Pulmonary Rehabilitation for People With Persistent Symptoms After COVID-19

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Keywords: Pulmonary Rehabilitation, COVID-19, exercise, long-COVID

Abbreviations

6MWD 6 Minute Walk Distance

BPAT Breathing Pattern Assessment Tool

BPD Breathing Pattern Disorder

COPD Chronic Obstructive Pulmonary Disease

PEM Post Exertional Malaise

PESE Post Exertional Symptom Exacerbation

PR Pulmonary Rehabilitation

Abstract

Topic importance

COVID-19 can cause ongoing and persistent symptoms (such as breathlessness and fatigue) that lead to reduced functional capacity. There are parallels in symptoms and functional limitations in adults with post-COVID symptoms and adults with chronic respiratory diseases. Pulmonary Rehabilitation is a key treatment for adults with chronic respiratory diseases with the aims to improve symptom management, increase functional capacity. Given the similarities in presentation and aims, a Pulmonary Rehabilitation programme may be optimally placed to meet the needs of those with ongoing symptoms following COVID-19.

Review findings

Aerobic and strength training has shown benefit for adults living with Long COVID though there is little evidence on structured education in this population. Breathing pattern disorder is common in adults with Long COVID and considerations to treatment prior to rehabilitation, or alongside rehabilitation are necessary. Considerations to Post Exertional Malaise is important in this population and evidence from the Chronic Fatigue Syndrome literature supports the need for individualisation of exercise programmes, and considerations for those that have an adverse reaction to activity and/or exercise.

Summary

This narrative review summarises the current evidence of Pulmonary Rehabilitation programmes in a long COVID population. Where the evidence is lacking in long COVID the supporting evidence of these programmes in chronic respiratory diseases has highlighted the importance of aerobic and strength training, considerations for fatigue, potential mechanism for immunology improvement and management of breathing pattern disorders in these programmes.

Introduction

SARS-CoV-2 infection can lead to ongoing symptoms long after the initial infection. Symptoms persisting greater than 12 weeks following the initial virus has been termed "long-COVID "or "post-COVID-19 condition" as outlined by the World Health Organisation (WHO)[1] (herein after described as long-COVID). Long-COVID reportedly effects upwards of 17 million people across the WHO European Region[1], and female sex, aged between 40-59, with two or more comorbidities have an increased risk[2]. The common symptoms include fatigue, breathlessness, pain, and, cognitive dysfunction, though there are approx. 200 recognised symptoms of Long-COVID, leading to complex presentations due to multi-system involvement during COVID infection[1]. In some instances, those with long-COVID may also experience post Intensive Care Syndrome that may contribute to their symptoms[3]. Individuals with long-COVID experience a reduction in quality of life, and physical impairment due to limitations caused by their symptoms[2], and other factors such as period of immobility, contribution of comorbidities and the presence of frailty[4].

Pulmonary Rehabilitation (PR) is highly evidenced, effective and, cost effective intervention developed for adults with chronic respiratory conditions. PR is a comprehensive programme of aerobic and strength training, education, and supportive self-management strategies[5,6]. The exercise component is individually prescribed and adapted/progressed in line with individuals' symptoms and improvements. Programmes can vary in duration and delivery but require the essential components of individual comprehensive assessment, including an exercise test, subsequent exercise prescription, and delivery by qualified healthcare professionals[5,6]. Structured education is a desirable component of PR and may provide important knowledge for managing respiratory symptoms. PR has demonstrated significant improvements in symptoms, health-related quality of life, mental wellbeing and functional capacity in multiple chronic respiratory diseases[7]. Those that attend PR present similarly to adults with long- COVID including symptoms of breathlessness, fatigue, pain, and cognitive dysfunction. An early consensus of experts identified the need for support of adults living with long-COVID and that PR may be an optimal setting to offer this support, particularly with the presence of respiratory symptoms[8]. Since then, guidance has supported that an adaptive PR model may be suitable for adults living with long-COVID[9,10].

Whilst there are some similarities between long-COVID and chronic respiratory conditions, long-COVID is poorly understood with a wide range of phenotypes and symptoms, some of which may respond to rehabilitation, however there are some additional considerations in regards to these interventions[2]. There has been an increasing amount of evidence for the prevalence of breathing pattern disorder and long-COVID, which appears higher than other disease areas[11]. This cohort may present with additional complications such as post-exertional symptom exacerbation or post exertional malaise whereby individuals experience an extreme, adverse reaction to exercise training/activity (PESE/PEM) that require consideration in relation to rehabilitation strategies. Additionally, there are individuals with long-COVID that present with frailty and related limitations as a direct result of their acute COVID event (which may include hospitalisation), where they may have previously not been frail[4].

The complexity and heterogeneity of long COVID highlights the importance of understanding the literature in relation to PR for adults living with Long COVID therefore this review will aim to assess the current literature on COVID rehabilitation and where evidence is lacking, explore the evidence of PR that may provide relevance to this population. This will give particular attention to the evidence on exercise training; and its subsequent effect on fatigue, breathing pattern disorder and frailty (figure 1).

Literature search

Searches were conducted in February 2023 (and updated in November 2023) from database inception and were performed on: PubMed (MEDLINE) and CINAHL. Combinations of the following terms were used in the searches: “COVID-19”, “COVID”, “SARS-CoV-2”, “rehabilitation”, “exercise” “frailty”, “dysfunctional breathing”, and “disordered breathing”. The abstracts of original investigations and review articles and the references of selected studies were screened and included based on relevance to the topics covered in this Series paper. Additional searches on ClinicalTrials.gov for active and planned clinical trials of investigational exercise or rehabilitation interventions in COVID-19 populations using the following terms: “COVID-19”, “COVID”, “pulmonary fibrosis”, “fibrotic”, “fibrotic lung disease”, and “post-COVID fibrosis”.

COVID rehabilitation review of the literature

There has been increasing evidence to support rehabilitation strategies for adults living with long-COVID symptoms. Several systematic reviews have demonstrated improvements in breathlessness and anxiety following rehabilitation, however there is heterogeneity among the interventions delivered[12]. Reviews that include interventions outside the American Thoracic Society definition of PR tend to have a diluted response in relation to exercise capacity and quality of life. These systematic reviews demonstrate promise for COVID rehabilitation, and have been supported by observational studies which include a form of exercise training, have shown significant improvements in the six minute walking distance (6MWD) compared to no intervention[13-15]. There is some evidence to suggest that rehabilitation with inspiratory muscle training and/or breathing exercises can improve lung function compared to a control in adults with long-COVID, however data are inconsistent and at odds with chronic respiratory disease data[13,14]. Two reviews concluded that PR has the potential to improve symptoms post-COVID and found moderate to large effects in breathlessness, physical function and quality of life, though were not able to demonstrate improvements in fatigue. This review includes a broad definition of PR and non-randomised controlled trials and therefore the lack of control group may dilute the results[16]. The studies in the systematic review include a variety of interventions but differ from “traditional” pulmonary rehabilitation models, and do not necessarily include the reported key components, but focus more on breathing techniques and respiratory muscle training[17].

Early data for COVID rehabilitation approximately four months after infection, that is based on a PR model, has shown promise in improving symptoms, exercise capacity and quality of life however studies to date have lacked a control group and may be affected by government mandated lockdown restrictions/shielding measures[18]. Similarly, a pilot study in North Africa has implemented a PR programme post-COVID-19 which shows improvements in quality of life, anxiety and depression, and physical activity[19].

The evidence for COVID rehabilitation is encouraging but further research of randomised controlled trials comparing rehabilitation based on PR key components, compared to a control group is required. There are several registered trials that will explore these models of care through face to face and digital modes[20] (trial registrations NCT05317975, NCT05244135, NCT04961333, ISRCTN10980107, ISRCTN11466448).

Learning from Pulmonary Rehabilitation

Aerobic training

Aerobic exercise has long been recognized as an important part of PR and likely forms an integral part of the management of long-COVID[5]. A systematic review of 433 participants with long-COVID has demonstrated an improved lung capacity, cardiovascular health, and, reduced risk of complications [21]. Increasing aerobic capacity is associated with increasing muscle endurance and strength as well as increasing immunity[22].

Aerobic exercise targets the reduced exercise tolerance that is an important factor in the symptoms and functional limitations present in long COVID[23]. Following an 8-week exercise rehabilitation programme consisting of aerobic exercise training in conjunction with strength training, a study of 50 patients with long-COVID showed significant improvement in cardiorespiratory fitness. Exercise capacity increased from 17.8 mL/kg/min to 20.5 mL/kg/min[24]. A significant increase in exercise capacity and lung function was found following a similar exercise programme[14].

A systematic review of aerobic exercise training in long-COVID provided recommendations for aerobic exercise in the form of cycling or walking for 20-60 minutes at an intensity of 55-80% $VO2_{max}$ or 60-80% of maximum heart rate, defined as 220 minus age, 2-3 times a week[25]. This exercise prescription is similar to the aerobic exercise component of PR, however this review does not report the pooled results of the included studies and does not consider the complexities of adults with long-COVID (such as fatigue and breathing pattern disorder- discussed in later sections). Therefore it is vitally important that aerobic exercise prescription is tailored to individual needs and symptoms, and progressed in line with these symptoms[23].

Interval training, defined as alternating short bursts of high-intensity exercise with periods of rest or lower-intensity exercise, could provide benefit in this population due to its ability to allow accumulation of volume whilst limiting breathlessness[26], and particularly ventilatory limitations such as those with breathing pattern disorder. The addition of resistance exercise alongside aerobic exercise helps improve overall fitness and in turn the ability to perform aerobic exercise, however there is a lack of evidence within a long-COVID population[27].

In addition to improving respiratory and cardiovascular health, aerobic exercise can also have positive effects on mental health and well-being, a common symptom of long-COVID. Studies have shown that regular exercise can reduce symptoms of anxiety and depression in individuals with a respiratory condition and individuals with an immediate history of COVID-19[5,25,28-30].

Overall, aerobic exercise could provide benefit in improving exercise capacity in long COVID.

Resistance training

Resistance exercises provide a potent stimulus for ameliorating the musculoskeletal consequences of COVID-19 and/or hospitalisation, which are often compounded by high levels of sedentary behavious[31].

Data in long-COVID suggests that improvements in muscle strength and function can be expected in this population[32], largely attributable to the resistance training portion of interventions. These effects are of great importance, as muscle strength is broadly associated with a reduced risk of disease and all-cause mortality in the general population[33]. A 28-day resistance programme combined with aerobic exercise in individuals recovering from COVID-19 improved skeletal muscle mass regardless of baseline muscle mass (“normal” +10.7% or “low” +8.5%), demonstrating equitable benefits irrespective of body composition[34]. Conversely a rehabilitation programme did not demonstrate changes in muscle mass in males with long-COVID and sarcopenia despite improvements in hand grip strength[35]. In a larger trial, individuals with impaired exercise capacity following hospitalisation with COVID-19 performed aerobic and resistance training for an 8-week period[24]. Resistance training was incorporated for both lower (leg extension/flexion, abduction/adduction, leg press) and upper body (push-up/pull-down and abdomen and back exercises) and was performed with relatively conservative loads (40% of subjects’ 1-repetition-maximum; 2-3 sets; 12 repetitions). Following the intervention, muscle strength increased for all major muscle groups ranging from 16% to 33%, although functional capacity and quality of life were not reported. This heterogeneity amongst studies in relation to muscle mass is perhaps unsurprising; as prescription of training load, frequency and volume differs substantially and will have a considerable impact on hypertrophic adaptations[36]. The utility of resistance training following COVID-19 infection seemingly lies in improving muscle strength and physical function, rather than driving body re-composition.

It is worth noting that adverse events are seldom reported in studies of resistance training in PR[37]. This is supportive of previous data demonstrating similar changes in VO_2 and minute ventilation between individuals with COPD and healthy controls during a resistance training session[38]. Additionally, when compared to whole-body aerobic exercise such as cycling, walking, and stair climbing, resistance training may elicit a lower relative cardiopulmonary stress response according to these metrics[39]. Although the safety and efficacy of resistance training in long-COVID has not been extensively explored; several trials have demonstrated clear improvements in both muscle strength and function utilising modified, multi-component PR programmes. Ultimately, these adaptations will likely facilitate the rehabilitation of musculoskeletal sequelae resulting from COVID-19, leading to potential improvements in daily functioning and quality of life. Further research should explore the duration, frequency and intensity for optimisation of resistance training.

Education and self-management

Education (formal and informal) and self-management strategies are essential within PR interventions. There is a lack of literature that explore the impact of formal education on the management of long-COVID, and few studies include details of education sessions. One study describes the educational topics as: breathlessness, cough, fatigue, fear and anxiety, memory and concentration, taste and smell, eating well, getting moving again, sleeping well, managing daily activities and, returning to work; suggesting some adaptations to the educational component are required[18]. However, education needs, and response to interventions are seldom explored, and therefore their importance remains uncertain. Within PR, formal education is a requirement and there has been evidence to support increased knowledge of disease within Chronic Respiratory Disease[40].

Rehabilitation and breathing pattern disorder

Breathing pattern disorder (BPD) or dysfunctional breathing is characterised by alterations in breathing mechanics that results in dyspnoea that is disproportionate to the level of activity, or occurring at rest. Several studies have highlighted the presence of irregularities in the breathing pattern of individuals with dyspnoea following COVID-19. BPD is a well-recognised cause of exertional dyspnoea in the general population and is a prevalent co-morbidity in individuals with airways disease[41,42]. Respiratory symptoms arising from BPD impact quality of life and influence simple activities such as climbing a flight of stairs[43].

In individuals with breathlessness and long-COVID, Hylton and colleagues used a simple breathing pattern assessment tool, the BPAT, to identify and report a 30% prevalence of BPD in individuals with long COVID[44,11]. Utilising the Nijmegen Questionnaire, hyperventilation was identified in approximately 21% of individuals assessed at an ambulatory care visit for persistent symptoms following COVID in a further study[45]. Studies utilising cardiopulmonary exercise testing to characterize physiological reasons for exertional limitation, such as deconditioning, have also identified a high prevalence of breathing pattern irregularities, with hyperventilation and erratic tidal volume patterns[46,47]. The use of non-linear statistical methods has been employed to emphasise and characterize the chaos of breathing in this context[48]. It thus seems apparent that in some individuals, BPD is an important factor underpinning the seemingly ‘unexplained’ dyspnoea associated with COVID-19 recovery, though the diagnosis of BPD remains a challenge[41]. Moreover, there is a recognised association between BPD and autonomic dysfunction and thus a likely interplay between these phenomena, in the context of long-COVID[49].

To date, there are no prospective studies reporting BPD-related outcomes following exercise or PR-based intervention in long-COVID. As described in this review, most studies have focussed on exercise capacity and quality of life associated metrics[50]. There is however a logical rationale for exploring the benefit of PR in this context, given the relevance of this condition, as described above, and also the known benefit of this class of interventions in non-COVID-19 associated BPD. Specifically, in individuals with airways disease and co-morbid BPD, several randomised control studies have shown that a physiotherapy-based intervention is associated with improved quality of life and perceived dyspnoea[51,52]. There are interventional studies on the use of inspiratory muscle training to improve breathlessness and respiratory muscle function in long-COVID and therefore may be considered a useful adjunct to PR[53]. PR includes strategies for the management of breathlessness within the educational component that may also add value to those with BPD. Future research should characterise BPD in this setting to evaluate the overlap with autonomic dysfunction and refine specific tools to address this issue when identified within a PR management plan.

Rehabilitation and fatigue

Fatigue is a hallmark symptom of COVID-19, both in acute disease and in individuals with long COVID[54-58]. A meta-analysis including 25,268 individuals reported that fatigue was found in 32% of individuals with COVID-19 at 12 weeks after the infection, though the diagnosis and reporting of fatigue can vary[59]. In the long-COVID literature fatigue is reported subjectively and importantly, both physical and mental fatigue has been described. Fatigue has been reported through questionnaires (e.g Functional Assessment of Chronic Illness Therapy- Fatigue Scale[60]), or through subjective description of the symptom. Further diagnosis for fatigue such as Chronic Fatigue Syndrome[61] may also be sought following long COVID whereby diagnoses may be made through clinician interviews. Fatigue can also be attributed to deconditioning, particularly following hospital admission such as post ITU syndrome[62]. Additionally, fatigue as a symptom is common in other chronic respiratory conditions such as COPD[63], and is a complex and multifactorial symptom.

There has been improvements in fatigue following rehabilitation in adults with COPD[64]. While the underlying mechanisms have not yet been unravelled, fatigue has been associated with changes in the immune response such as: a cytokine storm, glial activation, T-cell exhaustion, mitochondrial impairment, neuronal toxicity and reactivation of Epstein-Barr virus[65-67]. Long-lasting fatigue is a common signature of long-COVID, yet favourable effects of regular physical activity on immune cell functions and pro-inflammatory cytokine release are apparent even with low to moderate levels of activity in populations with limited physical capacity and symptoms of daily fatigue[68,69]. Furthermore, reducing time spent sedentary (sitting, reclining or lying down) is independently associated with lower circulating concentrations of pro-inflammatory cytokines, even when adjusting for physical activity habits in large cohort of adults aged 60-64[70]. An observational study examining lymphocyte populations and inflammatory consequences in previously hospitalised COVID-19 individuals found persistent perturbations in T cell function and phenotype at 6 months of convalescence[71]. In particular, individuals exhibited elevated proportions of ‘exhausted’ terminally differentiated effector memory (TEMRA) T cell subsets. These cells have reduced capacity to respond to future antigen challenge, increasing the risk of more frequent and more severe infections, and reducing responses to vaccines, which may in part explain the prevalence of fatigue within long COVID[71]. Accordingly, a recent systematic review of 30 studies concluded that regular exercise limits the accumulation of exhausted CD8+ T cells[72]. The authors concluded that this effect seems likely related to preferential mobilisation of exhausted T cells with each exercise session, subsequently promoting their apoptosis in the peripheral blood compartment by other immune cells, creating ‘immune space’ and stimulating the production of naïve T cells. The findings of these, and other exercise and physical activity studies, even at lower intensities and volumes, may suggest some potential for carefully directed activity within rehabilitation programmes to manage persistent immune perturbations within adults with long-COVID.

Many trials that have reported on the beneficial effects of rehabilitation in individuals with long-COVID – mostly including previously hospitalized individuals – did not include fatigue as an outcome. Al-Chickanie et al reported an improvement of fatigue after PR in patient that survived respiratory failure due to COVID-19[73]. In a cohort of 30 individuals (87% previously hospitalised), Daynes et al. found a clinical important improvement in fatigue[18]. Importantly they also observed an improvement in fatigue and functional capacity in most individuals, with no individuals worsening in both fatigue and functional capacity. Further studies have demonstrated functional improvements, while fatigue remains indicating that individuals are able to do more before experiencing similar levels of fatigue[74,75]. Two randomised controlled trials have demonstrated an improvement in fatigue following tailored exercise or telerehabilitation[76,77].

It has been demonstrated that PR can improve fatigue in other disease areas such as COPD, which can improve other important outcomes such as 5-year mortality[78]. In patients with persisting dyspnoea, Dalbosco-Salas observed an improvement of fatigue after a primary care tele-rehabilitation programme[76]. Strategies within PR programmes, such as pacing and prioritising techniques are recommended for the management of long-COVID and there has been evidence in individuals with COPD that pacing/energy conservation techniques are effective at reducing energy consumption, and therefore would likely add value in the management of long-COVID fatigue[79].

While fatigue might be a treatable and transient symptom in a proportion of individuals, there may be a proportion of individuals where exercise is not beneficial, particularly in the presence of PESE. There has been guidance on the management of PESE and PEM for consideration in long-COVID, drawing parallels from the myalgic encephalomyelitis and chronic fatigue syndrome literature. PEM or PESE refer to a significant a debilitating worsening of symptoms despite minimal physical or mental exertion, lasting several days or weeks. The prevalence of this phenomenon is not known, largely due to challenges in diagnosing this phenomenon and there has been no research that has explored the impact of rehabilitation strategies on the changes in PESE in adults with long-COVID. Data from post viral diseases identified that the severity of the initial virus and recurrence of infection can lead to increased severity of PEM[80]. Patient selection, individualisation and symptom titrated rehabilitation, alongside strategies such as pacing are crucial to ensure the correct management of this symptom[81]. Progression of exercise and activity should be based on the symptom improvement and should be regularly reviewed. Rehabilitation services should ensure that fatigue, PEM, and PESE are screened and monitored throughout the programme in order to guide interventions, and where necessary other interventions should be explored.

Rehabilitation and physical frailty/skeletal muscle dysfunction

Among survivors of COVID-19 a significant burden of frailty has been seen with 7% of those hospitalised being categorised as frail one year following discharge while a further 59% were found to be at risk of developing frailty[4]. PR, involving a combination of aerobic and resistance exercise, has well described impacts upon skeletal muscle[82] and frailty[83] with measures of both improving following the completion of PR among individuals living with COPD. Similarly, patients with sarcopenia or frailty who participate in PR programmes have favourable outcomes despite those living with frailty being less likely to complete PR programmes[82,83]. Furthermore, the two domains of phenotypic frailty most frequently observed were low physical activity and reduced hand grip strength[4], both areas may benefit from PR, particularly with strength training, and reassurance around aerobic exercise and physical activity. Evidence for improved physical activity following PR is conflicting, and exploration of how frailty status may impact physical activity remain unknown[84].

Skeletal muscle weakness and loss of muscle mass have both been noted among individuals suffering long-COVID[85,86] while a high prevalence of sarcopenia has been seen in some populations[87] with the extent of muscle deficit relating to the severity of the acute illness. This suggests that for many survivors of COVID-19 with ongoing health impairments muscle changes may follow similar patterns to those seen following hospitalisation and critical care admission for other conditions where rehabilitation strategies implemented both during[88] and following the acute illness[82] have proven effects on ameliorating the loss of muscle function. Pharmacological interventions have yet to show clinically relevant benefits for patients suffering muscle loss or sarcopenia[89] further highlighting the importance of rehabilitative interventions.

Adaptations and considerations for COVID Rehabilitation

In addition to exercise training, PR offers a multidisciplinary approach to support physical, psychological and functional impairments. Whilst there are similarities between those with chronic respiratory disease and long-COVID, there are differences that require consideration in COVID rehabilitation. Return to work support through education, adjustments and signposting, is highly relevant in this population, with 23.3% of 16-64 year olds reportedly off work with self-reported long COVID[90]. This may lead to challenges in progression of exercise/activity, whereby individuals may increase activity rapidly and worsen symptoms. Therefore strategies for gradual return to activity/work and detailed symptom management in vital[90]. Adults with long-COVID may have new onset of oxygen requirements, particularly those with pre-existing comorbidities[91]. This can be supported within PR, whereby healthcare professionals are experienced in supporting supplemental oxygen. Additionally, there is a high prevalence of anxiety and depression; however this is comparable to those living with a chronic respiratory disease, whereby PR has demonstrated improvements in mood disorders[92]. As a result, patient selection is vital in the success of PR for adults living with long COVID, highlighted within the British Thoracic Society Clinical Statement[93]. Notably, PR should be offered to those with ongoing functional impairment ≥3 months, with considerations to complex symptoms as listed above. PR may be prioritised or stratified for those phenotypes with a more severe functional impairment, where those with milder impairment may benefit from “lighter touch” interventions[94], as guided by the COVID-19 Functional Status Scale[95].

Considerations of the timing of intervention would be helpful, though there is little exploration of this in the literature. As some individuals will recover and not be classified as “long COVID” it would seem appropriate for rehabilitation to be offered after this stage. Though, those that have had a long stay in intensive care or signs of post intensive care syndrome, may be more appropriately treated early and in line with intensive care rehabilitation services[96]. Generally, the population may be younger, and of working age, and therefore there is opportunity for digital rehabilitation to support individuals, though this has not been explored at length in this review.

Discussion

This review has explored the evidence for COVID rehabilitation, and where evidence is lacking, the potential usefulness of PR evidence (figure 2). Adults living with long-COVID will experience a plethora of symptoms including breathlessness and fatigue, which have long been addressed within PR. The PR model of aerobic and resistance exercise, alongside symptom management shows promise in improving symptoms associated with long-COVID. Evidence has demonstrated improvements in health-related quality of life, and functional capacity though particular considerations may be required for the presence of BPD, frailty and severe fatigue. The anti-inflammatory benefits of exercise and promoting physical activity may begin to explain some improvements in key symptoms such as fatigue among this population. Currently there is a lack of evidence for adapted PR programmes in the treatment of long-COVID that has a control group, though there are several registered trials that aim to answers these unknowns.

Future prospects

Research is ongoing for PR in adults with Long COVID, and it is important for high quality, rigorous studies with an appropriate control group in order to provide recommendations for PR, and there are several studies ongoing, due to read out in the short-term. Further research on who benefits, and when would be beneficial, and exploration of potential mechanisms in adults with Long COVID. Evidence for diagnosing and treating breathing pattern disorder and post-exertional malaise/post exertional symptom exacerbation would be useful in recommending and identifying appropriate participants.

Summary

PR programmes can provide benefit and support for adults living with long COVID. Considerations for timing of the intervention, particularly in relation to Breathing Pattern Disorder, and paying consideration to natural recovery is important. Fatigue is a prevalent symptom in Long COVID and programmes need to ensure the delivery of individualised care.

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