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The Effect of Pursed Lip Breathing and Diaphragmatic Breathing on Increasing Oxygen Saturation in COPD Patients

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition marked by continuous airflow limitation, often resulting in hypoxemia and hypercapnia. The WHO (1) projects that by 2030, COPD will rank as the third leading cause of death globally. In Indonesia, the prevalence of COPD reached 2.4% in 2018. One of the key clinical manifestations of COPD is a decline in oxygen saturation. Non-pharmacological breathing techniques such as *Pursed Lip Breathing* (PLB) and *Diaphragmatic Breathing* (DB) have been shown to improve ventilation and oxygenation.

Purpose: This study aimed to determine the effectiveness of PLB and DB in improving oxygen saturation among COPD patients.

Methods: A quasi-experimental one-group pre-post test design was used, involving 30 purposively selected COPD patients from a population of 35 treated. Each participant performed PLB and DB for 5-10 minutes per session, three times daily, for four weeks-initially during hospitalization and later at home under supervision. Inclusion criteria were COPD patients with oxygen saturation levels of 88–90% who had not previously received PLB or DB therapy. Exclusion criteria included those with prior experience of PLB/DB, anxiety, anti-anxiety treatment, as anxiety can alter breathing patterns and reduce therapy effectiveness. Data were collected using observation sheets and pulse oximeters and analyzed with Wilcoxon Signed Rank Test.

Results: Mean oxygen saturation increased from 89.40% (SD = 2.15) to 92.10% (SD = 1.98) with a significant p-value (0.000 < 0.05).

Conclusion: PLB and DB effectively enhance oxygen saturation in COPD patients and have important implications for evidence-based nursing practice and education.

Keywords: COPD, *diaphragmatic breathing, oxygen saturation, pursed lip breathing*

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BACKGROUND

Chronic Obstructive Pulmonary Disease (COPD) refers to a group of chronic respiratory disorders characterized by progressive and irreversible airflow limitation, primarily resulting from an abnormal inflammatory response of the lungs to harmful particles or gases (2). This pathological process contributes to impaired gas exchange, leading to hypoxemia and hypercapnia, as well as respiratory muscle weakness, increased airway resistance, pulmonary hyperinflation, and ventilation-perfusion mismatch.

Chronic Obstructive Pulmonary Disease (COPD) is a group of lung disorders characterized by progressive airflow restriction, usually associated with an increased chronic inflammatory response to harmful particles or gases in the respiratory tract (2). This condition can lead to hypoxemia and hypercapnia, accompanied by respiratory muscle weakness, increased airflow resistance, pulmonary hyperinflation, and ventilation-perfusion imbalance.

According to the (3), COPD ranked sixth among causes of death worldwide in 1990, rose to fifth in 2002, and is projected to become third in 2030 after cardiovascular disease and cancer (4). The economic burden of COPD is also significant; in the United States, the cost of treatment reached USD 50 billion in 2010, with nearly half of that amount spent on hospitalization costs. In Indonesia, the prevalence of COPD in 2018 was recorded at 2.4% with the highest prevalence in East Nusa Tenggara at 10.0% (5). West Java Province has a prevalence of 4.0% and is among the top 10 provinces with the highest number of COPD cases (6).

The main risk factors for COPD include exposure to cigarette smoke, air pollution, and harmful particles. Indonesia is the third-highest tobacco-consuming country in the world after China and India, with one in four people being smokers (7). The clinical manifestations of COPD include shortness of breath, productive cough with purulent sputum, wheezing, rales, weight loss, and hypoxia (8). Hypoxemia in COPD can reduce quality of life, limit physical activity tolerance, reduce skeletal muscle function, and increase the risk of death (9).

The management of COPD includes pharmacological therapies such as bronchodilators and corticosteroids, as well as non-pharmacological therapies aimed at improving breathing patterns and oxygenation. Recommended non-pharmacological methods include pursed lip breathing (PLB), a breathing technique where the lips are pursed during exhalation to prolong exhalation, prevent collapse of small airways, and improve alveolar ventilation, and diaphragmatic breathing (DB), which involves deep, slow breathing (maximally holding inspiration) and exhaling slowly at a respiratory rate of 3-6 breaths per minute. This technique can enhance alveolar ventilation, maintain gas exchange, prevent pulmonary atelectasis, improve cough efficiency, and reduce both physical and emotional stress (10).

PLB can reduce shortness of breath, is easy to learn, does not require any costs, and can be done anytime (11). Diaphragmatic breathing facilitates the expansion of the thoracic cavity and lungs during inspiration through active contraction of the diaphragm accompanied by relaxation of the abdominal muscles. This coordinated movement allows optimal lung expansion and reduces the work of breathing. During exhalation, gentle or active contraction of the abdominal muscles assists in returning the diaphragm to its resting position, thereby promoting more efficient air expulsion and enhancing overall ventilation. Improved ventilation increases alveolar gas exchange efficiency, leading to a reduction in arterial carbon dioxide (CO_2) levels and an increase in oxygen saturation. Consequently, diaphragmatic breathing plays a significant role in optimizing respiratory mechanics and improving oxygenation in patients with chronic respiratory disorders such as Chronic Obstructive Pulmonary Disease (COPD) (12).

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Preliminary observations in the Fatmawati Ward of Sekarwangi Regional General Hospital indicated that many COPD patients who practiced Pursed Lip Breathing (PLB) and Diaphragmatic Breathing (DB) reported greater comfort, easier sputum expectoration, and improved oxygen saturation. While these findings suggest potential benefits of PLB and DB, the evidence remains largely anecdotal and lacks systematic evaluation using standardized research methods. Moreover, limited empirical studies in the Indonesian clinical context have rigorously assessed the physiological effectiveness of these breathing techniques among hospitalized COPD patients. Therefore, this study was designed to provide quantitative evidence on the effect of Pursed Lip Breathing and Diaphragmatic Breathing on oxygen saturation levels in COPD patients treated in the Pulmonary Ward of Sekarwangi Regional General Hospital.

METHODS

This study used a one-group pretest-posttest design conducted in the Pulmonary Ward of Sekarwangi Regional General Hospital, Sukabumi. The study population consisted of COPD patients who met the inclusion criteria, namely having a diagnosis of COPD, not being in a state of severe acute exacerbation, and being able to follow instructions, and the exclusion criteria were the presence of severe comorbidity. Sampling in this study was conducted using purposive sampling with a total of 30 participants. The implementation of PLB and DB was carried out through structured breathing exercises guided by the researcher. During PLB, patients were instructed to inhale slowly through the nose for approximately two seconds, followed by a prolonged exhalation through pursed lips for about four seconds, ensuring that the exhalation phase lasted twice as long as inspiration. Meanwhile, in DB, patients were positioned in a semi-Fowler position and directed to place one hand on the chest and the other on the abdomen to ensure proper diaphragmatic movement. Patients were instructed to inhale deeply through the nose, allowing the abdomen to rise while keeping the chest relatively still, and then exhale slowly through pursed lips to facilitate complete air expulsion. Each breathing session lasted for 5–10 minutes and was performed three times daily for four consecutive weeks under supervision during hospitalization and self-practice at home.

After performing the Pursed Lip Breathing (PLB) and Diaphragmatic Breathing (DB) techniques, oxygen saturation was measured after a 3–5-minute interval to allow stabilization of respiration and alveolar gas exchange. This interval ensured that the obtained oxygen saturation values reflected the true physiological effects of the breathing interventions rather than transient fluctuations from muscle activity. Oxygen saturation was measured using a calibrated fingertip pulse oximeter. Patients were positioned comfortably in a sitting or semi-Fowler's position with their arms relaxed on their thighs to minimize motion artifacts. SpO_2 readings were recorded after the monitor displayed a stable value for at least 10–15 seconds. All measurements were conducted at the same time each day to maintain data consistency.

To control confounding variables that might affect oxygen saturation measurements, all patients were assessed in a semi-Fowler's position after resting for at least five minutes. Measurements were taken using a calibrated pulse oximeter, with readings recorded once values stabilized for 10–15 seconds. Participants were instructed to avoid physical activity, smoking, and caffeine 30 minutes prior to testing. The probe was placed on a clean finger without nail polish to prevent optical interference. Consistent measurement procedures and trained data collectors were used to ensure accuracy and reliability across all participants. The measurement data were analyzed using the Wilcoxon Signed Rank Test with a significance

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level of $p < 0.05$. This study has received ethical approval from the Rajawali Health Institute Research Ethics Committee with number 023/IKR/KEPK/2025.

RESULTS

Table 1. Characteristics of COPD Patients (n=30)

Characteristics	Category	f	%
Age	41–50 years old	5	16,7
	51–60 years old	12	40,0
	61–70 years old	9	30,0
	>70 years old	4	13,3
Gender	Male	20	66,7
	Female	10	33,3
Smoking History	Yes	22	73,3
	No	8	26,7
Duration of COPD	< 5 years	11	36,7
	5–10 years	13	43,3
	>10 years	6	20,0

Based on Table 1, the characteristics of respondents show that most are aged 51–60 years (40%), male (66.7%), have a history of smoking (73.3%), and the majority have suffered from COPD for 5–10 years (43.3%).

Table 2. Analysis of Differences in Oxygen Saturation Before and After Intervention (n=30)

Variable	Mean ± SD (Pre)	Mean ± SD (Post)	Z	p-value
Oxygen Saturation (%)	89,40 ± 2,15	92,10 ± 1,98	-4,652	0,000*

* Description: Wilcoxon Signed Rank Test, $\alpha = 0,05$, $p < 0,05$ significant

Table 2 shows that the average oxygen saturation increased from 89.40% (SD=2.15) in the pre-test to 92.10% (SD=1.98) in the post-test. The Wilcoxon test results show a significant difference ($Z = -4.652$; $p = 0.000$). Thus, it can be interpreted that this breathing technique intervention is effective in increasing oxygen saturation in COPD patients.

Table 3. Wilcoxon Signed Rank Test Results (n = 30)

Category	N	Mean Rank	Sum of Ranks
Negative Ranks	1	3,00	3,00
Positive Ranks	27	14,85	401,00
Ties	2	–	–
Total	30		

Based on Table 3, out of 30 respondents, 27 respondents (90.0%) experienced an increase in oxygen saturation, 1 respondent (3.3%) experienced a decrease, and 2 respondents (6.7%) experienced no change. The dominance in the positive ranks group indicates that Pursed Lip Breathing and Diaphragmatic Breathing interventions consistently have a positive effect on the oxygen saturation of COPD patients.

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DISCUSSION

This study shows that the application of PLB and DB can increase oxygen saturation in COPD patients with pre-test results of 89.40% (SD= 2.15) and post-test results of 92.10% (SD=1.98). This improvement is supported by respiratory physiology, whereby PLB slows down exhalation and keeps the airway open longer, thereby preventing air trapping and reducing CO_2 retention. DB increases the effectiveness of diaphragmatic contractions, thereby increasing tidal volume and improving gas exchange.

The results of this study demonstrated that the implementation of Pursed Lip Breathing (PLB) and Diaphragmatic Breathing (DB) significantly increased oxygen saturation among patients with Chronic Obstructive Pulmonary Disease (COPD) (13). These findings are consistent with previous studies reporting that breathing exercises using PLB and DB can improve ventilation efficiency and enhance oxygenation in patients with chronic respiratory disorders (14). Physiologically, these techniques work by slowing the respiratory rate, prolonging the expiratory phase, and facilitating the release of trapped air in the lungs, thereby promoting more effective gas exchange (15).

The implications of these findings suggest that PLB and DB are effective non-pharmacological interventions to improve oxygenation status in COPD patients (16). These techniques are simple, cost-efficient, and easy to implement in both clinical and home settings, making them suitable for inclusion in patient self-care education programs (17) (18). However, this study has a limitation due to its quasi-experimental design with a one group pre–post test approach, which lacked a control group for comparison. The absence of a control group limits the ability to establish a definitive causal relationship between the interventions and the observed improvement in oxygen saturation. Therefore, future research using a randomized controlled trial design with larger sample sizes is recommended to validate and strengthen these findings.

CONCLUSION

The study demonstrated that the application of Pursed Lip Breathing (PLB) and Diaphragmatic Breathing (DB) effectively increased oxygen saturation among patients with Chronic Obstructive Pulmonary Disease (COPD). These techniques enhance respiratory function by optimizing alveolar ventilation and facilitating more efficient gas exchange. The findings suggest that PLB and DB are feasible, cost-efficient, and safe nursing interventions that can be implemented both in hospital and community settings. Integrating structured breathing exercises into COPD management may serve as an important non-pharmacological strategy to improve patients' oxygenation and overall quality of life.

Further research employing randomized controlled designs with larger sample sizes and extended intervention durations is recommended to confirm these results and to determine the long-term effects, optimal frequency, and potential integration of PLB and DB into comprehensive pulmonary rehabilitation programs.

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