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COMPARATIVE EFFECTS OF ACTIVE CYCLE OF BREATHING TECHNIQUES AND ALTERNATIVE NOSTRIL BREATHING TECHNIQUES ON OXYGEN SATURATION AMONG COPD PATIENTS

Original Research

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a progressive, irreversible condition marked by airflow limitation, chronic cough, sputum production, and breathlessness. It is projected to become the fourth leading cause of death globally by 2030. Non-pharmacological interventions such as structured breathing techniques have shown promise in improving oxygen saturation and relieving dyspnea, thereby enhancing respiratory efficiency and quality of life in COPD patients.

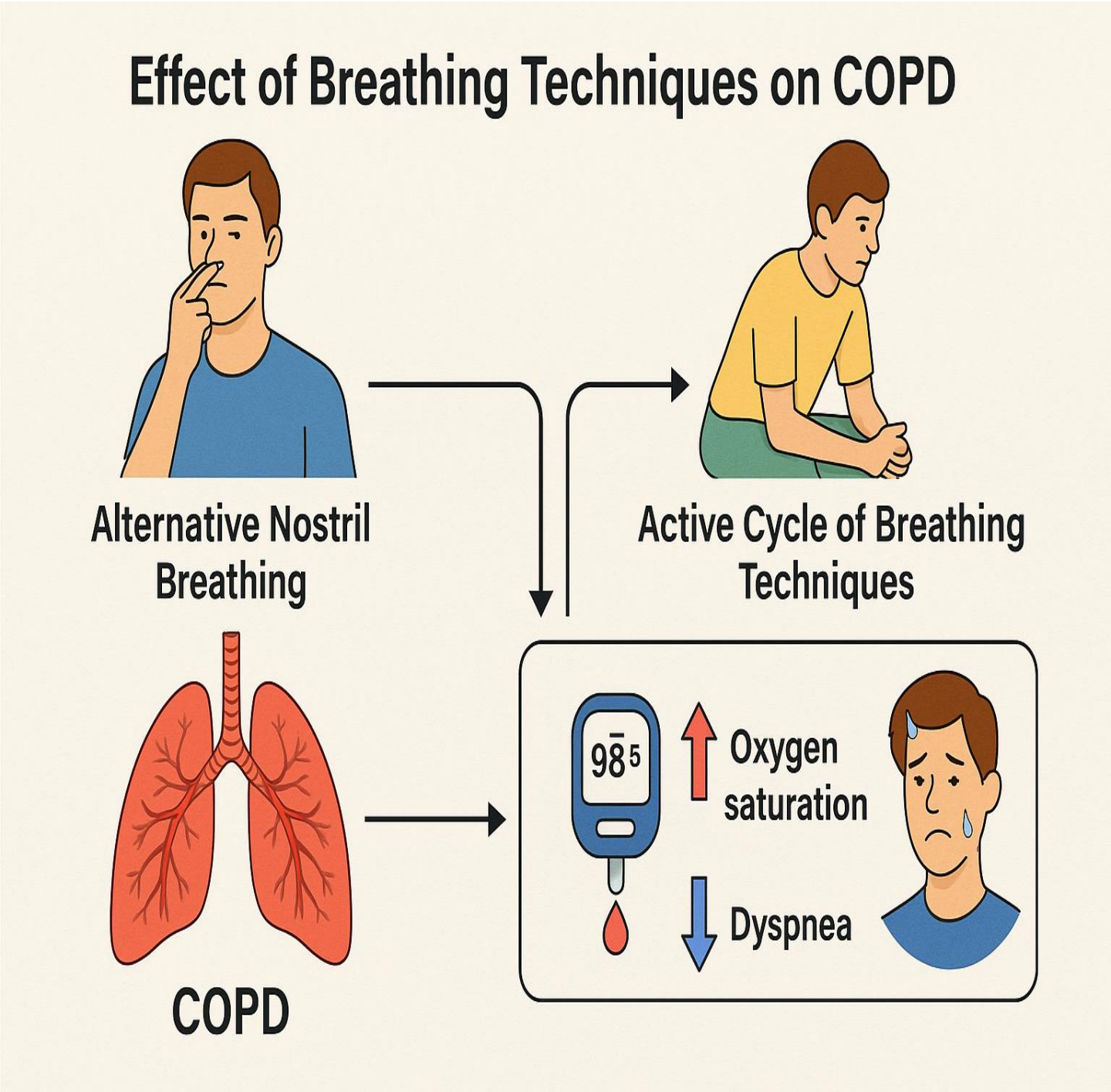
Objective: To evaluate and compare the effectiveness of Active Cycle of Breathing Techniques (ACBT) and Alternative Nostril Breathing Techniques (ANBT) in improving oxygen saturation and reducing dyspnea among patients with COPD.

Methods: A randomized controlled trial was conducted involving 28 COPD patients recruited from Madinah Teaching Hospital, Allied Hospital, Aziz Fatimah Hospital, and DHQ Hospital in Faisalabad. Participants were selected through purposive sampling based on defined inclusion and exclusion criteria and randomly divided into two equal groups. Group A practiced ANBT and Group B practiced ACBT, each for 10 minutes, twice daily, over three consecutive days. Oxygen saturation was measured before and after intervention using a fingertip pulse oximeter, and dyspnea severity was assessed using the modified Medical Research Council (mMRC) scale. Data were analyzed using SPSS version 20.

Results: Group B (ACBT) showed a pre- to post-intervention improvement in SpO_2 from $92.41 \pm 1.06\%$ to $94.65 \pm 1.06\%$ ($p < 0.001$), while Group A (ANBT) improved from $92.29 \pm 1.01\%$ to $93.94 \pm 0.90\%$ ($p < 0.001$). Between-group comparison indicated a statistically significant difference ($p=0.01$). mMRC dyspnea scores reduced more notably in Group B (from 3.29 ± 0.61 to 2.36 ± 0.93) compared to Group A (from 2.71 ± 0.47 to 1.86 ± 0.54).

Conclusion: Both ACBT and ANBT improved oxygen saturation and reduced dyspnea in COPD patients, with ACBT demonstrating superior outcomes. These findings support the incorporation of ACBT into pulmonary rehabilitation strategies for enhanced respiratory care.

Keywords: ACBT, ANBT, COPD, Dyspnea, Oxygen Saturation, Pulmonary Rehabilitation, Respiratory Therapy.



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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a preventable yet progressive respiratory condition characterized by persistent airflow limitation and chronic respiratory symptoms such as dyspnea, chronic cough, sputum production, and reduced exercise capacity (1). It is primarily caused by long-term exposure to noxious particles or gases, particularly tobacco smoke, leading to structural and functional damage in the airways and alveoli (2). The disease pathophysiology involves chronic inflammation, airway remodeling, emphysema, and skeletal muscle dysfunction, often compounded by malnutrition and systemic comorbidities (3,4). Notably, COPD is underdiagnosed due to its gradual onset and overlapping symptoms with other conditions, which may be asymptomatic in early stages (4). As the disease progresses, patients frequently experience acute respiratory failure, for which non-invasive ventilatory support has shown encouraging results (3). Hypoxemia—resulting from damaged alveoli and impaired gas exchange—is a central contributor to dyspnea and reduced oxygen saturation in COPD (5). The severity of COPD varies widely and is influenced by multiple factors including smoking history, environmental exposures, genetic susceptibility, comorbid illnesses, and even prenatal passive smoke exposure, indicating that disease onset can occur early in life (6). Breathing pattern alterations, especially shallow and rapid breathing due to CO_2 retention and reduced lung elasticity, are common among patients, and adaptive techniques are often necessary to relieve symptoms (7). In Pakistan, research reveals that over 90% of smokers in a study exhibited airway obstruction, emphasizing the heavy burden of COPD in regions with high tobacco use and environmental pollution (8).

Furthermore, extra-pulmonary manifestations such as osteoporosis, depression, and metabolic syndrome significantly worsen prognosis and quality of life in COPD patients (9). Physical therapy plays a central role in COPD management, focusing on improving airway clearance, enhancing mobility, and reducing dyspnea through structured interventions like breathing exercises and rehabilitation programs (10). Among these, the Active Cycle of Breathing Technique (ACBT) and Alternate Nostril Breathing Technique (ANBT) have emerged as non-pharmacological tools that improve oxygenation, reduce breathlessness, and enhance functional capacity (11,12). ACBT involves a cycle of breathing control, thoracic expansion, and forced expiration, while ANBT promotes pulmonary efficiency through controlled nasal breathing (13,14). Additionally, positioning techniques such as the tripod posture aid in optimizing accessory muscle function and easing respiratory effort (15). Despite the individual benefits of ACBT and ANBT, limited evidence exists regarding their comparative effectiveness in enhancing oxygen saturation among COPD patients. Therefore, this study aims to evaluate and compare the impact of ACBT and ANBT on oxygen saturation in individuals with Chronic Obstructive Pulmonary Disease to inform best practices in cardiopulmonary physical therapy rehabilitation.

METHODS

This randomized controlled trial was conducted over a period of four months following the approval of the Institutional Review Board (IRB) at the University of Faisalabad. The study was carried out in multiple tertiary care settings in Faisalabad, including Madinah Teaching Hospital, Allied Hospital, DHQ Hospital, and Aziz Fatimah Hospital. Patients clinically diagnosed with Chronic Obstructive Pulmonary Disease (COPD) were recruited through purposive sampling based on well-defined inclusion and exclusion criteria. All participants provided written informed consent, and formal permissions were obtained from the respective hospital administrations. Confidentiality and participant safety were ensured throughout the study period. A total of 28 individuals who met the eligibility criteria were enrolled. Inclusion criteria required participants to be aged over 40 years with a clinical diagnosis of COPD, characterized by chronic cough and sputum production persisting for at least three months, along with dyspnea and a modified Medical Research Council (mMRC) dyspnea score greater than 2. Participants were also required to have resting oxygen saturation levels between 88% and 95% as measured by pulse oximetry. Individuals were excluded if they had a recent history of thoracic, abdominal, or cardiac surgery, required mechanical ventilation, were unconscious, or had coexisting respiratory conditions such as pleural effusion, lung collapse, or carcinoma.

Eligible participants were randomly assigned to one of two intervention groups using a simple coin toss method. Group A performed the Alternative Nostril Breathing Technique (ANBT), while Group B practiced the Active Cycle of Breathing Technique (ACBT). The ANBT protocol involved a controlled sequence of slow inhalation and exhalation through alternate nostrils. Each session consisted of three complete cycles performed twice daily under supervision for three consecutive days. In contrast, the ACBT group engaged in a structured three-phase breathing cycle: breathing control, thoracic expansion exercises, and forced expiration (huffing), all conducted in a tripod position to facilitate respiratory muscle recruitment. These sessions were also performed twice daily for three days, with each session lasting approximately 10 minutes. Oxygen saturation levels were recorded before and after each session using a calibrated fingertip pulse oximeter to ensure objective measurement. Dyspnea severity was assessed as a secondary outcome using the mMRC

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scale. All interventions were conducted under the close supervision of trained physical therapists to ensure proper technique and participant adherence. Data were statistically analyzed using SPSS version 20. Descriptive statistics were used to summarize baseline characteristics, and paired as well as independent t-tests were applied to evaluate within-group and between-group differences in oxygen saturation levels.

RESULTS

A total of 28 participants were enrolled in the study, of which 89.29% were male and 10.71% were female, indicating a higher prevalence of COPD among males in the selected population. The most commonly reported age was 49 years. Regarding the hospital distribution, 50% of participants were recruited from Madinah Teaching Hospital, 39.2% from Aziz Fatimah Hospital, and 10.7% from Allied Hospital Faisalabad. At baseline, oxygen saturation (SpO_2) levels were comparable between the two groups. The pre-intervention SpO_2 values were 92.41 ± 1.06% in the ACBT group and 92.29 ± 1.01% in the ANBT group (p=0.68), indicating no significant difference. Following the intervention, both groups showed a statistically significant improvement in SpO_2 levels. The post-intervention mean SpO_2 increased to 94.65 ± 1.06% in the ACBT group and 93.94 ± 0.90% in the ANBT group. The between-group comparison of post-intervention values revealed a significant difference (p=0.01), with the ACBT group demonstrating greater improvement. The within-group p-values for both interventions were <0.001, confirming significant oxygenation enhancement in each group individually. Effect sizes calculated using Cohen's d were 2.11 for ACBT and 1.79 for ANBT, both categorized as large, suggesting clinically meaningful changes. Daily monitoring of SpO_2 over the three-day intervention period indicated a steady upward trend in both groups. The ACBT group demonstrated a more consistent and pronounced increase, particularly evident by the third day, compared to the gradual improvement observed in the ANBT group.

Assessment of dyspnea severity using the modified Medical Research Council (mMRC) Dyspnea Scale also revealed significant reductions in symptom burden. In the ANBT group, the mean mMRC score decreased from 2.71 ± 0.47 to 1.86 ± 0.54 post-intervention. In comparison, the ACBT group experienced a decrease from 3.29 ± 0.61 to 2.36 ± 0.93, indicating a more substantial reduction in perceived dyspnea. Participants in both groups reported subjective relief from breathing difficulty, though improvements were more pronounced in the ACBT group. Subgroup analysis by age and hospital revealed consistent improvements in oxygen saturation across all categories, with the Active Cycle of Breathing Technique (ACBT) group demonstrating superior outcomes compared to the Alternative Nostril Breathing Technique (ANBT) group. In the age-wise comparison, participants aged 48–50 in the ACBT group showed the highest increase in mean oxygen saturation, rising from 92.33% to 94.52%, followed by those in the 51–54 group (92.32% to 94.45%). The ANBT group showed modest improvements across all age brackets, with the highest post-intervention value of 93.98% seen in the 48–50 age group. Although improvements were evident in both groups, ACBT consistently resulted in higher post-intervention SpO_2 levels across all age ranges. In the hospital-wise analysis, patients from Madinah Teaching Hospital (MTH) who received ACBT achieved the highest improvement, with mean SpO_2 increasing from 92.50% to 94.72%. This was followed by patients at AFH (92.22% to 94.35%) and AH (91.90% to 94.03%). In comparison, the ANBT group also improved but to a lesser extent, with post-intervention SpO_2 reaching 94.12% at MTH, 93.93% at AFH, and 93.53% at AH. These findings indicate that the effectiveness of ACBT in improving oxygen saturation is consistent across different age groups and hospital settings, further supporting its clinical utility in COPD management.

Table 1: Comparison of Oxygen Saturation before and after Intervention in Each Group

Parameter	Group A (ACBT)	Group B (ANB)	*p*-value (between groups)
Pre-intervention SpO_2 (%)	92.41 ± 1.06	92.29 ± 1.01	0.68
Post-intervention SpO_2 (%)	94.65 ± 1.06	93.94 ± 0.90	0.01
Within-group *p*-value	< 0.001	< 0.001	
Effect size (Cohen's *d*)	2.11 (large)	1.79 (large)	1.67 (large)

Note: SpO_2 = oxygen saturation; ACBT = Active Cycle of Breathing Techniques; ANB = Alternative Nostril Breathing.

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Table 2: Pre- and Post-Intervention Dyspnea Scale Scores (mMRC) in ACBT and ANBT Groups

Group	Phase	Mean Score ± SD	Mean Rank
ANBT	Pre-test	2.71 ± 0.47	6.00
ANBT	Post-test	1.86 ± 0.54	–
ACBT	Pre-test	3.29 ± 0.61	7.54
ACBT	Post-test	2.36 ± 0.93	–

Table 3: Age-wise Subgroup Analysis

Age Group	Group	Pre SpO_2 (%)	Post SpO_2 (%)
45–47	ACBT	92.05	94.22
45–47	ANBT	92.10	93.88
48–50	ACBT	92.33	94.52
48–50	ANBT	92.23	93.98
51–54	ACBT	92.32	94.45
51–54	ANBT	92.08	93.85

Table 4: Hospital-wise Subgroup Analysis

Hospital	Group	Pre SpO_2 (%)	Post SpO_2 (%)
AFH	ACBT	92.22	94.35
AFH	ANBT	92.17	93.93
AH	ACBT	91.90	94.03
AH	ANBT	91.90	93.53
MTH	ACBT	92.50	94.72
MTH	ANBT	92.28	94.12

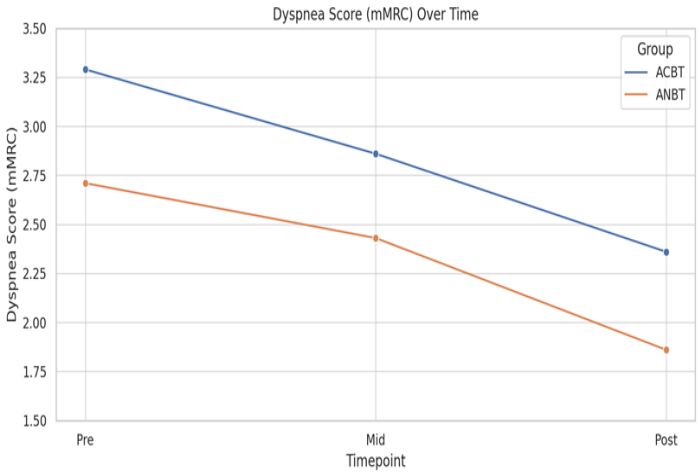

Figure 1 Dyspnea Score (mMRC) Over Time

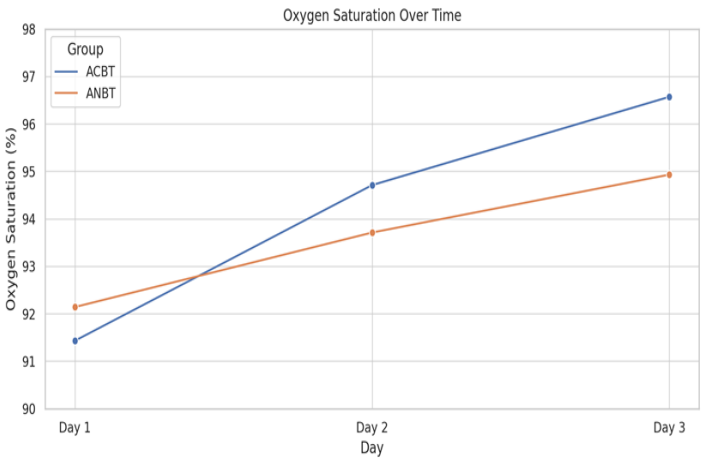

Figure 2 Oxygen Saturation Over Time

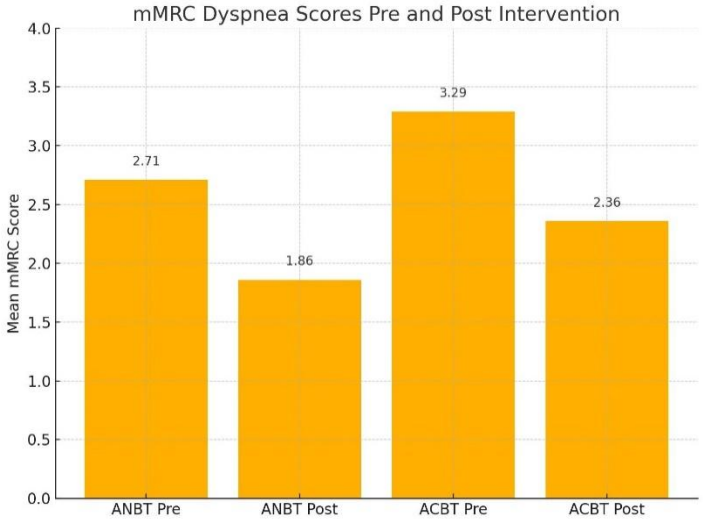

Figure 3 mMRC Dyspnea Scores Pre and Post Intervention

DISCUSSION

The findings of the present study confirmed that both Active Cycle of Breathing Technique (ACBT) and Alternative Nostril Breathing Technique (ANBT) were effective in enhancing oxygen saturation and reducing dyspnea among patients with Chronic Obstructive Pulmonary Disease (COPD). However, ACBT demonstrated significantly greater improvements, reinforcing its clinical relevance as a preferred non-pharmacological intervention. The physiological basis for ACBT's superiority lies in its structured phases that promote alveolar recruitment, mobilize secretions, reduce dynamic hyperinflation, and improve overall ventilation-perfusion matching, particularly when combined with the tripod position which supports accessory muscle engagement and diaphragmatic efficiency. These findings are strongly supported by previous literature. One study demonstrated that ACBT combined with pursed-lip breathing in the tripod position significantly improved oxygen saturation, with post-test SpO_2 increasing from 88.27% to 90.13% ($p = 0.000$), compared to a modest rise from 84.27% to 85.47% in the pursed-lip breathing group ($p = 0.023$), indicating a stronger clinical effect when ACBT was used (15). Additional evidence from cardiac rehabilitation programs showed that ACBT effectively improved arterial blood gases, oxygen saturation, respiratory rate, and chest expansion, yielding statistically significant changes compared to conventional chest physiotherapy ($p < 0.01$) (16). Another study with a 5-day intervention further demonstrated ACBT's efficacy in improving oxygen saturation and respiratory rates, alongside reductions in dyspnea severity and enhanced lung tissue re-expansion (17). Comparative evidence from other modalities such as incentive spirometry and yoga-based techniques, including Nadi Sodhana Pranayama, also supported the effectiveness of breathing exercises in COPD. For instance, studies analyzing flow and volume incentive spirometers alongside ACBT showed statistically significant improvements in peak expiratory flow rate (PEFR), SpO_2, and chest expansion post-operatively ($p \leq 0.05$) (18). Similarly, trials involving Nadi Sodhana Pranayama and pursed-lip breathing reported enhanced cardiopulmonary outcomes, although the pranayama techniques were marginally more effective than pursed-lip breathing alone (19).

Furthermore, extended-duration interventions with ANBT and pursed-lip breathing over 4–6 weeks resulted in significant respiratory benefits, validating their roles in long-term respiratory care strategies (20). Despite these promising outcomes, the current study has several limitations. The sample size was relatively small ($n = 28$), and the intervention period was limited to three consecutive days, which may not fully capture the long-term effects or sustainability of the interventions. Moreover, the use of purposive sampling followed by random assignment could introduce selection bias, and no blinding was performed, which might affect internal validity. Another limitation was the lack of subgroup analysis by comorbidities, baseline severity of COPD, or duration of illness. While age-wise and hospital-wise subgroup analyses were later conducted, these were not pre-specified and thus exploratory in nature. Furthermore, no follow-up data were collected to evaluate sustained improvement or relapse, and no qualitative measures such as patient satisfaction or quality of life assessments were included. The study's strength lies in its controlled design, the use of standardized clinical tools (pulse oximeter, mMRC dyspnea scale), and the practical applicability of the interventions in real-world settings. Both techniques were low-cost, non-invasive, and easily teachable, making them suitable for integration into routine physiotherapy and rehabilitation plans,

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especially in resource-limited environments. Future research should focus on larger, multi-centered trials with extended follow-up periods to evaluate the long-term impact of ACBT and ANBT on oxygenation, dyspnea, exercise tolerance, and quality of life. Investigating combined or sequential use of different breathing techniques, and assessing their effects across various COPD phenotypes, could yield deeper insights into personalized respiratory care. Incorporating psychological and behavioral assessments alongside physiological outcomes may also help elucidate the holistic impact of these interventions on patient well-being.

CONCLUSION

This study concluded that both Active Cycle of Breathing Techniques (ACBT) and Alternative Nostril Breathing Techniques (ANBT) are beneficial in enhancing oxygen saturation and alleviating dyspnea in individuals with chronic obstructive pulmonary disease. However, ACBT demonstrated more substantial clinical gains, reinforcing its role as a preferred intervention in respiratory rehabilitation. By integrating ACBT into routine physiotherapy protocols, healthcare providers can offer a simple, non-invasive, and effective strategy to support pulmonary function, reduce symptom burden, and improve the overall quality of life in patients with COPD.

AUTHOR CONTRIBUTION

Author	Contribution
Nidra Mustafa*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Anza Afzal	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Ayesha Siddiqua	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

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