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LETTER TO EDITOR

Do the benefits of exercise in indoor and outdoor environments during the COVID-19 pandemic outweigh the risks of infection?

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The coronavirus disease (COVID-19) pandemic has caused an unprecedented lockdown worldwide, resulting in social isolation due to the guidance for people to stay at home in quarantine to prevent the spread of this infectious disease [1]. However, this control measure has several impacts on society, such as on psychological health, relationships, education, business, employment, and leisure time.

Evidence shows that longer durations of quarantine are associated with poorer mental health, specifically post-traumatic stress symptoms [2]. The duration of quarantine is a stress factor, and people who have stayed in quarantine for more than 10 days have shown significantly higher post-traumatic stress symptoms than those in quarantine for fewer than 10 days [2]. During the COVID-19 pandemic, symptoms of anxiety were verified in college students in China and in the Indian population, which could be caused by social distancing [3, 4].

In a recent analysis of human needs in COVID-19 isolation, Matias, Dominski and Marks (2020) [5] showed several conditions emphasized by social distancing, such as satisfying immediate physiological needs, and the need for self-protection, affiliation and status/self-esteem; hence, there are negative mental health consequences, such as fear, anxiety and distress, and people are more vulnerable to depression due to low self-esteem [5]. This is evident in some fragile populations: in addition to being within the at-risk/vulnerable group, older adults may be adversely affected by the discourses that imply that the loss of older life is not as important as the loss of life of younger people [6], for example, when health systems worldwide need to decide who should be prioritized for treatment of COVID-19.

Although research on the consequences of the COVID-19 pandemic on physical inactivity is at an initial stage [7], it is expected that people in quarantine at home could increase their sedentary behaviour through more screen time, characterized by the time watching television, using mobile devices, and playing games, thereby reducing physical activity levels. Physical inactivity is a huge public health issue and approximately one in three adults and four in five adolescents, worldwide, do not achieve the recommended quantity and quality of physical activity [8–10], and this issue can be potentiated as a function of COVID-19. There is a current concern about the effects of physical inactivity on the general population and notably on at-risk/vulnerable groups for severe illness from COVID-19, such as older adults, people with cardiovascular disease and rheumatic diseases [11–16]. The reduction in physical activity worsens the risks to these populations since there is an increasing risk factor burden.

Social distancing implies negative consequences that are already happening; however, we need to discuss ways to mitigate these issues. There is a strong recommendation for people to stay active during this critical period to maintain physical and mental health [17, 18]. In light of public health recommendations, physical activity is on the table. Thus, this work aimed to discuss the counterbalance between the benefits of physical activity and the current infection risks of performing exercise in different environments.

People should be advised of the need to perform regular physical activity due to two major points related to the fundamental role of physical activity: mental health and the immune system. Significant evidence shows that physical activity enhances the immune system [19, 20] as well as psychological well-being [21, 22], and anti-inflammatory effects [23]. Next we expose the positive potential role of exercise that should be considered, especially in times of pandemic.

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Physical activity has a positive effect on immune competence, increasing the host immune defences [19, 20, 24]. It is recognized that active people are less likely to present symptoms of upper respiratory (a vulnerable area to infections) illness [24, 25]. In recent analysis of a holistic immunological model of COVID-19, Matricardi, Negro, and Nisini (2020) [26] highlighted the opposite impact of low–moderate versus strenuous exercise, in which low–moderate exercise has benefits for the innate immune response against respiratory infections, in contrast to strenuous exercise, in which there is a tremendous increase of alveolar ventilation and susceptibility to upper respiratory airways infection [26].

Matias, Dominski, and Marks (2020) [5] provided the rationale to understand the relationship between physical activity at home and mental health during the COVID-19 pandemic and showed that increased physical activity enables a reset of physical and mental well-being. At this time, bouts of exercise are fundamental in the means of distracting individuals from worrying and negative thoughts, evidenced by the pandemic [5]. A daily exercise routine is important to offer pleasant situations at some moment in the day. Furthermore, exercise might be accompanied by higher self-esteem, and a satisfying of basic psychological needs [5].

Strength, flexibility and stability training can have a positive impact on physiological domains (hormonally, neurologically, metabolically, and behaviourally); therefore, they are both a viable and potent adjunct to any physical activity prescription for adults, and can be considered parameters associated with physical fitness and health [27, 28]. Lee et al. (2017) [29] proposed a review surrounding the impact of running on health outcomes and premature mortality, highlighting plausible underlying mechanisms linking running with chronic disease prevention and longevity. Skeletal muscle is known to be a very adaptable tissue that atrophies during conditions of unloading, such as bed rest, and hypertrophies in response to resistance exercise [30]. Regular physical activity helps reduce several cardiovascular risk factors, including obesity, dyslipidaemia, metabolic syndrome, among others [31].

Sleep is another aspect of people's lives and health affected by the COVID-19 pandemic. Initial research showed that the sleep quality of isolated individuals during the COVID-19 outbreak in China was low [32, 33]. Evidence supports that exercise improves sleep quality in middle-aged and older adults [34].

Recent evidence showed that enhanced aerobic capacity could protect against COVID-19 through improving specific immunity elements (especially if the exercise requires mainly the cardiorespiratory system, which mobilizes billions of lymphocytes) [24], and may decrease the severity of the disease [35]. Therefore, in addition to age and clinical criteria, the maximal oxygen uptake (VO_2 max) has the potential to be used as a clinically relevant triage tool [36].

Knowing that exercise could become a key pillar for health recovery and COVID-19 prevention, it is important to keep following the physical activity guidelines for adults and older adults—150–300 min of moderate- to vigorous-intensity cardiorespiratory physical activity and two sessions of muscle strength training, per week [37, 38]. Considering the need to maintain a healthy lifestyle with regular physical activity, associated to the public health guidelines about what people can do or avoid regarding physical activity through exercise, considering the risks related to the environments to perform this activity, the question to be discussed is: What are the implications of exercise in indoor and outdoor environments during the COVID-19 pandemic? Public health messages are necessary and should be careful, clear, evidence-based, and transparent during the pandemic; this editorial also aims to address this issue.

Considering that COVID-19 is spread by human-to-human transmission via droplets [39, 40], in several countries, as a control measure to prevent the spread of COVID-19, a social distance of about 1.5 m between individuals was adopted [41, 42]. However, research has indicated that the virus can be detected—but not necessarily capable of infecting—within 4 m of patients with COVID-19 in hospital wards in Wuhan, China [43]. Besides, infection spread by direct contact, the airborne transmission of SARS-CoV-2, should be considered, especially in indoor environments [44, 45]. Small particles (< 5 mm), known as aerosols, can result in airborne transmission potentially over longer distances because these particles can remain suspended in the air for prolonged periods [45, 46], especially the smaller droplets that can travel tens of meters [44].

In preprint research, Blocken et al. [47] discussed that the distance of 1.5 m may be sufficient when people are standing still and only if everybody wears face masks [45]; however, there is a need to know if it is different when people walk, run, or cycle. In this sense, through computational fluid dynamics simulations, the authors considered different configurations of walkers/runners according to distance and positions among them, and the worst scenario was when the trailing runner is positioned in the slipstream of the leading runner, resulting in the largest exposure to droplets [47]. The distance among runners and the traveling speed are important factors, due to the exposure to a larger fraction of droplets; thus, the authors recommended a distance of about 5 m and 10 m for walking fast and running, respectively [47]. The World Health Organization (2020) [17] recommends that if people go to a park or open public space to walk, run, or exercise, there is a need to always practice physical distancing. While the safe distance is still discussed in science, care is needed in the interpretation of these preliminary and non-published results, and it is important to

analyze influencing factors in further studies, such as the head position of the practitioners during exercise, as well as the direction and speed of the wind.

Although there is no study on cycling, even with small groups of cyclists, if there is a potential symptomatic carrier in front of the group, this individual could cause droplet transfer to the others (slipstream of the leading person). This issue could be worse than walking or running due to the traveling speed during cycling, which requires more distance between the cyclists. It is no small matter, as the risk of accident is intrinsic to cycling. Falls, for example, are a serious issue for cyclists. In this context, the recommendation for outdoor activities may need to be carefully evaluated, because hospital beds must be prioritized for patients with COVID-19.

The literature suggests that indoor environments have the greatest risk of infection, due to the larger density of people, the possible buildup of airborne virus-carrying droplets, and the likely higher stability of the virus in indoor air [44, 45]. The risk of infection for individuals exercising indoors increases during the peak of occupancy when the ventilation required by those training is greater [48]. Thus, indoor exercise in places with a higher number of people is an activity with a high risk of infection at this moment and should be avoided. Furthermore, human coronaviruses can remain infectious on inanimate surfaces for up to 9 days and in the air for up to 5 hours [49, 50].

In a recent analysis during 24 days at 12 sports facilities in Cheonan, South Korea, Jang, Han, and Rhee (2020) [51] identified 112 persons infected with COVID-19 associated with fitness dance classes. The large class sizes, small spaces, and intensity of the workouts were factors that influenced the infections [51]. In gyms, a common place to exercise worldwide, inefficient ventilation could be a significant problem, resulting in an increased risk of infections [48, 52]. In an editorial discussing whether exercise should be performed, Halabchi et al. (2020) [53] call attention to high-intensity exercise in public gyms and crowded environments, in which, in these conditions, the hazards may outweigh the benefits.

Most people can feel physical and mental benefits from exercise,; however, this practice needs to be performed safely and appropriately [5]. In this sense, setting specific standards of exercise practice regarding safety and hygiene protocols and procedures to avoid failing social distance during training sessions is required. Besides the general recommendations, guidelines and orientations specific to exercise environments are available in the literature, as well as from institutions and governments worldwide [26, 44, 45, 54–59] and are shown in Table 1.

Besides the safety and hygiene protocols, an appropriate exercise prescription, based on an individual assessment of health status and fitness levels, is more necessary than ever. Initially, in environments and facilities such as gyms and fitness centers, there is a need for better screening for exercise. In this sense, Neto et al. (2020) [60] developed the Pre-Exercise Screening Questionnaire (PESQ), which assesses in an easy, simple and quick way whether people are in a suitable place to start exercising during the COVID-19 pandemic through questions related to symptoms of COVID-19. From now on, this instrument could be applied on a large scale with low implementation costs.

It is important to highlight that relevant physiological changes occur during exercise, such as increased ventilation demand and respiratory frequency (from 15 to 20 up to 50 breaths per min), enhanced volume of exhaled air and airflow velocity, and inhalation of air through the mouth rather than through nasal filtering mechanisms [61–63]; these changes vary according to exercise intensity. These are important factors that should be considered in this analysis for both indoor and outdoor exercise. In this sense, exercise stress is associated with an increased risk of upper respiratory tract infection. In the meantime, moderate exercise has been associated with a decreased risk. There is a growing body of evidence showing that severe exercise can increase susceptibility to upper respiratory tract infection [64].

Therefore, the guidance based on research and official guidelines is to avoid exercise in indoor environments with higher occupancy, and if performing outdoor exercise (walking, running, or cycling), there is a need to keep larger social distances or adopt a side-by-side arrangement. In summary, the benefits of exercise during the COVID-19 pandemic may outweigh the risks of infection; however, caution is needed in both indoor—where contamination could be airborne and through touching potentially contaminated materials—and outdoor environments. Exercise should be as promoted as social isolation [5]. We strongly recommended that people stay active with regular exercise.

The present analysis promotes a critical appraisal that is relevant to help people to stay active while preventing the spread of the disease, thus avoiding additional cases of infection in the near future by individuals who are exercising to maintain health but could be at risk of infection, which is a contrast to the fact that individuals exercise for better health. The summary of guidelines and orientations related to social distancing, safety and hygiene applied to exercise environments, based on research and official institutions, has useful practical applications and may collaborate with the implementation of public health strategies both during the pandemic and in the post-pandemic period.

Table 1 Guidelines and orientations related to social distancing, safety and hygiene when exercising in indoor and outdoor environments, according to the environment and place

Guideline related to	Orientation	Environment	Place
Social distancing	Exercise as long as you follow social distancing guidelines—at least 2 m/6 feet apart (if there is use of face masks) but "further is safer"	Outdoor	Parks or open public space
	When face masks are not used more extensive distancing measures (up to 10 m of distance among persons) should be adopted in indoor environments	Indoor	Gyms and fitness centers
	Implement protective measures as wearing masks and daily health checks for symptoms	Indoor	
	Avoid physical activities that involve body contact, such as team sports	Indoor/outdoor	Sporting courts and fields
Safety	Limit the number of people in the facility at one time, typically vary between 10 m^2 and 15 m^2 per person	Indoor	Gyms and fitness centers
	Prefer moments in which there is little flow of people in exercise facilities	Indoor/outdoor	All
	Limit the time people spend exercising in the indoor environment to decrease exposure time	Indoor	Gyms and fitness centers
	Avoid the use of cellphone during exercise in shared environments	Indoor	
	Using natural ventilation, increasing the ventilation rate, avoiding air recirculation, and guiding people to avoid staying in another person's direct air flow in indoor environments	Indoor	
	Prefer low-moderate intensity exercises rather than strenuous exercise	Indoor/outdoor	All
Hygiene	Avoid the sharing of bottles	Indoor/outdoor	All
	The need for hand-washing or hand-sanitizer stations with easily accessible in facilities	Indoor	Gyms and fitness centers
	Sanitize exercise equipment's regularly (before and after using the equipment), not only weight machines but also bands, hand weights, foam rollers, yoga blocks, mats and towels	Indoor	
	Cleaning, ventilation, and disinfection processes are required in group exercise spaces by at least a 10–15 min space between classes	Indoor	

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Not applicable.

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