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EFFECTS OF PHYSIOTHERAPEUTIC PROTOCOLS ON PATIENTS WITH COVID-19

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Abstract: Introduction: COVID-19 is classified into 3 stages: early infection, pulmonary stage and hyperinflammation stage, characterized by specific biochemical changes. Physiotherapeutic treatment focuses on assisting, treating and recovering patients, especially in severe cases that can lead to death. Interventions such as early mobilization (PM), Neuromuscular Electrical Stimulation (NMES), out-of-hospital protocols and Chinese and hindu alternative exercises can be used in the rehabilitation of COVID-19. **Goal**: To identify the effects of physiotherapeutic protocols applied in the rehabilitation of patients with COVID-19 in a systematic review without meta-analysi. **Methodology:** search in MEDLINE/PubMed, PEDro and SciELO databases, using the search strategies "physiotherapy" AND "COVID-19" NOT "remote control"; "rehabilitation" AND "COVID-19" NOT "remote control", and their respective translations in Portuguese, combined with each other, present in the title or abstract. The surveys were carried out in September and October 2021. **Conclusion:** MP and the use of NMES, still in the critical phase of COVID-19, with the use of IMV and neuromuscular blockers, proved to be more efficient than the late start of the procedure, reducing the stay in the ICUs. Respiratory strength exercises improved: functional dependence, Autonomic Nervous System (ANS), quality of life (QoL), locomotion capacity, fatigue, cognition and breathing. Low and high-intensity aerobic exercises based on Maximum Heart Rate (HRmax) improved functional capacity, respiratory function, QOL, anxiety and sarcopenic symptoms. Alternative practices such as Acupressure, Liu Zi Jue and pursed lip breathing associated with Bhastrika Pranayama proved to be viable alternatives, which produced better functional capacity and QOL.

Keywords: Early mobilization; HRmax; rehabilitation; COVID-19; physiotherapy.

INTRODUCTION

The new coronavirus (SARS-CoV-2) belongs to a viral family, which caused a respiratory infection in Wuhan, China, being discovered on December 31, 2019 and leading the World Health Organization (WHO) to declare a pandemic on the day March 11, 2020 (AQUINO et al., 2020).

Because COVID-19 is highly contagious, it occurs through contact with droplets such as: coughing, sneezing, body fluids and different types of contaminated surfaces (BAPTISTA; FERNANDES, 2020). With an incubation period of 1 to 14 days, its clinical course is classified into three stages known as: early infection, pulmonary phase and hyperinflammation phase, where each of them is characterized by specific biochemical changes (CARELLI et al., 2020).

The main signs and symptoms are: fever, dry cough, apathy, myalgia, partial or total loss of smell (hyposmia/anosmia), alteration, decrease and/or total loss of taste (dysgeusia/hypogeusia/ageusia), renal failure and acute respiratory disease requiring invasive mechanical ventilation (FRANCO et al., 2020).

Its detection is based on radiology to look for clinical changes in suspected patients, using imaging tests such as computed tomography (CT) of the chest and chest X-ray (CXR) to more broadly visualize the internal organs, bones and tissues. moles, as well as cell culture techniques that rely on the isolation of SARS-CoV-2 in cell lines that promote the growth and replication of the virus to enable analysis (ASRANI et al., 2020).

Clinical treatment respects the procedures that depend on the classification and evolution of the infection. In mild clinical

conditions, treatment is carried out in home isolation and with control of their symptoms. In the severe form of the disease, evolving from its initial mild condition to a worsening of respiratory symptoms, suggesting lung damage, in-hospital follow-up is required. And in critical clinical conditions with rapid progression to multiple organ failure, with high and persistent viral load in samples from the upper and lower respiratory tracts, combined with systemic spread of the virus and detection of viremia, such patients are admitted to the Intensive Care Unit (ICU), which may require Orotracheal Intubation (OTI) (DIAS et al., 2020).

Studies reveal that there are still no medications with proven efficacy specifically for reducing the viral load of SARS-CoV-2 and drug treatment is aimed at preventing and resolving symptoms and complications arising from tissue reactions in response to viral infection (DIAS et al., 2020).

Physiotherapeutic treatment, on the other hand, focuses on assisting, treating and recovering patients with COVID-19, especially in serious cases that can cause death. Assistance in a hospital environment ensures ventilatory support, minimizes the effects of immobility in bed on the patient's body and possible complications that may arise (COSTA; LOIOLA, 2020).

The relevance of early mobilization is known as a preventive and effective approach against the deleterious effects of immobility in bed, as well as reducing the length of hospital stay, in addition to improving self-confidence and motivating the patient to return to their activities of daily living (ADL's). (GOUVÊA; SANTOS, 2009; SCHOBER; THORNTON, 2013).

Rehabilitation in an extra-hospital environment has as its primary objective the restoration of functions aimed at ADL's such as walking, going up and down stairs, eating, dressing and performing personal hygiene autonomously, without generating systemic decompensations such as respiratory discomfort, tachycardia, muscle fatigue, as well as strengthening the cardiorespiratory system, and rehabilitating neurogenic functions, such as activities that depend on somatosensory systems (AVILA; PEREIRA; TORRES, 2020).

Alternative Traditional Chinese Medicine Rehabilitation (TCMR) programs consisting of Acupressure Therapy and Liu Zi Jue Qigong, and Hindu practices such as Bhastrika Pranayama can be used as a complementary therapy for COVID-19 (ZHANG et al., 2020; SRINIVASAN et al., 2021).

Since COVID-19 is a relatively new and unknown pathology, the objective of the present study was to identify the effects of physiotherapeutic protocols applied in the rehabilitation of patients affected by COVID-19 in a systematic review without meta-analysis.

METHODOLOGY

A search was performed in the following databases: Medical Literature Analyzes and Retrieval Sistem Online (MEDLINE/ PubMed), Physiotherapy Evidence Database (PEDro) and Scientific Eletronic Library Online (SciELO), using the keywords "physiotherapy" AND "COVID-19" NOT "remote control"; "rehabilitation" AND "COVID-19" NOT "remote control", combined together, present in the title or abstract.

The searches in the databases were carried out in September and October 2021, independently by the authors, in order to identify studies that report physical therapy protocols for the rehabilitation of patients affected by COVID-19. The selection of articles was based on the proposed inclusion criteria.

As inclusion criteria, original articles, clinical trials and case studies in English, Portuguese and Spanish were considered, including articles published in the last two years, involving individuals of any age, affected in any way by COVID-19. Editorials, letters to the editor, abstracts, review articles and articles that focused on the analysis of rehabilitation in COVID-19 through tele-rehabilitation were excluded.

Initially, the target articles were screened by reading the titles. Studies were selected that presented any reference to the physiotherapeutic rehabilitation of patients in COVID-19. Then, the abstracts were read and those without correlation with physical therapy were excluded.

The search on scientific research platforms resulted in 108 articles based on keywords and filtered by year of publication, full texts and exclusion of non-cited articles (Table 1). Fourteen articles were selected for full reading and were part of the present study (Figure 1).

RESULTS

After a careful analysis carried out using a predefined sequence of inclusion and exclusion criteria, as shown in Figure 1, 77 articles were excluded and 14 studies relevant to this review were selected, which are arranged in Table 1, organized by Author/ Year of publication, Title of the article, Objective/Samples of the study, Protocols/Interventions used, Main Effects/Results and Conclusions.

DISCUSSION

Since the 1940s, the benefits of early mobilization in patients admitted to Intensive Care Units (ICU's) for cardiorespiratory diseases have been known and discussed (GOUVÊA; SANTOS, 2009).

Curci *et al.* (2020), analyzed early rehabilitation in patients in the post-acute phase of COVID-19 with and without the use of oxygen therapy, achieving recovery of mobility, peripheral and respiratory muscle strength, orthostatism, adequate clearance in hypersecretive patients. Some of the difficulties encountered in the application of the study were related to aerobic activities, due to the risk of patients developing respiratory failure during exercises and the difficult management of the common space, reserved for the care of patients with COVID-19.

In another study, Medrinal et al. (2021) suggested that early mobilization, including the prone position, has reduced the severity of muscle weakness in the evaluated patients.

In contrast, Taskiran et al. (2021) and McWilliams et al. (2021), bring results contrary to the use of early mobilization, due to the presence of the pathology originating from COVID-19.

Studies such as those by Medrinal et al. (2021) show that the research by Taskiran et al. (2021) presented limitations when they decided not to apply early rehabilitation protocols. The application of such techniques proved to be more effective and resulted in a shorter length of stay in the ICU, even when applied to patients still using neuromuscular blockers, that is, still in the acute phase of COVID-19 and in need of invasive mechanical ventilation. (VMI) (MEDRINAL et al., 2021).

In the report of two cases of children with COVID-19, Schaan et al. (2021) brought up the importance of manual techniques to maintain lung expansion and bronchial hygiene, as well as daily motor stimulation in the critical period of COVID-19 while still inside the ICU. In that publication, physical therapy was essential for the maintenance and improvement of the patients' functional status.

Hayden et al. (2021) corroborated the studies by LIU, Kai et al. (2020). Both

Base de Dados	Key Words: "physiotherapy " AND "COVID-19"	Key Words: "rehabilitation " AND "COVID-19"	Results
SCIELO	8	7	15
PubMed	12	65	77
PEDro	2	14	16
Total	22	86	108

Table 1 - Search results in the databases.

Study Characterization: this is a systematic review article without meta-analysis.

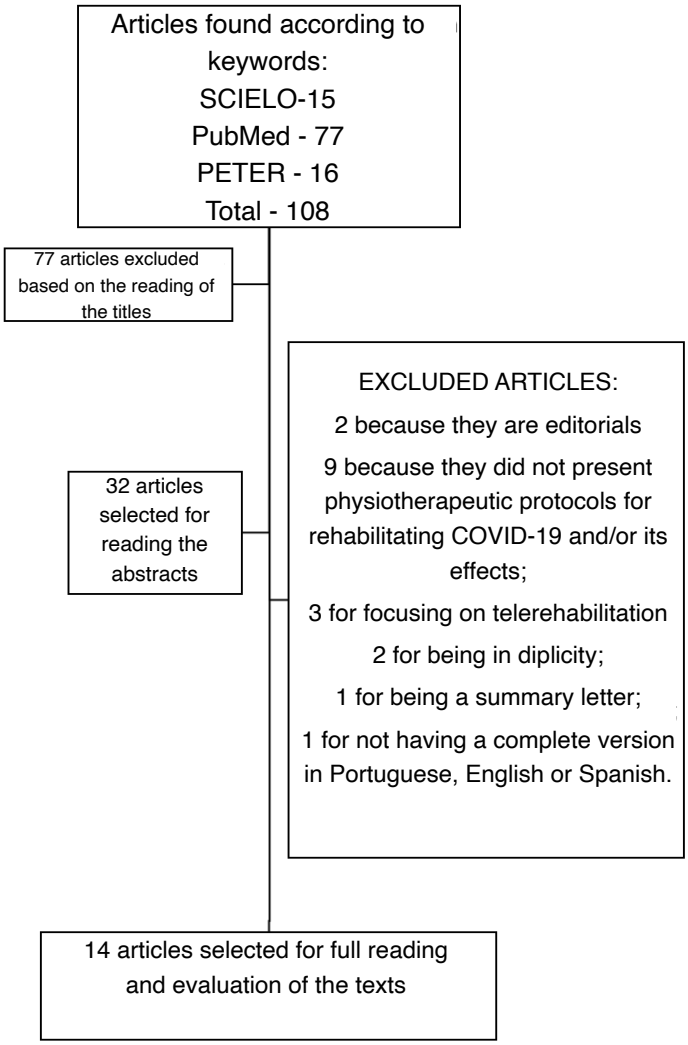

Figure1-Flowchart of the article selection process.

Source - authors' personal files, 2021.

AUT / YEAR	TITLE	PURPOSE / SAMPLES	PROTOCOLS / INTERVENTIONS	MAIN EFFECTS / RESULTS	CONCLUSIONS
Daynes *et al.* (2021)	Early experiences of rehabilitation for post-COVID individuals to improve fatigue, breathlessness exercise capacity and cognition – a cohort study	To report the experience of 32 individuals, with a mean age of 58 years, with acute symptoms, who completed rehabilitation after COVID-19 infection.	Rehabilitation program lasting 6 weeks, consisting of 2 supervised sessions per week, comprising: 1) aerobic exercise (walk/treadmill-based); 2) upper and lower limb strength training; 3) educational discussions with handouts from www.yourcovidrecovery.nhs.uk There was no comparison group.	· Significant improvements in clinical outcomes of walking ability and symptoms of fatigue, cognition and respiratory symptoms; · Increase of 112 meters in ISWT and 544 seconds in ESWT; · There were no recorded serious adverse events, and there were no dropouts related to worsening symptoms	Long (persistent) post-COVID rehabilitation programs: · must be holistic and multifaceted; · demonstrate improvements in exercise capacity and symptoms of shortness of breath, fatigue, and cognition.
Hayden *et al.* (2021)	Effectiveness of a Three-Week Inpatient Pulmonary Rehabilitation Program for Patients after COVID-19: A Prospective Observational Study	To evaluate the effectiveness of RP in 120 adult patients, with persistent symptoms, recovered from acute COVID-19, divided into three groups according to the initial severity of the disease - Group A: Severe Acute, Group B: Record after break and Group C: Light after break.	All groups performed: **Physical Training** (2–3 supervised sessions per week of 45–60 minutes each): a) resistance training (target range 4–6): Nordic walking and indoor sports, for example; b) Strength training focused on the main muscle groups (12 reps in 3 sets); c) Whole body vibrating training (7 times a week, 3 sets of 1 to 2 min) d) Inspiratory muscle training, 7 times a week, for 21 min each, 1 of which was supervised; Respiratory physiotherapy (2 un in groups of activities a, b, c or d, for 45 min per week) - a) individual respiratory training by physiotherapists, b) coughing techniques, c) mucolytic inhalation therapies, d) breathing exercises Buteyko breathing. General Physiotherapy: pain management, mobility or gait training, ADL management or fascia training.	· Moderate to high improvement for dyspnea on exertion; exercise capacity, quality of life, fatigue and depression; · Moderate effects on dyspnea at rest and dyspnea in daily life; · Improved performance on the 6MWT and on the general health assessment test; · Less significant but important improvements related to cough, sputum, pain, anxiety, lung function parameters (CV, TLC, FEV1, PaO2, TLCO, MIP) and laboratory blood test results (D-dimers, CRP).	The most significant results and effects were presented by groups A - after 1 month of hospital discharge, and in group B - more than 1 month after hospital discharge. Group C, composed of patients who underwent PR after outpatient treatment or monitored in the hospital for a maximum of one night, showed less significant improvements. All persistently symptomatic post-COVID-19 patients can benefit from adequate pulmonary rehabilitation.

Caption: COVID-19 - coronavirus disease 2019; MMSS - Upper Members; MMII - Lower Limbs; ISWT - Incremental Shuttle Walking Test; ESWT - Endurance Shuttle Walking Test; RP - Pulmonary Rehabilitation; rep - repetitions; min - minutes; un - units; active - activities; ADL's - Activities of Daily Living; 6MWT - 6-minute walk test; FEV1 - Forced expiratory volume in one second; VC - vital capacity; RV - residual volume; TLC - total lung capacity; MIP - maximum inspiratory pressure; TLC - Total Lung Capacity; TLCO - single factor breath transfer from lung to carbon monoxide; PaO2 - Partial Oxygen Pressure; CRP - C-Reactive Protein.

Table 1 - Description of selected studies in order of year of publication.

AUT / YEAR	TITLE	PURPOSE / SAMPLES	PROTOCOLS / INTERVENTIONS	MAIN EFFECTS / RESULTS	CONCLUSIONS
Maldaner *et al.* (2021)	Adjunctive inspiratory muscle training for patients with COVID-19 (COVIDIMT): protocol for randomised controlled double-blind trial	To determine whether the addition of a supervised IMT to a PR is more effective than the PR itself in improving dyspnea, health-related QoL and exercise capacity in 138 symptomatic post-COVID-19 patients, divided into 2 groups: 1 - Default RP and 2 - Default RP added to TMI.	· Group 1: Tailored individualized PR program 3x/week for 8 weeks (+/- 24 sessions), 30-50 min supervised exercise sessions, with progressive, individualized multimodal exercise (including both aerobic, strength training and functional fitness modalities). · https://meet.google.com/aby-xpfe-eok Supervised training at 50-60% MIP load, 2 sets of 30 breaths/day, 2 min interval, 3 days/week, with charging device cone flow resistive (model POWERbreathe KH2, HaB International, UK) for 8 weeks;	· Improved inspiratory muscle strength and dyspnea; reduced diaphragm activation during maximal exercise; · TMI with biofeedback provided by the POWERbreathe KH2 device can modulate all aspects of muscle performance including strength, power and work capacity.	The use of IMT added to PR programs may improve exercise capacity in post-COVID-19 patients
McWilliams *et al.* (2021)	Rehabilitation Levels in Patients with COVID-19 Admitted to Intensive Care Requiring Invasive Ventilation. An Observational Study	To describe the demographics, clinical status, level of rehabilitation, and mobility status at ICU discharge of 117 patients with COVID-19.	· VM; · Neuromuscular block; · Postponement of the beginning of the physiotherapeutic rehabilitation inside the ICU - COVID due to the severity of the disease; · 1st mobilization: sitting at the bedside · Patient repositioning: pronation, chest physiotherapy to optimize secretion elimination; · Orthostatism and walking gait.	· Longer VM time; · Reduction in mobility levels such as getting up and stepping on a chair with or without assistance, achieved at ICU discharge. · Average mobilization time required: 14 ± 7 days. · Only 50% of patients were able to transfer the step or perform ambulation at the time of discharge from the ICU; · The higher the patient's BMI, the longer the mobilization time required for rehabilitation and discharge from the COVID-ICU. · Increase in the average time of rehabilitation in the ICU.	The delay in starting the 1st rehabilitation resulted in an increase in rehabilitation time and a worsening in mobility rates at the time of ICU discharge.

Caption: COVID-19 - coronavirus disease 2019; COVIDIMT - Adjunctive inspiratory muscle training for patients with COVID-19; IMT - Inspiratory muscle training; RP - Pulmonary Rehabilitation; QOL - Quality of life; MIP - maximum inspiratory pressure; min - minutes; ICU - Intensive Care Unit; VM - Mechanical Ventilation; BMI - Body Mass Index.

Table 1 - Description of the selected studies in order of year of publication (continued).

AUT / YEAR	TITLE	PURPOSE / SAMPLES	PROTOCOLS / INTERVENTIONS	MAIN EFFECTS / RESULTS	CONCLUSIONS
Medrinal *et al.* (2021)	Muscle weakness, functional capacities and recovery for COVID-19 ICU survivors	To report the incidence of limb and respiratory muscle weakness in COVID-19 ICU survivors, in 23 patients from 2 different treatment centers.	invasive MV; prone position; Neuromuscular blockers; Center 1: rehabilitation only after cessation of neuromuscular blockers; Postponement of the start of physical therapy rehabilitation within the ICU - COVID rehabilitation during the use of neuromuscular blockers; Passive mobilization; NMES; strengthening in bed; TMI; orthostatism;	Patients treated at Center 1 developed greater weakness of peripheral muscles, took longer to sit, stand, and stride, in addition to performing worse on functional tests 30 days after hospital discharge, compared to patients treated at Center 2.	It is possible that early physical therapy intervention reduced the severity of muscle weakness in the evaluated patients.
Nambi *et al.* (2021)	Comparative effectiveness study of low versus high-intensity aerobic training with resistance training in community-dwelling older men with post-COVID 19 sarcopenia: A randomized controlled trial	To find and compare the effects of low- and high-intensity aerobic training combined with resistance training in 76 elderly men with symptoms of post-COVID-19 sarcopenia, randomized into two groups.	30 minutes/session, 1 session/day, 4 days/week for 8 weeks. Low-intensity aerobic training group used 40-60% of HRmax: static stretching of the upper and lower limbs muscles (20 minutes on the treadmill + 10 minutes on a cycle ergometer) followed by resistance training and 15 minutes of cooling through gentle stretching of all major muscles to release tension and breathe deeply. High-intensity aerobic training group, participants followed similar exercise protocol, but the intensity of aerobic exercises was fixed between 60-80% of HRmax.	Low-intensity aerobic training combined with resistance training has better effects on handgrip strength, kinesiophobia status and quality of life than high-intensity aerobic training combined with resistance training in patients with post-COVID-19 sarcopenia. Low- and high-intensity aerobic training has a similar role in increasing the cross-sectional area of the arm, thigh, and calf muscle in older adults with symptoms of sarcopenia.	Low-intensity aerobic training improved handgrip strength, kinesiophobia status, and quality of life aspects more than high-intensity aerobic training in older adults with symptoms of sarcopenia.

Caption: COVID-19 - coronavirus disease 2019; ICU - Intensive Care Unit; VM - Mechanical Ventilation; NMES - Neuromuscular Electrical Stimulation; HRmax - Maximum Heart Rate; IMT - Inspiratory muscle training.

Table 1 - Description of the selected studies in order of year of publication (continued).

AUT / YEAR	TITLE	PURPOSE / SAMPLES	PROTOCOLS / INTERVENTIONS	MAIN EFFECTS / RESULTS	CONCLUSIONS
Srinivasan *et al*. (2021)	Efficacy of pursed lip breathing with Bhastrika Pranayama versus incentive spirometry in rehabilitating post COVID-19 follow up - a randomized control study	Explore the effectiveness of combining various breathing exercises to improve ventilation in 48 patients and randomly divided into 2 groups: · Experimental - pursed lip breathing training together with Bhastrika Pranayama · Control - training with incentive spirometry	**Experimental Group - Breathing training with LP + BP** - daily home exercise for 5 minutes, 3x/day for 6 weeks. **Control Group - Training with incentive spirometry** - cycle is repeated 5-10 times three times a day over a period of 6 weeks with home exercises.	**Experimental Group:** there was a significant improvement in FVC values, with greater performance than in the control group. Control Group: there was a significant improvement in FEV1 values, with higher performance than in the experimental group.	Both interventions had advantages, with LP + BP being able to improve the air capacity within the lung and incentive spirometry, the volume of expired air.
Schaan *et al*. (2021)	Hospital physical therapy management in pediatric patients with COVID-19: case reports	To report the physiotherapeutic management of two pediatric cases with COVID-19 admitted to a state referral hospital for the treatment of the disease in Porto Alegre, RS.	**Case 1:** MV-dependent PCT via tracheostomy, as a result of preexisting disease. Closed suction circuit, oxygen therapy (1 L/min); Manual techniques to maintain lung expansion and bronchial hygiene such as: Compression/decompression, ELPr, HM with self-inflating bag and bag squeezing; Daily motor stimulation. **Case 2**: IoT; On the 4th day, introduction of physiotherapy 3 times / day; passive CNT, limb stretching and functional bed positioning; 4x prone position / hospitalization. Extubation after 17 days of MV. Oxygen therapy: non-rebreathing mask (7 L/min); Tracheal aspiration. Physiotherapy performed equally in case 1 + passive CNT and then assisted CNT, stretching and transfer training. PCT evolved into atelectasis: HM with self-inflating bag and HEPA filter 2x/day, 3 cycles of 10 rep.; assisted and active CNT; standing and walking in the room with assistance; resisted CNT and independent ambulation 2X/day.	**Caso 1:** Discharge with moderate dysfunction, the most affected domains being: feeding and breathing, due to the use of nasoenteral tube and IMV. **Case 2**: Slight degree of dysfunction in the food domain; Preserved muscle strength; Progressive evolution of intensity and frequency of interventions according to clinical condition and PCT tolerance.	In both cases, physical therapy was essential for the maintenance and improvement of the functional status. The use of MV proved to be essential for the maintenance and improvement of the respiratory condition.

Caption: COVID-19 - coronavirus disease 2019; LP - Pursed Lips; BP - Bhastrika Pranayama, a breathing exercise recorded in the ancient Indu Yoga Hatha Yoga Pradipika text; FVC - Forced Vital Capacity; FEV1 - Forced Expiratory Volume in the first second; ICU - Intensive Care Unit; PCT - Patient; VM - Mechanical Ventilation; ELPr - prolonged slow expiration; HM- manual hyperinflation; OTI - Orotracheal Intubation; CNT - Kinesiotherapy; rep - repetitions; HEPA - High Efficiency Particulate Air;

Table 1 - Description of the selected studies in order of year of publication (continued).

AUT / YEAR	TITLE	PURPOSE / SAMPLES	PROTOCOLS / INTERVENTIONS	MAIN EFFECTS / RESULTS	CONCLUSIONS
Tang *et al.* (2021)	Liu Zi Jue is a promising exercise option for rehabilitating discharged COVID-19 patients	To investigate the effects of Liuzijue exercise on the rehabilitation of 33 patients with COVID-19.	Liuzijue Exercises 1 time a day for 20 min. for 4 weeks. There was no control group.	**Functional capacity**: significant increase in MIP, FIP, DM-DB, dyspnea and patients' ability to perform exercises after 4 weeks of intervention. Quality of Life: SF36 questionnaire scores such as physical functioning (FP) and physical function (PR) improve significantly. In addition, Liuzijue can considerably alleviate patients' state of depression and anxiety.	Liuzijue Exercise is a viable alternative to home exercise that has produced better functional capacity and quality of life in patients discharged with COVID-19.
Taskiran *et al.* (2021)	Physical rehabilitation in Intensive Care Unit in acute respiratory distress syndrome patients with COVID-19	To evaluate the effects of an early rehabilitation program in an intensive care unit in 35 patients with acute respiratory distress syndrome secondary to COVID-19, divided into 2 groups: non-rehabilitation and rehabilitation.	**Rehabilitation** - Early rehabilitation program: passive or active range of motion exercises + NMES + standard Intensive Care; **No Rehabilitation** - Standard Intensive Care Standard ICU care: medical competence activities and examinations; VM; oxygen therapy; neuromuscular blockers associated with prone position; Passive ROM exercises of the extremities (10-15 repetitions, lasting approximately 15 min/day, 6 days/week); PCT in NIV, high-flow nasal oxygen or nasal oxygen: active-assistive exercises or active ROM in bed; Transfer program (sitting, standing, walking), **No active secretion removal techniques, including chest percussion or assisted coughing, were applied.** NMES - applied to quadriceps and tibialis anterior muscles bilaterally, Symmetrical biphasic square waves with 6 sec contraction duration at 50 Hz frequency at 20-25 mA amplitudes with adjustments to obtain visible muscle contraction for 52 min.	The results do not point to benefits in acute rehabilitation in the ICU, when related to: improvement in muscle strength, survival or reduction in length of stay or duration of MV.	The greater number of PCTs with pulmonary and neurological diseases in the rehabilitation group reinforces the need for rehabilitation.

Caption: Liu Zi Jue - Traditional Chinese type of exercise; COVID-19 - coronavirus disease 2019; MIP - Maximum Inspiratory Pressure; PIF - Maximum Inspiratory Flow; DM-DB - Diaphragm Movement in Deep Breathing min. - minute; SF36 - Short Form 36 Item Health Survey; PF - physical functioning; PR - physical function; NMES - Neuromuscular Electrical Stimulation; NMES - Neuromuscular Electrical Stimulation; VM - Mechanical Ventilation; PCT - Patient; ROM - Range of Motion; NIV - Non-Invasive Ventilation; min - minutes; sec - seconds; without - week; Hz - Hertz; mA - milliampere;

Table 1 - Description of the selected studies in order of year of publication (continued).

AUT / YEAR	TITLE	PURPOSE / SAMPLES	PROTOCOLS / INTERVENTIONS	MAIN EFFECTS / RESULTS	CONCLUSIONS
Tozato *et al.* (2021)	Reabilitação cardiopulmonar em pacientes pós COVID-19: série de casos	To describe the experience of four cases, of different severities, who underwent a CPR program for 3 months post-COVID-19.	All groups performed: · Aerobic exercise: treadmill, upper and lower limb cycle ergometer and step exercises; · Load 60% and 80% of reserve HR (Karvonen), Borg scale (0 - 10) between 4 and 6, Spo2 ≥ 90% ; · Volume (3 times a week for 30 min); · Resistance exercise (1 RM test); · Load (Evaluated weekly 60% RM, all muscle groups); · Volume: 3 x / wk, 3 sets with 10 repetitions each; · Initial assessment and after 3 months: 6MWT, Handgrip Strength Test and 1RM Test for each muscle group.	Cardiovascular recovery; Reduced sensation of dyspnea on exertion; Increased peripheral muscle strength and functional independence reported and observed throughout rehabilitation. Increase in the distance covered in the 6MWT: 16%, 49%, 67% and 94%, respectively from cases 1 to 4; DP reduction, respectively, by 42%, 27%, 8% and 34%. Borg Scale reduction in all cases; Increase in functional capacity; Improved prognosis of severity; Palm grip (2nd and 3rd case): tendinopathy in the wrists and late fracture of the left humerus. 4th case: cardiopulmonary, neurofunctional and occupational therapy, associated with medical care: allowed the removal of gait aids.	In all cases, there was an increase in peripheral muscle strength, ranging from 20% to six times its initial value. The results demonstrate that the personifications of the rehabilitation protocols allowed the achievement of good results in this series of cases.
Curci *et al.* (2020)	Early rehabilitation in post-acute COVID-19 patients: data from an italian covid-19 rehabilitation unit and proposal of a treatment protocol	To characterize lung function and disability status in 32 post-acute COVID-19 patients admitted to an Italian Rehabilitation Unit;	Early rehabilitation protocol: 2 sessions per day of 30 minutes each for 2 to 3 weeks. PCT with FiO_2 ≥40 and <60%: **Bedside mobilization** - passive and actively assisted exercises for limb ROM, stretching and pumping limbs; **Pulmonary Rehabilitation**: breath control; chest-abdomen coordination exercises; cough stimulus. PCT with FiO_2 ≥ 21% and <40%: active exercises performed at the bedside; orthostatism; static and dynamic balance training; **Fall Prevention Program**: muscle reconditioning and low-intensity exercises of limb and trunk muscles, taking care of the potential perception of dyspnea or fatigue even after minimal activities. Walking training; **pulmonary rehabilitation**: chest expansion training, forced inspiration/expiration, incentive spirometer and use of positive expiratory pressure; Aerobic activities such as treadmill or cycle ergometer were not considered.	**bedside exercises:** recuperou a mobilidade, a força muscular adequada e alcançou a posição de pé; Prevenção de Quedas; **pulmonary rehabilitation**: achieved the release of the accessory respiratory muscles from overload and promoted adequate recruitment of the diaphragm muscle; promoted pulmonary recruitment and design of adequate clearance in hypersecretive patients, strengthening of respiratory muscles **aerobic activities**: risk of respiratory failure and the difficult management of common spaces to avoid contamination by COVID-19.	PCT with COVID-19 had severe respiratory symptoms even in the post-acute phase of the disease and were therefore at risk for PICS; SARS-CoV-2 can be neuroinvasive, leading to cognitive impairment, critical illness-related sarcopenia, and neuropathy

Caption: COVID-19 - coronavirus disease 2019; PCT - patients; CPR - Cardiopulmonary Rehabilitation; MMSS - Upper Members; MMII - Lower Limbs; HR - Heart Rate; SpO2 - Peripheral Oxygen Saturation; RM - Maximum Repetition; FiO2 - Inspired Oxygen Fraction; ROM - Range of Motion; 6MWT - 6-minute walk test; DP - Double Product; PICS - Post-Intensive Therapy Syndrome; DP - Double Product; without - weeks;

Table 1 - Description of the selected studies in order of year of publication (continued).

AUT / YEAR	TITLE	PURPOSE / SAMPLES	PROTOCOLS / INTERVENTIONS	MAIN EFFECTS / RESULTS	CONCLUSIONS
LIU, Kai *et al.* (2020)	Respiratory rehabilitation in elderly patients with COVID-19: A randomized controlled study	To investigate effects of respiratory rehabilitation training on RF, QoL, mobility in 72 elderly PCTs with COVID-19, divided into 2 groups: intervention and control.	**Intervention Group:** **Pulmonary Rehabilitation**: 10 min., 1x/day, 2x/wk, for 6 wk.: **Respiratory muscle training:** DRMC (Threshold PEP; Philips Co.) 3x10 breaths at 60% of MEP and 1 min interval; Cough stimulus: 3 x 10 active coughs; **Diaphragmatic training**: 30 maximal active diaphragmatic contractions in the supine position, average weight (1 – 3 kg) on the anterior abdominal wall resisting diaphragmatic descent; **Stretching**: supine or lateral decubitus with the knees flexed, move the arms in flexion, horizontal extension, abduction and external rotation; **Exercises at home:** pursed-lip breathing and cough training, 30 repetitions/day. **Group control**: there was no intervention	Pulmonary Rehabilitation: Improvement in lung function and exercise capacity; Physical training: positive impact on physical and mental health and QoL of PCTs with COVID-19.	6-week respiratory rehabilitation may improve respiratory function, QOL, and anxiety in elderly patients with COVID-19, but it does not show significant improvement in the elderly's depressive state and activities of daily living.
Zha *et al.* (2020)	Modified rehabilitation exercises for mild cases of COVID-19	Design modified rehabilitation exercises to ease breathing and ease the sputum process in 60 PCTs with mild COVID-19.	6-8 sessões de MRE: quatro séries: Alongamento de Tórax e Ombros (1ª série), Elevações do Calcanhar em Pé e Acupressão da Parte Superior (2ª série), Rotação da Parte Superior (3ª Série) e Massagem de Acupressão para as Mãos (4ª Série). Não houve grupo de comparação.	Great Remission of Symptoms: Dry or productive cough, difficulty in expectoration and dyspnea.	MREs are specific for the rehabilitation of patients with mild COVID-19, at home or in health facilities. Recommended only for PCT with mild COVID-19. MRE is considered a suitable rehabilitation exercise to ease breathing and ease the expectoration process.

Subtitle: COVID-19 - coronavirus disease 2019; PCT - patients; FR - Respiratory function; HR - Heart Rate; SpO2 - Peripheral Oxygen Saturation; RM - Maximum Repetition; FiO2 - Inspired Oxygen Fraction; RP - Pulmonary Rehabilitation; DRMC - commercial manual resistance device; PEmax - Maximum Expiratory Pressure; QOL - Quality of Life; ROM - Range of Motion; PICS - Post-Intensive Therapy Syndrome; DP - Double Product; without - weeks; Pmax - maximum pulse; MRE - Modified Rehabilitation Exercise.

Table 1 - Description of the selected studies in order of year of publication (continued).

authors tested the need and effectiveness of a pulmonary rehabilitation treatment in a long-term period after hospital discharge for patients who developed the most severe form of the disease.

Daynes et al. (2021), Tozato et al. (2021) and Nambi et al. (2021) applied studies that proved the effectiveness of training based on the intensity of exercises based on HRmax, where it is possible to affirm that musculoskeletal strength exercises and high aerobic load are beneficial for post-COVID-19 patients. Still referring to cardiorespiratory training, Maldaner et al. (2021) tested respiratory muscle protocols with the help of resistance trainers, suggesting that the use of Incentive Muscle Training (IMT) added to Pulmonary Rehabilitation (PR) programs could improve exercise capacity in these patients.

Considering the human being as a holistic being, ancient alternative techniques such as Chinese exercises and acupressure were tested, respectively, by Tang et al. (2021) and Zha et al. (2020).

Zha et al. (2020) combined kinesiotherapy with upper limb acupressure (ULM) sessions resulting in great remission of symptoms such as dry or productive cough, difficulty in expectoration and dyspnea. More recently, Tang et al. (2021) investigated the efficiency of Liu Zi Jue's exercises and obtained extremely favorable results not only for physical but also for mental rehabilitation.

One of the limitations demonstrated in the use of alternative techniques is related to the degree of complication of COVID-19 developed by the patient. Zha et al. (2020) made it clear that acupressure is effective specifically for patients with mild COVID. Tang et al. (2021) used a Sample Universe (n) of low significance. Considering that of its (n) total, only five patients had developed the severe or critical form of the disease, it is suggested that their results have a real influence on the rehabilitation of patients with mild or moderate post-COVID.

Another study that addressed alternative techniques was that of Srinivasan et al. (2021). Bhastrika Pranayama, a breathing exercise recorded in the ancient text Yoga Hatha Yoga Pradipika, was of extreme relevance as it was associated with exhaling with pursed lips, improving the air capacity within the lung.

Srinivasan et al. (2021) used incentive spirometry in their control group, however, it was not specified which type of device was used, which refers to a limitation of reliability in the reproduction of their results.

The present systematic review is extremely important for Physiotherapy, as it elucidates still obscure issues of rehabilitation in COVID-19, such as the best time to start early mobilization in critically ill patients. As already mentioned, the beginning of this procedure, still in the hyperinflammation phase, with the patient on IMV and using neuromuscular blockers, generated better results than the late start. Having knowledge and security of the effects that each physiotherapeutic protocol exerts on the different types of patients affected by this pathology, provides better results and makes it possible to save a greater number of lives.

It was possible to notice that for patients with mild symptoms of COVID-19, home isolation followed by procedures based on traditional Chinese and Hindu medicine, chest and shoulder stretches bring good results. Patients with moderate to severe symptoms, the most appropriate would be in-hospital outpatient follow-up, application of bedside protocols and pulmonary rehabilitation exercises. For patients admitted to ICUs, it was observed that early mobilization, applied as early as possible, associated with pulmonary rehabilitation protocols and exercises to strengthen

the respiratory and peripheral muscles. Exercises with intensity based on HRmax are recommended for all degrees of COVID-19 complexity.

More research with children and adolescents is still needed. It is also unclear whether the application of tests in patients with such different age groups and with such different degrees of complications in the same sample is capable of demonstrating accuracy and reliability in the results.

It is suggested that future studies be carried out with closer age groups and with groups that present the same severity classification of COVID-19.

CONCLUSION

Early mobilization and the use of Neuromuscular Electrical Stimulation (NMES) still in the critical phase of COVID-19, with the patient using IMV and neuromuscular blockers, proved to be more efficient than the late initiation of the procedure, including reducing the length of hospital stay. in ICUs.

The use of protocols with respiratory strength exercises showed an improvement in functional dependence, changes in the Autonomic Nervous System (ANS), in mood, satisfaction and pleasure, significant improvements in the clinical results of locomotion capacity, fatigue symptoms, cognition and respiratory symptoms.

Low and high-intensity aerobic exercises, based on HRmax, had positive impacts on the monitored cases, improving functional capacity, respiratory function, quality of life (QoL), patient anxiety and sarcopenia symptoms.

Rehabilitation protocols based on alternative practices such as Liu Zi Jue and pursed-lip breathing training associated with Bhastrika Pranayama proved to be viable exercise alternatives, which produced better functional capacity and quality of life, and could considerably alleviate patients' depression and anxiety.

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