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Review Article

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Respiratory physiotherapeutic interventions in patients with post-COVID-19 involvement: A systematic review

Intervenções fisioterapêuticas respiratórias em pacientes com acometimento pós-COVID–19: Uma revisão sistemática

Caroline Paula Gomes[1]
Orcid: https://orcid.org/0000-0002-7910-232X

Renata Ellen Magalhães da Silveira[2]
Orcid: https://orcid.org/0000-0003-0699-0036

Laila Moreira Damázio[3]
Orcid: https://orcid.org/0000-0001-7370-8892

Abstract

Introduction: Due to the scarcity of studies on pulmonary rehabilitation post-Coronavirus Disease-19 (post-COVID-19) in the available health databases and, currently, the large number of positive cases of the disease in Brazil, it was necessary to carry out this systematic review, assuming that, after a period of hospitalization, many of these patients will present different sequelae, and, depending on their functional situation, physical therapy will be required to restore function in the medium and long term. **Objectives:** To investigate whether respiratory physiotherapeutic interventions are effective in treating post-COVID-19 patients. **Material and Methods:** Searches were carried out between August 19 and September 2, 2021, in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) recommendations, in the databases Latin American and Caribbean Literature in Health Sciences (LILACS), Scientific Electronic Library Online (SciELO), Medical Literature Analysis and Retrieval System Online (MEDLINE/PubMed), and Physiotherapy Evidence Database (PEDro), in Portuguese and English. The keywords are part of the list of Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH). Boolean logic (AND and OR) was used. **Results:** Eight articles were selected, 03 clinical studies, 03 observational studies, and 02 case studies. **Discussion:** Clinical management in post-COVID-19 patients aims to improve lung function, fatigue, and exercise tolerance. Early treatment is not recommended in critically ill patients to avoid worsening respiratory distress and virus spread. **Conclusion:** It can be concluded that post-COVID-19 physiotherapy is extremely important for preventing and reducing the sequelae of the disease.
Keywords: rehabilitation; physiotherapy; covid.

Resumo

Introdução: Devido à escassez de estudos em reabilitação pulmonar pós-Doença do Coronavírus-19 (pós-COVID-19) encontrados nos bancos de dados de saúde e, atualmente, ao elevado número de casos positivos da doença no Brasil, fez-se necessária a realização desta revisão sistemática, presumindo que, após um período de internação, muitos desses pacientes sejam portadores de sequelas diversas e, conforme a situação funcional, a fisioterapia poderá ser necessária para restaurar a função a médio e longo prazo. **Objetivos**: Investigar se as intervenções fisioterapêuticas respiratórias são eficazes no tratamento de pacientes pós-COVID-19. **Materiais e Métodos:** As pesquisas foram realizadas entre 19 de agosto e 02 de setembro de 2021, de acordo com as recomendações PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*), nas bases de dados da Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), *Scientific Electronic Library Online* (SciELO), *Medical Literature Analysis and Retrieval System Online* (MEDLINE/PubMed) e

[1] Universidade Presidente Antônio Carlos – UNIPAC. E-mail: carolinepgomes@outlook.com
[2] Universidade Presidente Antônio Carlos – UNIPAC. Minas Gerais, Brasil. E-mail: carolinepgomes@outlook.com
[3] Universidade Federal de São João del-Rei, Universidade Federal de Viçosa. Minas Gerais, Brasil.

Physiotherapy Evidence Database (PEDro), na língua portuguesa e inglesa. As palavras-chave faziam parte da lista dos Descritores em Ciências da Saúde (DeCS) e do *Medical Subject Headings* (MeSH). Foi utilizada a lógica booleana (*AND* e *OR*). **Resultados:** Foram selecionados 8 artigos, sendo 03 de estudo clínico, 03 de estudo observacional e 02 de estudo de caso. **Discussão:** O manejo clínico em pacientes pós-COVID-19 tem como objetivo melhorar a função pulmonar, a fadiga e a tolerância ao exercício. O tratamento precoce não é recomendado em pacientes graves e críticos, a fim de evitar o agravamento da dificuldade respiratória e a dispersão do vírus. **Conclusão:** Conclui-se que a fisioterapia pós-COVID-19 é extremamente importante para a prevenção e diminuição das sequelas da doença.
Palavras-chave: reabilitação. fisioterapia. covid.

Introduction

In December 2019, in the city of Wuhan, China, a series of reports of pneumonia-like viral infections of unknown etiology and involvement emerged. Studies with respiratory tract samples revealed a new coronavirus, which was deemed SARS-CoV-2, and the pathology caused by the virus was called Coronavirus Disease-19 (COVID-19). The World Health Organization (WHO) declared the spread of the virus a pandemic on March 11, 2020.[1]

The high risk of transmission and dissemination was due to the different forms of contagion, through direct contact with saliva droplets, aerosols, feces, and urine, and through contact between the mucosa and the hands. The incubation period of the virus varies from 5 to 14 days, and in 80% of the cases, its clinical manifestations present a mild clinical aspect, with dry cough, fever, sore throat, diarrhea, and myalgia, and 20% progress to acute respiratory distress syndrome, requiring care in ICU (Intensive Care Unit).[2,3]

COVID-19 severity is related to older age, and the risk of death from the disease increases according to the senility of the individual. Elderly people over 60 years of age are at a higher risk of severe complications due to the natural aging of the immune system (immunosenescence), as well as the predisposition to cardiovascular disease. In addition to age, several other risk factors, such as systemic arterial hypertension (SAH) and chronic lung and cardiovascular diseases, interfere with the patient's prognosis.[4]

The damage caused by COVID-19 is diverse and multisystemic. In the respiratory system, for example, there is an acute systemic response, with reduced oxygenation (hypoxia, altered partial pressure of arterial oxygen-PaO_2/fraction of inspired oxygen-FiO_2 ratio) and consequent dyspnea, as well as changes in the functional pattern of the lungs that directly compromise the function of the respiratory muscles, resulting in intolerance to physical exercise.[5,6]

Understanding the damage caused by COVID-19 has become necessary in order to develop pulmonary rehabilitation protocols. These procedures should be performed by a trained physical therapist who will evaluate and set up a specific treatment plan for each patient aiming at a better recovery.[7] Considering the severity of the observed dysfunctions, rehabilitation is a key component of recovery, being essential to improve physical and cognitive function and reduce the risk of disability and morbidity.[8,9]

Due to the scarcity of studies on pulmonary rehabilitation post-COVID-19 in the available health databases and, currently, the large number of positive cases of the disease in Brazil, we found it necessary to elaborate this systematic review, assuming that, after a period of hospitalization, many of these patients will present different sequelae, and, depending on their functional situation, physical therapy may be necessary to restore function in the medium and long term. Thus, the aim of the study was to investigate whether respiratory physiotherapeutic

interventions are effective in treating post-COVID-19 patients.

Materials and Methods

Sample and type of study

The present systematic review followed the guidelines proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[10]

Study design

For article selection, searches were carried out using the following databases: Latin American and Caribbean Literature in Health Sciences (LILACS), Scientific Electronic Library Online (SciELO), Medical Literature Analysis and Retrieval System Online (MEDLINE/PubMed), and Physiotherapy Evidence Database (PEDro). Studies published in Portuguese and English between 2019 and 2021 were considered.

Inclusion and exclusion criteria

The following inclusion criteria were taken into account: (i) full-text articles, limited to randomized controlled trials, observational studies (including cross-sectional studies), and studies on post-COVID-19 homecare cases that were in isolation or after hospital discharge, and (ii) articles written in English and Portuguese. Studies were excluded when they (i) described an in-hospital pulmonary rehabilitation program (in ICU beds or inpatient/outpatient clinics) or (ii) were review articles, guidelines, or editorials. During the article selection process, two independent blinded researchers analyzed the results, and, in case of divergence, the final decision involved a third reviewer.

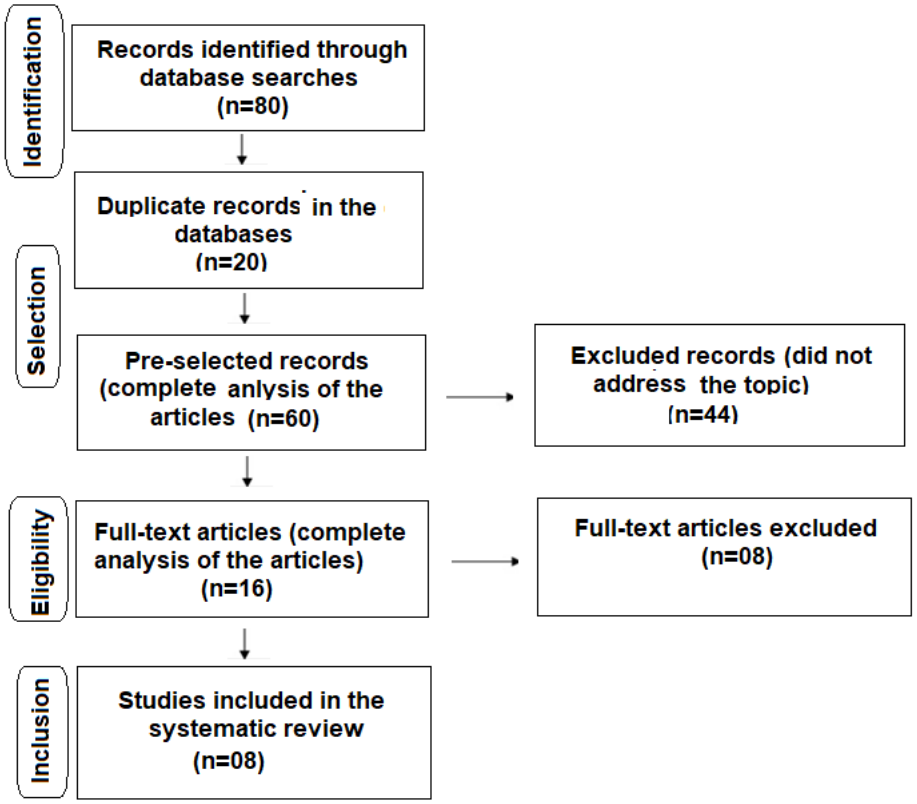
Procedures

The descriptors used in the database searches were “rehabilitation”, “pulmonary”, “physical therapy”, “COVID-19”, and “SARS-CoV-2”, which are part of the list of Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH). Boolean logic (AND and OR) was used to generate different search combinations: Premature Newborn, Neonatal ICU, and patient positioning.

Results

Based on the inclusion criteria, a total of eight potentially relevant articles were considered eligible for analysis, 03 of which were clinical studies, 03 observational studies, and 02 case studies (Figure 1). Their results are described in Table 1.

Figure 1. Profile of the bibliographic search according to PRISMA guidelines.



As respiratory physiotherapeutic interventions in post-COVID-19 patients, the selected studies indicated group and self-managed exercises, telerehabilitation, and individual exercises using equipment that significantly improve respiratory functions, aerobic and functional capacity, physical fitness, and even emotional aspects.

Among the analyzed studies, 02 used telerehabilitation as a respiratory physiotherapeutic intervention, 02 used aerobic exercises, and 06 used interventions with group, self-managed, or individual exercises, as shown in Table 1.

Table 1. Measures, protocols, and results of the selected articles in the systematic review.

AUTHOR (S)	OBJECTIVES	APPLIED REHABILITATION PROTOCOLS	RESULTS
Liu et al.[11]	To investigate the effects of respiratory rehabilitation in elderly patients with COVID-19 who were discharged from the hospital, outpatient clinic, or home setting.	2x per week/6 weeks in 72 patients: Pulmonary Rehabilitation Group-PRG (n=36): - 3 sets x 10 breaths, resistance; - 3 sets x 10 active coughs; - 30 diaphragm contractions, mean weight (1–3 kg) of resistance; - Flexion, extension, abduction, and external rotation of the arms;	- Statistically significant difference among forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FCV, diffusing capacity for carbon monoxide (DLCO PRG in relation to the CG); - There were no alterations in the CG compared to the PRG; - The 6MWT distance of the PRG was significantly greater than before the intervention; - There were no improvements in the activities of daily life;

AUTHOR (S)	OBJECTIVES	APPLIED REHABILITATION PROTOCOLS	RESULTS
		- Pursed-lip breathing and cough training, 30 sets per day. Control Group-CG (n=36): No intervention.	- Significant improvements in quality of life; - There was a significant reduction in anxiety among and between groups, although no alterations in depression were observed.
Gonzalez-Gerez et al.[12]	To analyze the feasibility and safety of breathing exercises using telerehabilitation devices for 7 days.	Recorded videos with 10 types of respiratory exercises modified from Thomas et al.[13] and Gaskell and Webber[14]: - Respiratory Exercises Group-REG (n=19): 1x per day/7 days, according to the Borg Scale (BS): - 4 (7–10); - 8 (5–7); - 12 (<5). - CG (n=19): sedentary activity.	- In the REG, a statistically significant improvement was found among and between groups ($p<0.001$) on the Borg Scale (BS), Multidimensional Dyspnea Profile-12 (MD-12), 30-second sit-to-stand test (30STST) and 6MWT; - No intragroup differences were found among the variables in the CG ($p>0.05$).
Puchner et al.[15]	To assess the impact of a post-acute rehabilitation program in 23 critically ill patients with COVID-19.	3 weeks, with group and individual sessions: 25 to 50 minutes each training in 23 patients: - Cardiopulmonary Exercise Test (CPET): - Training phase: - 20 minutes, 50% resistance of the maximum individual duration of the P wave (Pmax). - Interval phase: - Warm-up for 8 minutes with 30% of individual Pmax, - 12x at 100% of Pmax for 30 seconds. - Active recovery phase: - 30 seconds with 0-20% of Pmax. - Cool-down phase: - 6x for 1min with 20% of Pmax. - Borg Scale (6-20) to relieve or improve intensity; trength training using a Proxomed Compass series device (Medizintechnik GmbH, Germany);	- Highly significant improvement in the 6WMT distance, mean increase of 176m; - Increased ability to perform daily tasks, evaluated using the Barthel Index (BI); - Increased pulmonary parameters: FVC, FEV1, DLCO, total lung capacity (TLC), however, 57% of the patients with TLC <80% and 83% of all patients still presented reduced DLCO.

AUTHOR (S)	OBJECTIVES	APPLIED REHABILITATION PROTOCOLS	RESULTS
		- Strength training (body weight, elastic bands, dumbbells).	
Zha et al.[16]	To present a modified version of the rehabilitation exercises to ease breathing and the expectoration process.	Rehabilitation through telerehabilitation in 60 patients, 2x/day with 6-8 repetitions during 4 weeks: (1) Chest and Shoulder stretching: - 1 set with 2 repetitions; (2) Standing Heel Raises and Upper Acupressure: - 2 sets with 12 repetitions; (3) Upper Body Rotation: - 1 set with 4 repetitions; (4) Hand Acupressure massage: - 3 sets with 12 repetitions.	- Basal prevalences for dry cough, productive cough, difficulty in expectoration, and dyspnea improved 30%, 31.6%, 26.7%, and 35%, respectively.
Wootton at al.[17]	To present the rehabilitation of three moderate to severe cases and discuss their management through telehealth pulmonary rehabilitation.	Rehabilitation of 3 patients, 4x initially until 6x/week for 6 weeks by videoconference: (1) Aerobic Exercise training: walking 5–10min initially, until 30 min.; (2) in case of excessive fatigue and shortness of breath: intermittent exercises (2-min intervals, resting for 1 minute); (3) strengthening exercises: 2 sets/10 repetitions each: sit-to-stand, heel raising, lunging, biceps curl with weights, wall push-ups, and triceps; - 1 rest day per week.	- The patients showed improvements in the five-repetition sit-to-stand test (5STS) and the 1-min sit-to-stand test (1minSTS); - Cognitively, all patients were within the normal range, although with some difficulty in memory recovery; - Case 2 presented worsened depression, fatigue, and persistent dyspnea, in which pulmonary embolism was verified; - Case 3 presented worsened fatigue; - The patients reported increased confidence and in the control of symptoms with the increase in functional demand.
Srinivasan et al.[18]	To identify an efficient combination of several therapeutic approaches to improve lung ventilation in post-COVID-19 patients.	Rehabilitation 6 weeks in 48 patients: Experimental Group-EG (n=24): breathing for 5 minutes/3x per day for 6 weeks: - Pursed-lip breathing; - Bhastrika Pranayama breathing. CG (n=24): 5-10 times/3x per day per exercise for 6 weeks:	- Significant improvement in both groups ($p<0.0001$) regarding FEV1 and FVC.

AUTHOR (S)	OBJECTIVES	APPLIED REHABILITATION PROTOCOLS	RESULTS
		- Incentive Spirometry.	
Betschart et al.[19]	To present feasibility data for outpatient pulmonary rehabilitation, with specific information on dose and training intensities.	2x per week for 8 weeks in 12 patients: (1) Ergometric bicycle - 2 sessions in interval mode: 30 minutes: - Warm-up 4 min at 15%; - High intensity: 4 min at 50%; - Moderate intensity: 3 min at 20-30%; - Cool-down: 3 min at 15%; - 2 sessions in continuous mode: 30 minutes: - 20-30% (2) bench press, low row, back extension, leg abductor, leg flexion, and leg press; - 30-40 min at 50%; - 10-12 repetitions with 50-85% of maximum repetition; - 3 rounds per device.	- Significant increase from 80m to 170m from the initial evaluation until the end of rehabilitation in the 6MWT distance; - 6 patients with restrictions due to COVID-19 did not present any after the training program; - 83% of the patients achieved exercise intensity progression; - None of the patients presented negative events induced by the training; - Eight patients completed 16–25 sessions; - Ten patients tolerated the training modes as recommended; - Eight patients trained in the continuous mode.
Tozato et al.[20]	To present the 12-week rehabilitation of 4 patients with different levels of post-COVID-19 severity.	Aerobic exercise: - Treadmill, ergometer cycle of upper and lower limbs, and step exercises. - Load: 60% and 80% of the HR reserve (Karvonen), BS (0 - 10) between 4 and 6, SpO2 ≥ 90%. - Volume: 3x/week, 30 minutes. Resistance exercise: - Maximum Repetition Test (1MR) - Load: Weekly evaluation 60% Maximum Repetition (RM), all muscle groups. - Volume: 3x/week 3 sets with 10 repetitions each.	- Increased peripheral muscle strength, varying from 20% to six times the basal values; - The 6MWT distance increased in 16%, 49%, 67%, and 94%; - Heart rate and systolic arterial Pressure ratio was reduced in 42%, 27%, 8%, and 34%; - All cases showed a reduction in the dyspnea variables evaluated by the BS and an increase in functional capacity.

Discussion

Respiratory rehabilitation can be defined as a multidisciplinary, individualized, and personalized form of intervention in terms of physical and educational training and behavioral modification that seeks to improve physical

and psychological conditions.[21] In Chronic Obstructive Pulmonary Diseases (COPD), it has already been established that pulmonary rehabilitation is an important intervention in the recovery and prevention of clinical complications in patients. Based on these guidelines, clinical management in post-COVID-19 patients aims to improve lung function, fatigue, and exercise tolerance.[8] Early treatment is not recommended in critically ill patients since it may worsen respiratory function and the spread of the virus.[22]

During the acute phase of COVID-19, it is recommended that patients carry out the management of secretions through postural drainage, remaining upright for extended periods. In the post-COVID-19 period, rehabilitation should include diaphragmatic and pursed-lip breathing, bronchial hygiene, airway clearance techniques, incentive spirometry, respiratory muscle mobilization and training, and aerobic and strength exercises,[22] consistent with the studies indicated in Table 1.

Physical exercise is crucial in respiratory physiotherapy and is prescribed in 76% to 100% of the international programs. However, it is important to pay attention to the guided parameters regarding the prescribed exercises, the intensity, and the time and location where they will be carried out for them to promote an effective impact on physical and mental health and on the quality of life of the COVID-19 patient. In those that require oxygen therapy, it is advised that low-intensity exercises be prescribed, increasing according to the decline in symptoms.[21]

In only one study were high-intensity physical exercises prescribed in the outpatient pulmonary rehabilitation of post-COVID-19 patients.[19] It is recommended that rehabilitation exercises in the subacute phase be maintained at light to moderate intensity and that impairments and disabilities caused by COVID-19 be reevaluated in the long run.[23]

Rehabilitation can be performed in the hospital and outpatient environment, at home, and remotely, with its duration depending on the patient's clinical conditions and the presence of comorbidities.[21] Although some studies recommend that rehabilitation be maintained for at least 6 to 8 weeks, improvements using short-term protocols may be related to the clinical progression of the disease.[20] According to the present systematic review, one study used a 4-week rehabilitation protocol; three studies[11,17,18] used 6-week protocols; one study[19] used an 8-week protocol; two studies[15,20] used 12-week protocols, and one study[12] used a 1-week protocol.

For patients in isolation at home, *e.g*., the elderly and patients with comorbidities, the recommendation is that assessments, monitoring, prevention, intervention, supervision, education, consultation, and counseling be carried out through telerehabilitation in a synchronous (real-time) or asynchronous (recorded videos) manner. This method enables an early intervention with the provision of appropriate therapy for each patient due to its portability and versatility. Two studies were found in which telerehabilitation treatment was used and showed significant improvements in the patients' breathing patterns.[16,17] Thus, it is clear that telerehabilitation, when conducted by a professional who assists the patient and controls the progression of treatment, may have positive results. However, it is important to understand that not all patients are indicated for this type of therapy, such as individuals with altered cognition, severe pulmonary hypertension, unstable cardiovascular disease, poor balance, or lack of vestibular control.[8]

In order to analyze the feasibility and safety of breathing exercises, which were performed entirely through telerehabilitation, in patients with mild and moderate symptoms and who did not require hospitalization, Gonzalez-Gerez *et al*. (2021)[12] provided 10 types of modified

exercises, which were recorded and presented to the participants through a platform, in addition to being remotely monitored by trained physical therapists. According to the authors, the 7-day intervention used resulted in statistically significant changes in the intervention group compared to the control group regarding all variables studied, demonstrating the clinical relevance of the intervention.

In the study by Liu *et al*. (2020),[11] an impact on pulmonary function was evidenced, indicating that in the PRG, there were significant differences among the following parameters: forced vital capacity (FVC), forced expiratory volume in one second (FEV1), the FEV1/FVC ratio, the diffusion capacity of the lung for carbon monoxide (DLCO), and the 6MWT; however, even after treatment, the FEV1/FVC ratio still remained below normal limits (EG: 68.19 ± 6.05%; CG: 61.23 ± 6.43%).

In the observational study by Puchner *et al*. (2021),[15] the authors provided a physiotherapeutic rehabilitation program to 23 critically ill COVID-19 patients referred to tertiary rehabilitation centers after hospital discharge, in which extensive monitoring aided in the assessment of lung function and performance from the beginning to the end of training. It was found that 74% of the patients had reduced FEV1 or FVC, 22% presented decreased total lung capacity, and 85% had reduced DLCO, indicating impaired lung function. The same parameters showed significant improvement after rehabilitation; however, through spirometry and body plethysmography, it was noted that 57% of the patients still presented pulmonary involvement, and 83% still had reduced DLCO. The 6MWT test showed to be a good method to assess pulmonary and neuromotor function.

An observational rehabilitation study conducted by Zha *et al*. (2020),[16] in which the applied breathing exercises were based on Chinese martial arts, analyzed self-reported symptoms such as dry and productive cough, difficulty in expectoration, and dyspnea at four different times: 1) hospital admission, 2) hospital discharge; 3) 2 weeks after discharge, and 4) 4 weeks after discharge. With rehabilitation, baseline rates showed a significant decrease over time, with lower rates of remission of productive cough and difficulty in expectoration, reducing from 35–50% to 5–15%.[26]

In the study by Wootton *et al*. (2020),[17] improvements in the 5STS and 1minSTS were observed after six weeks of rehabilitation focused on physical training. The authors reported that the patients also benefited from symptom control in the face of increased functional demands, support in quarantine, and isolation.

As for the study by Betschart *et al*. (2021),[19] in which rehabilitation was performed in patients 21 to 73 days after the diagnosis of COVID-19, it was found that 83% of the patients progressed in intensity in the training program and 9 showed a significant improvement in 6MWT distance, ranging from 80-170m from the initial assessment to the end of treatment (11 to 24 sessions). The authors' findings evidenced the positive effects of the outpatient pulmonary recovery program[19]. These data corroborate the study by Tozato *et al*. (2021),[20] in which three-month rehabilitation was performed in post-COVID-19 patients, with cardiovascular recovery, reduction of dyspnea on exertion, increased peripheral muscle strength, and functional independence being reported and observed throughout the rehabilitation period.

Thus, it is evident that physical therapy programs have a positive impact on the rehabilitation of post-COVID-19 patients, with improvements in their respiratory, cardiovascular, and motor function. However, further research is warranted since the studies presented

variations in the applied intervention methods, sample number, and testing and evaluation instruments. COVID-19 has brought sequelae that are still being studied in the scientific environment, a fact that greatly limits the proper use of interventions in respiratory rehabilitation.

The present study proposes that further studies be carried out with patients who were affected by COVID-19 that seek to rehabilitate and evaluate the respiratory and cardiovascular capacity of these individuals since most studies have shown that these complications are the main complaints of patients.

Conclusion

It can be concluded that respiratory physiotherapeutic interventions improve respiratory, cardiovascular, and even emotional parameters among post-COVID-19 patients. Thus, post-COVID-19 physiotherapeutic interventions are essential in the rehabilitation of these patients to improve functional capacity, physical fitness, and breathing patterns. Nevertheless, further studies are needed since post-COVID-19 complications are still being assessed in the scientific community.

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