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REVIEW

Physical, Functional, Psychological, and Social Effects of a Physical Activity Program in Adults and Older Adults During and/or After Hospitalization for COVID-19: A Systematic Review

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Background: It is necessary to investigate the effects of physical activity (PA) on the recovery of adults and the elderly, considering PA positively affects pathologies that share similarities with COVID-19. We present the results of a systematic review whose objective was to analyze the physical, functional, psychological, and social effects of PA in adults and the elderly during and/or after hospitalization for COVID-19.
Methods: Searches were conducted between July and August 2021, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. Randomized clinical trials (RCTs) and non-randomized interventional studies were included in the databases: PubMed, Web of Science, Scopus, EBSCOhost, Science Direct, Cochrane Library, Physiotherapy Evidence Database (PEDro), and electronic search engines. Study quality was assessed using the PEDro for RCTs and the methodological index scale for non-randomized studies. This systematic review included original articles investigating the physical, functional, psychological, and social effects of any PA program on adults and older adults.
Results: A total of 302 studies were found. After applying filters according to the eligibility criteria, five studies were finally included for analysis, three RCTs and two intervention studies without a control group. Although the studies measured different variables of the physical, functional, and psychological components, the results showed significant differences in the variables between the control and intervention groups in both the RCTs and the single-group studies. The variables assessed in the social aspect were less homogeneous.
Conclusion: In the available scientific evidence, respiratory muscle training was the most widely used intervention, which showed positive results in the physical, pulmonary, psychological, and social components. More research is required on the effects of PA on the population studied.
Keywords: physical exercise, physical activity, relaxation, respiratory therapy, pulmonary rehabilitation, COVID-19

Introduction

In December 2019, an outbreak of acute respiratory disease characterized by fever, dry cough, and shortness of breath began in Wuhan (People's Republic of China). Weeks later, a novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causing coronavirus disease 2019 (COVID-19) was identified.[1] The disease evolves similarly to the influenza virus, with general pain, sputum, weakness, and headache.[2] However, in other cases, several risk factors are associated with COVID-19 complications and mortality, including chronic respiratory disease (8.0%), cardiovascular disease (13.2%), hypertension (8.4%), diabetes (9.2%), and cancer (7.6%).[3–6] In addition to the aforementioned, some people experience psychological symptoms such as irritability, anxiety, depression, and sleep disorders, among others.[7]

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The severity of the disease depends mainly on the immune system and age of the infected individual, where most (86.6%) of the patients with confirmed cases are between the ages of 30 and 79 years. Also, patients aged >65 years tend to present a worse prognosis and may need between 7 and 11 days of hospitalization, intensive care, or a ventilator to help them breathe.[8,9] All the above make older adults' infection forecasts even higher than the rest due to the comorbidity, geriatric syndromes, and frailty associated with aging.[10]

The confinement to contain the COVID– 19 outbreak increased sedentary time and altered life habits, mainly in older adults. Similarly, during and after the COVID-19 infection, patients of this age group decrease their physical activity (PA) levels, bringing with them a general physical condition in general, such as aerobic capacity, loss of muscle mass, and strength.[11] This leads to a decrease in the autonomy and functionality of people, affecting their well-being and quality of life (QoL) even after illness.[7,12]

Because COVID-19 is a multisystem disease that, in some cases, can affect different organs and functions, its approach and treatment must be interdisciplinary. The early initiation of a structured and adapted PA program, in accordance with the patient's age, fitness levels, previous comorbidities, and disease severity, contributes to improvement in cognitive, respiratory, neuromuscular, and osteoarticular function.[13,14] It also reduces the clinical sequelae, restores functional capacity, and, above all, shortens the length of stay in the intensive care unit (ICU).[13,14]

It is necessary to investigate the favorable effects of PA and physical exercise (PE) on the recovery of these patients, considering that there is sufficient evidence that protective factors against noncommunicable diseases are established through these interventions. Additionally, PA and PE positively affect multiple pathologies that share similarities in terms of symptoms and their possible pathogenic mechanisms.[15]

Non-pharmacological interventions, such as PE and pulmonary rehabilitation, are effective in patients with chronic obstructive pulmonary disease and are currently used in patients with COVID-19.[16] For example, respiratory muscle training is performed to decrease the incidence of COVID-19 symptoms and improve dyspnea, exercise capacity, and, thus, QoL.[16] In addition, relaxation exercises are implemented to manage anxiety and sleep problems. Economic interventions are also used because they do not require any technology or special equipment.[17–20] Moreover, PA and PE have a positive effect on both mental health and physical health.[21]

Therefore, this systematic review aimed to analyze the available scientific evidence regarding the effects of a PA program on adults and older adults during and after hospitalization for COVID-19.

Materials and Methods

This review was registered in the "International Prospective Register of Systematic Reviews" (PROSPERO; registration number, CRD42021267517).

The approach to reporting the systematic review was in line with the PRISMA.[22] The study evidence quality for RCTs was evaluated using data derived from the Physiotherapy Evidence Database (PEDro) as it provides information resources to support evidence-based clinical practice.[23] The methodological index for non-randomized studies (MINORS) scale was used for intervention studies.[24]

Below is the PICOS strategy used in the review:

- Population: Patients aged >18 years who were hospitalized for COVID-19.
- Intervention: Intervention studies that incorporated programs of PA, PE, physical therapy, or pulmonary rehabilitation in patients during or after hospitalization for COVID-19.
- Comparison: Patients who followed the usual medical care.
- Result: Physical effects (dyspnea, fatigue, the 6-minute walk test), functional effects (pulmonary function test forced expiratory), psychological effects (anxiety, sleep quality and depression), and social effects of a PA program in adults and older adults (activities of daily living and quality of life).
- Study design: Randomized clinical trials and intervention studies.
- Research question: What are the effects of a PA program on adults and older adults during and after hospitalization for COVID-19 for physical effects, psychological effects, and social effects?

Information Sources and Searches

The systematic review was performed from July to August 2021 in nine databases and electronic search engines: PubMed, Web of Science, Scopus, EBSCOhost, Science Direct, Cochrane Library, PEDro, SciELO, and Google Scholar. In addition, the exact keywords were combined with Boolean operators (ie, AND and OR) and Medical Subject Heading (MeSH) terms centered on the title and abstract. Updated literature in Spanish, English, and Portuguese was considered without specifying the publication date. We selected the studies that included patients aged >18 years who were hospitalized for COVID-19 and intervention studies that incorporated programs of PA, PE, physical therapy, or pulmonary rehabilitation in patients during or after hospitalization for COVID-19. The main reasons for exclusion in the systematic review were as follows: gray or unconventional literature and specific COVID-19 studies without PA programs or containing programs with passive gymnastics, management guidelines for COVID-19, or recommendations for PA during the COVID-19 pandemic.

The search strategy was adapted to the characteristics of each of the search engines. We used the following keywords: COVID, SARS, coronavirus, SARS-CoV-2, physical activity, physical exercise, aerobic capacity, resistance training, aerobic exercise, therapeutic exercise, physical therapy, physiotherapy, physical rehabilitation, respiratory rehabilitation, and pulmonary rehabilitation. For example, the Cochrane database used the following strategy: "('physical activity' OR 'physical exercise' OR 'aerobic capacity' OR 'resistance training' OR 'aerobic exercise' OR 'fitness' OR 'therapeutic exercise' OR 'physical therapy' OR 'physical rehabilitation' OR 'respiratory rehabilitation' OR 'pulmonary rehabilitation' OR physiotherapy):ti AND ('Covid' OR 'SARS' OR 'coronavirus' OR 'SARS-CoV-2'):ti." The authors performed a reference review of the definitive studies, where a study was included for the analysis. The complete strategy of all search engines is shown in Supplementary Table 1.

Selection of Studies

Two authors independently exported the search engine results to an online reference manager (EndNote version 18.2.0.13302). Here, the duplicate studies were automatically deleted. Subsequently, the reviewers removed those duplicates not detected by the program through a detailed manual inspection. Discrepancies between evaluators were resolved by mutual agreement or by a third evaluator. The titles and abstracts were reviewed, verifying each article's inclusion and exclusion criteria. Then, a complete reading of the remaining studies was performed, and by consensus, the final list of studies included in the review was selected.

Data Extraction and Quality Assessment

Two investigators independently extracted the following data using an Excel form: characteristics of the studies, characterization of the population, demographic data of the participants, methodology of the study, details of the intervention, outcomes of interest, and monitoring and analysis of the results (Table 1).

PEDro[23] was used to determine the quality of RCTs, which helps users quickly assess whether studies have sufficient internal validity and the statistical information necessary for their results to be interpretable. Non-randomized intervention studies were evaluated with the MINORS scale,[24] determining whether the studies had sufficient quality to be included in reviews. Any disagreement was resolved through discussion by the authors.

Data Analysis

Because of the limited number of studies, diversity of variables analyzed, and use of different scales for evaluating the same variable, the authors analyzed the data descriptively, using numbers, means, percentage distributions, standard deviations, and frequencies.

Results

Characteristics of Intervention Studies

After a comprehensive search of the literature on our topic of interest, 302 titles were identified for inclusion. Of these, 274 titles were identified in seven databases and 28 titles through other search methods. For the selection of our studies,

Table 1 Characteristics of the Included Studies

Reference, Year	Language Country Methodology Origin of Data	Participants	Previous History and Symptoms	Intervention	Duration/ Frequency	Results of Interest
Liu, Chen et al, 2020[25]	Ingles China RCT Hainan General Hospital	51 patients were randomized: EG, n = 25 CG, n = 26 Follow-up, n = 51 Males (%): EG, 56.0 CG, 53.85 Age, mean (± SD): 50.41 (13.04) years	No previous history report Clinical symptoms, n (%) Fever: EG, 17 (68.00) CG, 24 (92.31) Cough and sputum: EG, 10 (40.00) CG, 11 (42.31) Fatigue: EG, 3 (12.00) CG, 4 (15.38) Headache: EG, 2 (8.00) CG, 3 (11.54) Diarrhea: EG, 2 (8.00%) CG, 3 (11.54%) Dyspnea: EG, 1 (4.00%) CG, 3 (11.54%)	Jacobson's relaxation techniques: muscle tension and deep breathing 20–30 min/day. Muscle tension for 10–15 s starts with the hand through the upper limbs, shoulders, head, neck, chest, abdomen, and finally the lower limbs. Relaxation for 15–20 s. Each group of muscles is repeatedly trained 3 times in sequence.	5 days, two times a day (noon and before sleep)	**STAI** mean (± SD) EG: pre, 57.88 (11.51); post, 44.96 (12.68) CG: pre, 56.92 (7.92); post 57.15 (9.24) Post-intervention (P < 0.05) **SRSS** mean (± SD) EG: pre, 24.04 (3.87); post 16.76 (4.10) CG: pre, 23.85 (2.82); post 23.23 (2.70) Post-intervention (P < 0.05)
Liu, Zhang et al, 2020[26]	Ingles China Observational, prospective, quasi-experimental study Hainan General Hospital	76 patients were randomized: EG, n = 38 CG, n = 38 Follow-up, n = 72: EG, n = 36 CG, n = 36 Males (%): EG, 66.7 CG, 69.4 Age, mean (± SD): EG, 69.4 (8.0) CG, 68.9 (7.6)	No report of symptoms Comorbidity, n (%) Hypertension: EG, 10 (27.8) CG, 8 (22.2) P = 0.56 T2DM: EG, 9 (25.0) CG, 9 (25.0) P = 0.67 Osteoporosis: EG, 8 (22.2) CG, 6 (16.7) P = 0.41	1. Respiratory muscle training, participants with a resistance device, 3 times (60% maximal expiratory mouth pressure) × 10 breaths—rest period of 1 min between sets 2. Cough exercise: 3 sets of 10 active coughs 3. Diaphragmatic training contractions in the supine position, placing a medium weight (1–3 kg) on the anterior 4. Respiratory muscle stretching exercise: supine or lateral decubitus position with the knees bent to correct the lumbar curve. 5. Home exercise 30 sets per day in pursed-lip breathing and coughing training	6 weeks, two times a week (respiratory rehabilitation once a day for 10 min)	**6MWT** mean (± SD) EG: pre, 162.7 (72.0); post, 212.3 (82.5) CG: pre, 155.7 (82.1); post after 6 weeks, 157.2 (71.7) Within the EG, it was statistically significantly before and after the intervention and compared with the CG (P < 0.05) Pulmonary function test **FEV1** mean (± SD) EG: pre, 1.10 (0.08); post, 1.44 (0.25) CG: pre, 1.13 (0.14); post after 6 weeks, 1.26 (0.32) **FVC** mean (±SD) EG: pre, 1.79 (0.53); post, 2.36 (0.49) CG: pre, 1.77 (0.64); post after 6 weeks, 2.08 (0.37) **DLCO** mean (± SD) EG: pre, 60.3 (11.3); post, 78.1 (12.3) CG: pre, 60.7 (12.0); post after 6 weeks, 63.0 (13.4) Statistically significant difference in FEV1, FVC, DLCO (P < 0.05) **SDS** mean (± SD) EG: pre, 56.4 (7.9); post, 54.5 (5.9) CG: pre, 55.9 (7.3); post after 6 weeks, 55.8 (7.1) SDS scores were not statistically significant within and between groups (P > 0.05) **SAS** mean (± SD) EG: pre, 56.3 (8.1); post, 47.4 (6.3); CG: pre, 55.8 (7.4); post after 6 weeks, 54.9 (7.3) SAS statistically significant within and between groups (P < 0.05). **ADLs**: mean (± SD) EG: pre, 109.2 (13); post, 109.4 (11.1) CG: pre, 109.3 (10.7); post after 6 weeks, 108.9 (10.1) No significant improvement within the intervention group or between the intervention and control groups **QoL (SF-36)** Scores in eight dimensions were statistically significant within the intervention group and between the two groups (P < 0.05)

(*Continued*)

Table 1 (Continued).

Reference, Year	Language Country Methodology Origin of Data	Participants	Previous History and Symptoms	Intervention	Duration/ Frequency	Results of Interest
Özlü et al, 2021[27]	Ingles Turkey RCT Emergency Department, Atatürk University	73 patients were randomized: EG, n = 36 CG, n = 37 Follow-up, n = 67: EG, n = 33 CG, n = 34 Males (%): EG, 64 CG, 47 Age, mean (± SD): EG, n = 36.48 (11.63) CG, n = 33.15 (11.90)	No report of symptoms Previous hospitalization (%) (P = 0.523) No: EG, 54 CG, 44 Once: EG, 37 CG, 38 Twice: EG, 9 CG, 18 Chronic illness (%) No: EG, 21 CG, 21 Yes: EG, 79 CG, 79 Exercise regularly (%) (P = 0.281) No: EG, 82 CG, 71 Yes: EG, 18 CG, 29	Progressive muscle relaxation exercises with music for 20–30 min. The muscle relaxation exercises were shown on the TVs in the patients' rooms, and the patients exercised along with their TVs to minimize direct patient contact.	5 days, two times a day	**STAI: SAS and TAS** No significant differences were found between the STAI levels of the groups (P > 0.05) **SAS** mean (±SD) EG: pre, 62.33 (8.33); post, 44.67 (5.41); CG: pre, 60.68 (9.17); post, 61.29 (7.95) A statistically significant difference was found between their mean posttest SAS scores (P < 0.05) A statistically significant difference was found within the EG and in comparison with the CG (P < 0.05) **TAS** mean (± SD) EG: pre, 48.12 (5.22); CG: pre, 45.35 (8.09) **RCSQ** mean (± SD) EG: post, 68.33 (14.53) CG: post, 46.71 (19.71) Statistically significant difference between groups (P < 0.05)
Sun et al, 2021[28]	Ingles China Prospective clinical trial Renmin Hospital of Wuhan University	31 participants Follow-up, n = 31 Males: 61.29% Age, mean (± SD): 60.39 (10.20)	No report of symptoms Coexisting disorder, n (%) Diabetes: 2 (6.45) Hypertension: 12 (38.71) Hepatitis B: 2 (6.45) Infection: 2 (6.45) Cancer: 2 (6.45) Chronic renal disease: 2 (6.45) Coronary heart disease: 2 (6.45) Tuberculosis: 1 (3.23) Do not have coexisting disorder: 9 (29.03) Clinical symptoms, n (%) Fever, 23 (74.19) Cough, 22 (70.97) Shortness breath, 12 (38.71) Sputum production, 4 (12.90) Fatigue, 1 (3.23)	The contents of pulmonary rehabilitation included the following: 1. Breathing method exercise (3–5–6 breathing): each breathing cycle consists of deep inhalation for 3 s holding breath for 3–5 s, and slow exhalation for approximately 6 s; 3–4 respiratory cycles in each set; pause for 30–60 s between each set. 2. Respiratory muscle training: in the lateral decubitus position, inhale slowly to let the gas fully into the lung, then exhale alternately for 15 min, and then change position. 3. Stretching training: (a) Upper limbs exercise: upward lift, lateral lift, abduction, chest enlargement, and grasping. (b) Lower limb exercise: lifting, kicking, tiptoeing, and stepping. Each action lasts for 5 s. Repeat the whole set two to three times each time. 4. Psychotherapy: patients listen to light music for 20 min per day, and a professional psychiatrist uses a mobile phone to perform psychological intervention.	3 weeks, two times at day. They were performed 3-week pulmonary rehabilitation.	**Fatigue**: n (%) Pre, 10 (32,26%); post, 28 (90,32%) (P = 0.003) **Dyspnea**: n (%) Pre, 16 (51,61%); post, 1 (3,23%) (P < 0.0001) **mMRC**: mean (SD) Pre, 2.07 (0,92); post, 1.00 (0,01) (P < 0.0001) **SpO2**: mean (SD) Pre, 97.88 (1.99); post, 98.89 (0,78) (P = 0.004) **Sleep quality**: n (%) Good Pre, 5 (16,13%); post, 24 (77,42%) (P < 0.0001) Wake up one to two times a night Pre, 23 (74,19%); post, 7 (22,58%) (P < 0.0001) Cannot sleep Pre, 3 (9,68%); post, 0 (0%) **ADLs**: mean (SD) Pre, 95.00 (6.68); post, 100.00 (0.00) (P < 0.0001)
Tang et al, 2021[29]	Ingles China Multicenter, prospective, self-controlled study First Affiliated Hospital of Nanchang University, First People's Hospital of Jiujiang, and Xinyu People's Hospital	33 participants Follow-up, n = 33 Males: 51.6% Age, mean (± SD): 43.2 (10.4)	Not reported	Liuzijue's exercise: Liuzijue combines abdominal breathing and pursed-lip breathing with uttering six different sounds: Xu, He, Hu, Si, Chui, and Xi, along with corresponding mild body movements and a calm state of mind.	4 weeks, once a day for 20 min	**6MWT**: mean (SD) Post-intervention: increased by 17.22 m (43.78)(P = 0.020) **Dyspnea**: mMRC (P = 0.022). **MIP** (cmH2O): mean (SD) Post-intervention 13.46 (20.06) (P < 0.001) **PIF** (L/s): mean (SD) Post-intervention: 0.74 (0.58) (P < 0.001) **HAM-A** (P < 0.001) **HAM-D** (P = 0.0032) **QoL (SF-36)** PF: P = 0.014 RP: P = 0.009 BP, GH, VT, SF, RE, MH: P > 0.05

Abbreviations: RCT, randomized controlled trial; SD, standard deviation; EG, experimental group; CG, control group; T2DM, diabetes mellitus type 2; STAI, Spielberger State-Trait Anxiety Inventory; SRSS, Sleep State Self-Rating Scale; 6MWT, 6-min walk test; FEV1, forced expiratory volume in 1 s; FVC, forced vital capacity; DLCO, diffusing capacity of the lungs for carbon monoxide; SDS, Self-Rating Depression Scale; SAS, Self-Rating Anxiety Scale; ADLs, activities of daily living; QoL, quality of life, TAS, Trait Anxiety Scale; RCSQ, Richards–Campbell Sleep Questionnaire; mMRC, Modified Medical Research Council Dyspnea Scale; SpO2, oxygen saturation; MIP, maximal inspiratory pressure; PIF, peak inspiratory flow; HAM-A, Hamilton Anxiety Rating Scale; HAM-D, Hamilton Depression Rating Scale; PF, physical functioning; RP, role-physical; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, role-emotional; MH, mental health.

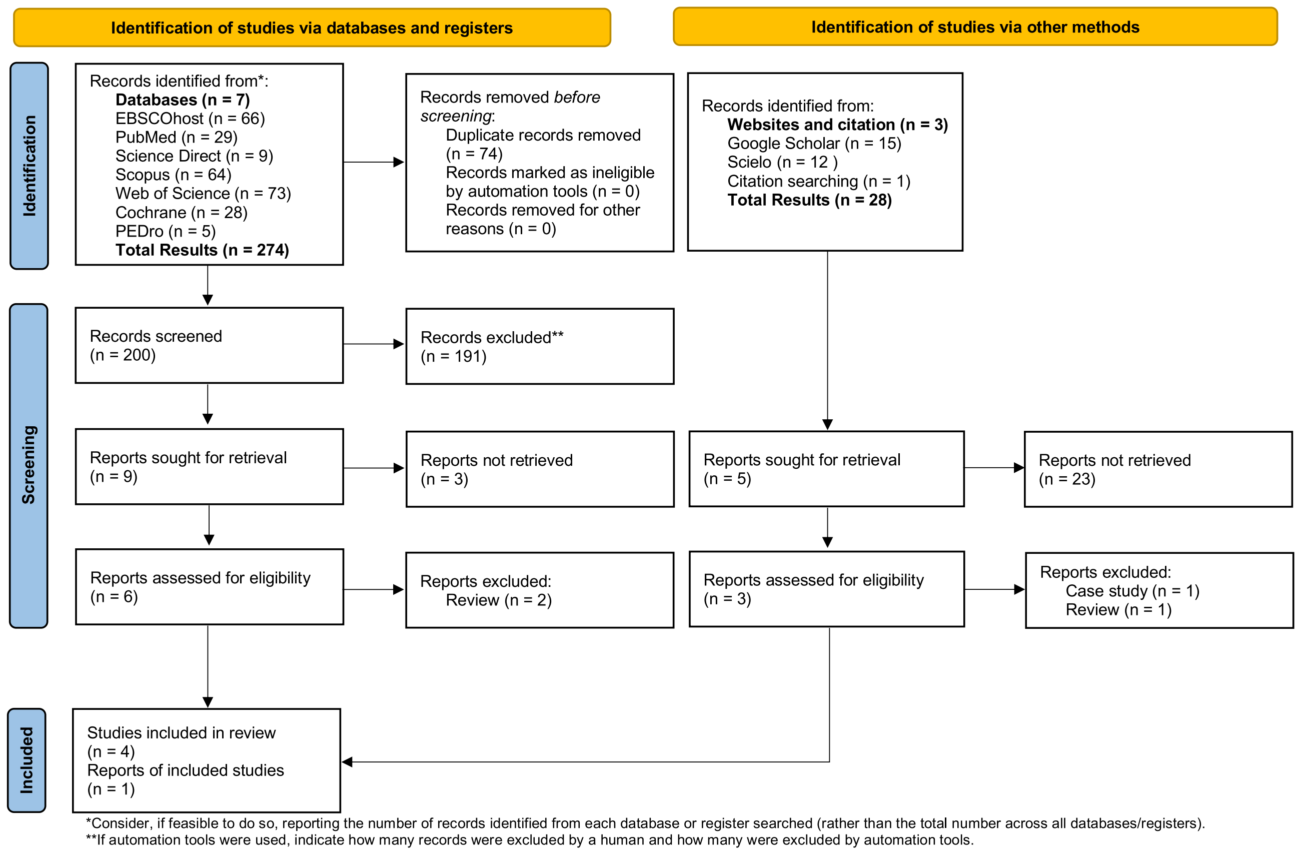

Figure 1 Flow diagram showing the number of studies identified and selected for inclusion in the systematic review according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020.
Note: PRISMA figure adapted from Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. doi:10.1136/bmj.n71. Creative Commons.[22]

74 automatically duplicated titles were discarded. The titles and abstracts were then reviewed, eliminating 191 studies that did not meet the eligibility criteria. Subsequently, six studies were evaluated through a full-text review, where four studies were included in the review. Using other search methods, an article was found to obtain five studies for the review. There were three RCTs[25–27] and two intervention studies without a control group (CG)[28,29] (Figure 1). The review of an institutional ethics board was not necessary for the research.

Characteristics of Participants

The studies included 254 patients, all diagnosed with COVID-19. The distribution by sex was 58.7% for men, and the mean age of the whole sample was 51.7±10.4 years. At follow-up, 96.2% of the population completed the intervention. In RCTs, the exercise group and CG did not differ in the baseline characteristics of the participants. Only two studies reported clinical symptoms,[25,28] the most relevant being fever, cough with sputum, fatigue, and dyspnea. Three studies reported a previous history of disease,[26–28] such as hypertension, diabetes, osteoporosis, cancer; previous hospitalization; and engaging in regular exercise prior to infection. Neither of the participants of studies included reported clinical complications. The complete details of the features are shown in Table 1.

Description of the Intervention

Sessions were performed twice a day in the studies of,[25,27,28] once a day in the study of,[29] and twice a week in the study of,[26] where an additional respiratory rehabilitation session was performed per day. The intervention time was 5 days in the studies of[25,27] and 3–6 weeks in the studies of.[26,28,29] The duration of each session ranged from 20 to 30 min for the studies, except for the study of,[26] which did not specify. Several studies included respiratory muscle training,[26,28,29] followed by relaxation techniques also used in three studies,[25,27,28] two of which used accompaniment with music to obtain better results.[27,28]

Three studies[26,28,29] evaluated the physical, lung function, psychological, and social components. However, one study[28] did not include the lung function results. Two studies[25,27] evaluated only the psychological component.

Primary Outcomes

The primary outcomes were anxiety and sleep quality, which were assessed in most results 80% and 60%, respectively.

Anxiety

Four studies[25–27,29] evaluated anxiety using different scales: Spielberger State-Trait Anxiety Inventory used in two studies,[25,27] Self-Rating Anxiety Scale (SAS) used in two studies,[26,27] Trait Anxiety Scale used in one study,[27] and Hamilton Anxiety Rating Scale used in one study.[29] The results of all studies were statistically significant within the intervention group, and in the three RCTs,[25–27] they were statistically significant compared with those in the CG ($P < 0.05$).

Sleep Quality

Sleep quality was investigated in three studies[25,27,28] using different scales: Sleep State Self-Rating Scale used in one study;[25] Richards–Campbell Sleep Questionnaire used in one study;[27] and sleep quality used in one study,[28] which was evaluated through three questions "sleep well", "wake up two to three times at night", and "do not sleep." Two studies[25,27] presented statistically significant results after the intervention ($P < 0.05$), and in one study[28] in the items "good" and "wake up one to two times a night", the results were also statistically significant after the intervention ($P < 0.0001$).

Secondary Outcomes

Two studies each evaluated the following variables, representing 40% of the total studies.

The 6-Minute Walk Test

Two studies[26,29] evaluated the 6-min walk test (6MWT), which reported significant differences before and after the intervention ($P = 0.020$). One[26] of these studies also showed statistically significant results compared with those in the CG.

Dyspnea

Two prospective intervention studies[28,29] evaluated dyspnea, showing highly significant results between before and after the exercise intervention ($P < 0.0001$ and $P = 0.022$, respectively).

Depression

Two studies evaluated depression. The study of[26] used the Self-Rating Depression Scale, which did not report statistically significant results within and between groups. On the other hand, the study of[29] used the Hamilton Depression Rating Scale, which showed statistically significant results in the intervention group ($P = 0.0032$).

Quality of Life

Two studies[26,29] measured the QoL through the short form – 36 health survey (SF-36). In the study of,[26] the scores in the eight dimensions were statistically significant between the intervention group and the two groups ($P < 0.05$). In the study of,[29] only two dimensions presented significant results after the intervention: physical functioning ($P = 0.014$) and role-physical ($P = 0.009$).

Activities of Daily Living

Two studies[26,28] analyzed the activities of daily living (ADLs) endpoint. In the study of,[26] no significant improvement was noted either within the intervention group or between the intervention group and CG. On the other hand, in the study of,[28] significant improvement was observed only in the intervention group ($P< 0.0001$).

Quality Assessment

The quality of three randomized studies[25–27] was evaluated using PEDro.[23] On the other hand, two studies[28,29] were reviewed using the MINORS scale because these were intervention studies and, thus, could not be evaluated using the same criteria.[24]

The PEDro helps users quickly identify whether RCTs have sufficient internal validity (criteria 2–9) and statistical information necessary for their results to be interpretable (criteria 10–11). The studies not in the PEDro were reviewed through independent, rigorous reading by the reviewers. The results were recorded in a spreadsheet where "Yes" or "No" was written if the study met or did not meet the criteria established by the PEDro. Any disagreement was resolved through discussion. Table 2 presents the elements selected for methodological evaluation according to the PEDro criteria and all complete information of the quality assessment.

The studies of[25–27] presented initial comparability, good follow-up, comparison between groups, and point estimates and variability. None of the studies had concealed allocation, blind subjects, blind therapists, blind assessors, and intention-to-treat analysis, which are common in the PEDro. Table 2 shows that the studies of[25–27] met the same criteria of the PEDro, except for that of.[26] Random allocation was met by approximately 97% of the studies in this database. The items concealed allocation, blind subjects, blind therapists, blind assessors, and intention-to-treat analysis that were not satisfied in any of the studies were reported in 27%, 6%, 1%, 36%, and 28% of the studies in the PEDro. The mean PEDro score was 5.1 ± 1.6, and the quality of the studies included in this review had a mean of 4.6 ± 0.57, classifying the studies as regular quality, which could hinder the development of the review.[23] Finally, these studies performed intragroup and intergroup comparisons.

For non-randomized studies,[28,29] the MINORS scale was used, which is a list containing eight essential points: at least one explicit research aim, information about the inclusion of consecutive patients, prospective data collection, appropriate assessment for the research goal, impartial evaluation of the endpoints, significant follow-up period, loss to follow-up not exceeding 5%, and prospective calculation of the sample size. The score of each section ranged from 0 to 2 depending on the quality (0, uninformed appearance; 1, inadequately informed appearance; and 2, adequately informed appearance). The overall assessed score was according to the following quality parameters, with 16 being the ideal score: 0–4, low quality; 5–10, medium quality; and 11–16, high quality.[24] These data are presented in Table 3.

The studies of[28,29] presented similar characteristics; did not report on the impartial evaluation of the results, rates of abandonment of the follow-up, and prospective sample size estimation; and adequately reported other points. The total score of the MINORS scale for each of these studies was 10, ranking studies with medium quality.[24]

Effect According to the Type of Intervention

Relaxation Exercises

Two studies[25,27] included relaxation exercises in their intervention, which only evaluated anxiety and sleep problems. The study of[25] used Jacobson's technique, which consisted of muscle contraction–distension, that is, contracting a muscle or a group of muscles for a few seconds and then loosening the contraction progressively. As such, Jacobson argued that if muscle tension is accompanied by anxiety, the individual can reduce the anxiety by learning to relax that muscle tension, decreasing almost entirely the muscle contractions and experiencing a feeling of relaxation. Jacobson's technique remains one of the most commonly used techniques to reduce anxiety and stress worldwide.[30] This study evaluated anxiety and sleep problems; both variables obtained statistically significant post-intervention results ($P< 0.05$).

The study of[27] performed an intervention of progressive relaxation exercises accompanied by music during the sessions. As in the previous study, progressive muscle relaxation is a deep relaxation technique based on the principle that muscle tension is a physiological response of the human body to disturbing thoughts. This technique leads to voluntary and regular relaxation of the main muscle groups and, thus, relieves the whole body.[27] In addition, the music component facilitates the process and could affect the reduction of anxiety, improve the QoL, relieve stress, and even facilitate social integration.[31] In this study, it effectively reduced and improved the anxiety and sleep problems in patients with COVID-19 ($P<0.05$).

Table 2 Quality of the Studies Included in the Review Using the PEDro[23]

Authors	Eligibility Criteria	Random Allocation	Concealed Allocation	Baseline Comparability	Blind Subjects	Blind Therapists	Blind Assessors	Adequate Follow-Up	Intention-to-Treat Analysis	Between-Group Comparisons	Point Estimates and Variability	Score
Liu, Chen et al, 2020[25]	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5/10
Liu, Zhang et al, 2020[26]	Yes	No	No	Yes	No	No	No	Yes	No	Yes	Yes	4/10
Özlü et al, 2021[27]	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5/10

Table 3 Methodological Items for Non-Randomized Studies Using the MINORS Scale[24]

Authors	A Stated Aim of the Study	Inclusion of Consecutive Patients	Prospective Collection of Data	Endpoint Appropriate To The Study Aim	Unbiased Evaluation of Endpoints	Follow-Up Period Appropriate to the Major Endpoint	Loss to Follow Up Not Exceeding 5%	Prospective Calculation of the Sample Size	Score
Sun et al, 2021[28]	2	2	2	2	0	2	0	0	10/16
Tang et al, 2021[29]	2	2	2	2	0	2	0	0	10/16

Respiratory Muscle Training

Three studies[26,28,29] included respiratory muscle training in their intervention. The first study[26] included pulmonary resistance, cough, stretching, and home breathing exercises in its program. The following variables were analyzed: 6MWT, forced expiratory volume in 1s (FEV1), forced vital capacity (FVC), FEV1/FVC, diffusing capacity of the lungs for carbon monoxide (DLCO), SAS, and QoL, where statistically significant differences were found between and compare to CG before and after the intervention (P<0.05). On the other hand, no statistically significant differences were noted in the depression and ADL variables.

The study of,[28] as in the previous one, included the combination of respiratory muscle training and psychological intervention, in which the patient listened to light music daily. The physical components fatigue, dyspnea, and oxygen saturation showed statistically significant post-intervention results (P=0.003, P<0.0001, and P=0.004, respectively). The psychological components sleep problems and ADLs also showed highly statistically significant results (P < 0.0001).

The study of[29] used Liuzijue's technique in their intervention, which consisted of the coordination and combination of movements and breathing patterns with specific sounds: Xu, He, Hu, Si, Chui, and Xi. In this study, different components were assessed and showed statistically significant post-intervention results: the physical components 6MWT (P=0.020) and dyspnea (P=0.022), pulmonary function components maximal inspiratory pressure and peak inspiratory flow (P<0.001), and psychological components anxiety (P<0.001) and depression (P=0.0032). No statistically significant results were noted in the social component QoL.

Discussion

Here, we describe the results derived from the systematic review of the physical, functional, psychological, and social effects of PA in adults and older adults during or after hospitalization for COVID-19. This systematic review included five studies, three RCTs, and two non-randomized intervention studies according to eligibility criteria. We found that there were a limited number of studies registered in the seven databases and two search engines and the references cited at the time of systematic review. We considered that the small number of intervention studies was due to the novelty of COVID-19 and the limited knowledge regarding SARS-CoV-2, the disease and its effects, and, indeed, both physical and psychosocial treatments for patients. To organize this section, the results of the physical and functional variables are discussed first, followed by the results of the psychological and social variables.

The studies reviewed included relatively few physical variables, 6MWT and dyspnea, measured by two studies. Both variables showed significant results in the post-intervention groups. These variables are essential in rehabilitation after hospital discharge for COVID-19. In this regard, the study of[32] was conducted in an Italian population that measured dyspnea and the 6MWT. Here, the patients presented with dyspnea and shortness of breath even when performing minimal activities. In addition, only a small percentage of patients could perform the 6MWT, resulting in low performance after discharge from the ICU.

For this reason, this study concluded that patients should be placed in a rehabilitation unit once they leave the ICU, for which an early rehabilitation protocol adapted to these patients would be proposed. Similarly, another study[33] highlighted the need to follow-up patients with hospital discharge. This study evaluated the benefits of the 6MWT and concluded that this test is pertinent because it is correlated with COVID-19 severity and functional impairment and can be used to determine improvement in exercise capacity.

Regarding the variables of lung function, the COVID-19 particularly affects lung function, given that in moderate and severe cases, it causes acute respiratory syndrome. However, few studies evaluated variables such as FEV1, FVC, and DLCO.[26] This finding is important considering that current scientific evidence shows that PA and PE are protective factors for multiple diseases and coronavirus-like symptoms.[15]

One study found improvement in dyspnea and respiratory muscle strength at the level of specific respiratory muscle training. The study estimated aerobic fitness, generating statistically significant changes for the intervention in maximal oxygen consumption (VO2 max).[34]

The systematic review of the literature on the psychological effects of PA in adults and older adults during or after hospitalization for COVID-19 is limited; however, there is evidence of a reduction in the levels of physical activity in these patients, leading to an increase in post-pandemic sedentary lifestyle.[35] This result may be related to the limited knowledge of the disease study in the psychological, physical, functional, and social fields. However, the studies reviewed showed the actual results concerning the psychological effects in three variables: anxiety, sleep problems, and depression.[36] Of these variables, the most frequently evaluated is anxiety, followed by sleep problems. Overall, the studies reviewed showed statistically significant results in the intervention group, especially for anxiety and sleep problems. On the other hand, the results for depression were heterogeneous.

Psychological conditions during and after COVID-19 have been identified, where patients report higher anxiety and depression levels than health professionals and the general population.[37] Similarly, a literature review[38] concludes that the COVID-19 pandemic has affected the population's mental health, particularly hospitalized patients with notable symptoms of anxiety, depression, and sleep disorders. These can be associated with psychosocial components, including the isolation that patients with COVID-19 experience and the series of uncertain situations resulting from a novel virus, which are related to negative emotions such as the fear of death that, in some cases, can lead to anxiety before death.

Symptoms of anxiety and depression in patients with COVID-19 may be associated with the inflammatory process and release of cytokines due to the multisystem disease. Similarly, the effects of psychological and physical stresses experienced by patients may be related to the activation of the hypothalamic–pituitary–adrenal axis.[39] One study[40] found that in diseases with some characteristics similar to COVID-19, such as SARS and Middle East Respiratory Syndrome (MERS), patients had psychological deterioration even 6 months after discharge from hospitalization.

The effects of COVID-19 on mental health in patients hospitalized for this disease and in the general population reported in the aforementioned studies highlight the need for further research to investigate possible treatments for patients' mental health during and after hospitalization for COVID-19. The studies discussed in this systematic review provide information on the positive effects of the different interventions on mental health, specifically in the reduction of anxiety and improvement of sleep problems: relaxation exercises such as Jacobson's technique, progressive muscle relaxation, Liuzijue's technique, and breathing muscle training. Additionally, it is essential to highlight the use of music as a form of psychological intervention in the patients who participated in the studies. Overall, these significant results can be associated with pre-COVID-19 pandemic scientific evidence confirming the positive effects of PE on mental health[41] and more recent studies interested in investigating mental health and PA in the general population during the COVID-19 quarantine.[42]

In comparison with the psychological results, the social results of the studies included in this systematic review were more heterogeneous. In one study with a single group, significant improvement in the ADL variable was evident, whereas in another, no differences were noted between the control and experimental groups. These results suggest the need for further studies about the effects of PA on the social components, such as ADLs. A study found that there is improvement in mental health, quality of life, and function even with low volumes of exercise per day. However, the studies had heterogeneous aspects in the dosage of exercise, and it is recommended to continue with the intervention processes in this area.[43]

Some studies also had heterogeneous results regarding the effects of PA on QoL. One study[26] presented significant results in all eight QoL dimensions, whereas another[29] found that only two of them had significant results. Regarding this variable, the systematic review of[40] found that 1 year after discharge, patients hospitalized for other viruses similar to COVID-19 had not resumed their working life level. These authors consider that one of the reasons why social life after the disease is affected could be related to symptoms such as fatigue that people who were infected continue to experience. Although it was not a direct objective of this review, it is estimated that between 10 and 20% of patients with SARS-CoV-2 present post-COVID-19 syndrome. These patients go through an acute symptomatic phase and experience the effects of the disease well beyond 12 weeks after diagnosis. Exercise is an adjuvant to stimulate the immune system by inducing mitochondrial adaptations, cell generation, and immune surveillance.[15]

Limitations

This review of literature has some limitations. First, the scientific evidence available at the time of systematic review was limited. Second, the studies reviewed included a few physical and functional variables. Therefore, further research is needed on the effects of PA in the studied population and, in particular, RCTs.

Conclusion

This review of literature found that men had the highest incidence of COVID-19 (58.7%), which is consistent with the findings of previous studies that reported that women are less susceptible to viral infections.[44,45] Moreover, the mean age (± standard deviation) of the whole sample was 51.7 ± 10.4 years, which is consistent with the data on the charts worldwide where the highest prevalence of confirmed cases is in the age range of 30 and 79 years.[10]

Considering that the lungs are the organs primarily affected, this review found that respiratory muscle training was the most commonly used intervention because the main symptoms of the disease showed positive results in the components: physical and pulmonary functions, psychological, and social. The relaxation exercises intervention showed positive effects with anxiety, sleep problems, and, therefore, the QoL of the affected individuals.

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