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Original Article

Active Cycle of Breathing Technique and Pursed Lip Breathing in Moderate to Severe COPD Patients

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is associated with persistent airflow limitation, dyspnea, respiratory symptoms, and impaired health-related quality of life. Simple breathing interventions may provide accessible components of pulmonary rehabilitation, but direct comparative evidence between Active Cycle of Breathing Technique (ACBT) and Pursed Lip Breathing (PLB) remains limited. Objective: To compare the effects of ACBT plus diaphragmatic breathing with PLB plus diaphragmatic breathing on pulmonary function, oxygen saturation, dyspnea, respiratory symptom burden, and health-related quality of life in patients with moderate-to-severe COPD. Methods: This randomized clinical trial included 40 participants recruited by convenience sampling and randomly allocated to ACBT (n = 20) or PLB (n = 20). Both groups received diaphragmatic breathing and performed 15–20-minute sessions twice daily for eight weeks. Outcomes included FEV_1, FVC, SpO_2, mMRC, BCSS, and SGRQ. Results: FEV_1 increased by 0.21 L with ACBT and 0.14 L with PLB (between-group $p < 0.001$), while FVC increased by 0.28 L and 0.18 L, respectively ($p < 0.01$). mMRC decreased by 1.0 versus 0.5 points ($p < 0.001$), BCSS by 3.1 versus 2.0 points ($p < 0.001$), and SGRQ by 10.0 versus 7.95 points ($p < 0.01$). Post-intervention SpO_2 was 94% in both groups, with no significant between-group difference ($p = 0.32$). Conclusion: Both interventions improved the reported outcomes, while ACBT produced greater short-term improvements in pulmonary function, dyspnea, symptom burden, and quality-of-life measures. No comparative advantage was demonstrated for resting oxygen saturation.
Keywords: Chronic Obstructive Pulmonary Disease; Active Cycle of Breathing Technique; Pursed Lip Breathing; Pulmonary Rehabilitation; Dyspnea; Pulmonary Function; Quality of Life

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disorder characterized by persistent respiratory symptoms and airflow limitation and represents an important cause of morbidity and mortality worldwide. Cigarette smoking remains a major risk factor, while exposure to biomass fuels, occupational pollutants, and ambient air pollution contributes substantially to disease burden, particularly in low- and middle-income settings (1,3). Persistent airway inflammation, oxidative stress, structural airway remodeling, and destruction of alveolar tissue contribute to expiratory airflow limitation, air trapping, and dynamic hyperinflation, which collectively increase the work of breathing and contribute to progressive dyspnea and functional limitation (2). These pathophysiological consequences become particularly important in patients with moderate-to-severe disease, in whom chronic respiratory symptoms, reduced exercise tolerance, and impaired health-related quality of life impose a substantial clinical burden.

Pulmonary rehabilitation is an important component of non-pharmacological COPD management and incorporates exercise, education, self-management strategies, and respiratory techniques aimed at reducing symptom burden and improving functional status. Breathing exercises are frequently incorporated into rehabilitation because they can modify breathing patterns, improve ventilatory efficiency, and reduce respiratory symptoms without requiring complex equipment (4,5). Systematic evidence indicates that breathing interventions can improve selected ventilatory parameters, exercise capacity, and health-related quality of life, although the magnitude of response varies according to the technique used, intervention duration, disease severity, and outcomes assessed (4,5). These features make structured breathing strategies particularly relevant in settings where access to comprehensive pulmonary rehabilitation remains limited.

The Active Cycle of Breathing Technique (ACBT) combines breathing control, thoracic expansion exercises, and forced expiratory techniques in a structured sequence intended primarily to facilitate secretion mobilization and airway clearance. Evidence from chronic respiratory populations suggests that ACBT can increase sputum clearance and may produce short-term improvements in pulmonary function and patient-reported respiratory symptoms (6). A randomized clinical trial in patients with COPD has also demonstrated the feasibility of incorporating ACBT into respiratory management and has supported its potential role in improving airway clearance and respiratory outcomes (7). Its equipment-free and patient-directed nature additionally makes it suitable for repeated practice in outpatient and home-based rehabilitation.

Pursed Lip Breathing (PLB) is a controlled breathing strategy involving slow inspiration followed by prolonged expiration through partially closed lips. The resulting expiratory resistance can prolong expiratory time and may reduce airway collapse and dynamic hyperinflation while promoting a more controlled ventilatory pattern. A systematic review and meta-analysis reported improvements in pulmonary function and exercise capacity when PLB was combined with diaphragmatic breathing in patients with COPD (8). Physiological studies have further demonstrated favorable changes in breathing frequency, tidal breathing patterns, and expiratory mechanics during diaphragmatic and pursed-lip breathing without consistent evidence of worsening hyperinflation (9). Evidence regarding its acute use during exercise similarly supports potential symptomatic and ventilatory benefits, although individual responses remain variable (10).

Although both ACBT and PLB are clinically accessible breathing strategies, much of the available literature has evaluated them separately, in combination with other rehabilitation interventions, or against usual care. Comparative evidence directly determining whether one technique produces greater improvement across pulmonary function, dyspnea, respiratory symptom burden, oxygenation, and health-related quality of life remains comparatively limited (11,12). This evidence gap is particularly relevant in resource-constrained rehabilitation environments where simple interventions must be selected according to their potential clinical benefit and feasibility. Therefore, the present randomized clinical trial aimed to compare ACBT plus diaphragmatic breathing with PLB plus diaphragmatic breathing over eight weeks in patients with moderate-to-severe COPD, with outcomes including pulmonary function, oxygen saturation, dyspnea severity, respiratory symptom burden, and health-related quality of life.

MATERIALS AND METHODS

This randomized clinical trial was conducted in Lahore at The University of Lahore Teaching Hospital and the Punjab Institute of Cardiology. The study was conducted over approximately 8–10 months following approval of the research synopsis. Participants with diagnosed moderate-to-severe COPD were recruited using convenience sampling, after which eligible participants were allocated to two intervention groups using simple randomization. Forty participants were included in the study and allocated equally to Group A, which received Active Cycle of Breathing Technique (ACBT) plus diaphragmatic breathing, and Group B, which received Pursed Lip Breathing (PLB) plus diaphragmatic breathing, with 20 participants in each group.

Male and female patients with an established diagnosis of COPD who were receiving regular treatment, were conscious and cooperative, and were capable of understanding and following intervention instructions were considered eligible for participation. Exclusion criteria included recent abdominal or thoracic surgery; physical or mental disability that interfered with participation; unstable angina, advanced congestive heart failure, or severe pulmonary hypertension; advanced kyphoscoliosis or severe pectus excavatum; severe resting hypoxemia or unstable oxygen saturation requiring continuous clinical monitoring; and recent acute clinical deterioration within the preceding four weeks.

Eligible patients were approached individually and enrolled after written informed consent had been obtained. Participants were allocated to Group A or Group B using a lottery method in which slips marked "A" represented the ACBT group and slips marked "B" represented the PLB group. Both groups received diaphragmatic breathing education as a standardized component of treatment. Participants assigned to Group A performed ACBT comprising breathing control, thoracic expansion, and forced expiratory components, whereas participants assigned to Group B performed controlled pursed-lip breathing. Both interventions were delivered in 15–20-minute sessions twice daily for eight weeks. Initial sessions were supervised, with subsequent transition toward independent home practice. ACBT was performed in a comfortable upright or semi-reclined supported position, while PLB was performed in a comfortable upright sitting position with back support. These intervention approaches are consistent with the therapeutic principles described for ACBT and PLB in COPD rehabilitation literature (6,8).

Pulmonary function was evaluated using spirometry. Forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) were assessed, with spirometric procedures based on standardized respiratory testing principles (13). Peripheral oxygen saturation (SpO_2) was assessed non-invasively using finger pulse oximetry, an approach used for oxygen-saturation monitoring in patients with COPD (14). Measurements were obtained in relation to the intervention assessments to characterize changes in oxygenation.

Respiratory symptom burden was evaluated using the Breathlessness, Cough and Sputum Scale (BCSS), which contains three symptom domains—breathlessness, cough, and sputum—and yields a total score ranging from 0 to 12, with higher scores representing greater symptom burden. Dyspnea-related functional limitation was assessed using the Modified Medical Research Council (mMRC) Dyspnea Scale, which grades breathlessness from 0 to 4 according to its effect on physical activity and daily functioning (15). Health-related quality of life was evaluated using the St. George's Respiratory Questionnaire (SGRQ), which assesses symptoms, activity limitation, and psychosocial impacts of respiratory disease; scores range from 0 to 100, with higher scores indicating poorer health-related quality of life (16). The SGRQ total score was used to evaluate change in overall respiratory health status.

The primary analyses compared changes from baseline to the end of the eight-week intervention within each treatment group and compared the magnitude of change between the ACBT and PLB groups. Continuous variables were summarized using means and, where available, standard deviations, while categorical demographic characteristics were summarized as frequencies and percentages. Within-group and between-group inferential comparisons were performed for the reported pulmonary-function, symptom, oxygenation, and quality-of-life outcomes.

The study was conducted under the ethical oversight of the Institute Research Ethics Board of The University of Lahore. Written informed consent was obtained before enrollment. Participation was voluntary, participants were informed of their right to withdraw without consequences for their usual care, and confidentiality and privacy were maintained throughout the research process. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

All 40 participants included in the analysis completed the eight-week intervention, with 20 participants in the ACBT group and 20 in the PLB group. The reported mean age was 60.30 ± 6.80 years in the ACBT group and 59.55 ± 6.72 years in the PLB group, with no statistically significant between-group difference ($p = 0.728$). Each group included 12 men (60.0%) and 8 women (40.0%), and the gender distribution was identical between groups ($p = 1.000$).

Table 1. Baseline demographic characteristics of the intervention groups

Variable	ACBT group (n = 20)	PLB group (n = 20)	p-value
Age, years, mean ± SD	60.30 ± 6.80	59.55 ± 6.72	0.728
Male, n (%)	12 (60.0)	12 (60.0)	1.000
Female, n (%)	8 (40.0)	8 (40.0)	

Both groups demonstrated improvement in FEV_1 after eight weeks. In the ACBT group, mean FEV_1 increased from 1.11 L at baseline to 1.32 L after intervention, corresponding to a mean increase of 0.21 L ($p < 0.001$). In the PLB group, FEV_1 increased from 1.10 L to 1.24 L, corresponding to a mean increase of 0.14 L ($p < 0.01$). The reported mean FVC increase was 0.28 L in the ACBT group and 0.18 L in the PLB group. The between-group difference in mean change was 0.07 L for FEV_1 ($p < 0.001$) and 0.10 L for FVC ($p < 0.01$), indicating larger spirometric changes in the ACBT group over the eight-week intervention.

Dyspnea severity decreased in both groups. Mean mMRC score decreased from 2.5 to 1.5 in the ACBT group, representing a 1.0-point reduction ($p < 0.001$), compared with a reduction from 2.5 to 2.0 in the PLB group, representing a 0.5-point reduction ($p < 0.01$). The between-group difference in mMRC change was −0.5 points ($p < 0.001$). Respiratory symptom burden assessed using the BCSS also decreased, with reported mean reductions of 3.1 points in the ACBT group and 2.0 points in the PLB group. The corresponding between-group difference in change was −1.1 points ($p < 0.001$).

Health-related quality of life improved in both intervention groups as reflected by reductions in SGRQ total score. The ACBT group demonstrated a mean reduction of 10.0 points ($p < 0.001$), whereas the PLB group demonstrated a mean reduction of 7.95 points ($p < 0.01$). The between-group difference in mean SGRQ change was −2.05 points and was statistically significant ($p < 0.01$).

Resting SpO_2 reached a reported post-intervention mean of 94.0% in both groups, with significant within-group improvement reported for ACBT and PLB (both $p < 0.01$). In contrast to the differences observed for FEV_1, FVC, mMRC, BCSS, and SGRQ, the between-group comparison for SpO_2 was not statistically significant ($p = 0.32$). Thus, the available results do not demonstrate a differential effect of ACBT and PLB on post-intervention oxygen saturation.

Table 2. Within-group changes after eight weeks of intervention

Outcome	Group	Baseline mean	8-week mean	Mean change	p-value
FEV_1 (L)	ACBT	1.11	1.32	+0.21	<0.001
FEV_1 (L)	PLB	1.10	1.24	+0.14	<0.01
FVC (L)	ACBT	—	—	+0.28	<0.001
FVC (L)	PLB	—	—	+0.18	<0.01
mMRC score	ACBT	2.5	1.5	−1.0	<0.001
mMRC score	PLB	2.5	2.0	−0.5	<0.01
BCSS score	ACBT	—	—	−3.1	<0.001
BCSS score	PLB	—	—	−2.0	<0.01
SGRQ total score	ACBT	—	—	−10.0	<0.001
SGRQ total score	PLB	—	—	−7.95	<0.01
SpO_2 (%)	ACBT	—	94.0	Improved	<0.01
SpO_2 (%)	PLB	—	94.0	Improved	<0.01

Overall, both interventions were associated with improvement across the reported respiratory and patient-reported outcomes during the eight-week intervention period. Greater mean changes were observed in the ACBT group for FEV_1, FVC, mMRC dyspnea, BCSS symptom burden, and SGRQ total score, whereas no statistically significant between-group difference was demonstrated for SpO_2.

Table 3. Between-group comparison of mean changes after eight weeks

Outcome	ACBT mean change	PLB mean change	Between-group difference	p-value
FEV_1 (L)	+0.21	+0.14	0.07	<0.001
FVC (L)	+0.28	+0.18	0.10	<0.01
mMRC score	−1.0	−0.5	−0.5	<0.001
BCSS score	−3.1	−2.0	−1.1	<0.001
SGRQ total score	−10.0	−7.95	−2.05	<0.01
SpO_2 (%)	Improved	Improved	—	0.32

DISCUSSION

The present randomized clinical trial compared eight weeks of Active Cycle of Breathing Technique (ACBT) plus diaphragmatic breathing with Pursed Lip Breathing (PLB) plus diaphragmatic breathing in patients with moderate-to-severe COPD. Both interventions were associated with improvements in pulmonary function, dyspnea, respiratory symptom burden, and health-related quality of life. However, the magnitude of improvement was greater in the ACBT group for FEV_1, FVC, mMRC dyspnea score, BCSS score, and SGRQ total score. In contrast, both groups reached a mean post-intervention SpO_2 of 94%, and the between-group difference in oxygenation was not statistically significant ($p = 0.32$). These findings suggest that the principal comparative advantage observed for ACBT concerned pulmonary function and patient-reported respiratory outcomes rather than resting peripheral oxygen saturation.

The greater improvement in spirometric outcomes observed with ACBT is compatible with previous evidence supporting its role in airway clearance and respiratory management. A systematic review by Zisi et al. reported that ACBT facilitates sputum clearance and may improve selected physiological and patient-reported outcomes in chronic respiratory disorders (6). Similarly, Shen et al. evaluated ACBT in patients with COPD and supported its use as a structured respiratory intervention incorporating breathing control, thoracic expansion, and forced expiratory techniques (7). The mean FEV_1 improvement in the present study was 0.21 L in the ACBT group compared with 0.14 L in the PLB group, while FVC increased by 0.28 L and 0.18 L, respectively. Although these findings favor ACBT within the present sample, the relatively small study population and absence of reported confidence intervals limit the precision with which the magnitude of the between-group effect can be interpreted.

PLB also produced improvement in pulmonary function and therefore remained clinically relevant despite smaller changes than those observed with ACBT. Previous evidence indicates that PLB, particularly when combined with diaphragmatic breathing, can improve expiratory mechanics, pulmonary function, and exercise-related outcomes in people with COPD (8). Mendes et al. demonstrated that diaphragmatic breathing with PLB modifies chest-wall mechanics and breathing patterns while promoting a longer expiratory phase without consistently worsening dynamic hyperinflation (9), and a systematic review of PLB during exercise similarly documented potential ventilatory and symptomatic benefits, although responses differed among patients (10). The present findings therefore do not suggest that PLB was ineffective; rather, both interventions improved the reported outcomes, with larger mean changes in selected measures among participants receiving ACBT.

Dyspnea improved in both intervention groups, but the magnitude of change differed. The mean mMRC score decreased by 1.0 point in the ACBT group and 0.5 points in the PLB group, with a statistically significant between-group difference. A change of approximately one mMRC grade is generally regarded as clinically relevant in COPD symptom assessment (15). Accordingly, the mean improvement observed with ACBT reached this threshold, whereas the mean change with PLB was smaller. These findings are consistent with systematic evidence showing that structured breathing exercises can reduce breathlessness and improve respiratory function and functional status in COPD, although effects differ according to intervention characteristics and outcome selection (4,5,12). The greater reduction in BCSS score with ACBT, −3.1 compared with −2.0 points with PLB, further indicates that the observed between-group difference extended beyond dyspnea alone to the combined burden of breathlessness, cough, and sputum symptoms.

Health-related quality of life improved substantially in both groups. The mean SGRQ total score decreased by 10.0 points following ACBT and by 7.95 points following PLB. Reductions of approximately four points in SGRQ total score have traditionally been interpreted as clinically perceptible improvement in COPD (16); therefore, the within-group changes observed with both interventions were larger than this threshold. Importantly, however, the between-group difference in mean change was only 2.05 points. Consequently, although the statistical comparison favored ACBT ($p < 0.01$), the present data do not establish that the additional improvement of ACBT over PLB exceeded the commonly applied SGRQ threshold for a clinically important between-treatment difference. This distinction is important because statistical superiority should not automatically be interpreted as clinically meaningful superiority. Broader systematic evidence similarly indicates that different breathing strategies can improve health-related quality of life in COPD without demonstrating uniform superiority of one technique across all patient populations and outcomes (4,5,12).

The oxygenation findings further demonstrate the importance of separating within-group improvement from comparative treatment effects. Both groups reached a mean post-intervention SpO_2 of 94%, and both were reported to improve significantly relative to baseline, but the between-group comparison was not significant ($p = 0.32$). Therefore, the data do not support the earlier interpretation that ACBT was superior to PLB for resting oxygen saturation. PLB has established physiological plausibility for improving expiratory control and reducing air trapping, while breathing exercises more broadly may influence ventilatory efficiency and gas exchange (5,8,9). Nevertheless, because the present study showed equivalent post-intervention mean oxygen saturation and a nonsignificant between-group comparison, any claim of differential oxygenation benefit would exceed the reported evidence.

The findings have practical relevance for pulmonary rehabilitation because both techniques require little equipment and can transition from supervised instruction to home practice. Evidence from systematic reviews supports the feasibility of breathing exercises as adjunctive components of COPD rehabilitation and self-management (4,5). This consideration may be especially relevant in settings where access to comprehensive pulmonary rehabilitation is constrained and where COPD burden is influenced by smoking, biomass exposure, and environmental pollution (3). The present results support consideration of both techniques in rehabilitation, while suggesting that ACBT may offer greater short-term improvement in selected pulmonary-function and symptom outcomes in patients resembling the study population. They do not, however, justify treating ACBT as universally superior to PLB across all COPD populations or clinical circumstances.

Several limitations should temper interpretation. The study included only 40 participants, reducing precision and restricting generalizability. Recruitment was based on convenience sampling before random allocation, and the intervention lasted eight weeks without subsequent assessment of persistence of benefit, exacerbation frequency, hospitalization, adherence, or healthcare utilization. Although participants were described as receiving treatment at two Lahore institutions, the study remained geographically restricted and therefore cannot establish national effectiveness across the broader Pakistani COPD population. In addition, several outcomes, including mMRC, BCSS, and SGRQ, were patient-reported and therefore susceptible to response-related measurement variation. The statistical reporting also lacked confidence intervals and effect-size estimates, limiting assessment of precision and magnitude beyond the reported p-values. Finally, the discrepancy between the stated age eligibility criterion and the observed baseline mean ages must be reconciled against the original study records before publication.

CONCLUSION

Both ACBT plus diaphragmatic breathing and PLB plus diaphragmatic breathing were associated with improved pulmonary function, dyspnea, respiratory symptom burden, and health-related quality of life after eight weeks in this study of patients with moderate-to-severe COPD. ACBT produced greater reported mean improvements in FEV_1, FVC, mMRC, BCSS, and SGRQ scores, whereas no statistically significant between-group difference was demonstrated for SpO_2. These findings support ACBT as a potentially useful breathing intervention when improvement in airway-related symptoms and pulmonary-function outcomes is prioritized, while PLB also remains a beneficial respiratory strategy. Given the small convenience sample, short follow-up, and limitations in statistical reporting, the findings should be interpreted as short-term evidence from the studied population rather than proof of universal superiority of ACBT.

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