.92 ± 3.23	47.20 ± 6.24	<0.001
Sex	1: 85 (84.2%); 2: 16 (15.8%)	1: 161 (80.9%); 2: 38 (19.1%)	0.593
Education	1: 31 (30.7%); 2: 50 (49.5%); 3: 17 (16.8%); 4: 3 (3.0%)	1: 109 (54.8%); 2: 66 (33.2%); 3: 13 (6.5%); 4: 11 (5.5%)	<0.001
Smoking status	1: 47 (46.5%); 2: 19 (18.8%); 3: 35 (34.7%)	1: 95 (47.7%); 2: 37 (18.6%); 3: 67 (33.7%)	0.980
mMRC	0: 55 (54.5%); 1: 44 (43.6%); 2: 2 (2.0%)	0: 17 (8.5%); 1: 84 (42.2%); 2: 65 (32.7%); 3: 29 (14.6%); 4: 4 (2.0%)	<0.001

Abbreviations: CAT, COPD Assessment Test; COPD, chronic obstructive pulmonary disease; FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; mMRC, modified Medical Research Council; MVV, maximal voluntary ventilation; PaCO2, arterial carbon dioxide tension; PaO2, arterial oxygen tension; PEF, peak expiratory flow; PIF, peak inspiratory flow; TSK-17, 17-item Tampa Scale for Kinesiophobia. Kinesiophobia was defined as a TSK-17 total score >37.

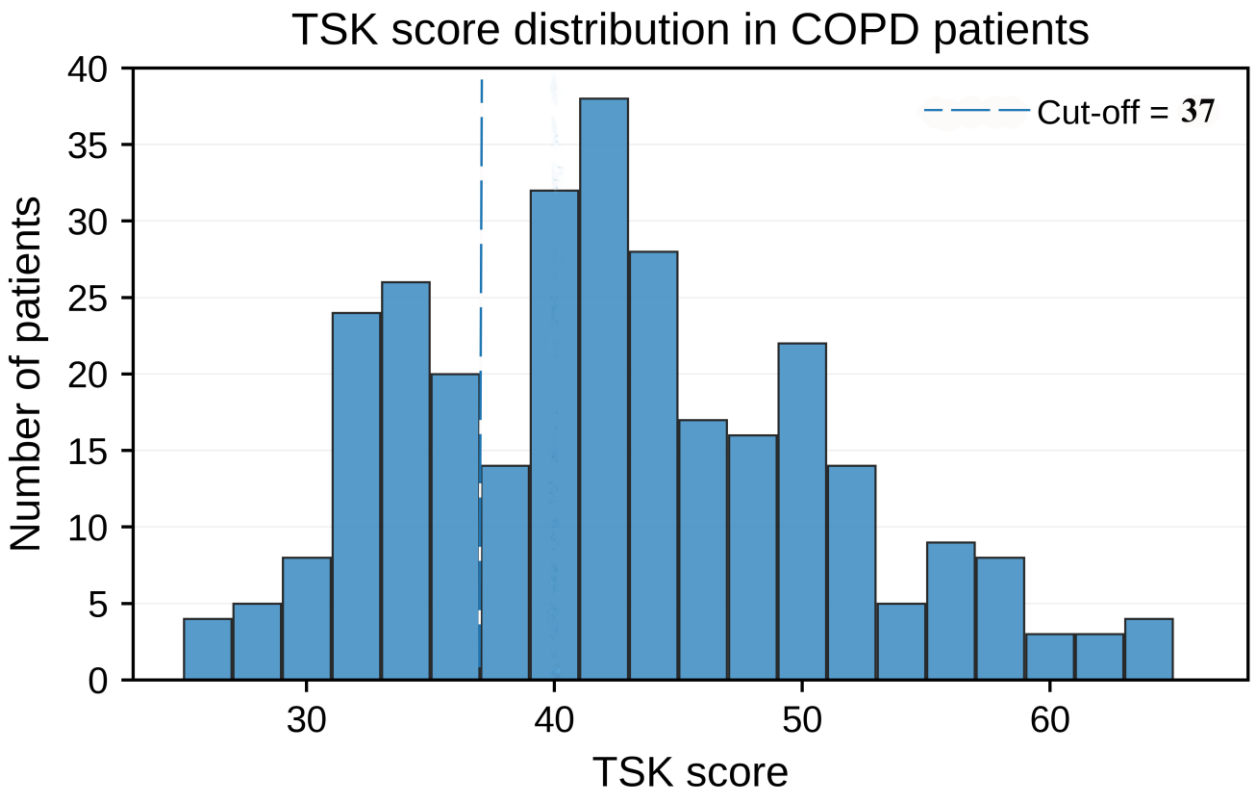


Figure 1. Distribution of TSK-17 scores among 300 hospitalized patients with COPD. The dashed line indicates the predefined cut-off of >37 points for kinesiophobia.

Correlation analysis

Correlation analysis further supported the relationship between kinesiophobia and both symptom perception and clinical vulnerability. TSK-17 score was strongly correlated with age (rho=0.795, p<0.001), mMRC score (rho=0.704, p<0.001), and CAT score (rho=0.614, p<0.001), suggesting that older patients and those with greater dyspnea and poorer health status tended to report more pronounced fear of activity. Moderate positive correlations were observed for acute exacerbations in the previous year (rho=0.388, p<0.001) and length of hospital stay (rho=0.274, p<0.001), indicating that recent disease instability was also associated with higher TSK-17 scores. TSK-17

score showed negative correlations with PaO2, MVV, PIF, and PEF, although the strengths of these associations were relatively modest. No significant correlations were observed for PaCO2, FEV1/FVC, or FEV1% predicted. This pattern indicates that kinesiophobia may be more strongly driven by perceived breathlessness and functional limitation than by conventional spirometric indices alone (Table 2).

Table 2. Correlations between clinical variables and TSK-17 score

Variable	Spearman rho	p value	n
Age	0.795	<0.001	300
Disease duration	0.187	0.001	300
Exacerbations in previous year	0.388	<0.001	300
Hospital stay	0.274	<0.001	300
pH	0.165	0.004	300
PaO2	-0.132	0.022	300
PaCO2	0.089	0.124	299
CAT	0.614	<0.001	300
Self-care score	-0.098	0.089	300
FEV1/FVC	-0.055	0.343	300
FEV1% predicted	0.017	0.770	300
MVV	-0.199	0.001	259
PIF	-0.260	<0.001	285
PEF	-0.191	<0.001	299
mMRC	0.704	<0.001	300

Abbreviations: see Table 1. Correlations were calculated using Spearman correlation analysis.

Risk factors and prediction model for kinesiophobia

Univariable logistic regression identified several candidate factors associated with kinesiophobia, including older age, lower educational level, longer disease duration, more frequent acute exacerbations, longer hospital stay, lower PaO2, higher mMRC and CAT scores, lower self-care ability, and reduced PIF and PEF (Table 3; Figure 2A). After multivariable adjustment and

collinearity screening, three variables remained independently associated with kinesiophobia: older age (OR=1.24, 95% CI 1.15-1.34, p<0.001), more frequent acute exacerbations in the previous year (OR=1.47, 95% CI 1.02-2.11, p=0.037), and higher mMRC score (OR=2.27, 95% CI 1.24-4.14, p=0.008) (Table 4; Figure 2B). Based on these variables, a simplified prediction model was constructed and displayed as a nomogram-style tool to support bedside risk approximation (Figure 2C). The model showed good discrimination, with an AUC of 0.915 (95% CI 0.881-0.943), sensitivity of 76.9%, and specificity of 92.1% (Figure 2D). Calibration analysis showed acceptable agreement between predicted and observed probabilities across risk strata, suggesting that the model provided a reasonable estimate of kinesiophobia risk within this cohort (Figure 2E).

Table 3. Univariable logistic regression for kinesiophobia

Variable	OR (95% CI)	p value
Age	1.33 (1.25-1.42)	<0.001
Education	0.66 (0.49-0.88)	0.004
Disease duration	1.05 (1.01-1.08)	0.012
Exacerbations in previous year	2.17 (1.64-2.86)	<0.001
Hospital stay	1.21 (1.11-1.33)	<0.001
PaO2	0.98 (0.97-1.00)	0.020
mMRC	8.23 (4.92-13.76)	<0.001
CAT	1.23 (1.16-1.30)	<0.001
Self-care score	0.97 (0.95-1.00)	0.025
PIF	0.68 (0.54-0.84)	<0.001
PEF	0.76 (0.65-0.89)	<0.001

Abbreviations: CI, confidence interval; OR, odds ratio. Only variables with p<0.10 in univariable analysis are shown.

Table 4. Multivariable logistic regression model for kinesiophobia

Variable	OR (95% CI)	p value
Age	1.24 (1.15-1.34)	<0.001

Variable	OR (95% CI)	p value
Exacerbations in previous year	1.47 (1.02-2.11)	0.037
mMRC	2.27 (1.24-4.14)	0.008

Abbreviations: CI, confidence interval; OR, odds ratio. The model retained age, exacerbation frequency, and mMRC score after clinical and collinearity screening.

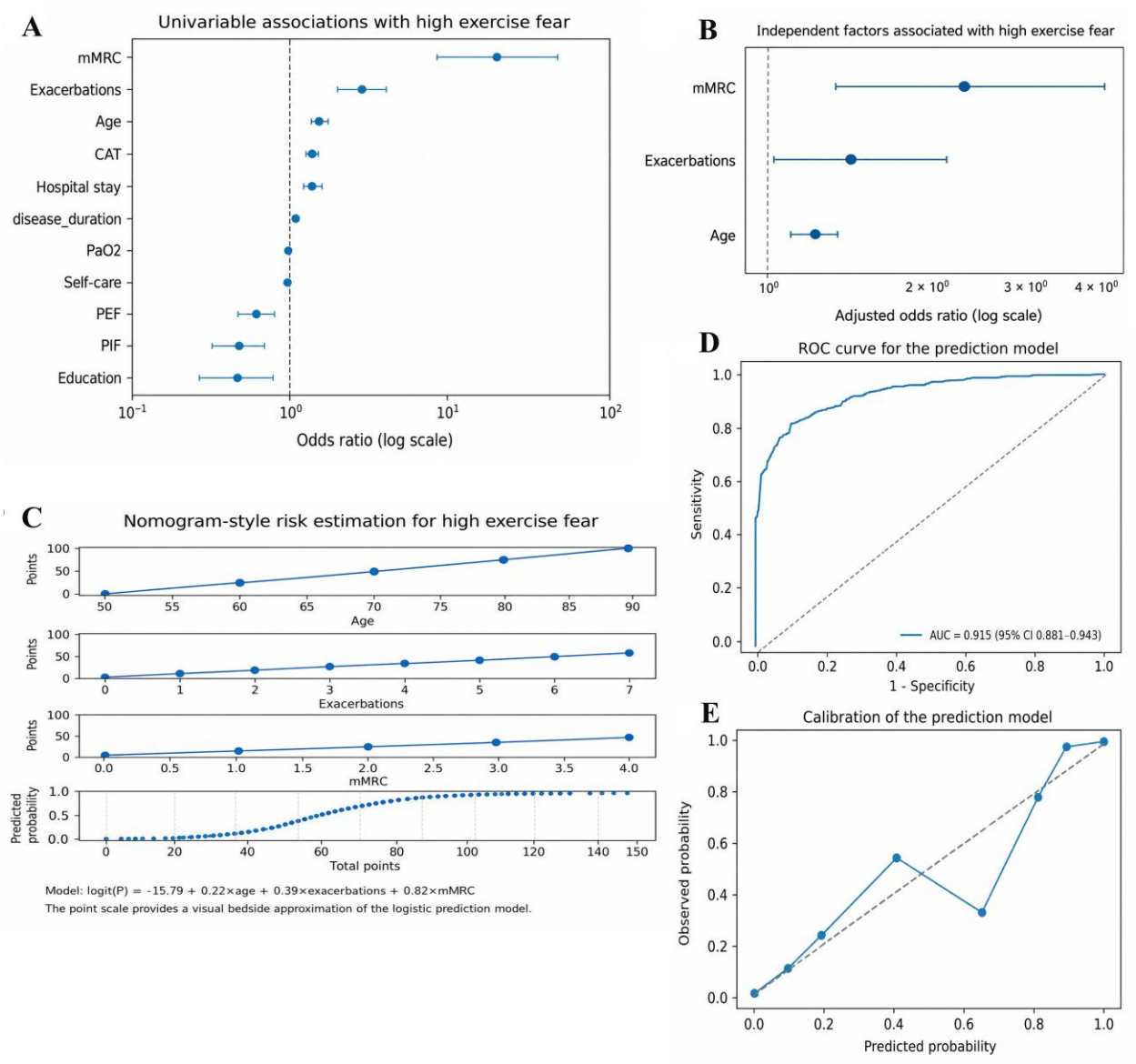


Figure 2. Integrated risk factor analysis and prediction model for kinesiophobia. (A) Univariable logistic regression forest plot showing candidate factors associated with kinesiophobia. (B) Multivariable logistic regression forest plot showing independent factors retained in the final model. (C) Nomogram-style

visualization based on age, number of acute exacerbations in the previous year, and mMRC score. (D) Receiver operating characteristic curve showing the discriminative performance of the model. (E) Calibration curve comparing predicted and observed probabilities of kinesiophobia. OR, odds ratio; CI, confidence interval; AUC, area under the curve; mMRC, modified Medical Research Council.

Baseline comparability in the intervention phase

In the intervention phase, 100 patients were included, with 50 in the nurse-led pulmonary rehabilitation group and 50 in the routine care group. Most baseline characteristics were comparable between groups, including age, sex, education, disease duration, smoking status, exacerbation frequency, hospital stay, PaO2, PaCO2, CAT score, self-care score, FEV1/FVC, PEF, and TSK-17 score (all $p>0.05$). Baseline TSK-17 scores were similar between the intervention and control groups (45.26 ± 5.16 vs 44.64 ± 5.83, $p=0.379$), indicating comparable initial kinesiophobia. Differences were observed for pH and FEV1% predicted, although the absolute difference in FEV1% predicted was small. Therefore, the intervention effect was evaluated using change scores and longitudinal mixed-effects models rather than relying only on post-intervention comparisons (Table 5). Although baseline pH differed statistically between groups, the absolute difference was small and remained within a clinically acceptable physiological range. Because pH was not included as a primary outcome, intervention effects were interpreted using longitudinal changes and group-by-time interactions rather than baseline post-hoc comparisons alone.

Table 5. Baseline characteristics of patients in the intervention phase

Variable	Intervention (n=50)	Control (n=50)	p value
Age	71.94 ± 5.65	70.60 ± 6.14	0.178
Sex	1: 44 (88.0%); 2: 6 (12.0%)	1: 39 (78.0%); 2: 11 (22.0%)	0.287
Education	1: 29 (58.0%); 2: 15 (30.0%); 3: 3 (6.0%); 4: 3 (6.0%)	1: 23 (46.0%); 2: 21 (42.0%); 3: 5 (10.0%); 4: 1 (2.0%)	0.363
Disease duration	8.98 ± 6.05	10.08 ± 7.48	0.695

Variable	Intervention (n=50)	Control (n=50)	p value
Smoking status	1: 20 (40.0%); 2: 9 (18.0%); 3: 21 (42.0%)	1: 21 (42.0%); 2: 10 (20.0%); 3: 19 (38.0%)	0.915
Exacerbations in previous year	1.90 ± 1.11	2.18 ± 1.49	0.519
Hospital stay	9.72 ± 4.22	8.94 ± 4.45	0.188
pH	7.41 ± 0.04	7.43 ± 0.04	0.003
PaO2	74.94 ± 8.11	73.12 ± 8.06	0.332
PaCO2	55.32 ± 6.61	54.52 ± 6.11	0.627
mMRC	0: 4 (8.0%); 1: 8 (16.0%); 2: 10 (20.0%); 3: 21 (42.0%); 4: 7 (14.0%)	0: 5 (10.0%); 1: 11 (22.0%); 2: 19 (38.0%); 3: 10 (20.0%); 4: 5 (10.0%)	0.107
CAT	15.06 ± 5.14	14.72 ± 5.18	0.696
Self-care score	80.40 ± 10.63	81.50 ± 12.83	0.270
FEV1/FVC	55.32 ± 15.90	54.64 ± 16.87	0.807
FEV1% predicted	64.58 ± 4.54	63.30 ± 10.77	0.044
PEF	3.28 ± 1.78	3.06 ± 1.25	0.852
TSK-17 score	45.26 ± 5.16	44.64 ± 5.83	0.379

Abbreviations: see Table 1. Data are expressed as mean ± SD or n (%).

Response to nurse-led pulmonary rehabilitation

Both groups improved during follow-up, but the magnitude and trajectory of change favored the nurse-led pulmonary rehabilitation group. From baseline to week 8, TSK-17 score decreased by 12.58 ± 1.16 points in the intervention group, compared with 5.88 ± 2.62 points in the control group (between-group $p<0.001$), indicating a substantially greater reduction in kinesiophobia (Table 6; Figure 3A). Dyspnea and health status followed the same pattern: mMRC score decreased by 1.18 ± 0.69 versus 0.56 ± 0.61 points ($p<0.001$), and CAT score decreased by 6.18 ± 0.85 versus 3.42 ± 1.54 points ($p<0.001$) in the intervention and control groups, respectively (Figure 3B-C). Physiological outcomes also improved more clearly in the intervention group.

PaO2 increased by 21.08 ± 4.27 mmHg compared with 3.16 ± 0.89 mmHg in controls, while PaCO2 decreased by 8.19 ± 1.11 mmHg compared with 2.27 ± 0.34 mmHg (both p<0.001) (Figure 3D-E). Pulmonary function and expiratory performance showed parallel improvement, with larger increases in FEV1/FVC, FEV1% predicted, and PEF in the intervention group (all between-group p<0.001; Table 6; Figure 3F-G). Mixed-effects models demonstrated significant group-by-time interactions for all primary and secondary outcomes, confirming that the longitudinal improvement was steeper and more sustained in the intervention group than in the routine care group (Table 7).

Table 6. Changes in outcomes from baseline to week 8

Outcome	Group	Baseline	Week 8	Change	Within-group p	Between-group p for change
TSK-17	Intervention	45.26 ± 5.16	32.68 ± 4.59	-12.58 ± 1.16	<0.001	<0.001
TSK-17	Control	44.64 ± 5.83	38.76 ± 7.38	-5.88 ± 2.62	<0.001	<0.001
mMRC	Intervention	2.38 ± 1.16	1.20 ± 0.83	-1.18 ± 0.69	<0.001	<0.001
mMRC	Control	1.98 ± 1.12	1.42 ± 0.73	-0.56 ± 0.61	<0.001	<0.001
CAT	Intervention	15.06 ± 5.14	8.88 ± 4.78	-6.18 ± 0.85	<0.001	<0.001
CAT	Control	14.72 ± 5.18	11.30 ± 4.55	-3.42 ± 1.54	<0.001	<0.001
PaO2	Intervention	74.94 ± 8.11	96.02 ± 6.19	21.08 ± 4.27	<0.001	<0.001
PaO2	Control	73.12 ± 8.06	76.28 ± 8.33	3.16 ± 0.89	<0.001	<0.001
PaCO2	Intervention	55.32 ± 6.61	47.14 ± 6.22	-8.19 ± 1.11	<0.001	<0.001

Outcome	Group	Baseline	Week 8	Change	Within-group p	Between-group p for change
PaCO2	Control	54.52 ± 6.11	52.25 ± 6.05	-2.27 ± 0.34	<0.001	<0.001
FEV1/FVC	Intervention	55.32 ± 15.90	64.22 ± 14.18	8.90 ± 2.83	<0.001	<0.001
FEV1/FVC	Control	54.64 ± 16.87	57.50 ± 17.35	2.86 ± 2.52	<0.001	<0.001
FEV1% predicted	Intervention	64.58 ± 4.54	71.24 ± 3.47	6.66 ± 3.65	<0.001	<0.001
FEV1% predicted	Control	63.30 ± 10.77	65.70 ± 10.60	2.40 ± 1.41	<0.001	<0.001
PEF	Intervention	3.28 ± 1.78	5.28 ± 1.78	2.00 ± 0.15	<0.001	<0.001
PEF	Control	3.06 ± 1.25	3.92 ± 1.26	0.86 ± 0.07	<0.001	<0.001

Abbreviations: see Table 1. Between-group p values refer to comparison of change scores.

Table 7. Mixed-effects model results for longitudinal intervention effects

Outcome	Group × time beta	p for interaction
TSK-17	-0.693	<0.001
mMRC	-0.075	<0.001
CAT	-0.327	<0.001
PaO2	2.074	<0.001
PaCO2	-0.741	<0.001
FEV1/FVC	0.757	<0.001
FEV1% predicted	0.485	<0.001
PEF	0.143	<0.001

Abbreviations: beta, regression coefficient; p, p value. Group × time terms represent the difference in longitudinal slope between intervention and control groups.

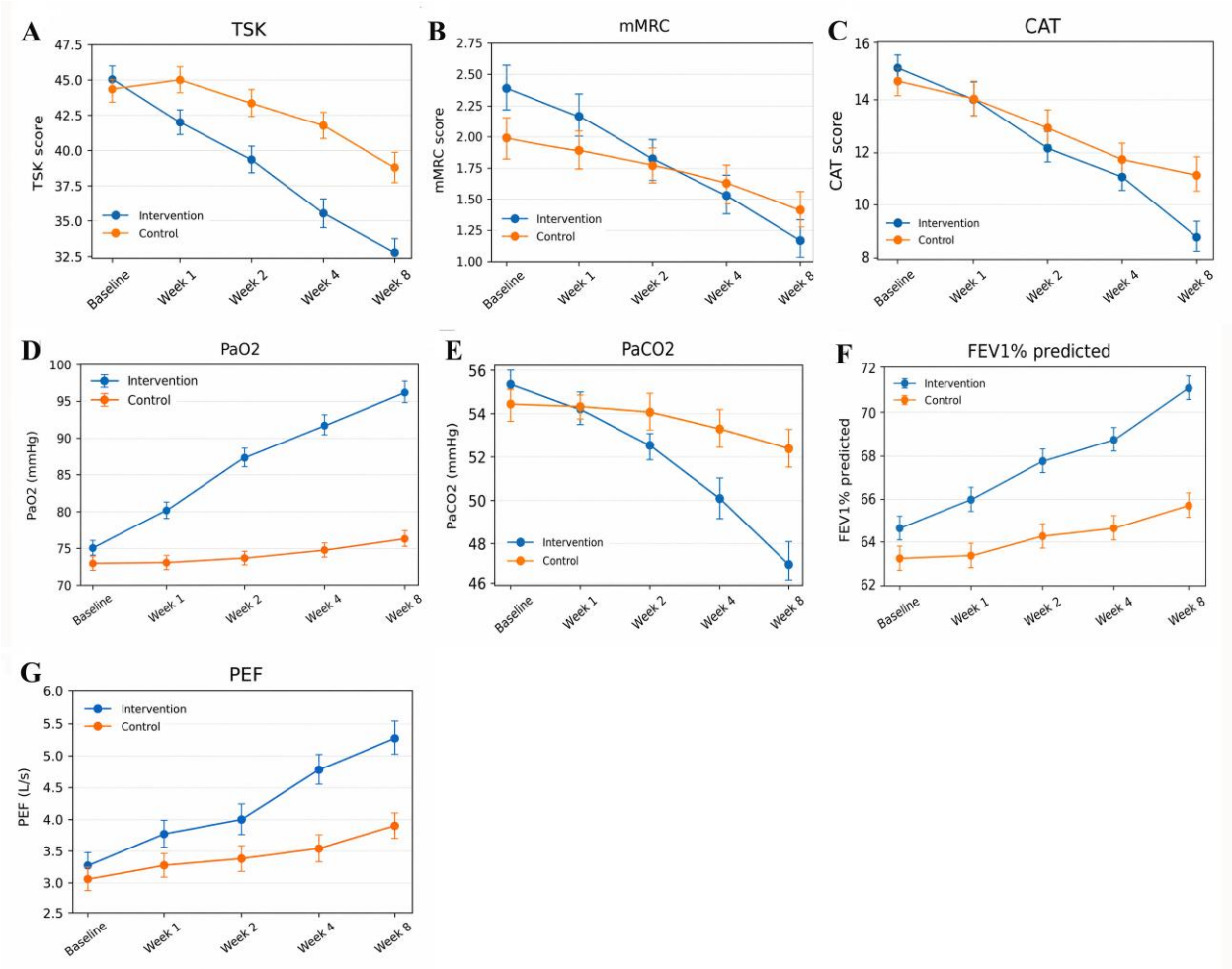


Figure 3. Longitudinal intervention effects over 8 weeks. (A-C) Changes in kinesiophobia, dyspnea, and health status assessed by TSK-17, mMRC, and CAT scores. (D-G) Changes in arterial blood gas and pulmonary function indices, including PaO2, PaCO2, FEV1% predicted, and peak expiratory flow. The intervention group showed greater improvement than the control group across psychological, symptom-related, and physiological outcomes. TSK-17, 17-item Tampa Scale for Kinesiophobia; mMRC, modified Medical Research Council; CAT, COPD Assessment Test; PaO2, arterial oxygen tension; PaCO2, arterial carbon dioxide tension; FEV1, forced expiratory volume in 1 second; PEF, peak expiratory flow.

Discussion

This study provides a combined cross-sectional and intervention-based evaluation of kinesiophobia in hospitalized patients with COPD. Approximately two-thirds of the cross-sectional cohort met the threshold for kinesiophobia. Older age, more frequent exacerbations, and greater dyspnea severity were independently associated with kinesiophobia, and the resulting three-variable model showed good discrimination. In the prospective phase, the nurse-led

pulmonary rehabilitation program was associated with greater reductions in kinesiophobia and broader improvements in dyspnea, health status, arterial blood gas indices, and pulmonary function-related outcomes over 8 weeks.

The high prevalence of kinesiophobia observed in this study is clinically meaningful. Recent COPD studies have identified distinct profiles of dyspnea-related kinesiophobia and have shown that dyspnea, fatigue, anxiety, exercise self-efficacy, and social support contribute to its development [11,12]. Dysfunctional beliefs about breathlessness may cause patients to interpret exertional symptoms as dangerous, while higher kinesiophobia may further reduce exercise adherence [13,14]. This supports a self-reinforcing process in which symptom-related fear promotes avoidance, deconditioning, and progressively greater difficulty with low-intensity activity.

Age was the strongest independent factor in the prediction model. Older patients may have lower physiological reserve, more comorbidities, poorer balance, and more previous experiences of exacerbation or hospitalization, all of which may increase concern about symptom worsening during activity. The independent association between exacerbation frequency and kinesiophobia further suggests that recent clinical instability contributes to avoidance behavior. These findings are compatible with recent studies showing heterogeneity in kinesiophobia among older adults with COPD and emphasizing the combined influence of dyspnea, psychological factors, and exercise self-efficacy [11,12,14].

The prediction model was intentionally simple. Although several physiological indices were associated with TSK-17 score in correlation or univariable analyses, the final model retained age, exacerbation frequency, and mMRC score because these variables are readily available during routine nursing assessment and remained independently associated with kinesiophobia. The AUC of 0.915 indicates strong discrimination within this cohort and suggests that the model may help identify patients requiring early psychological support and individualized rehabilitation planning. Nevertheless, it was developed and internally assessed in a single-center sample, so external validation is necessary before wider clinical use.

The intervention results support combining cognitive-behavioral guidance with pulmonary rehabilitation. Evidence from nurse-led COPD interventions, a cognition-plus-breathing trial, and a Hope Theory-based active-cycle breathing program indicates that education, self-management support, symptom reinterpretation, and structured follow-up can improve engagement and

relevant outcomes [9,10,15]. Maintenance rehabilitation and individualized exercise prescription are also important because patients differ in symptom burden, exercise tolerance, and the intensity they can safely sustain [16,17]. In this study, one-to-one communication, graded progression, safety monitoring, and follow-up supervision were used to address both physiological limitations and fear-related beliefs.

The improvements in mMRC and CAT scores suggest that the intervention was associated with reduced kinesiophobia as well as better symptom burden and health status. Breathing-exercise syntheses support the use of individualized respiratory training for dyspnea and quality of life, although the magnitude of benefit varies by technique and population [18,19]. Evidence also indicates that clinically meaningful improvements can be achieved with either center-based or home-based pulmonary rehabilitation, while web-based delivery may broaden access for selected patients [20,21]. Telerehabilitation and mobile app-based programs offer additional options for supervision, adherence support, and continuity after discharge [22,23].

Recent reviews further show that multiple exercise and physical-activity formats can improve exercise capacity, lung function, and other patient-centered outcomes in COPD [24-26]. Pulmonary rehabilitation may also influence physical activity, sedentary behavior, and sleep, although changes are heterogeneous and may not parallel improvements in exercise-test performance [27]. Component-level evidence suggests that program design and the combination of exercise, education, and behavioral support affect effectiveness [28]. These observations align with contemporary European and British clinical statements emphasizing individualized assessment, exercise training, education, and continuity across care settings [29,30]. They support individualized rather than uniform rehabilitation planning, consistent with current GOLD priorities [31], while emerging evidence on rehabilitation during or after hospitalization also emphasizes careful selection of timing and safety criteria [32].

This study has several limitations. First, it was conducted at a single center, and generalizability requires confirmation in other institutions. Second, the cross-sectional component cannot establish causality between clinical variables and kinesiophobia. Third, although the intervention phase was prospective and controlled, patients were not randomized; therefore, selection bias and residual confounding cannot be excluded. The sample size was also modest, and baseline differences in some physiological variables remained. Fourth, follow-up was limited to 8 weeks, so the durability of improvements remains uncertain. Fifth, the prediction model was internally

assessed only and should undergo external validation and evaluation of clinical utility. Finally, the study relied on the total TSK-17 score; future work should examine specific dimensions of fear, avoidance, dyspnea-related beliefs, anxiety, and exercise self-efficacy.

Conclusion

Kinesiophobia is common among hospitalized patients with COPD and is independently associated with older age, frequent acute exacerbations, and more severe dyspnea. A simple clinical prediction model based on readily available clinical variables may help identify patients at risk. Nurse-led pulmonary rehabilitation combining cognitive guidance, breathing training, graded exercise, symptom self-management, and follow-up supervision may reduce kinesiophobia and improve respiratory-related outcomes. Further multicenter studies with longer follow-up are needed to confirm these findings.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Affiliated Renhe Hospital of China Three Gorges University on November 27, 2024 (approval no. RH-2024-31). Written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Written informed consent was obtained from all participants. No individual identifiable data or images are included in this manuscript.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was supported by the General Program of the Natural Science Foundation of Hubei Province (No. 2020CFB758; project title: Preliminary Study on the Mechanism by Which the GPC6 Gene Inhibits Lung Adenocarcinoma Cell Proliferation).

Authors' contributions

Yali Peng: conceptualization, data curation, investigation, and writing – original draft. Chunyan Li: data curation, investigation, and writing – review and editing. Jinxia Zhang: validation and writing – original draft. Gan Luo: software, formal analysis, and visualization. Shuang Wu: formal analysis, methodology, and validation. Donglan Xiong: investigation and visualization. Lin Yang: data curation and investigation. Zhiwen Huang: methodology, validation, and formal analysis. Tingting Chen: data curation, visualization, and writing – review and editing. Huaiyan Liu and Hao Qiaorong: conceptualization, project administration, supervision, and resources. Mozhen Chi: conceptualization, methodology, supervision, project administration, and writing – review and editing. All authors contributed to and approved the final version of the manuscript.

Acknowledgements

The authors thank the patients and the nursing staff who supported data collection, pulmonary rehabilitation implementation, and follow-up.

References

1. Adeloye D, Song P, Zhu Y, et al. Global, regional, and national prevalence of, and risk factors for, chronic obstructive pulmonary disease in 2019: a systematic review and modelling analysis. Lancet Respir Med. 2022;10(5):447-458. doi:10.1016/S2213-2600(21)00511-7. PMID: 35279265.

2. Stolz D, Mkorombindo T, Schumann DM, et al. Towards the elimination of chronic obstructive pulmonary disease: a Lancet Commission. Lancet. 2022;400(10356):921-972. doi:10.1016/S0140-6736(22)01273-9. PMID: 36075255.

3. Agustí A, Celli BR, Criner GJ, et al. Global Initiative for Chronic Obstructive Lung Disease 2023 Report: GOLD Executive Summary. Eur Respir J. 2023;61(4):2300239. doi:10.1183/13993003.00239-2023. PMID: 36858443.

4. Rochester CL, Alison JA, Carlin B, 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(4):e7-e26. PMID: 37581410.

5. Meneses-Echavez JF, Chavez Guapo N, Loaiza-Betancur AF, Machado A, Bidonde J. Pulmonary rehabilitation for acute exacerbations of COPD: a systematic review. Respir Med. 2023;219:107425. doi:10.1016/j.rmed.2023.107425. PMID: 37858727.

6. Dupuis F, Cherif A, Batcho CS, Massé-Alarie H, Roy JS. The Tampa Scale of Kinesiophobia: a systematic review of its psychometric properties in people with musculoskeletal pain. Clin J Pain. 2023;39(5):236-247. doi:10.1097/AJP.0000000000001104. PMID: 36917768.

7. Wang J, et al. The relationship between dyspnea-related kinesiophobia and physical activity in people with COPD: cross-sectional survey and mediated moderation analysis. Heart Lung. 2023;59:95-101. PMID: 36796249.
8. Bayraktar D, Felekoğlu E, Apaydın AÖ, Özalevli S. Breathlessness beliefs and related factors in male patients with chronic obstructive pulmonary disease. Thorac Res Pract. 2023;24(3):137-142. PMID: 37503615.
9. Aranburu-Imatz A, et al. Nurse-led interventions in chronic obstructive pulmonary disease patients: a systematic review and meta-analysis. Int J Environ Res Public Health. 2022;19(15):9101. doi:10.3390/ijerph19159101. PMID: 35897469.
10. Cai S, Yao J, Han M, et al. The effect of cognition in combination with an active cycle of breathing technique on dyspnea-related kinesiophobia in patients with moderate to severe COPD: a quasi-randomized controlled trial. Geriatr Nurs. 2024;56:138-147. doi:10.1016/j.gerinurse.2024.01.002. PMID: 38342002.
11. Peng L, Xu M, Wang Y, et al. Latent profile analysis of dyspnea-related kinesiophobia in older adults with chronic obstructive pulmonary disease. Heart Lung. 2025;69:241-247. doi:10.1016/j.hrtlng.2024.10.016. PMID: 39522284.
12. Wang Y, Zou X, Xiong C, Xie X, He G. Influencing mechanisms of kinesiophobia in middle-aged and elderly patients with chronic obstructive pulmonary disease: a cross-sectional study. BMC Pulm Med. 2025;25:233. doi:10.1186/s12890-025-03699-6. PMID: 40361050.
13. Gurses HN, Saka S, Zeren M, Bayram M. Validity and reliability of the Turkish version of the Breathlessness Beliefs Questionnaire. Physiother Theory Pract. 2023;39(4):834-839. doi:10.1080/09593985.2022.2027586. PMID: 35042443.
14. Feng L, Ji HY, Yang QQ, Liang M. Non-linear threshold effects of kinesiophobia on exercise adherence in older adults with COPD: a segmented regression analysis. Front Public Health. 2025;13:1668157. doi:10.3389/fpubh.2025.1668157. PMID: 41312249.
15. Li M, An X, Wang Q, Ma J, Wang Y, Ma J. Effect of Hope Theory combined with active cycle of breathing techniques on pulmonary rehabilitation among COPD patients: a quasi-experiment study. Appl Nurs Res. 2024;79:151842. doi:10.1016/j.apnr.2024.151842. PMID: 39256012.
16. Moy ML. Maintenance pulmonary rehabilitation: an update and future directions. Respir Care. 2024;69(6):724-739. doi:10.4187/respcare.11609. PMID: 38744473.
17. Gloeckl R, Zwick RH, Fürlinger U, et al. Prescribing and adjusting exercise training in chronic respiratory diseases: expert-based practical recommendations. Pulmonology. 2023;29(4):306-314. doi:10.1016/j.pulmoe.2022.09.004. PMID: 36272962.
18. Cai Y, Ren X, Wang J, Ma B, Chen O. Effects of breathing exercises in patients with chronic obstructive pulmonary disease: a network meta-analysis. Arch Phys Med Rehabil. 2024;105(3):558-570. PMID: 37150427.
19. Burge AT, Gadowski AM, Jones A, et al. Breathing techniques to reduce symptoms in people with serious respiratory illness: a systematic review. Eur Respir Rev. 2024;33(174):240012. doi:10.1183/16000617.0012-2024. PMID: 39477355.

20. Bondarenko J, Dal Corso S, Dillon MP, et al. Clinically important changes and adverse events with centre-based or home-based pulmonary rehabilitation in chronic respiratory disease: a systematic review and meta-analysis. Chron Respir Dis. 2024;21:14799731241277808. doi:10.1177/14799731241277808. PMID: 39187265.
21. Ayala-Chauvin M, Chicaiza FA, Acosta-Vargas P, et al. Web-based pulmonary telerehabilitation: a systematic review. NPJ Prim Care Respir Med. 2024;34(1):38. doi:10.1038/s41533-024-00396-5. PMID: 39550365.
22. Dai Y, Huang H, Zhang Y, et al. The effects of telerehabilitation on physiological function and disease symptoms for patients with chronic respiratory disease: a systematic review and meta-analysis. BMC Pulm Med. 2024;24:305. doi:10.1186/s12890-024-03104-8. PMID: 38943129.
23. Chung C, Lee JW, Lee SW, Jo MW. Clinical efficacy of mobile app-based, self-directed pulmonary rehabilitation for patients with chronic obstructive pulmonary disease: systematic review and meta-analysis. JMIR Mhealth Uhealth. 2024;12:e41753. doi:10.2196/41753. PMID: 38179689.
24. Priego-Jiménez S, et al. Efficacy of different types of physical activity interventions on exercise capacity in patients with chronic obstructive pulmonary disease: a network meta-analysis. Int J Environ Res Public Health. 2022;19(21):14539. doi:10.3390/ijerph192114539. PMID: 36361418.
25. Zhu Z, Muhamad AS, Omar N, Ooi FK, Pan X, Ong MLY. Efficacy of exercise treatments for chronic obstructive pulmonary disease: a systematic review. J Bodyw Mov Ther. 2024;38:106-127. doi:10.1016/j.jbmt.2024.01.019. PMID: 38763549.
26. Priego-Jiménez S, Cavero-Redondo I, Pascual-Morena C, Martínez-García I, Martínez-Vizcaíno V, Álvarez-Bueno C. Effect of different exercise programs on lung function in people with chronic obstructive pulmonary disease: a network meta-analysis of RCTs. Ann Phys Rehabil Med. 2024;67(2):101792. doi:10.1016/j.rehab.2023.101792. PMID: 38128349.
27. Manifield J, Chaudhry Y, Singh SJ, et al. Changes in physical activity, sedentary behaviour and sleep following pulmonary rehabilitation: a systematic review and network meta-analysis. Eur Respir Rev. 2024;33(172):230225. PMID: 38599676.
28. Ward TJC, Latimer L, Daynes E, et al. Impact of pulmonary rehabilitation programme design on effectiveness in COPD: a systematic review and component network meta-analysis. EClinicalMedicine. 2025;87:103433. doi:10.1016/j.eclinm.2025.103433. PMID: 40896469.
29. Troosters T, Janssens W, Demeyer H, Rabinovich RA. Pulmonary rehabilitation and physical interventions. Eur Respir Rev. 2023;32(168):220222. doi:10.1183/16000617.0222-2022. PMID: 37286219.
30. Man W, Chaplin E, Daynes E, et al. British Thoracic Society Clinical Statement on pulmonary rehabilitation. Thorax. 2023;78(Suppl 4):s2-s15. doi:10.1136/thorax-2023-220439. PMID: 37770084.
31. Venkatesan P. GOLD COPD report: 2025 update. Lancet Respir Med. 2025;13(1):e7-e8. doi:10.1016/S2213-2600(24)00413-2. PMID: 39647487.

32. Jia P, Zhang H, Li Y, Yao Z, Wang L. The timing of the commencement of pulmonary rehabilitation in hospitalized patients with acute exacerbation of COPD: a systematic review and network meta-analysis. BMC Med. 2026;24:260. doi:10.1186/s12916-026-04774-3. PMID: 41840577.