Original Article

Combined Effect of Respiratory Muscle Stretching and Active Cycle of Breathing Technique on Kinesiophobia, Functional Capacity and Anxiety among Chronic Obstructive Pulmonary Disease Patients

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ABSTRACT

Background: COPD causes chronic airflow limitation and dyspnea, reducing function and quality of life. Objective: To evaluate the combined effect of the Active cycle Breathing Technique (ACBT) with Respiratory Muscle Stretching (RMS) on kinesiophobia, functional capacity and anxiety among Chronic Obstructive Pulmonary Disease (COPD) patients. Methods: This randomized controlled trial was conducted at Arif Memorial Teaching Hospital in Lahore. Forty Patients with COPD moderate to severe were randomly assigned into group A and group B (n=20 each). Group A received active cycle breathing technique (ACBT), alone and Active cycle Breathing Technique with Respiratory Muscle Stretching (RMS) was received by Group B. The Tampa kinesiophobia scale Questionnaire was used to evaluate kinesiophobia. The functional capacity was assessed by 6-minute walk test, and hospital anxiety and depression were used to assess anxiety. Results: Both groups showed significant with-in group improvements in kinesiophobia, functional capacity and anxiety with p-value < 0.05. Between group analysis showed that there is greater improvement in ACBT combined with RMS compared to ACBT alone with p-value < 0.05. Conclusion: This trial concluded that the combination of ACBT and respiratory muscle stretching could be a promising intervention for COPD patients, offering a potential solution to the challenges of kinesiophobia, reduced functional capacity, and anxiety.

Keywords: *Chronic Obstructive Pulmonary Disease, Active Cycle of Breathing Technique, Respiratory muscle stretching, Tampa Scale Kinesiophobia, Functional Capacity*

Clinical Trial Registry: *IRCT20220604055072N1*

INTRODUCTION

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Chronic obstructive pulmonary disease (COPD) is a preventable and treatable dysfunction of lungs in which there is limitation in airflow, airway and alveoli caused by continuous exposure to noxious gases over long period of time (1). COPD is quite prevalent as its ranges between 7.8% and 13% depending on whether screening among smokers or population-based studies is considered (2).

As compared to 40-49 year-aged people, people with age 50 to 69 years were two to five times more capable of developing COPD, respectively. Some other factors contribute to

development and progression of COPD including tobacco smoking or chewing, and if anyone has history of asthma, they have higher probability of developing COPD. Considering gender and socioeconomic status, Male and low socioeconomic status were also the risk factors of the COPD (2).

The hallmark symptoms include sputum production, dyspnea, and cough. Many patients may experience an exacerbation requiring additional therapy (3). Among these symptoms dyspnea is the most distressing and the American Thoracic Society defines dyspnea as "a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity" (4).

Persistent dyspnea often leads to dyspnea-related kinesiophobia, avoiding activities associated with dyspnea (5). Kinesiophobia is the fear of activity and movement leading from a feeling of vulnerability to re-injury. Dyspnea, functional capacity, and quality of life are all highly positively related with degree of kinesiophobia in COPD patients (6). Physiologically many factors may, therefore, increase symptom severity hence reduces quality of life. High rate breathing may stimulates brain activity at rate higher which triggers the sympathetic nervous system that leads to accelerate stress hormones secretion, sweat production, increase heart rate, blood pressure, muscle tension and anxiety (7). This interaction between respiratory mechanics, psychological responses, and physical deconditioning highlights the importance of comprehensive rehabilitation approaches.

The Active Cycle of Breathing Techniques (ACBT) is one method which helps to clear sputum from lungs. These are set of breathing exercises that loosen the sputum and then move it from airways (1). Respiratory muscle stretching is also suggested to increase lung expansion, improving ventilator patterns and reduce chest wall rigidity in COPD patients (8). Although there is known clinical use of ACBT and proposed physiological benefits by RMS, few randomized controlled trials are available in literature related to whether RMS added to ACBT is more significant than ACBT alone in terms of improvement in kinesiophobia, function capacity, and anxiety in patients with COPD. The study aims to determine the combined effect of the Active cycle Breathing Technique with Respiratory Muscle Stretching on kinesiophobia, functional capacity and anxiety among patients with Chronic Obstructive Pulmonary Disease.

MATERIAL AND METHODS

Study Design: This clinical trial was randomized, single blinded with parallel group allocation, approved by the Institutional Ethical Review Board of Rashid Latif Medical College. This trial was registered at the Iranian registry of clinical trials (IRCT20220604055072N1) prospectively, prior to participants requirement. The study was conducted in accordance with the Declaration of Helsinki and followed by consort guidelines. A detailed flow chart is included (Figure I), providing a clear overview of the study's methodology.

Sample size: The total sample size calculation was done by using the WHO calculator (12.2.2 version). Based on published data (Saka et al., 2021) the Mean value of group A was 39.80, the Mean value of group B was 43.00, the Population variance was 43.2964, the Level of significance was 1.96, and the power of the test was 90. The sample size calculated was 38 participants, accounting for potential attrition.

Participants' Selection: Participants were recruited using convenience sampling from Arif memorial Teaching Hospital, Lahore. The eligible participants included were adults over 40 years old with moderate-to-severe COPD diagnosed defined according to Global initiative for

chronic obstructive lung disease (GOLD) criteria. These patients had clinical stability defined as no exacerbations, no medication changes or hospitalization over the previous month and did not require additional oxygen. Exclusion Criteria included Patients with a history of cognitive abnormalities or comorbidities that interfered with their ability to walk or engage in activities (such as severe neurological or heart conditions, cancer, and musculoskeletal problems). Before the commencement of the intervention, the participants were provided with an overview of the study's protocol, cultural norms, and values. They were also told of the benefits and drawbacks of the circumstances, and they received assurances that their information would remain private and confidential. Written informed consent was obtained prior to enrollment.

Randomization and Allocation: After the baseline evaluation, the participants were randomly assigned in a 1:1 ratio to either of the two groups using a random sequence generated by a computer and prepared by an independent researcher who did not take part in the recruitment and evaluation of the study. The randomization was concealed using opaque, sealed, and numbered envelopes. A total of 40 participants was randomized, of whom 38 were analyzed: 19 in each group. Two dropped out before the post-intervention assessment for personal reasons, as shown in the CONSORT flow diagram. All recruited participants were analyzed in the study.

Outcomes: The Tampa Scale (TSK) is a scale with high retest reliability and validity and was used to assess kinesiophobia. There are 17 items marked on a 4-point Likert scale: strongly disagree, disagree, agree and strongly agree. The scores for questions 4, 8, 12, and 16 are reversed. The scores 17 to 68 points, indicates stronger Kinesiophobia (9).

The 6-meter walk Test (6MWT) is a safe test with rare complications according to American Thoracic Society guidelines. Outcomes were recorded as 6-minute walk distance (6MWD) in meters, treated as a continuous variable. The 0 points represents > 350 m, 1 point represents 250 to 349 m, 2 points shows 150 to 249 m, and 3 points represents ≤ 149 m (10).

The Hospital Anxiety and Depression Scale (HADS) have subscales for the evaluation of anxiety and depression, respectively. There are seven items for each subscale that evaluate the frequency and intensity of symptoms in the last week, with scores ranging from 0 (for example, not at all, only occasionally, and so on) to 3 (for example, very much indeed, most of the time, and so on).

There are six items related to anxiety and one question related to panic in the Anxiety subscales (HADS-A). The scores range from 0 to 21, and a score above 8 denotes the presence of significant Anxiety Symptoms. Minimal Clinically Important Difference (MCID) of 1.5 has been established in patients with COPD (11). Only the anxiety subscale was analyzed, consistent with the study objectives.

Treatment Protocol: Both groups underwent supervised 30-minute sessions, three times per week for two weeks, conducted by a licensed physiotherapist. There was no home program prescribed, with attendance for each session recorded.

Group A: Active Cycle Breathing Exercise Group B: Active Cycle Breathing Exercise + Respiratory Stretching Exercise (Pectoralis Major, Pectoralis Minor, Upper Trapezius, Scalene, Sternocleidomastoid, Intercostal and anterior serratus)

The investigator started the intervention with 30-minute sessions, three sessions/per week for two weeks. Active Cycle Breathing Exercise (ACBT) consists of three stages: breathing control, thoracic expansion exercises, and the forced expiration technique in gravity-assisted positions. The first stage involves breathing control and is referred to as tidal volume

breathing with the lower chest with a relaxed chest and upper back. The second stage involves thoracic expansion exercises, with deep breathing practices with an emphasis on inspiration. This is an active process; however, expiration occurs passively. This cycle ends with the forced expiration method of huffs and breathing control (12). A huff aimed at a low volume of lungs will remove secretions more located outward, while a huff aimed at a high volume of lungs will remove secretions near the airways (13).

Respiratory muscle stretching: These were all done by clinical physical therapist. Participants were supine with knees flexed to correct the curvature of lumbar, with repositioned scapular waist and scapular and arm abduction to avoid compensation. The Stretching was done on both sides. For Upper trapezius stretching, the participant was in a supine position with side bending of the head to the opposite side of that stretch, while the support to the occipital region with one hand and the shoulder with the other hand was provided by physical therapist. For Sternocleidomastoid stretching, the participant was in a supine position with side bending and rotation of the head to the opposite side of that stretch; the physical therapist displaced hands in the cranial to caudal direction as hands was on the occipital region and sternal region, For Scalene stretching, the supine position is maintained by participant, the physical therapist promoted displacement as in previous stretching. For Pectoralis major stretching, the subject retained the supine position, one arm of the participant was abducted, the forearm flexed, and the hand on the occipital area; this movement was carried out with one hand on the upper third region of the arm and the other hand on the lateral portion of the upper chest region. For Serratus Anterior stretching, the patient remained in a lateral position on a half-moon-shaped foam in the infra-axillary region, with flexed forearms and hands positioned on the occipital region; this stretching involved the use of two palmar region hands to move the ribs in a cranial to caudal position during inspiration and in expiration phases. For intercostals muscle stretching, a side stretch approach in a lateral decubitus position during inspiration was used; during expiration, observations followed rib movement (14). The stretching exercises were conducted on the exhale while stretching each muscle, with 2 sets of 10 reps on each stretch, rest interval of one minute, and closely observed to ensure safety. No adverse events were reported during and after the treatment period.

Data Analysis: The data analysis software used was SPSS version 22. The demographics of the participants were demonstrated using descriptive statistics. To assess normality Kolmogorov's Smirnov test was used, and the statistics indicated normal distribution of the data with a p-value>0.05. Paired t-tests were utilized for parametric analysis of the pretest post-analysis of Kinesiophobia, Functional Capacity, and Anxiety before and after therapy within each group. The study employed an independent sample t-test to calculate the differences between the groups under investigation. Mean differences were considered significant at a 95% confidence interval (CI) and a 5% probability level (p-value 0.05).

RESULTS

Demographics: A total of 40 participants were included initially, of which 38 participants were eligible for the study. Two participants withdrew from the study for personal reasons that were unrelated to the intervention as shown in the CONSORT Diagram (Figure 1). There were 19 males in group A and 17 in group B. Active Cycle Breathing Exercise with Respiratory muscle stretching). The socio-demographic data of participants is represented in Table 1. No adverse events or intervention-related complications were reported in either group during the study period.

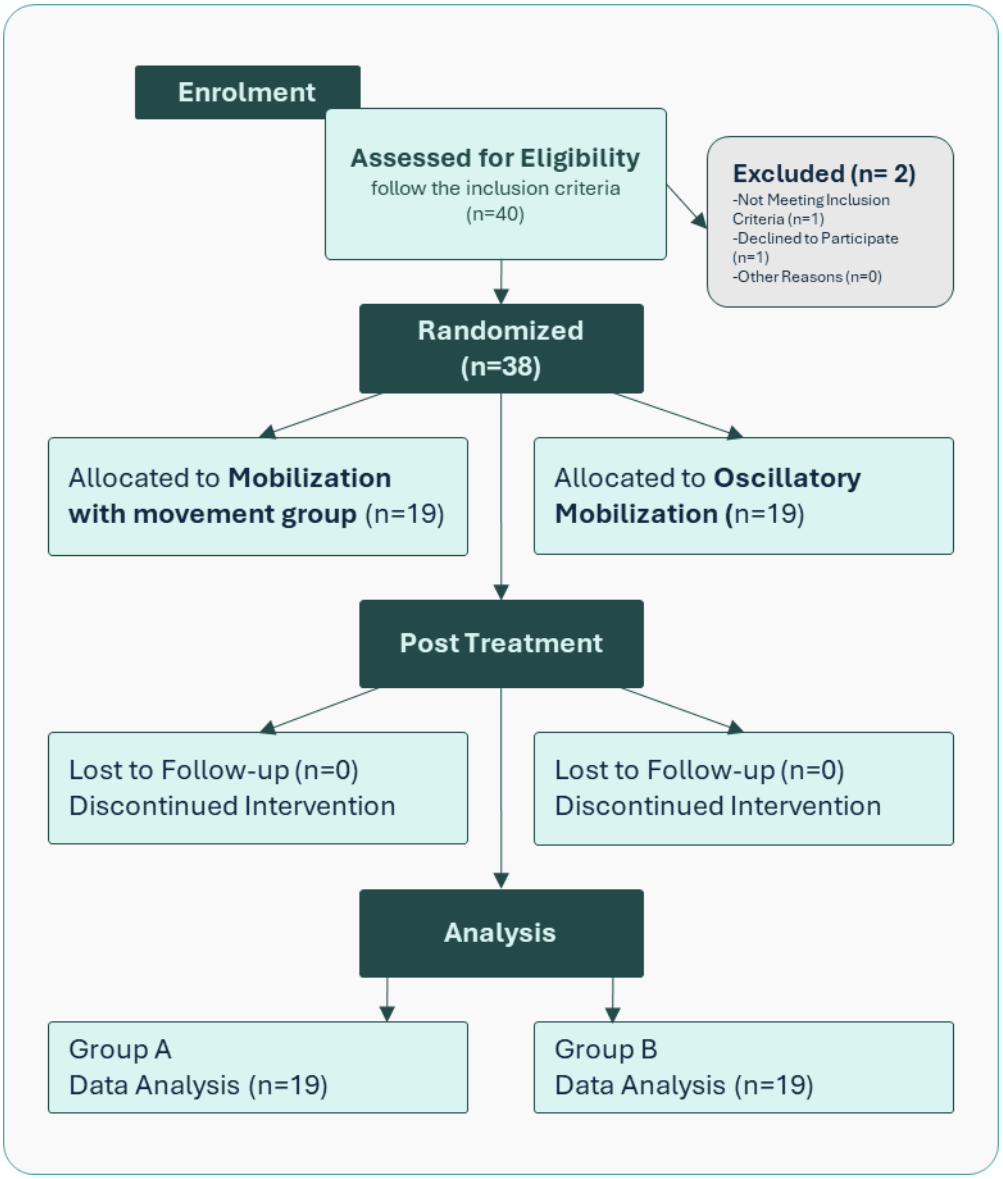

Figure 1 Participants Enrolment, Follow up and Analysis.

Within Group Comparison for Kinesiophobia, Functional Capacity, and Anxiety: The pre- and post-value of Kinesiophobia of Group A and Group B showed significant difference with p-value <0.05. There is a significant difference between the pre- and post-value of the Functional Capacity of Group A and Group B with p-value <0.05. The pre- and post-value of Anxiety of Group A and Group B showed significant difference with p-value <0.05. (Table 2)

Table 1: Demographics profile of participants

Demographics	Demographics	Group A (ACBT)	Group B (ACBT + RMS)	P –value
Gender	Male	19	17	0.154
	Female	0	2	
Socioeconomic Status	Low class	16	16	1.000
	Middle Class	3	3	
Body Mass Index	Under weight	2	0	0.450
	Normal	4	7	
	Overweight	2	6	
	Obesity Class I	7	3	
	Obesity Class II	3	3	
	Obesity Class III	1	0	
Age		55.368	55.842	0.888
Height in meters		1.567	1.536	0.407
Weight		70.131	64.578	0.227

Demographics	Demographics	Group A (ACBT)	Group B (ACBT + RMS)	P –value
Body Mass Index		**29.393**	**28.437**	**0.409**
Blood Pressure Systolic		**117.368**	**115.79**	**0.733**
Blood Pressure Diastolic		**78.368**	**76.842**	**0.612**
Pulse		**81.105**	**80.369**	**0.826**
Oxygen Saturation (O2)		**96.421**	**95.895**	**0.343**
Respiratory Rate		**27.105**	**27.105**	**1.000**

Table 2: Within-group Comparison of Kinesiophobia, Functional Capacity, and Anxiety

Groups	Outcome	Evaluation	Mean	Std. Deviation	Sig.
Group A (ACBT)	Kinesiophobia	Pre-intervention	50.684	1.600	<0.001
		Post-intervention	28.263	1.446	
	Functional Capacity	Pre-intervention	373.263	10.071	<0.001
		Post-intervention	389.157	15.510	
	Anxiety	Pre-intervention	20.578	1.121	<0.001
		Post-intervention	15.684	2.625	
Group B (ACBT + RMS	Kinesiophobia	Pre-intervention	49.736	1.967	<0.001
		Post-intervention	26.210	1.134	
	Functional Capacity	Pre-intervention	376.947	12.335	<0.001
		Post-intervention	407.421	17.522	
	Anxiety	Pre-intervention	19.263	1.910	<0.001
		Post-intervention	9.368	0.597	

*P value <0.05 is taken as significant

Between Group Comparison for Kinesiophobia

Functional Capacity, and Anxiety: The results showed a significant difference in kinesiophobia of Groups A and B as the p-value <0.05. There was a significant difference in the functional capacity values of Groups A and B as the p-value <0.05. There was a significant difference in Anxiety values of Groups A and B as the p-value <0.05. The effect sizes (Cohen's d values) were computed based on differences between groups at post-intervention. Post-intervention, there were significantly greater improvements within Group B (ACBT + RMS) than in Group A (ACBT) in all measures. There were greater decreases in kinesiophobia within Group B (mean difference = 2.052, with a large effect size, Cohen's d = 1.579), a large effect size. Functional capacity was improved to a great extent (mean difference = 18.263, with a large effect size, Cohen's d = 1.103). Improvement in anxiety and depression scores was noticed to the largest extent (mean difference = 6.316, with an extremely large effect size, Cohen's d = 3.318). These results implied that the addition of RMS to ACBT makes significantly greater improvements in reducing kinesiophobia, anxiety, and increasing functional capacity in the patients with COPD.

Table 3: Comparison between Group comparison for Kinesiophobia, Functional Capacity and Anxiety

Outcomes	Groups	Evaluation	Mean	Std. Deviation	P-Value	Mean Diff.	Cohen's d
Kinesiophobia	**Group A (ACBT)**	Pre-intervention	50.684	1.600	0.112	0.947	
	Group B (ACBT + RMS		49.736	1.967			
	Group A (ACBT)	Post-intervention	28.263	1.446	<0.001	2.052	1.579
	Group B (ACBT + RMS)		26.210	1.134			
Functional Capacity	**Group A (ACBT)**	Pre-intervention	373.263	10.071	0.320	3.684	
	Group B (ACBT + RMS)		376.947	12.335			
Functional Capacity	**Group A (ACBT)**	Post-intervention	389.157	15.510	0.002	18.263	1.103
	Group B (ACBT + RMS)		407.421	17.522			
Anxiety	**Group A (ACBT)**	Pre-intervention	20.578	1.121	0.014	1.316	
	Group B (ACBT + RMS)		19.263	1.910			
Anxiety	**Group A (ACBT)**	Post-intervention	15.684	2.625	<0.001	6.316	3.318
	Group B (ACBT + RMS)		9.368	0.597			

*P value <0.05 is taken as significant

DISCUSSION

The present study evaluates the efficacy of respiratory muscle stretching and Active Cycle Breathing Technique (ACBT) in lowering kinesiophobia associated with dyspnea and enhancing functional ability in patients with COPD. The study's observation of decreased kinesiophobia aligns with other research findings. It has been demonstrated that physical and psychological interventions effectively reduce patients' fear of movement. For instance, Cai et al. (2023) discovered that kinesiophobia was considerably reduced when combined with cognitive-behavioral treatment and physical rehabilitation (15). In the same direction, Wileman et al. (2023) showed that specialized interventions that target psychological barriers can improve program participation (16). Group B's additional respiratory muscle stretching helped even more by lowering muscle tension and enhancing breathing mechanics, which could aid in the more efficient reduction of kinesiophobia. Patients with various respiratory conditions benefit from ACBT, which consists of forced expiratory technique (FET), thoracic expansion exercises, and breathing control cycles. Zisi et al. (2022) examined the efficacy of ACBT. They offered a summary of relevant research, broadening the data from the previous 12 years and assessing the treatment's impact on outcome factors linked to pulmonary function in patients with long-term respiratory conditions (12). A prior meta-analysis and comprehensive review revealed that ACBT may be helpful for individuals with a range of respiratory conditions, such as COPD, CF, and non-cystic fibrosis (CF) bronchiectasis. The increase in functional ability is consistent with the large amount of research that shows pulmonary rehabilitation regimens are effective. Significant improvements in exercise tolerance and functional capacity were seen by Priego-Jiménez et al. (2022) after structured exercise treatments (17).

By increasing respiratory efficiency and lowering breathing effort, respiratory muscle stretching added to ACBT in Group B might have improved results. Beaumont et al. (2018) supported this by highlighting the advantages of respiratory muscle training for enhancing exercise performance in individuals with COPD (18). The effects of breathing exercises on chest expansion in older people with inspiratory muscular limitations were demonstrated by Jyothi et al. in 2022. Essential elements influencing airflow during inspiration and expiration are the rib cage's muscular tension and the mechanical characteristics brought on by its movement. The thoracic capacity, influenced by the respiratory muscles' intensity, the skeletal muscles' mobility, and the flexibility of the surrounding soft tissues, is the primary factor influencing the lungs' ability to expand and contract (19). The decrease in hospital anxiety and depression scores reinforces other research emphasizing the value of all-encompassing treatment strategies for long-term conditions. Rahi et al. (2023) discovered that patients with COPD have a significant reduction in symptoms of anxiety and sadness when they combine psychological support with physical activity. The current study found that Group B experienced a higher decrease in anxiety; it can be stated that the addition of respiratory muscle stretching had additional psychological effects, such as improving general well-being and lowering perceived breathing effort (20).

CONCLUSION

The study's findings suggest that the combination of ACBT and respiratory muscle stretching could be a promising intervention for COPD patients, offering a potential solution to the challenges of kinesiophobia, reduced functional capacity, and anxiety.

Limitations and Recommendations: There are some limitations to the study. Being a short duration study with a small sample population makes it difficult to generalize. Certain

important covariates like the stage of COPD, smoking status, medications taken, number of exacerbations in the past one year, and initial level of dyspnea were not accounted for. Large effects were found; although, it should be noted that large effects can be attenuated when calculated from post-test differences in small samples. Between-group tests were conducted using independent t-tests. Although ANCOVA could have controlled imbalances, especially on anxiety, it was not used because of limited sample size and potential overfitting. Future research work should investigate larger numbers of subjects for longer periods of time with more careful measurement of disease severity, dyspnea, smoking exposure, and medication used to confirm and expand upon these observations.

DECLARATIONS

Ethical Approval

The Institutional Ethical Committee at Rashid Latif Medical College approved the research protocol. All the methods were performed according to the guidelines stated in the Helsinki Declaration.

Informed Consent

Informed consent was obtained from all the subjects/patients in the study.

Conflict of Interest

The authors declare no conflict of interest.

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Authors' Contributions

Fariha Faisal: Conceptualization and study design; drafting of the manuscript.
Aleena Waheed: Data acquisition; critical revision of the manuscript for important intellectual content.
Rehana Niazi: Data analysis and interpretation; visualization.
Nazeer Ahmad: Revision of the submitted version for publication.
Tahir Mahmood: Editing of the manuscript; final approval of the version to be submitted/published.

Data Availability

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

Acknowledgments

Not applicable.

Study Registration

IRCT20220604055072N1

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