Geriatric Nursing 56 (2024) 138–147

Contents lists available at ScienceDirect

Geriatric Nursing

journal homepage: www.gnjournal.com

Featured Article

The effect of cognition in combination with an ACBT on dyspnea-related kinesiophobia in patients with moderate to severe COPD: Quasirandomized controlled trial study

Shasha Cai, MSN, RN[a], Jinlan Yao, MSN, RN[b], Maomao Han, MSN, RN[c], Xiaolin Luo, MSN, RN[d], Yudi Yu, MSN, RN[a], Xiaorong Lu, MSN, RN[c], Xinyue Xiang, MSN, RN[a], Lihua Huang, MSN, RN[a,*]

[a] *Department of Nursing, The First Affiliated Hospital, Zhejiang University School of Medicine, China*
[b] *School of Medicine, Huzhou University, Huzhou Central Hospital, Huzhou, Zhejiang Province, China*
[c] *Department of Nursing, Haining People's Hospital, Haining, Zhejiang Province, China*
[d] *Zhejiang Evaluation Center for Medical Service and Administration, Hangzhou, Zhejiang Province, China*

A R T I C L E I N F O

Article history:
Received 19 October 2023
Received in revised form 4 January 2024
Accepted 11 January 2024
Available online 10 February 2024

Keywords:
COPD
Kinesiophobia
ACBT
Social cognitive theory

A B S T R A C T

Patients with moderate to severe COPD frequently experience dyspnea, which causes these patients to acquire a fear of dyspnea and a fear of activity. This study developed a cognitive intervention combined with active cycle of breathing technique (ACBT) intervention program based on the fear-avoidance model, with the goal of evaluating the program's effectiveness in improving dyspnea-related kinesiophobia in patients with moderate to severe COPD. This study had a total of 106 participants. For 8 weeks, the intervention group (N=53) received cognitive combined with ACBT, while the control group (N=53) received standard care. The findings of the four times the dyspnea belief questionnaire were collected indicated that the combined intervention had a better impact on reducing dyspnea-related kinesiophobia than did routine nursing ($P<0.05$), and the impact persisted even after the intervention. Additionally, it may enhance dyspnea and quality of life, increase exercise capacity, and lower the BODE index.

Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive lung disease characterized by airflow limitation. The most common clinical signs are chronic cough, expectoration, and dyspnea.[1] The study discovered that 98% of COPD patients experienced dyspnea symptoms.[2] The sense of dyspnea in moderate and severe patients became increasingly noticeable as airway obstructive dysfunction progressed, and 47% of them were afraid of daily activity due to dyspnea.[3] This long-standing fear, which differs from general anxiety and fear, can cause patients to avoid activities, accelerate the degradation of bodily function, and reduce skeletal muscle strength, all of which are detrimental to the long-term recovery of physical activities.[4, 5]

Dyspnea-related kinesiophobia refers to individuals who have experienced dyspnea, misunderstand dyspnea, exaggerate the threat of dyspnea, cause anxiety and fear activities, and restrict or even avoid activities to relieve symptoms. [5, 6] According to studies, dyspnea-related kinesiophobia in COPD patients will further limit their daily activities, exacerbate the degree of dyspnea, affect the rehabilitation effect of lung function, and form a vicious circle, eventually affecting the quality of life and leading to increased disease burden.[7] In recent years, researchers at home and abroad have been investigating kinesiophobia related to dyspnea in COPD patients, implementing tailored interventions to alleviate the patients' dread of dyspnea and fear of activities, as well as minimize the disease's risk. Currently, studies have shown that inspiratory muscle training (IMT) can exercise patients' inspiratory muscle strength and endurance,[8, 9] strengthen patients' ability to cope with dyspnea, alleviate kinesiophobia related to dyspnea, thereby reducing dyspnea symptoms and disease burden.[5] We discovered that IMT is mostly dependent on inspiratory devices, and while varied levels of inspiratory pressure can be regulated, it has drawbacks such as high cost and tedious operation. The active cycle of breathing technique (ACBT) is a type of respiratory muscle training method[10] that includes breathing control,

Abbreviations: COPD, Chronic obstructive pulmonary disease; ACBT, Active cycle of breathing approach; SCT, Social cognitive theory; IMT, Inspiratory muscle training; BBQ, Breathlessness beliefs questionnaire; mMRC, Modified medical research council; 6MWT, The 6-minute walk test; HADS, Hospital anxiety and depression scale; CAT, COPD assessment test

*Corresponding author.
E-mail address: lihuahuang818@zju.edu.cn (L. Huang).

https://doi.org/10.1016/j.gerinurse.2024.01.002
0197-4572/$ – see front matter

chest expansion exercise, and forced expiratory technique.[11, 12] While focusing on the exercise of inspiratory muscles,[13–15] it can also significantly improve lung function and arterial oxygen saturation and finally reduce the symptoms of dyspnea and improve daily physical activity.[12, 16] Therefore, we suggest that ACBT be used to reduce dyspnea-related kinesiophobia in COPD patients in order to increase the acceptance of the intervention program. However, a single respiratory muscle function training only addresses modifying the patient's behavioral ability and cannot change their cognitive level or stimulate their motor efficacy, resulting in a sluggish intervention effect that is normally visible after 8 weeks.[17] Traditional cognitive intervention has been proven in studies to reduce fear in patients with a range of chronic conditions and to increase self-efficacy by modifying patients' behavior cognition.[18] It can alleviate patients' anxiety and despair caused by dyspnea during exercise, so improving their level of daily activities, and it has a good compliance and lung rehabilitation impact.[19] However, only by changing patients' cognition, the continuation effect on their behavior change ability is not good, and patients cannot be constrained to develop good behavior habits for a long time.[20]

The treatment of dyspnea-related kinesiophobia in patients is a multifaceted procedure, and improving respiratory muscle function and altering one's thinking should work in tandem. According to the fear-avoidance model put out by Leeuw W,[6] when people feel threatened by an illness, some will have incorrect cognition, experience anxiety, and feel fear, which will cause them to engage in avoidance behavior. A vicious spiral will eventually arise as the illness damage progressively worsens and the body's functioning status declines. This model suggests that lowering patients' experiences of dyspnea and altering their incorrect perception of dyspnea are effective ways to treat kinesiophobia.[21] Based on this model, we believe that in order to alleviate the kinesiophobia symptoms of patients with moderate to severe COPD, the patient's misperception of dyspnea should be used as the starting point for study. That is, patients will receive cognitive intervention while undergoing respiratory muscle function training. This combination intervention may have a greater impact than a single intervention, and there is currently no such combined intervention plan in place. Consequently, the primary purpose of this study was to develop a cognitive intervention combined with an active cycle of breathing technique protocol that is culturally appropriate in China. We hypothesized that this intervention would reduce dyspnea-related kinesiophobia in patients with moderate to severe COPD, exercise their lung function, alleviate dyspnea, and increase exercise capacity, lowering the risk of disease and eventually enhancing quality of life.

Methods

Study design

This was an 8-week multicenter, prospective, quasiexperimental study in which researchers and subjects were not blinded, but data collectors and data analysts were. It was registered in the Chinese Clinical Trial Registry with the registration number ChiCTR2200058498 on 10/04/2022.

Participants

In this study, convenience sampling was used to select moderate to severe COPD patients who were treated in the Department of Respiratory Medicine of the First Affiliated Hospital of Zhejiang University School of Medicine and Haining First People's Hospital from April to August 2022. The inclusion criteria were as follows: (1)Meet the diagnostic criteria of the Global Strategy for the Diagnosis, Management, and Prevention of COPD 2021 for patients with COPD; (2) GOLD II and III patients; (3)Patients without psychiatric disorders and communication disorders; (4)No somatic or limb dysfunction; (5)Being capable in the interpretation and comprehension of both written and spoken language; (6)Patients provided informed consent and actively cooperated with exercise training; (7)Patients had access to smartphones and wechat. The exclusion criteria were (1)Co-occurring with other respiratory illnesses including pulmonary bullae, pulmonary embolism, pneumothorax, and asthma (where FEV_1 increased by $\geq$12% and the absolute value of FEV_1 increased by $\geq$200 ml upon inhaling bronchodilators); (2)Presence of activity-limiting comorbidities (such as severe heart illness, neurological disease, liver and renal disease, etc.); (3)Patients who have undergone recent surgical procedures; (4)Participation in other medical clinical research; (5)Patients unable to be followed up regularly.

Sample size and recruitment

The sample size was derived from the preexperimental data using the formula for the sample size necessary for comparing the sample means of two groups. Taking into account a power of 0.9 and an alpha of 0.05. The major endpoint of the preliminary experimental research was the breathlessness beliefs questionnaire (BBQ) scores, with a mean score of 37$\pm$5.83 in the control group and a mean score drop of 4 points in the intervention group; thus, 45 cases in each group were necessary. Assuming a 15% attrition rate, each group included 52 individuals.

The study comprised a total of 106 patients, including 59 inpatients and 47 outpatients, who fulfilled the inclusion and exclusion criteria. Inpatients were grouped according to ward. Patients admitted to ward A were included in the control group, and patients admitted to ward B were included in the intervention group. Outpatients were grouped according to the date of visit. Patients who visited on odd days were included in the control group, and patients who visited on even days were included in the intervention group. There were 53 cases in each group.

Intervention group

Using a literature review as a foundation, this study created the initial draft of the intervention strategy. The initial intervention plan was examined and discussed through expert consultation and pretesting. The intervention plan was enhanced and changed in accordance with the expert opinions that were included, and a final document was created (Table 1).

The intervention process, which lasted for 8 weeks, was divided into in-hospital intervention and out-of-hospital intervention. Interventions included respiratory muscle training (active cycle of breathing technique) and cognitive intervention. The cognitive intervention in this study was based on Social cognitive theory (SCT), which aims to emphasize the interaction between individual cognition, subject behavior, and environmental factors, and believes that self-efficacy can directly affect target behavior.[22, 23] As a result, the patient's correct awareness of the activity should be built ahead of time in the program design to rectify the false belief that the activity will increase the symptoms of dyspnea. Improve the patient's ability to accomplish the behavior, then improve self-efficacy and belief in the action. Finally, it should be strengthened to make it easier to follow. All interventions were carried out by the researcher and team members. The team members (with a bachelor's degree or higher and a good level of communication) were trained and assessed by the researcher one week before the intervention. The content includes the movement steps of the active cycle of breathing technique, the introduction of relevant manuals, and the evaluation index standards to ensure the uniformity of the intervention.

Table 1
Cognitive intervention combined with ACBT intervention program.

Projects			Specific implementation plan			
			Interventions	Intervention time	Intervention sites	Intervention purpose
Intervention	**Experience of dyspnea**	**Inspiratory muscle training**	Exercises in active cycle of breathing technique (ACBT)	Three times daily for fifteen minutes for eight weeks	Out-of-hospital interventions	Improve respiratory muscle strength, dyspnea, and kinesiophobia
	Catastrophic Perception	**Altered awareness**	Engage in conversation with patients and encourage them to discuss their disease-related experiences, present state, etc	The first day in the hospital	in-hospital intervention	Patients' kinesiophobia were investigated
			The "Manual Related to Kinesiophobia in COPD" was utilized to outline the causes, influencing elements, present condition, impacts, and consequences of kinesiophobia	The first day in the hospital	in-hospital intervention	To promote patients' faith and subjective initiative, as well as to heighten their sense of the significance of actions
		Regulation of behavior	To demonstrate the training method of the ACBT	The first day in the hospital	in-hospital intervention	To allow family members and patients to directly experience the advantages of respiratory muscle training
			Send a self-recorded video of the active cycle of breathing technique (ACBT)	Every morning for 8 weeks	Out-of-hospital interventions	Ensure patients are aware of the workout steps and serve as a reminder
		Self-efficacy	Disease education videos were sent, including the related manuals of COPD kinesiophobia, the mechanism of inspiratory muscle training, the mechanism of active cycle of breathing technique, exercise training methods and precautions	Monday evening of the second to eighth week of admission	Out-of-hospital interventions	Easily gain access to disease rehabilitation information and acquire disease-specific knowledge
			Communicate with patients to clarify obstacles faced during exercise training and promptly resolve their questions	Every day for 8 weeks	Out-of-hospital interventions	Assisting patients in independently analyzing and resolving problems to enhance their self-care skills
		Reinforcement	Invite the patient's family to participate in health education and activities	Every day for 8 weeks	Out-of-hospital interventions	Help patients receive family support and supervision
Quality Control		**Clock in**	Reporting Active cycle of breathing technique training via WeChat to the investigator	Every day for 8 weeks	Out-of-hospital interventions	Preventing forgetfulness
		Follow-up visits	Follow-up by phone	1 week, 1 occasion	Out-of-hospital interventions	Comprehend the self-management, issues, and psychological dynamics of the patients, and encourage them

Control group

Clinical nurses provided standard care to patients in the control group, including breathing exercises, oxygen treatments, and the distribution of brochures on routine COPD prevention and treatment in the department. Patients were asked to closely adhere to medical recommendations about medicine, to avoid smoking and drinking, to contact the department for counseling in the event of challenging situations and to seek medical treatment as soon as uncomfortable symptoms manifested. We contacted our patients once each week to assess their psychological state and exercise regimen.

Treatment Fidelity and Monitoring

To monitor the fidelity of treatment delivery, the principal investigator created a manual of each intervention step following standardized training, organized the research team to discuss the intervention process every two weeks, and randomly selected research team members to describe the intervention implementation process. The integrity of the treatment received was monitored. After the first teaching of the active cycle of breathing technique, the study team members were instructed to let the patients demonstrate the breathing exercise until they had thoroughly grasped the breathing exercise technique. Following discharge, patients were contacted by phone once a week to inquire about any issues they had regarding the content of relevant cognitive treatments and exercise training videos. Teams conducted daily wechat interviews with patients or their families to check on the enactment of treatment skills. They also followed up with relevant education films to guarantee that patients or their families were watching the videos in a high-quality manner.

Measurements

Sociodemographic profile questionnaire

The sociodemographic data comprised age, gender, height, weight, education, place of residence, and income. Illness-related factors included disease duration, hospitalization frequency during the previous two years, and GOLD classification.

Primary outcome

The degree of dyspnea-related kinesiophobia of patients was utilized as the major outcome index in this study, and the Chinese version of the breathlessness beliefs questionnaire (BBQ), translated by Wu Qing in 2015, was used to quantify it.[21] The measure comprises 11 items, comprising the dread of dyspnea dimension (five items) and the fear of activity dimension (six things), and each item is rated from "strongly disagree" (score = 1) to "strongly agree" (score = 5) for a total score between 11 and 55. The higher the score on the dyspnea belief scale, the greater the degree of dyspnea belief, the stronger the perception that dyspnea is harmful and catastrophic, and the more they believe that minimizing or avoiding activities will ease dyspnea symptoms.

Secondary outcome

Cognitive intervention and active cycle of breathing technique can exercise the lung function of patients, alleviate the degree of dyspnea, improve dyspnea-related kinesiophobia, and improve exercise ability, so as to reduce the risk of disease and improve the quality of life.

Measurements of pulmonary function included forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), FEV_1/FVC, and the FEV_1%.

The severity of patients' dyspnea was assessed using the Modified Medical Research Council (mMRC) scale.[24] The scale ranges from 0 to 4, where 0 represents mild, 1 represents moderate, and 2-4 represents severe. The scale is straightforward and quick to use, and it helps gauge how much patients are struggling with dyspnea.

Guyatt GH devised the 6-minute walk test (6MWT) in 1985 to measure the exercise ability of patients by measuring the distance they walk in 6 minutes.[25] The patient's capacity for exercise improved the farther they walked throughout the allotted period. The Borg fatigue scale was used to gauge the degree of dyspnea and exhaustion at the conclusion of the trial.

The BODE index, which consists of the patient's body mass index, airflow obstruction, dyspnea, and exercise capacity, is used to evaluate the patient's risk factors for mortality or death from respiratory illness. BMI represents nutritional status, the predicted FEV_1 value reflects airway obstruction, the mMRC dyspnea score reflects dyspnea severity, and the 6MWT reflects exercise capability. The overall score runs from 0 to 10, with a higher number indicating a higher probability of the patient dying.

The COPD assessment test (CAT) questionnaire was utilized to measure the clinical symptoms and quality of life of COPD patients.[26] The scale includes eight categories: cough, sputum, chest tightness, mobility, ability to complete daily tasks, ability to go out, sleep, and energy, with each entry scoring 0-5 and a total score of 0-40, with higher values signifying more severe disease and lower quality of life.

Data collection

Data was collected through a pre- and post-survey. Before grouping (T0), all patients' general information was gathered. The dyspnea belief questionnaire was used to assess the degree of kinesiophobia at the conclusion of the 8-week intervention (T2), and other secondary outcomes, such as lung function, degree of dyspnea, exercise capacity, BODE index, and quality of life, were also collected. The dyspnea belief questionnaire was administered again at week 4 of the intervention (T1) and week 4 after all interventions were completed (T3). Informed consent was obtained from all subjects in this study.

Statistical analysis

Excel was used to create a database and double-check the input data, and the SPSS 22.0 software package was used to analyze the data. The frequency and percentage of count data were expressed, and the chi-square test or Fisher exact test was used to compare groups. The normally distributed measurement data are expressed as the mean $\pm$ standard deviation. The difference between the two groups before and after intervention was compared by two independent sample t test, and the paired t test was used for intra-group comparison. Nonnormally distributed measurement data are expressed as the median (interquartile range) and were tested using the nonparametric rank sum Mann–Whitney U test. We used repeated-measure ANOVA to explore the within-group effect, between-group effect, and the interaction effect of group*time of dyspnea belief. Statistical significance was accepted for p values $<$ 0.05.

Results

The trial originally enrolled 139 patients with moderate-to-severe COPD, however 33 were dropped because they did not match the inclusion criteria. There were 106 patients in all, comprising 47 outpatients and 59 ward patients. These qualified patients were divided into two groups at random: the control group (n=53) and the intervention group (n=53). During the intervention's implementation, one patient dropped out of the control group, one patient dropped out of the intervention group, and 104 patients finished the trial. The reasons for withdrawal from the trial were a lack of time for intervention

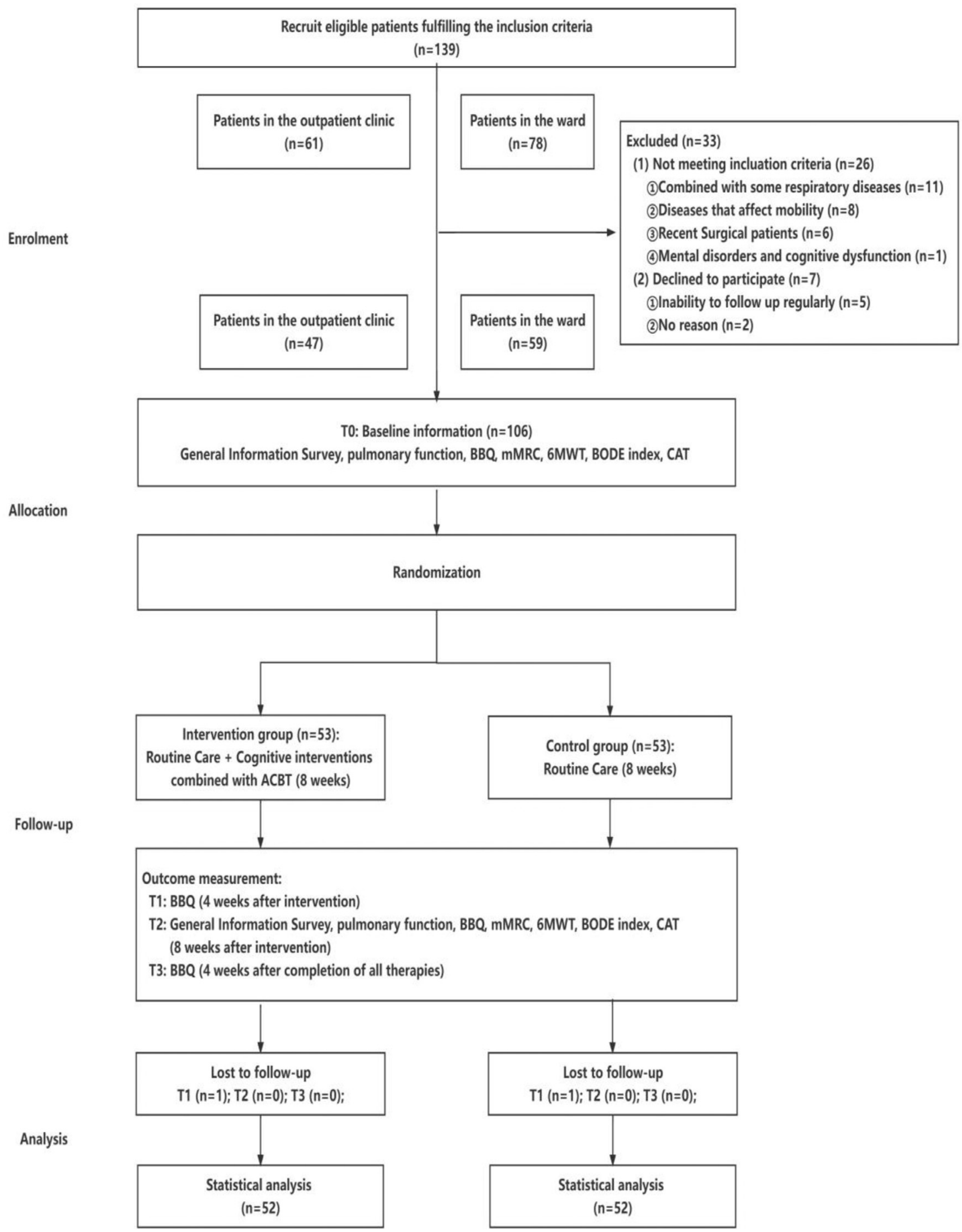

Fig. 1. Flow chart of the study process. BBQ, Breathlessness Beliefs Questionnaire; mMRC, Modified Medical Research Council; 6MWT, 6-minute walk test; CAT, COPD Assessment Test; ACBT, Active Cycle of Breathing Technique.

(n=1) and disease exacerbation (n=1), while the rest of the intervention subjects complied well. Fig.1 depicts the recruitment and dropout of participants at each stage of the experiment.

Baseline characteristics of patients

There was no significant difference between the two groups in terms of general data and evaluation markers ($P > 0.05$), and the two groups were comparable. See Tables 2 and 3.

Primary efficacy

The BBQ comprised of two dimensions: the Breathlessness Beliefs Questionnaire-Somatic Focus (BBQ-SF) and the Breathlessness Beliefs Questionnaire-Activity Avoidance (BBQ-AA). A statistical analysis was done on the scores before the intervention (T0), four weeks after it (T1), eight weeks after it (T2), and three weeks after it (T3). The findings demonstrated that there was no significant difference in the two groups' total BBQ scores at T0 (P=0.098). Following the intervention, there were statistically significant variations in BBQ scores between

Table 2
Demographic characteristics of the study sample $[n(\%), \bar{X} \pm s]$

		Control group N=52 (%)	Intervention group N=52 (%)	t/X^2	P value
Gender	Male	34 (65.4%)	38 (73.1%)	0.722[b]	0.395
	Female	18 (34.6%)	14 (26.9%)		
Age (year)		67.96±9.19	67.56±8.05	0.238[a]	0.812
BMI (kg/m$^{2)}$		22.58±3.45	22.77±3.78	-0.266[a]	0.791
Education level	Primary school or below	32 (61.5%)	25 (48.1%)	2.45[b]	0.294
	Junior high school	16 (30.8%)	19 (36.5%)		
	Senior high school	4 (7.7%)	8 (15.4%)		
	University	0 (0%)	0 (0%)		
Method of payment	Self-funded	8 (15.4%)	5 (9.6%)	1.236[b]	0.539
	Public funded	0 (0%)	0 (0%)		
	Medical insurance	32 (61.5%)	37 (71.2%)		
	Social security	12 (23.1%)	10 (19.2%)		
Economic income	<1000	3 (5.8%)	2 (3.8%)	1.559[c]	0.707
	1000-3000	16 (30.8%)	13 (25.0%)		
	3000-5000	19 (36.5%)	25 (48.1%)		
	>5000	14 (26.9%)	12 (23.1%)		
Place of residence	Rural	29 (55.8%)	33 (63.5%)	0.639[b]	0.424
	City	23 (44.2%)	19 (36.5%)		
Disease duration (year)	<1	11 (21.2%)	13 (25.0%)	0.987[b]	0.804
	2-5	12 (23.1%)	15 (28.8%)		
	5-10	15 (28.8%)	12 (23.1%)		
	>10	14 (26.9%)	12 (23.1%)		
Number of admissions in recent two years		3.00±1.44	3.10±1.54	-0.329[a]	0.743
GOLD stage	II	22 (42.3%)	24 (46.2%)	0.156[b]	0.693
	III	30 (57.7%)	28 (53.8%)		

Notes.
[a] Student's t test
[b] chi-square test
[c] continuous correction chi-square test.

the two groups at T1, T2, and T3 (P<0.05), as revealed by the comparison of BBQ total scores between groups. The BBQ scores of both groups also showed a declining tendency over time, with the intervention group's fall being more pronounced than the control group's, as shown in Fig. 2. The within-group effect of BBQ score was statistically significant (F=227.344, P<0.05). The control group's BBQ overall score was the lowest at T3, and the difference was statistically significant when compared to T0, T1 and T2 (P<0.05). Between any two time points, the intervention group's overall BBQ score showed a statistically significant difference (P<0.05). The total BBQ score between groups and time had an interaction effect (F=106.857, P<0.05) (Table 4).

Secondary outcomes

Intragroup comparison showed that there were significant differences in FVC, FEV_1, FEV_1%, mMRC, 6MWTD and CAT values between T0 and T2 in the control group (P < 0.05). There was no significant difference in FEV_1/FVC or BODE values (P > 0.05). The comparison between T0 and T2 in the intervention group showed that only FEV_1/FVC data had no significant difference, and the rest had significant differences. The intervention group's six-minute walk distance was significantly higher than that of the control group at the end of the 8-week intervention, and the intervention group's mMRC, BODE index, HADS total score and each dimension score, and CAT score were significantly lower than those of the control group (P<0.05). The differences between the two groups before and after the intervention were statistically significant (P<0.001). Only the difference in FEV_1% score before and after intervention was statistically significant (P<0.001) in the pulmonary function index, whereas the changes in FVC, FEV_1, and FEV_1/FVC scores were not (P > 0.05). See Table 5 for details.

Table 3
Physical and baseline clinical characteristics of the patients. $[\bar{X} \pm s, M(IQR)]$

	Control group N=52 (%)	Intervention group N=52 (%)	t/z	P value
FVC (L)	2.17±0.59	2.37±0.65	-1.630[a]	0.106
FEV_1 (L)	1.19±0.37	1.28±0.37	-1.197[a]	0.234
FEV_1 (%)	46.00 (19.75)	49.00 (23.50)	-0.530[b]	0.596
FEV_1/FVC (%)	55.23±9.00	54.52±9.59	0.392[a]	0.696
BBQ	33.62±3.16	34.73±3.64	-1.669[a]	0.098
BBQ-SF	15.88±1.53	16.46±1.70	-1.821[a]	0.072
BBQ-AA	17.73±2.18	18.27±2.26	-1.237[a]	0.219
mMRC	1.0 (2.0)	1.0 (2.0)	-0.233[b]	0.816
6MWTD (m)	292.69±30.25	302.71±32.36	-1.631[a]	0.106
BODE	3.62±1.81	3.33±1.81	0.813[a]	0.418
CAT	18.81±7.44	18.12±6.84	0.494[a]	0.622

Notes.
[a] Student's t test,
[b] Mann−Whitney U test.

Discussion

When patients with moderate to severe COPD experience persistent dyspnea, they tend to limit their daily activities out of concern that it will worsen the disease's progression. This ultimately results in a decline in the patients' lung muscle strength and continued atrophy of their physical function.[6, 27] As a result, it is critical to develop an intervention plan for dyspnea-related kinesiophobia in order to reduce the severity of dyspnea and kinesiophobia in patients. This study, which creatively integrates cognitive intervention and ACBT based on the fear-avoidance model, tests the hypothesis that the combined intervention can significantly improve exercise fear in patients with moderate to severe COPD and has positive implications for related secondary outcomes.

Patients with moderate to severe COPD in our research all reported a high level of dyspnea-related kinesiophobia. The control group's BBQ score was 33.62±3.16, while the intervention group's BBQ score was 34.73±3.64, which matched the cross-sectional survey results of domestic scholars.[28] After 8 weeks of cognitive intervention

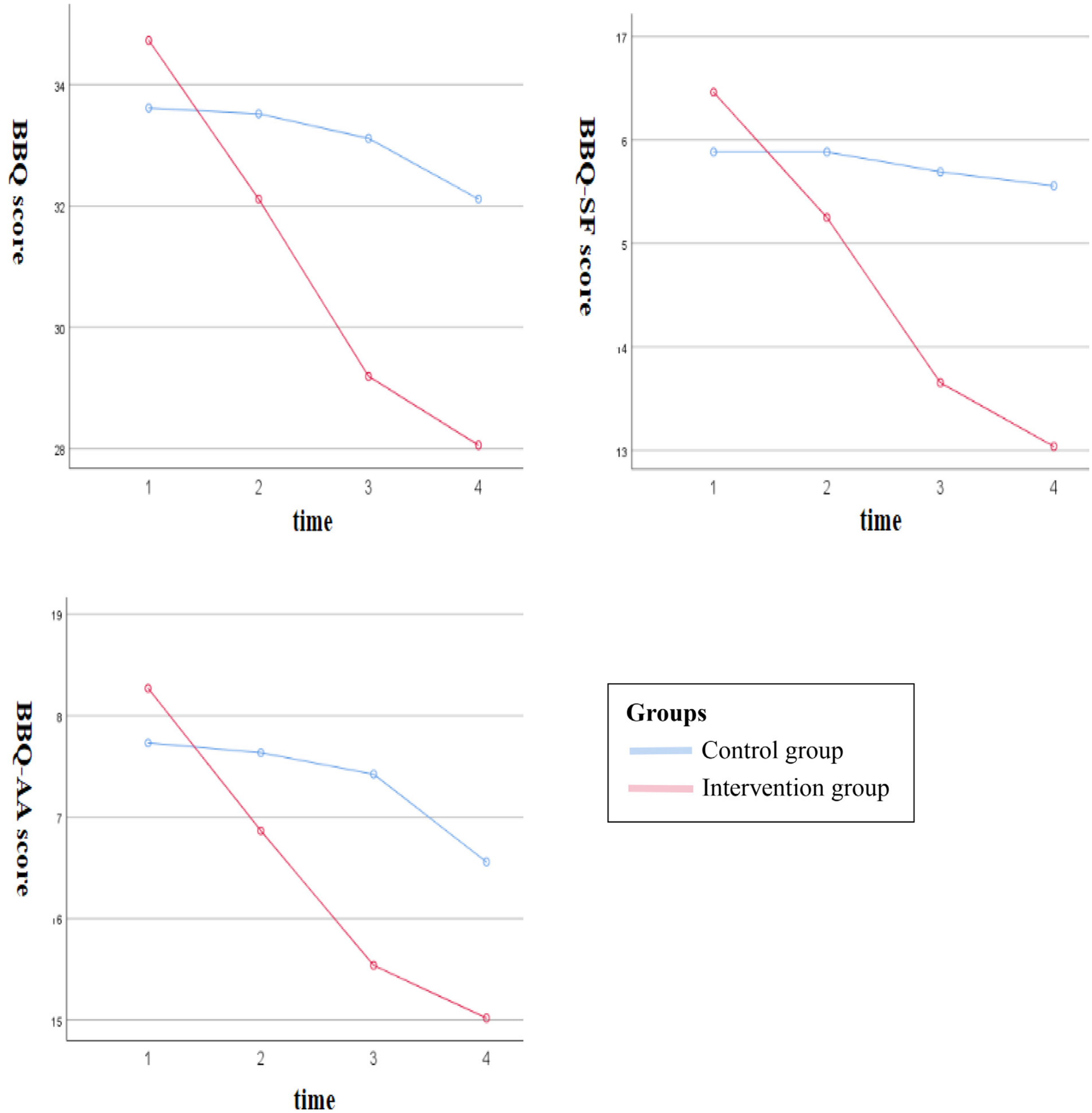

Fig. 2. BBQ, BBQ-SF, and BBQ-AA scores in the two groups plotted over time.

coupled with active cycle breathing technology intervention, the BBQ score and scores of each dimension of the intervention group were significantly lower than those of the control group, and the differences were statistically significant ($P<0.05$). This demonstrates that routine nursing was not as effective as the combination intervention in alleviating dyspnea-related kinesiophobia in patients with moderate to severe COPD. Repeated-measure ANOVA revealed that the BBQ score and the scores for each dimension in the intervention group exhibited a decreased trend at the fourth week of the intervention (T1). Comparing the differences to the control group revealed that they were statistically significant. The intervention group's synergistic effect was still noticeable four weeks after the intervention ended (T3). Even though the decrease trend was slower than it was in the fourth and eighth weeks, the difference from the control group was nonetheless statistically significant. This suggests that a combination of interventions is more effective than a single intervention. Not only does the intervention take effect more quickly, but it also has a considerable long-term impact.

Three causes for analysis are possible. To start, individuals with poor disease knowledge are more likely to have anticipatory anxiety about dyspnea, which leads to avoidance behavior.[29] A person's sickness experience will be exaggerated by such anticipatory anxiety over time, which will cause cognitive errors. In this study, intervention measures such as weekly educational videos and manuals were sent to patients to assist in establishing correct disease cognition, enhancing self-efficacy, lowering anxiety, accepting the existence of dyspnea symptoms, and correcting the false belief that exercise aggravates the disease. Furthermore, persons with COPD require more suction pressure than average individuals. Exertional dyspnea and decreased daily exercise are easily produced by increased inspiratory nerve drive brought on by stress when the power of the inspiratory muscle is compromised.[30,31] However, the three sets of respiratory exercises in the active cycle of breathing technique can exercise the inspiratory muscles' strength and endurance to varied degrees. This minimizes the neuromechanical separation of the respiratory system, lessens the body's intervention from the inspiratory

Table 4
Comparison of BBQ scores between the two groups at different time points ($\bar{\chi} \pm s$)

Measure	time	Control group (N=52)	Intervention group (N=52)	*t*	*P*	$F_{between-group}$ ($P_{between-group}$)	$F_{within-group}$ ($P_{within-group}$)	$F_{group*time}$ ($P_{group*time}$)
BBQ	T0	33.62±3.16	34.73±3.64	-1.669	0.098	11.772	227.344	106.857
	T1	33.52±3.22	32.12±3.16[a]	2.244	0.027*	(0.001)	(0.000)	(0.000)
	T2	33.12±2.78	29.19±3.12[a,b]	6.767	0.000*			
	T3	32.12±3.15[a,c,d]	28.06±3.06[a,c,d]	6.668	0.000*			
BBQ-SF	T0	15.88±1.53	16.46±1.70	-1.821	0.072	17.569	66.906	46.399
	T1	15.88±1.46	15.25±1.76[a]	2.000	0.048*	(0.000)	(0.000)	(0.000)
	T2	15.69±1.46	13.65±1.64[a,b]	6.682	0.000*			
	T3	15.56±1.55	13.04±1.55[a,c,d]	8.293	0.000*			
BBQ-AA	T0	17.73±2.18	18.27±2.26	-1.237	0.219	6.472	77.643	27.923
	T1	17.63±2.09	16.87±1.75[a]	2.037	0.044*	(0.012)	(0.000)	(0.000)
	T2	17.42±1.79	15.54±1.81[a,b]	5.346	0.000*			
	T3	16.56±2.00[a,c,d]	15.02±1.92[a,c,d]	4.003	0.000*			

Notes.
*Significant changes were observed between groups at different time points, p <0.05,
[a] Significant change from baseline, p <0.05
[b] Significant change between T1 and T2, p <0.05
[c] Significant change between T2 and T3, p <0.05
[d] Significant change between T1 and T3, p <0.05, T0=Preintervention assessment, T1=4-week postintervention assessment, T2=Postintervention assessment, T3=12-week follow-up.

nerve drive, and improves respiratory mechanics and muscle function.[30] Last but not least, when cognitive intervention and ACBT were combined, ACBT made up for the shortcomings of the poor continuous effect of cognitive intervention by strengthening respiratory muscle, relieving dyspnea symptoms, reducing disease-related anxiety and fear, and gradually developing a good behavior habit of daily exercise. Simultaneously, early cognitive intervention can provide patients with proper disease knowledge and enhance their motor efficacy, compensating for the slow start of ACBT.

In the current study, combining cognitive therapy with an active breathing technique can dramatically reduce patients' dyspnea and increase their ability to exercise. This is due to a related "steal phenomenon" in the muscles of inspiration,[32] which states that the total blood flow in the pulmonary circulation is constant. Patients with inspiratory muscle weakness can benefit from strength training by strengthening their respiratory muscles, increasing their lung volume, and increasing their venous return blood volume and left ventricular ejection volume, which will improve their ventilation dysfunction and ease their dyspnea symptoms.[33] Simultaneously, it enhances skeletal muscle perfusion, speeds up skeletal muscle's delivery of oxygen to the body, and ultimately boosts the muscle's ability to take in oxygen and do exercises.[34] Furthermore, personal attention is vital in the regulation of dyspnea[29]. As the perceived symptoms of dyspnea worsen, some patients shift their focus to the illness. In this study, cognitive interventions (such as educational videos, manuals, etc.), requiring family members to exercise with patients, and requiring patients to exercise in front of a mirror may all help patients avoid paying too much attention to their dyspnea. This will allow them to better coordinate inspiratory muscle movements, alleviate breathing difficulties, and increase daily activity levels. However, we discovered that our intervention's impact on lung function was insignificant. In comparing the two groups' values before and after the intervention, it was discovered that only FEV_1% had statistical significance. This finding was in line with Leelarungrayub J's research findings[35]. It could be because functional training of the inspiratory muscles was unable to reverse the pathological changes of airway obstruction.

After the cognitive combined active respiratory cycling technique intervention, the BODE index of the intervention group was significantly lower than that of the control group (P=0.009), and the difference in BODE index before and after the intervention group was higher than that of the control group, with a statistically significant difference (P<0.001). The analysis could be because FEV_1%, dyspnea, and walking distance are all components of the BODE index. Following the intervention, the patients' BODE index improves as their lung function improves, their dyspnea symptoms improve, and their ability to exercise improves. According to research, the BODE index of COPD patients is strongly correlated with their quality of life,[36] so the

Table 5
The two groups' outcome indices were compared before and after intervention

	Control group (N=52)				Intervention group (N=52)				(95%CI)	*P*
	T0	T2	*t/z*	*P*	T0	T2	*t/z*	*P*		
FVC (L)	2.17±0.59	2.35±0.49	-2.41	0.02[c]*	2.37±0.65	2.65±0.60	-3.14	0.003[c]*	(-0.33-0.14)	0.411[a]
FEV_1 (L)	1.19±0.37	1.28±0.32	-2.91	0.004[d]*	1.28±0.37	1.44±0.40	-4.41	<0.001[c]*	(-0.15-0.03)	0.143[b]
FEV_1 (%)	46.00 (19.75)	47.50 (19.50)	-3.12	0.002[d]*	49.00 (23.50)	54.00 (21.50)	-6.02	<0.001[d]*	(-4.0–2.0)	<0.001[b]*
FEV_1/FVC (%)	55.23±9.00	54.72±9.75	0.42	0.677[c]	54.52±9.59	54.67±9.07	-0.14	0.89[c]	(-4.01-2.67)	0.692[a]
mMRC	1.0 (2.0)	1.0 (3.0)	-2.83	0.005[d]*	1.0 (2.0)	1.0 (2.0)	-4.0	<0.001[d]*	(0.0-0.0)	<0.001[b]*
6MWTD (m)	292.69±30.25	305.85±31.95	-6.14	<0.001[d]*	302.71±32.36	323.48±33.69	-5.93	<0.001[d]*	(-14.0–6.0)	<0.001[b]*
BODE	3.62±1.81	3.00 (3)	-0.79	0.432[d]	3.33±1.81	2.00 (3)	-4.94	<0.001[d]*	(0.0-1.0)	<0.001[b]*
CAT	18.81±7.44	16.13±6.03	8.15	<0.001[c]*	18.12±6.84	13.65±4.43	10.29	<0.001[c]*	(0.71-2.87)	0.001[a]*

Notes.
*P<0.05
[a] Student's t test,
[b] Mann–Whitney U test,
[c] pared-samples t-test,
[d] Paired rank sum test, T0=Preintervention assessment; T2=Postintervention assessment.

improvement in the intervention group's patients' quality of life in this study may be linked to the patients' declining BODE index. Additionally, patients' understanding of the condition has a direct impact on their quality of life, with depression and compliance with pulmonary rehabilitation having a considerable chain mediating influence.[37] This study's cognitive intervention, which is based on social cognitive theory, aids patients in developing accurate disease cognition, ensuring exercise compliance through daily clock-in and weekly follow-up, lowering anxiety and depression, all of which may contribute to the improvement in quality of life seen in this study.

Limitations

This research has several limitations. First, this was a nonrandomized controlled trial, and blinding of investigators and participants was not feasible in this research, which may have skewed the findings. Second, due to personnel, material, and COVID-19 constraints, this study only included patients with moderate to severe COPD who were treated in hospitals, and there is a lack of studies of COPD patients with other degrees of disease in communities and nursing homes, so the findings are limited in their generalizability. Finally, because this study only collected data from the fourth week following the intervention to assess the long-term effect of the intervention, the follow-up time can be extended for additional investigation.

Since this cognitive combined with active cycle of breathing technique developed in this study can have a significant effect on patients with moderate to severe COPD, it is suggested that researchers conduct higher quality and larger sample size randomized controlled trials to demonstrate the findings of this study. Given that this study only included moderate to severe COPD patients who visited the hospital, future studies could include a broader sample. Furthermore, greater study of the duration and applicability of long-term effects, as well as the exploration of potential moderating variables, is recommended.

Conclusion

In conclusion, this study discovered that dyspnea-related kinesiophobia was highly scored in COPD patients. This emphasizes the need of early symptom assessment and treatments. The cognitive intervention based on fear-avoidance model combined with an active cycle of breathing technique can significantly improve kinesiophobia symptoms related to dyspnea in patients with moderate to severe COPD, and the effect remains significant when the intervention time is extended. Furthermore, the program has a beneficial impact on the degree of dyspnea and quality of life, enhancing exercise capacity and lowering the BODE index, which may be extensively employed in clinical practice.

Funding

This work was supported by grants from General Public Welfare Projects of Science and Technology Department of Zhejiang Province of China (LGF20G030009). Study funders were not involved in the study design, data collection, or data analysis.

Ethical consideration

All methods were conducted in accordance with the ethical standards of the Declaration of Helsinki/relevant guidelines and regulations. The ethics committees of the First Affiliated Hospital of Zhejiang University School of Medicine (approval number: Lun Review 2022 Research No. 238) and Haining First People's Hospital accepted the study protocol (approval number: Lun Review 1, 2022). For this study, we obtained written informed consent from the participants before including them.

Authors' contributions

SSC and LHH designed the study and wrote the protocol. SSC, MMH, XYX and XRL planned and implemented the study design. JLY, XLL and YDY reviewed the study instruments and performed the data analysis. SSC wrote the article. All the authors contributed to the conception and design of the study, and all reviewed and approved the final text.

Declaration of competing interest

The authors state that none of the work described in this publication may have been influenced by any known competing financial interests or personal relationships.

CRediT authorship contribution statement

Shasha Cai: Writing – review & editing, Writing – original draft, Supervision, Software, Methodology, Conceptualization. **Jinlan Yao:** Software, Data curation. **Maomao Han:** Methodology, Data curation. **Xiaolin Luo:** Software, Data curation. **Yudi Yu:** Supervision, Investigation. **Xiaorong Lu:** Software, Methodology, Investigation. **Xinyue Xiang:** Supervision, Investigation. **Lihua Huang:** Writing – review & editing, Supervision, Resources, Methodology.

Acknowledgments

Not applicable.

Availability of data and materials

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

References

1. Chronic obstructive pulmonary disease group of Chinese Thoracic Society COPDCoCAoCP. Guidelines for the diagnosis and management of chronic obstructive pulmonary disease (revised version 2021). *Chin J Tuberc Respir Dis*. 2021;44(03):170–205. https://doi.org/10.3760/cma.j.cn112147-20210109-00031.
2. Zhu XM. *Status and Influence Factors of Breathlessness Beliefs of Patients with Chronic Obstructive Pulmonary Disease*. Yangtze University; 2019.
3. Vardar-Yagli N, Calik-Kutukcu E, Saglam M, et al. The relationship between fear of movement, pain and fatigue severity, dyspnea level and comorbidities in patients with chronic obstructive pulmonary disease. *Disabil Rehabil*. 2019;41(18):2159–2163. https://doi.org/10.1080/09638288.2018.1459886.
4. Liu CY, Zhong CF, Luo CF, et al. Study on the occurrence and related factors of motion phobia in patients with chronic obstructive pulmonary disease. *J Xinjiang Med Univ*. 2020;43(10):1328–1331. https://doi.org/10.3969/j.issn.1009-5551.2020.10.013.
5. Saka S, Gurses HN, Bayram M. Effect of inspiratory muscle training on dyspnea-related kinesiophobia in chronic obstructive pulmonary disease: A randomized controlled trial. *Complement Ther Clin Pract*. 2021;44: 101418. https://doi.org/10.1016/j.ctcp.2021.101418.
6. Leeuw M, Goossens M, Linton S, et al. The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. *J Behav Med*. 2007;30(1):77–94. https://doi.org/10.1007/s10865-006-9085-0.
7. Liang FC, Liu MR, Yin YR, et al. Investigation on the development trajectories of exercise fear in patients with chronic obstructive pulmonary disease. *Chin J Nurs*. 2023;58(06):721–726. https://doi.org/10.3761/j.issn.0254-1769.2023.06.012.
8. Beaumont M, Mialon P, Le Ber C, et al. Effects of inspiratory muscle training on dyspnoea in severe COPD patients during pulmonary rehabilitation: controlled randomised trial. *Eur Respir J*. 2018;51(1). https://doi.org/10.1183/13993003.01107-2017.
9. Cutrim ALC, Duarte AAM, Silva-Filho AC, et al. Inspiratory muscle training improves autonomic modulation and exercise tolerance in chronic obstructive pulmonary disease subjects: A randomized-controlled trial. *Respir Physiol Neurobiol*. 2019;263:31–37. https://doi.org/10.1016/j.resp.2019.03.003.

10. Phillips J, Lee A, Pope R, et al. Effect of airway clearance techniques in patients experiencing an acute exacerbation of bronchiectasis: a systematic review. *Physiother Theory Pract*. 2020;36(12):1300–1315. https://doi.org/10.1080/09593985.2019.1579286.
11. Burgel P, Nesme-Meyer P, Chanez P, et al. Cough and sputum production are associated with frequent exacerbations and hospitalizations in COPD subjects. *Chest*. 2009;135(4):975–982. https://doi.org/10.1378/chest.08-2062.
12. Shen M, Li Y, Xu L, et al. Role of active cycle of breathing technique for patients with chronic obstructive pulmonary disease: A pragmatic, randomized clinical trial. *Int J Nurs Stud*. 2021;117: 103880. https://doi.org/10.1016/j.ijnurstu.2021.103880.
13. Ubolnuar N, Tantisuwat A, Mathiyakom W, et al. Effect of pursed-lip breathing and forward trunk lean positions on regional chest wall volume and ventilatory pattern in older adults: An observational study. *Medicine (Baltimore)*. 2022;101(4):e28727. https://doi.org/10.1097/md.0000000000028727.
14. Langer D, Ciavaglia C, Faisal A, et al. Inspiratory muscle training reduces diaphragm activation and dyspnea during exercise in COPD. *J Appl Physiol (Bethesda, Md.: 1985*. 2018;125(2):381–392. https://doi.org/10.1152/japplphysiol.01078.2017.
15. Salehi Derakhtanjani A, Ansari Jaberi A, Haydari S, et al. Comparison the effect of active cyclic breathing technique and routine chest physiotherapy on pain and respiratory parameters after coronary artery graft surgery: a randomized clinical trial. *Anesth Pain Med*. 2019;9(5):e94654. https://doi.org/10.5812/aapm.94654.
16. Pawadshetty V, Munde S, Sureshkumar T, et al. A study to evaluate the effect of ACBT over autogenic drainage technique in COPD patients-a comparative study. 2016. https://doi.org/10.5958/0973-5674.2016.00125.8.
17. Donesky D, Nguyen H, Paul S, et al. The affective dimension of dyspnea improves in a dyspnea self-management program with exercise training. *J Pain Symptom Manag*. 2014;47(4):757–771. https://doi.org/10.1016/j.jpainsymman.2013.05.019.
18. Guo H, Gou YL, Sha LY. Research progress on pain fear psychology in patients with chronic pain. *Chin Nurs Manag*. 2020;20(4):623–627. https://doi.org/10.3969/j.issn.1672-1756.2020.04.030.
19. Aliakbari F, Alipour FM, Tavassoli E, et al. The effect of empowerment program based on the social cognitive theory on the activity of daily living in patients with chronic obstructive pulmonary disease. *J Educ Health Promot*. 2020;9:146. https://doi.org/10.4103/jehp.jehp_752_19.
20. Silva L, Maricoto T, Costa P, et al. A meta-analysis on the structure of pulmonary rehabilitation maintenance programmes on COPD patients' functional capacity. *NPJ Prim Care Respir Med*. 2022;32(1):38. https://doi.org/10.1038/s41533-022-00302-x.
21. Wu Q. Breathlessness beliefs and its effect on functional status in patients with chronic obstructive pulmonary disease abstract. *Peking Union Med Coll*. 2015. https://doi.org/10.7666/d.Y2818597.
22. Locke EA. Social foundations of thought and action: a social cognitive theory. *Acad Manag Rev*. 1987;12(1):169–171. https://doi.org/10.2307/258004.
23. Glanz K, Rimer BK, Lewis FM. Health behavior and health education: theory, research, and practice. *Jossey-Bass*. 1997. https://doi.org/10.1249/00005768-199112000-00016.
24. Mahler DA, Wells CK. Evaluation of clinical methods for rating dyspnea. *Chest*. 1988;93(3):580–586. https://doi.org/10.1378/chest.93.3.580.
25. Guyatt G, Sullivan M, Thompson P, et al. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. *Can Med Assoc J*. 1985;132 (8):919–923. https://doi.org/10.1016/S0065-2423(08)60274-7.
26. Jones PW, Harding G, Berry P, et al. Development and first validation of the COPD assessment test. *Eur Respir J*. 2009;34(3):648–654. https://doi.org/10.1183/09031936.00102509.
27. Dyspnea. Mechanisms, assessment, and management: a consensus statement. American Thoracic Society. *Am J Respir Crit Care Med*. 1999;159(1):321–340. https://doi.org/10.1164/ajrccm.159.1.ats898.
28. Wang Y, Zhang L, Zhu Y, et al. Breathlessness beliefs status and its relation to quality of life in patients with chronic obstructive pulmonary disease. *Pract J Card Cereb Pneumal Vasc Dis*. 2020;28(01):70–74. https://doi.org/10.3969/j.issn.1008-5971.2020.01.010.
29. Hayen A, Herigstad M, Pattinson K. Understanding dyspnea as a complex individual experience. *Maturitas*. 2013;76(1):45–50. https://doi.org/10.1016/j.maturitas.2013.06.005.
30. O'Donnell DE, Milne KM, James MD, et al. Dyspnea in COPD: new mechanistic insights and management implications. *Adv Ther*. 2020;37(1):41–60. https://doi.org/10.1007/s12325-019-01128-9.
31. Chuang H, Chang H, Fang Y, et al. The effects of threshold inspiratory muscle training in patients with chronic obstructive pulmonary disease: a randomised experimental study. *J Clin Nurs*. 2017;26. https://doi.org/10.1111/jocn.13841.
32. Guo JB, Zhu Y. Clinical research progress of inspiratory muscle training. *Chin J Rehabil Med*. 2014;29(09):888–892. https://doi.org/10.3969/j.issn.1001-1242.2014.09.023.
33. Becker LC. Conditions for vasodilator-induced coronary steal in experimental myocardial ischemia. *Circulation*. 1978;57(6):1103–1110. https://doi.org/10.1161/01.cir.57.6.1103.
34. Huo FX, Zhang HR, Yang S, et al. Clinical effect of progressive obstructive respiratory muscle training on respiratory function and motor capacity in patients with chronic obstructive pulmonary disease. *J Jining Med Univ*. 2022;45(01):6–10. https://doi.org/10.3969/j.issn.1000-9760.2022.01.002.
35. Leelarungrayub J, Pinkaew D, Puntumetakul R, et al. Effects of a simple prototype respiratory muscle trainer on respiratory muscle strength, quality of life and dyspnea, and oxidative stress in COPD patients: a preliminary study. *Int J Chron Obstruct Pulmon Dis*. 2017;12:1415–1425. https://doi.org/10.2147/copd.S131062.
36. Medinas-Amorós M, Alorda C, Renom F, et al. Quality of life in patients with chronic obstructive pulmonary disease: the predictive validity of the BODE index. *Chron Respir Dis*. 2008;5(1):7–11. https://doi.org/10.1177/1479972307082329.
37. Tan F, Zhang R, Guo Q, et al. Study on chain mediating effects of pulmonary rehabilitation training compliance and depression on disease cognition affecting quality of life of patients with COPD. *China J Health Psychol*. 2021;29(7):1019–1023. https://doi.org/10.13342/j.cnki.cjhp.2021.07.014.