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Effects of modified pulmonary rehabilitation on patients with moderate to severe chronic obstructive pulmonary disease: A randomized controlled trail

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ABSTRACT

Objectives: This study aimed to assess the effects of modified pulmonary rehabilitation (PR) on patients with moderate to severe chronic obstructive pulmonary disease (COPD).
Methods: A total of 125 patients (63 in the PR group and 62 in the control group) were recruited in this study. The patients in the PR group received 12 weeks of conventional treatment, nursing, and modified pulmonary rehabilitation, while the patients in the control group underwent 12 weeks of conventional treatment, nursing, pursed-lip breathing training, and abdominal breathing training. Baseline characteristics, St. George's Respiratory Questionnaire (SGRQ), the six-minute walk test (6MWT), modified medical research council (MMRC) dyspnea scale, and lung function were compared between the two groups.
Results: A total of 112 patients (58 patients in the PR group and 54 patients in the control group) completed the 12-week monitoring and follow-up. The SGRQ scores, symptoms (54.933 ± 11.900), activity (52.644 ± 14.334), impact (55.400 ± 9.905), and total score (54.655 ± 10.681) of the PR group did not significantly differ in pre- and post-treatments ($P < 0.05$). No significant change was also observed in the control group ($P > 0.05$). 6MWT [(372.089 ± 67.149) m] was significantly improved in the PR group ($P < 0.05$) but was not significantly different in the control group ($P > 0.05$). MMRC (actual rank sum 1719, rank sum 2047.5) was significantly reduced in the PR group ($P < 0.05$) but not in the control group ($P > 0.05$). The lung function (FVC, FEV1, FEV1/FVC, FEV1% and PEF) of the patients in both groups did not significantly change ($P > 0.05$).
Conclusion: Modified PR reduces the symptoms of dyspnea, increases exercise capacity, and improves the quality of life of patients with moderate to severe COPD.

1. Introduction

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) defined chronic obstructive pulmonary disease (COPD) as the limitation of a partially reversible airflow usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases [1]. COPD is a major cause of mortality and morbidity worldwide [2]. This disease causes symptoms of breathlessness, which limits daily activities and consequently reduces quality of life (QoL) [3]. A decreased QoL is indicated as an exacerbated emotional status and is related to fatigue [4]. COPD management aims to improve pulmonary function, prevent deterioration, and enhance QoL [5].

Few guidelines are related specifically to the physiotherapeutic management of COPD. Pulmonary rehabilitation (PR) is defined as a "supervised therapeutic process of restoring a patient's function" [6]. PR is an essential treatment for Patients with COPD [7]. A few statements and guidelines have recommended PR as a first-line management strategy for patients with COPD [8–11]. In China, PR incorporates ventilatory muscle and breathing exercises.

PR usually includes physical exercise, education, psychosocial therapy, and self-management [8,9]. The effectiveness of PR in

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exercise capacity, symptoms, and QoL of patients with COPD have also been investigated [12,13].

Studies have yet to bridge the gaps between PR guidelines and clinical implementation in China. Most of the publications on PR have mostly focused on medications, education, oxygen therapy, breathing exercises, and traditional Chinese exercise [14–16].

This study aimed to incorporate relaxation exercises and extremity muscle training to a conventional PR program and to assess the effects of these exercises on QoL, dyspnea degree, exercise tolerance, and pulmonary function of patients with COPD.

2. Methods

2.1. Study design

This study employed a prospective, randomized, and controlled trial. Participants were recruited from patients in the Department of Respiratory Disease discharged between September 2014 and December 2015 and assigned either to the conventional care group or to the PR group. These were then assessed upon enrollment in the study and after a 12-week intervention.

2.2. Participants

The participants were recruited from the patients admitted in the Department of Respiratory Disease and were discharged by the study's principal investigator. The following inclusion criteria were considered: age >50 years, diagnosed with moderate to severe COPD [moderate, forced expiratory volume in one second (FEV1)/forced vital capacity (FVC) < 70%, 50% ≤ the percentage of FEV1 in FVC (FEV1%) < 80%; severe, FEV1/FVC < 70%, 30% ≤ FEV1% < 50%], presence of a stable condition without infection or exacerbation for more than 4 weeks after hospital discharge, and could walk independently and complete a questionnaire. The following exclusion criteria were determined: severe and unstable cardiac disease, pulmonary bulla, pneumothorax, orthopedic disease, malignant tumor, or mental disorder. The following withdrawal criteria during the 12-week observation were set: inability to complete exercises and acute exacerbation, which was defined as the presentation of productive cough or purulent sputum and worsened shortness of breath or refusal to undergo follow-up visits [17].

2.3. Intervention

The patients in the control and PR groups received conventional drug treatment and nursing care. All of the patients were given an inhaled corticosteroid and an inhaled β-agonist or an anticholinergic agent according to the physicians' prescriptions. Health education included information about COPD, acute exacerbation of symptoms, and benefits of various habits, including smoking cessation, healthy diet, and medication compliance.

2.4. Control group

The control group was given conventional treatment and nursing care combined with breathing exercises incorporating pursed lip breathing and diaphragmatic breathing. Pursed lip breathing involves patients relaxing the muscles in the neck and shoulders, breathing (inhaling) slowly through the nose with no deep breaths, and keeping their mouths closed. During inhalation, the patients puckered or “pursed” their lips as they counted to two. As they exhaled, the patients breathe out through their pursed lips as they counted to four. Diaphragmatic breathing involves slow inhalation through the nose, usually to a count of 10, followed by an exhalation to the same count. Inefficient ventilation during exercise is a key pathophysiological feature of COPD [18]. Respiratory muscle training is an established effective method to increase inspiratory muscle strength [19–21]. These two exercises were repeated by participants five to 10 times, several times a day [22]. A follow-up through telephone was conducted once a week and lasted 12 weeks.

2.5. PR group

Relaxation exercises and extremity muscle training were incorporated in the PR group. Relaxation exercises can increase the SpO_2 of patients with COPD [23]. Extremity muscle training can enhance muscle force and tolerance to hypoxia [24]. The patients in the PR group received conventional treatment and nursing care combined with a 12-week outpatient PR program, including the same pursed lip breathing and diaphragmatic breathing as in the control group. Relaxation exercises are performed in supine position, with slow music, tensing muscles while inhaling and then relaxing muscles while exhaling, starting at the toes and working all the way up to the scalp. These exercises are performed for approximately five minutes, twice a day, before getting out of bed and before falling asleep. Upper extremity muscle training involves slowly lifting the arms while inhaling and lowering the arms while exhaling, 10 repetitions per set for three sets per day. For this exercise, the elbows are then flexed, with fists clenched, and punched obliquely forward alternating fists, inhaling while stretching and exhaling while drawing back, 10 repetitions per set, three sets per day. Finally, lower extremity muscle training involves standing and bending alternating knees to 90°, 10 repetitions per set, three sets per day. Follow-up by telephone was conducted once a week for 12 weeks.

2.6. Quality control

Our study team, supervised by a chest physician, consisted of respiratory nurses, occupational therapists, physiotherapists, a dietician, a psychologist, and social workers. All team members were trained for two weeks and qualified after inspection. The training contents included the screening of study subjects, communication skills with subjects, conventional treatment methods and nursing, methods of PR, collection of data, and methods of follow-up. Patients were instructed to practice the program daily and were supervised by a respiratory therapist in the hospital.

2.7. Measurements and outcomes

General characteristics of patients, such as sex, age, severity, duration, and Barthel index were recorded during the baseline assessment. Four outcome measures are as follows: QoL, level of dyspnea, exercise tolerance, and pulmonary function. Related data were assessed at baseline and again after 12-week intervention. Questionnaires were independently completed by patients.

QoL was assessed using the St. George's Respiratory Questionnaire (SGRQ), a 76-item self-administered disease specific questionnaire for patients with COPD [25]. The translated Chinese language version was used for this study. Scores were calculated for the three domains of symptoms, activity, and impacts (Psycho-social) and for a total score. Scores ranged from 0 to 100, with higher scores indicating poorer health.

The level of dyspnea was assessed through modified medical research council (MMRC) dyspnea scale. The scores of MMRC were determined as: 0 (patients breathless with strenuous exercise), 1 (patients short of breath when hurrying on level ground or walking up a slight hill), 2 (patients walk slower on level ground than people

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of the same age because of breathlessness or have to stop for breath when walking at own pace), 3 (patient stops for breath after walking about 100 yards or after a few minutes on level ground), and 4 (patients too breathless to leave the house or breathless when dressing).

Exercise tolerance was assessed using the six-minute walk test (6MWT). 6MWT was originally designed to measure exercise tolerance in heart disease [26]. 6MWT has also been used in patients with COPD [27]. 6MWT measures the distance by which an individual can walk on a hard, flat surface in six minutes.

The pulmonary function tests performed included FVC, FEV1, ratio of FEV1/FVC, FEV1%, and peak expiratory flow (PEF). Pulmonary function tests were performed every four weeks.

Every patient was asked to record an exercise log that was checked periodically by interdisciplinary team members.

2.8. Sample size calculation

With the assumption that the number of patients of the two groups were equal, the necessary sample size in our study could be calculated as $N1 = N2 = 2\ [(u\alpha+u\beta)\sigma/\delta]2$. δ is defined as the difference between the averages of the PR group and the control group. With the assumption of one-sided 10% α and 80% power, a total of 50 eligible patients were required and observed for one year. With a maximum lost-to-follow-up rate of 20%, the total required sample size was estimated to be around 80 patients.

2.9. Randomization

Patients were randomly assigned to the control group or the PR group. The trail statistician generated the random allocation sequence using the random procedure in SPSS (v16.0, SPSS Inc.), with a 1:1 allocation. Neither the patients nor the data collectors were informed about the group allocation.

2.10. Statistical analysis

Data were entered into Excel software (v2013, Microsoft Inc.) by two research team members independently and checked for accuracy twice by two independent assessors. Data were analyzed using SPSS software (v16.0, SPSS Inc.). Baseline demographic and clinical characteristics of the two groups were compared using two Independent Samples *t*-tests for continuous variables and either a chi square test or Fisher exact test for categorical data comparisons. The degrees of dyspnea (MMRC) were compared by a rank sum test. The quality of life (SGRQ) was tested by RMANOVA. Pre- and post-intervention data were compared using paired Student *t*-test. Statistical significance was set at $P < 0.05$.

2.11. Ethical aspects

This study was approved by the Ethics Committee of The Third Affiliated Hospital of Soochow University. This study complied with the principles of the Declaration of Helsinki and Good Clinical Practice guidelines.

3. Results

3.1. Patient baseline characteristic

A total of 125 patients with COPD discharged from the Department of Respiratory Diseases of The Third Affiliated Hospital of Soochow University between September 2014 and December 2015 were enrolled in the study. Of the 125 patients recruited, a total of 112 completed the 12-week study period and were used in the data analysis (Fig. 1). In the PR group, two patients had an acute exacerbation or symptoms and three patients did not complete the PR program as required. In the control group, three patients had an acute exacerbation of symptoms, two patients did not complete the PR program as required, and three patients refused follow-up. The data of the 112 patients were collected for statistical analyses. Patients' baseline characteristics are presented in Table 1. No significant difference exists between the baseline data of SGRQ scores, MMRC scores, 6MWT scores or pulmonary function of the two groups ($P > 0.05$).

3.2. Intra-group assessment pre- and post-intervention

The SGRQ score (Symptoms, Activity and Impacts and total score) was significantly lower in pre-intervention than in post-intervention ($P < 0.05$) in the PR group but not in the control group ($P > 0.05$). The MMRC score was statistically significantly lower pre-intervention than post-intervention ($P < 0.05$) but not in the control group ($P > 0.05$). Walking distance results from the 6MWT were significantly longer pre-intervention than post-intervention ($P < 0.01$) in the PR group but not in the control group ($P > 0.05$).

No statistically significant differences were observed between pre-intervention and post-intervention pulmonary function in either PR group or the control group ($P > 0.05$). See Tables 2–5 for detailed data.

3.3. Inter-group assessment between the PR group and control group

After intervention, the SGRQ (Symptoms, Activity and Impacts and total score) and MMRC scores were significantly lower in the PR group than in the control group ($P < 0.01$). After intervention, the distance of the 6MWT was significantly longer in the PR group than in the control group ($P < 0.01$). After intervention, no statistically significant difference was observed in the pulmonary function results between the PR group and the control group ($P > 0.05$). See Tables 6 and 7 for detailed data.

4. Discussion

This randomized controlled study aimed to determine the beneficial effect of a modified PR. Breath exercises, relaxation exercises, and extremity muscle training were combined with conventional care to improve the care of patients with moderate to severe COPD. After 12 weeks, the modified pulmonary rehabilitation program was associated with a significant improvement in QoL, dyspnea level, and exercise tolerance but not with pulmonary function.

After adjustment was performed for baseline values, the QoL scores significantly differed between pre- and post-intervention in the PR group. The QoL scores of the PR and control groups also significantly differed. These differences have been detected in varying degrees in previous studies in response to pulmonary rehabilitation in patients with COPD [28].

Exercise tolerance measured by 6MWT and dyspnea level determined through MMRC were significantly improved after 12 weeks of modified PR. Cheng et al. [29] observed significant improvements in maximal exercise performance after 12 weeks of exercise twice a week. Altenburg et al. demonstrated that four variables are correlated with an improvement in endurance exercise capacity after 7 weeks of exercise in patients with COPD [30]. In three other studies, the tidal volume and respiratory rate of participants trained at a high intensity (70%–80% maximum workload) significantly change [31–33]. Sundararajan et al. investigated the

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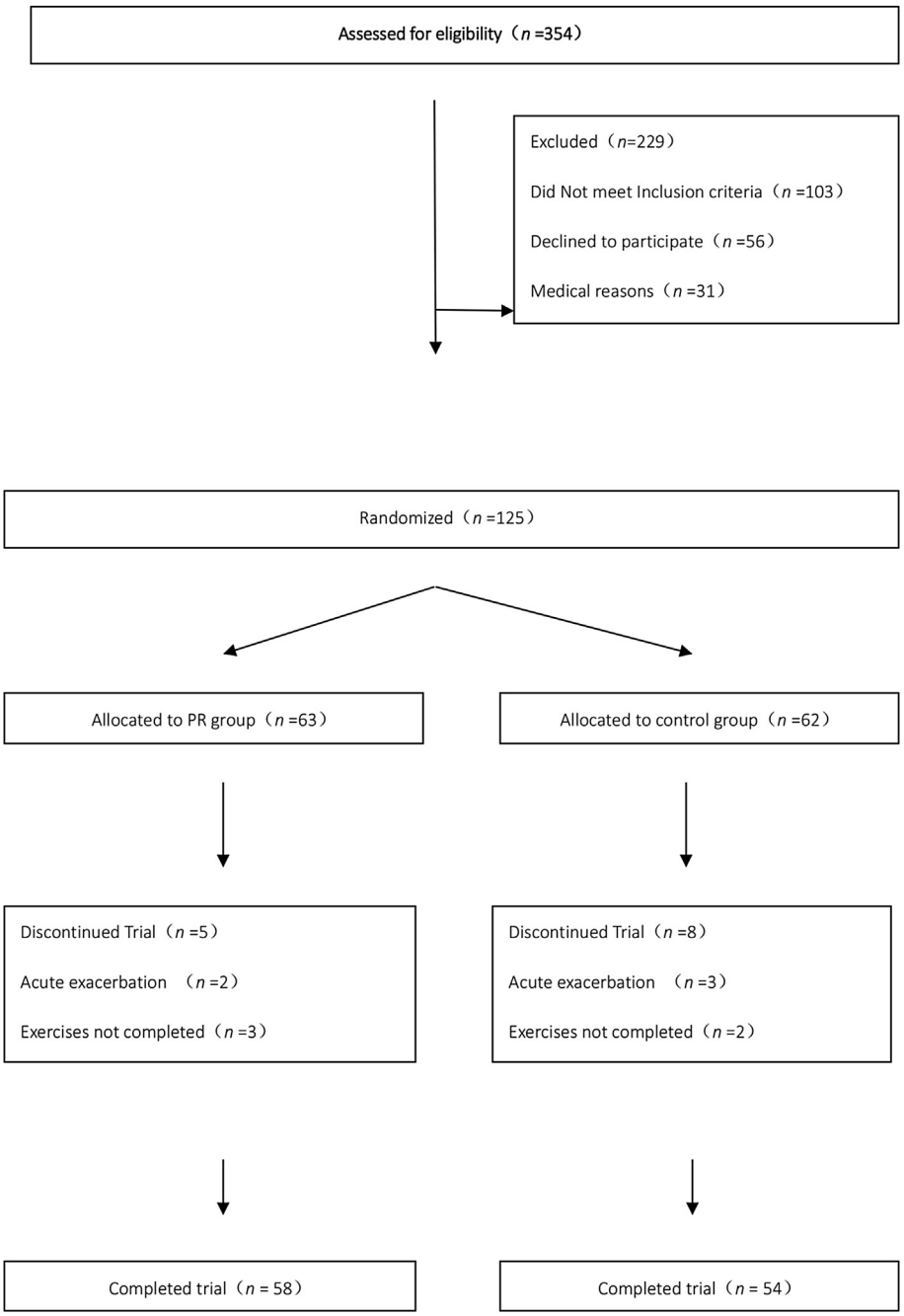

Fig. 1. Flowchart of the trial.

Table 1
Baseline data comparison of two groups.

Group	Age (yr)	Sex [n (%)]		GOLD grade [n (%)]			Duration of disease (yr,Mean ± SD)	Barthel index (Mean ± SD)
		Male	Female	Moderate	Severe	Very severe		
Control ($n = 54$)	68.1 ± 9.3	43 (80.0)	11 (20)	23 (42.6)	20 (37.0)	11 (20.4)	20.6 ± 15.9	89.3 ± 13.7
PR ($n = 58$)	68.9 ± 8.2	50 (86.2)	8 (13.8)	23 (39.7)	23 (39.7)	12 (20.6)	20.8 ± 16.9	84.5 ± 15.1
$t/\chi^2/Z$	−0.403	0.569		0.066			−0.273	0.713
P	0.689	0.451		0.968			0.761	0.239

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Table 2
Intra-group comparisons between the SGRQ scores pre- and post-intervention.

Group	Pre-intervention	Post-intervention	*t*	*P*
Control ($n = 54$)				
Symptoms	61.791 ± 10.414	61.093 ± 10.607	0.816	0.417
Activity	60.814 ± 14.817	61.860 ± 14.857	−0.596	0.553
Impacts	60.535 ± 8.776	60.674 ± 9.365	0.084	0.933
Total	61.086 ± 9.907	61.268 ± 10.280	−0.075	0.940
PR ($n = 58$)				
Symptoms	60.111 ± 11.050	54.933 ± 11.900	2.728	0.008
Activity	58.333 ± 14.206	52.644 ± 14.334	2.207	0.030
Impacts	60.978 ± 9.486	55.400 ± 9.905	2.916	0.005
Total	60.162 ± 10.312	54.655 ± 10.681	2.525	0.013

Table 3
Intra-group comparisons between the MMRC scores pre- and post-intervention.

Group	Pre-intervention	Post-intervention	*Z*	*P*
Control ($n = 54$)				
Median	2.0	1.0		
IQR	(1.0, 2.5)	(1.0, 2.0)	0.224	0.822
Actual rank sum	1895	1846		
Rank sum	1870.5	1870.5		
PR ($n = 58$)				
Median	2.0	2.0		
IQR	(1.0, 3.0)	(1.0, 3.0)	2.804	0.005
Actual rank sum	2376	1719		
Rank sum	2047.5	2047.5		

Table 4
Intra-group comparisons between the 6MWT pre- and post-intervention.

Group	Pre-intervention	Post-intervention	*t*	*P*
Control ($n = 54$)	312.488 ± 62.460	300.954 ± 61.065	0.866	0.389
PR ($n = 58$)	315.267 ± 61.838	372.089 ± 67.149	−4.176	0.000

specific effect of a 6-week outpatient PR program and found an improvement in walking distance, dyspnea score, and health status [34].

Other investigators have examined whether or not PR can enhance exercise capacity. Differences in results may be due to variations in patient selection, interventions, outcome measures, and statistical methods. Garrod et al. investigated the effects of a 7-week PR, measured 6MWT for exercise capacity, and observed no changes in exercise capacity [35]. Plankeel et al. indicated that the benefits of PR depends on the initial factors that limit exercise [36]. Our findings vary from previous results possibly because of differences in sample sizes, population, and study settings.

In addition to exercise training, progressive relaxation was included in the PR program. Anxiety is a common comorbid condition in patients with COPD, and this condition can intensify symptom perception [37]. Singh et al. found that progressive muscle relaxation effectively reduces anxiety, dyspnea, and physiologic measures, such as systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate(HR), and respiratory rate (RR), in patients with COPD [38].

No significant difference was observed in pre- and post-intervention and between the two groups in our study. Littlejohns et al. also revealed that no significant difference exists in the predicted change in FEV1% [39]. Bavarsad et al. [40]showed a significant decline in the mean FEV1% predicted in the control group.

Some limitations remain in our study. The intervention for the PR group lasted only 12 weeks. As a result, the long-term effect of PR on patients with COPD was not observed. The time points of data collection were pre-enrollment and 12 weeks after pre-enrollment. Additional time points might reflect the short-term, intermediate, and long-term effects of PR. Furthermore, a real-time heart rate and degree of blood oxygen saturation were not collected during the intervention. In future studies, vital signs can be monitored to obtain additional information. Intervention approaches for patients with different degrees of COPD were similar. As such, intervention approaches should be varied.

Our study demonstrated that PR is an effective treatment to alleviate dyspnea symptoms in patients with COPD, increase their exercise capacity, and improve their QoL.

Table 5
Intra-group comparisons between pulmonary function pre- and post-intervention.

Group	FVC (L)	FEV1 (L)	FEV1/FVC (%)	FEV1%	PEF (L/min)
Control ($n = 54$)					
Pre-intervention	2.006 ± 0.627	1.081 ± 0.426	52.952 ± 8.762	44.696 ± 14.079	2.543 ± 1.110
Post-intervention	2.052 ± 0.598	1.073 ± 0.410	52.044 ± 9.049	45.314 ± 13.976	2.560 ± 1.101
t	−0.530	−1.000	1.845	−0.865	−0.255
P	0.599	0.323	0.072	0.392	0.800
PR ($n = 58$)					
Pre-intervention	1.868 ± 0.520	1.032 ± 0.378	54.598 ± 10.288	46.235 ± 14.645	2.491 ± 1.081
Post-intervention	1.974 ± 0.580	1.088 ± 0.417	54.789 ± 10.330	47.574 ± 14.463	2.441 ± 0.923
t	−0.829	−1.00	−0.273	−1.558	0.752
P	0.411	0.323	0.786	0.126	0.456

Table 6
Inter-group comparisons of the SGRQ scores and 6MWD variety in the PR and control groups post-intervention.

Group	SGRQ (score)				6MWT (m)
	Symptoms	Activity	Impacts	Total score	
Control ($n = 54$)	0.698 ± 2.932	−1.047 ± 4.467	−0.140 ± 2.965	−0.181 ± 1.917	−56.822 ± 8.448
PR ($n = 58$)	5.178 ± 2.773	5.689 ± 3.197	5.578 ± 3.450	5.507 ± 1.866	11.535 ± 14.006
t	4.860	5.034	3.877	6.598	7.614
P	0.000	0.000	0.000	0.000	0.000

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Table 7
Inter-group comparisons of pulmonary function and MMRC variety in the PR and control groups post-intervention.

Group	Pulmonary function					MMRC			
	FVC (L)	FEV1 (L)	FEV1/FVC (%)	FEV1% (%)	PEF (L/min)	Media(n)	IQR	Actual rank sum	Expected rank sum
Control ($n = 54$)	−0.046 ± 0.323	0.009 ± 0.146	0.908 ± 3.010	−0.618 ± 4.149	−0.017 ± 0.516	1.0	(1.0, 2.0)	1509	1913.5
PR ($n = 58$)	−0.106 ± 0.372	−0.056 ± 0.198	−0.191 ± 4.930	−1.339 ± 5.918	0.050 ± 0.683	2.0	(1.0, 3.0)	2407	2002.5
t/Z	−305	0.255	1.748	1.535	−0.614	3.944			
P	0.762	0.800	0.088	0.132	0.542	0.001			

Conflict of interest

None.

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References

[1] Rabe KF, Hurd S, Anzueto A, Barnes PJ, Buist SA, Calverley P, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med 2007;176(6):532–55.
[2] Chapmann KR, Mannino DM, Soriano JB, Vermeire PA, Buist AS, Thun MJ, et al. Epidemiology and costs of chronic obstructive pulmonary disease. Eur Respir J 2006;27(1):188–207.
[3] Lilholt PH, Witt Udsen F, Ehlers L, Hejlesen OK. Telehealthcare for patients suffering from chronic obstructive pulmonary disease: effects on health-related quality of life: results from the Danish 'TeleCare North' cluster-randomised trial. BMJ Open 2017 May 9;7(5):e014587.
[4] Engstrom CP, Persson LO, Larsson S, Sullivan M. Health-related quality of life in COPD: why both diseasespecifc and generic measures should be used. Eur Respir J 2001;18(1):69–76.
[5] McKenzie DK, Abramson M, Crockett AJ, Glasgow N, Jenkins S, McDonald C, et al. The COPD-X plan: Australian and New Zealand guidelines for the management of chronic obstructive pulmonary disease 2007. Med J Aust 2003;178(Suppl):S7–39.
[6] IMPRESS (BTS and PCRS-UK). IMPRESS guide to pulmonary rehabilitation. Retrieved from: http://www.haringey.gov.uk/sites/haringeygovuk/files/impress_pulmrehab_191211_lres_1_-2.pdf; 2011.
[7] Bolton CE, Bevan-Smith EF, Blakey JD, Crowe P, Elkin SL, Garrod R, et al. British Thoracic Society guideline on pulmonary rehabilitation in adults. Thorax 2013;68(suppl 2). ii1–30.
[8] Rochester CL, Vogiatzis I, Holland AE, Lareau SC, Marciniuk DD, Puhan MA, et al. An official American thoracic society/European respiratory society policy statement: enhancing implementation, use, and delivery of pulmonary rehabilitation. Am J Respir Crit Care Med 2015;192(11):1373–86.
[9] Ries AL, Bauldoff GS, Carlin BW, Casaburi R, Emery CF, Mahler DA, et al. Pulmonary rehabilitation, joint ACCP/AACVPR evidence-based clinical practice guidelines. Chest 2007;131(5 Suppl):4S–42S.
[10] Moore E, Newson R, Joshi M, Palmer T, Rothnie KJ, Singh S, et al. Effects of pulmonary rehabilitation on exacerbation number and severity in people with COPD: an historical cohort study using electronic health records. Chest 2017 [Epub ahead of print].
[11] Hogg L, Garrod R, Thornton H, McDonnell L, Bellas H, White P. Effectiveness, attendance, and completion of an integrated, system-wide pulmonary rehabilitation service for COPD: prospective observational study. COPD 2012;9(5):546–54.
[12] Lacasse Y, Goldstein R, Lasserson T, Martin S. Pulmonary rehabilitation for chronic obstructive pulmonary disease. Cochrane Database Syst Rev 2006;(4):CD003793.
[13] Ghanem M, Elaal EA, Mehany M, Tolba K. Home-based pulmonary rehabilitation program: effect on exercise tolerance and quality of life in chronic obstructive pulmonary disease patients. Ann Thorac Med 2010;5(1):18–25.
[14] Yan J, Wang L, Liu C, Yuan H, Wang X, Yu B, et al. Effect of a hospital outreach intervention programme on decreasing hospitalisations and medical costs in patients with chronic obstructive pulmonary disease in China: protocol of a randomised controlled trial. BMJ Open 2016;6(6):e009988.
[15] Luo X, Zhang J, Castelberg R, Wu T, Yu P, He C, et al. The effects of traditional Chinese exercise in patients with chronic obstructive pulmonary disease: a meta-analysis. PLoS One 2016;11(9):e0161564.
[16] Fu JJ, Min J, Yu PM, McDonald VM, Mao B. Study design for a randomised controlled trial to explore the modality and mechanism of Tai Chi in the pulmonary rehabilitation of chronic obstructive pulmonary disease. BMJ Open 2016;6(8):e011297.
[17] Anthonisen NR, Manfreda J, Warren CP, Hershfield ES, Harding GK, Nelson NA. Antibiotic therapy in exacerbations of chronic obstructive pulmonary disease. Ann Intern Med 1987;106(2):196–204.
[18] Neder JA, Arbex FF, Alencar MC, O'Donnell CD, Cory J, Webb KA, et al. Exercise ventilatory inefficiency in mild to end-stage COPD. Eur Respir J 2015;45(2):377–87.
[19] Leelarungrayub J, Pinkaew D, Puntumetakul R, Klaphajone J. 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;12:1415–25.
[20] Dellweg D, Reissig K, Hoehn E, Siemon K, Haidl P. Inspiratory muscle training during rehabilitation in successfully weaned hypercapnic patients with COPD. Respir Med 2017;123:116–23.
[21] Crisafulli E, Costi S, Fabbri LM, Clini EM. Respiratory muscles training in COPD patients. Int J Chron Obstruct Pulmon Dis 2007;2(1):19–25.
[22] Beauchamp MK, Janaudis-Ferrerira T, Goldstien RS, Brooks D. Optimal duration of pulmonary rehabilitation for individuals with COPD - a systematic review. Chron Respir Dis 2011;8(2):129–40.
[23] Volpato E, Banfi P, Rogers SM, Pagnini F. Relaxation techniques for people with chronic obstructive pulmonary disease: a systematic review and a meta-analysis. Evid Based Complement Altern Med 2015;2015:628365.
[24] Borghi-Silva A, Arena R, Castello V, Simões RP, Martins LE, Catai AM, et al. Aerobic exercise training improves autonomic nervous control in patients with COPD. Respir Med 2009;103(10):1503–10.
[25] Punekar YS, Sharma S, Pahwa A, Takyar J, Naya I, Jones PW. Rescue medication use as a patient-reported outcome in COPD: a systematic review and regression analysis. Respir Res 2017;18(1):86.
[26] Diniz LS, Neves VR, Starke AC, Barbosa MPT, Britto RR, Ribeiro ALP. Safety of early performance of the six-minute walk test following acute myocardial infarction: a cross-sectional study. Braz J Phys Ther 2017;21(3):167–74.
[27] Meriem M, Cherif J, Toujani S, Ouahchi Y, Hmida AB, Beji M. Sit-to-stand test and 6-min walking test correlation in patients with chronic obstructive pulmonary disease. Ann Thorac Med 2015;10(4):269–73.
[28] Fuchs-Climent D, Le Gallais D, Varray A, Desplan J, Cadopi M, Préfaut CG. Factor analysis of quality of life, dyspnea, and physiologic variables in patients with chronic obstructive pulmonary disease before and after rehabilitation. Am J Phys Med Rehabil 2001;80(2):113–20.
[29] Cheng ST, Wu YK, Yang MC, Huang CY, Huang HC, Chu WH, et al. Pulmonary rehabilitation improves heart rate variability at peak exercise, exercise capacity and health-related quality of life in chronic obstructive pulmonary disease. Heart Lung 2014;43(3):249–55.
[30] Altenburg WA, de Greef MH, ten Hacken NH, Wempe JB. A better response in exercise capacity after pulmonary rehabilitation in more severe COPD patients. Respir Med 2012;106(5):694–700.
[31] Gigliotti F, Coli C, Bianchi R, Romagnoli I, Lanini B, Binazzi B, et al. Exercise training improves exertional dyspnea in patients with COPD: evidence of the role of mechanical factors. Chest 2003;123(6):1794–802.
[32] Skumlien S, Skogedal EA, Bjørtuft O, Ryg MS. Four weeks' intensive rehabilitation generates significant health effects in COPD patients. Chron Respir Dis 2007;4(1):5–13.
[33] Ramponi S, Tzani P, Aiello M, Marangio E, Clini E, Chetta A. Pulmonary rehabilitation improves cardiovascular response to exercise in COPD. Respiration 2013;86(1):17–24.
[34] Sundararajan L, Balami J, Packham S. Effectiveness of outpatient pulmonary rehabilitation in elderly patients with chronic obstructive pulmonary disease. J Cardiopulm Rehabil Prev 2010;30(2):121–5.
[35] Garrod R, Marshall J, Barley E, Jones PW. Predictors of success and failure in pulmonary rehabilitation. Eur Respir J 2006;27(4):788–94.
[36] Plankeel JF, McMullen B, MacIntyre NR. Exercise outcomes after pulmonary rehabilitation depend on the initial mechanism of exercise limitation among non-oxygen-dependent COPD patients. Chest 2005;127(1):110–6.
[37] Halpin D, Hyland M, Blake S, Seamark C, Pinnuck M, Ward D, et al. Understanding fear and anxiety in patients at the time of an exacerbation of chronic obstructive pulmonary disease: a qualitative study. JRSM Open 2015;6(12). 2054270415614543.
[38] Singh VP, Rao V, Prem V, Sahoo RC, Keshav Pai K. Comparison of the effectiveness of music and progressive muscle relaxation for anxiety in COPD–a randomized controlled pilot study. Chron Respir Dis 2009;6(4):209–16.
[39] Kaymaz D, Candemir İÇ, Ergün P, Demir N, Taşdemir F, Demir P. Relation between upper-limb muscle strength with exercise capacity, quality of life,

and dyspnea in patients with severe chronic obstructive pulmonary disease. Clin Respir J 2017.
[40] Bavarsad MB, Shariati A, Eidani E, Latifi M. The effect of home-based inspiratory muscle training on exercise capacity, exertional dyspnea and pulmonary function in COPD patients. Iran J Nurs Midwifery Res 2015;20(5): 613–8.

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