LITERATURE REVIEW

Functional Breathing and Approaches in Pulmonary Rehabilitation: A Literature Review

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ABSTRACT

Introduction: Pulmonary rehabilitation is a multidisciplinary approach to improving individuals' quality of life and functional capacity with chronic respiratory diseases. Functional breathing exercises are essential to pulmonary rehabilitation programs, focusing on coordinating respiratory and postural mechanisms to optimize gas exchange, reduce dyspnea, and improve exercise tolerance. This study aimed to discuss the importance of functional breathing exercises in pulmonary rehabilitation and outlines the fundamental principles and techniques used in their implementation.

Methods: Original articles and systematic or narrative reviews on the implementation of functional breathing exercises in pulmonary rehabilitation in patients with chronic lung disease were searched using PubMed, Google Scholar, and the Cochrane Library.

Results: The principle of functional breathing is the use of an efficient respiratory system and respiratory muscles that work optimally. The techniques included in functional breathing are postural alignment, diaphragmatic breathing, pursed-lip breathing and coordinated breathing and movement.

Discussion: To obtain optimal results, exercise prescription must be tailored to the patient's needs and abilities. Regular monitoring and assessment is required to ensure exercises are performed with proper technique.

Conclusion: Functional breathing exercises play a vital role in the success of pulmonary rehabilitation programs. By improving respiratory function and reducing dyspnea, these exercises can help patients better manage their chronic respiratory diseases and maintain an active, high-quality lifestyle.

Keywords: Chronic respiratory diseases, exercise tolerance, functional breathing, gas exchange, pulmonary rehabilitation

ABSTRAK

Pendahuluan: Rehabilitasi paru merupakan pendekatan tim multidisplin untuk meningkatkan kualitas hidup dan kapasitas fungsional penderita penyakit paru kronik. Functional breathing exercise merupakan salah satu komponen penting dari program rehabilitasi paru yang berfokus melatih koordinasi respirasi dan mekanisme postural untuk mengoptimalkan pertukaran gas, mengurangi sesak dan memperbaiki toleransi latihan. Artikel ini bertujuan mendiskusikan prinsip dasar dan teknik implementasi functional breathing exercise dalam rehabilitasi paru.

Metode: Artikel asli dan tinjauan sistematis atau naratif mengenai penerapan latihan pernapasan fungsional dalam rehabilitasi paru pada pasien penyakit paru kronis dicari menggunakan PubMed, Google Scholar, dan Cochrane Library.

Hasil: Prinsip dalam functional breathing adalah penggunaan sistem respirasi yang efisien dan otot respirasi yang bekerja optimal. Teknik yang termasuk dalam functional breathing exercise yaitu postural aligment, pernafasan diafragma, pursed-lip breathing dan koordinasi nafas dan gerakan.

Diskusi: Untuk dapat memperoleh hasil yang optimal, peresepan latihan harus taylor-made disesuaikan dengan kebutuhan dan kemampuan pasien. Monitoring dan penilaian secara berkala diperlukan untuk memastikan latihan dilakukan dengan teknik yang tepat.

Kesimpulan: Functional breathing exercise memiliki peranan penting dalam keberhasilan program rehabilitasi paru. Dengan perbaikan fungsi respirasi dan mengurangi sesak nafas, latihan ini membantu pasien dalam tatalaksana penyakit paru kronik yang lebih baik dan mempertahakan pasien agar tetap aktif sehingga tercapai kualitas hidup yang baik.

Kata kunci: Functional breathing, penyakit paru kronik, pertukaran gas, rehabilitasi paru, toleransi latihan

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INTRODUCTION

Pulmonary rehabilitation is a comprehensive, evidence-based approach to improving individuals' quality of life and functional capacity with chronic respiratory diseases.[1–3] It is designed to address patients physical, emotional, and social needs, helping them better manage their condition and maintain an active lifestyle.[1,4] Functional breathing exercises are crucial to pulmonary rehabilitation programs, as they help optimize gas exchange, reduce dyspnea, and improve exercise tolerance.[1,5]

One of the most critical goals in pulmonary rehabilitation is to increase physical activity.[6] The symptom that most limits patients with chronic lung disease from performing daily activities and physical exercise is breathlessness.[7–9] Shortness of breath that appeared during exercise became a significant burden experienced by the patient and made the patient worry until he stopped training.[8,10] In addition, the systemic consequences of chronic lung disease, such as cardiovascular complications, muscle weakness, and osteoporosis, will directly or indirectly lead to an inactive lifestyle. This will become a vicious cycle that, if not broken, will increase mortality in chronic lung disease patients. One of the efforts that can be optimized is with functional breathing.[2,3,5]

Functional breathing exercises are designed to improve the coordination of respiratory and postural mechanisms, allowing for more efficient gas exchange and reduced dyspnea. These exercises can be performed in various positions, including sitting, standing, and lying down, and can be adapted to individual patient's needs and abilities. By incorporating functional breathing exercises into pulmonary rehabilitation programs, healthcare professionals can help patients better manage their symptoms and improve their overall quality of life.[1,10]

According to Courtney R., an osteopath, functional breathing exercise refers to efficient and optimal breathing. Although this term has not been widely used in studies, its principles and techniques have been included in pulmonary rehabilitation programs. This review discusses the importance of the functional breathing approach and its implementation techniques in pulmonary rehabilitation.

METHODS

This literature review seeks current evidence on implementing functional breathing exercises in pulmonary rehabilitation. Search for English literature using PubMed, Google Scholar, and the Cochrane Library in the last ten years. The search terms (MesH) were "functional breathing," "breathing exercise," "diaphragmatic breathing," "pursed-lip breathing," "pulmonary rehabilitation," "chronic pulmonary obstructive disease," "review," and "randomized controlled trial." There were reviews of 5 articles and 11 randomized controlled trials. In this study, a systematic analysis of the available databases was not carried out.

RESULTS

The Role of Functional Breathing in Pulmonary Rehabilitation

Pulmonary rehabilitation is one of the non-pharmacological treatments proven effective for pulmonary diseases, especially COPD.[10] Based on the American Thoracic Society/ European Respiratory Society statement, pulmonary rehabilitation consists of exercise training, chest physical therapy techniques (including functional breathing, postural drainage, and airway clearance techniques), nutritional support, education, and psychological support.[3,6] Functional breathing is an important component of pulmonary rehabilitation. It provides an effective method for long-term improvement of patients' self-

efficacy and is recommended as a practical exercise modality in patients with COPD.[5,11] In this paper, much will be discussed related to functional breathing.

Functional Breathing is just like normal regular breathing. To breathe normally, we need all systems to work efficiently and optimally.[12] When these two things are not achieved, dysfunctional breathing will occur. Efficient use of the respiration system aims to obtain optimal oxygen uptake and release carbon dioxide. Optimal is related to respiratory muscle. In a normal state of relaxation, the two compartments of the chest wall, or thoracic and abdominal, work together to make the respiratory pump work effectively, which produces coordinated movements of the diaphragm, scalenes, intercostals, abdominals, and respiratory accessory muscles. If the respiratory muscle does not work correctly, it will interfere with breathing efficiency.[7,13] In normal subjects, nasal breathing is more efficient than mouth breathing. In conditions of hypertrophied concha, allergies or rhinitis can cause a person to breathe through the mouth (mouth breather). Mouth breathing is very annoying because there is no difference in atmospheric and lung pressure, so gas exchange is inadequate. Nasal breathing is more efficient as it filters, warms, and humidifies the air before it reaches the lungs, thus optimizing oxygen absorption. In addition, nasal breathing is essential for maximum washout of CO2 out of the body. Intake of oxygen into the body will not be optimal if CO2 does not exit optimally.[2,14]

Functional breathing is adaptive and appropriate.[13] In healthy subjects, breathing patterns change every time, sometimes with more thoracic breathing and sometimes with more abdominal breathing. By applying functional breathing, the subject can adapt to changes in conditions appropriately to activity and rest. When resting, we must provide much less ventilation than when doing activities. If breathing does not adapt to resting conditions, the subject's breathing will exceed their metabolic needs. In people with COPD, this will undoubtedly increase the energy expended, making fatigue easier.[15,16]

Breathing exercise reduces hyperinflation by improving respiratory muscle strength and endurance and correcting abnormal thoracic and abdominal breathing patterns. How we breathe can significantly impact performance, endurance, and overall health.[3,17] Functional breathing is essential for overall well-being. It impacts cardiovascular health, efficient oxygenation, emotional regulation, and cognitive function. Improving oxygenation can maximize oxygen delivery to skeletal muscles, increase endurance, and reduce fatigue complaints during exercise.[18]the diaphragmatic breathing pattern seems to be the most favourable. However, recent reports indicate that athletes often have dysfunctional breathing patterns, which may be associated with an increased risk of musculoskeletal injuries. The influence of the type of breathing pattern on the mechanical airways in athletes has not been investigated. The aim of the present study was to determine the characteristics and relationships between breathing patterns and respiratory function in athletes. This study included 69 Polish elite endurance athletes (♂40, ♀29 Functional breathing exercises activate core muscle

use, improving trunk stability and increasing respiratory efficiency. They also increase the virtuous cycle that maintains the body's homeostasis. Stress reduction is obtained by activating the parasympathetic nervous system, raising awareness of the mind-body connection, relaxation, and mental well-being.[7,15]

Key Principles and Techniques of Functional Breathing

a. Postural alignment: Proper posture is essential for optimal respiratory function. Patients should be encouraged to sit upright with their shoulders relaxed and their spine straight. This can help to expand the chest wall and improve lung capacity.[19]

In the upright position, during normal breathing, the diaphragm is lower than in the supine position due to gravity. During the supine position, the movement of the diaphragm is more significant than during sitting. This is because the weight of the abdominal component during the supine position pushes the diaphragm further into the chest cavity than during sitting. The diaphragm has two critical roles: stability and breathing, especially during body movement.[20]

The soda pop can model theory explains the relationship between the diaphragm and its role in maintaining trunk stability. In this model, the trunk is depicted as a cylindrical soda pop can, with the upper valve being the vocal cord structure and the pelvic floor muscles connected by the diaphragm at the center of the can as the base valve. To keep the can structure from collapsing, the carbonated liquid in the can is positively pressurized to maintain this condition. This is analogous to intra-thoracic or intraabdominal positive pressure working against external pressure and gravity to stabilize the torso. The prerequisite for generating positive pressure is if the contraction of the intercostal muscles in the thoracic and transversus abdominis muscles in the abdomen is optimal, the role of vocal cords and an intact pelvic floor will ensure an excellent closed system.[20]

Subjects with poor posture, scapular dyskinesia, low back pain, neck pain, and temporomandibular joint pain will experience the wrong breathing mechanism. According to Vickery, decreased abdominal motion relative to upper thoracic motion confirms poor diaphragm movement. The diaphragm is the crucial prime mover of the respiratory pump attached to the lower six ribs, the xiphoid process of the sternum, and the lumbar vertebral column (L1-3). Hodges et al. stated that the diaphragm has both postural and respiratory functions, so interference with one will affect the other.[21]

Respiratory muscles become shortened or hypertonic under stress or disease conditions, decreasing strength and inefficiency. There is a loss of normal coordination function and an increased demand for motor control mechanisms. The ability of respiratory muscles to create fine-tuning adjustments necessary for postural support is also impaired.[22]

b. Diaphragmatic breathing: Diaphragmatic breathing, also known as belly breathing, involves using the diaphragm to initiate inhalation and exhalation. The patient should be instructed to place one hand on the chest

and the other on the abdomen, focusing on expanding the abdomen during inhalation and contracting during exhalation.[4,12,16]

Dome-shaped, parachute-like diaphragm consisting of 4 quadrants: upper, lower, right, and left. The right-left phrenic nerve innervates them. Disease, surgery, and inflammatory processes may weaken the diaphragm on one side, referred to as the hemidiaphragm. In conditions of under stimulation, we use the anterior muscles more often; the posterior part of the diaphragm is only used to maintain posture, so it often spasms. The diaphragm is located at the last rib, rotating backward to the lumbar and core muscles. Therefore, patients with complaints of lower back pain usually experience respiratory dysfunction. Diaphragmatic breathing involves synchronizing the movements of the upper rib cage, lower rib cage, and abdomen. Focus on using the diaphragm as the primary breathing muscle. Exhale slowly and thoroughly, allowing the diaphragm to rise and the abdomen to contract. Engage the diaphragm to take a deep breath, allowing maximum air intake.[12,15,20]

Diaphragm movement positively correlates with lung volume; using the diaphragm consciously during exhalation will increase lung capacity. Diaphragmatic breathing that controls the respiratory rate at six breaths/minute reduces the chemoreflex response to hypoxia and hypercapnia compared to normal breathing. A decreased respiratory rate increases tidal volume, which improves oxygen ventilation efficiency through alveolar recruitment and distension, increases alveolar ventilation due to reduced alveolar dead space, and improves oxygen saturation. Therefore, diaphragmatic breathing has the potential to increase blood oxygen levels.[12]

Breathing has a close relationship with the function of the autonomic nervous system. The phrenic nerve that controls diaphragm movement is connected to the vagus (parasympathetic) nerve. A decrease in respiratory rate is produced by diaphragmatic breathing through parasympathetic activation, suppressing sympathetic activity.[12] Chang et al. reported that slow breathing of eight breaths/minute makes the balance of parasympathetic nerve activity dominant. Diaphragmatic breathing can regulate hypoactive sympathetic and parasympathetic activity, which is good for cardiovascular health.[23] The movement of the diaphragm, directly and indirectly, affects the sympathetic and parasympathetic nervous systems, motor nerve activity, and brain mass. In addition, a study by Jerath et al. showed that breathing stimulates vagal activation of the gamma-aminobutyric pathways in the brain, which plays a role in managing stress and anxiety. This is very beneficial in COPD patients who have anxiety in doing daily activities.[24]

Diaphragmatic breathing minimizes disease-induced respiratory demand, improving breathing patterns and ventilation efficiency without causing shortness of breath.[8] Practicing diaphragmatic breathing can increase the strength and endurance of the diaphragm muscle. Mendes et al. 2019 showed that diaphragmatic breathing combined with pursed-lip breathing can increase tidal volume, improve chest wall volume, and reduce diaphragm fatigue by reducing the respiratory

rate. This breathing technique can be given to patients at all stages of COPD because it is simple to apply and has low serious side effects during exercise.[12,16]

The diaphragm has two functions: posture and respiration.[25] When doing diaphragm exercises, a backrest can be given to rest the back so that the diaphragm works more efficiently as a respiration muscle. The lungs are shaped like three dimensions; if those that develop are not the same, the lungs that expand will not be the same. Similarly, when deflating, the expelling air is inefficient if there is a collapsed part. For example, the incoming air is difficult to get out in people with COPD, and removing it requires efficient breathing.[12,15,26]

Standard diaphragm exercises are performed in an upright position and stabilize posture. Tactile stimulation is provided by placing one of the patient's hands on their abdomen and the other hand on their chest. The patient is instructed to inhale from the nose of the inflated abdomen, hold for a count of 5, and then exhale the deflated abdomen. Ensure that chest expansion does not occur by comparing the movement of the chest abdomen from the tactile sensor of the hand. The movement is repeated ten times each session, performed for 10-30 minutes/day. After completing one session, the patient can rest for about 20 seconds or adjust to the patient's ability. Exercise is performed every weekday (5 times a week).[16,20,27]

In addition to standardized exercises, diaphragm exercises can be performed by undirected pressure biofeedback using a simple spring manometer commonly used to measure blood pressure. Before doing the exercise, we can quantitatively determine which part of the diaphragm is weak using the manometer. The parameter seen is the change in pressure seen on the manometer. This exercise can be done in a standing position, sitting position, or lying on the back or stomach. Ensure the patient is relaxed and calm and the stomach is not complete or at least 1 hour after eating before the exercise. The manometer is placed at the lumbosacral angle (the center of the lumbar spine from L1 to about L3). The manometer was developed and held in a pressure position of 40 mmHg. The patient is instructed to inhale and inflate the abdomen until it presses the manometer by 2-4 mmHg, hold for a count of 5, and then release. The movement was repeated ten times in each session. Exercise was done every weekday (5 times a week) for four weeks.[20,27]

c. Pursed-lip breathing (PLB): PLB involves exhaling through pursed lips, which can help slow down the breathing process and reduce air trapping. This technique can be particularly beneficial for COPD patients.[28]

Saenge introduced PLB as a self-initiate technique in emphysema patients in 1910 and Hofbauer in 1925. Pursed-lip breathing involves inhaling through the nose for two counts and exhaling through pursed lips for four counts. This breathing technique helps improve ventilation by decreasing minute ventilation and breathing frequency.[29,30]

Pursed-lip breathing maintains positive pressure in the airways and prevents premature airway collapse. In the case of COPD, the lack of elastic recoil will cause airway collapse and

cause air to be trapped in the alveoli (bullae), resulting in CO2 retention. Theoretically, PLB forms high pressure on the airway by pressing the lip or tightly pursed lip to prevent sudden alveoli collapse. PLB is important so that turbulence occurs, mucus can move upwards, and CO2 can escape. The positive pressure created counteracts the force exerted by the airway on flow exhalation, so air flows from the inside out.[29–31]

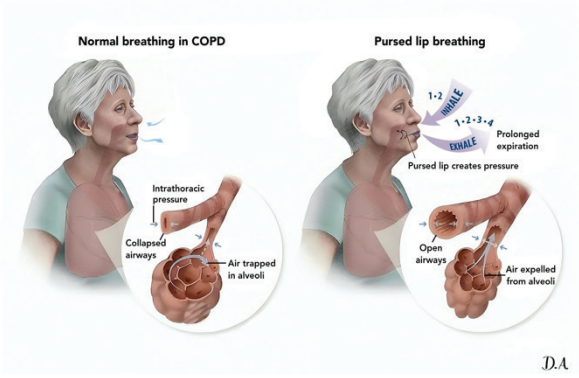

Figure 1. Pursed-lip breathing technique in COPD

The study of Cabral et al. reported PLB reduced expiratory peak flow and respiratory rate, improved exercise tolerance, and arterial oxygenation in moderate stable COPD patients.[32] In addition, a study by Nield et al. on COPD subjects reported a significant improvement in dyspnea score at week 12 in the group given PLB compared to the control group and subjects given expiratory muscle training.[33]

Not all patients with dyspnea complaints are appropriate for pursed-lip breathing exercises. However, this technique is helpful if done correctly in conditions of air trapping that cause hypercapnia, such as in COPD patients.[28] Physiatrist assessment before giving this exercise is very important. If facilities are available, end-tidal CO2 testing can be done before giving this exercise. Pursed-lip breathing is not appropriate for dyspnoea caused by hypocapnia. CO2 is an essential biomarker of breathing pattern regulation and efficiency. CO2 hypersensitivity is also known as a biomarker of anxiety disorder. High CO2, which triggers anxiety and panic, will increase the risk of ventilatory pump failure in COPD. Anxiety leads to low compliance in pulmonary rehabilitation and poor outcomes.[10,34]

d. Coordinated breathing and movement: Functional breathing exercises often involve coordinating breathing with movement, such as walking or performing arm circles. This can help to improve cardiovascular fitness and reduce dyspnoea.[6,35]

Maintaining a proper breathing pattern is key to achieving optimal exercise capacity.[21,36] A dysfunctional breathing pattern is associated with decreased lung function tests in patients with chronic lung disease. The study by Sikora et al., 2024, showed low respiration system efficiency in subjects with dysfunctional breathing patterns.[18] Dysfunctional breathing patterns are commonly found in subjects with low physical activity (sedentary) and patients with chronic respiratory diseases. Using respiratory muscles other than the diaphragm results in fatigue during exercise and reduces oxygen supply to working muscles.[16]

During exercise or physical activity, the surface area of the alveoli will increase, and contact with the pulmonary capillary becomes greater. The Sikora et al. 2024 study showed that diaphragmatic breathing during exercise would provide better benefits than thoracic

breathing in terms of higher lung diffusing capacity for carbon monoxide (DLCO) results in healthy subjects. [18] DLCO is a gas exchange measurement that reflects the complex interactions at the alveolar-capillary interface. DLCO reflects changes in lung functional volume and gas transport across the alveolar-capillary membrane at the same time. Pathological changes that characterize COPD patients are airway abnormalities, lung parenchyma, and pulmonary vasculature. Hyperinflation and pulmonary hypertension that occur in patients with COPD both affect lung diffusing capacity, resulting in a decrease in DLCO.[37]

Functional breathing is also included in managing energy conservation techniques that must be implemented in COPD patients.[9,11] The study of Cazorla, 2023 in patients with COPD who underwent pulmonary rehabilitation in an inpatient setting showed decreased dyspnoea perception in patients who were given breathing exercises during exercise.[7] Exercise training improves exercise tolerance, decreasing the need for ventilation, which is particularly relevant in respiratory patients. Alternating respiratory muscle recruitment and promoting changes in breathing patterns towards functional breathing and operating lung volume reduces the intensity of breathlessness during activity. Prieur et al. showed that the breathing exercise energy conservation strategy enabled COPD patients to complete the stair-climbing task without affecting total task time.[38]

Implementation of Functional Breathing in Pulmonary Rehabilitation Programs

Functional breathing exercises should be tailored to the patient's needs and abilities. Healthcare professionals should work closely with patients to develop a personalized exercise program that incorporates functional breathing techniques and other aspects of pulmonary rehabilitation, such as aerobic exercise, strength training, and education on disease management.[10,39]

The core components of exercise in pulmonary rehabilitation are strengthening endurance and other exercises related to respiratory muscles and extremities to carry out daily activities. These exercises are tailor-made according to the patient's ability and need to provide specific changes in the underlying pathophysiology to achieve the goals of pulmonary rehabilitation, namely increasing functional ability, improving symptoms, and improving quality of life. The program in pulmonary rehabilitation is tailored to the patient's access to health facilities, understanding, and ability to complete the rehabilitation program. Patient compliance is the key to a successful pulmonary rehabilitation program.

The initial stage of pulmonary rehabilitation is patient assessment. Patients referred by colleagues are assessed for respiratory function problems. Several examinations can be done to determine the right dose of functional breathing, namely a lung function test (spirometry), diaphragm strength with a spring tensimeter (manometer), assessment of inspiratory and expiratory muscle strength, and assessment of expiratory ability.

One of the objective assessments of expiratory ability is using the Peak Flow Meter tool. This tool shows the patient's expiratory ability

using a scale from 0 to 500 ml. The patient is instructed to inhale, then blow out as hard and fast as possible in a single blow. If done with open glottis or huffing, the rate of expiration is assessed, known as the expiratory rate or peak respiration flow. If we do it with closed glottis, the purpose is to determine the ability to cough and whether it is sufficient to remove phlegm. Based on a scale of <160 ml, including less, 160-270 ml, moderate, and above 270 ml, including good cough ability. We can optimize moderate ability with breathing exercises in pulmonary rehabilitation. Meanwhile, it must be assisted if it is lacking because it indicates that the diaphragm muscle is weak.[17,20]

The current guideline recommends that pulmonary rehabilitation should be considered in patients with persistent symptoms and limitations in physical activity, as well as for subjects who cannot adjust to their disease despite optimal medical management. Pulmonary rehabilitation benefits COPD patients regardless of the degree of baseline dyspnoea. Recent recommendations recommend pulmonary rehabilitation for a minimum of 8 weeks, with a frequency of two to three times a week.[6,10]

There are currently no studies on the long-term benefits of pulmonary rehabilitation. If exercise training is stopped, the effects of the training will also stop. Therefore, it is essential to perform pulmonary rehabilitation for more than eight weeks, as it allows patients to change their behavior and make this aspect of pulmonary rehabilitation, namely functional breathing, a habit/lifestyle in patients with chronic respiratory disease.[5,39]

DISCUSSION

There are not many studies that specifically discuss functional breathing. Functional breathing exercise is a simple breathing technique that patients with chronic lung disease should apply to improve lung function and functional ability as optimally as possible to achieve well-being in daily activities.[11,25,35]

One of the barriers to participating in pulmonary rehabilitation in patients with chronic lung disease is the anxiety of the onset of tightness when performing movements.[9] It is essential to educate patients on what activities are safe for them and techniques that they can perform. Functional breathing exercise is a type of aerobic exercise that integrates mind, body, and spirit and is theoretically based on the dynamic response of the respiratory system. Based on the study of Cao et al. 2022, this exercise reduces the adverse effects of decreased lung function, increases respiratory muscle strength and endurance, optimizes chest wall and abdominal movement, reduces dynamic hyperinflation, and improves gas exchange.[16] This is also supported by a study by Wang et al. in 2020. Functional breathing exercises help reduce symptoms of shortness of breath, minimizing disability and reducing anxiety in COVID-19 patients.[1]

Pursed lip breathing can increase expiratory time, decrease breathing frequency, decrease end-expiratory lung volume, increase exercise capacity, and effectively reduce dyspnoea.[29,32] While diaphragmatic breathing focuses on improving breathing patterns, increasing the use of the diaphragm muscle, and reducing the use of the auxiliary muscles of the breath

to improve ventilation efficiency and oxygen saturation, based on the study of Jones et al., the combination of both breathing exercises provides a significant reduction in breathing frequency and oxygen consumption compared to spontaneous breathing. The Mendes et al. 2020 study also supports this; the decrease in breathing frequency is more significant when the two exercises are combined compared to quiet and diaphragmatic breathing alone. A reduction in expiratory flow causes a decrease in pressure along the airways, which prevents airway collapse and reduces air trapping. Subjects with minor lung recoil elastic pressure benefit most from this technique. Combining the two exercises will decrease the duty cycle and increase the time for lung emptying.[31]

Functional breathing can be applied in inpatient, outpatient, and home-based pulmonary rehabilitation settings.[3,10,22] Lu et al. 2020 meta-analysis study proved home-based breathing exercise is safe and benefits lung function, respiratory muscle strength, exercise capacity, dyspnoea, and Health-related Quality of Life for stable COPD patients.[22,39] Some studies report less effective results from the PLB technique due to the difficulty of providing standardized instructions so that subjects rarely use and perceive the technique as inappropriate.[30] Furthermore, this technique should not be performed continuously as it may induce fatigue. Regular monitoring and reassessment of patients' progress are essential to ensure that the exercise program remains effective and safe.[1,16,30]

CONCLUSION

Functional breathing exercises play a vital role in the success of pulmonary rehabilitation programs. By improving respiratory function and reducing dyspnea, these exercises can help patients better manage their chronic respiratory diseases and maintain an active, high-quality lifestyle. Healthcare professionals should be well-versed in the principles and techniques of functional breathing and prepared to adapt their approach to each patient's unique needs

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