



Review Article

Exercise and Physical Health in Survivors of COVID-19: A scoping review

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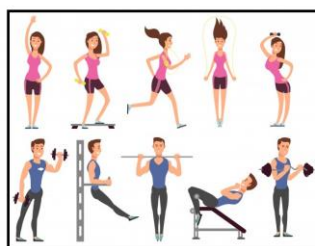
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ABSTRACT

Till now not so many research studies have been conducted on the body's immune response to COVID-19 infection, and it is not clear whether those who had recovered from the COVID-19 virus may get reinfected again or not. The vulnerable groups include young children and older adults who were at high risk of infected by this pandemic COVID-19. Those who had recovered from these infections also need to maintain and improves their quality of living. However, there is limited evidence regarding the exercise and physical activity that helps to maintain the overall physical functions. Therefore, this current paper was to map out empirical evidence on exercise prescriptions and physical activity for the prevention and managing the spread of COVID-19 infections. The methodological framework by the TIDIER guidelines were utilized to guide the conduct of MEDLINE complete at EBSCOhost, PubMed, ScienceDirect, CINAHL, Scopus, and Google Scholar. All authors extracted data, summarized the exercise prescription into the relevant concept, and reported the results using a chart and writing a narrative synthesis. Most of the 15 sources that were reviewed reported that the combination of aerobic and strengthening exercise with moderate intensity was considered safe to be performed by individuals under COVID-19 recovery. Moderate intensity indicates effects in enhancing the immune system, preventing cardiorespiratory system problems, and improving the cardiometabolic system. From all kinds of exercises, moderate-intensity is strongly suggested undertaken following the TIDIER guidelines. Moderate-intensity exercise was proven to have positive and safe effects that are recommended for COVID-19 survivors. It is recommended to increase the frequency of exercise from 150-300 to 200-400 minutes per week, including strengthening exercises.

GRAPHICAL ABSTRACT

Exercise and Physical Health in Survivors of COVID-19



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Introduction

Since the COVID-19 case in Wuhan, China, in December 2019, the spread of these cases has continued to reach 3,951,905 cases [1, 2]. This virus, as human-to-human transmission, will enter the respiratory tract and replicate the epithelial cells in the upper respiratory tract. The virus will then disperse to the lower respiratory tract to weaken the immune system and cause a more severe condition [3]. For this reason, changing the host behaviour, and human contact could be prioritized to overcome the transmission [4]. COVID-19 has been a terrifying and life-changing experience for most patients with serious diseases requiring hospitalization. The energy of health care teams at the height of the pandemic was concentrated on saving lives and preventing health systems from being overwhelmed. Without a rigorous follow-up procedure, those who survived were frequently discharged. The incidence of complications after COVID-19 is not yet completely understood and will only become evident in the months and years to come. After COVID-19 infected, the COVID-19 survivor has a risk for several problems after recovery, such as the cardiorespiratory function and fitness as dominant clinical manifestation influencing the basic daily activities day-to-day and quality of life worse [5, 6]. The strategies are needed to accelerate the recovery time of patients by using primary and secondary preventive strategies because self-quarantine poses a threat to potential physical inactivity followed by cumulative calorie intake which will damage the cardiometabolic profile and the immunity system [7]. The training program like the exercises could be as the alternative solution to increase several indicators of the physical profile, such as increased immunity [8], cardiorespiratory fitness, an individual cardiometabolic profile. Also, they are possible to prevent re-infection by stimulating the immunity of survivors. This activity program and physical exercise are considered as essential strategies to overcome this condition. For instance, aerobic exercise programs, muscle-strengthening

(resistance) exercises, and flexibility for 3-12 months have a positive effect on improving cardiorespiratory fitness and cardiometabolic profiles [9].

The previous study stated that exercise can significantly boost the cardiorespiratory fitness, whether in absolute and relative to aspects of lipid and lipoprotein metabolism, glucose intolerance and insulin resistance, systemic inflammation, and hemostasis [10]. It is also associated with the cardiorespiratory capacity and immune system. Increased aerobic capacity has short and prolonged effects on the strength of the immune system and the respiratory system that are important for dealing with COVID-19 infection and complications related to COVID-19. Increased aerobic capacity can be improved through exercise methods. Various studies have shown that moderate-intensity exercise and sport will improve the cardiorespiratory system and the immune system directly through acute and chronic effects [11]. The preventive program against COVID-19 and recurrent risks are still limited, and pharmacological therapy is the least strategy when encountered with a preventive program [12]. In contrast, exercise's physical activity is an effective strategy to improve the immune system and avoid viral infections. Exercise programs for patients recovered from COVID-19 need to be adjusted to considerations and exercise implementation, which cannot be equated with conditions outside of a pandemic, especially with the focal point of adhering to physical distancing, safety considerations for appearing symptoms, consideration of doses and suitable exercises [13]. As recommended, the characteristics of the training program need to be formulated, such as type, frequency, duration, volume, and intensity [7]. This study aimed to safely convey the exercise programs for COVID-19 survivors to maintain the immune system and cardiorespiratory system, prevent pneumonia and acute respiratory disease syndrome and cardiometabolic by preventing various risk factors and possibly recurrent of COVID-19 as

followed by the TIDieR checklist and guide format.

Material and methods

This work was compiled through a scoping review related to optimizing the health outcomes for COVID-19 by proper exercises. Various academic articles, literature, and media sources taken from various databases were collected to answer these questions. The synthesis is about various issues during the COVID-19 pandemic which presented based on the scoping review protocol according to, which consists of (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarizing and reporting results. These steps are carried out to complete each stage of the review; thus, the exercise recommendations are formulated in the TIDieR checklist and guide format [14].

Identifying Research Question and Relevant Studies

The first stage of a scoping review is to conduct a meeting to create solutions. The team identified various relevant studies to keywords as in Table 1 consisting of 5 categories, namely (1) focus (e.g., exercise); what (e.g., the dose of aerobic exercise); who (e.g., COVID-19 survivors); why (e.g., effect); where (patient’s house). Four types of effects were identified for the “why” category (the importance of aerobic exercise for COVID-19 survivors), and keywords were generated for respective effects. The “where” category was utilized to see the phenomenon of several countries affected by the COVID-19 pandemic and especially at houses of COVID-19 survivors as a place to conduct this exercise programs.

Table 1: Scoping Review Keyword Search Strategy

Exercise	Dose of exercise	Covid-19 survivor	Immune system	Affected countries
1. Aerobic 2. Resistance				
	Mild exercise		Cardiorespiratory system problems: pneumonia and acute respiratory disease syndrome	Home-based Exercise
	Moderate Exercise		Cardiometabolic system problems: prevent various risk factors	
	High Exercise		Preventing the recurrence of COVID-19	

Database search strategies collaborated with librarians to explore related literature that will improve COVID-19 survivors’ condition. The combinations of all keywords were searched in 7 databases for all years except media sources, as revealed in Table 2. The data were obtained from the academic database and the media with five categories of keywords, as presented in Table 1. Several combinations of keywords generating hundreds of sources were found, but after conducting keywords combination, then specific results could be identified by the search manager drawn from 20 sources.

Table 2: Databases Searched for Scoping Review

Database type	Database	Temporal Period covered
Academic	PubMed	2010-2020
	ScienceDirect	2005-2020
	PEDro	2010-2020
	Jane biosemantic	2010-2020
	Grey Literature	2019 -2020
Media	CNN	2020
	Prevention.com	2020

Studies Selection

Studies selection began with the identification of title and abstract sources by search strategy independently then reviewed. For the next step, team members met and found a consensus on whether specific sources must be read thoroughly. Following the condition of the scoping review process, all the inclusion criteria are developed at this stage. Three bases included in the exclusion criteria had been identified, namely: (1) indistinct on exercise interventions, for instance, literature sources about exercises; (2) too focused on specific things on the exercise especially for COVID-19 Survivors; (3) only revolving around general exercise as a solution; nonetheless, there was no explicit reference to problems in overcoming COVID-19 rehabilitation problems, particularly solutions to improve the immune system, prevent cardiorespiratory problems, cardiometabolic system, avoid risk factors, aggravating factors, prevent complications and recurrence of COVID-19. Media sources were taken from various media that supported the review to answer and formulate the problems.

After reviewing the title and abstract, sources were reviewed in a complete form. The list of approved reference sources for review was retrieved manually, and relevant sources were not identified in the initial strategy because those were deemed relevant to the questions; thus, those proceeded for a full review. Exclusion criteria were developed by reviewing the titles and abstracts and reviewing all contents of determining of source based on inclusion done by the team and approved by team leader the article. Some additional criteria were also attached. Exclusion data is needed when there is no source answering the review question. Then, determining the source (full text) based on inclusion done by the team and approved by a team leader.

Charting, Collecting, and Summarizing the Data

It should be noted that the spreadsheets of material were retrieved from the internet have been thoroughly reviewed by team members. Details regarding information: background, objectives, research design and sample, research results, publication information, and data related to the scoping review questions were written down on spreadsheets. A gradual meeting was held between team members and leaders to discuss the extracted data and get an overall perspective on the literature's arising issues. Next, the team leader or main writer reviewed the extracted data and determined the most relevant theme of matters had been obtained from the source. The identification theme that is reviewed with relevant literature toward the scoping question is an essential part of the charting process [14]. All team members reviewed the theme to confirm the interpretation that had been generated. Data extracted in the spreadsheet were marked and separated according to the theme. It was performed to facilitate organizing the findings that have been found from a scoping review and would be summarized and reported. The scoping review activity's final step was the cooperation between team members to identify gaps arising from the reviewed literature sources, which had direct relevance to the scoping review question.

Formulation of Recommended Exercise Format

The outcome of this research study was to optimize the health outcome for the COVID-19 survivors by proper exercises and creating of recommendation. This recommendation is presented by the form of exercise training programs in the TIDieR guideline format, it is an appropriate reporting model of intervention and is sufficient as a form of non-pharmacological intervention [15, 16]. There are 200 samples of randomized controlled study have evaluated for completeness physiotherapy intervention. It was found that approximately $\frac{1}{4}$ of the studies did not fulfil the criteria. Therefore, the recommended

exercise program intervention could not be fully followed [17].

The extracted literature source was reviewed from 7 databases which 133 reference lists were found based on hand searching. A further 59 source to be based on inclusion criteria in the scoping review found 20 studies (Figure 1).

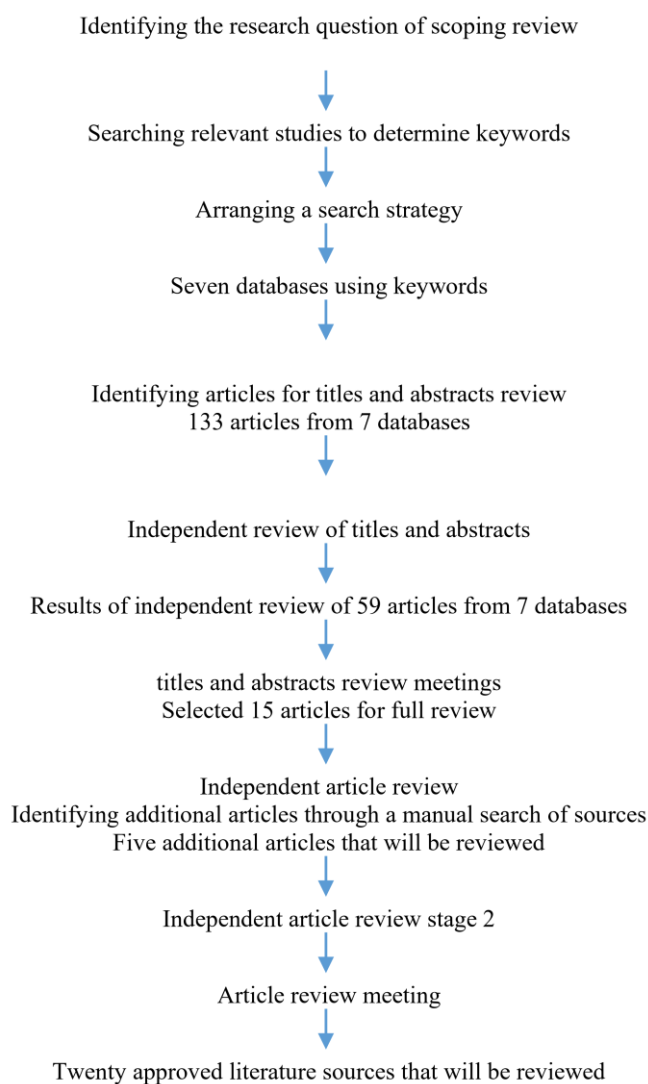


Figure 1: Scoping Review Search Strategy and Results

Exercise Program and Cardiorespiratory System on COVID-19 Survivors

An exercise program consists of chest physiotherapy, stretching exercises, and home executions for patients with COVID-19, which done twice a week for six weeks, can improve respiratory function, QoL, and anxiety in elderly patients with COVID-19 but does not significantly improve the depressive status and activities of

daily living [18]. The supervised exercise program has a good effect on cardiorespiratory fitness (achieved during the first three-month programs) after being given exercise for 3-12 months [19]. Exercises reveal that 20 minutes of mild aerobic exercise for 12 weeks can increase alveoli function and lung elasticity, and the next 40 minutes of mild aerobic exercise increase the strength of the respiratory muscles, inspiratory muscle performance, and maximal exercise capacity [11].

Exercise Program and Cardiometabolic System on COVID-19 Survivors

As cited in the previous study, there is the urgency to maintain an optimum health status for post-COVID-19 recovery as it may help in reducing the risk of complications due to results from other comorbidities in the elderly such as diabetes, hypertension, and cardiovascular problems [20]. Till now, moderate and high-intensity exercise programs generally have almost the same effect on influencing cardiometabolic health, especially in increasing lipid profiles, lower levels of triglycerides, higher levels of high-density lipoprotein cholesterol, and apolipoprotein A1 [20]. Besides, also affects the lower levels of insulin fasting, the homeostasis model assessment of insulin resistance, and glycosylated hemoglobin A1c [10]. Physical activity coupled with weight management is shown to have a positive effect, either acute or chronic on improving insulin performance facilitated by aerobic and resistant exercise. Recommended physical activity to prevent diabetes is at least 2.5 h/week with moderate to heavy doses [21]. Recommended exercise for weight loss is 60 min/day; physical activity and the incidence of hypertension are interrelated. Further supported, the previous study had revealed that a structured physical activity or an exercise program has significant effects on normotensive, prehypertensive individuals, and against hypertension [22].

The types and dosages of exercise used are very diverse such as aerobics, resistance, a

combination of them for moderate-intensity, and exercises with accumulation duration still needs to be re-explored [23]. World Health Organization (WHO) guidelines reported that physical activity enhances endothelial function by increasing vasodilation ability and vasomotor function in blood vessels. This physiological change greatly helps in blood pressure. Furthermore, a long-term engagement in any physical activity can contribute to weight control, glycemic control, improving blood pressure, lipid profile, and insulin sensitivity. Although several studies explain that the benefits of physical activity on cardiovascular risk are on intermediate risk factors, the low physical activity and physical fitness are independent predictors of individuals with type II diabetes [24, 25]. A moderate strengthening training program is vital and recommended for obese individuals to be an exercise program because it is not only a non-pharmacological but also an inexpensive and viable way to cope with corona [26]. Accordingly, all the recommended physical activity and exercise could beneficially benefit for all, especially those who had cardiovascular problems.

Exercise Program and Immune System on COVID-19 Survivors

Efforts to improve the immune system are urgently needed for COVID-19 survivors, such as an increase in cellular adenosine triphosphate (c-ATP), which has the potential to increase the efficiency of the innate and adaptive immune system to prevent and fight COVID-19 [27]. Efforts to improve the immune response are also related to efforts to increase the level of cardiorespiratory fitness. Moderate to high-intensity exercise programs can improve the immune response to vaccination, reduce chronic inflammation, and be able to increase immune markers in several diseases such as cancer, HIV, cardiovascular disease, diabetes, cognitive disorders, and obesity [28, 29]. Exercise can also be started with mild intensity if it is not possible to do with moderate intensity through the

monitoring of “warning exercise” [11]. State that the mild to moderate-intensity aerobic exercise program is beneficial for the immune system in COVID-19 patients [29]. Another study has shown that HIIT (90% maximum heart rate, three times a week) promotes the inflammatory response and suppresses immune function and consequently can increase the risk of advanced and chronic inflammation that increases TNF Alpha, where moderate intensity is the opposite [30]. Moderate-intensity aerobic exercise for 20 minutes improved mood status that contributes to the immune system [31].

Exercise Program and Prevention of Recurrent Risk COVID-19

The results demonstrated that the physically active individuals will avoid upper respiratory tract disease symptoms and some exercise evidence can protect the host from several types of viral infections such as influenza, rhinovirus, varicella-zoster, and herpes-simplex-virus-1 [32]. Moderate intensity less than 60 minutes was seen as having an essential role in the immune system to help stimulate active cell immunity between circulation and tissue, which would further increase antipathogenic activity in coherent tissue macrophages with increased recirculation of immunoglobulins, anti-inflammatory cytokines, neutrophils, NK CELLS, Cytotoxic T cells, and repairing immature B cells. Aerobic exercise programs can also be a protective barrier to reduce COVID-19 risk factors and the incidence and progression of COVID-19 [29].

A possible and Safe Exercise Program for COVID-19 Survivors at Home

The above review shows that several exercises are recommended for effects, especially for the recovery period of COVID-19 at home. Active training during social distancing and maintain fitness regimens during the stay-at-home period, at least with exercise for 30 min, five days a week [33]. Sedentary style during the pandemic also affects the cardiovascular system. Modification and adaptation of regular exercise programs from

outside the house to the house are needed according to the conditions, especially the presence of space and materials needed [7]. With various considerations of study results and a review of several studies, the authors compile an exercise program protocol as in the attached TIDleR format attached.

Warning Exercise

Another important point about the physical activity program experienced by COVID-19 survivors is a warning exercise. If there are symptoms of the upper respiratory tract such as coughing, sneezing, and sore throat called "neck check rule" then COVID-19 survivor is instructed to jog for 10 minutes. If the condition sign is getting worse, it means having to avoid physical activity first until full recovery. If no sign present, the individual is instructed to do the exercise below 80% of VO_2 Max. However, if symptoms also appear below the neck, such as myalgia, fever, and gastrointestinal symptoms, physical activity must be stopped until truly full recovery. In individuals with pneumonia, returning to physical activity should be more slowly and gradually over four weeks [12].

During the recovery time, the challenge is how to develop a new and suitable program to continue the activities at the home of an appropriate and safe that recommended for COVID-19 survivors. The home exercise program is carried out simply, measurable, and safe so that it is possible to be carried out by COVID-19 survivors because it has been synthesized from previous evidence. Home training programs are conducted to avoid airborne spreads and maintain fitness levels. Programs can include a combination of aerobic and strengthening exercises, which begin and end with warm-up and cool-down exercises with breathing exercises and stretching exercises [12]. The principle of maintaining a level of physical activity through an exercise program is the key to changing sedentary behaviour, which is very detrimental to cardiovascular function [34]. The authors recommend moderate exercise

programs, especially for individuals who are undergoing quarantine, to increase the frequency of exercise from 5-7 days per week, with a total duration of aerobic training (brisk walking and interval training) from 150-300 to 200-400 min/week, including strengthening exercises (send upon request). The recommendation is that individuals avoid sitting > 60 min and try to implement activities several minutes at intervals so that the recommended physical activity time can be achieved. Meanwhile, an exercise program with high intensity is not recommended during a pandemic because it can reduce immunity. Some studies have found that exercise intensity and more extended periods can cause immune dysfunction with a form of decreased metabolic capacity of immune cells [29].

Implication to Practice

The sources that have been reviewed show moderate exercise with the TIDleR modification format above can be implemented while paying attention to training warnings or starting with mild intensity if the moderate-intensity is not yet possible. During the exercise, it is inevitable that the patient can achieve the specified target heart rate to reach the moderate intensity, and the principle of progressiveness must be applied to improve the physiological adaptation process of COVID-19 survivors concomitant with other aspects such as economic growth, financial, occupational and safety [35].

Limitations

In this review, most review approaches on the relevant material between exercise and COVID-19 due to the limited form of randomized control trial studies or systematic reviews. Synthesis of exercise program recommendations and clinical reasoning is based on a review of a randomized control trial study and a systematic review of relevant topics that are not directly related to the COVID-19 case despite having a common thread. Another limitation is the limited number of relevant sources. However, the authors have tried to find a common thread between problems

during recovery/rehabilitation of COVID-19 survivors with the effects of exercise programs, good for healthy people, people with various risks, and positive COVID-19. Another limitation is the findings of several studies related to the ideal exercise program, for example, an exercise that should follow the ideal recommendations of ACSM and CSEP with a target of 45-50 min during the first three months. However, on the other hand, the research team instructs to do a personal exercise design based on ability and individual/personal needs. Personalization is critical in increasing the effectiveness of lifestyle interventions in the health system but has implications in analysis and interpretation. Further research is recommended to implement this exercise program and pay attention to the duration and intensity of training to see optimal targets for more specific clinical outcomes and measure the performance of training programs at home and from the economic side, primarily related to financing.

Conclusion

In the current study, it was tried to study the body's immune response to COVID-19 infection. In other words, the main target of the current paper was to answer the question that whether those who had recovered from the COVID-19 virus may get reinfected again or not. Given that the previous studies emphasized that exercise can significantly boost the cardiorespiratory fitness, the authors sought to investigate the effects of exercise on those recovering from the coronavirus to be able to design and submit a checklist and a help form for it. The moderate exercise program has been proven to have a positive effect on COVID survivors. It is recommended that a moderate exercise program can improve the immune system, preventing cardiorespiratory problems, cardiometabolic status and preventing various risk factors such as DM, hypertension and heart problems, and recurrent risk of COVID-19.

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Authors' contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to be responsible for all the aspects of this work.

Conflict of Interest

We have no conflicts of interest to disclose.

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