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Review

Physical exercise and COVID-19 pandemic in PubMed: Two months of dynamics and one year of original scientific production

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ABSTRACT

Our aim was to conduct a narrative review about physical exercise and Corona Virus Disease 2019 (COVID-19). A literature search was completed crossing the keywords "COVID-19" and "physical exercise", for a narrative review, and physical activity (PA), physical exercise, physical training, sport, physical fitness, for a systematic review; search strategy (Randomized Controlled Trial, in the last 1 year, English). The first search date was closed on 04/26/2020 and 06/26/2020. This strategy was chosen to assess the dynamics of scientific information production for the pandemic. In two months, an increase of 76%, from 12 (19.4%) to 50 (80.64%) COVID-19 articles ($n = 62$, 100%) was found. The main types of articles published were editorial articles (16.13%, $n = 10$ of 62 articles) and commentary (9.68%, $n = 6$ of 62 articles). The most frequent country of origin of the scientific production was the United States (12.90%, $n = 8$ of 62 articles), the United Kingdom (12.90%, $n = 8$ of 62 articles), and Brazil (11.29%, $n = 7$ of 62 articles). However, in 2020, there were only 2 relevant randomized controlled trials on the COVID-19 topic in the context of physical exercise. Scientific information production shows the concern of the PA science community to bring a solution to the increase in physical inactivity generated by the COVID-19 pandemic. Our findings show the dynamics of scientific production on the COVID-19, in a situation so unique such as a pandemic, denotes that the practice of PA is essential to improve and/or maintain physical and mental health.

Introduction

Corona Virus Disease 2019 (COVID-19) is an infectious disease caused by "Severe acute respiratory syndrome coronavirus 2".[1] Evidence suggests that the severity of COVID-19 is associated with the health status of individuals prior to infection.[1–3] Factors linked with increased risk of hospitalization and mortality in COVID-19 patients include overweight/obesity, diabetes mellitus and insulin resistance, arterial hypertension and its comorbidities, and coronary heart and cerebrovascular diseases.[2,3] Sedentary behavior, poor dietary habits, and physical inactivity are characterized by chronic and high inflammation.[4,5] Supposedly, these conditions make people more vulnerable to the most serious forms of COVID-19. People with more morbidities and low levels of functional capacity on admission to the hospital; immunosuppression and chronic low-grade inflammation characterized by increased levels of several proinflammatory cytokines, particularly the elderly, tend to have more severe forms of the disease and higher mortality rates.[2–5] It should be noted that moderate levels of physical exercise improve immunity and could provide an immuno-protective effect.[5]

One important point is that during the COVID-19 pandemic, the

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practice of physical exercise could contribute to reduced social and economic concerns and negative health, physical, and mental impacts. However, to decrease the disease dissemination/transmission in many countries,[6,7] it is necessary to keep closed public facilities involving clusters of people such as exercise facilities and gyms. Supposedly, this scenario could worsen the pandemic of physical inactivity and sedentary behaviors as well as mental disorders such as depression and anxiety.

The COVID-19 pandemic has brought forward the importance of healthy living including PA during the period of quarantine, isolation, and social distancing recommended by The World Health Organization (WHO)[1,8] and Centers for Disease Control and Prevention (CDC).[9–11] However, social isolation and quarantine can have a negative impact on physical exercise levels, quality of life, and physical fitness, while increasing psychiatric disorders.[12,13]

The physical exercise is an important tool because it could reduce noncommunicable diseases risk (heart disease, diabetes, and cancer and associated with reducing arterial hypertension, overweight, and obesity) associated with sedentary lifestyle[14,15] during and after social isolation and quarantine.[1,8–11,16] For example, the COVID-19 pandemic is likely to increase screen time and decreased energy expenditure. This type of sedentary behavior is associated with an increase in morbidity and prevalence of noncommunicable diseases.

According to the WHO,[17] regular physical exercise participation is essential for preventing and treating non-communicable diseases which can improve and maintain mental health, quality of life, wellbeing, and improve the quality of the aging process.[14,15,18,19]

However, during the COVID-19 outbreak, the levels of physical exercise around the world have decreased significantly because of social isolation and physical inactivity[6] and consequently increased the risk for mental disorders.[6,7] Thus, maintaining physical exercise levels is an effective way to deal with the negative effects imposed by confinement and strategies created by health professionals to face these situations must be implemented. For example, through education and health promotion campaigns, initiatives to encourage and give access to home-based exercise was programmed. Therefore, physical exercise professionals should use different communication channels including television, social networks and media, and technological resources to bring education for the use of low cost and viable physical exercise programming. the use of education and technological inclusion, in the context of public health associated with the pandemic, is necessary to increase and/or maintain global physical exercise levels during social isolation and confinement.

Finally, the scientific information production concerning COVID-19 vs. physical exercise is moving at a rapid pace, producing interesting public health information. In addition, the dynamics and profile of scientific production are interesting to observe. Thus, the aims of this review are (1) to present main terms and concepts about (and applied in) COVID-19 pandemic and physical exercise; (2) to describe/assess the dynamics of scientific information production concerning physical exercise and COVID-19 in the PubMed database taken during the first two months of the pandemic; and (3) to conduct a review of randomized controlled trial articles for one-year of information production focusing on the year 2020 concerning COVID-19 and PA, physical exercise, physical training, sport, and physical fitness.

Materials and methods

First, a literature search was completed using standard terms and concepts linked and frequently mentioned in the context of the COVID-19 outbreak. The standardization of terms and concepts in scenarios as uncertain and confusing as the one we are experiencing is essential to assist the scientific community and the public (AIM 1).

Second, a PubMed literature search was completed within 2 months and performed crossing only the words "COVID-19 and physical exercise" terms/descriptors in the PubMed database for two specific dates 04/26/2020 and 06/26/2020 to assess the dynamics of scientific information production (author, type article, country of origin, and main conclusion). Two months of scientific information production was chosen because the movement of the scientific production presented a rapid increase. So, we thought it necessary to close the time of the literature search to meet the purpose of the present study (AIM2).

The focus of this aspect of the literature search was to analyze the scientific information production of one of the most traditional scientific databases which is PubMed (https://pubmed.ncbi.nlm.nih.gov/).

Articles were reviewed by two authors independently and at the same time. After analyzing the article title, which was the titled related to the theme of COVID-19 and physical exercise, the article information content and conclusion were analyzed. Only articles in the English language were considered. The reason for choosing the keywords physical exercise vs. COVID-19 was to focus our attention on one set of crucial keywords when the study propose was to improve physical fitness. That is, the planned and structured physical exercise aimed to improve the state of health and quality of life.

Finally, an one-year's scientific production focusing on randomized controlled trials; on COVID-19 and PA, physical exercise, physical training, sport, physical fitness; in the PubMed database was verified and evaluated (AIM 3). To broaden the vision within the proposed aim, we decided to expand the literature search with respect to the keywords used.

Fig. 1 shows the article selection diagram according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol.[115]

Results

Table 1 presents important terms and concepts (definitions, sources, and references) used extensively during the COVID-19 pandemic and concepts and keywords related to physical exercise (AIM 1). When searching the PubMed database on 04/26/2020, 12 relevant articles concerning COVID-19 and physical exercise were found (Table 2). After two months, the scientific information production increased by 76% from 12 articles on 04/26/2020 to 50 articles on 06/26/2020. Of these articles, the production of original articles on the subject was considered low ($n = 8$, 12.7%). Regarding scientific information production on COVID-19 and physical exercise, progressive and strong growth in the number of citations on the subject existed. This growth denotes a mobilization of the global scientific community for physical exercise in the information production and knowledge to cope with the pandemic (AIM 2).

Of the 62 total articles concerning COVID-19 and physical exercise produced in two months, 12 articles on 04/26/2020 and 50 articles on 06/26/2020, the profile of the published articles were:

Article type: brief report ($n = 1$, 1.61%), clinical practice ($n = 1$, 1.61%), commentary ($n = 6$, 9.68%), communication ($n = 1$, 1.61%), consensus statement ($n = 1$, 1.61%), editorial ($n = 10$, 16.13%), infographic ($n = 3$, 4.84%), letter ($n = 11$, 17.74%), opinion ($n = 5$, 8.06%), original article ($n = 9$, 14.52%), perspective ($n = 1$, 1.61%), rapid report ($n = 1$, 1.61%), review ($n = 6$, 9.68%), short paper ($n = 1$, 1.61%), special article ($n = 1$, 1.61%), spotlight ($n = 2$, 3.23%), thematic section ($n = 1$, 1.61%), and viewpoint ($n = 1$, 1.61%).

Country of origin: Of the 62 articles, according to the affiliation of the first author, the following frequency was observed (countries are in alphabetic order); Australia ($n = 5$, 8.06%), Belgium ($n = 1$, 1.61%), Brazil ($n = 7$, 11.29%), Canada ($n = 2$, 3.23%), Chile ($n = 1$, 1.61%), China ($n = 6$, 9.68%), France ($n = 1$, 1.61%), Greece ($n = 1$, 1.61%), Germany ($n = 1$, 1.61%), Iran ($n = 2$, 3.23%), Italy ($n = 6$, 9.68%), Japan ($n = 1$, 1.61%), Norway ($n = 1$, 1.61%), Portugal ($n = 1$, 1.61%), Saudi Arabia ($n = 1$, 1.61%), Singapore ($n = 1$, 1.61%), South Africa ($n = 2$, 3.23%), South Korea ($n = 1$, 1.61%), Spain ($n = 3$, 4.84%), Switzerland ($n = 1$, 1.61%), The Netherlands ($n = 1$, 1.61%), United Kingdom ($n = 8$, 12.90%), and United States ($n = 8$, 12.90%). The results in Tables 2 and 3 present information (author, country, article type, and main conclusion)

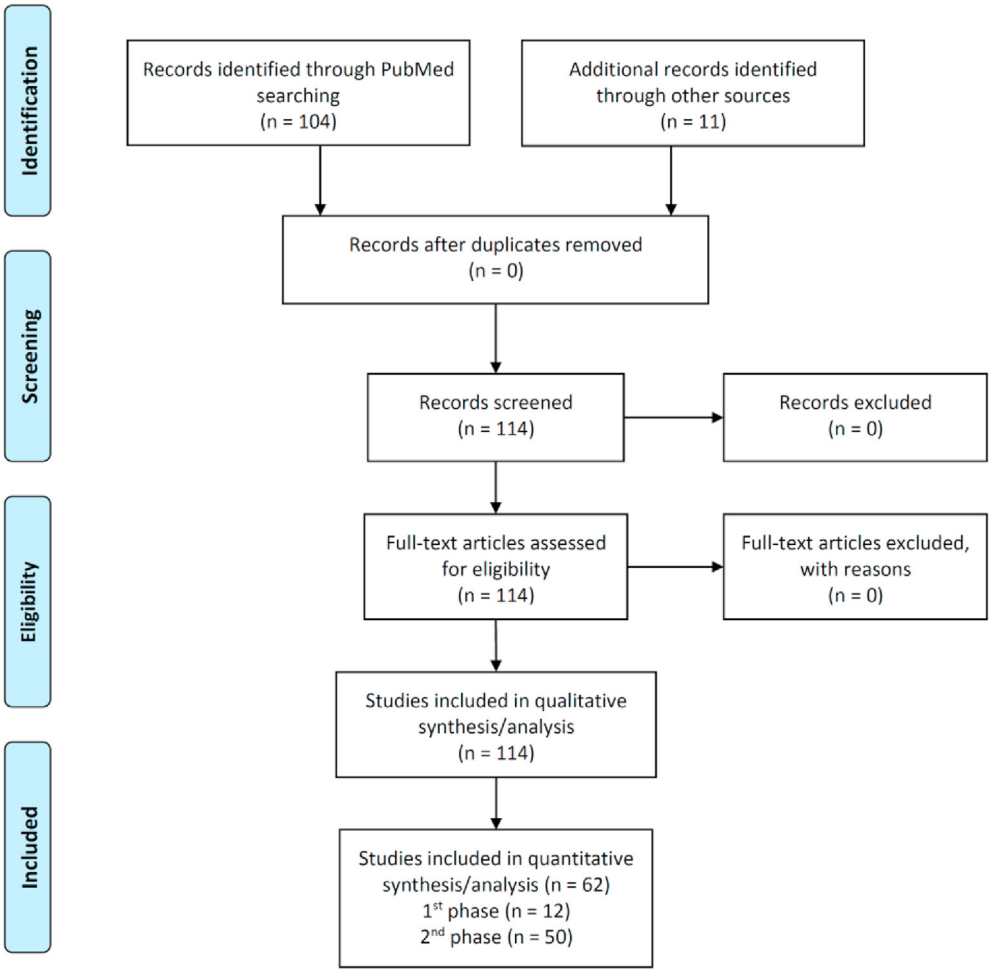

Fig. 1. Article selection - Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol.[115] Other sources refer to material relevant to the context of the pandemic and physical exercise.

of relevant articles published in the PubMed database in the break of 04/26/2020 to 06/26/2020, respectively (AIM 2).

Regarding AIM 3, assessing systematically the scientific information production of randomized clinical trials in 2020 in English only, on COVID-19 vs. PA, physical exercise, physical training, sport, and physical fitness found in the PubMed Database on 06/12/2020. This assessment observed using the crossing (AND) of the subject descriptors PA and COVID-19. The search found throughout the PubMed database, without a search filter, 1,187 articles. When filters were applied - *Randomized Controlled Trial, in the last 1 year, English* - six articles were found. Of these six articles, only two articles were related to the aims of the present work. The article by Liu et al.,[95] which investigated the effects of 6-week respiratory rehabilitation training on respiratory function, quality of life, mobility, and psychological function in elderly patients with COVID-19, and the article by Shaw et al.[96] assessed whether wearing face masks helped prevent developing COVID-19. With the same search strategy in the crossing (AND) of the subject descriptors (physical exercise and COVID-19), without a search filter, 862 articles were found. When the previous research strategy was used (*Randomized Controlled Trial, in the last 1 year, English*) five articles were found. Of these five articles, when analyzing the title, only two articles - Liu et al.[95] and Shaw et al.[96] - were related to the objectives of the present work. With the same strategy based on crossing (AND) the subject descriptors (physical training and COVID-19), without a search filter, 843 articles were found. When this search strategy was entered, six articles were found. Of these six articles, when analyzing the title, only one article was related to the objectives of the present work.[95] For the same search strategy using the terms sport AND COVID-19, without a search filter, 791 articles were found. When filters were added, only one article [95] was found. Finally, when the terms physical fitness AND COVID-19 without a search filter were crossed, 78 articles were found. However, with a search filter, no results were found.

Discussion

The COVID-19 pandemic has forced the sport and physical exercise science community to provide information and promoting/educating about the practice of safe physical exercise. The main aim of this review was 1) to define the main concepts related to COVID-19 and physical exercise, to better understand and interpret the results of studies (Table 1) and; 2) to evaluate the two-month effect of the pandemic on the scientific information production concerning COVID-19 and PA (Tables 2 and 3). Table 4 presents the main applications of the most discussed concepts on physical exercise vs. COVID-19 during the pandemic regarding scientific information production linked to the PubMed database.

Regarding the main concepts and their respective definitions (Table 1), when analyzing the articles, the following terms: PA, physical exercise, physical fitness, home-based exercise, physical inactivity, pandemic, COVID-19, quarantine, isolation, social distancing, and immune system were highlighted. The main conclusion gained from this analysis is that physical inactivity increases during periods of pandemic and social isolation.[43,102] However, maintaining social distance[105] as well as seeking alternatives for physical exercise, outdoors and at home, and maintaining social distance, decreases the possibility of disease

Table 1
Standardization of terms and concepts in the context of the COVID-19 pandemic (AIM 1).

TERM/ EXPRESSION	DEFINITION/CONTEXTUALIZATION	REFERENCE
Physical activity	"Any body movement generated by the contraction of skeletal muscles that raises energy expenditure. It is characterized by its modality, frequency, intensity, duration, and context of practice. The energy expenditure can be measured in kilocalories. Physical activity in daily life can be categorized into occupational, sports, conditioning, household, or other activities".	Caspersen et al. [20]
Physical exercise	"Subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate aim the improvement or maintenance of physical fitness".	Caspersen et al. [20]
Physical fitness	"It is defined as a set of attributes that people have or achieve that relates to the ability to perform physical activity. It is also characterized by (1) an ability to perform daily activities with vigor, and (2) a demonstration of traits and capacities that are associated with a low risk of premature development of hypokinetic diseases (e.g., those associated with physical inactivity). The degree to which people have these attributes can be measured with specific tests".	Caspersen et al. and Wilder et al. [20,21]
Sport	"Sport is part of the physical activity spectrum and corresponds to any institutionalized and organized practice, reined over specific rules".	Thivel et al. [22]
Home-based exercise	"This type of exercise intervention may have advantages over facility-based exercise as a result of the relative ease of integration into routine practice, lessened requirement for programmatic overhead, and because it alleviates common barriers to routine participation that is, access, transportation, and cost. It is prescribed by a qualified exercise professional to be performed independently. Participants may be supported with a training log, manual, APP, and/or equipment, such as resistance bands or a stability ball. The settings in which a participant exercises are quite diverse, including at-home, independently at a local and home indoor fitness facilities. Furthermore, if the exercise is performed at home, space, furniture configuration, available resources (condominium fitness facility, additional exercise equipment, and coin-habitants may differ greatly between individual homes and influence one's ability to perform the prescribed exercises".	Lopez et al. and Tremblay et al. [23,24]
Physical inactivity	"Represents the non-achievement of physical exercise guidelines. An insufficient physical exercise level to meet present physical exercise recommendations".	Thivel et al. and Tremblay et al. [22,23]
Sedentarism	"Low levels of self-efficacy for participation in physical activity. For definition, it is necessary to evaluate the following domains: total energy expenditure, self-reported subjective perception of levels of inactivity/physical activity, quantify levels of inactivity/ physical activity, measurement of the levels of leisure time activities/vigorous exercise".	Ricciardi [25]
		Tremblay et al. [23]
Sedentary behaviors	"Any waking behaviors characterized by an energy expenditure ≤1.5 metabolic equivalents (METs. Refers to activities that do not increase energy expenditure substantially above the resting level and includes activities such as sleeping, sitting, lying down, and watching television, and other forms of screen-based entertainment".	
Pandemic	"Defined as an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people. Seasonal epidemics are not considered pandemics".	Kelly [26]
COVID-19	"Corona Virus Disease 2019 is a respiratory illness. Initially, mostly cause a common cold and flu (involving symptoms such as fever, muscle pain, nasal congestion, headache, malaise, dry cough, expectoration, and dyspnea). In the most serious cases evolves a severe pneumonia and with a bronchiolitis and may be associated with severe acute respiratory syndrome infection (SARS)".	Cascella et al. [27]
Quarantine	"Refers to the restriction of movement or separation of persons who have been exposed to a contagious disease, before it is known whether they will become ill. It usually takes place in the home and may be applied at the individual level or to a group or community of exposed persons".	Cetron et al. [28]
Social isolation	"Refers to the separation and restricted movement of ill persons who have a contagious disease in order to prevent its transmission to others. It typically occurs in a hospital setting, but can be done at home or in a special facility. Usually individuals are isolated, but the practice may be applied in larger groups".	Cetron et al. [28]
Social distancing	"Also called "physical distancing," means keeping space between yourself and other people outside of your home. To practice social or physical distancing: Stay at least 6 feet (about 2 arms' length) from other people. Do not gather in groups. Stay out of crowded places and avoid mass gatherings. In addition to everyday steps to prevent COVID-19, keeping space between you and others is one of the best tools we have to avoid being exposed to this virus and slowing its spread locally and across the country and world".	CDC [9]
Lockdown	"The meaning is confinement. Like a prisoner. It would be a measure of aggressive social isolation. It is a prison protocol that usually prevents people from leaving an area or building. The protocol can usually only be initiated by someone in a position of authority. A temporary condition imposed by governmental authorities (as during the outbreak of an epidemic disease) in which people are required to stay in their homes and refrain from or limit activities outside the home involving public contact (such as dining out or attending large gatherings)".	Diversified. By the authors.
Immune system	"A collection of cells, chemicals and processes that function to protect the skin, respiratory and gastrointestinal systems and other areas from foreign antigens, such as microbes (bacteria, fungi, and parasites), cancer cells, toxins, and viruses".	Marshall et al. [29]
		Marshall et al. [29]

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Table 1 (*continued*)

TERM/ EXPRESSION	DEFINITION/CONTEXTUALIZATION	REFERENCE
Innate immunity	"Represents the first line of defense to an intruding pathogen. It is an antigen-independent (non-specific) defense mechanism that is used by the host immediately or within hours of encountering an antigen. The innate immune response has no immunologic memory and, therefore, it is unable to recognize or "memorize" the same pathogen should the body be exposed to it in the future".	
Adaptive immunity	"It is antigen-dependent and antigen-specific and, therefore, involves a lag time between exposure to the antigen and maximal response. The hallmark of adaptive immunity is the capacity for memory which enables the host to mount a more rapid and efficient immune response upon subsequent exposure to the antigen".	Marshall et al. [29]
Viruses	"A small obligate intracellular parasite, which by definition contain either ribonucleic acid (RNA) or deoxyribonucleic acid (DNA) genome surrounded by a protective, virus-coded protein coat. Viruses may be viewed as mobile genetic elements, most probably of cellular origin and characterized by a long co-evolution of virus and host. For propagation viruses depend on specialized host cells supplying the complex metabolic and biosynthetic machinery of eukaryotic or prokaryotic cells. A complete virus particle is called a virion. The main function of the virion is to deliver its DNA or RNA genome into the host cell so that the genome can be expressed (transcribed and translated) by the host cell".	Gelderblom [30]
Vaccine	"Agents that elicit an immune response to a specific antigen derived from an infectious disease-causing pathogen".	Czochor and Turchick [31]

infection while improving health status.[98,106]

When the two-month impact of the COVID-19 pandemic on scientific information production was assessed, the article production increased by 76% from 12 articles published on 04/26/2020 to 50 articles published on 06/26/2020. The main form of scientific information production were letters ($n = 11$, 18%) and editorial ($n = 10$, 16%). However, in the first literature search carried out on 04/26/2020, no original research publication was found. The lack of an original research article was expected, because the pandemic is new, and the scientific laboratories are closed due to the pandemic. Therefore, conducting original research aiming to investigate COVID-19 and physical exercise is not possible. In the second literature search completed on 06/26/2020, 15% ($n = 9$), 62 original articles for the two months period were found. Regarding the country with the most original scientific research and information production, United States (13%), United Kingdom (13%), Brazil (11%), China (10%), Italy (9%), and Australia (8%) were the most frequent.

These results denote a progressive and strong growth in the literature concerning COVID-19 and physical exercise. This growth reflects the global scientific community's ability to mobilize quickly to better understand the importance of physical exercise and to increase information and knowledge for coping with the pandemic. Moreover, the country distribution of the scientific information production of articles concerning COVID-19 and physical exercise reflects the epicenters of the pandemic around the world. The ability to observe the distribution of the number of confirmed worldwide COVID-19 cases as compiled by the WHO are, approximately when the article was finalized (06/20)/

Table 2
Papers found in the PubMed database about COVID-19 and Physical exercise. The research in database was performed on 04/26/2020 (AIM 2).

N.	Author	Main Conclusion(s)
1	Li[32]	Physical rehabilitation could have a beneficial effect on the acute stage of the disease, especially on recovery, including improved respiratory function, resistance to physical exercise and performance in activities of daily living.
2	Ahmed[33]	Maintaining physical exercise levels during the COVID-19 pandemic can have significant health benefits. In this context, maximum oxygen consumption could be used as part of screening criteria and help to stratify patient risk.
3	Chen et al.[34]	COVID-19 continues to spread globally, it is imperative that administrators, health and education managers, teachers and parents as well as school institutions remain vigilant to infection prevention and control measures, as students return to normal life as well such as sports and daily physical activities.
4	Zbinden-Foncea et al.[5]	The severity of COVID-19 symptoms is associated with the individuals' initial health status. Among the factors linked to the increased risk of hospitalization and mortality are overweight and obesity, resistance to the action of insulin and diabetes. Moderate doses of physical exercise improved immunity. High levels of cardiorespiratory fitness are likely to promote immunoprotecting patients who contract "Severe acute respiratory syndrome coronavirus 2".
5	Fallon[35]	The practice of physical exercise could reduce the risk of contracting the COVID-19 and mitigate the negative mental and physical effects of quarantine. The home-based physcial exercise is a good option. The practice of aerobic exercise can be performed with the use of stairs; running in place; stationary bikes, and treadmills or even running in the backyard. Household items, such as full water bottles and food packages, can be useful as weights to maintain and work muscle endurance. Exercises that involve supporting body weight such as squats, push-ups, sit-ups are also useful. However, the introduction and gradual progression of the activity is important.
6	Ceravolo et al.[36]	The COVID-19 pandemic challenged health care providers for the frail elderly. The main tips for this population are: 1) rehabilitation for inpatients with COVID-19; 2) people with restricted mobility due to quarantine should receive physical exercise programs to reduce and alleviate frailty, sarcopenia, cognitive decline, and depression; and 3) telerehabilitation can be a good option.
7	Mann et al.[37]	Elite athletes are setting a positive example that distance and social interconnection for a worthy cause are important for everyone's safety. It is necessary to look carefully at this very specific and special audience to provide health protection when the mega sporting events return. Despite this, it is necessary to understand why many athletes and members of the technical team have contracted the disease around the world.
8	Laddu et al.[38]	A structured program of physical exercise can be a useful strategy to optimize the functional integrity of the immune system and prevent or mitigate the severity of COVID-19 infection, especially among risky and immunocompromised populations.
9	Hall et al.[39]	COVID-19 and physical inactivity are both pandemics. In this context, aggressive efforts by public health authorities and civil society need to be taken so that people do the least amount of physical exercise to stay healthy during and after the COVID-19 pandemic.
10	Hull et al.[40]	Robust data needs to be collected on how COVID-19 affects elite athletes. This could help to understand how the level of general physical fitness interacts with the susceptibility, behavior and prognosis of COVID-19.
11	Jiménez-Pavón et al.[41]	Maintaining an active lifestyle during quarantine is very important for the health state. Especially for those with morbidities and elderly. Physical exercise is essential for the elderly during quarantine to maintain the physiological function and fight the negative mental and physical consequences and the severity of COVID-19. The main elements to be considered to design an exercise program suitable for quarantined elderly people are the modality, frequency, volume and intensity of exercise.

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Table 2 (*continued*)

N.	Author	Main Conclusion(s)
12	Chen et al.[42]	Prolonged stay at home can increase sedentary behavior and physical inactivity. This can contribute for anxiety and depression. Maintaining routine physical exercise at home is an important strategy for healthy living during the COVID-19 pandemic.

currently (03/24/21) – total deaths (world – 2,719,163): Americas (4,816,79/54,249,753 – 1,306,186), Europe (2,638,903/42,870,334 – 935,703), Eastern Mediterranean (1,006,279/7,199,413 – 154.365), South-East Asia (710,455/14,287,370 – 215,530), Africa (268,102/3,013,815 – 76,413), and Western Pacific (211,774/1,797,635 – 30,953).[92]

Regard scientific information production highlighted below is a discussion to assist in the understanding of conclusions concerning COVID-19 and the practice of physical exercise. Middleton et al.[46] concluded that the implementation and delivery of telehealth exercise programs for older adults with functional impairments during periods of social distancing and quarantine are feasible. Phillipou et al.[48] reported low levels of physical exercise during the COVID-19 pandemic in Australian people and concluded that mental and physical health impacts of changed eating and exercise behaviors in the general population need monitoring for potential long-term consequences. Lesser and Nienhuis[49] showed that Canadian physically inactive people who spent more time engaged in the outdoor physical exercise had lower anxiety than those who spent less time in outdoor physical exercise. Health strategies were concluded to combat physical inactivity and are essential for improving well-being. Ammar et al.[51] showed that COVID-19 home confinement had a negative effect on all physical exercise intensity levels. Daily sitting time increased from 5 to 8 h/day. Zhang et al.[16] concluded that the severity of the COVID-19 pandemic indirectly affected emotions by negatively affecting sleep quality. A possible strategy for improving mental health includes performing daily physical exercise and proper sleep. Goethals et al.[52] verified that the COVID-19 pandemic affected before quarantine measures, the number of seniors attending group physical exercise programs. Communication was deemed an important necessity for older adults to maintain physical exercise at home. Tornese et al.[56] reported that glycemic control of type 1 diabetes mellitus in 13 adolescents using a hybrid closed loop system did not worsen during the restrictions imposed by the COVID-19 pandemic and found further improved glycemic control in individual who continued physical exercise during quarantine. Constandt et al.[59] showed that Belgium individuals who were highly physically active before COVID-19, were 55 years and older, having low education levels, were physically active with friends or in a sports club, and who were not using online tools to exercise, self-reported exercising less during the lockdown. Public health authorities should consider how to encourage individuals to become physical exercise during a lockdown. Pillay et al.[61] showed that 56% of South African elite and semi-elite athletes ($n = 692$, 67% males) expected to return to sport (training and competitions), in the course of the COVID-19 pandemic, after 1–6 months. Sixty-one percent trained alone, daily (61%) at moderate intensity (58%), and for 30–60 min (72%). During leisure time, athletes preferred sedentary above physical active behavior. Fifty-two percent of the athletes felt depressed and 55% required motivation to keep physically active. Guerrero et al.[68] examined physical exercise profile from Canadian children (5–11 years old) or youth (12–17 years old). Characteristics associated with non-adherence to physical exercise recommendation(s) included the low parental perceived capability to restrict screen time and capability to support children's sleep and decreases in children's and youth's outdoor physical exercise/sport and increases in sleep duration since the COVID-19 outbreak began. Antunes et al.[74] using a cross-sectional design assessed the lifestyle habits and mood state disorders in Portuguese adults during the COVID-19 pandemic. Strategies for promoting well-being during

Table 3
Papers found in the PubMed database about COVID-19 and Physical exercise from 04/26/2020 to 06/26/2020 (AIM 2).

N.	Author	Main Conclusions
1	Peçanha et al.[43]	Impact of physical inactivity on cardiovascular diseases and interventions based on scientific evidence to combat it are essential amid the COVID-19 pandemic.
2	Rahmati-Ahmadabad et al.[44]	High-intensity physical exercise can cause immunosuppression and help exacerbate the damaging effects of COVID-19. COVID-19 can be asymptomatic for several days. However, moderate intensity physical exercise can be a non-pharmacological, low-cost and viable alternative to deal with COVID-19.
3	Yeo[45]	Education and expert guidance are needed for the safety of everyone involved in recreational and competitive sports in the course of the COVID-19 pandemic. Collaboration between international sports entities is vital to facilitate global consensus on best practices and recommendations for health and safety in the practice of sport
4	Middleton et al.[46]	Physical therapy professional can help people at risk of functional decline during periods of social withdrawal and quarantine. This includes elderly people with low functional capacity. In this context, the so-called telehealth has gained a prominent role in responding to the pandemic.
5	Burtscher et al.[47]	The uncertainty of the duration of the confinement, on account of COVID-19, increases the need for public health campaigns to improve physical and mental health in order to improve the quality of life of the populations. Recommendations for physical exercise adapted to isolation conditions for risk groups with morbidities and the elderly are essential.
6	Phillipou et al.[48]	There are negative psychological and health consequences associated with confinement during the COVID-19 pandemic. Increased levels of physical inactivity and binge eating are important factors. Thus, it is essential to provide psychological support, given the uncertainty of the duration of the pandemic.
7	Lesser and Nienhuis[49]	Health promotion measures to increase levels of physical exercise for less active individuals may be essential to improve well-being in the course of the COVID-19 pandemic. The practice of physical exercise outdoors could offer benefits and increase well-being. Therefore, opportunities to be physically active outdoors during the period of public health restrictions should be offered when possible.
8	Nyenhuis et al.[50]	Physicians must address their own wellness, including performing physical exercise because there is an increase in emotional stress and uncertainty regarding to family and financial aspects and medicine practice during COVID-19 pandemic.
9	Ammar et al.[51]	There is a negative effect of confinement and quarantine on the levels of physical exercise and a significant increase in sitting time and sedentary behavior.
10	Goethals et al.[52]	The level of independence, autonomy, and mental health of the elderly during quarantine is worrying. Public health campaigns to promote physical exercise are needed to be carried out at home for the elderly.
11	Zhang et al.[16]	To deal with negative emotions during the COVID-19 pandemic, physical exercise and good sleep hygiene are economic and practical mitigation strategies during the period of social isolation.
12	Narici et al.[53]	During COVID-19 pandemic, because the increase of physical inactivity levels, loss of muscle mass occurs quickly and is associated with denervation of fibers, damage to the neuromuscular junction and increased degradation and suppression of muscle protein synthesis. Physical inactivity also affects glucose homeostasis and reduces insulin sensitivity. In addition, aerobic capacity is impaired at all levels of the oxygen distribution and consumption cascade, including peripheral circulation and muscle oxidative function. The positive energy balance during physical

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Table 3 (*continued*)

N.	Author	Main Conclusions
		inactivity is associated with fat deposition, associated with systemic inflammation and activation of antioxidant defenses, exacerbating muscle loss. However, the deleterious effects of physical inactivity (combined with a 15–25% reduction in daily energy intake) can be lessened by the practice of routine physical, aerobic and muscle strength exercises, thus preserving neuromuscular, metabolic, and cardiovascular health.
13	Leandro et al.[54]	The practice of moderate intensity physical exercise at home is recommended since the immunomodulation induced by physical exercise could help to improve the immune response against the progression of "Severe acute respiratory syndrome coronavirus 2 infection".
14	Heffernan and Jae[55]	Physical exercise is a medicine. It can help reduce the risk of COVID-19 infection and minimize cardiopulmonary sequelae in recovery after illness.
15	Tornese et al.[56]	Metabolic control of type 1 diabetes mellitus in adolescents, by remote and hybrid monitoring, did not worsen during the confinement associated with the COVID-19 pandemic. In addition, it improved even more in young people who continued to practice physical exercise at home during quarantine.
16	Sañudo et al.[57]	Whole-body vibration exercise could help help infected individuals to mitigate the decline in physical function during the COVID-19 recovery and rehabilitation period. Its practical application for hospitalized patients could be associated with the relief of symptoms of dyspnea, anxiety and depression and improvement of physical function and quality of life and possible reduction of time in the intensive care unit.
17	Vancini et al.[58]	Physical exercise is medicine for people with epilepsy. There is sufficient evidence that physical exercise has positive effects on physical fitness, mental health, and lifestyle in patients with epilepsy. Staying healthy by following a nutritious diet and exercising during the COVID-19 pandemic is critical. However, it is essential to respect social isolation and quarantine and look for alternative strategies for home-based exercise programs.
18	Constandt et al.[59]	The promotion of physical exercise at home and in public spaces (provided that the recommended social distance is respected) during the confinement associated with the pandemic can prevent the increase in physical inactivity. Support and guidance for physical exercise, for example, online tools and organized sport are recommended to exercise safely and achieve the benefits of physical exercise. The results of this study also suggest that governments and public health authorities should consider people over 55 and low schooling should be encouraged to exercise during the confinement associated with the pandemic.
19	Schwendinger and Pocecco[60]	Scientific evidence-based exercise recommendations are a safe strategy for maintaining or improving health-related physical fitness and, consequently, preventing the exacerbation of the risk of diseases associated with sedentary habits and mortality in healthy people and pre-existing medical conditions. This can have important public health implications during and after the COVID-19 pandemic.
20	Pillay et al.[61]	COVID-19 has negative physical and mental effects on athletes, including physical deconditioning, altered sleep patterns, worsening nutrition, uncertainty about returning to sport and depression. Medical, nutritional and psychological support is recommended during and after the period of social confinement. Missed opportunities and an uncertain financial and sporting future can have lasting effects on athletes and the sports industry. The readjustment to normal life and the return to sport will undoubtedly be a challenge. Governments and sports federations should develop and implement regional sport-specific guidelines based on scientific evidence for safe return

Table 3 (*continued*)

N.	Author	Main Conclusions
		in an environment of possible contagion and spread of COVID-19 to minimize the risk of transmission and preserve public health.
21	Phelan et al.[62]	The resumption of intensive physical training and competition requires care Testing for large-scale disease, vaccination to prevent disease and strict surveillance of clinical examinations among athletes will be necessary to ensure the safe start and global maintenance of the world and the sports industry.
22	Barker-Davies et al.[63]	Scientific evidence indicates a multisystemic effect of the COVID-19. For the survivors of COVID-19, the domains of rehabilitation would be cardiorespiratory, psychological, neuromuscular, and clinical. This multidisciplinary rehabilitation process would positively impact physical and sports performance after COVID-19 infection.
23	Dixit[64]	Moderate intensity physical exercises, done at home and monitored by the Borg scale (from 0 to 10), can increase immunity and prevent the incidence of COVID-19 and thus benefit people with morbidities and non-communicable diseases and promote well-being psychological.
24	Carmody et al.[65]	Professional sporting events and their resumption have been a global concern for managers, sportsmen, coaches, and spectators in the COVID-19 pandemic scenario. To mitigate the negative effects associated with the pandemic, it is necessary to plan the safe resumption of sporting events, given the health, social and economic benefits of professional sport.
25	Souza Filho and Tritany[66]	Currently, physical exercise done at home should be consolidated as a public health policy. The new era of social relations requires the encouragement of autonomy and independence and the strengthening of self-care. This includes physical exercise practice.
26	Morrey and Wichser[67]	Short-term disruption to normal exercise routines is unlikely to have catastrophic effects on mood and mental state, physical health, athletic goals, and social relationships. However, it is necessary to recognize, be prepared, and seek solutions related to the practice of physical exercise if this period of social isolation associated with COVID-19 is prolonged, as this can have harmful effects on physical and mental health.
27	Guerrero et al.[68]	To meet physical exercise guidelines for children during the COVID-19 pandemic, parents must restrict their children's screen time.
28	Lakicevic et al.[69]	Physical exercise at home has the function of improving general health, promoting independence and functional capacity and preventing the aggravation of diseases caused by lack of movement. Despite the current movement restriction associated with the COVID-19 pandemic, it is crucial that the elderly remain physically active to preserve and improve their health status and functional capacity.
29	Bhatia et al.[70]	Strict social distance measures to reduce the impact of the COVID-19 pandemic are likely to drastically reduce the amount of exercise for most people, whether recreational or elite athletes. The duration of the pandemic is uncertain, so regular exercise is important for maintaining physical and mental health as well as helping with the ability to fight infections.
30	Hughes et al.[71]	Decisions regarding the resumption of sporting events must be based on objective and accurate medical information regarding the transmission of COVID-19, for the safety and well-being of athletes and spectators as well as public health systems.
31	Kenyon[72]	Prevention of future pandemics and the improvement of the quality of life of human beings, is linked to a more harmonious coexistence with the planet earth and its finite natural resources. To help, each of us could put on running shoes more regularly.
32	Viana and de Lira[73]	Exergames can be considered a useful tool for dealing with anxiety and can be easily shared with colleagues and family in situations of social isolation and be a useful tool for maintaining levels of physical exercise and physical fitness.
33	Antunes et al.[74]	

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N.	Author	Main Conclusions
		Strategies to promote healthy eating habits, physical exercise, good sleep hygiene and identification of risk groups, due to social isolation and distance, are essential. Women and children may need more attention, as they seem to practice less physical exercise and have higher levels of anxiety.
34	Shariat et al.[75]	Staying at home for the prevention of COVID-19 virus is an accepted fact for everyone. Office workers are a group of people, who had to wake up early in the morning and at least had a fixed pattern of sleeping and working. In this situation, complaints about neck, shoulder, and lower back tend to increase and this is a good time to learn and do some practical exercise at home.
35	Faghy et al.[76]	Cardiopulmonary exercise testing (CPET) is an established investigative strategy for many clinical scenarios which includes preoperative evaluation of risk for postoperative complications. The list of indications is likely to be extended, and include post-COVID-19 complications in a currently unquantified caseload of patients. Implementation of CPET requires careful consideration alongside a risk/benefit analysis to ensure mitigation of sustained transmission. This may lead to shorter testing protocols and more use of 'threshold testing' to reduce the potential exposure to an undiagnosed virus.
36	Ferreira et al.[77]	It is important to emphasize that the home and family environment is also conducive to perform physical exercise. Physical activities that are pleasurable, exploring spaces around the house and using equipment to move about; perform daily activities, such as cleaning, maintaining, and organizing spaces around the house; play and exercise with children, adolescents, and pets, using games that promote energy expenditure higher than resting; avoid sedentary behavior, alternating time spent sitting or lying down with periods of physical exercise, reducing time spent using electronic devices; set aside a few minutes for stretching, relaxation, and meditation activities. In this manner, faced with the exponential growth of this pandemic in Brazil. The recommendations is that the population maintain a physically active lifestyle to face COVID-19 and the eventual consequences of social confinement.
37	Guan et al.[78]	Parents should incorporate physical exercise into the daily routine of children and the family during the period of isolation and physical distance. Extended sitting periods should be interrupted every 30–60 min. Care should also be taken with regard to children's screen time and encourage positive screen interactions and social experiences. To help children get enough sleep, keep your bedtime and waking times fixed. Screen time before bed is contraindicated. Educators and teachers should promote active behavior guidelines and policies (schedule online classes, limit sitting time, encourage standing, stretching, and standing in place) among children. Health professionals, governments, influential people and the media should provide regular messages and examples to promote physical exercise and interrupt long periods of sitting, at the moment in a hybrid and remote way.
38	de Oliveira Neto et al.[79]	The Pre-Exercise Screening Questionnaire (PESQ) aims to quickly detect and track COVID-19 symptoms to assess a person's readiness for exercise. This is prudent to avoid the potential risk of exacerbating respiratory symptoms. PESQ has advantages for being easy, simple, quick to apply and low cost. In addition, it helps in screening individuals in need of additional clinical examinations. However, the instrument does not eliminate the need for medical authorization and/or physical stress testing to assess cardiac health.
39	Vasiliadis and Boka[80]	Can professional and recreational runners practice their sport during the COVID-19 pandemic? Public health authorities have stated, sometimes under the law, that a minimum distance of about 1.5 m from other people must be maintained. However, social distance has been defined for individuals who are only standing. What about those who are on the move and running? Running is usually very safe, but at this point you must keep your physical distance. Thus, the term "distance from running" makes sense.
40	Jang et al.[81]	During 24 days in Cheonan, South Korea, 112 people were infected with COVID-19. This was associated with fitness dance classes at 12 exercise facilities. The practice of physical exercise in facilities with crowded people and confined spaces can increase the risk of infection and should be avoided in outbreaks.
41	Manferdelli et al.[82]	Upon returning to sea level, careful monitoring of the athlete's health, especially of the immune system and the signs and symptoms related to COVID-19, is recommended. In addition, it is recommended to test athletes for COVID-19 infection. Today, with the emergence of global health, the adoption of specific care is suggested before, during and in the return of exposure to altitude. In particular, the first symptoms of poor adaptation to hypoxia and respiratory problems should be considered carefully, as they can mask symptoms of COVID-19.
42	Mukaino et al.[83]	Minimize declines in functional status; especially in vulnerable populations, is essential such as the elderly and people with disabilities. Telerehabilitation and physical exercise can be easily implemented using a combination of accessible technologies and a powerful tool to tackle the social inequalities that have emerged most strongly in the pandemic.
43	Sarto et al.[84]	Because COVID-19 pandemic, it is difficult to predict when elite sports will be fully restarted in its fullness and the way it was before the pandemic. There are two possible scenarios. In the first, the situation of the pandemic will improve rapidly and it will be possible to restart sporting events behind closed doors. In this context, in order to conclude championships many games and events would be condensed in a short time and athletes could be unprepared to deal with the high demands of training and play. For this reason, a period of physical reconditioning for the sport would be necessary for athletes to regain their neuromuscular and cardiorespiratory fitness and thus reduce the risk of musculoskeletal injuries. In the second scenario, the emergency will continue and the championships will not be concluded. This situation of insufficient training would be prolonged for several months and the physiological decline even more accentuated. In this case, a prolonged pre-season would be guaranteed to allow the athletes' physiological and mental performance to be restored.
44	Herrero-Gonzalez et al.[85]	The task force's proposal is a minimum training period of 4–6 weeks before the first official soccer match after the pandemic. This time is recommended for periods of physical and social isolation longer than 30 days. In addition, the recommendation is at least 72 h apart between official soccer matches. This measure will produce a less congested soccer schedule, which could potentially reduce the injury rate of players. Other recommendations, on an exceptional basis, are the inclusion of two substitutions of players with five substitutions allowed per soccer match, mandatory breaks for hydration in the 30th and 75th minutes of the match, and choice of game times with low solar radiation and the temperature.
45	Fitzpatrick et al.[86]	People with morbidities and aging diseases are at risk of death from COVID-19 infection. The COVID-19 pandemic brought with it the need for more or less aggressive security measures in terms of physical and social isolation. This negatively impacted people's mental health and physical exercise levels. The world health authorities recognized the vital role that physical exercise plays in physical and mental health and recommended and allowed (depending on the country) the practice of physical exercise (indoor and outdoor) with the fulfillment of strict safety measures.

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N.	Author	Main Conclusions
46	Adams and Périard[87]	The adoption of conservative measures of acclimatization to heat, in the post-pandemic, extending the duration of this period and focusing on improving cardiovascular fitness before total exposure to heat, can allow a safer transition from returning to sports practice for the student-athlete of secondary school athletics.
47	Hughes[88]	The resumption of sports and recreational activities can contribute to physical and psychological benefits for societies in the period of restrictions after COVID-19. However, the form of resumption is still uncertain.
48	Bongers et al.[89]	Cooling solutions (ingesting cold water and ice paste and cooling vests) can contribute to alleviating heat stress in healthcare personnel during the COVID-19 pandemic and improve performance on physical exertion and decrease heat stress
49	Elliott et al.[90]	If an athlete has symptoms of COVID-19, he should speak to his doctor and do appropriate quarantine, testing, monitoring, and screening. Athletes should maintain good hydration, a balanced diet, and be alert if symptoms worsen or persist for more than 7 days. A gradual return to sport protocol is required, with some athletes taking more than 3 weeks to recover. Athletes must have at least 10 days of rest and 7 days without symptoms before starting again. For less physically intense sports the progression can be faster. Monitoring the resting heart rate, perceived exertion, quality of sleep, stress, fatigue and muscle pain is interesting. Athletes with comorbidities and diagnosed with COVID-19 must undergo a rigorous medical evaluation before returning to sport. Athletes with COVID-19 whose condition has become complicated may need further investigation, including: assessment of inflammatory markers, cardiac monitoring, echocardiogram, exercise tolerance test, assessment of respiratory function and renal and hematological monitoring.
50	Chen et al.[91]	It is interesting to assess whether a physical rehabilitation program is able to promote the full recovery of patients with COVID-19 as well as to improve their physical exercise levels.

social isolation should consider psychological dimensions and lifestyle habits. Higher values for anxiety were found in the 18–34 years-old group. Liu et al.[95] concluded that six weeks of respiratory rehabilitation improved respiratory function, quality of life, and anxiety status of elderly patients with COVID-19. However, little improvement in depression were reported. Shaw et al.[96] reported the use of a face mask during vigorous exercise had no noticeable detrimental effect on blood or muscle oxygenation or on the physical performance of healthy young people.

When searching with the terms physical exercise and COVID-19 and focusing only on systematic reviews, 20 articles were found, of which 8 articles were relevant according to this study's aim.[97–104] The central themes were: recovery of physical function and fitness after coronavirus infection; staying physically active during the quarantine to mitigate COVID-19; psychological health and physical exercise levels during the COVID-19 pandemic; interventions to address anxiety, depression, and stress during COVID-19 social distancing and quarantine; and recommendations for maintaining active lifestyle during the COVID-19 pandemic. In addition, physical function and physical fitness are impaired after infection by COVID-19. Deficiencies and damage may persist for 1 to 2 years after infection. Although physical exercise can improve physical function and fitness after infection, more research is needed to determine its effectiveness in people recovering from similar conditions and infections.[97] In addition, early rehabilitation associated with COVID-19 must be provided to patients who needed hospitalization; people with restricted mobility due to quarantine should receive physical exercise programs to reduce the risk of frailty, sarcopenia, cognitive decline, and depression.[104] Telerehabilitation is an alternative for people

Table 4
Summary common keywords and recommendations about physical exercise and COVID-19.

KEY-WORDS	RECOMMENDATIONS	
Physical activity	Respecting social distancing, the practice of physical activity is important, during the COVID-19 pandemic, due to its benefits for physical and mental health.	Dwyer et al.[105]
Physical exercise	The practice of physical exercise strengthens the immune and pulmonary systems and can positively impact viral and infectious conditions; as is the case with COVID-19. Provided that it is prescribed at the appropriate intensity, volume, and frequency.	da Silveira et al.[106]
Physical fitness	The role of regular physical activity in the levels of physical fitness is fundamental for maintaining the quality of life during and after the outbreak of COVID-19.	Pinho et al.[107]
Sport	Globally, professional sport and its resumption is a secondary concern in the face of the COVID-19 pandemic. However, international collaboration has allowed major sporting events to occur during public health emergencies declared by WHO, including the Vancouver 2010 Olympic Games (during the H1N1 pandemic) and the Rio 2016 Olympic Games (during the Zika virus outbreak). It is important to resume sporting events, given the health, social, and economic benefits linked to professional sport, but fail to take into account the WHO recommendations.	Carmody et al.[108]
Home-based exercise	At the moment, staying at home is necessary during the COVID-19 pandemic, especially for populations at risk such as the elderly and people with morbidities. It is still possible to meet the WHO recommendations for physical activity. In this sense, it is necessary to avoid sedentary behavior and use domestic activities as an opportunity to remain physically active.	Carvalho and Gois[109]
Physical inactivity	Physical inactivity is common during periods of social self-isolation. People with morbidities should receive support and care to maintain physical activity and avoid prolonged periods of sitting and screen time.	Pinto et al.[110]
Sedentarism/ sedentary behavior	Although it is necessary to prevent the spread of the COVID-19 virus, a prolonged stay at home (quarantine) can result in unfavorable sedentary behaviors and increased sedentary lifestyle and the prevalence and incidence of chronic-degenerative diseases, for example, cardiovascular disease, obesity, hypertension, cancer, and mental illness. Therefore, it is essential to perform periods of physical activity that can reverse the adverse effects associated with excessive sitting and screen time during the period of social isolation and lockdown.	Chandrasekaran and Ganesan[111]
Pandemic	There is a substantial decrease in global levels of physical activity during the period of social isolation associated with COVID-19	Peçanha et al.[43]

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Table 4 (*continued*)

KEY-WORDS	RECOMMENDATIONS	
	pandemic. The decrease in levels of physical activity induced by confinement and the increase in sedentary behavior can cause a rapid deterioration of cardiovascular health and premature deaths. In this critical scenario, home physical activity programs appear as an alternative to promote health benefits. Public health policies based on scientific evidence are urgently needed to counteract the impact of increased physical inactivity and sedentary behavior during the COVID-19 outbreak.	
Quarantine/ social isolation	Quarantine and social isolation can have long-term effects and increase the prevalence of cardiovascular diseases, mainly related to unhealthy lifestyles and anxiety. After the quarantine associated with COVID-19, a global supportive action and public health policies that promote adherence to a healthy diet and increased physical activity is mandatory to encourage people to return to a better lifestyle.	Mattioli et al.[112]
Social distancing	Social distance during the COVID-19 outbreak increased physical activity outdoors. Outdoor physical activity can be safe (from a physical, biological, and psychological point of view) as long as meticulous physical distance, hand hygiene, use of face masks, and cleaning the surface of public resources are maintained.	Park and Lee[113]
Immune system	The immune response to the virus depends on factors such as genetics, age, and physical state. During and after physical exercise, pro- and anti-inflammatory cytokines are released, lymphocyte circulation increases, as well as cell recruitment. Such practice has an effect on the lower incidence, intensity of symptoms and mortality in viral infections observed in people who practice physical activity regularly, mainly in older adults. In general, due to the positive role of regular exercise training on the immune system of the older adults as well as the involvement of the immune system in COVID-19, it's necessary to guide and implement home-based exercises for older adults to decrease the effects of immunosenescence.	Shahrbanian et al.[114] and da Silveira et al.[106]

needing to stay at home.[99]

Finally, to facilitate the understanding of the current panorama of main keywords, applications, and recommendations concerning COVID-19 and physical exercise, Table 4 below was developed.

Conclusion

Our main aim was to conduct a review about physical exercise and COVID-19 on the PubMed database. Our research is relevant because we show the dynamics of scientific production on the COVID-19, in a situation so unique as a pandemic. It was possible to observe that the scientific production on COVID-19 and physical exercise has been growing during the pandemic, being almost a "space race" and that aroused the interest of the world scientific community given the gravity of the situation even today (04/16/2021) On that date, when we crossed the terms COVID-19 (AND) and physical exercise, $n = 1{,}624$ articles were found, with all production practically concentrated between the years 2019 to 2021. In general lines, the practice of physical exercise is essential, to improve and/or maintain physical and mental health, in situations as serious from the point of view of public health as the one we are experiencing as health professionals, scientists and people.

Final considerations and perspectives

Information presented in this review supports the general recommendations concern maintaining healthy habits during the COVID-19 outbreak. These recommendations include (a) regular practiced physical exercise (b) and good diet and (c) sleep habits. Maintaining physical fitness relates to both good physical health and mental health, to better cope with the COVID-19 pandemic. These recommendations apply to all people, of all ages and nationalities, and individuals with co-morbidities. In the face of the COVID-19 pandemic, the WHO and CDC are encouraging individuals to remain or become physically active and for the scientific community/educators to disseminate information and guidance for surviving the COVID-19 pandemic. Proper health/lifestyle information, quality of life, and physical exercise whether initiating or continuing regular physical exercise participation to maintain physical and mental health and wellbeing[93,94] are essential.

The general pandemic recommendations for people are to stay at home, wear a face mask, and maintain social distance. Though this conduct is essential to control the spread of the virus, this same behavior has a downside on individual health and quality of life, and on maintaining physical exercise levels. The WHO[93] has acknowledged that the COVID-19 pandemic has conditioned many people to stay at home and sit more than usual, becoming even more physically inactive, which compounds the already global physical inactivity pandemic while adding to the COVID-19 pandemic.[14,39] In recognition of this concern, the WHO has developed a campaign titled Be Active. The program is interesting and incorporates breaks in sitting time by performing 5 min of light intensity physical exercise performed in the home. Exercise examples include walking, dancing, and stretching. WHO provides additional support for physical exercise improving physical and mental health by reviewing a few other exercise health benefits such as lowering blood pressure, maintain/control/loss of body mass, reducing heart disease risk, stroke, type 2 diabetes and various types of cancer; conditions that could increase susceptibility to the most severe version of COVID-19.

Submission statement

The work described has not been published previously, it is not under consideration for publication elsewhere, that its publication is approved by all authors, and, if accepted, it will not be published elsewhere including electronically in the same form.

Authors' contributions

Conceptualization, R.L.V.; Methodology, R.L.V.; Validation, R.L.V.; Formal analysis, R.L.V.; Investigation, R.L.V.; Resources, R.L.V.; Data curation, R.L.V.; Writing—original draft preparation, M.S.A.; R.B.V.; P.T.N.; B.K.; C.R.V.C.; A.A.A.; P.G.; C.A.B.L.; Writing—review and editing, M.S.A.; R.B.V.; P.T.N.; B.K.; C.R.V.C.; A.A.A.; P.G.; C.A.B.L.; Visualization, R.L.V.; Supervision, R.L.V..; Project administration, R.L.V.; R.L.V. All authors have read and agreed to the published version of the manuscript

Conflict of interest

Authors have no competing interests to declare.

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