




Rehabilitation interventions and outcomes for post-COVID condition: a scoping review

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ABSTRACT

Objective Several rehabilitation interventions have been proposed to support people with post-COVID-19 condition (PCC). However, the full spectrum of these interventions remains unclear, partly due to the complexity of PCC, which encompasses a broad range of symptoms affecting multiple organ systems and health domains. This scoping review aimed to identify the available rehabilitation interventions for PCC and the outcome measures used to evaluate them, to facilitate the development of multifaceted interventions and improve patient care.

Methods Following the Joanna Briggs Institute Framework, we searched CINAHL, EMBASE, MEDLINE, PsychINFO, CENTRAL and Scopus databases from inception to 22 January 2024 for experimental and observational studies investigating rehabilitation interventions for adults with PCC. Interventions and their corresponding outcome measures were synthesised based on targeted outcomes aligned with the most common manifestations of PCC. The quality of intervention reporting was assessed using the Template for Intervention Description and Replication (TIDieR) checklist.

Results We identified 74 studies; 28 randomised trials (37.8%) and 46 observational and quasi-experimental designs (62.2%). Most interventions consisted of different combinations of education, exercises and therapies to manage dyspnoea, fatigue and psychological symptoms, such as anxiety and depression. Few studies addressed postexertional malaise, cognitive function, memory, balance and coordination. At least half of the included studies required a confirmed SARS-CoV-2 infection for participant inclusion. Reporting on adherence rates was limited, and 65% of the studies did not report adverse events.

Conclusion There is a need for more comprehensive and inclusive approaches that address the full spectrum of PCC symptomatology to improve patient care and enhance the reproducibility of future studies.

INTRODUCTION

Early in the COVID-19 pandemic, a considerable number of people reported persistent symptoms months beyond the initial infection phase, leading to the recognition of

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Post-COVID condition (PCC) is commonly defined as the persistence or emergence of new symptoms at least 3 months after the initial SARS-CoV-2 infection, lasting for at least 2 months with no alternative explanation. PCC has significant impacts on both Canadian and global populations, yet no comprehensive intervention exists to address its full range of symptoms.

WHAT THIS STUDY ADDS

⇒ This study provides a comprehensive synthesis of rehabilitation interventions and their corresponding outcomes for PCC.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings of this study aim to inform future research and evidence synthesis to enhance patient care and guide rehabilitation strategies for PCC.

post-COVID condition (PCC).¹ The World Health Organization (WHO) characterises PCC as symptoms that persist or arise at least 3 months after a confirmed or probable SARS-CoV-2 infection, lasting for a minimum of 2 months, with no alternative diagnosis.^{1 2} Common enduring symptoms include fatigue and dyspnoea, which can significantly impact an individual's ability to perform activities of daily living, maintain employment and fulfil caregiving responsibilities.^{3 4}

Globally, SARS-CoV-2, the virus responsible for COVID-19, has infected over 770 million individuals, and it is estimated that at least 65 million people meet the diagnostic criteria for PCC.^{4 5} Importantly, the development of PCC is not solely dependent on the severity of the initial infection, but it is influenced by a multifaceted pathophysiology.⁶ Current research indicates that factors, such as older age, female sex, pre-existing comorbidities and severe acute infection, may increase the



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risk of developing PCC.^{1 7} Moreover, recent research highlights that certain populations, such as individuals living with HIV, may experience a higher prevalence of PCC, further highlighting the complexity of this condition and the need for tailored rehabilitation approaches.⁸

Considering the substantial burden of PCC, identifying effective rehabilitation interventions to alleviate these persistent symptoms and to improve the quality of life of the affected individuals is critical.⁴ Rehabilitation, as defined by the WHO, encompasses 'a set of interventions designed to optimise functioning and reduce disability in individuals with health conditions in interaction with their environment'.⁹ Rehabilitation strategies can support individuals regaining independence and resuming everyday tasks, such as work, school and family responsibilities.⁹ These interventions often include education, exercise and psychological therapies, which are typically individualised and multidimensional to address the unique needs of each patient.⁹ Among these, exercise interventions have been proposed as a valuable approach for managing PCC, given their potential to reduce inflammation, which it is believed to play a key role in the chronic symptoms of the condition, including fatigue.^{10 11} However, it is important to note that exercise may exacerbate PCC symptoms, such as postexertional malaise (PEM), muscle pain and dyspnoea.¹² Therefore, careful supervision and individualised programme modifications are essential to prevent symptom exacerbation and ensure patient safety.^{13 14}

This scoping review aims to synthesise the existing evidence on rehabilitation interventions for patients with PCC and the outcome measures used to assess their effectiveness. By identifying gaps in the literature and highlighting areas for further research, this review seeks to contribute to the ongoing efforts to better understand PCC and develop targeted therapeutic strategies.

METHODS

Ethical approval was not required, and there was no funding source for this study. We used the framework provided by the Joanna Briggs Institute.¹⁵ A protocol was developed a priori and registered to Open Science Framework, and no deviations from this protocol occurred.¹⁶ We first defined our research objectives, then conducted a systematic literature search across multiple databases and assessed the eligibility of the studies based on predefined criteria. Data extraction was conducted using a structured form. We then synthesised our findings into a comprehensive map to highlight patterns across studies and identify research gaps. We assessed the quality of the intervention reporting, and finally, we interpreted our findings to describe the existing rehabilitation interventions and outcome measures for PCC in order to inform future research and evidence synthesis aimed at improving patient care and rehabilitation strategies.

Data sources and searches

After consulting a librarian, a systematic literature search was carried out in CINAHL, EMBASE, MEDLINE, PsychINFO, CENTRAL and Scopus from inception until 22 January 2024. As the goal of this review was to synthesise the latest available evidence, we included preprints and theses. We also conducted a manual search on the references of the included studies, and the references of previously published reviews to ensure that we did not miss any studies. The full search strategy is available in online supplemental table 1.

Study selection

We included experimental, quasi-experimental, and observational studies that collected primary data and investigated rehabilitation interventions for adult or paediatric patients with PCC. Reviews, editorials, commentaries and conference abstracts were excluded. Studies were also excluded if they contained animal subjects or if they included a pharmacological intervention without a rehabilitation component. Protocols of studies were not included. There were no limits applied for country, setting or language of publication.

All records were imported into the Covidence platform, where duplicates were removed automatically.¹⁷ Screening was completed independently by two reviewers (EGS and DVP). Title and abstract screening were carried out, followed by full-text screening. Any conflicts that arose during the screening processes were resolved by consulting a senior member of the team (PB). Any studies that satisfied the inclusion criteria were carried forward for data extraction.

Data extraction and quality assessment

Data extraction was carried out independently by one researcher (EGS) and checked for accuracy by another (DVP). A table was developed to guide the extraction of the following information from each of the included studies: citation; author and date, country the study was conducted in; study design; intervention details; population characteristics (hospitalised during acute phase, number of participants, confirmed or suspected SARS-CoV-2 infection, number of females and age of participants), outcome measures used; results and adverse events reported.

The quality of the reporting of the interventions in all studies included in this review was assessed using the Template for Intervention Description and Replication (TIDieR) checklist.¹⁸ Intervention reporting was assessed as it is necessary to fully understand the procedures of any interventions that are to be replicated in the future, such as rehabilitation and exercise interventions for PCC implemented in clinical practice.¹⁸

Data synthesis

To ensure a clear and structured synthesis of the evidence, interventions and outcome measures were categorised based on the targeted outcomes, corresponding to the

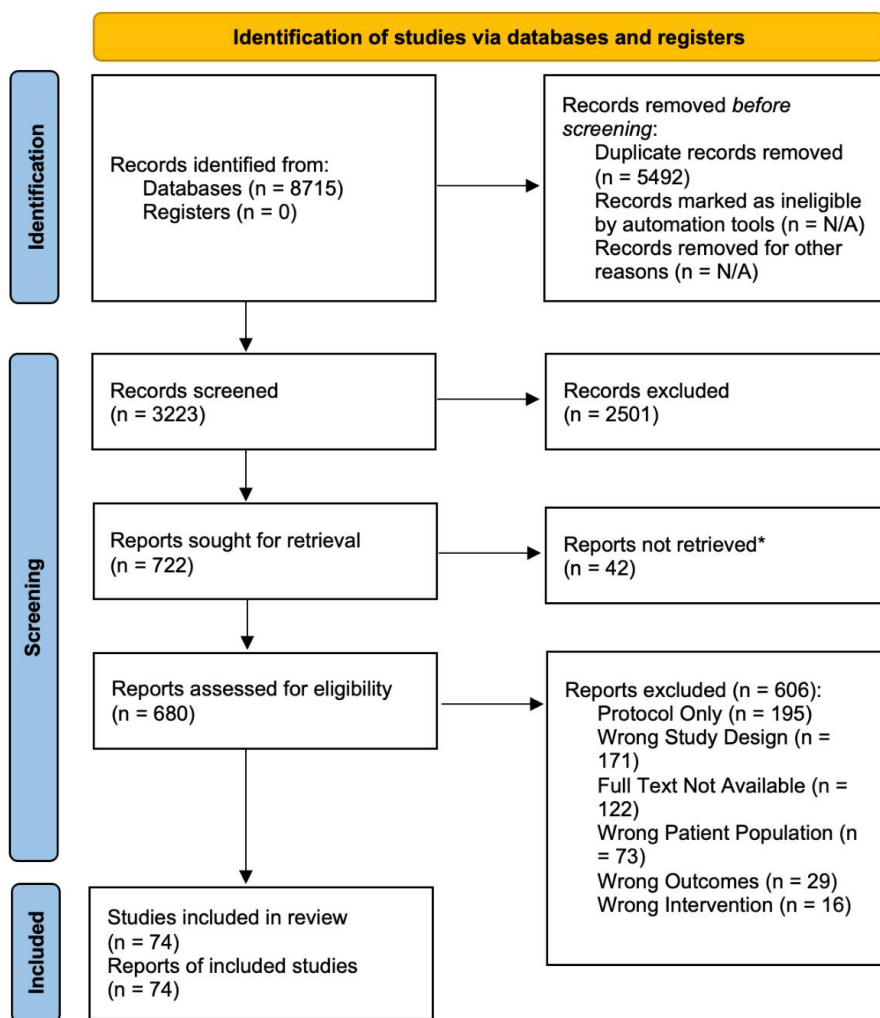


Figure 1 PRISMA flow diagram outlining the screening process.^{19 20} *Additional duplicates identified manually during screening.

most common manifestations of PCC. This systematic approach facilitates a comprehensive presentation of interventions in relation to specific outcomes, aiding in the interpretation of current evidence and highlighting gaps for future research. By organising the findings in this manner, the review aims to improve the relevance and applicability of the results for healthcare providers and policymakers.

Patient and public involvement

Patients and members of the public were not involved in the planning or execution of this research in any way.

RESULTS

Overall, 8715 papers were imported into Covidence. After automatic duplicate removal, title and abstract screening and full-text screening, 74 studies were included in the review. Refer to [figure 1](#) for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow-chart outlining the results of the screening process.^{19 20}

Study characteristics

Of the included studies, 28 were randomised controlled trials (RCTs),^{21–48} 24 were prospective cohort studies,^{49–72} 7 were quasi-experimental studies,^{73–79} 5 were retrospective cohort studies^{80–84} and 1 study of each of the following designs: non-randomised open controlled trial,⁸⁵ descriptive cohort study,⁸⁶ service evaluation using quantitative methods,⁸⁷ mixed methods study,⁸⁸ longitudinal study,⁸⁹ cross-sectional study,⁹⁰ diagnostic survey,⁹¹ pre–post feasibility study,⁹² retrospective secondary data analysis⁹³ and uncontrolled open-label feasibility study.⁹⁴ The sample size ranged from 14 to 483 in the studies involving one group, and from 24 to 499 in the studies involving at least two groups (RCTs, non-randomised open controlled trials, etc). Refer to online supplemental table 2 for a detailed summary of the design of the included studies.

The populations of the included studies consisted of individuals experiencing persistent COVID-19 symptomology that met the WHO criteria for a PCC diagnosis. 22 studies (30%) included only patients who had been hospitalised during the acute

phase,^{21 28 30 32 34 35 37 40 41 46–48 51 55 65 71 72 74 81–84} 5 studies (7%) included only patients who had not been hospitalised during the acute phase,^{22–24 26 29} 31 studies (42%) included both patients who had been hospitalised and patients who had not been^{25 27 30 33 38 39 42–44 49 53 56–58 62 64 66–70 76–79 85 86 88–91} and 16 studies (22%) did not specify.^{36 45 50 52 54 59–61 63 73 75 80 87 92–94} 36 studies (49%) included only individuals with a confirmed SARS-CoV-2 infection,^{22–25 28 29 33 35 37 38 43 45–49 51 55 56 59 60 63 65 70 74–78 80 81 84 85 88 90 94} 4 studies (5%) included individuals with a confirmed or suspected SARS-CoV-2 infection,^{39 61 62 67} and 34 studies (46%) did not specify.^{21 26 27 30–32 34 36 40–42 44 50 52–54 57 58 64 66 68 69 71–73 79 82 83 86 87 89 91–93} Additionally, 33 studies required the presence of specific symptoms for inclusion, the most common being fatigue, dyspnoea and functional impairments.^{22–26 28 30–32 37 37–39 41–43 49–51 57 69–71 73 77 80 82–85 88 92 94} See online supplemental table 2 for the individual study population characteristics. 53 studies were conducted in Europe,^{22–27 29 32–34 36–40 44 45 48–50 52–54 56–61 63–70 72 73 76–80 82 83 87–89 91–94} 5 were conducted in South America,^{47 51 71 74 85} 4 were conducted in Asia,^{31 41 75 84} 4 were conducted in North America^{46 62 86 90} and 3 were conducted in Africa.^{21 28 35} Additionally, five studies were conducted in Turkey, which is a part of both Asia and Europe.^{30 42 43 55 81} See online supplemental table 2 for the exact locations of each study.

Interventions and outcomes

The interventions that were explored in the included studies were identified and recorded. The range of intervention duration was 3 days to 15 weeks. One study did not specify the intervention duration.⁶³ The range of the timing of intervention delivery was 3 to 116 weeks. The timing of intervention delivery was not specified in 14 studies,^{21 25 30 31 41 51–53 65 66 71 82 86 87} and 1 study examining hospitalised and non-hospitalised patients only included the timing of intervention delivery for the hospitalised group.⁵⁸ Most interventions targeted multiple outcomes and were multidimensional, involving multiple components. The most common intervention component was aerobic exercises, followed by strengthening exercises. The targeted outcomes considered in the included studies have been divided into eight categories: fatigue, PEM, health-related function and quality of life, mental health outcomes, cognitive function and memory, dyspnoea, muscle strength and aerobic endurance and balance, gait and coordination. These categories have been based on the most reported symptoms of PCC. Each of the outcome measures used in the included studies have been classified according to whether they are patient-reported or performance-based outcome measures. Of the 74 included studies, only 26 reported on adverse events.^{22–24 26 31 36 38 40 42 44 46 48 53 54 56 60–64 73 76 77 79 82 84} Of these 26 studies, only 7 reported an occurrence of intervention-induced adverse events.^{36 38 44 46 53 60 61} The most common intervention-related adverse events were dizziness (2 studies)^{44 53} and postexertional symptom exacerbation (2 studies).^{38 61} Two studies reported respiratory reinfection.^{36 61} Refer to online supplemental

table 2 for details on the intervention, the outcome measures and the adverse events for each individual study.

Fatigue

We identified 39 studies that reported fatigue as one of their targeted outcomes following a rehabilitation intervention. 37 different intervention components were used. The most common intervention components used for fatigue were strength training and aerobic training (16 studies, 41%). Most of the study interventions (87%) were multidisciplinary rehabilitation programmes that used a combination of at least two different therapeutic interventions. 20 interventions (53%) were conducted face-to-face,^{21 23 26–28 33 35 50 55–57 60 64 74 76 80 89–92} 11 interventions (26%) were conducted remotely^{22 25 29–32 51–53 62 81} and 8 interventions (20%) were a combination of in-person and remote.^{24 49 54 59 75 83 85 86} Refer to figure 2 for an overview of all the intervention used in the studies examining fatigue. 14 different outcome measures were used to measure fatigue before and after a rehabilitation intervention. The most common outcome measure was the fatigue severity scale (seven studies, 18%). One study did not use a standardised scale, and only reported fatigue as a binary outcome based on the presence or absence of symptoms.⁹⁰ Refer to figure 3 for an overview of all the outcome measures used.

Postexertional malaise

We identified four studies that reported PEM as one of their targeted outcomes following a rehabilitation intervention. Ten different intervention components were used. The most common intervention component used for PEM was breathing exercises (three studies, 75%). Refer to figure 4 for an overview of all the intervention components used in the studies examining PEM. All the study interventions were multidisciplinary, using a combination of at least two different therapeutic interventions. One intervention was conducted in-person,²³ and three interventions were conducted remotely.^{61 62 88} Three different outcome measures were used to measure PEM. The most common outcome measure was the DePaul Symptom Questionnaire Short Form (two studies, 50%). Refer to figure 5 for an overview of all the scales and tools used.

Health-related function and quality of life

We identified 52 studies that reported health-related function and quality of life as one of their targeted outcomes following a rehabilitation intervention. 40 different intervention components were used. The most common intervention used was aerobic training (22 studies, 42%). Refer to online supplemental figure 1 for an overview of all the intervention components used in the studies examining health-related function and quality of life. Most of the study interventions (87%) were multidisciplinary rehabilitation interventions, encompassing two or more different interventions. 24 interventions (46%) were conducted in-person,^{23 26 27 36 37 41 43 55 56 63–66 71 74 76 77 80 82 87 89–92} 18 interventions (35%)

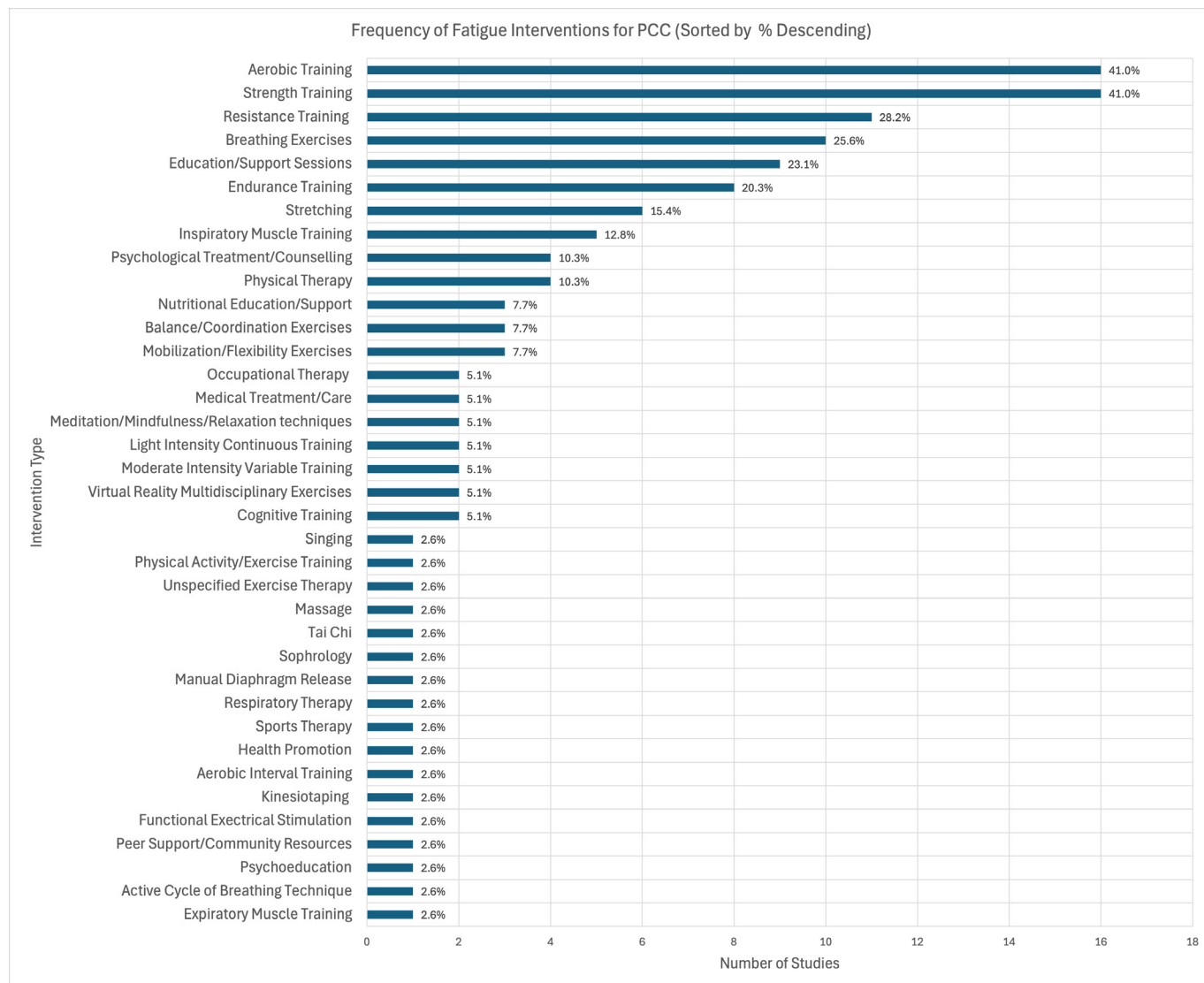


Figure 2 Fatigue interventions. ALT TEXT: graph outlines the interventions used in the studies examining fatigue. Note: when professions (ie, physical therapy, occupational therapy and respiratory therapy) are listed as interventions, this is how the study defined their intervention, with no other specifics provided. PCC, post-COVID condition.

were conducted remotely^{22 25 30 32 38 39 44–46 51 53 61 62 67 68 73 88 94} and 10 interventions (19%) were a combination of in-person and remote.^{24 40 42 49 54 75 83 85 86 93} 42 different outcome measures were used to measure health-related function and quality of life. The most common outcome measure was the EuroQol Five Dimensions (15 studies, 29%). Refer to online supplemental figure 2 for an overview of all the outcome measures used.

Mental health outcomes

We identified 31 studies that reported mental health outcomes as one of their targeted outcomes following a rehabilitation intervention. 32 different intervention components were used. The most common intervention was aerobic training (11 studies, 35%). Refer to online supplemental figure 3 for an overview of all the intervention components used in the studies examining mental health outcomes. Most of the studies (90%) included multidisciplinary rehabilitation

interventions, encompassing two or more different interventions. 13 interventions (42%) were conducted in-person,^{23 27 33 43 55 60 63–66 69 89 91} 11 interventions (35%) were conducted remotely^{22 25 30 38 44–46 52 53 78 81} and 7 interventions were a combination of in-person and remote.^{24 54 75 83 85 86 93} 17 different outcome measures were used. The most common outcome measures were the Hospital Anxiety and Depression Scales (15 studies, 48%). Refer to online supplemental figure 4 for an overview of all the scales and tools used.

Dyspnoea

We identified 37 studies that reported dyspnoea as one of their targeted outcomes following a rehabilitation intervention. 34 different intervention components were used. The most common intervention component used for dyspnoea was aerobic training (16 studies, 43%). Refer to online supplemental figure 5 for an overview of all the intervention components used in the studies examining

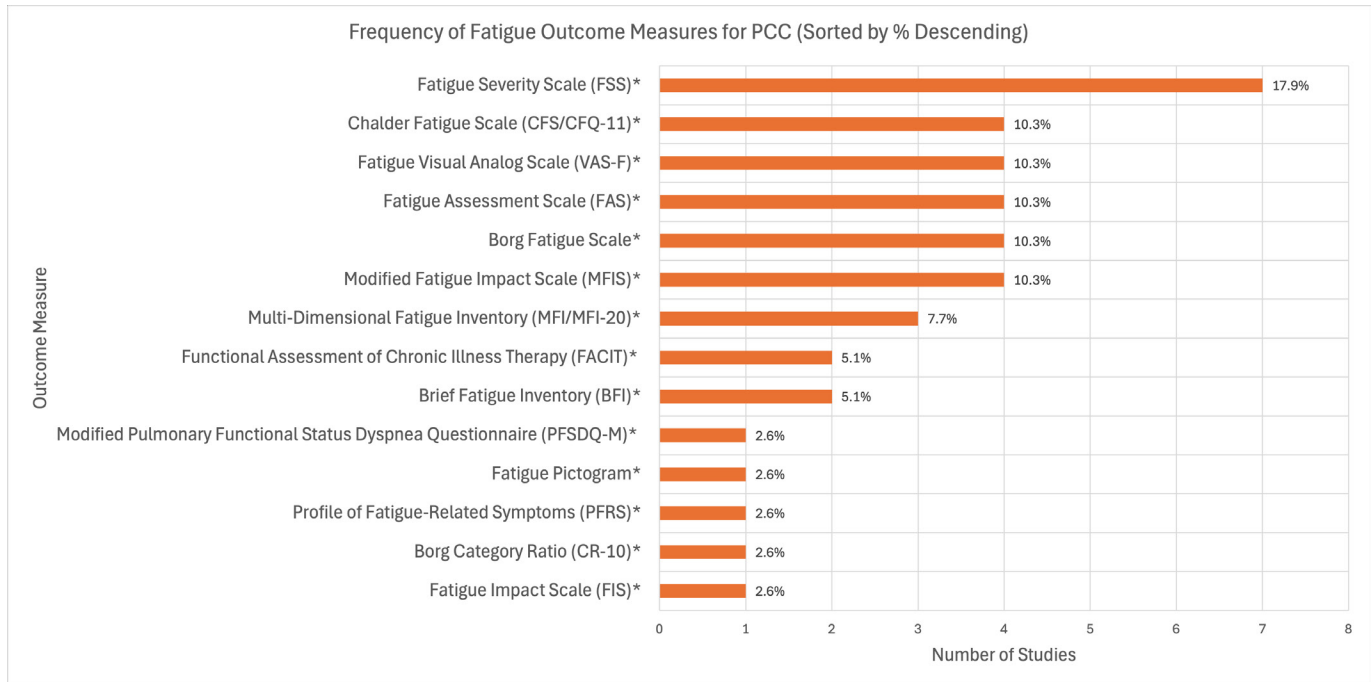


Figure 3 Outcome measures used in the studies examining fatigue. ALT TEXT: graph outlining the outcome measures used in the studies examining fatigue. Note: *patient-reported outcome measure and +performance-based outcome measure. PCC, post-COVID condition.

dyspnoea. Most of the interventions (86%) were multidisciplinary, encompassing two or more different rehabilitation interventions. 18 interventions (49%) were conducted in-person,^{23 28 33 34 36 37 43 50 55–57 64 71 76 77 80 84 90} 13 interventions (35%) were conducted remotely^{22 29 31 39 44 46 51 52 58 62 68 73 81} and 6 interventions (16%) were a combination of in-person and remote.^{24 32 42 75 83 85} 14 different outcome measures were used to measure dyspnoea. The most common outcome measure was the Modified Medical Research Council Scale (18 studies, 49%). One study did not use a standardised scale, and only reported dyspnoea as a

binary outcome based on the presence or absence of symptoms.⁹⁰ Refer to online supplemental figure 6 for an overview of all the outcome measures used.

Cognitive function and memory

We identified 12 studies that reported cognitive function and memory as one of their targeted outcomes following a rehabilitation intervention. 23 different intervention components were used. The most common intervention component used was cognitive training (five studies, 42%). Refer to online supplemental figure 7 for an

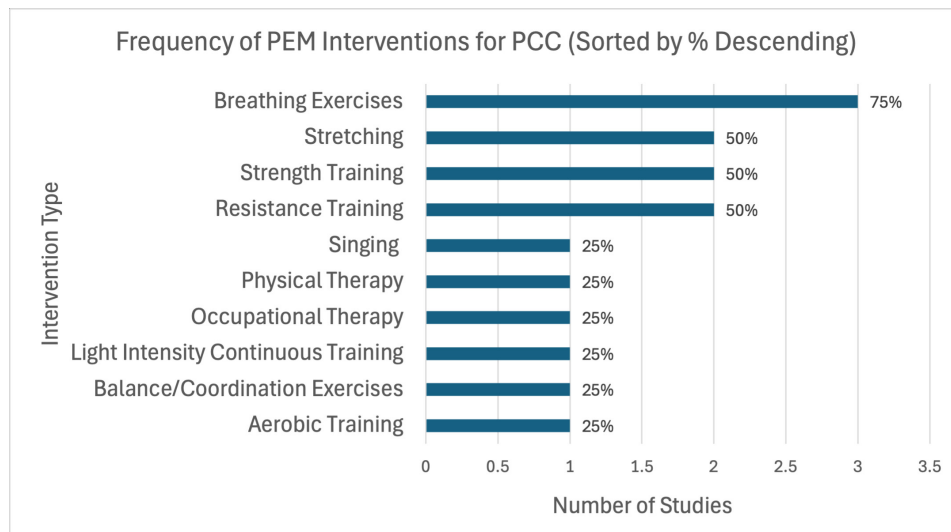


Figure 4 PEM interventions. ALT TEXT: outlines the interventions used in the studies that examined PEM. Note: when professions (ie, physical therapy) are listed as interventions, this is how the study defined their intervention, with no other specifics provided. PCC, post-COVID condition; PEM, postexertional malaise.

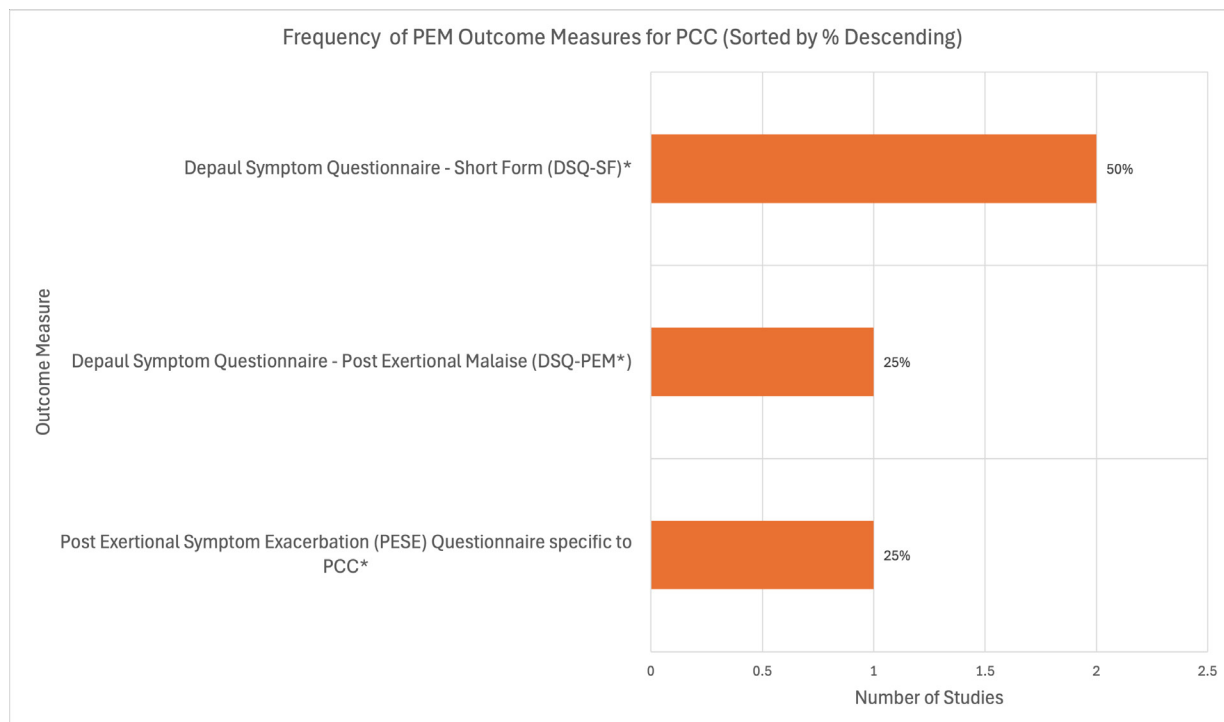


Figure 5 Outcome measures used in studies examining PEM. ALT TEXT: graph outlining the outcome measures used in the studies examining PEM. Note: *patient-reported outcome measure and +performance-based outcome measure. PCC, post-COVID condition; PEM, postexertional malaise.

overview of all the intervention components used in the studies examining cognitive function and memory. Most of the study interventions (92%) were multidisciplinary rehabilitation interventions, using two or more different rehabilitation interventions. Four interventions (33%) were conducted in-person,^{64 65 69 89} six interventions (50%) were conducted remotely^{38 45 46 52 53 78} and two interventions (17%) were a combination of in-person and remote.^{49 85} Ten different outcome measures were used to measure cognitive function and memory. The most common outcome measure was the Montreal Cognitive Assessment (six studies, 50%). Refer to online supplemental figure 8 for an overview of all the outcome measures used.

Muscle strength and aerobic endurance

We identified 52 studies that reported muscle strength and/or aerobic endurance as one of their targeted outcomes following a rehabilitation intervention. 43 different intervention components were used. The most common intervention was aerobic training (28 studies, 54%). Refer to online supplemental figure 9 for an overview of all the intervention components used in the studies examining muscle strength and aerobic endurance. Most of the study interventions (92%) were multidisciplinary rehabilitation interventions, encompassing two or more different rehabilitation interventions. 27 interventions (52%) were conducted in-person,^{21 23 26–28 33–36 43 50 56 57 63 64 66 70–72 74 77 78 284 89–91} 16 interventions (31%) were conducted remotely^{22 25 29 30 38 45–48 51 53 58 67 73 79 81} and 9 interventions (17%) were a combination of in-person

and remote.^{24 32 42 49 54 75 83 85 93} different outcome measures were used to measure muscle strength and/or aerobic endurance. The most common outcome measure was the 6-minute walk test (30 studies, 58%). Refer to online supplemental figure 10 for an overview of all the outcome measures used.

Balance, gait and coordination

We identified 7 studies that reported balance, gait and coordination as one of their targeted outcomes following a rehabilitation intervention. Nine different intervention components were used in the studies examining balance, gait and coordination. The most common intervention component was aerobic training (six studies, 86%). Refer to online supplemental figure 11 for an overview of all the intervention components used in the studies examining balance, gait and coordination. All but one (86%) of the studies employed multidisciplinary rehabilitation interventions, encompassing two or more different interventions. Four interventions (57%) were conducted in-person,^{35 71 82 91} and three interventions (43%) were conducted remotely.^{46 47 53} Six different outcome measures were used to measure balance, gait and coordination. The most common outcome measure was the Timed up and Go test, which was used in all seven studies. Refer to online supplemental figure 12 for an overview of all the outcome measures used.

Intervention supervision

Of the interventions that were conducted remotely, or included a remote component, 28 indicated that they

were supervised.^{22 24 25 29 30 32 34 40 42 44–48 51–53 62 67 68 73 75 79 81 83 85 86 88} Modes of supervision included videoconferencing (such as Zoom), telephone calls, mobile applications, home activity logs and cameras installed in participants' homes. Interventions were not supervised in three studies,^{39 59 93} and eight studies did not specify whether the interventions were supervised or not.^{31 38 49 50 54 61 78 94}

TIDieR analysis

Intervention reporting in the 74 included studies was assessed using the TIDieR checklist. Overall, the quality of the included studies was relatively good. Only one study indicated concerns in almost all the categories on the checklist.³¹ All 74 studies provided a brief name of the intervention (item 1). All but one study provided the rationale, theory or goal behind the study (item 2),²¹ and all but three studies provided the mode of delivery (item 6)^{31 56 71} and information on intervention delivery (item 8).^{66 86 89} 29 (40%) of the included studies did not include details on how the intervention was tailored (item 9).^{21 29 31 32 34 38 43–47 52 56 57 59 60 64 68–71 73 76 82 84 86 88 89 94} Only 14 of the 74 studies (19%) included methods to measure study adherence (item 11),^{22–24 44 46–48 51 58 72 75 79 85 88} and only 10 of those (14%) reported on actual adherence within the study (item 12).^{46–48 51 58 72 75 79 85 88} Refer to online supplemental table 3 for a summary of the TIDieR checklist results.

DISCUSSION

This scoping review synthesised the intervention components and outcome measures used across 74 rehabilitation intervention studies of people with PCC. Of these, 28 were randomised trials and 46 were observational and quasi-experimental designs. Across all targeted outcomes, aerobic training emerged as the most common intervention component, except for PEM and cognitive function and memory, where breathing exercises and cognitive training were most frequently used, respectively. Most of the interventions were multimodal, integrating multiple components to target multiple outcomes. Dyspnoea, fatigue and psychological symptoms, such as anxiety and depression, were the most commonly targeted outcomes, while fewer studies addressed PEM, cognitive function, memory, balance and coordination. At least half of the studies required participants to have a confirmed SARS-CoV-2 infection for inclusion, potentially excluding a significant portion of the affected population. Furthermore, our TIDieR analysis revealed limited reporting of adherence rates, and the majority of studies did not report on adverse events. The included studies spanned diverse populations across various geographical regions, with the majority conducted in Europe.

The interventions and outcomes identified in this review were consistent with the WHO guidelines for managing PCC.⁹⁵ Specifically, they encompass a combination of aerobic and strength training, balance and gait exercises, endurance training, breathing exercises,

pulmonary rehabilitation and educational and nutritional support interventions. Across all outcomes, most of the rehabilitation interventions were delivered in-person or through a hybrid approach combining remote and face-to-face components. This may suggest that in-person engagement remains a critical aspect of rehabilitation delivery for PCC patients.

The outcomes' measures examined in this scoping review are consistent with a core outcome set (COS) that has been established for PCC. COSs are combinations of outcomes that are classified as those that are necessary to be measured and reported in any study in the respective clinical area.^{96 97} A consensus meeting involving patients, family members/caregivers, healthcare providers and researchers took place to identify the outcomes that should be included in a COS.⁹⁶ Subsequently, the following set of outcomes was identified: cardiovascular functioning, symptoms and conditions, fatigue or exhaustion, pain, nervous system functioning, symptoms and conditions, mental functioning, symptoms and conditions, respiratory functioning, symptoms and conditions, postexertion symptoms, physical functioning, symptoms and conditions and work or occupational and study changes.⁹⁶ This review's categorisation of outcomes, such as fatigue, PEM, health-related function and quality of life, mental health outcomes, cognitive function and memory, dyspnoea, muscle strength and aerobic endurance, and balance, gait and coordination, demonstrates alignment with these established outcome domains, reinforcing their relevance and importance.

Understanding the breadth of rehabilitation interventions for PCC is essential, as no universal rehabilitation intervention has yet been established for this evolving condition. The findings of this review provide a comprehensive overview of the wide scope of rehabilitation strategies currently being tested, which may inform future research efforts aimed at developing more standardised, multifaceted interventions.

Despite the progress in PCC rehabilitation research, significant gaps remain. There is a pressing need for more studies focusing on less frequently examined outcomes, such as PEM, cognitive function, memory, balance, gait and coordination. Additionally, future research should be more inclusive of individuals with suspected SARS-CoV-2 infections who were not formally diagnosed, as the lack of testing availability during the pandemic's early stages may have led to the underrepresentation of affected individuals in research studies. This exclusion could further contribute to healthcare inequities by limiting access to appropriate rehabilitation services. A key area for improvement in future studies is the consistent reporting of adherence rates and adverse events to enhance the reproducibility and applicability of findings. Without adequate reporting, it is challenging to determine the safety and feasibility of various interventions, which may hinder the development of evidence-based guidelines.

Through this review, we described the rehabilitation intervention components and outcomes for PCC and highlighted where gaps exist in the currently available research. This enhances the knowledge surrounding PCC and provides clinicians and healthcare providers with a roadmap to consider outcomes and interventions that are relevant to their patient population, thus broadening their thinking about different courses of treatment. Furthermore, a review that summarises the efficacy of the currently available interventions would provide additional information for patients and their healthcare providers to decide on clinical courses of action.

Limitations

Of the 74 included studies, 48 did not report on adverse events. Of the 21 studies that did report, only 7 reported an occurrence of adverse events. The absence of adverse event reporting does not necessarily indicate their absence; rather, it highlights the lack of transparency in reporting. This lack of transparency in these studies is a significant limitation because it is important to report the presence or absence of adverse events to ensure that the proposed interventions are both safe and effective for the populations receiving them.⁹⁸ Additionally, the search strategy is nearing a year old, which could potentially miss capturing some important information. However, due to the speed at which this topic is evolving, it would be challenging to capture every study on the topic.

CONCLUSIONS

The currently available rehabilitation interventions for PCC primarily focus on managing fatigue and improving quality of life. However, there is a noticeable gap in research addressing outcomes, such as PEM, cognitive function and memory and balance, gait and coordination. Furthermore, our analysis highlights the need for improved reporting on intervention adherence to enhance the fidelity and reproducibility of future studies. Moving forward, the development of comprehensive, multifaceted rehabilitation interventions that address the full spectrum of PCC manifestations will be crucial to ensuring optimal patient care and health outcomes.

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Contributors EGS developed and ran the search strategy, screened and extracted the data, developed the plan for data synthesis and drafted and revised the article. EGS is the guarantor. EGS accepts full responsibility for the finished

work and/or the conduct of the study, had access to the data and controlled the decision to publish. DVP assisted with conceptualisation, screening, extraction, writing and revision of the draft. EM, NB, JCM, LB, KLQ, TVP and PB assisted with conceptualisation, writing and revision of the draft.

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