2024, Retos, 59, 690-696
© Copyright: Federación Española de Asociaciones de Docentes de Educación Física (FEADEF) ISSN: Edición impresa: 1579-1726. Edición Web: 1988-2041 (https://recyt.fecyt.es/index.php/retos/index)

Effect of exercise rehabilitation on breath muscles in COPD patients
Efecto de la rehabilitación con ejercicios sobre los músculos respiratorios en pacientes con EPOC

*Hawkar S. Ahmed, ** Shimal H. Hamad, ***Ammar Hamza Hadi, ****Hussain Ali Khudair, ****Riyadh Hasan Salih
*University of Sulaimani (Iraq), ** Soran University (Iraq), ***University of Babylon (Iraq), ****Al Mustakbal University (Iraq)

Abstract. This study aimed to determine the effect of exercise rehabilitation on the breathing muscles of Chronic Obstructive Pulmonary Disease (COPD) patients. Thirty patients (age 52 ± 0.66 years; body mass 66.15 ± 0.75 kg; height 176.17 ± 2.45 cm) with COPD were included in the study. The study used the experimental method by designing a three-month exercise rehabilitation program and using specific exercises to help patients reduce shortness of breath and strengthen their inspiratory and expiratory muscles. The current study was conducted at Babylon's pulmonary rehabilitation center. The Forced Expiratory Volume in the first second (FEV1), the Maximum Inspiratory Pressure (PImax), the maximum expiratory pressure (PEmax), and shortness of breath were all measured. The result shows that the difference in the shortness of breath (Borg Scale) between the pre and post-tests is insignificant at the error rate (5%). Furthermore, the value of calculated T (1.66) is smaller than the value of tabular T (2.57), indicating that there has been no improvement in the level of shortness of breath for the control group.

The difference in the level of shortness of breath shown in the table is significant at the error rate (5%). Furthermore, the pre- and post-tests are calculated as T(3.24), greater than the value of tabular T (2.57). Exercise rehabilitation altered FEV1, PImax, PEmax, and shortness of breath in COPD patients in the experimental group, pre-and post-tests supporting the experimental community, suggesting that physical activity affected FEV1, PImax, PEmax, and shortness of breath. According to our study, physical exercise improves COPD patients' respiratory muscles. This study concluded that patients expressed a desire to continue the exercise.
Keywords: physical exercise, breathing muscles, COPD patients.

Resumen. Este estudio tuvo como objetivo determinar el efecto de la rehabilitación con ejercicios en los músculos respiratorios de pacientes con enfermedad pulmonar obstructiva crónica (EPOC). Se incluyeron en el estudio treinta pacientes (edad 52 ± 0,66 años; masa corporal 66,15 ± 0,75 kg; altura 176,17 ± 2,45 cm) con EPOC. El estudio utilizó el método experimental diseñando un programa de rehabilitación de ejercicios de tres meses y utilizando ejercicios específicos para ayudar a los pacientes a reducir la dificultad para respirar y fortalecer sus músculos inspiratorios y espiratorios. El estudio actual se realizó en el centro de rehabilitación pulmonar de Babylon. Se midieron el volumen espiratorio forzado en el primer segundo (FEV1), la presión inspiratoria máxima (PImax), la presión espiratoria máxima (PEmax) y la dificultad para respirar. El resultado muestra que la diferencia en la dificultad para respirar (escala de Borg) entre las pruebas previas y posteriores es insignificante con una tasa de error (5%). Además, el valor de T calculado (1,66) es menor que el valor de T tabular (2,57), lo que indica que no ha habido ninguna mejora en el nivel de dificultad para respirar para el grupo de control. El nivel de dificultad para respirar muestra en la tabla que la diferencia es significativa en la tasa de error (5%). Además, las pruebas previas y posteriores se calculan como T (3,24), mayor que el valor de la T tabular (2,57). La rehabilitación con ejercicios alteró el FEV1, PImax, PEmax y la dificultad para respirar en pacientes con EPOC en el grupo experimental, pruebas previas y posteriores que respaldaron a la comunidad experimental, lo que sugiere que la actividad física afectó el FEV1, PImax, PEmax y la dificultad para respirar. El ejercicio físico mejora la musculatura respiratoria de los pacientes con EPOC, según nuestro estudio. Este estudio concluyó que los pacientes expresaron el deseo de continuar con el ejercicio.
Palabras clave: ejercicio físico, inspiratorio y espiratorio, pacientes con EPOC.

Fecha recepción: 25-03-24. Fecha de aceptación: 19-07-24
Shimal Hamad
shamal.hamad@soran.edu.iq

Introduction

Chronic obstructive pulmonary disease (COPD) is a prevalent and sometimes fatal illness that affects people worldwide (World Health Organization 2019). Patients with COPD experience higher work of breath and dyspnea due to pathophysiological alterations in the tissue, airway, and vascular supply to the lungs, these changes additionally raise resistance to the airway and obstruction of air and impair lung compliance(Goldstein et al., 2023). Patients with COPD frequently restrict or avoid physical activity to prevent dyspnea; this lowers exercise tolerance and increases anxiety, and a lower quality of life (QoL)(Xiang et al., 2022). Therefore, this population requires comprehensive therapy, to reduce dyspnea sensation and enhance exercise tolerance and quality of life(Patiño & Ramírez, 2024).

In healthy people, respiratory muscles adapt to overload stimulation during exercise training, substantially increasing respiratory muscle function and individual improvement (Anziska & Sternberg, 2013). Conversely, the respiratory musculature's weakness (decreased strength and resistance) has significant clinical effects on COPD patients. This can account for typical symptoms such as effort dyspnea, hypercapnia, and reduced tolerance to exercise training (Crisafulli et al., 2007; Mendes et al., 2022). As with most chronic diseases and the healthy population, exercise training is essential for addressing extra-pulmonary signs of COPD, such as reduced muscular and respiratory function(Wang et al., 2020).

The management of COPD relies heavily on exercise rehabilitation, which produces several physiological adaptations, such as enhanced exercise capacity and structural and muscle changes(Jakobsson et al., 2022). Exercise rehabilitation for the breathing muscles is a critical component of the treatment of patients with COPD; however, its appli-

© Copyright: Federación Española de Asociaciones de Docentes de Educación Física (FEADEF) ISSN: Edición impresa: 1579-1726. Edición Web: 1988-2041 (https://recyt.fecyt.es/index.php/retos/index)

cation is contingent on the management of scientific and objective evaluations for COPD patients to achieve optimal function and health, as well as high quality of life, for individuals who suffer from weakness and disability as a result of chronic respiratory disease (Buist, 1987). In addition, exercise rehabilitation is also critical in guiding COPD patients to use all available treatment services in a structured manner, whether through substance use or exercise rehabilitation programs (Wijkstra et al., 1994).

People with COPD who regularly exercise can improve their respiratory fitness partly because of increased oxidative enzyme activity and mitochondrial density(Holland et al., 2021). Significantly, exercise rehabilitation has also been demonstrated to enhance health-related quality of life and lessen fatigue and dyspnea during everyday activities (Hoult et al., 2022). Exercise rehabilitation helps COPD patients with many extra-pulmonary symptoms. Nonetheless, it is frequently noted that the acute physiological response and the degree of chronic adaptations differ and are altered in COPD patients compared to healthy individuals without the disease(Machado et al., 2021).

To accomplish the objective of exercise rehabilitation for individuals with COPD, it is necessary to concentrate on the criteria that result in good achievement and are met through a variety of rehabilitation services that are appropriate for each individual's status, in addition to the comprehensiveness and range of these programs for patient outcomes (do Nascimento et al., 2015; Faraj et al., 2015). The increase in stress-bearing following recovery programs typically results in an improved status of the respiratory muscle and an increase in mechanical performance and adaptability that is beneficial to the breathing pattern, as well as the ability of the patient to withstand oxidative stress and lack of pulmonary inflation(Barreiro & Gea, 2015; Wilson et al., 2015).

In Iraq, the majority of doctors are interested in prescribing medication without advising patients to follow exercise rehabilitation. Thus, many studies have attempted to change this perception by using exercise rehabilitation to treat patients with COPD. For example,(Hamad, Hadi, et al., 2023) used exercise instead of medication to treat patients with COPD. However, numerous studies have not specialized hospitals in treating COPD. According to(Zeng et al., 2023) , aerobic exercise training is a type of pulmonary rehabilitation for lung disorders and is crucial for enhancing the quality of life connected to health and reducing dyspnea. Moreover, this study showed that aerobic exercise training can safely and effectively enhance stable COPD therapy by reducing the incidence of adverse events (aerobic exercise) and potentially boosting immunological function. Whereas, (Kjærgaard et al., 2020) found in stable COPD patients, evidence of a significant improvements in cardiopulmonary fitness as well as reports of therapeutic efficacy after exercise rehabilitation have been made. Therefore, we consider all these problems the main reason to study the effect of exercise rehabilitation on breath muscles in COPD patients. The general purpose of this study was to investigate the exercise rehabilitation effects on patients with COPD compared to a control group, Specifically, the study will address the question: Are there differences in chronic adaptations such (as level of shortness of breath, FEV1, PI,max, and PE,max) to exercise rehabilitation in people with COPD? The primary objective is to identify the chronic adaptations response to exercise rehabilitation in experimental and control groups who perform the different exercise interventions. The secondary objective is to compare the chronic adaptations response to exercise rehabilitation in experimental and control groups who performed different exercise interventions.

Materials and Methods

Participant

Thirty male patients (age 52 ± 0.66 years; body mass 66.15 ± 0.75 kg; height 176.17 ± 2.45 cm) from Babylon-Iraq with a low to severe COPD prevalence were recruited to participate in this study. Patients were randomly divided into groups (control and experimental groups), each consisting of 15 patients. Written informed consent was obtained from the patients. Thus, the study was conducted under the declaration of Helsinki. In addition, Table (1) shows participant specifications.

Table 1.
Participant specifications

Variables	Mean	Standard deviation
The amount of smoking	Half baguette 0.50	0.5
How long smoking	6 years	1.7
FEV1% predicted	65	1.16
PI,max %	72.14	1.23
PE,max %	92.19	1.64
Shortness of breath	level 5	1.37

Experimental design

The study used an experimental method. This study designed a three-month exercise rehabilitation program and used specific exercises to help patients reduce shortness of breath and strengthen their respiratory and expiratory muscles. In addition, this study included load, volume, and rest periods appropriate for the sample to achieve positive results.

Measurements

Measurement of FEV1

We used the Pneumotachometer spirometer, which is model(*IN-SP-100 Digital Spirometer*). All participants completed a three-month exercise rehabilitation program. Spirometer measurements were taken following American Thoracic Society (ATS) and ERS Consensus Classification of the Idiopathic Interstitial Pneumonias, (Travis et al., 2002) .using previously collected reference values from safe members of our community(Enright et al., 2003). Each participant's smoking status was classified as a never-smoker at each test. In addition, the following are excluded from the 12MWT: regular use of an ambulatory aid (walker); inability to walk due to musculoskeletal problems; chest pain in the preceding two weeks; a heart attack or heart surgery

© Copyright: Federación Española de Asociaciones de Docentes de Educación Física (FEADEF) ISSN: Edición impresa: 1579-1726. Edición Web: 1988-2041 (https://recyt.fecyt.es/index.php/retos/index)

in the preceding four months; heart rate 55 beats/min at rest (unless a physician or nurse determined that an AV block or conduction problem was not the cause of the bradycardia); heart rate 60 beats/min at rest. These exclusions were possibly prudent (they excluded many participants who might have willingly and safely completed the test) because physicians could not be present in the clinics for all exams to diagnose and treat symptomatic participants.

Measurement of the level of dyspnea

The Borg scale (Borg, 1982) was a rating system for dyspnea with a linear scale ranging from none–0 to a maximum–10 (Borg, 1982).

Pulmonary Rehabilitation Program:

Patients in our hospital's Pulmonary Rehabilitation (PR) Unit participated in a hospital-based outpatient PR program for ten weeks, three times a week. PR was specifically designed to meet the needs of a subject. Counseling and supervised exercise training comprised the PR program. We selected exercises for each patient based on their dyspnoea severity and ability to tolerate exercise. Exercises involved the following: treadmill (min. 10-20 minutes), cycle training (10-20 minutes), breathing exercises (10-15 minutes), peripheral muscle training (20-30 minutes), and stretching (10 minutes). The trainer also offered the patients tips on relaxing to lessen dyspnea (pruit et al., 2013). Exercises for strengthening and extending the lower and upper extremities were done. We started the strengthening exercises without using any weight. Every four workout cycles, a half-kilogram weight was added by the BORG scale (Gloeckl et al., 2013). However, for aerobic workouts, the treadmill and bicycle/arm ergometer were utilized. The speed of the treadmill and bicycle/arm ergometer started from 3MPH to 6MPH. During patient training, 50% to 80% of the maximum heart rate was used. To control exercise loads and duration, we employed BORG dyspnea scores. Patients' progress was found to correlate with increased exercise intensity. We monitored the patients using pulse oximetry during the activity, and if the SpO2 fell below 90% oxygen, supplements were given. FEV1 measurements were taken both before and after PR (GOLD Executive Committee 2016, Spruit et al., 2013).

3.PImax and PEmax

The Black and Hyatt technique executed maximum inspiratory pressure and PEmax maneuvers (Black & Hyatt, 1969). The PImax and PEmax were calculated at the mouth from residual volume and total lung capacity. A tube-type mouthpiece was connected to the pressure transducer (P23 ID, Gould Instrument Systems, Valley View, Ohio) through 60 cm of pressure tubing. A small hole (diameter = 1.6 mm) was drilled in the mouthpiece to reduce the contribution of buccal muscles during the maneuver. Both maneuvers were carried out while seated in a chair upright. To exhaustion, data collection was paced as follows: five PImax and five PEmax maneuvers were conducted with one-minute rest intervals; patients rested for five minutes before performing another five PImax and five PEmax tricks with one-minute rest intervals. The PImax and PEmax trials had the highest sustained negative and positive pressures against an occluded airway. The PImax percent predicted (percent predicted) was estimated using Black and Hyatt's prediction equations: PImax percent predicted = 120 - (0.25 age) for men and 122 - (0.79 age) for women.

Statistical analysis

Data were initially assessed for normality of distribution by using a Shaprio-Wilk test. Data are presented as mean ± standard deviation (SD). Data analysis was performed using SPSS (23 Amonk, NY: IBM Corp). The paired sample t-test was used to compare the pre-test and post-tests of the control and experimental groups for the four variables (FEV1, Pimax, PEmax, and shortness of breath). In addition, an independent sample t-test was used to compare post-tests between control and experimental groups.

Results

Paired t-test was conducted to examine the differences between the pre-and post-test for control and experimental groups of the variables (FEV1, Pl,max, PE,max and shortness of breath), Table (2) showed that there was no significant difference between the pre-test and post-test for the control group (FEV1, Pl,max, and PE,max) respectively $t = -1.000$, $p = 0.334$, $t = -1.000$, $p = 0.334$, and $t = -1.000$, $p = 0.334$. However, there was a significant difference between pre-test and post-test for shortness of breath ($t = 3.500$, $p = 0.004$)

For the experimental group, Paired t-test was also conducted to examine the differences between the pre-and post-test for the experimental group of the variables (FEV1, Pl,max, PE,max and shortness of breath), Table (3) showed that there was a significant difference between pre-and post-test for the experimental group in (FEV1, Pl,max, PE,max and shortness of breath) as shown in Table 3, respectively ($t = -4.627$, $p = 0.001$, $t = -6.481$, $p < 0.001$, $t = -7.581$, $p < 0.001$ and $t = 8.789$, $p < 0.001$) this indicated that there was improvement occurred as a result of medication treatment.

Table 2.
Paired sample t-test results in Respiratory Data for comparing pre-and post-tests of the Control group

Tests Variables	Pre		Post		t-test	Sig
	mean	SD	mean	SD		
FEV1	68.33	1.98	68.40	2.02	- 1.000	p = 0.334
PI,max	68.26	1.86	68.40	1.91	- 1.000	p = 0.334
PE,max	90.26	1.79	90.40	1.84	- 1.000	p = 0.334
Breath of Shortness	4.93	1.27	4.00	1.25	3.500	p = 0.004 *

Sd. Dev. = Standard Deviation; Sig = Level of Significance (n=15)
Significant difference, *p < 0.05 , **p < 0.01 .

© Copyright: Federación Española de Asociaciones de Docentes de Educación Física (FEADEF) ISSN: Edición impresa: 1579-1726. Edición Web: 1988-2041 (https://recyt.fecyt.es/index.php/retos/index)

Table 3.
Paired sample t test results in Respiratory Data for comparing pre- and post-tests of Experimental group

Tests Variables	Pre		Post		t-test	Sig
	mean	SD	Mean	SD		
FEV1	68.26	1.48	71.93	2.68	- 4.627	p = 0.001 *
PI,max	68.13	1.95	72.13	1.76	- 6.481	p < 0.001 **
PE,max	90.60	1.45	94.33	1.44	- 7.581	p < 0.001 **
Breath of Shortness	5.06	1.03	2.40	0.98	8.789	p < 0.001**

Sd. Dev. = Standard Deviation; Sig = Level of Significance (n=15)
Significant difference, *p < 0.05 , **p < 0.01 .

An independent sample t-test was conducted to examine the differences between control and experimental groups for post-tests of the variables of (FEV1, Pl,max, PE,max and shortness of breath), Table (4) showed that there was no significant difference between pre-test (pre-control and post-test) for FEV1, Pl,max, PE,max and shortness of breath, respectively ($t = -4.067$, $p < 0.001$, $t = -5.541$, $p < 0.001$, $t = -6.499$, $p < 0.001$, and $t = 3.886$, $p = 0.001$). Therefore, there was an improvement in favor of the experimental group in (FEV1, Pl,max, PE,max and shortness of breath) as shown in Table 4.

Table 4.
Independent sample t-test results of Respiratory Data, means, standard deviations, T-test, and the significance level of the post-tests between control and experimental groups.

Tests Variables	Control Post-test		Experimental Post-test		t-test	Sig
	mean	SD	mean	SD		
FEV1	68.40	2.02	71.93	2.68	- 4.067	p < 0.001 **
PI,max	68.40	1.91	72.13	1.76	- 5.541	p < 0.001 **
PE,max	90.40	1.84	94.33	1.44	- 6.499	p < 0.001 **
Breath of Shortness	4.00	1.25	2.40	0.98	3.886	p = 0.001 *

Sd. Dev. = Standard Deviation; Sig = Level of Significance (n=15)
Significant difference, *p < 0.05 , **p < 0.01 .

Discussion

A form of COPD is progressive and persistent. Its distinct clinical changes are mostly observed in pulmonary parenchyma, pulmonary arteries, chronic airway inflammation, and structural alterations brought on by repetitive damage and repair(Brandsma et al., 2020). Because COPD takes longer to cure, there will be various degrees of lung function impairment. However, in addition to pharmacological treatment, pulmonary rehabilitation with non-drug treatment is crucial.

The study's findings validate the benefits of exercise rehabilitation for enhancing lung function and reducing dyspnea. Patients in an experimental group showed significant improvement in FEV1, PI,max, PE,max, and shortness of breath, indicating that COPD patients benefited from the exercise rehabilitation program compared to the control group. This result corroborates and clarifies the gains in exercise rehabilitation documented in earlier research(Burge et al., 2020; Freedman, 2019). The trial's exercise rehabilitation program employed a mix of walking and resistance exercises. The frequency of involvement in this study was the most notable variation. Previous reports have noted increases in involvement frequency, which varies from three to twelve weeks(Alexiou et al., 2021) According to the trial's findings, patients with stable COPD may also benefit from eight weeks of exercise rehabilitation. Additionally, the experimental group experienced a significant decrease in dyspnea and other symptoms. Exercise rehabilitation may have enhanced an individual's quality of life and stamina for everyday activities. This suggests that physical activity can prevent or delay the onset of COPD.

Prior research on the effectiveness of exercise rehabilitation in COPD patients reveals a dearth of patients who have undergone a thorough assessment. Although methods of effectiveness included a 6MWD and some other quality measures, the results of previous studies suggested that exercise rehabilitation would be safe and valid for people with stable COPD(HUANG et al., 2021). According to the results of one study, exercise training-based pulmonary rehabilitation is beneficial in reducing the symptoms of COPD, strengthening muscular and cardiovascular function, increasing tolerance to physical activity, and promoting quality of life. This study also demonstrated that the most popular types of pulmonary rehabilitation exercises are high-intensity interval training (HIIT), resistance training, and moderate-intensity aerobic exercise. Individualized pulmonary rehabilitation exercise regimens are increasingly incorporating other forms of exercise, such as tai chi, yoga, water exercise, and whole-body vibration training. However, published guidelines indicate that individuals with stable respiratory illness symptoms can benefit from pulmonary rehabilitation, even if some patients may not respond appropriately or respond inconsistently to specific training programs(Theander et al., 2009).

Patients in the control group displayed low percentages of FEV1, PI,max, PE,max, and high levels of dyspnea brought on by damage to the airways and lungs, as well as a lack of engagement in exercise rehabilitation and a limited improvement in some variables as a result of medication treatment. Additionally, a rehabilitation program that incorporates regular exercise is crucial in managing COPD disease, as confirmed by(Petrovic et al., 2012). This is because the narrow airway caused by wall damage is one of the reasons the patient is unable to inhale enough oxygen(Barreiro & Gea, 2015). Furthermore, it was established by (Duiverman et al., 2011) that regular sports participation is necessary for both healthy individuals and those with COPD to maintain better health.

The rehabilitation programs have a clear impact on a tight airway through expansion due to increased amounts of oxygen entering and pointed out the importance of sports rehabilitation in improving the functioning of the lungs (Cochrane & Clark, 1990). We believe that the rehabilitation program has impacted patients with chronic COPD, and it was observed that the rehabilitation program seems to have improved the participants' feelings, so they rushed toward regular sports training powerfully. However, for COPD patients, pulmonary rehabilitation is a beneficial strategy. The primary goal of pulmonary rehabilitation training is to create a program that is appropriate for the

© Copyright: Federación Española de Asociaciones de Docentes de Educación Física (FEADEF) ISSN: Edición impresa: 1579-1726. Edición Web: 1988-2041 (https://recyt.fecyt.es/index.php/retos/index)

patient's circumstances in order to enhance the patient's quality of life, increase their level of endurance, and lessen their dyspnea symptoms(Vagvolgyi et al., 2018).

FEV1, Pl,max, PE,max and dyspnea are frequently used in clinical practice to evaluate how COPD patients' lung functional ability has changed following pulmonary rehabilitation(Zhang et al., 2022). According to the pertinent literature, the pulmonary rehabilitation group in this study demonstrated a significantly higher FEV1, Pl,max, PE,max, and less dyspnoea after intervention as compared to the control group on an individual basis (Theander et al., 2009). This result supports earlier studies on COPD patients(Janssens et al., 2010; Molenaar et al., 2007a) which suggested that FEV1, Pl, max, PE, max, and dyspnoea are impacted by training. Furthermore, as exercise represents the pressure produced by the inspiratory muscles,(Keogh & Williams, 2021) demonstrated how exercise rehabilitation affected the respiratory muscles and submaximal exercise capability of COPD patients.

This study's findings regarding the impact of exercise rehabilitation on the breath muscles have never been documented in the literature before (Mickleborough et al., 2011), they evaluated the effect of upper limb and thoracic muscular endurance on respiratory patients; however, the authors did not include the breath muscles in their study. Nonetheless, several authors have identified the effect of lower-limb peripheral muscle function on exercise ability in COPD patients, including (Hamad, Hadi, & Ahmad, 2023; Kortianou et al., 2010; Roig & Reid, 2009). In addition, there is substantial evidence that exercise rehabilitation can significantly improve the symptoms of COPD patients. These muscles have been proven to directly connect to walking (Jarosch et al., 2017; Pedersen & Saltin, 2015). This may explain why many studies have been conducted to determine the effect of exercise rehabilitation.

The influence of exercise rehabilitation can be demonstrated because the pulldown exercise engages many accessory respiratory muscles (Romer et al., 2017). The muscles for this exercise include the latissimus dorsi, trapezius, rhomboids, pectoralis major, and biceps (Molenaar et al., 2007b). In addition, when the primary respiratory muscles are defective or incapable of meeting ventilator requirements, some of these muscles may believe they are performing an accessory respiratory role (Sakhaei et al., 2018). This is consistent with previous research (Chen et al., 2015), which demonstrated a significant positive impact of exercise rehabilitation on the breathing muscles of COPD patients and established this particular muscular endurance as a predictor of 6MWD in healthy elderly individuals (Calzetta et al., 2017; Spielmanns et al., 2016). Since exercise rehabilitation directly improves respiratory muscle endurance and strength, our results assert that exercise rehabilitation improves breathing muscles.

Conclusions

The present study found that exercise rehabilitation affected the levels of FEV1, PI,max, PE,max, and shortness of breath in COPD patients in the experimental group but that pharmaceutical therapy alone was inadequate to achieve full recovery in the control group. This study also concluded that patients expressed a desire to continue the exercise.

Acknowledgments

The researchers are grateful for the kind support and guidance in every study step. The researchers acknowledge and thank all the participants who participated in this study.

References

Alexiou, C., Ward, L., Hume, E., Armstrong, M., Wilkinson, M., & Vogiatzis, I. (2021). Effect of interval compared to continuous exercise training on physiological responses in patients with chronic respiratory diseases: A systematic review and meta-analysis. *Chronic Respiratory Disease*, *18*, 14799731211041506.

Anziska, Y., & Sternberg, A. (2013). Exercise in neuromuscular disease. *Muscle & nerve*, *48*(1), 3-20.

Barreiro, E., & Gea, J. (2015). Respiratory and limb muscle dysfunction in COPD. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, *12*(4), 413-426.

Black, L. F., & Hyatt, R. E. (1969). Maximal respiratory pressures: normal values and relationship to age and sex. *American review of respiratory disease*, *99*(5), 696-702.

Brandsma, C. A., Van den Berge, M., Hackett, T. L., Brusselle, G., & Timens, W. (2020). Recent advances in chronic obstructive pulmonary disease pathogenesis: from disease mechanisms to precision medicine. *The Journal of pathology*, *250*(5), 624-635.

Borg, G. A. (1982). Psychophysical bases of perceived exertion. Medicine and science in sports and exercise, 14(5), 377-381.

Buist, A. S. (1987). Standardization of spirometry. *The American review of respiratory disease*, *136*(5), 1073-1074.

Burge, A. T., Cox, N. S., Abramson, M. J., & Holland, A. E. (2020). Interventions for promoting physical activity in people with chronic obstructive pulmonary disease (COPD). *Cochrane Database of Systematic Reviews*(4).

Calzetta, L., Ora, J., Cavalli, F., Rogliani, P., O'Donnell, D. E., & Cazzola, M. (2017). Impact of LABA/LAMA combination on exercise endurance and lung hyperinflation in COPD: a pair-wise and network meta-analysis. *Respiratory medicine*, *129*, 189-198.

Chen, W., Thomas, J., Sadatsafavi, M., & FitzGerald, J. M. (2015). Risk of cardiovascular comorbidity in patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis. *The Lancet Respiratory medicine*, *3*(8), 631-639.

Cochrane, L., & Clark, C. (1990). Benefits and problems of a physical training programme for asthmatic patients.

Thorax, *45*(5), 345-351.

Crisafulli, E., Costi, S., Fabbri, L. M., & Clini, E. M. (2007). Respiratory muscles training in COPD patients. *International journal of chronic obstructive pulmonary disease*, *2*(1), 19.

do Nascimento, E. S. P., Sampaio, L. M. M., Peixoto-Souza, F. S., Dias, F. D., Gomes, E. L. F. D., Greiffo, F. R., de Oliveira, A. P. L., Stirbulov, R., Vieira, R. P., & Costa, D. (2015). Home-based pulmonary rehabilitation improves clinical features and systemic inflammation in chronic obstructive pulmonary disease patients. *International journal of chronic obstructive pulmonary disease*, *10*, 645.

Duiverman, M. L., Wempe, J. B., Bladder, G., Vonk, J. M., Zijlstra, J. G., Kerstjens, H. A., & Wijkstra, P. J. (2011). Two-year home-based nocturnal noninvasive ventilation added to rehabilitation in chronic obstructive pulmonary disease patients: a randomized controlled trial. *Respiratory research*, *12*, 1-10.

Enright, P. L., McBurnie, M. A., Bittner, V., Tracy, R. P., McNamara, R., Arnold, A., & Newman, A. B. (2003). The 6-min walk test: a quick measure of functional status in elderly adults. *Chest*, *123*(2), 387-398.

Faraj, J. S., Abbas, A. H., & Hadi, A. H. Effect of Whole Body Exercise Program in Chronic Obstructive Pulmonary Disease Patients.

Faraj, J. S., Abbas, A. H., & Hadi, A. H. (2015). Effect of Whole Body Exercise Program in Chronic Obstructive Pulmonary Disease Patients. *International Journal of Advanced Sport Sciences Research*, *3*(2), 549-554.

Freedman, N. (2019). Reducing COPD readmissions: strategies for the pulmonologist to improve outcomes. *Chest*, *156*(4), 802-807.

Goldstein, N. E., Woodrell, C. D., & Morrison, R. S. (2023). *Evidence-based practice of palliative medicine*. Elsevier Health Sciences.

Hamad, S. H., Hadi, A. H., & Ahmad, B. A. (2023). Effect of lower torso training on asthma patients. *Physical Rehabilitation and Recreational Health Technologies*, *8*(1), 13-21.

Hamad, S. H., Hadi, A. H., Mohr, M., Mahadevan, S. P., & Kzar, M. H. (2023). The Effect of Threshold Loading Training and an Innovative Respiratory Training Devices with Lower Torso Sports Training in Asthma Patients: A Randomized Trial. *BioMed Research International*, *2023*(1), 3049804.

Holland, A. E., Cox, N. S., Houchen-Wolloff, L., Rochester, C. L., Garvey, C., ZuWallack, R., Nici, L., Limberg, T., Lareau, S. C., & Yawn, B. P. (2021). Defining modern pulmonary rehabilitation. An official American Thoracic Society workshop report. *Annals of the American Thoracic Society*, *18*(5), e12-e29.

Hoult, G., Gillespie, D., Wilkinson, T. M., Thomas, M., & Francis, N. A. (2022). Biomarkers to guide the use of antibiotics for acute exacerbations of COPD (AECOPD): a systematic review and meta-analysis. *BMC pulmonary medicine*, *22*(1), 194.

HUANG, X., QIAN, J., CHEN, F., HAO, J., YAO, Y., ZHU, S., & WANG, J. (2021). Impact of aerobic exercise on serum inflammatory factors and cardiopulmonary function in patients with stable chronic obstructive pulmonary disease. *Chinese General Practice*, *24*(28), 3615.

Jakobsson, J., De Brandt, J., & Nyberg, A. (2022). Physiological responses and adaptations to exercise training in people with or without chronic obstructive pulmonary disease: protocol for a systematic review and meta-analysis. *BMJ open*, *12*(9), e065832.

Janssens, W., Bouillon, R., Claes, B., Carremans, C., Lehouck, A., Buysschaert, I., Coolen, J., Mathieu, C., Decramer, M., & Lambrechts, D. (2010). Vitamin D deficiency is highly prevalent in COPD and correlates with variants in the vitamin D-binding gene. *Thorax*, *65*(3), 215-220.

Jarosch, I., Hitzl, W., Koczulla, A. R., Wencker, M., Welte, T., Gloeckl, R., Janciauskiene, S., & Kenn, K. (2017). Comparison of exercise training responses in COPD patients with and without Alpha-1 antitrypsin deficiency. *Respiratory medicine*, *130*, 98-101.

Keogh, E., & Williams, E. M. (2021). Managing malnutrition in COPD: a review. *Respiratory medicine*, *176*, 106248.

Kjærgaard, J. L., Juhl, C. B., Lange, P., & Wilcke, J. T. (2020). Early pulmonary rehabilitation after acute exacerbation of COPD: a randomised controlled trial. *ERJ open research*, *6*(1).

Kortianou, E. A., Nasis, I. G., Spetsioti, S. T., Daskalakis, A. M., & Vogiatzis, I. (2010). Effectiveness of interval exercise training in patients with COPD. *Cardiopulmonary physical therapy journal*, *21*(3), 12.

Machado, A., Marques, A., & Burtin, C. (2021). Extra-pulmonary manifestations of COPD and the role of pulmonary rehabilitation: a symptom-centered approach. *Expert review of respiratory medicine*, *15*(1), 131-142.

Mendes, P. C., Gomes, R., Furtado, G. E., Amoroso, J., Lemos, S., Dias, G., & Mendes, R. (2022). Technical performance and aerobic fitness in Padel amateurs players with different practice levels. *Retos*(46), 890-895.

Mickleborough, T., Mcconnell, A., Stager, J., Tecklenburg-Lund, S., & Lindley, M. (2011). Effect of inspiratory muscle training on exercise tolerance in asthmatic individuals.

Molenaar, I., Warnaar, N., Groen, H., Tenvergert, E., Slooff, M., & Porte, R. (2007a). Efficacy and safety of antifibrinolytic drugs in liver transplantation: a systematic review and meta-analysis. *American journal of transplantation*, 7(1), 185-194.

Molenaar, I., Warnaar, N., Groen, H., Tenvergert, E., Slooff, M., & Porte, R. (2007b). Efficacy and safety of antifibrinolytic drugs in liver transplantation: a systematic review and meta-analysis. *American Journal of Transplantation*, 7(1), 185-194.

© Copyright: Federación Española de Asociaciones de Docentes de Educación Física (FEADEF) ISSN: Edición impresa: 1579-1726. Edición Web: 1988-2041 (https://recyt.fecyt.es/index.php/retos/index)

Patiño, B. A. B., & Ramírez, F. J. P. (2024). Importance of learning to learn competence in Colombian university students based on multivariate analysis: challenges, opportunities and challenges for education. *Retos: nuevas tendencias en educación física, deporte y recreación*(55), 613-623.

Pedersen, B. K., & Saltin, B. (2015). Exercise as medicine–evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scandinavian journal of medicine & science in sports*, *25*, 1-72.

Petrovic, M., Reiter, M., Zipko, H., Pohl, W., & Wanke, T. (2012). Effects of inspiratory muscle training on dynamic hyperinflation in patients with COPD. *International journal of chronic obstructive pulmonary disease*, 797-805.

Roig, M., & Reid, W. D. (2009). Electrical stimulation and peripheral muscle function in COPD: a systematic review. *Respiratory medicine*, *103*(4), 485-495.

Romer, S. H., Seedle, K., Turner, S. M., Li, J., Baccei, M. L., & Crone, S. A. (2017). Accessory respiratory muscles enhance ventilation in ALS model mice and are activated by excitatory V2a neurons. *Experimental Neurology*, *287*, 192-204.

Sakhaei, S., Sadagheyani, H. E., Zinalpoor, S., Markani, A. K., & Motaarefi, H. (2018). The impact of pursed-lips breathing maneuver on cardiac, respiratory, and oxygenation parameters in COPD patients. *Open access Macedonian journal of medical sciences*, *6*(10), 1851.

Spielmanns, M., Gloeckl, R., Schmoor, C., Windisch, W., Storre, J., Boensch, M., & Kenn, K. (2016). Effects on pulmonary rehabilitation in patients with COPD or ILD: a retrospective analysis of clinical and functional predictors with particular emphasis on gender. *Respiratory medicine*, *113*, 8-14.

Theander, K., Jakobsson, P., Jörgensen, N., & Unosson, M. (2009). Effects of pulmonary rehabilitation on fatigue, functional status and health perceptions in patients with chronic obstructive pulmonary disease: a randomized controlled trial. *Clinical rehabilitation*, *23*(2), 125-136.

Travis, W. D., King, T. E., Bateman, E. D., Lynch, D. A., Capron, F., Center, D., Colby, T. V., Cordier, J. F., DuBois, R. M., & Galvin, J. (2002). American Thoracic Society/European Respiratory Society international multidisciplinary consensus classification of the idiopathic interstitial pneumonias. *American journal of respiratory and critical care medicine*, *165*(2), 277-304.

Vagvolgyi, A., Rozgonyi, Z., Kerti, M., Agathou, G., Vadasz, P., & Varga, J. (2018). Effectiveness of pulmonary rehabilitation and correlations in between functional parameters, extent of thoracic surgery and severity of post-operative complications: randomized clinical trial. *Journal of Thoracic Disease*, *10*(6), 3519.

Wang, T., Mao, L., Wang, J., Li, P., Liu, X., & Wu, W. (2020). Influencing factors and exercise intervention of cognitive impairment in elderly patients with chronic obstructive pulmonary disease. *Clinical interventions in aging*, 557-566.

Wijkstra, P., TenVergert, E., Van Der Mark, T., Postma, D., Van Altena, R., Kraan, J., & Koëter, G. (1994). Relation of lung function, maximal inspiratory pressure, dyspnoea, and quality of life with exercise capacity in patients with chronic obstructive pulmonary disease. *Thorax*, *49*(5), 468-472.

Wilson, A. M., Browne, P., Olive, S., Clark, A., Galey, P., Dix, E., Woodhouse, H., Robinson, S., Wilson, E. C., & Staunton, L. (2015). The effects of maintenance schedules following pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a randomised controlled trial. *BMJ open*, *5*(3), e005921.

Xiang, X., Huang, L., Fang, Y., Cai, S., & Zhang, M. (2022). Physical activity and chronic obstructive pulmonary disease: a scoping review. *BMC pulmonary medicine*, *22*(1), 301.

Zeng, Q., Liao, W., Fang, W., Liu, S., Duan, C., Dai, Y., & Wei, C. (2023). Clinical effect of aerobic exercise training in chronic obstructive pulmonary disease: A retrospective study. *Medicine*, *102*(42), e35573.

Zhang, H., Hu, D., Xu, Y., Wu, L., & Lou, L. (2022). Effect of pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis of randomized controlled trials. *Annals of medicine*, *54*(1), 262-273.

Datos de los/as autores/as y traductor/a:

Shimal Hamad	shamal.hamad@soran.edu.iq	Autor/a – Traductor/a
hawkar Ahmed	hawkar.ahmed@univsul.edu.iq	Autor/a
Hussain Khudair	hussein.ali.khadir@uomus.edu.iq	Autor/a
Ammar Hadi	ammarhadi_1976@yahoo.com	Autor/a
Riyadh Salih	dr.riyadh1972@mu.edu.iq	Autor/a