



# Exercise recommendations after COVID-19 infection: a scoping review

Recomendações de exercício físico após adoecimento por COVID-19: revisão de escopo

## AUTHOR'S

Alexandre Konig Garcia Prado<sup>1</sup>   
 Jhennifer Carolina de Almeida Alves<sup>1</sup>   
 Renata Neli Moreno Gurginski<sup>1</sup>   
 Thaymara Mikuni<sup>1</sup>   
 Danieli Zata<sup>1</sup>   
 Paula Lucia Magalhães da Silva  
 Albuquerque<sup>2</sup>   
 João Ricardo Gabriel de Oliveira<sup>1,3</sup>

<sup>1</sup> Federal University of Mato Grosso, Department of Physical Education, Cuiabá, Mato Grosso, Brazil.

<sup>2</sup> University of Cuiabá, Cuiabá, Mato Grosso, Brazil.

<sup>3</sup> Centro Mato-grossense Faculty, Sorriso, Mato Grosso, Brazil.

## ABSTRACT

In addition to its acute effects, COVID-19 can cause prolonged symptoms and sequelae. Physical exercise can be an important countermeasure during the disease recovery process, but little is known about its effects on COVID-19 convalescents. This scoping review aimed to summarize physical exercise recommendations after COVID-19 (acute and post-acute phases). A search was carried out in the following databases: Cochrane, PEDro, PubMed, SciELO, Sport Discus and Web of Science. Two independent reviewers read the titles, abstracts and articles and collected the data. A total of 445 references were found, 16 of which were included in the final version. Among the studies included, the most frequently cited are: 1) recommendations for people over 18 years, with different degrees of COVID-19 severity; 2) remote rehabilitation and use of personal protective equipment for biosafety procedures; 3) physical fitness tests and clinical evaluations; 4) oxygen saturation and heart rate for session monitoring; 5) more than one type of exercise (multicomponent), mainly aerobic and strength exercises, and; 6) the need for individualized prescription and multidisciplinary intervention. The rehabilitation program must consider the individual peculiarities and COVID-19 severity, with prescription focused on overall improvement. Based on frailty studies, the effectiveness of physical exercise in post-COVID-19 rehabilitation cannot be confirmed. Randomized controlled trials should be performed.

**Keywords:** SARS-CoV-2; Physical training; Rehabilitation.

## RESUMO

Além dos efeitos agudos, o adoecimento por COVID-19 pode deixar sintomas e sequelas persistentes por um longo período. O exercício físico pode ser uma importante contramedida durante o processo de recuperação de doenças, porém pouco se sabe a respeito dos efeitos dessa prática em pessoas convalescentes da COVID-19. O presente estudo apresenta uma revisão de escopo de recomendações para a prática de exercícios físicos após adoecimento por COVID-19 (fases aguda e pós-aguda). Foi realizada uma busca eletrônica nas bases: Cochrane, PEDro, PubMed, SciELO, Sport Discus e Web of Science. A leitura do título e resumo, dos artigos na íntegra e extração dos dados foi realizada por dois revisores independentes. Foram encontradas 445 referências, sendo 16 estudos incluídos na versão final. Entre os estudos incluídos, são citados com maior frequência: 1) recomendações para maiores de 18 anos, com diferentes graus de acometimento; 2) reabilitação à distância e uso de equipamentos de proteção individual nos procedimentos de biossegurança; 3) testes de aptidão física e avaliações clínicas; 4) saturação de oxigênio e a frequência cardíaca para monitoramento da sessão; 5) programas com mais de um tipo de exercício (multicomponente), sendo os exercícios aeróbios e de força os mais indicados; e; 6) necessidade de prescrição individualizada e intervenção multiprofissional. O programa de reabilitação deve considerar as peculiaridades individuais e a gravidade da COVID-19, com prescrição centrada na melhoria geral. Baseados em estudos frágeis, a eficácia do exercício físico na reabilitação após COVID-19 não pode ser confirmada. Ensaios clínicos randomizados controlados devem ser realizados.

**Palavras-chave:** SARS-CoV-2; Treinamento físico; Reabilitação.

## DOI

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## Introduction

On March 11, 2020, the WHO declared COVID-19, an acute respiratory disease caused by SARS-CoV-2, a pandemic. By the end of August 2021, more than 215 million cases and nearly 4.5 million deaths had been recorded worldwide<sup>1</sup>. In the same period, Brazil reported approximately 21 million infections, with 579,000

deaths<sup>1</sup>. SARS-CoV-2 fuses its viral envelope with cell membranes, resulting in the entry and replication of the virus in humans, which may lead to inflammatory processes, decreased immunological and pulmonary compromise with alveolar damage<sup>2,3</sup>.

In addition to acute symptoms, which normally last 4 weeks after onset<sup>4</sup>, pulmonary, cardiovascular, hema-

tological, renal, central nervous system, gastrointestinal, psychosocial and post-intensive syndrome manifestations are potential long-term effects of SARS-CoV-2 infection<sup>5</sup> (post-acute phase: more than 4 weeks after symptoms onset<sup>4</sup>). Patients who undergo intensive treatment exhibit physical, cognitive and/or mental disorders that persist after hospital discharge<sup>5</sup>. Persistent symptoms are fatigue, muscle weakness, dyspnea, memory loss, concentration and sleep disorders, anxiety or depression<sup>6,7</sup>.

Prolonged symptom duration and disability may persist even in individuals who do not require ICU admission. Carfi et al.<sup>8</sup> reported that only 12.6% of their sample needed ICU treatment, and over half (87.4%) reported persistence of at least one symptom 60 days after COVID-19 recovery. Another study showed that 35% of non-hospitalized symptomatic patients after recovery from COVID-19 had not returned to their normal health status three weeks after testing positive<sup>9</sup>. Manifestations resulting from COVID-19 may be related to quality of life<sup>10,11</sup> and should be treated as soon as possible.

Among the strategies applied to health recovery, physical exercises (PE) stand out as a non-drug and/or preventive treatment for a wide range of conditions<sup>12</sup>, such as depression<sup>13</sup>, cardiovascular diseases<sup>14,15</sup>, respiratory diseases<sup>16</sup>, weakness/sarcopenia<sup>17</sup> and chronic fatigue syndrome<sup>18</sup>. Physical aptitude and performance in the activities of daily living<sup>19</sup>, in addition to quality of life, primarily in people with a medical condition<sup>20</sup> or recovering from some disease<sup>21</sup>, are also positively associated with PE. The positive health effects of PE are widely recognized, but little is known about its recommendations for people recovered or recovering from COVID-19.

Although a number of reviews and trials have sought to elucidate questions regarding the prescription of PE in COVID-19 recovery<sup>22-25</sup>, few studies<sup>24,25</sup> have systematically summarized recommendations in terms of biosafety protocols, exercise monitoring, assessments and other aspects that should be part of a PE program for the population in question. A COVID-19 recovery program that considers these factors is an important therapeutic tool in reducing complications related to immobility and preventing middle and long-term readmissions, thus improving the health and perceived quality of life of people affected by this disease. Taken together, these effects may lower public health costs and reduce hospitalizations and death directly or indirectly related to COVID-19.

Thus, the aim of the present study was to conduct a scoping review to systematically analyze and summarize PE recommendations for post-COVID-19 patients. The results may contribute to the methodological procedures and relevant issues in future studies and indirectly help physical education professionals and multiprofessional health teams prescribe PE for individuals needing post-COVID-19 rehabilitation.

## Methods

The study meets the PRISMA guidelines for scoping reviews<sup>26</sup>. The research was conducted during the second half of May 2021. The following databases were consulted: Cochrane, PEDro, PubMed, SciELO, Sport Discus and Web of Science. Combined search terms used the Boolean operators AND and OR to select the studies, as follows: Rehabilitation OR Recovery OR aftercare OR "After Care" OR After-Treatment OR "After Treatment" OR After-Treatments OR "Follow-Up Care" OR Care, Follow-Up OR Cares, Follow-Up OR "Follow Up Care" OR "Follow-Up Cares" AND Exercise OR Exercises OR "Physical activity" OR "Physical activities" OR "Physical exercise" OR "Physical exercises" AND Coronavirus OR Coronaviruses OR Delta coronavirus OR Delta coronaviruses OR COVID-19 OR COVID19 OR "2019 novel coronavirus" OR SARS-CoV-2 OR 2019-nCoV. The search was performed only in English. An example of the search is presented in Table 1.

**Table 1** – Example of the search in one of the databases.

Base	Busca
PUBMED	Search: (((((Exercise[Title/Abstract]) OR (Exercises[Title/Abstract])) OR ("Physical activity"[Title/Abstract])) OR ("Physical activities"[Title/Abstract])) OR ("Physical exercise"[Title/Abstract])) OR ("Physical exercises"[Title/Abstract])) AND (((((((Coronavirus[Title/Abstract]) OR (Coronaviruses[Title/Abstract])) OR (Deltacoronavirus[Title/Abstract])) OR (Deltacoronaviruses[Title/Abstract])) OR (COVID- 19[Title/Abstract])) OR (COVID19[Title/ Abstract])) OR ("2019 novel coronavirus"[Title/ Abstract])) OR (SARS-CoV-2[Title/Abstract])) OR ("2019-nCoV"[Title/Abstract])) AND (((((((After Care[Title/Abstract]) OR (After-Treatment[Title/ Abstract])) OR ("After Treatment"[Title/Abstract])) OR ("After-Treatments"[Title/Abstract])) OR ("Follow-Up Care"[Title/Abstract])) OR (Care, Follow-Up[Title/Abstract])) OR (Cares, Follow- Up[Title/Abstract])) OR ("Follow Up Care"[Title/ Abstract] AND "Follow-Up Cares"[Title/Abstract])) OR ("Follow Up Care"[Title/Abstract])) OR ("Follow- Up Cares"[Title/Abstract])) OR (recovery[Title/ Abstract])) OR (Rehabilitation[Title/Abstract]))

We included reviews, opinion articles reviews, opinion articles, original articles, viewpoints, interviews, comments, editorials, protocol proposals and experimental studies published in scientific journals with recommendations for exercise or physical activity for people in the acute and post-acute phases of COVID-19 infection, with or without sequelae. Recommendations involving PE pertinent to the physical education professional were considered. These included walking, running, cycling, swimming, gym workouts, stretching, dance, water aerobics, strength exercises or similar. Studies with PE recommendations associated with physiotherapy or breathing exercises were also included. Qualifying studies made specific recommendations for at least two of the following variables involved in PE: type, intensity, volume and/or duration. In order to be included, studies had to be written in English, Spanish or Portuguese.

To ensure objectivity of the review in terms of rehabilitation using PE pertinent to the range of activities of physical education professionals and focused on overall improvement, studies with recommendations exclusively for physiotherapy treatment or breathing exercises were excluded. Similarly, with a view to determining the possible effects of a PE program aimed strictly at rehabilitating patients with COVID-19 and its harmful effects on human beings, animal studies and articles that used exercise to recover from other diseases during the pandemic, such as cancer, heart or respiratory disease not related to COVID-19 were not considered.

Initially, the search was conducted by two independent authors, with the help of the EndNote reference manager (Web version) and an Excel spreadsheet (Microsoft Corporation), followed by analysis of the titles and abstracts of the articles selected. Following standard criteria, the two independent authors read the articles in their entirety. After analysis, the results of each author were compared, and disagreements over inclusion/exclusion were submitted to a third assessor.

Two independent reviewers used a standard Microsoft Office Word table (Microsoft Corporation) to organize data extraction. The data extracted included the author, type of article (based on information from the journal or the article itself; when this information was absent or unclear, the type of study was determined by the authors of the present study), year of publication and recommendations related to the exercise variables (type, intensity, volume, duration and others), biosafety protocols to be implemented, exercise monitoring and assessments to be conducted, in addition to other

important recommendations. Comparative analysis of data extraction was performed by a third independent author, who determined which data would be included in the final version in case of disagreement between the two reviewers. The studies were grouped according to the type of study, and quantitative and qualitative data presented in a table divided into three sections: experimental studies, review studies and trials/opinion articles. The extracted data are subdivided in the table according to the participants' information, biosafety protocols, exercise protocols, assessments, monitoring, results and other relevant data.

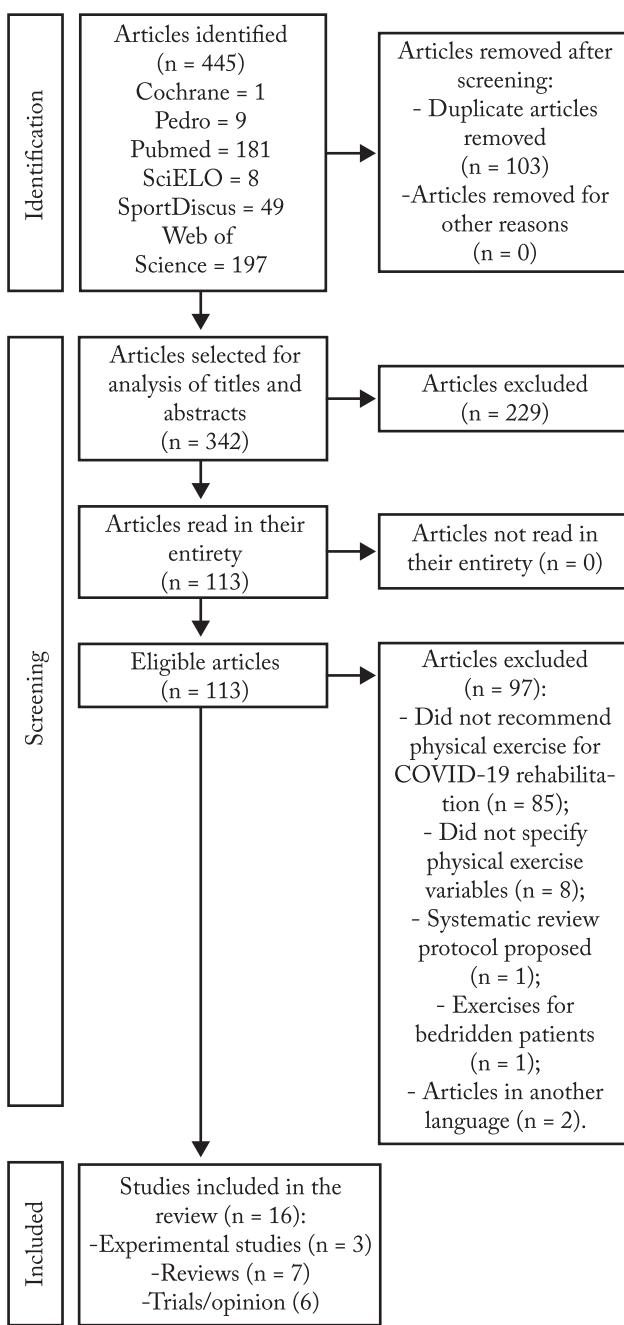
A summary of recommendations was created considering the target public, biosafety measures, assessments, session monitoring, PE protocols and other recommendations. These aspects were determined by consensus among the authors of the present study, who considered the frequency with which each item appeared in the selected studies, as well as the relevance of each piece of information for executing a safe and effective physical rehabilitation program.

Given that this review focuses on discussing the issues and characteristics of studies containing PE recommendations after COVID-19, without distinguishing or assessing the potential risks of biases and methodological shortcomings for these recommendations, methodological quality was not analyzed. This is expected in scoping reviews using this approach<sup>26</sup>.

## Results

The results of the search are presented in Figure 1. A total of 445 articles were found. After exclusion of duplicates, reading of titles, abstracts, and the entire texts of the selected studies, 16 articles were included in the final version<sup>27-42</sup>.

Of the studies included, only three were experimental<sup>27-29</sup> and none were randomized controlled trials. Six studies were classified as narrative reviews<sup>30-35</sup>, one a scoping review<sup>36</sup> and the others trials or opinion articles<sup>37-42</sup>. One study in this last group proposed a randomized controlled trial<sup>39</sup>. One was a consensus declaration from the Defence Medical Rehabilitation Centre Stanford Hall<sup>40</sup> and another the shared experience of different rehabilitation centers consisting of specialists in physical medicine and rehabilitation from eleven different countries in Europe and North America<sup>38</sup>. In addition, one study made recommendations based on the Brazilian Guidelines for Cardiovascular Rehabilitation and the Chinese Association of Rehabilitation Medicine<sup>32</sup>.



**Figure 1 – Flowchart of the search results.**

The sample size of experimental studies<sup>27-29</sup> was between 10 and 30 subjects of both sexes, with average age of more than 50 years and hospitalization time of 5 to 19 days. Considering all the studies, the characteristics of the target population varied widely. These contained individuals aged 18 years or older, convalescing from different degrees of COVID-19, with or without the need for mechanical ventilation<sup>32,36,39,41</sup>, with no symptoms such as fever, dyspnea or tachycardia, low oxygen saturation and stable hemodynamic and respiratory or

mild pulmonary symptoms<sup>28,34,36,38</sup>. Two experimental studies<sup>27,28</sup> and 9 reviews or trials<sup>31,32,35-40,42</sup> applied or suggested biosafety protocols, with distance rehabilitation<sup>27,31,32,36,38,39,42</sup> and the use of personal protective equipment the most recommended procedure<sup>28,35-38,40</sup>.

Among the experimental studies, two<sup>28,29</sup> combined strength training (ST) and aerobic training (AT), conducted 5 to 7 times a week. ST consisted of 3 to 20 repetitions with tolerated maximum capacity or intensity between 30 and 80% of one repetition maximum (1RM), and AT of walking, stationary cycling or step, with a maximum tolerated or continuous load<sup>28</sup> between 5 and 15 minutes and intensity of 3 to 5 on the modified Borg scale<sup>29</sup>. Balance training<sup>29</sup> and low-intensity exercise for the entire body<sup>27</sup> were also applied in experimental studies. In relation to review and opinion studies and trials, programs recommending more than one type of exercise (multicomponent) were cited in over half the studies<sup>30,32,33,35-40,42</sup>. Aerobic exercises were recommended in 11 of the articles<sup>30,32-40,42</sup> and strength/strengthening exercises in 9<sup>32,33,36-42</sup>. Others such as Qigong<sup>30,31</sup>, stretching or flexibility<sup>32,33,35,40,42</sup>, balance<sup>32,36,39,42</sup>, and functional exercises<sup>32</sup> for coordination<sup>39</sup> and breathing<sup>31,32,35,36</sup> were also cited. For the aerobic exercises reported in the reviews and trials, the most recommended were walking<sup>35-37,42</sup> and stationary cycling/outdoor cycling<sup>35,37,42</sup>. The volume of aerobic exercises ranged from five<sup>38</sup> to 50 minutes<sup>32</sup> per session, 30 minutes being the most cited<sup>32,34,36-39</sup>. Three times a week was reported in five studies<sup>30,32,35-37</sup>. With respect to aerobic exercise intensity, recommendations were predominantly for low (primarily at the onset of the program and for symptomatic individuals) and moderate intensity<sup>30,33-37,42</sup>, limited to 80-85% of maximum exertion<sup>37,38</sup> or maximum heart rate (HR)<sup>32</sup>. For strength exercises, low (30 - 40% of 1 RM)<sup>29,33,37</sup> to high-intensity exercises (80% of 1RM)<sup>37</sup> were indicated. The number of sets varied between 1 and 4, with 3 to 5 repetitions<sup>32,36-38,42</sup> and 1 to 2 minutes of rest between sets<sup>32,36,42</sup>. The weekly frequency of ST varied from 1 to 3 sessions<sup>32,36-38</sup>. For multicomponent programs, frequency should be 4 or more times a week<sup>42</sup>.

Assessments were cited in 11 studies<sup>27-29,32,33,35-41</sup>, 3 of which were experimental<sup>27-29</sup>. The most mentioned physical tests were the 6-minute walk<sup>28,29,32,36-38</sup> and sit-to-stand tests<sup>29,32,36</sup>. Physical/functional tests or physical aptitude questionnaires<sup>28,29,32,37</sup>, and physical activity level<sup>37,39</sup> were also cited. Spirometry<sup>28,36,37</sup> and dyspnea<sup>35,37,39</sup> tests may be relevant. Comorbidities/

history of disease<sup>28,29,41</sup>, health status<sup>37,39</sup>, cognitive assessment<sup>27,29,39</sup>, symptoms of depression and/or anxiety and/or psychological state<sup>28,37,39</sup>, quality of life<sup>28,37,39</sup>, electrocardiogram<sup>32,40</sup> and blood tests<sup>28,40</sup> were part of clinical assessment in at least two studies. The session monitoring in 10 studies<sup>27,28,32,33,35-40,42</sup>. Among the

possibilities presented, oxygen saturation<sup>28,32,33,35-38,40</sup>, HR<sup>32,35,37,38,40</sup> and blood pressure<sup>32,40</sup> stood out. Seven studies<sup>28,29,32,33,40-42</sup> recommended individualized prescription or the need to attend to individual needs. The need for multiprofessional team intervention was reported in 10 studies<sup>27,28,30,32,35-37,39,40,42</sup> (Table 2).

**Table 2** – Participants, biosafety protocols, exercise protocols, assessments, monitoring, results and other relevant information from studies included in the review.

Author and study type*	Study data
Experimental studies	
Chen et al. <sup>27</sup> Opinion	<p><b>Participants:</b> 18 to 75 years (n = 10); mild to moderate COVID-19 and no other severe respiratory or systemic diseases; hospitalization between <math>5.0 \pm 2.0</math> days.</p> <p><b>Biosafety protocol:</b> individualized care; remote program (in-person at the onset of the program and progression to distance exercises).</p> <p><b>PE protocol:</b> 30 min, every day for 2 weeks during hospitalization; after discharge, 6 sets of 8 low-intensity exercises for the entire body with 2 repetitions.</p> <p><b>Assessments:</b> muscle strength, cognition.</p> <p><b>PE monitoring:</b> constant review of the potential clinical risk of PE.</p> <p><b>Results:</b> improvement in PA, perceived dyspnea and QoL compared to a control group undergoing standard treatment.</p> <p><b>Other relevant information:</b> maintenance of nasal cannula oxygen during training; interruption in case of fatigue and asthma; PE program combined with nutritional intervention, drug therapy and traditional Chinese medicine.</p>
Hermann et al. <sup>28</sup> Short report	<p><b>Participants:</b> <math>66.04 \pm 9.30</math> years, mechanically ventilated (n = 12) or not ventilated (n = 16), with stable respiratory and hemodynamic functions; hospitalization between <math>19.3 \pm 10.7</math> days.</p> <p><b>Biosafety protocol:</b> asymptomatic individuals admitted; COVID-19 detection tests; individualized treatment; use of personal protective equipment.</p> <p><b>PE protocol:</b> Combined AT and ST, 2 to 4 weeks, 5 to 6 days a week, totaling 25–30 sessions; AT consisting of walking or cycling with maximum tolerated load; ST composed of 3 to 20 repetitions with maximum tolerated load.</p> <p><b>Assessments:</b> walk tests; QoL; motor functionality; health status; psychological health; diagnostic tests of pulmonary health.</p> <p><b>PE monitoring:</b> SpO<sub>2</sub>; HR; perceived subjective exertion (PSE).</p> <p><b>Results:</b> significant increase in the 6-minute walk and feelings thermometer for the total cohort, with no significant differences between the ventilated and non-ventilated; persistent bilateral infiltrations in 20 individuals (74%); persistent obstructed ventilation in only a few cases, but predominantly restricted ventilation and reduced diffusion capacity in most of the participants, with no significant differences between the two groups; 25% still needed supplementary oxygen after discharge; everyone could go home with no nursing support; no deaths.</p> <p><b>Other relevant information:</b> PE program adapted to disease severity and individual specificities; combined with respiratory physiotherapy, educational sessions, nutritional and diabetes counseling, smoking cessation program and psychosocial support.</p>
Udina et al. <sup>29</sup> Short report	<p><b>Participants:</b> <math>66.20 \pm 12.80</math> years (n = 33) who recovered from COVID-19 and able to walk unassisted pre-COVID-19; hospitalization of <math>10.3 \pm 9.9</math> days.</p> <p><b>Biosafety protocol:</b> not provided (NP).</p> <p><b>PE protocol:</b> multicomponent intervention of 30 min/session, 7 days/week consisting of ST of 2-4 exercises, 1-2 sets with 8-10 repetitions and intensity between 30 and 80% of 1RM; continuous AT of 5-15 minutes and intensity of 3-5 on Borg's modified scale; balance training.</p> <p><b>Assessments:</b> health status; drugs used; motor functionality; cognition; psychological test; walk tests; balance; strength test.</p> <p><b>PE monitoring:</b> NP.</p> <p><b>Results:</b> all the physical performance measures exhibited statistically significant improvement when compared to the initial and final values of the global sample and in post-ICU patients; non-ICU patients showed no improvement in balance; post-ICU patients improved more in the short battery of performance tests and average change in gait speed when compared to their non-ICU counterparts, with no deaths; all subjects were discharged.</p> <p><b>Other relevant information:</b> PE program adapted to individual specificities; recommendations for less sedentary behavior.</p>
Review studies	
Alschuler et al. <sup>30</sup> Narrative review	<p><b>Participants:</b> convalescents from mild-to-moderate COVID-19.</p> <p><b>Biosafety protocol:</b> NP.</p> <p><b>PE protocol:</b> Qigong; 20 – 90 min/day; PE: moderate aerobics, 10-15 min, 1-2 x / day, 3-4 days/week.</p> <p><b>Assessments:</b> NP.</p> <p><b>PE monitoring:</b> NP.</p> <p><b>Other relevant information:</b> PE program should be associated with the nutritional intervention, breathing exercises, drug use and stress control.</p>
Feng et al. <sup>31</sup> Narrative review	<p><b>Participants:</b> older adults.</p> <p><b>Biosafety protocol:</b> remote program (recorded videos).</p> <p><b>PE protocol:</b> Qigong, Ba Duan Jin, Liu Zi Jue and light-to-moderate abdominal respiration; continuous practice.</p>

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Continuation of **Table 2** – Participants, biosafety protocols, exercise protocols, assessments, monitoring, results and other relevant information from studies included in the review.

Author and study type*	Study data
Feng et al. <sup>31</sup> Narrative review	<b>Assessments:</b> medical consultation. <b>PE monitoring:</b> NP. <b>Other relevant information:</b> specific attention to the exercise setting, meals near the session and instructor experience.
Frota et al. <sup>32</sup> Narrative review	<b>Participants:</b> post-hospital discharge patients. <b>Biosafety protocol:</b> remote program (synchronous meetings). <b>PE protocol:</b> recommendations based on type of rehabilitation; respiratory rehabilitation with multiple exercises for at least 6 to 8 weeks; cardiovascular rehabilitation consisting of 3 to 5 sessions a week for a total of 150 minutes a week of aerobic, strength, and stretching exercises, starting with low intensity at the onset of the program (<3 METs) and gradually increasing based on individual tolerance, reaching moderate-to-vigorous intensity (70 to 85% of peak HR); musculoskeletal rehabilitation consisting of aerobic exercises 3 to 5 days/week from 20 to 30 minutes, and intermittent PE for individuals exhibiting fatigue with minimum exertion, in addition to progressive ST, 2 to 3 times a week, 1 to 3 sets and 8 to 12 RM; instrumental training is also recommended. <b>Assessments:</b> walk and muscle strength tests; battery of physical tests; motor functionality; diagnostic tests of pulmonary health; diagnostic tests of cardiac health; <b>PE monitoring:</b> SpO <sub>2</sub> ; HR; BP; perceived subjective exertion. <b>Other relevant information:</b> PE program based on individual specificities; included speech therapy, gustatory and olfactory rehabilitation and nutritional guidance.
Greve et al. <sup>33</sup> Narrative review	<b>Participants:</b> patients with different levels of COVID-19. <b>Biosafety protocol:</b> NP. <b>PE protocol:</b> for participants with very mild symptoms, activities up to 3 METs (PSE 9-12 or equivalent), avoiding sedentary behavior for prolonged periods; mild or moderate symptoms, stretching exercise and low-intensity ST before AT sessions; asymptomatic individuals continue normal activities. <b>Assessments:</b> NP. <b>PE monitoring:</b> SpO <sub>2</sub> ; fatigue. <b>Other relevant information:</b> PE program adapted to disease severity and individual specificities.
Mohamed e Alawna <sup>34</sup> Narrative review	<b>Participants:</b> patients with mild pulmonary symptoms. <b>Biosafety protocol:</b> NP. <b>PE protocol:</b> mild-to-moderate aerobics for 10 to 30 minutes. <b>Assessments:</b> NP. <b>PE monitoring:</b> NP. <b>Other relevant information:</b> NP.
Wang et al. <sup>35</sup> Narrative review	<b>Participants:</b> patients with mild, moderate and severe COVID-19 cases. <b>Biosafety protocol:</b> personal protective equipment; hand sanitizing. <b>PE protocol:</b> patient in acute care, general mobility exercises, respiratory rehabilitation, yoga, tai chi a Borg dyspnea scale score ≤3. 2 times/day, 10-15 min in the first 3 or 4 sessions and gradual rise in load/exertion on the Borg scale of 4-6 and 30-45 min duration each 2-3 sessions; routine stretching 3 times/day can be applied; in mildly affected patients, walking, cycling with Borg dyspnea scale ≤3, 1-2 times/day, 3-4 times a week, 10-15 min for the first 3-4 sessions and gradual increase, seeking total duration of 30- 45 min per session, with a gradual working load/exertion increase every 2-3 sessions to achieve 4-6 on the Borg dyspnea scale; breathing exercises can be applied 2-3 times/day, for 10-15 min in the first 3-4 sessions, progressing every 2-3 sessions to a total duration of 60 min; encourage stretching 3 times/day. <b>Assessments:</b> dyspnea; symptoms; diagnostic examinations of pulmonary health. <b>PE monitoring:</b> SpO <sub>2</sub> ; HR; BP; dyspnea; respiratory rate; body temperature, awareness level. <b>Other relevant information:</b> PE program can be associated with nutritional education, breathing exercises and osteopathic manipulation; oxygen supplementation during PE can be used.
Siddiq et al. <sup>36</sup> Scoping review	<b>Participants:</b> asymptomatic individuals after hospital discharge. <b>Biosafety protocol:</b> remote program (recorded videos); personal protective equipment. <b>PE protocol:</b> low-intensity aerobic PE at the onset, 3-5 sessions/week, from 20 to 30 min/session; interval PE in the event of fatigue; ST starting with a reduced load, 8-12 repetitions per exercise, 1-3 sets, with a 2-min interval between sets, 2-3 sessions/week, for 6 weeks and a 5-to-10% rise in load per week; balance training; breathing exercises. <b>Assessments:</b> muscle strength; walk test; diagnostic examinations of pulmonary health. <b>PE monitoring:</b> SpO <sub>2</sub> ; vital signs; PE-induced symptoms. <b>Other relevant information:</b> a PE program is not recommended for severely ill patients or those suffering from deteriorating conditions; combine a training program, patient counseling, nutritional intervention, psychological intervention (when appropriate), long-term oxygen therapy (if necessary), neurological assessment and care with comorbidities.

#### Trials/ Opinion articles

Thomas <sup>37</sup> Protocol proposal	<b>Participants:</b> patient in hospital/clinic/rehabilitation; <b>Biosafety protocol:</b> asymptomatic individuals admitted; individualized care; minimum distancing; remote program; use of personal protective equipment; hand, equipment and environment sanitizing; COVID-19 detection tests. <b>PE protocol:</b> aerobic PE with Borg dyspnea scale score of 4-7, interval or continuous exercises, for 20-30 min, 3-7 times a week (combined with ST), for at least 6 weeks, progressing between 2 and 4 weeks; for those unable to achieve maximum heart rate
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Continuation of **Table 2** – Participants, biosafety protocols, exercise protocols, assessments, monitoring, results and other relevant information from studies included in the review.

Author and study type*	Study data
Thomas <sup>37</sup> Protocol proposal	<p>during the aerobic test, physical training of the entire body at 60-80% of maximum load, for 20-30 min; individuals restricted by a ventilatory system, duration of less than 10 min in the test with constant work load, interval training, intensity greater than 80% of maximum load with 20-30 repetitions of 30-60s; ST with individualized progression between 2 and 4 weeks, 40-80% of 1RM, corresponding to 8-25 repetitions, 2-3 sets, totaling 20 to 30 min, 3-7 times a week (combined with AT), for at least 6 weeks; for patients with lower limb weakness/muscle atrophy and moderate dyspnea, small muscle group training at 70-80% of 1RM, 4 sets of 8-12 repetitions; remote PE program consisting of a 5-10-min warmup, followed by 4 sets of 6 interval exercises of 80 to 160 seconds for 10 weeks, with progressive volume; for light PE, 15-25 min on a mini ergometer, with no load and 30 min of calisthenics, 3 times a week and walking twice a week; for more intense PE, 30-45min on a mini-ergometer with incremental load (0 to 60W), 30-40 min of muscle reinforcement with 0.5 kg weights and walking 3 to 7 days/week.</p>
	<p><b>Assessments:</b> walk tests; PE level; physical aptitude; health status; QoL; psychological health; diagnostic examination of pulmonary health; dyspnea.  <b>PE monitoring:</b> SpO<sub>2</sub>; HR.</p>
	<p><b>Other relevant information:</b> PE program can include educational intervention on Covid-19, drug use and medical equipment, breathing and relaxation techniques, nutrition and smoking abstinence; can include therapy and psychological help; should include a multidisciplinary team.</p>
Carda et al. <sup>38</sup> Protocol proposal	<p><b>Participants:</b> patients contaminated by COVID-19 with pulmonary fibrosis 7 days after diagnosis, without symptoms and with stable signs.  <b>Biosafety protocol:</b> use of personal protective equipment; remote program.  <b>PE protocol:</b> AT between 50 and 80% of peak work rate, 5 to 30 min per session, goal of 60% of maximum HR or 80% of gait speed in the 6-min walk test; ST of 10 repetitions for lower and upper limb exercises, 1 to 3 weekly sessions (intensity not provided).  <b>Assessments:</b> walk test.  <b>PE monitoring:</b> SpO<sub>2</sub>; HR; respiratory rate.  <b>Other relevant information:</b> direct transfer of an ICU patient to the rehabilitation services should be avoided.</p>
McGregor et al. <sup>39</sup> Randomized controlled trial proposal	<p><b>Participants:</b> age ≥18; ≥ 3 months after any hospital discharge related to COVID-19 infection, irrespective of the need for intensive care or ventilatory support.  <b>Biosafety protocol:</b> remote program (hybrid, with alternate in-person and distance meetings).  <b>PE protocol:</b> progressive multimodal exercises (aerobic, strength, balance and coordination), with intensity regulated by shortness of breath and perceived exertion scales, for up to 30 min, 2 to 3 times a week, for 8 weeks.  <b>Assessments:</b> QoL; dyspnea; cognition; health status, PA level; psychological health.  <b>PE monitoring:</b> adverse events; protocol safety; progressive training; changes in health; frequency control.  <b>Other relevant information:</b> in addition to physical education professionals, the program should include physiotherapists and psychologists.</p>
Barker-Davies et al. <sup>40</sup> Consensus declaration	<p><b>Participants:</b> physically active population in post-COVID-19 rehabilitation.  <b>Biosafety protocol:</b> use of personal protective equipment;  <b>PE protocol:</b> for patients after mild/moderate COVID-19, 1 week of light stretching and light muscle strengthening before targeted cardiovascular sessions; for very mild symptoms, only light activity (≤3 METs or equivalent), avoiding sedentary periods;  <b>Assessments:</b> medical consultation, blood analyses; cardiac health diagnostic examinations; physical aptitude.  <b>PE monitoring:</b> HR, SpO<sub>2</sub> and BP.  <b>Other relevant information:</b> increase rest periods if symptoms worsen; avoid prolonged exhaustive or high-intensity training; severely-ill patients should be treated with specific pulmonary rehabilitation; individuals with very sore throat, body pains, shortness of breath, general fatigue, chest pain, cough or fever should avoid activities with intensity &gt; 3 METs or equivalent for 2 to 3 weeks after the end of symptoms; PE program adapted to disease severity and individual specificities; pulmonary, cardiac, psychological, musculoskeletal and neurological rehabilitation may be necessary; combination with educational practices is recommended.</p>
Roman-Belmonte et al. <sup>41</sup> Letter to the editor	<p><b>Participants:</b> cured of infection with significant functional compromise in those who received hospital discharge.  <b>Biosafety protocol:</b> NP.  <b>PE protocol:</b> progressive exercise program with low-load restricted blood flow.  <b>Assessments:</b> medical consultation; health status; muscle strength.  <b>PE monitoring:</b> NP.  <b>Other relevant information:</b> individualized prescription; a possible association between thrombotic events and COVID-19 requires special care for exercise with restricted blood flow;</p>
Salini et al. <sup>42</sup> Short report	<p><b>Participants:</b> adults and older people recovered from COVID-19  <b>Biosafety protocol:</b> remote program (in-person at the onset of the program and progression to distance exercises);  <b>PE protocol:</b> multimodal program (aerobic, strength, flexibility and balance) centered on walking as the primary exercise, 3-5 times a week, with a weekly goal of 150 min, light intensity at the onset of the program, increasing during the first two weeks; walking is moderate for 30 min (13 on the Borg scale), not above 15 ("strong") or below 11 ("very light"); when walking cannot be performed, use a stationary bicycle; 3 ST sessions per week, consisting of 5 lower limb exercises (upper limb exercises at the end of the session, once a week), with 2 sets of 10 repetitions at 15-16 on the Borg scale; balance training with 5 progressive levels of difficulty, once a day, every day;  <b>PE monitoring:</b> NP.  <b>Other relevant information:</b> PE program adapted to individual specificities; nutritional support is recommended.</p>

\* Type of study extracted according to the criterion of the journal in which it was published or of the authors of the present review when this information is absent or unclear; PA = physical activity; PE = physical exercises; HR = heart rate; QoL = quality of life; NP = not provided; BP = blood pressure; RM = repetition maximum; SpO<sub>2</sub> = oxygen saturation; AT = aerobic training; ST = strength training

**Table 3 – Summary of recommendations.**

Recommendations	
Target population	- Age ≥18 years, convalescents with different degrees of COVID-19, after hospital discharge <sup>32,36,39,41</sup> , with no symptoms such as fever, dyspnea or tachypnea and low oxygen saturation, exhibiting stable hemodynamic and respiratory functions <sup>28,34,36,38</sup> .
Biosafety	- Whenever possible, use distance rehabilitation protocols <sup>27,31,32,36,38,39,42</sup> ; - For in-person meetings, prioritize individualized sessions <sup>28,50</sup> , with the obligatory use of personal protective equipment (mask and face visor) and constant hand, equipment and environment sanitizing <sup>28,35-38,40</sup> .
Assessments	- Medical assessment with examinations such as electrocardiogram <sup>32,40</sup> , and physical exercise authorization should be the criterion to start; - Analysis of comorbidities/disease history and health status are indispensable <sup>28,29,41</sup> ; - Tests that assess cardiorespiratory capacity (6-minute walk test) and lower limb strength (sit-to-stand test) should be conducted, if possible, within a battery of functional tests <sup>28,29,32,36-38</sup> .
Session monitoring	- Monitor oxygen saturation <sup>28,32,33,35-38,40</sup> and heart rate <sup>32,35,37,38,40</sup> . - In all cases, oxygen saturation less than 88% should be the criterion for interrupting the session <sup>37,40</sup> .
Physical exercises	- Warmup: low-intensity exercises for the entire body for 5 to 10 minutes. - Aerobic exercises: 30 minutes of activity with progressive intensity throughout the program, varying from light (PSE: 9 -12) to moderate (PSE: 13 – 15), at least 3 times a week (preferentially combined with strength exercises) <sup>28-30,32-40,42</sup> ; - Strength exercises: 1 to 3 sets of 8 to 12 repetitions and progressive intensity throughout the program, varying between 40 and 80% of 1RM, 2 to 3 times a week (preferentially combined with aerobic exercises) <sup>32,33,36-42</sup> ; - Stretching or flexibility exercises <sup>32,33,35,40,42</sup> , breathing <sup>31,32,35,36</sup> and balance exercises <sup>32,36,39,42</sup> can be included in the training program.
Other recommendations	- Consider individual physical condition, applying the exercise protocol adapted to disease severity <sup>28,29,32,33,40-42</sup> ; - Include educational interventions <sup>28,36,37</sup> ; - Involvement of a multiprofessional team is essential <sup>27,28,30,32,35-37,39,40,42</sup> .

## Discussion

The present study aimed to review the recommendations for PE after COVID-19. Evidence on the issue remains scarce, contained in narrative reviews, consensus declarations and a few experimental studies, but no randomized controlled trial, thus weakening the conclusions on the effectiveness of PE as a means to rehabilitate post-COVID-19. Some of the current care approaches are based on treatments extrapolated from different underlying health conditions. In some cases, the recommended procedures are the same as those used to rehabilitate patients with chronic obstructive pulmonary disease<sup>37</sup> or extrapolated from studies and the experiences of people with COVID-19, patients in pulmonary rehabilitation without COVID-19, and previous severe acute respiratory syndromes such as MERS<sup>35</sup>.

Considering the frequency in which each item appeared in the studies included, the relevance of each article, as well as the pertinence of information in executing a safe and effective physical rehabilitation program, we examined the characteristics of the target population, biosafety protocols, assessments, PE session monitoring, concluding with the information on PE protocols for people with COVID-19. Considering the same criteria, a summary of recommendations was compiled (Table 3).

### Target population

Experimental studies assessed the effect of PE on CO-

VID-19 recovery<sup>27-29</sup> for groups with an average age of 50 years or older. Research carried out with adults aged 60 years or older, hospitalized due to COVID-19, showed that 66% reported a negative change in one of the dimensions of functional status. Furthermore, six months after hospitalization, mortality seems to increase with age<sup>43</sup>. These findings reinforce the importance of studying the older population affected by COVID-19.

However, in order to devise strategies that improve functionality and prolong life expectancy after contracting COVID-19, studies with superior methodological quality (randomized controlled trials) should be conducted. In the studies included, general recommendations are made for individuals aged 18 years and older, who may have been infected by severe COVID-19, without the need for intubation, provided that at the onset of the PE program, they are free of symptoms such as fever, dyspnea or tachypnea, or low oxygen saturation, and exhibit stable hemodynamic and respiratory functions<sup>28,34,36,38</sup>. Patients that remain hospitalized may be included in PE rehabilitation programs<sup>27,37</sup>. In all the cases, medical authorization/recommendations are suggested to engage in the practice.

### Biosafety

Even when maintaining the 1.5-meter social distancing recommended by the World Health Organization, airborne SARS-CoV-2 transmission occurs due

to its persistence in aerosol droplets<sup>44</sup>. Given that PE can raise aerosol propagation<sup>45</sup>, the risk of contamination may increase in environments where this practice takes place, making remote rehabilitation programs an interesting biosafety strategy. The fact that social distancing is effective in reducing COVID-19 transmission<sup>46,47</sup> reinforces this proposal.

Implementing distance interventions via online platforms or videos recorded on portable devices was the most common strategy indicated by the studies<sup>7,31,32,36,38,39,42</sup>. Chen et al.<sup>27</sup> asked individuals who had recovered from COVID-19 to continue the exercise program they started while hospitalized, at home. The PE program was to be maintained for 4 weeks and visualized on a tablet, cell phone or TV. Signs of improved physical activity, perceived dyspnea and quality of life were observed when compared to a control group undergoing standard treatment.

Indeed, PE/remote rehabilitation programs have proven to be effective in improving motor function parameters in different populations<sup>48,49</sup>, demonstrating it to be a promising intervention. However, studies that experimentally assessed the effectiveness of PE are scarce, primarily randomized controlled trials. Rehabilitation using distance PE can be carried out via synchronous meetings where participants undergo professionally supervised training<sup>32</sup> or in the form of videos<sup>31,36</sup>. Intervention can also be applied in a hybrid manner, alternating between in-person and distance meetings<sup>39</sup>, or with in-person sessions at the start of the program, progressing to distance exercises<sup>27,42</sup>.

During in-person sessions, subjects had to be symptom-free for at least two days<sup>28</sup>, if possible, assessed by regular COVID-19 tests<sup>28,37</sup>. Individualized sessions may be more appropriate<sup>28,50</sup>. The use of personal protective equipment is mandatory in order to ensure the safety of the practitioners and professionals involved<sup>28,35-38,40</sup>. Mask use is associated with lower risk of contamination, and is effective against COVID-19 propagation<sup>51</sup>. Masks and face protectors are recommended to avoid contact with infected droplets<sup>35</sup>, which may increase during PE<sup>45</sup>. Given that during daily activities, exercises and rehabilitation, masks are safe for healthy individuals and those with cardiopulmonary disease, this type of protection should be maintained. The benefits of using this equipment during the COVID-19 pandemic greatly exceed the risks, and the increased use of masks causes adaptive responses, making it tolerable in the long-run<sup>52</sup>.

Sanitizing hands and equipment with 70% alcohol, as well as surfaces and the environment with active chlorine-based products (0.5% sodium hypochlorite solution) should occur regularly. A study with more than 1100 people revealed that hand cleansing was substantially less common in the infected than non-infected population, indicating that frequent sanitizing may be associated with a lower risk of contamination<sup>51</sup>. It is recommended that the guidelines of the Brazilian Society of Cardiology, Department of Exertion Testing, Sport Exercise, Nuclear Cardiology and Cardiovascular Rehabilitation (DERC/SBC)<sup>50</sup> on the biosafety protocols to be followed during tests and PE be consulted.

## Assessments

Physical assessments and clinical examinations should be carried out before and after the PE program. Given its scope and easy application, undergoing a battery of functional tests<sup>28,29,32,37</sup> may be the best option. Among the common tests in functional batteries, the 6-minute walk<sup>28,29,32,36-38</sup> and 1-minute sit-to-stand tests<sup>32,36</sup> can be applied instead of the complete battery. From a clinical standpoint, identifying comorbidities/disease history<sup>28,29,41</sup> and assessing health status<sup>37,39</sup>, including an electrocardiogram<sup>32,40</sup>, should be part of assessments, primarily before the onset of a PE program. Additional tests can be conducted to provide more comprehensive monitoring.

## Monitoring sessions

Constant monitoring of the PE session is recommended via assessment of oxygen saturation<sup>28,32,33,35-38,40</sup> and HR<sup>32,35,37,38,40</sup>. A decline in oxygen saturation of less than 88%<sup>37,40</sup> or a rise or more than 80% of age-adjusted maximum HR (for patients in rehabilitation)<sup>37</sup>, can be considered parameters for interrupting the session. The session should not be held if oxygen saturation is less than or equal to 90%; blood pressure lower than 90/60 mmHg or higher than 180/90 mmHg; respiratory rate is above 40 breaths per minute, or if HR is less than 40 or more than 120 beats a minute<sup>35</sup>. In an asynchronous remote session, other people being nearby during exercise and weekly surveys to identify possible adverse effects<sup>39</sup> may be alternatives.

## Physical exercise protocols

The use of PE for post-COVID-19 rehabilitation is the consensus among the studies included. The safety

and efficacy of PE as a rehabilitation strategy for diseases related to the respiratory system, such as chronic obstructive pulmonary disease, are well established in the scientific literature<sup>53,54</sup>. However, the conclusions of the present review are based predominantly on narrative reviews, opinion articles and trials, but not on original studies with robust methods.

Although promising results have been observed for perceived dyspnea, quality of life and physical performance parameters<sup>27</sup>, the effectiveness of PE in post-COVID-19 rehabilitation was measured in only three experimental studies<sup>27-29</sup>, whose data validity is limited by the absence of a control group<sup>28,29</sup>, small sample size, short assessment period and restricted to the characteristics of the populations studied. As such, the conclusions drawn from this review preclude confirming the efficacy of PE in COVID-19 rehabilitation, meaning extrapolations should be made with caution.

Considering all the studies, aerobic and strength exercises, combined or not<sup>28-30,32-40,42</sup> are the most indicated for people convalescing from COVID-19. The combination of ST and AT was applied in two studies<sup>28,29</sup> and conducted for 5 to 7 weeks. According to review and opinion studies and trials, aerobic exercises such as walking or cycling should be performed for approximately 30 minutes per session<sup>32,34,36-39</sup>, preferentially combined with strength exercises, 3 to 5 times a week. Specialists in medicine and rehabilitation from different centers in Europe and North America also recommend the combined practice of ST and AT<sup>38</sup>. In all cases, intensity and volume should be progressive during the training program<sup>32,35,37,39,41,42</sup>, occurring over 2 to 4 weeks<sup>37</sup> or based on the patient's tolerance<sup>32</sup> and/or correct exercise execution<sup>42</sup>.

## Other recommendations

Each session should consider individual physical condition, with the protocol adapted to disease severity<sup>28,29,32,33,40-42</sup>. The program can also include treatment counseling, COVID-19 management and signs via educational sessions<sup>28,36,37</sup>; a multiprofessional team composed of physical education professionals, doctors, nurses, physiotherapists, occupational therapists, psychologists, speech therapists, nutritionists, social workers and others<sup>27,28,30,32,35-37,39,40,42</sup>.

The present review has limitations, since the reduced scope of the types of studies that could be included weakens the level of evidence. In addition, the small number of experimental studies and absence of

randomized controlled trials preclude extrapolating our findings. The relatively short period between the onset of the pandemic and this research, as well as the social distancing restrictions adopted worldwide, may partially explain the scarcity of experimental studies. On the other hand, the originality, in-depth investigation and importance of this scoping review may help multiprofessional teams create robust rehabilitation programs for people who suffer from the effects of COVID-19.

Based on weak and still scarce evidence, we conclude that the efficacy of PE programs in post-COVID-19 rehabilitation cannot be proved. According to narrative review studies, limited experimental studies, consensus declarations and the experiences of health professionals in trials and opinion articles, the multiprofessional team should be aware of the individual peculiarities and severity of COVID-19, adopting biosafety protocols and assessments throughout the PE program. Moreover, prescription should be centered on the overall improvement of participants and based on aerobic and strength exercises, with constant session monitoring. Additional interventions by a multiprofessional team should also be part of a rehabilitation program.

Future studies should focus on conducting randomized controlled trials consisting of a control group, in order to determine the safety and effectiveness of COVID-19 rehabilitation using different types of PE, for 3 or more months. Samples should be homogeneous and stratified by variables such as age, disease severity, and length of hospitalization, among others.

## Conflict of interest

The authors declare no conflict of interest.

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## Authors' contributions

Prado AKG participated in the conception, database search, and writing and revision of content. Alves JCA and Gurginski RNM participated in eligibility analysis of the articles found in the search, review of the content and final approval of the version to be published. Mikuni T and Zata D participated in data extraction, revision

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