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RESEARCH

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Influencing mechanisms of kinesiophobia in middle-aged and elderly patients with chronic obstructive pulmonary disease: a cross-sectional study

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Abstract

Background The aim of this study is to explore the mechanism of the role of kinesiophobia in patients with chronic obstructive pulmonary disease (COPD), to construct a structural equation model of the factors influencing kinesiophobia in patients with COPD, and to provide a theoretical basis for the development of targeted intervention strategies.

Methods The cross-sectional design was conducted from December 2023 to July 2024, and middle-aged and elderly patients with COPD from a tertiary hospital in Guangzhou, China, were selected using convenience sampling. A general demographic information questionnaire, Breathlessness Beliefs Questionnaire scale (BBQ), modified Medical Research Council Dyspnea Scale (mMRC), Fatigue Scale (FS-14), Hospital Anxiety and Depression Scale (HADS), Self-Efficacy for Exercise (SEE), and Social Support Rating Scale (SSRS) were used for data collection. Spearman correlation analysis and structural equation modeling (SEM) were used for data analysis.

Results A total of 278 COPD patients were included. Correlation analysis showed that dyspnoea ($r = 0.689$, $p < 0.01$), fatigue ($r = 0.731$, $p < 0.01$) and anxiety ($r = 0.678$, $p < 0.01$) were significantly positively correlated with kinesiophobia, whereas social support (r=-0.518, $p < 0.01$) and exercise self-efficacy (r=-0.740, $p < 0.01$) were significantly negatively correlated with kinesiophobia. SEM analyses revealed six significant pathways of action: dyspnoea, exercise self-efficacy was a direct predictor of kinesiophobia. Fatigue, and social support were indirect predictors of kinesiophobia. Anxiety was a direct and indirect predictor of kinesiophobia.

Conclusions Dyspnoea, fatigue, anxiety, social support and exercise self-efficacy are important predictors of kinesiophobia in COPD patients. Clinical interventions should focus on the synergistic effects of these five types of variables to establish a multidimensional and comprehensive management programme.

Trial registration The protocol was reviewed by the Ethics Committee of the Third Affiliated Hospital of Guangzhou Medical University (Ethics Code: LCYJ-2023-055).

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Keywords Chronic obstructive pulmonary disease, Dyspnoea, Kinesiophobia, Influencing mechanisms, Exercise self-efficacy

Background

Chronic obstructive pulmonary disease (COPD) is a common respiratory disease [1], which currently affects up to 391.9 million people worldwide [2], with the highest prevalence in people over 40 years of age [3]. In China it is around 13.7% among people over 40 years of age, and it is expected that the total prevalence will continue to increase, reaching 24% by 2030 [4]. By 2023, COPD will be the third leading cause of death worldwide [5]. Pulmonary rehabilitation is the first choice of non-pharmacological treatment for COPD patients, and exercise program is a core part of it [6]. A growing body of research suggests that a modest increase in physical activity can significantly improve health outcomes in COPD patients [7]. However, the current status of pulmonary rehabilitation participation is not encouraging, and kinesiophobia is an important psychological barrier to participation in COPD patients [8].

Kinesiophobia is an excessive and irrational fear of physical activity or exercise due to fear of injury or re-injury [9]. One study showed that the prevalence of kinesiophobia in COPD patients was as high as 93% [10]. A study has found that kinesiophobia significantly reduces participation in pulmonary rehabilitation in patients [11]. As patients with COPD often experience dyspnoea and persistent fatigue, they will show more kinesiophobia, which may reduce their willingness to participate in pulmonary rehabilitation [12, 13]. At the same time, the recurrence of COPD symptoms leads to anxiety and depression in patients [14]. This negative psychological state acts as a risk factor for controlling behaviours severely constraining COPD patients' participation in exercise rehabilitation [15]. In addition, it has been demonstrated that exercise self-efficacy is also one of the important factors affecting patients' exercise rehabilitation [9]. The reason for this may be that COPD patients' long-term symptoms such as dyspnoea and anxiety cause low levels of exercise self-efficacy in patients, which leads to avoidance of exercise [16, 17]. In contrast, high levels of social support can increase patients' exercise self-efficacy, thus reducing the level of kinesiophobia [18]. Thus, it can be seen that exercise self-efficacy plays an important role in kinesiophobia, but the mechanism of action with the factors is not clear and needs further verification.

Lethem's Fear-Avoidance Model (The Fear-Avoidance Model) suggests that pain is influenced by distressing experiences and triggers catastrophic thinking, causing the individual to be highly alert and fearful of the behaviour of the activity that caused the pain or injury [19]. The symptoms of dyspnoea in patients with COPD have a similar experience to pain. The self-efficacy theory, developed by Albert Bandura in 1977, states that "the degree of confidence people have in their ability to use the skills they possess to perform a given work behaviour" [20]. Therefore, it is hypothesised that exercise self-efficacy plays a moderating role between the aforementioned underlying factors and kinesiophobia. In this study, we attempted to explore the mechanisms underlying the occurrence of kinesiophobia in COPD patients through structural equation modelling. Our goal is to provide theoretical guidance for future intervention strategies for kinesiophobia in COPD patients.

Methods

Study design

This is a cross-sectional investigation. We aimed to investigate the relationship between dyspnoea, fatigue, anxiety, exercise self-efficacy, social support, and kinesiophobia in COPD patients and to explore the mechanisms of interaction between these variables. The protocol was reviewed by the Ethics Committee of the Third Affiliated Hospital of Guangzhou Medical University (Ethics Code: LCYJ-2023-055).

Participants

Middle-aged and elderly patients with COPD who attended outpatient clinics and were hospitalized at a tertiary hospital in Guangzhou, China, from December 2023 to July 2024 were selected using the convenience sampling method. Before the start of the study investigation, the purpose of the study was explained to the subjects and they were informed that their participation was voluntary. Each participant was required to provide written informed consent. The inclusion criteria were as follows: (I) meeting the diagnostic criteria of the 2022 Global Initiative for Chronic Obstructive Pulmonary Disease guidelines [21]; (II) aged ≥ 45 years; (III) conscious and without communication barriers. The exclusion criteria were as follows: (I) Patients with mental illness or cognitive impairment who were unable to complete the questionnaire; (II) Persons with other diseases that seriously affect their ability to exercise; (III) Critically ill patients (such as on life support) and major physical illnesses (end-stage renal disease, malignant tumors, severe heart failure, etc.); (IV) Patients participating in similar studies of the same type.

According to the criteria advocated by Kendall (1975), the sample size should be 5–10 times the number of variables [22]. The general sample size for structural equation analysis needs to be more than 200 cases, in this study, there are a total of 23 parameters. However, an additional 10% was considered to account for potential dropouts or invalid questionnaires [23]. Therefore, the sample size is at least 254 cases.

Research tools

General demographic information

It was designed by the investigators themselves and included demographic information: age, gender, body mass index, marital status, education, smoking, occupational status. Disease-related information: number of acute exacerbations in the previous 1 year, pulmonary function classification, duration of the disease, the presence of comorbidities with other chronic diseases, and the presence of regular exercise.

Breathlessness Beliefs Questionnaire (BBQ)

The BBQ, which is commonly used to measure kinesiophobia associated with dyspnoea, consists of two dimensions: somato-focus (BBQ-SF, 5 terms) and activity avoidance (BBQ-AA, 6 terms) [24]. A high score on the BBQ-SF scale reflects the patient's belief that dyspnoea is a sign of a dangerous disease process, whereas a high score on the BBQ-AA scale reflects the patient's belief that PA-induced dyspnoea should be avoided [24]. The BBQ has a total of 11 items, each of which is rated between 1 (strongly disagree) and 5 (strongly agree). This study used the entire Chinese version of the BBQ questionnaire to assess kinesiophobia (Cronbach's $\alpha = 0.81$) [25].

Modified medical research council dyspnea scale (mMRC)

The mMRC is a scale that evaluates the symptoms of dyspnoea in COPD patients, which is graded from 0 to 4 according to the degree of activity at the time of shortness of breath, with higher scores indicating greater dyspnoea [26]. The present study was conducted to measure dyspnoea in COPD patients using a scale developed by D Singh's team in the 2019 Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease: the GOLD [26].

Fatigue scale (FS-14)

The FS-14 was developed by Chalder at the Psychological Medicine Research Unit, King's College Hospital, UK, in 1992 to measure the level of fatigue of patients in the community or clinic. Including two dimensions, physical fatigue (8 entries) and mental fatigue (6 entries), with higher scores representing higher fatigue, and Cronbach's alpha coefficients ranging from 0.88 to 0.90 [27].

Hospital Anxiety and Depression Scale (HADS)

The HADS consists of two subscales, in which the cumulative score of the odd-numbered item ratings is used to assess anxiety, denoted by A, and the cumulative score of the even-numbered items is used to assess depression, denoted by D [28]. Each entry in the scale is scored from 0 to 3, and the level of score is positively correlated with the degree of anxiety and depressive symptoms. Negative mood in COPD patients was assessed using the Chinese version of the HADS (Cronbach's $\alpha = 0.806$) [29].

Self-Efficacy for Exercise (SEE)

The scale was compiled by Resnick's team, with 9 entries, each of which was measured on a scale of 0–10, i.e., 0–10, with higher scores suggesting a stronger sense of exercise self-efficacy in patients [30]. The Chinese version of the scale was translated and revised by Lee's team of scholars from Taiwan, China (Cronbach's $\alpha = 0.75$) [31].

Social Support Rating Scale (SSRS)

Compiled and re-tested by Xiao Shuiyuan's team, it includes 3 dimensions of objective support, subjective support, and utilisation of support, and the cumulative score of the 10 entries is the total score of social support; the consistency coefficient of the scale for each entry is 0.89–0.94, and the re-test reliability is 0.92, and the Cronbach's alpha coefficient is 0.721 [32].

Data collection

The questionnaires were paper-based, distributed by the investigator in person, and completed by the patients themselves. All questionnaires were verified and collected on the spot, and those completed with the assistance of the investigator were again verified with the study participants after the survey. The information collected was summarised into a simple table, excluding information or incomplete information, and two nursing postgraduate students worked together for a second information check, EpiData 3.1 was used to create a database to facilitate data collation.

Statistical analyses

Data were analyzed using IBM SPSS (version 25.0) software. The demographic data and clinical characteristics of the patients were analyzed descriptively. Spearman correlation analysis was used to analyze the correlation between variables. SEM was performed with AMOS 24.0 software. Normalized $\chi2$ ($\chi2$ /df), root mean square error of approximation (RMSEA), the goodness of fit index (GFI), normalized fit index (NFI), and comparative fit index (CFI) were selected to assess the degree of model fit. The values should meet the following criteria: $\chi2$ / df < 3, RMSEA < 0.08, and GFI, NFI, and CFI values > 0.8 indicate acceptable model fit and > 0.9 indicate excellent.

Table 1 Results of the survey on general demographic information of COPD patients

Variables	Category	N	% or mean(SD)
Gender	Male	251	90.29
	Female	27	9.71
Age, years	-	278	72.12 (7.59)
Body mass index	< 18.5	47	16.91
	18.5–23.9	160	57.55
	24 to 27.9	55	19.78
	≥ 28	16	5.76
marital status	unmarried	4	1.44
	married	226	81.29
	divorcee	9	3.24
	bereaved of one's spouse	39	14.03
Educational background	Primary and below	88	31.65
	junior high school	126	45.32
	High school or secondary school	47	16.91
	College and above	17	6.12
Occupation before retired	incumbency	8	2.88
	retirement	269	96.76
	unemployment	1	0.36
smoking state	Never smoked	34	12.23
	Quit smoking	118	42.45
	Smoke all the time	126	45.32
Number of readmissions over the past year, times	< 2	230	82.73
	≥ 2	48	17.27
Duration, years	-	278	8.38 (6.78)
Pulmonary Function Classification (GOLD)	I	12	4.32
	II	114	41.00
	III	117	42.09
	IV	35	12.59
Presence of other chronic diseases	there are	236	84.89
	not have	42	15.11
With or without regular exercise	there are	197	70.86
	not have	81	29.14

Mediating effects were examined using the bootstrap method.

Results

General demographic characteristics

A total of 282 patients were screened for eligibility, 282 patients were invited (eligible) and 278 patients were accepted for inclusion in this study. The mean age of the subjects was (72.12 ± 7.59) years. The majority of the subjects were male; and 82.73% of the patients were hospitalized more than twice in the past year due to COPD. In addition, the average duration of illness of the subjects was (8.38 ± 6.78) years; and 84.89% of the patients had other chronic diseases in combination (Table 1).

Correlation between different variables

As shown in Table 2, the degree of dyspnoea ($r = 0.689$, $p < 0.01$), fatigue ($r = 0.731$, $p < 0.01$) and anxiety ($r = 0.678$, $p < 0.01$) were positively correlated with kinesiophobia in patients with COPD, whereas social support (r=-0.518, $p < 0.01$) and exercise self-efficacy (r=-0.740, $p < 0.01$) were negatively correlated with kinesiophobia were negatively correlated.

Structural equation modelling of kinesiophobia in COPD patients

The path coefficients of the model were estimated using AMOS 24.0 and the maximum likelihood method was used for parameter estimation. The final model results and parameter estimates are shown in Fig. 1; Table 3. The fit of the test data to the hypothesized model was satisfactory (model fit indices showed: $\chi 2/df = 1.387$, RMSEA = 0.037, GFI = 0.995, NFI = 0.996, CFI = 0.999), indicating good fit indices and high data-model agreement. Our final model showed that dyspnoea, anxiety, and exercise self-efficacy could directly influence the level of kinesiophobia. In addition, exercise self-efficacy can indirectly influence kinesiophobia through 3 different mediating pathways (Fig. 1).

Results of the test for intermediation effects

In AMOS 24.0 software, 5000 bootstrap samples were conducted and mediation effects were assessed using

Table 2 Correlation analysis between different variables ($n = 278$)

	1	2	3	4	5	6
1	1					
2	0.689**	1				
3	0.731**	0.662**	1			
4	0.678**	0.533**	0.647**	1		
5	−0.518**	−0.460**	−0.531**	−0.524**	1	
6	−0.740**	−0.540**	−0.707**	−0.679**	0.520**	1

Notes: 1: kinesiophobia; 2: degree of dyspnoea; 3: fatigue; 4: anxiety; 5: social support; 6: exercise self-efficacy

** indicates $P < 0.01$

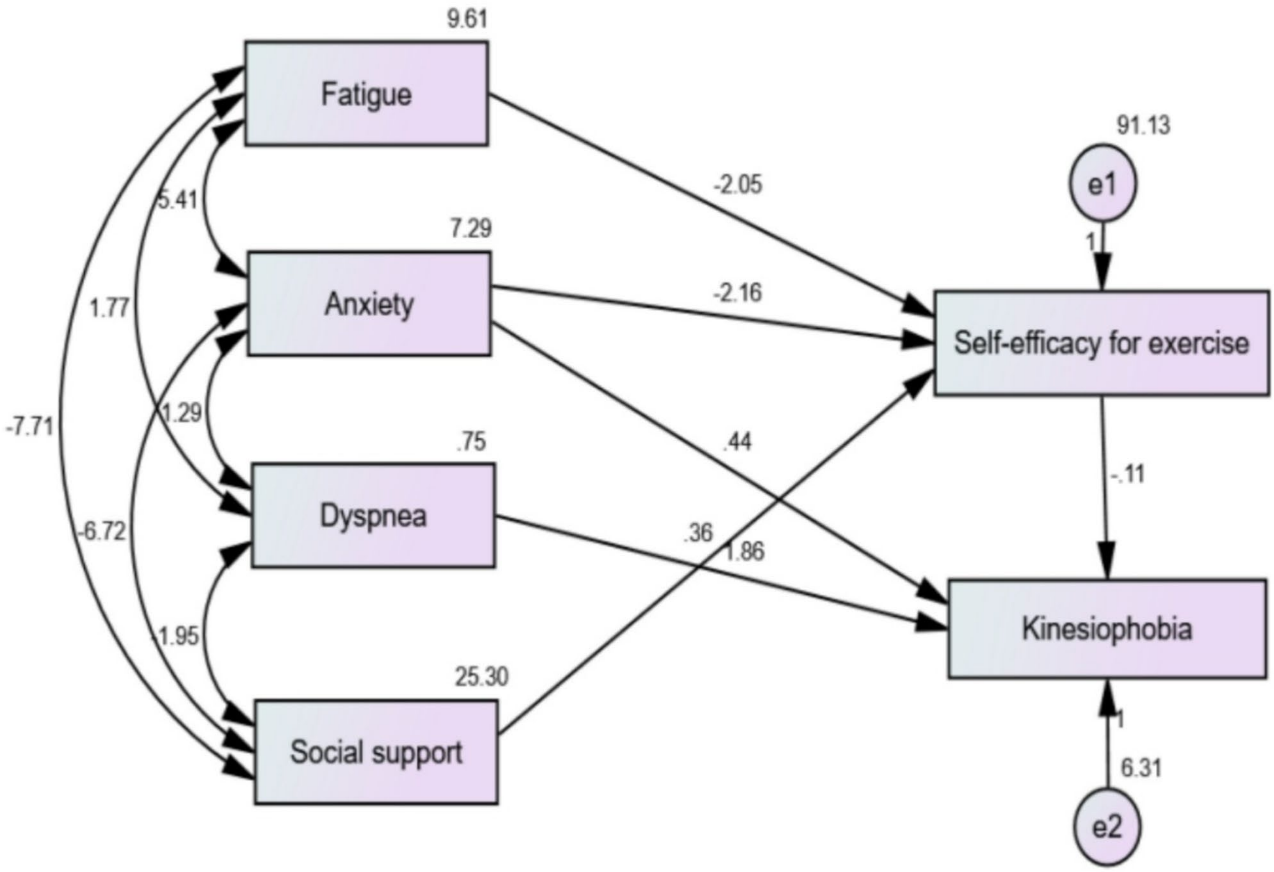

Fig. 1 Structural equation model of kinesiophobia in COPD patients

Table 3 Standardised path coefficient results for the model

Pathways	U. Estimate	Estimate	S.E.	C.*R.*	*P*
A → E	-2.049	-0.411	0.251	-8.148	***
B→E	0.360	0.117	0.136	2.644	0.008
C→E	-2.163	-0.378	0.289	-7.496	***
D→F	1.861	0.347	0.216	8.635	***
C→F	0.439	0.255	0.082	5.344	***
E→F	-0.115	-0.382	0.014	-8.104	***

Note: A: fatigue; B: social support; C: anxiety; D: dyspnoea; E: exercise self-efficacy; F: kinesiophobia

$p < 0.05$ indicates significance and *** indicates $p < 0.001$

bias-corrected 95% confidence intervals (CIs). As shown in Table 4, the upper and lower 95% CIs for the three mediating pathways did not contain 0, indicating that the indirect effects were all significant. The results of the mediation effect of structural equation modeling showed that exercise self-efficacy partially mediated the effect between fatigue, anxiety, social support, and kinesiophobia. In the total effect of kinesiophobia in patients with COPD, the effect of anxiety was the largest (0.400), followed by exercise self-efficacy (-0.382), dyspnoea (0.347), fatigue (0.157) and social support (-0.045).

Table 4 Decomposition of effects of variables

Pathways	Standardised Direct Effects	Standardised Indirect Effects	Standardised Total Effects	Bais-corrected95 per cent CI	
				Lower	Upper
A→E→F		0.157	0.157	0.102	0.224
B→E→F		-0.045	-0.045	-0.089	-0.007
C→E→F	0.255	0.144	0.400	0.299	0.494
D→F	0.347		0.347		
E→F	-0.382		-0.382		

Note: A: fatigue; B: social support; C: anxiety; D: dyspnoea; E: exercise self-efficacy; F: kinesiophobia

Discussion

This study used Bandura's self-efficacy theory to examine the mechanism of action of kinesiophobia in COPD patients. It is worth noting that the present study used the BBQ scale total score for the assessment of kinesiophobia, which may reflect more of the kinesiophobia associated with dyspnoea. Our results suggest that dyspnoea, fatigue, anxiety, exercise self-efficacy, and social support are influential factors for kinesiophobia in patients with COPD, and that exercise self-efficacy can influence the level of kinesiophobia in patients through 3 different mediating pathways.

Our study showed that dyspnoea was positively correlated with kinesiophobia, and further path analysis showed that the degree of dyspnoea could directly contribute to the development of kinesiophobia in patients. This is in line with the study by Vardar-Yagli who explored kinesiophobia associated with pain in COPD patients [10].One possible reason for this is that dyspnoea and pain share many common features, with common neural pathways and cortical projection areas [33]. Patients with COPD may develop a morbid fear of acute airflow limitation when they experience activity-related dyspnoea. This psychological response often manifests itself in maladaptive avoidance behaviours, leading to a reduction in exercise [34]. Whereas persistent dyspnoea dramatically reduces the patient's ability to exercise, it can trigger catastrophic thinking and lead to kinesiophobia [35]. Healthcare professionals should choose appropriate exercise modalities and exercise intensity to avoid adverse events and gradually reduce patients' kinesiophobia [36].

The results of this study showed a positive correlation between fatigue and kinesiophobia. Fatigue can indirectly affect kinesiophobia in COPD patients through exercise self-efficacy. We complemented previous research by clarifying the mechanism of action of fatigue and fear of movement [13]. COPD patients with reduced self-efficacy following physical and psychological fatigue tend to have a lack of confidence in exercise and lower expectations of exercise outcomes [37]. This catastrophic mindset predisposes them to kinesiophobia and ultimately to adaptive avoidance strategies characterised by exercise withdrawal [34]. Therefore, we can correct kinesiophobia by improving patients' exercise self-efficacy, and methods such as action planning and task division of labor are effective in improving exercise self-efficacy [18].

Our study showed a positive correlation between anxiety and kinesiophobia in COPD patients. Anxiety has two pathways of action on exercise fear in patients with COPD: one is directly on kinesiophobia and the other is indirectly on kinesiophobia through exercise self-efficacy. This is consistent with previous studies that anxiety in COPD patients is strongly associated with dyspnoea-related kinesiophobia [38]. In patients with COPD, anxiety-induced hyperventilation triggers bronchoconstriction and lung hyperinflation, thereby exacerbating dyspnoea. This physiological response often triggers catastrophic misinterpretation of the patient's symptoms, leading to a cycle of fear of specific triggers, which in turn creates a mental model of avoidance behaviour [39]. A study has found that a negative correlation between anxiety and exercise self-efficacy, and the mechanism of action between the two is unclear [16]. Our study explains the mechanism of action between anxiety and kinesiophobia. Therefore, clinical staff should pay attention to the prevention and management of anxiety in patients with COPD, and improve the symptoms of anxiety by correcting the patients' catastrophic cognition, to reduce the patients' kinesiophobia and improve the patients' adherence to exercise.

This study showed that exercise self-efficacy was negatively related to kinesiophobia. Social support acts indirectly on kinesiophobia through exercise self-efficacy. This study is consistent with the results of Qin [18]. COPD patients with higher exercise self-efficacy have greater exercise confidence and they have lower levels of kinesiophobia [40]. In addition, adequate social support moderates confidence in adherence to treatment in patients with COPD by enhancing their self-efficacy [41]. Conversely, reduced social support can weaken exercise-related self-efficacy, predisposing patients to avoidance of activities and ultimately to kinesiophobia [42]. Therefore, different aspects of social support can enhance patients' motivation to exercise. Caregivers' involvement in patients' exercise programs can improve their exercise self-efficacy [43].

Limitations

This study still has many limitations. Firstly, the convenience sampling method used in this study, with more than 90% male participants, may limit the generalisability of the findings. Therefore future studies with gender-stratified sampling in COPD patients are needed. Secondly, some demographic characteristics may have an impact on kinesiophobia, such as comorbidities, length of time with COPD, and pulmonary function classifications, but they were not included in the SEM. Finally, the present study was a single-center design with a small sample size, and an in-depth investigation with a larger sample size and multi-centers could be adopted in the future to address kinesiophobia in COPD patients.

Conclusion

In conclusion, guided by the fear-avoidance model and self-efficacy theory, we tested the SEM model of kinesiophobia in COPD patients and identified six pathways of action for kinesiophobia. A multilevel intervention framework should be implemented in COPD exercise programmes, combining symptom control programmes, emotion regulation strategies and social support network activation to enhance exercise self-efficacy and reduce kinesiophobia through biopsychosocial pathway regulation.

Abbreviations

COPD	Chronic obstructive pulmonary disease
BBQ	Breathlessness Beliefs Questionnaire scale
mMRC	Modified Medical Research Council Dyspnea Scale
FS-14	Fatigue Scale
HADS	Hospital Anxiety and Depression Scale
SEE	Self-Efficacy for Exercise
SSRS	Social Support Rating Scale
SEM	Structural equation modeling
RMSEA	Root mean square error of approximation
GFI	Goodness of fit index
NFI	Normalised fit index
CFI	Comparative fit index
GOLD	Global initiative for chronic obstructive lung disease

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Author contributions
Y.W. and X.Z. conceived the idea and the study.C.X and X.X.collected the data. G.H.analyzed the data. Y.W. wrote the draft.X.Z.took full responsibility for the work as a whole, including the study design, access to the data, and decision to submit. All authors have read and agreed to the published version of the manuscript.

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Data availability
The data presented in this study are available only upon request from the corresponding author.

Declarations

Ethics approval and consent to participate
This study strictly adhered to the relevant provisions of the Declaration of Helsinki and was approved by the the Ethics Committee of the Third Affiliated Hospital of Guangzhou Medical University (Ethics Code: LCYJ-2023-055). All participants were given informed consent and had the right to withdraw from the study at any time. Their names and other confidential information were protected. No harm was caused to the participants during the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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