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Review Article

Recommendations for physical activity during COVID-19: an integrative review

Recomendações para a prática de exercício físico em face do COVID-19: uma revisão integrativa

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ABSTRACT

Objective: To evaluate and synthesize the scientific evidence in relation to the recommendations on the practice of physical activity during and after the pandemic period. **Methods:** A search was carried out with the Medline/Pubmed, Cochrane, Web of Science and Scopus databases, and manual searches in journals, in the references of the selected studies, in addition to the use of pre-print studies. The initial search totaled 1026 records and after applying the filters, 321 publications were selected. After the exclusion by title, summary, duplicates and full reading, 13 publications remained, in addition to another 10 studies selected manually, totaling 23 publications. **Results:** After analyzing the results, the evidence was categorized according to: the effects of physical exercise on viral respiratory infections, the impact of COVID-19 in relation to physical inactivity, physical and mental health and recommendations on regular physical activity during the COVID-19 pandemic and recommendations on post-pandemic physical activity. **Conclusion:** Most evidence recommends regular moderate physical activity during and after the pandemic. However, more specific recommendations on intensity, type of exercise, sets and duration of training need further investigation.

Keywords: exercise; coronavirus; coronavirus infections; exercise therapy.

RESUMO

Objetivo: Avaliar e sintetizar as evidências científicas com relação as recomendações sobre a prática de atividade física durante e após o período da pandemia. **Métodos:** Realizou-se uma busca junto às bases Medline/Pubmed, Cochrane, Web of Science e Scopus, e buscas manuais em periódicos, nas referências dos estudos selecionados, além da utilização de estudos pré-print. A busca inicial totalizou 1026 registros e após a aplicação dos filtros, 321 publicações foram selecionadas. Após a exclusão por título, resumo, duplicatas e leitura na íntegra restaram 13 publicações, além de mais 10 estudos selecionados manualmente, totalizando 23 publicações. **Resultados:** Após análise dos resultados, as evidências foram categorizadas de acordo com: os efeitos do exercício físico sobre infecções respiratórias virais, o impacto da COVID-19 em relação à inatividade física, saúde física e mental e recomendações sobre a atividade física regular durante a pandemia da COVID-19 e recomendações sobre atividade física pós pandemia. **Conclusão:** A maioria das evidências recomendam a realização de atividade física moderada regular durante e após a pandemia. No entanto, recomendações mais específicas sobre a intensidade, o tipo de exercício, séries e duração do treino precisam de maiores investigações.

Palavras-chave: exercício físico; coronavírus; infecções por coronavírus; terapia por exercício.

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Introduction

Coronavirus (COVID-19) emerged in late December 2019, in the city of Wuhan in China, as the leading cause of viral pneumonia [1-3] and spread rapidly across the country and all continents in the world [2,4-6]. In March 2020, the World Health Organization (WHO) declared the SARS-Cov-2 virus to be a global pandemic [3,7].

The current COVID-19 pandemic presents an unexpected public health challenge. Ambitious measures are being implemented worldwide by governments, non-governmental organizations, and individuals to delay the spread of the virus and prevent overloading the health system [8]. However, much remains to be done to "flatten the curve" and mitigate the impact of the coronavirus [9].

The transmission of SARS-Cov-2 occurs mainly from the respiratory spread from person to person (people in close contact or through respiratory droplets produced when an infected person coughs or sneezes) and, to a lesser extent, from contact with infected people, surfaces or objects [1,10]

Clinical conditions such as hypertension, respiratory, cardiovascular and metabolic diseases are important risk factors for severity in COVID-19 [11,12]. Current studies point to potential risk groups: the elderly [11,13,14], young adults, obese individuals with the comorbidities described above, chronic diseases with hemodynamic and immunological repercussions [6,15].

According to Carda *et al*. [16], COVID-19 has different clinical manifestations and the most observed are: 1) mild: no dyspnea, no low blood oxygen saturation (SatO2), with or without fever spikes, loss of smell and taste; 2) moderate: dyspnea during light or strenuous activities, SatO2 94% to 98%, and radiological signs of pneumonia; 3) severe: dyspnea, SatO2 ≤ 93%, respiratory rate (RR)> 30/min, radiological progression of the lesions, need for O2 supplementation, possibly with non-invasive ventilation; and 4) critical: patients need mechanical ventilation.

Physical activity helps to improve immunity in the prevention and complementary treatment for chronic diseases and viral infections such as the new coronavirus [1,6,11,17-22]. The protective effect of exercise on the immune system is crucial to adequately respond to the threat of COVID-19 [15,21,23].

Regular physical activities of moderate to vigorous intensity, according to the guidelines of the American College of Sports Medicine (ACSM), will improve the immune responses to infections; decrease chronic low-grade inflammation, and improve immunological and inflammatory markers in various disease states, including cancer, HIV, cardiovascular disease, diabetes, cognitive impairment, and obesity [21,23].

To fight sedentary lifestyle and improve physical and mental health, ACSM [24] recently released a guide suggesting that moderate-intensity physical activity (PA) should be maintained in the COVID-19 quarantine, emphasizing the importance of every physically active minute for health. The guidelines, in the current situation, suggest 150 to 300 minutes per week of aerobic physical activity of moderate intensi-

ty and two sessions per week of muscle strength training [11,24].

This recommendation is also for people in social distance who are not infected with COVID-19 and people who are infected but remain asymptomatic. If symptoms persist, exercise should be stopped and the individual should seek medical advice [25].

Although containing the virus as quickly as possible is an urgent public health priority, there are few guidelines for the public on what people can or should do in terms of maintaining their daily exercise or physical activity routines [26].

Given the concerns about the increasing spread of COVID-19, it is imperative that infection control and safety precautions, as well as appropriate recommendations for physical exercise, be followed [26].

In view of the world pandemic of COVID-19 and the inevitable need of the population to remain active mainly through physical activity, the present study aims to evaluate and summarize the scientific evidence on the recommendations for engaging in physical activity and exercise during and after the pandemic COVID-19.

Methods

The stages of this review were conducted based on methodology that provides synthesis of knowledge and applicability of results of significant publications to practice [27].

The review followed the following stages: formulation of the guiding question; selection of studies based on the year of publication and title; selection of studies by their abstracts and selection by the full text; and afterwards, extraction of data from the studies included; evaluation and interpretation of results, and, finally, presentation of the review of the knowledge produced [28].

Selection of studies

The literature survey was carried out in the Medical Literature Analysis and Retrieval System Online (MEDLINE) databases through the National Library of Medicine (PUBMED), Cochrane Central Register of Controlled Trials, Web of Science, and Scopus. Other sources were also searched: journal hand-searching, references described in the selected studies, and use of unpublished material (pre-print).

The initial search identified 1026 records and after applying the filters, 321 publications were selected. After removing duplicates, manual screening was performed and those that were not relevant were excluded. Selected publications were assessed in full text for eligibility. Those that did not meet the inclusion criteria were excluded. Ten (10) publications were included by journal handsearching and references in the selected and pre-print studies. The selection of publications is described in the flowchart (Figure 1).

Search strategy

The search was carried out by trained researchers with experience in the topic of the articles. The searches were carried out in April 2020. The descriptors selected in the Health Sciences Descriptors (DeCS) and Medical Subjetc Headings (MeSH) were: exercise, coronavirus, covid-19, and coronavirus infections, as described and presented together with the search strategy in Chart 1. From this search, publications for complete reading that met the inclusion criteria for this review were selected. Regarding the scientific analysis of publications, according to Qualis CAPES and SCImago Journal Rank (SJR), it was observed that 52.2% were classified as belonging to extract A by Qualis CAPES and 34% of publications were classified as belonging to quartile 1 (Q1) according to SJR.

Chart 1 – Controlled descriptors used to build the search strategy in the Medline/Pubmed, Cochrane, Web of Science, and Scopus databases

Database	Search strategy
Medline/ Pubmed	((“Coronavirus” OR “Coronaviruses” OR “Deltacoronavirus” OR “Deltacoronaviruses” OR “Covid-19” OR “2019 novel coronavirus disease” OR “COVID19” OR “COVID-19 pandemic” OR “SARS-CoV-2 infection” OR “COVID-19 virus disease” OR “2019 novel coronavirus infection” OR “2019-nCoV infection” OR “coronavirus disease 2019” OR “coronavirus disease-19” OR “2019-nCoV disease” OR “COVID-19 virus infection” OR “Coronavirus Infection” OR “Infection, Coronavirus” OR “Infections, Coronavirus” OR “Middle East Respiratory Syndrome”)) AND (“Exercise” OR “Exercises” OR “Physical Activity” OR “Activities, Physical” OR “Activity, Physical” OR “Physical Activities” OR “Exercise, Physical” OR “Exercises, Physical” OR “Physical Exercise” OR “Physical Exercises” OR “Acute Exercise” OR “Acute Exercises” OR “Exercise, Acute” OR “Exercises, Acute” OR “Exercise, Isometric” OR “Exercises, Isometric” OR “Isometric Exercises” OR “Isometric Exercise” OR “Exercise, Aerobic” OR “Aerobic Exercise” OR “Aerobic Exercises” OR “Exercises, Aerobic” OR “Exercise Training” OR “Exercise Trainings” OR “Training, Exercise” OR “Trainings, Exercise”)
Cochrane	#1 - “Coronavirus” OR “Covid-19” OR “covid19” OR “Coronavirus Infections” OR “Middle East Respiratory Syndrome” OR “MERS” OR “Corona virus” OR “2019-nCoV” OR “SARS-CoV” OR “MERS-CoV” OR “Severe Acute Respiratory Syndrome”
	#2 - “Exercise OR Exercises” OR “Physical Activity” OR “Activities, Physical” OR “Activity, Physical” OR “Physical Activities” OR “Exercise, Physical” OR “Exercises, Physical” OR “Physical Exercise” OR “Physical Exercises” OR “Acute Exercise” OR “Acute Exercises” OR “Exercise, Acute” OR “Exercises, Acute” OR “Exercise, Isometric” OR “Exercises, Isometric” OR “Isometric Exercises” OR “Isometric Exercise” OR “Exercise, Aerobic” OR “Aerobic Exercise” OR “Aerobic Exercises” OR “Exercises, Aerobic” OR “Exercise Training” OR “Exercise Trainings” OR “Training, Exercise” OR “Trainings, Exercise”
	#3 - #1 AND #2

Chart 1 – Continuation

Database	Search strategy
Scopus	"Coronavirus" OR "Coronaviruses" OR "Deltacoronavirus" OR "Deltacoronaviruses" OR "Covid-19" OR "2019 novel coronavirus disease" OR "COVID19" OR "COVID-19 pandemic" OR "SARS-CoV-2 infection" OR "COVID-19 virus disease" OR "2019 novel coronavirus infection" OR "2019-nCoV infection" OR "coronavirus disease 2019" OR "coronavirus disease-19" OR "2019-nCoV disease" OR "COVID-19 virus infection" OR "Coronavirus Infection" OR "Infection, Coronavirus" OR "Infections, Coronavirus" OR "Middle East Respiratory Syndrome" AND "Exercise" OR "Exercises" OR "Physical Activity" OR "Activities, Physical" OR "Activity, Physical" OR "Physical Activities" OR "Exercise, Physical" OR "Exercises, Physical" OR "Physical Exercise" OR "Physical Exercises" OR "Acute Exercise" OR "Acute Exercises" OR "Exercise, Acute" OR "Exercises, Acute" OR "Exercise, Isometric" OR "Exercises, Isometric" OR "Isometric Exercises" OR "Isometric Exercise" OR "Exercise, Aerobic" OR "Aerobic Exercise" OR "Aerobic Exercises" OR "Exercises, Aerobic" OR "Exercise Training" OR "Exercise Trainings" OR "Training, Exercise" OR "Trainings, Exercise" AND (LIMIT-TO (PUBYEAR , 2020))
Web of Science	#1 TS=("Coronavirus" OR "Coronaviruses" OR "Deltacoronavirus" OR "Deltacoronaviruses" OR "Covid-19" OR "2019 novel coronavirus disease" OR "COVID19" OR "COVID-19 pandemic" OR "SARS-CoV-2 infection" OR "COVID-19 virus disease" OR "2019 novel coronavirus infection" OR "2019-nCoV infection" OR "coronavirus disease 2019" OR "coronavirus disease-19" OR "2019-nCoV disease" OR "COVID-19 virus infection" OR "Coronavirus Infection" OR "Infection, Coronavirus" OR "Infections, Coronavirus" OR "Middle East Respiratory Syndrome") *Índices=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Tempo estipulado=Todos os* anos
	#2 TS=("Exercise" OR "Exercises" OR "Physical Activity" OR "Activities, Physical" OR "Activity, Physical" OR "Physical Activities" OR "Exercise, Physical" OR "Exercises, Physical" OR "Physical Exercise" OR "Physical Exercises" OR "Acute Exercise" OR "Acute Exercises" OR "Exercise, Acute" OR "Exercises, Acute" OR "Exercise, Isometric" OR "Exercises, Isometric" OR "Isometric Exercises" OR "Isometric Exercise" OR "Exercise, Aerobic" OR "Aerobic Exercise" OR "Aerobic Exercises" OR "Exercises, Aerobic" OR "Exercise Training" OR "Exercise Trainings" OR "Training, Exercise" OR "Trainings, Exercise") *Índices=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Tempo estipulado=Todos os* anos
	#3 #2 AND #1 *Índices=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Tempo estipulado=Todos os* anos

Source: Author 2020

Eligibility criteria

Full articles in English, Spanish, or Portuguese related to the effects of exercise and recommendations on PA during and after the COVID-19 pandemic were included. The evidence included original articles and consensus, reviews, editorials, interviews, in addition to studies in the pre-publication phase (pre-print).

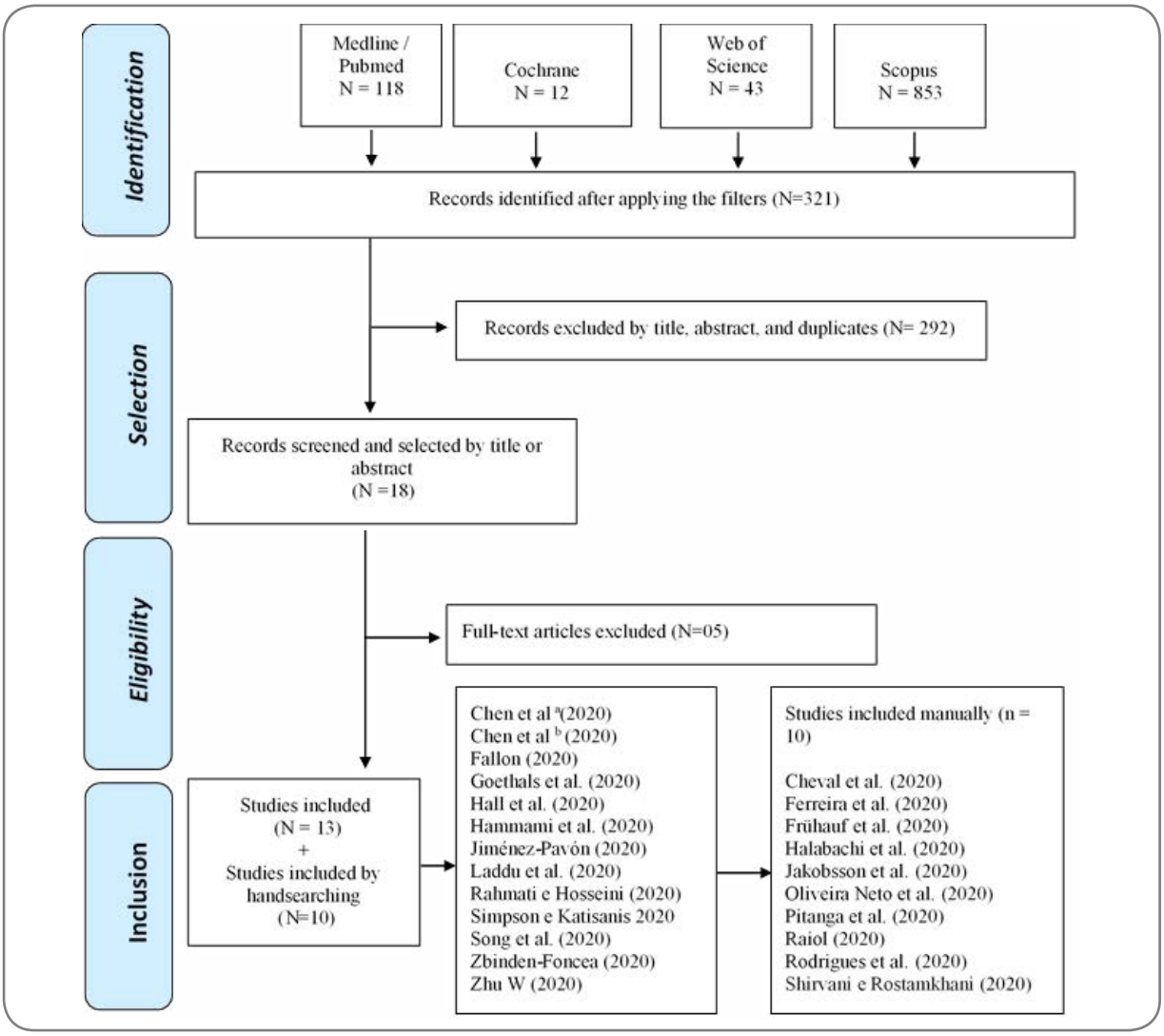
Data extraction

The summary included the extraction of the following data: authors and year of publication, type of study, objective, and evidence. Finally, the results relevant to current knowledge on the study topic were evaluated for producing evidence.

Results

The search identified 1026 records and after applying the filters, 321 publications were selected. Two-hundred ninety-seven (297) studies were excluded by title, abstract, duplicates, and after reading full-text articles. At the end, 13 publications made up the sample and were analyzed, in addition to another 10 pre-print studies hand selected. Figure 1 (Prisma Flow) describes the path taken to select the studies, according to the consulted basis.

According to the descriptors used in the research, 118 publications were identified in Medline/Pubmed, 12 in Cochrane, 43 in Web of Science and 853 in Scopus. Figure 1 shows the search strategy after applying the filters in the Prisma Flow diagram.



Source: Author, 2020 adaptation by Moher *et al.* (2008) [29]
Figure 1 -Flow diagram of article selection (Prisma Flow)

A narrative synthesis of the selected publications was carried out, presenting the scientific evidence on physical exercise and COVID-19 and the main recommendations for physical activity during and after the pandemic. Data extraction was performed with a specific instrument, containing information about authors; year of publication; journal, database, Qualis, SJR, as well as the identification of the scientific evidence of the selected studies. The included reports were organized in tables according to the identified variables.

Chart 2 - Synthesis of the reports included in the integrative review, according to author/year of publication, journal, database, Qualis and SJR

Author/ year of publication	Journal	Databank	Qualis	SJR
Chen[a] *et al.* (2020)	Journal of Sport and Health Science	Pubmed/Medline Web of Science e Scopus	A3	Q1 0.98
Pitanga *et al.* (2020)	Arquivos Brasileiros de Cardiologia	Preprint	B1	Q3 0.41
Hall *et al.* (2020)	Progress in Cardiovascular Diseases	Pubmed/Medline Scopus	A1	Q1 2.79
Laddu *et al.* (2020)	Progress in Cardiovascular Diseases	Pubmed/Medline Scopus	A1	Q1 2.79
Jakobsson *et al.* (2020)	Frontiers in Sports and Active Living	Preprint	SQ	-
Jiménez-Pavón *et al.* (2020)	Progress in Cardiovascular Diseases	Pubmed/Medline Scopus	A1	Q1 2.79
Goethals *et al.* 2020	JMIR Aging	Pubmed/Medline	SQ	-
Zhu W (2020)	Journal of Sport and Health Science	Pubmed/Medline Web Of Science E Scopus	A3	Q1 0.98
Song *et al.* (2020)	Journal of Environmental Research and Public Health	Pubmed/Medline Scopus	A2	Q2 0.82
Cheval *et al.* (2020)	Sport aRxiv	Preprint	SQ	-
Ferreira *et al.* (2020)	Arquivos Brasileiros de Cardiologia	Preprint	B1	Q3 0.41
Frühauf *et al.* (2020)	Current Issues in Sport Science	Preprint	SQ	-
Raiol (2020)	Brazilian Journal of health Review	Preprint	B3	-
Oliveira Neto *et al.* (2020)	Revista Brasileira de Fisiologia do Exercício	Preprint	A3	-
Rodríguez *et al.* (2020)	Revista Espanola De Cardiologia.	Preprint	A4	Q2 0.58
Hammami *et al.*, (2020)	Managing Sport and Leisure	Web of Science SCOPUS	SQ	Q3 0.29
Fallon *et al.* (2020)	Australian Journal of General Practice / Australian Family Physician	Pubmed/Medline Scopus	SQ	Q2 0.32

Chart 2 - Continuation

Author/ year of publication	Journal	Databank	Qualis	SJR
Rahmati-Ahmadabad; Hosseini (2020)	Obesity Medicine	Pubmed/Medline	B1	Q3 0.22
Zbinden-Foncea *et al.* (2020)	Obesity	Pubmed/Medline	A2	Q1 2.12
Simpson & Katisanis (2020)	Brain, Behavior, and Immunity	Scopus	A1	Q1 2.66
Halabchi *et al.* (2020)	Asian Journal of Sports Medicine	Preprint	A4	Q3 0.43
Shirvani e Rostamkhani (2020)	Journal of Military Medicine	Preprint	SQ	Q4 0.19
Chen [b] *et al.* (2020)	Journal of Sport and Health Science	PUBMED/MEDLINE SCOPUS	A3	Q1 0.98

* Preprint: study hand selected (Preprint means pre-publication: a scientific study that has not yet been published). SQ: Without QUALIS; Source: Author, 2020

Table II shows that the journals that published articles on the topic are dispersed. Two journals (Progress in Cardiovascular Diseases and Journal of Sport and Health Science) published 03 articles each, making 26.6% of the total articles selected. Of these journals, 47.83% are indexed in Pubmed/Medline and 43% in Scopus and, it is noteworthy that some journals are indexed in more than one database.

Taking into account Qualis Capes (Brazilian journal evaluation system) and SJR (a measure of the scientific influence of academic journals that accounts for the number of citations received by a journal and the importance or prestige of the cited journals), we found that 52.2% were classified as Qualis A and, 8 journals, 34.8%, were classified and qualified as Q1 by SJR.

After analyzing the results, four thematic categories emerged, which were characterized below and presented according to their scientific evidence on physical activity and COVID-19 in Table III:

a) Effects of physical exercise on viral respiratory infections;
b) Impact of COVID-19 related to physical inactivity, physical and mental health;
c) Recommendations on regular physical activity during the COVID-19 pandemic;
d) Recommendations on post-COVID-19 physical activity.

Chart 3 - Systematization of the main evidence on physical activity related to COVID-19

Author	Study type	Objective	Evidence
Halabchi *et al.* 2020 [1]	Information Article	Check in the field of sports and exercise medicine whether PA is appropriate during the outbreak of COVID-19.	Low to moderate intensity exercise is recommended for healthy or asymptomatic people. For people with upper respiratory tract infection (IRS) with symptoms limited to the neck, a 10-minute running test is suggested to assess the general condition and, if signs are deteriorated, physical activity should be prohibited until full recovery. For people with IRS (symptoms below the neck) PA should be banned until full recovery.
Laddu *et al.* 2020 [19]	Comment	Strengthen the benefits of regular PA in improving immune function and reducing the risk, duration or severity of infections.	Evidence suggests the regular PA (~ 150 min per week) of moderate intensity for optimal immune support. However, even acute sessions of PA showed protection against viral infections, supporting the idea that just moving more in the form of structured activity every day can be an important strategy to optimize immunity and prevent or mitigate the severity of the infection..
Shirvani e Rostamkhani 2020 [30]	Narrative Review	Analyze the main considerations about PA during the COVID-19 outbreak.	Healthy or asymptomatic individuals may exercise moderately. People with mild symptoms of the upper respiratory tract may perform PA slightly with caution. Suspected symptoms of Covid-19 (eg, fever, severe sore throat, body aches, shortness of breath, general fatigue, chest cough) should avoid exercise.
Simpson & Katisanis 2020 [23]	Point of view	Inform about the need to maintain the recommended exercise levels during the COVID-19 pandemic to improve immune function.	It has been found that high levels of cardiorespiratory fitness and exercising with moderate to vigorous intensity can improve immunological responses to vaccination, reduce chronic low-grade inflammation and improve various immunological markers.
Zhu 2020 [31]	Interview	Should you exercise during the coronavirus outbreak, and if so, how?	Dr Woods says it is safe to exercise during the coronavirus outbreak. However, if the person is sedentary, they should not overdo the exercises and those who have already been infected with COVID-19 can exercise moderately, as long as the symptoms of the upper respiratory tract are mild.
Song *et al.* 2020 [14]	Review	Summarize the current literature on the effects of PA on influenza or pneumonia and determine the most appropriate form of PA in the elderly.	Literature review demonstrated that moderate long-term aerobic exercise can help to reduce the risk of influenza-related infection, improve immune responses and vaccination against pneumonia in the elderly. In addition, traditional Asian martial arts can also contribute to some related benefits.

Chart 3 - Continuation

Author	Study type	Objective	Evidence
Hammami *et al.*, 2020 [32]	Comment	Provide useful information on home PA for sedentary people, including children and adolescents during the current pandemic or other outbreaks of infectious diseases.	Following the recommendations of the WHO, children and young people (5 to 17 years) should perform 60 min / week of daily PA with aerobic exercises of moderate to vigorous intensity in addition to muscle and bone strengthening three times a week. For adults and the elderly, daily PA for 75 min / week is recommended with aerobic exercises of vigorous intensity or 150 min / week of moderate intensity, with muscle strengthening twice a week.
Jakobsson *et al.* 2020 [33]	Opinion article	Provide recommendations for maintaining and performing PA as a means of preventing the decline in metabolic and immunological functions during COVID-19	For additional health benefits, 300 minutes of moderate PA or 150 minutes of vigorous intensity per week is recommended. A combination of muscle strengthening exercises, walking, climbing stairs and performing household chores is also recommended to maintain PA during the coronavirus crisis. In the case of exercising outdoors you should keep your distance from other people. Intense exercise for an extended period should be avoided.
Raiol 2020 [25]	Review	Clarify the effects of physical exercise during COVID-19 related to immunity, disease control, functional capacity and mental health.	During Social Distancing, physical exercises should be performed at home or outdoors, avoiding crowds. It is recommended 5 to 7 days a week with adjustments in the volume and intensity of the training. Resistance exercises must be inserted at least 2 to 3 days a week. The intensity should be moderate in order to maximize the positive effects on the immune system.
Hall *et al.* 2020 [34]	Comment	Report the impact of coronavirus in relation to people's physical inactivity and sedentary behavior.	The intersection between the current risks of health complications and the mortality rates associated with COVID-19 and the current state of physical inactivity and sedentary behavior cannot be ignored. We must take this opportunity as valuable lessons from this outbreak and improve human's health outcomes and resilience during future pandemics.
Zbinden-Foncea *et al.* 2020 [6]	Review	Verify whether the high cardiorespiratory fitness provides some protection against pro-inflammatory responses after infection by SARS - CoV - 2	Given the positive effects of moderate doses of exercise on selected immune markers associated with many disease states, it is suggested that physical training and high levels of cardiorespiratory fitness are likely to be immunoprotective in patients infected with SARS-CoV-2..

Chart 3 - Continuation

Author	Study type	Objective	Evidence
Goethals *et al.* 2020 [35]	Qualitative research	Assess the impact of the quarantine period on the organizations of the PA program and on the physical and mental health of French elderly people.	This study suggests that COVID-19 affected, before quarantine measures, the number of PA programs in groups of elderly people. A national policy to support elderly adults for PA at home seems essential to help them integrate simple and safe ways to stay physically active at home. Before the quarantine measures, COVID-19 affected the number of elderly people attending PA programs. This was mainly due to the fear of meeting potentially infected people.
Jiménez--Pavón *et al.* 2020 [13]	Special comment	Suggest PA as therapy to fight the physical and mental effects of COVID-19 with focus on the elderly.	Physical exercise becomes essential for the elderly during quarantine, because it maintains the physiological function and reserve of most organic systems, contributing to the fight against the physical and mental consequences and the severity of COVID-19.
Chen *et al.* 2020 [26]	Opinion article	Guidance on the need for regular PA and caution during the COVID-19 crisis.	Regular PA at home is an important strategy for healthy living during COVID-19. At least 30 minutes of moderate PA should be performed every day and/or at least 20 minutes of vigorous PA every two days. A combination of both intensities is recommended in addition to muscle strengthening regularly.
Pitanga *et al.* 2020 [37]	Point of view	Highlight the importance and propose suggestions for continuing PA and reducing sedentary behavior during the pandemic of the new coronavirus in Brazil.	Evidence based on the literature confirms the importance of engaging in PA during COVID-19, with mild to moderate intensity/duration, preferably in an open environment, or even indoors. Furthermore to emphasize the need to reduce the time spent sitting, lying down or reclining in front of the television, computer and the like, with the exception of hours of sleep, thus reducing sedentary behavior.
Cheval *et al.* 2020 [38]	Longitudinal Study	Assess whether changes in PA and sedentary behaviors during COVID-19 quarantine are associated with changes in mental and physical health.	Differences in PA and sedentary behaviors were assessed before and during the quarentine. Changes in PA and sedentary behaviors during confinement are associated with changes in physical and mental health. Ensuring sufficient levels of PA and reducing sedentary time during confinement can benefit individuals' health

Chart 3 - Continuation

Author	Study type	Objective	Evidence
Oliveira Neto *et al.* 2020 [39]	Opinion article	Propose to integrate physiological and psychobiological aspects of how physical exercise can be prescribed at home in the face of social isolation worldwide.	Considering the physiological aspects, a prescription model that encourages the performance of at least 150 minutes of moderate intensity aerobic exercise and considers the possibility of performing strength exercises for the main muscle groups. Behavioral and motivational aspects should be considered alongside the physiological variables as one of the major challenges, given the need to conduct training with little or no face-to-face supervision, which can increase behavioral difficulties (for example, habit) to practice physical exercises.
Fallon *et al.* 2020 [18]	Editorial	Present varied and adapted forms for physical exercise at home during the COVID-19 pandemic.	Aerobic exercise can be done using stairs and inclines; running on the spot; home exercise bikes, treadmills and running machines; or laps from the backyard pool. Strengthening activities can be performed through exercises against body weight, such as squats, push-ups, abdominals and calf raises at the edge of a stair or incline.
Ferreira *et al.* 2020 [11]	Editorial	Encourage the maintenance of a physically active routine by the population as a preventive measure for health and coping with COVID-19	Behaviors and attitudes that will help in maintaining a physically active life, physical and mental health are recommended to the population: performing physical activities that are pleasurable; perform activities of daily living such as cleaning, maintenance and organization of domestic spaces; playing and exercising with children, adolescents and pets; avoid sedentary behavior, reduce the time spent using electronic devices, and set aside a few minutes for stretching, relaxation and meditation.
Rodríguez *et al.* 2020 [15]	Editorial	Reinforce the need for a new strategy to achieve a healthy level of physical exercise during COVID-19.	The authors recommend moderate forms of exercise, such as low to moderate resistance sports (running, Nordic walking and fast walking in parks, trails and forest roads with flat terrain and affordable). Muscle strengthening activities and other types of physical activity that can be done at home or outdoors, at a safe distance from others.
Rahmati-Ahmadabad & Hosseini 2020 [40]	Mini Review	Sugere uma abordagem conservadora sobre o uso de exercícios de alta intensidade sobre fatores inflamatórios e imunológicos.	Com base em evidências indiretas, o exercício físico de alta intensidade pode ser prejudicial (especialmente em pessoas obesas) e agravar o vírus COVID-19. No entanto, o exercício de intensidade moderada deve ser recomendado como uma maneira não farmacológica, barata e viável de lidar com o vírus COVID-19.

Chart 3 - Continuation

Author	Study type	Objective	Evidence
Frühauf *et al.* 2020 [8]	Editorial	Present scientifically-based interdisciplinary recommendations for exercising during COVID-19	The authors recommend moderate forms of exercise, such as low to moderate resistance sports (running, Nordic walking and fast walking in parks, trails and forest roads with flat terrain and affordable). Muscle strengthening activities and other types of physical activity that can be done at home or outdoors, at a safe distance from others.
Chen *et al.* 2020 [41]	Opinion article	Present actions and precautions for the return of Chinese school-age children and adolescents to physical activity after COVID-19..	With the return to school activities there is a need for public health to ensure that all Chinese children and youth effectively overcome the imposed restrictions that limited exercise, participating in the recommended levels of PA during the school day. This resumption of regular exercise can help students recover from the stress and anxiety they experienced while in quarantine.

Source: Author, 2020

Discussion

Effects of physical activity on viral respiratory infections

The main question in sports and exercise medicine is whether physical activity is appropriate during the viral respiratory tract epidemic or not [1]. Studies have indicated that exercise performed at moderate intensity has positive effects on the immune system's responses to viral respiratory infections [17,19,23,30,41-43] and is associated with several anti-influenza benefits, including reduced risk influenza and the increase in vaccine efficacy rates [21,23,30,31].

After moderate intensity physical activity, an increase in the count of neutrophil and natural killer cells (NK) is detected, and an increase in the salivary concentrations of IgA [42,43]. Moderate physical activity increases stress hormones and, thus, reduce excessive inflammation [43] and lead to increased immunity against viral infections by altering the responses of Th1/Th2 cells [42].

To study this situation more deeply, Song *et al.* [14] summarized the current literature on the effects of exercise on influenza or pneumonia in the elderly to determine the appropriate exercise that contributes to beneficial clinical outcomes for this population. The results confirmed that aerobic exercise with moderate intensity can help to reduce the risk of influenza-related infection, improve immune responses to influenza and pneumonia vaccine in the elderly. Even traditional Asian martial arts can also contribute to some related benefits.

Impact of COVID-19 on physical inactivity and physical and mental health

The COVID-19 pandemic appears to have a major impact on physical activity behaviors worldwide, forcing people to remain self-isolated in their homes for a period. These acts will negatively affect people's physical activity behaviors [25,32,33].

Currently, the world lives with two concomitant pandemics. Although of a different nature, the physical inactivity pandemic has been present in society for some years and becomes even more worrying, given that COVID-19 is making people move less than before, bringing the risk of worsening the situation with resuming to normality. The interaction between the current risks of health complications and the mortality rates associated with COVID-19 and the current state of physical inactivity and physical inactivity cannot be ignored. Therefore, global society needs to establish great effort to encourage people to engage in physical activity after COVID-19, or at the very least to maintain at the level they had before the pandemic. In this way, they will avoid a possible vicious cycle in which current and high standards of physical inactivity and sedentary behaviors worsen the impact of future pandemics [34].

The impact of a sedentary lifestyle may be less for children and young adults, but much more decisive for at-risk populations, which include older people (± 60 years), presenting obesity, diabetes, hypertension, cardiovascular disease, history of smoking, and chronic obstructive pulmonary disease (COPD) [6].

Because of the higher risk of COVID-19 infection, older people need to stay at home, making physical activities during quarantine crucial to avoid sedentary lifestyle [35]. How will the elderly maintain their independence and mental wellbeing after ending the quarantine if they have no appropriate promotion of physical activity at home?

In this sense, Goethals *et al.* [35] conducted a qualitative study to assess the impact of quarantine on the program of the French Federation of Physical Education and Voluntary Gymnastics and on the physical and mental wellbeing of older adults. They also looked at the alternatives that could be offered to this population to avoid a sedentary lifestyle. The research was carried out using semi-structured interviews with managers of the PA programs for the elderly and sports coaches who supervise these programs. The results of the study suggested that COVID-19 affected the number of PA programs in the elderly groups even before the quarantine measures were implemented. It was found that the elderly expressed the need to exercise at home during quarantine despite the decline in participation in physical activities before isolation measures due to fear of contact with infected people. Therefore, the authors recommend assistance to help the elderly to engage in simple and safe ways to remain physically active during the pandemic and a national policy to support this population to exercise at home [35].

For this population, Jiménez-Pavón *et al.* [13] propose a more precise prescription and recommendation to ensure an appropriate exercise program, which is designed to maintain or improve the main components of health-related physical fitness during COVID-19 through regular participation in moderate-intensity aero-

bic exercise, muscle strengthening, balance, coordination, and stretching activities.

Another risk group, vulnerable to respiratory infection and adverse effects of COVID-19 are obese, overweight, and insulin-resistant people with diabetes. These individuals usually have low-grade chronic inflammation characterized by elevated levels of various pro-inflammatory cytokines. Considering that the COVID-19 progression depends largely on the individual's initial health status and the immune response triggered by the infection, it is suggested that previous physical training and high levels of cardiorespiratory fitness by moderate intensity aerobic training are probably immunoprotective in patients infected with SARS-CoV-2, especially those with these chronic comorbidities [6]. Thus, as exercise of moderate intensity can increase the immune response and reduce the patterns of pro-inflammatory cytokines, it is recommended for this population to carry out moderate regular physical activity in a safe environment combined with an adequate diet to promote beneficial effects on immune function and health maintenance avoiding the complications of COVID-19 [36].

Recommendations on regular physical activity during the COVID-19 pandemic

Due to the global increase in the pandemic, it is essential to follow the measures of infection control and safety. Thus, staying at home is a fundamental safety principle that can limit the spread of infections [26]. However, staying at home for a long time can intensify behaviors that lead to a sedentary lifestyle and contribute to anxiety and depression, which can result in a series of chronic health conditions [26,33]. For this reason, it is important that the population be informed about the need to reduce sedentary behavior during the period of social isolation [37].

In this regard, maintaining regular physical activity and exercising routinely in a safe home environment is an important strategy for a healthy life during the coronavirus pandemic [26]. The same authors, following the guidelines of the US Department of Health and Human Services, recommend at least 30 minutes of moderate physical activity every day and/or at least 20 min of vigorous physical activity every other day, in addition to regular strengthening exercise [26]. It is suggested that children, the elderly, and people who have already had symptoms of coronavirus infection or are susceptible to chronic cardiovascular or pulmonary disease should seek guidance from specialized health professionals on the safety of physical activity [26,31].

Cheval *et al*. [38] found that changes in physical activity and sedentary behaviors during lockdown are associated with changes in physical and mental health. The authors assessed differences in physical activity and sedentary behaviors before and during the lockdown in a total of 267 (1st wave of COVID-19) and 110 participants (2nd wave of COVID-19) who live in France or Switzerland. Based on the results, the authors reinforce that ensuring sufficient levels of physical activity and reducing sedentary time during the lockdown can benefit health of individuals.

It is important to underline the reasons why regular exercise should not be

interrupted during the COVID-19 pandemic. For this purpose, Raiol *et al*. [25] studied the beneficial effects of exercise for people in social distance, addressing aspects of immunity, disease control, functional capacity, and mental health. After analyzing the literature, the authors suggested that, during social distance, physical exercises should be performed at home or in open-air places without crowds. The frequency should be 5-7 days a week for aerobic exercises and, at least, 2-3 days a week for muscle strengthening exercises, both with moderate intensity, in order to maximize the positive effects on the immune system.

Based on proven evidence, Laddu *et al*. [19] extend the benefits of regular physical activity to improving immune function and reducing the risk, duration, or severity of viral infections. Therefore, they recommend the usual practice (~ 150 min per week) of moderate intensity physical exercises to obtain ideal immune support. However, evidence strengthens that even acute PA sessions can protect people from viral infections [45], agreeing with the view that moving daily in a structured manner can optimize immune system functions and prevent or mitigate the severity of infection, especially among vulnerable and immunocompromised populations.

Consistent with available evidence and the similarity of some of the signs and/or symptoms of COVID-19 with the H1N1 virus, moderate exercise may be recommended during the outbreak for healthy or asymptomatic individuals. People with mild symptoms of the upper respiratory tract (eg, runny nose, nasal congestion, mild sore throat) may exercise lightly with precautions [30]. It is worth mentioning that prolonged exercise programs or high intensity training without adequate recovery can cause immunodepression and increase susceptibility to pathogens and infectious diseases [19,23,30,31,41,42,45,46].

Oliveira Neto *et al*. [39] proposed an exercise prescription during the COVID-19 pandemic, integrating the physiological and psychobiological aspects, considering the barriers confronted by the population in the face of social isolation worldwide. They recommend a prescription that encourages at least 150 minutes of aerobic exercise with moderate intensity complemented with strength exercises for the main muscle groups. The authors emphasize the importance of behavioral and motivational aspects alongside physiological variables as one of the major challenges, given the need to train with little or no face-to-face supervision, which can increase behavioral difficulties (for example, habit) to exercise.

In conformity with the WHO recommendations, Jakobsson *et al*. [33] highlight the benefits of PA during the COVID-19 pandemic in the respect that "doing something is better than doing nothing". They also establish the following recommendations: avoid prolonged sitting time; reduce sedentary lifestyle with brief active breaks during the day; accumulate at least 150 minutes of moderate intensity PA or 75 minutes of vigorous intensity per week; use training applications to monitor PA and/or follow online exercise classes to motivate exercise; include cardiovascular and muscle strengthening exercises; always be cautious and aware of your own limitations, and do not exercise with infection symptoms.

Hammami *et al*. [32] present useful information for daily home PA for sedentary people during the pandemic, extending the recommendations to children and adolescents. Children and young people (5 to 17 years old) should perform 60 min/week of daily PA with aerobic exercises of moderate to vigorous intensity in addition to muscle and bone strengthening three times a week. For adults and the elderly (>17 years), they recommend 75 min/week of daily PA with aerobic exercises of vigorous intensity or 150 min/week of moderate aerobic intensity, with muscle and bone strengthening twice a week. They also recommend that people remain active by exercising at home. In this respect, different types of activities can be scheduled, including aerobic exercises using stationary bikes or rowing ergometers, strength training with body weight, exercises based on dance, and active games.

Fallon *et al*. [18] increase the types of exercises to be performed at home during the COVID-19 pandemic. A simple search on the Internet or YouTube will reveal many home programs for dance, aerobics, yoga, Pilates, strength, and stretching exercises. Aerobic exercise can be facilitated by the use of stairs and inclines; running on the spot; home bikes, treadmills; or laps around the backyard pool. The strengthening activity can be performed through bodyweight exercises such as squats, push-ups, abdominal work, and stair or inclination calf raises are also useful. Simple household items such as full water bottles and cans or food packages can be used as overload. However, Simpson and Katisanis [23] maintain that it is probably unnecessary to use specialized technology and equipment to remain physically active during the coronavirus outbreak, since exercising at home or outdoors through fast walks, climbing stairs, working in the yard/house and/or playing active games can be equally effective using online exercise platforms in this period.

To better cope with the social isolation, Ferreira *et al*. [11] proposes to the population some behaviors and attitudes that will help in maintaining an active life and improving physical and mental health: performing pleasurable physical activities, exploring the best available spaces and materials; perform routine activities such as cleaning, maintenance and organization of domestic spaces; playing and exercising with children, adolescents, and pets (so that energy expenditure is higher than in the resting condition); avoid sedentary behavior, alternating sitting or lying down with periods of PA, reducing the time spent using electronic devices [37], and allowing a few minutes for stretching, relaxation, and meditation activities [11].

Due to the increased need for exercise during the quarantine, Jiménez-Pavón *et al*. [13] made a critical analysis of the most appropriate recommendations for exercising, especially for the elderly population and adjusted and increased the international recommendations on PA for the current situation. The authors suggest an increase to 200 to 400 minutes per week, spread over 5 to 7 days to compensate for the decrease in normal daily levels of PA. In addition, a minimum of 2-3 days a week of resistance training may be recommended, in addition to daily stretching routines and balance and coordination exercises at least twice a week, which are distributed among the different training days. Pitanga *et al*. [37] recommend the duration of

approximately 30 to 60 minutes a day for each exercise session. The control of exercise intensity is crucial to avoid harmful effects and promote the improvement of the immune system. For this purpose, during quarantine times, moderate intensity (40 to 60% of heart rate reserve or 65 to 75% of maximum heart rate) should be the best option, especially for the elderly [13].

Rodrígues *et al*. [15] analyzed the recommendations for performing PA in health institutions during the pandemic period, inside and outside Spain. In general, all entities provide the same general recommendations: stay active at home, take short breaks, and avoid a sedentary lifestyle. They also reinforce that, to remain active during lockdown, the population must carry out multifunctional programs for the whole body, which include aerobic exercises, muscle strengthening, balance and stretching, in addition to cognitive tasks that are strongly recommended for the elderly. However, none of the institutions makes specific recommendations about series and repetitions, intensity or frequency, and most recommend the use of online classes or mobile applications [15].

Considering PA outside the home environment, publications based on scientifically sound findings and observing the current rules of social distance recommend the permission of moderate outdoor sports activities (such as running, walking, and cycling) and park trails, hiking trails, and forest roads on easy terrain [8,48]. The results of a recent study on the aerodynamic effects of movement carried out through a computer simulation of fluid dynamics, in the absence of head wind, tail wind, and cross wind, point to the need for additional precautions of social distance for outdoors activities and sports. Distances of 05 meters must be kept when walking fast at 4 km/h and 10 meters when running at 14.4 km/h. In addition, people should avoid walking or running directly behind the main person and keep a distance of 1.5 m in an alternating or side-by-side arrangement [49].

Some indirect evidence shows that moderate PA can be recommended as a non-pharmacological, inexpensive, and feasible way of facing COVID-19 infection. However, high-intensity exercise can be harmful and exacerbate the infection, especially in patients at risk. This is probably due to the oxidant production and the suppression of the immune system. Thus, the recommendation of these exercises needs further investigation [40,47]. The results of a recent systematic review have shown that long, intense exercise can lead to higher levels of inflammatory mediators, which can lead to an increased risk of injury and chronic inflammation. However, moderate or vigorous exercise with appropriate rest periods can be significantly beneficial for improving immune function [47].

According to Zhu [31], it is safe to exercise during the coronavirus outbreak. However, there may be some additional precautions to reduce the risk of transmission. For social exercisers, it is opportune to limit exposure to symptomatic exercise partners and in some cases, it may be appropriate to use a mask during exercise to avoid exposure.

Azizi *et al*. [50] present some recommendations to athletes and non-athletes during the COVID-19 pandemic to maintain good health conditions for a future return to activities: regular physical activity of moderate intensity avoiding extreme physical efforts; aerobic or resistance activities in safe environments, respecting the recommended social distance; disinfection of the training equipment; no physical activity in case of fever or other suggestive symptoms; choose to perform physical activity at home through safe, simple physical exercises that are easy to perform and adapt; avoid drinking alcohol, and maintain quality sleep.

Specifically related to strength and power training, with equipment and load variety, in order to limit access to training sites due to the COVID19 pandemic, Guimarães-Ferreira and Bocalini [51] present practical recommendations for strength training in the home environment during the pandemic to maintain physical fitness and reduce the deleterious effects of detraining. These authors recommend performing exercises using your own body weight, household items and, when accessible, dumbbells, and elastic bands. For low loads (30-50% of 1 maximum repetition), the series should be performed to concentric failure to optimize gains in strength and muscle mass. Exercises should be performed on most days of the week (>5 days/week), in combination with domestic and leisure activities that involve the movement of the whole body. To maintain and/or develop muscle power, ballistic movements should be included with or without external loads.

Recommendations on physical activity after COVID-19

An important situation to be discussed is the maintenance or return to PA during or after an upper respiratory tract infection. Halabchi *et al*. [1] are based on evidence about the neck check rule. If symptoms of upper respiratory tract infection are limited to the neck, including coughing, sneezing, and sore throat, the individual is asked to run for 10 minutes. If the general condition and signs are deteriorated, physical activity should be prohibited until full recovery. If the conditions do not change after 10 minutes of running, the person may return to physical activity of low to moderate intensity (below 80% of VO2 max). However, due to the new COVID-19 characteristics and its negative effect on the immune system and rare cardiac complications, including myocarditis, more caution is required regarding the continuation of exercise in symptomatic patients [1].

Therefore, people who have already been infected with influenza, severe acute respiratory syndrome (SARS), or the current COVID-19 can exercise moderately as long as they have mild symptoms of the upper respiratory tract (for example, runny nose, nasal congestion, mild sore throat). However, physical exercise is not recommended for people with symptoms of severe sore throat, body aches, shortness of breath, general fatigue, chest cough or fever [30]. It is recommended to seek medical attention if you experience these symptoms [31]. In general, recovery from respiratory viral infections takes 2 to 3 weeks, which corresponds to the time for the immune system to generate cytotoxic T cells needed to clear the virus from infected cells. After

this period, when the symptoms disappear, it is safe to start exercising regularly in a progressive manner [31].

With regard to school-age children and adolescents returning to PA after COVID-19, Chen *et al.* [41] point out that with the resumption of school activities, public health need to ensure that all children and youth effectively overcome the imposed restrictions that limited exercise. Children should participate in the recommended levels of PA during the school day, including the time they spend in physical education classes. This return to PA can help students recover from the stress and anxiety they experienced while in quarantine. Thus, restoration of daily physical and sports activities must be progressive, starting with short periods of activities more attractive to children and young people and gradually increasing the number of days and the amount of time for participation, so that eventually it will be enough to meet the guidelines, minimizing the risk of injury after lockdown [41].

There are two limitations in this research. First, the absence of randomized clinical trials and the scarcity of studies with experimental design, with little methodological rigor on the current topic, making it impossible to determine the validity of methods and results. Second, it refers to publications about different populations due to the emergence of the topic under study.

Conclusion

Regarding the effects of exercise on viral respiratory infections, the evidence points to the positive effects of exercising in an appropriate manner with moderate intensity in the responses of the immune system, which may contribute to the reduction of inflammation and the risk of infection.

With respect to the impact of COVID-19 related to physical inactivity, physical health and mental wellbeing, the results show a negative impact of physical inactivity and sedentary lifestyle during and after the pandemic, with a greater effect on populations at risk, especially the elderly.

In relation to the recommendations on regular PA during COVID-19, it is evident that moving daily in a structured way, by exercising, can optimize the functions of the immune system and prevent or mitigate the severity of the infection, especially in the most vulnerable populations. In this sense, most recommendations are for PA of moderate intensity during the period of social isolation. Aerobic exercises 5-7 days a week are suggested, muscle strengthening exercises at least 2-3 days a week, and coordination, balance, and mobility exercises. Prolonged exercise programs or high intensity training without adequate recovery to avoid immunosuppression and greater susceptibility to infections are contraindicated. Physical outdoor activities are recommended if additional precautions for social distance are taken.

The analysis of the evidence in the present study shows a lack of publications that focus on determining the intensity of exercises during the pandemic, as well as specific recommendations on series and repetitions. Caution is required regarding

the return, maintenance, and continuity of PA after COVID-19, mainly due to the negative effect on the immune system and cardiac complications caused by the virus.

Conflict of interest
No conflicts of interest have been reported for this article.

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Authors´s contributions
Conception and design of the research: Nogueira CJ, Cortez AL. **Data collection:** Nogueira CJ, Cortez AL, Leal SMO. **Analysis and interpretation of data:** Nogueira CJ, Cortez AL. **Obtaining financing:** Dantas EHM. **Writing of the manuscript:** Nogueira CJ, Cortez AL, Leal SMO, Dantas EHM. **Critical revision of the manuscript for important intellectual content:** Nogueira CJ, Cortez AL, Leal SMO, Dantas EHM.

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