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Long-Term Impact of Diaphragmatic Breathing and Pursed Lip Breathing on Pulmonary Function in Patients with COPD: A Systematic Review

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ABSTRACT:

Background: Chronic Obstructive Pulmonary Disease (COPD) is a progressive lung disease characterized by airflow limitation. Breathing techniques such as diaphragmatic breathing (DB) and pursed lip breathing (PLB) are commonly used to improve pulmonary function in patients with COPD. Objective: To conduct a systematic review of the literature on the long-term impact of DB and PLB on pulmonary function in patients with COPD.

Methods: A comprehensive search of major databases was conducted to identify studies that investigated the effects of DB and PLB on pulmonary function in patients with COPD. Studies were included if they reported outcomes on lung function, exercise capacity, or health-related quality of life.

Results: This systematic review included 10 studies that met the inclusion criteria. The results showed that long-term practice of DB and PLB can lead to significant improvements in lung function, exercise capacity, and health-related quality of life in patients with COPD.

Discussion: The findings of this systematic review suggest that breathing exercises are a beneficial adjunctive therapy for patients with COPD. The results are consistent with previous studies that have shown that breathing exercises can improve respiratory function and quality of life in patients with COPD.

Conclusion: This systematic review provides evidence that DB and PLB can be effective adjunctive therapies for improving pulmonary function in patients with COPD. The findings of this review can inform the development of pulmonary rehabilitation programs for patients with COPD.

Keywords: COPD**,** Diaphragmatic Breathing, Pursed Lip Breathing, Breathing exercise, pulmonary function.

INTRODUCTION:

Chronic obstructive pulmonary disease (COPD) is a common and treatable disease characterized by progressive airflow limitation and tissue destruction. It is associated with structural lung changes due to chronic inflammation from prolonged exposure to noxious particles or gases most commonly cigarette smoke. Chronic inflammation causes airway narrowing and decreased lung recoil. The disease often presents with symptoms of cough, dyspnea, and sputum production. Symptoms can range from being

asymptomatic to respiratory failure. COPD is primarily present in smokers and those greater than age 40. Prevalence increases with age and it is currently the third most common cause of morbidity and mortality worldwide. In 2015, the prevalence of COPD was 174 million and there were approximately 3.2 million deaths due to COPD worldwide. However, the prevalence is likely to be underestimated due to the under diagnosis of COPD. It is caused by prolonged exposure to harmful particles or gases. Cigarette smoking is the most common cause of COPD worldwide. Other causes may include second-hand smoke, environmental and occupational exposures, and alpha-1 antitrypsin deficiency (AATD). COPD is an inflammatory condition involving the airways, lung parenchyma, and pulmonary vasculature. The process is thought to involve oxidative stress and protease-antiprotease imbalances. Emphysema describes one of the structural changes seen in COPD where there is destruction of the alveolar air sacs (gas-exchanging surfaces of the lungs) leading to obstructive physiology. In emphysema, an irritant (e.g., smoking) causes an inflammatory response. The inflammatory response and obstruction of the airways cause a decrease in the forced expiratory volume (FEV1) and tissue destruction leads to airflow limitation and impaired gas exchange. Hyperinflation of the lungs is often seen on imaging studies and occurs due to air trapping from airway collapse during exhalation. The inability to fully exhale also causes elevations in carbon dioxide (CO2) levels. Acute exacerbations of COPD are common and usually occur due to a trigger (e.g., bacterial or viral pneumonia, environmental irritants). There is an increase in inflammation and air trapping often requiring corticosteroid and bronchodilator treatment. [1]

Pathophysiological changes in airway, tissue, and vascular supply to lungs increase airway resistance and air trapping, and decrease lung compliance resulting in increased work of breath, and dyspnea in COPD patients. To avoid dyspnea, COPD patients commonly avoid or limit physical activities which, in turn, lead to decrease in exercise tolerance, and an increase in anxiety, disability, and poor quality of life (QoL). So, comprehensive management including interventions to relieve sensation of dyspnea to improve exercise tolerance and QoL, is needed in this population. Breathing exercise (BE) has been an essential part of a comprehensive pulmonary rehabilitation program, for COPD patients. [2]

Pulmonary rehabilitation is a crucial component of COPD management, leading to positive outcomes in patient symptoms and functioning. Pulmonary rehabilitation includes chest physiotherapy techniques, such as breathing exercises, postural drainage, spirometry, clapping, vibration, and breathing techniques. Breathing exercises, part of the lung rehabilitation program, offer benefits to patients with COPD, including improved breathing patterns, increased arterial oxygen saturation, and enhanced lung volumes. These exercises also improve pulmonary function, respiratory muscle strength, exercise capacity, dyspnea, and health-related quality of life in COPD patients. As a complementary and non-pharmacological therapy, breathing exercises can reduce sleep deprivation and stimulate body and brain function, sympathetic–parasympathetic systems function, and relaxation. Research has shown that slow, paced breathing can enhance vagal activity and improve sleep quality, particularly in insomniacs. [3]

Diaphragmatic breathing (DB) and pursed-lip breathing (PLB) exercises are two commonly used respiratory exercises that can be performed individually or in combination.19 PLB is an important aspect of respiratory exercise training for COPD patients, promoting maximum exhalation and improving patency. PLB can strengthen respira tory muscles, improve oxygen saturation, and prevent bronchiolar collapse.13 DB increases asynchronous and paradoxical ribcage motion, which may account for the work of breathing. The mechanisms responsible for the improvement in dyspnea following these exercises are not fully understood, but several hypotheses have been suggested, including reduction of

minute ventilation, slowing of inspiratory flow rates, improvement of ventilation–perfusion relationships, diminution of the work of breathing, and promotion of a feeling of well-being. [4]

METHOD:

- Systematic review of 10 studies
- **Inclusion criteria:** RCTs, quasi-experimental, and cross-sectional studies investigating breathing exercises in COPD patients
- **Exclusion criteria:** non-English, non-peer-reviewed, and non-COPD studies
- **Search strategy:** PubMed, Scopus, Web of Science, CINAHL, and Cochrane Library
- **Study selection:** independent screening and assessment by two reviewers
- **Data extraction:** standardized form
- **Data synthesis:** narrative synthesis

LITERATURE REVIEW:

This review aims to summarize the existing literature on the effects of breathing exercises in patients with COPD.

1. Sleep Quality and Breathing Exercises

Zahra Dodange Z et al. (2024), conducted a randomized controlled trial to compare the effects of diaphragmatic breathing (DB) and pursed-lip breathing (PLB) exercises on 60 elderly patients along with sleep quality in patients with Chronic Obstructive Pulmonary Disease (COPD). The study aimed to determine whether a specific sequence of breathing exercises could improve sleep quality in patients with COPD. The results of the study showed that the sequence of exercises in Group 1, which consisted of DB followed by PLB, resulted in greater improvement in average sleep quality compared to Group 2. Specifically, the study found that patients in Group 1 demonstrated significant improvements in sleep quality, including reduced sleep latency, increased sleep duration, and improved sleep efficiency. In contrast, patients in Group 2, who received PLB followed by DB, showed minimal improvements in sleep quality. This study suggests that breathing exercises can improve sleep quality in patients with COPD, and that the specific sequence of exercises may play a crucial role in achieving optimal benefits. The findings of this study have important implications for the management of COPD, as poor sleep quality is a common comorbidity in patients with COPD, and can exacerbate symptoms and reduce quality of life. By incorporating breathing exercises into their treatment plan, patients with COPD may be able to improve their sleep quality and overall well-being.[5]

2. Regional Ventilation and Breathing Exercises

Yang L et al. (2023), conducted a randomized controlled trial to investigate the effects of three breathing exercises on regional ventilation in healthy individuals and patients with Chronic Obstructive Pulmonary Disease (COPD). The three breathing exercises examined were diaphragmatic breathing, pursed-lip breathing with full inhalation, and pursed-lip combining diaphragmatic breathing. The study aimed to determine whether these breathing exercises could improve regional ventilation in patients with COPD. The results of the study showed that tidal volume was significantly larger during various breathing exercises compared to quiet tidal breathing, in both healthy and COPD patients. This suggests that breathing exercises can improve regional ventilation in patients with COPD, which may help to increase oxygenation and reduce symptoms of dyspnea. The study's findings have important implications for the management of COPD, as impaired regional ventilation is a hallmark of the disease.

By incorporating breathing exercises into their treatment plan, patients with COPD may be able to improve their lung function and overall quality of life.[4]

3. Dyspnea and Breathing Exercises

Ceyhan Y et al. (2022), conducted a randomized controlled trial to investigate the effects of breathing exercises and inhaler training on the severity of dyspnea and life quality in 67 patients with Chronic Obstructive Pulmonary Disease (COPD). The study aimed to determine whether a combination of breathing exercises and inhaler training could improve symptoms of dyspnea and quality of life in patients with COPD. The results of the study showed that the pursed lips exercise, a type of breathing exercise, and inhaler drug use skills of patients increased significantly, indicating improved lung function and medication adherence. Moreover, the severity of dyspnea, a common symptom of COPD, decreased significantly, suggesting improved respiratory function and reduced breathlessness. The study's findings have important implications for the management of COPD, as dyspnea is a debilitating symptom that significantly impacts quality of life. By incorporating breathing exercises and inhaler training into their treatment plan, patients with COPD may be able to improve their symptoms, lung function, and overall quality of life.[10]

4. Exercise Tolerance and Breathing Exercises

Cabral LF et al. (2022), conducted a randomized controlled trial to evaluate the effect of pursed-lip breathing (PLB) on exercise tolerance, breathing pattern, dynamic hyperinflation, and arterial oxygenation in 40 patients with Chronic Obstructive Pulmonary Disease (COPD) during high-intensity exercise. The study aimed to determine whether PLB, a technique that involves breathing out slowly through pursed lips, could improve exercise performance and reduce respiratory distress in patients with COPD. The results of the study showed that PLB significantly reduced dynamic hyperinflation, which is a condition characterized by excessive air trapping in the lungs, leading to breathing difficulties. Additionally, PLB improved exercise tolerance, as measured by the six-minute walk distance (6MWD), and enhanced breathing pattern, as measured by respiratory rate and tidal volume. Furthermore, PLB increased arterial oxygenation, as measured by pulse oximetry, indicating improved oxygen delivery to the body's tissues. The study's findings suggest that PLB is a valuable technique for improving exercise performance and reducing respiratory distress in patients with COPD, particularly during high-intensity exercise. By incorporating PLB into their exercise routine, patients with COPD may be able to enhance their physical fitness, reduce symptoms of dyspnea, and improve their overall quality of life.[11]

5. Breathlessness and Diaphragmatic Breathing Exercise

Budiman et al. (2020), conducted a quasi-experimental study to investigate the effects of diaphragmatic breathing exercise on the degree of breathlessness in 33 patients with Chronic Obstructive Pulmonary Disease (COPD). The study aimed to determine whether diaphragmatic breathing exercise could alleviate breathlessness, a common and debilitating symptom of COPD. The results of the study showed a significant reduction in the degree of breathlessness after the intervention, indicating that diaphragmatic breathing exercise can effectively reduce breathlessness in patients with COPD. This finding is clinically significant, as breathlessness is a major contributor to decreased quality of life and increased morbidity in patients with COPD. The study's results suggest that diaphragmatic breathing exercise can be a useful adjunctive therapy for managing breathlessness in patients with COPD, and may be incorporated into pulmonary rehabilitation programs to improve patient outcomes.[6]

6. Respiratory Function and Breathing Exercises

Mendes L et al. (2018), conducted a cross sectional study to investigate the effects of diaphragmatic

breathing with and without pursed-lips breathing on respiratory function in 17 patients with Chronic Obstructive Pulmonary Disease (COPD). The study aimed to determine whether diaphragmatic breathing, alone or in combination with pursed-lips breathing, could improve respiratory function in patients with COPD. The results of the study showed that both diaphragmatic breathing and diaphragmatic breathing plus pursed-lips breathing promoted a significant increase in chest wall tidal volume and its compartments, indicating improved lung function and respiratory mechanics. This finding is clinically significant, as impaired respiratory function is a hallmark of COPD. The study's results suggest that breathing exercises, particularly diaphragmatic breathing with or without pursed-lips breathing, can be a useful adjunctive therapy for improving respiratory function in patients with COPD, and may be incorporated into pulmonary rehabilitation programs to enhance patient outcomes.[7]

7. Exercise Capacity and Breathing Exercises

Fatemeh Z et al. (2018), conducted a randomized controlled trial to compare the effects of breathing exercises alone and combined with breathing-stretching exercises on respiratory indices, disease severity, and exercise capacity in 32 patients with Chronic Obstructive Pulmonary Disease (COPD). The study aimed to determine whether the addition of breathing-stretching exercises to breathing exercises could enhance the benefits of pulmonary rehabilitation in patients with COPD. The results of the study showed that the combination of routine breathing and breathing-stretching exercises resulted in significant improvements in respiratory indices, including lung function and gas exchange, compared to breathing exercises alone. Furthermore, the combined exercise program reduced disease severity, as measured by the COPD Assessment Test (CAT), and increased exercise capacity, as measured by the six-minute walk distance (6MWD). This study suggests that the addition of breathing-stretching exercises to breathing exercises can enhance the benefits of pulmonary rehabilitation in patients with COPD, leading to improved respiratory function, reduced disease severity, and increased exercise capacity. The findings of this study have important implications for the development of comprehensive pulmonary rehabilitation programs for patients with COPD.[9]

8. Ventilatory Functions and Breathing Exercises

Abdelaal et al. (2015), conducted a randomized controlled trial to investigate the effects of diaphragmatic and costal manipulation on ventilatory functions and functional capacity in 195 males with Chronic Obstructive Pulmonary Disease (COPD). The study aimed to determine whether diaphragmatic and costal manipulative procedures could improve lung function and exercise capacity in patients with COPD. The results of the study showed that diaphragmatic and costal manipulative procedures are effective therapeutic tools in improving ventilatory functions and functional capacity in COPD patients. Specifically, the study found that patients who received diaphragmatic and costal manipulation demonstrated significant improvements in lung function, including increased forced expiratory volume (FEV1) and forced vital capacity (FVC). Additionally, the study found that patients who received diaphragmatic and costal manipulation also demonstrated significant improvements in functional capacity, including increased six-minute walk distance (6MWD) and reduced dyspnea. The study suggests that diaphragmatic and costal manipulation may be a useful adjunctive therapy for patients with COPD, as it may help to improve lung function and exercise capacity, and reduce symptoms of dyspnea. The findings of this study have important implications for the management of COPD, as they highlight the potential benefits of diaphragmatic and costal manipulation as a complementary therapy for patients with COPD.[8]

9. Volitional Pursed-Lip Breathing and Exercise Capacity

Bhatt SP et al. (2013), conducted a randomized controlled trial to investigate the effects of volitional pursed-lip breathing (PLB) on exercise capacity in 14 patients with moderate to severe chronic Obstructive Pulmonary Disease (COPD) who did not spontaneously adopt PLB. The study aimed to determine whether teaching patients with COPD to use PLB during exercise could improve their exercise capacity. The results of the study showed that pursed-lip breathing has an acute benefit on exercise capacity in patients with COPD. Specifically, the study found that patients who used PLB during exercise were able to walk further and longer than those who did not use PLB. The study suggests that PLB may be a useful technique for improving exercise capacity in patients with COPD, particularly those who do not spontaneously adopt this breathing technique. The findings of this study have important implications for the management of COPD, as they suggest that teaching patients to use PLB during exercise may be a simple and effective way to improve their exercise capacity and overall quality of life.[12]

10. Breathing Exercises with Positive Expiratory Pressure and Reading Aloud

Özden G et al. (2013), conducted a randomized controlled trial to investigate the efficacy of breathing exercises with Positive Expiratory Pressure (PEP) and reading aloud on 103 patients with Chronic Obstructive Pulmonary Disease (COPD). The study aimed to determine whether the combination of breathing exercises with PEP and reading aloud could improve respiratory function, reduce fatigue and dyspnea, and enhance overall quality of life in patients with COPD. The results of the study demonstrated significant improvements in respiratory function, as measured by forced expiratory volume (FEV1) and forced vital capacity (FVC), following the intervention. Additionally, patients reported reduced fatigue and dyspnea, as measured by the Borg Dyspnea Scale and the Medical Research Council (MRC) Dyspnea Scale, respectively. The study's findings suggest that breathing exercises with PEP and reading aloud may be beneficial adjunctive therapies for COPD patients, as they can improve respiratory function, reduce symptoms of fatigue and dyspnea, and enhance overall quality of life. The incorporation of these therapies into pulmonary rehabilitation programs may provide additional benefits for patients with COPD, beyond those achieved with traditional therapies alone.[13]

This review suggests that breathing exercises can improve respiratory function, exercise capacity, sleep quality, and reduce breathlessness, dyspnea, and fatigue in patients with COPD. Breathing exercises with Positive Expiratory Pressure (PEP) and reading aloud may be beneficial adjunctive therapies for COPD patients. The evidence supports the incorporation of breathing exercises into the management plan for patients with COPD. However, further research is needed to determine the optimal type, frequency, and duration of breathing exercises for patients with COPD. Additionally, studies investigating the long-term effects of breathing exercises on COPD outcomes are warranted.

RESULT:

This systematic review of 10 studies found that breathing exercises significantly improve various outcomes in patients with Chronic Obstructive Pulmonary Disease (COPD), including respiratory function, exercise capacity, sleep quality, breathlessness, dyspnea, and fatigue. Specifically, studies showed that breathing exercises increased tidal volume, improved sleep quality, reduced breathlessness and dyspnea, and enhanced exercise capacity. Additionally, breathing exercises with Positive Expiratory Pressure (PEP) and reading aloud were found to improve respiratory function, fatigue, and dyspnea. Overall, the evidence suggests that breathing exercises are a beneficial adjunctive therapy for patients

with COPD, improving symptoms, functional capacity, and quality of life.

DISCUSSION:

The results of this systematic review suggest that breathing exercises can improve various outcomes in patients with COPD, including respiratory function, exercise capacity, sleep quality, breathlessness, dyspnea, and fatigue. The evidence supports the incorporation of breathing exercises into the management plan for patients with COPD. The mechanisms by which breathing exercises improve outcomes in COPD patients are not fully understood. However, several possible explanations have been proposed:

- Breathing exercises may strengthen the diaphragm and other respiratory muscles, improving respiratory function and exercise capacity.
- Breathing exercises may improve lung volumes and capacities, reducing dyspnea and fatigue.
- Breathing exercises may improve sleep quality by reducing symptoms of COPD and improving respiratory function during sleep.

The results of this systematic review are consistent with previous studies that have investigated the effects of breathing exercises on outcomes in COPD patients. For example, a systematic review by McCarthy et al. (2015) found that breathing exercises improved respiratory function, exercise capacity, and quality of life in patients with COPD. The findings of this systematic review have implications for clinical practice. Breathing exercises can be incorporated into the management plan for patients with COPD, either as a standalone intervention or in combination with other therapies. Healthcare providers should consider recommending breathing exercises to patients with COPD, particularly those with symptoms of dyspnea, fatigue, and poor sleep quality.

CONCLUSION:

This systematic review provides evidence that breathing exercises can improve various outcomes in patients with COPD, including respiratory function, exercise capacity, sleep quality, breathlessness, dyspnea, and fatigue. The mechanisms by which breathing exercises improve outcomes in COPD patients are not fully understood, but may involve strengthening of respiratory muscles, improvement in lung volumes and capacities, and reduction in symptoms of COPD.

The findings of this systematic review have implications for clinical practice. Breathing exercises can be incorporated into the management plan for patients with COPD, either as a standalone intervention or in combination with other therapies. Healthcare providers should consider recommending breathing exercises to patients with COPD, particularly those with symptoms of dyspnea, fatigue, and poor sleep quality.

Future research is needed to determine the optimal type, frequency, and duration of breathing exercises for patients with COPD. Additionally, studies investigating the long-term effects of breathing exercises on COPD outcomes are warranted. Further research is also needed to explore the mechanisms by which breathing exercises improve outcomes in COPD patients, and to identify the most effective ways to implement breathing exercises in clinical practice.

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