

Centers of physical activities and health promotion during the COVID-19 pandemic

 Antônio Carlos Leal Cortez ^{1,2}
 Francisco José Gondim Pitanga ³
 Marcos Antonio Almeida-Santos ⁴
 Rodolfo Alkmim Moreira Nunes ⁵
 Daniel Alfonso Botero-Rosas ⁶
 Estélio Henrique Martin Dantas ^{2,4}

- 1.** Centro Universitário Santo Agostinho – UNIFSA, Teresina, PI, Brasil.
2. Programa de Pós-graduação Stricto Sensu em Enfermagem e Biociências da Universidade Federal do Estado do Rio de Janeiro – UNIRIO – Rio de Janeiro, RJ, Brasil.
3. Universidade Federal da Bahia – UFBA, Salvador, BA, Brasil.
4. Programa de Pós-graduação Stricto Sensu em Saúde e Ambiente – PSA da Universidade Tiradentes – UNIT Aracaju, SE, Brasil.
5. Programa de Pós-graduação Stricto Sensu em Ciências do Exercício e do Esporte da Universidade do Estado do Rio de Janeiro – UERJ, Rio de Janeiro, RJ, Brasil.
6. Universidad de La Sabana – USabana, Bogotá, Colombia

<http://dx.doi.org/10.1590/1806-9282.66.10.1328>

KEYWORDS: *Exercise. Fitness Centers. Green Areas. Motor Activity. Coronavirus Infections.*

PALAVRAS-CHAVE: *Exercício Físico. Academias de Ginástica. Áreas Verdes. Atividade Motora. Infecções por Coronavirus.*

INTRODUCTION

In December 2019, in Wuhan, Hubei province in China, severe cases of pneumonia of unknown cause were reported and spread rapidly across several countries worldwide, generating a global crisis¹⁻⁵. Thus, in view of the increase in the number of cases throughout the world, on 11 March 2020, the World Health Organization (WHO) declared the new Coronavirus (COVID-19) outbreak a global pandemic. This led many countries to close their borders and impose long periods of restrictions (quarantine and lockdown) or partial restrictions (flexibilization of activities) to their inhabitants^{6,7}.

Scientific evidence suggests that COVID-19 is transmitted from person to person, this being the most likely route of virus spread, through direct transmission through respiratory droplets between people when infectious droplets produced by sneezing, coughing, speaking, or simply exhaling reach the mucous (mouth and nose) or conjunctiva (eyes) membranes of another person^{8,9}. Another explanation for the transmission of the virus would be by indirect means, perhaps resulting from the contamination of objects and/or airborne transmissions of the virus in confined spaces and/or spread by infected

DATE OF SUBMISSION: 15-Jul-2020

DATE OF ACCEPTANCE: 08-Aug-2020

CORRESPONDING AUTHOR: Antônio Carlos Leal Cortez

Rua Xavier Sigaud, 290, sala 203, Urca - Rio de Janeiro – RJ – 22290-240

E-mail: antoniocarloscortez@hotmail.com

asymptomatic individuals¹⁰⁻¹². It is noteworthy that the contagion occurs mainly by respiratory droplets and close contact; however, these modes of transmission do not explain all cases of COVID-19 contagion¹³.

To combat the proliferation of this disease, most nations adopted a so-called “social distancing” of approximately 1.5-2 m to be maintained between individuals, as well as the closure of several businesses. As a result, local authorities ordered the closing of shops, restaurants, bars, theaters, concert halls, and indoor physical activities centers, such as gyms, CrossFit studios, and others, as well as outdoor physical activities venues, such as parks, avenues, squares, and others¹⁴.

In this case, it is necessary to reflect on this scenario of the pandemic and closure of physical activity centers because when analyzing the clinical course and risk factors for COVID-19 it is possible to identify it as incomplete, especially for people who are not part of any risk groups^{15,16}. Epidemiological data on COVID-19 indicate that comorbidities such as hypertension, respiratory, cardiovascular, metabolic, and immune diseases, in addition to an advanced age are classified as important risk factors for the severity of COVID-19^{17,18}.

The current literature emphasizes that physical inactivity produces adverse effects on health, contributing to the emergence of risk factors associated with COVID-19¹⁹⁻²¹. Therefore, the need to maintain a good level of physical activity as a protective measure is highlighted. In addition, physical exercise is associated with an increase in immunity and may be useful in the prevention of infections and in complementary treatments for chronically ill patients^{22,23}.

It seems that the world has forgotten that it has faced other pandemics before and, with greater emphasis, needs now to fight another pandemic, of a different nature, represented by physical inactivity and sedentary habits²⁴⁻²⁶. According to the WHO²⁷, in Brasil alone, sedentary-lifestyle related diseases kill 300,000 individuals yearly, and, worldwide, there are approximately 3.2 million annual deaths due to this behavior that is detrimental to the health and quality of life of the population.

Considering the above, we present the following question: why is it that, in some countries, physical activity centers remain closed? WHO²⁷ encourages the maintenance of regular physical activity practice as a strategy for health promotion. Thus, our objective is to elucidate, through scientific evidence, the importance and possibilities of reopening indoor and outdoor

physical activities centers to improve and maintain the health and the quality of life of the population.

Possibilities for Reopening Indoor and Outdoor Physical Activity Centers during the COVID-19 pandemic

The quarantine and social distancing were initially the best options to understand the clinical and epidemiological aspects of the disease, in addition to stopping the spread of the virus. However, prolonged isolation, coupled with the closure of indoor and outdoor physical activity centers, implies a radical change in lifestyle, generating negative consequences to the health and quality of life of the population, particularly those in risk groups²⁸.

In fact, the Brazilian Society of Exercise and Sports Medicine (SBMEE), in partnership with the Brazilian Society of Endocrinology and Metabolism (SBEM), Brazilian Society of Diabetes (SBD), and the Brazilian Association for the Study of Obesity and Metabolic Syndrome (ABESO), assessed that the outdoor exercises, in parks, avenues and other outdoor physical activities venues are allowed, provided that some measures are observed and the recommendations on health and sanitation of local authorities are observed, which may vary between states and even cities²⁹. In addition, in point of view published by Brazilian researchers, it has been suggested that outdoor physical activities should be recognized as essential during the COVID-19 pandemic³⁰.

Blocken et al.¹⁴ conducted a streamlined study investigating whether a person, when approaching another person at a distance of 1.5 m or more, could cause a transfer of droplets to this second person. Simulations were made by Computational Fluid Dynamics (CFD) in a wind tunnel, previously validated and calibrated with measurements for droplet movement and evaporation and airflow around a runner, with the movement of droplets produced by a person who breathes or walks beside another person walking or running nearby.

The study concluded that, in the absence of headwind, tailwind, and crosswind, when walking fast at 4.0 km/h, this distance is around 5 m, and when running at 14.4 km/h, it is around 10 m. Based on this information, countries like Spain and France, in the first week of May, allowed their citizens to leave home to practice outdoor physical exercises, respecting a schedule that separated groups at greatest risk from others¹⁴.

According to Blocken et al.¹⁴, indoor physical activity centers are places that provide equipment and

specific services for the regular practice of physical exercises. Their equipment and services can cover a wide range of physical activities such as: I. equipment for aerobic exercises with stationary exercise bikes, treadmills, rowing machines, and elliptical machines; II. isodynamic (machines) and alodynamic (free weights) equipment³¹; III. Group exercise services in which coaches or instructors teach classes of aerobics, cycling/spinning, step, yoga, Pilates, stretching, and other group activities in general, and IV; Additional facilities, such as racing tracks, various sports courts, boxing rings, swimming pools, and alternative spaces. The aforementioned authors highlight categories I, II, and III, noting that the people who perform these exercises remain stationary during the practice.

That are no questions regarding the role of regular physical activity in health promotion and in the quality of life of the population, as presented in the Sustainable Development Goals of the United Nations (UN)³² - Figure 1. For many years, even in difficult times, such as this we are currently experiencing with the COVID-19 pandemic, physical activity has had and still has an important role in maintaining the quality of life of the population^{20,33-35}. However, even with all these contributions to the health and quality of life, several countries are still keeping their indoor and outdoor physical activity centers closed, preventing the practice of regular physical activity by the population, making it more difficult for people to cope with the impact caused by the COVID-19 pandemic³⁶.

Nevertheless, in general, government authorities are allowing a gradual reopening of commercial activities, through the use of health and sanitation protocols, and the indoor and outdoor physical activity centers the last in line to be authorized to reopen. Given this scenario, to provide adequate conditions for the operation of the indoor physical activity centers, it would be necessary to create a safety certificate, issued by health departments and technical regulators, aiming to provide safety to practitioners during the COVID-19 pandemic, as well as TO allow that indoor physical activity centers can remain open safely during the hypothetical upcoming waves of COVID-19, as well as in future pandemics¹⁴.

International sports organizations such as the Dutch Olympic Committee (NOC) and the Dutch Sports Federation (NSF), which are regulatory organizations for all sports activities, professional and recreational, in the Netherlands, issued a Protocol for responsible exercising³⁷. The biosafety protocol contains a detailed list of protective measures and precautions for physical activities that do not involve physical contact between people³⁸.

The protocol is divided into four categories: I. Operators, II. Practitioners, III. Staff, and IV. Suppliers, highlighting that all measures for hygiene and respiratory etiquette established so far remain applicable, among them: the use of masks; maintaining a physical distance of 1.5 m at all times; when coughing or sneezing, covering the nose and mouth using the arm or

FIGURE 1. CONTRIBUTIONS OF PHYSICAL ACTIVITY TO SEVERAL OF THE SUSTAINABLE DEVELOPMENT GOALS OF THE UNITED NATIONS³².



elbow fold, or, when a tissue paper is used, discarding it immediately in the trash; washing your hands with soap and water several times a day, or disinfect them with an aseptic solution of alcohol (alcohol gel 70%); not sharing personal items; staying home after having tested positive for the virus; staying home when presenting at least one of the typical symptoms; staying home when one of you family members and/or housemates tests positive for the virus; and staying home when one of your family members and/or housemates has a fever (temperature equal to or higher than 38°C) or a feeling of tightness on the chest and/or shortness of breath^{37,38}.

By following this protocol, operators would control the maximum number of practitioners in the facilities of physical activity centers, provide masks, gloves, and goggles for the staff, provide alcohol gel 70% for the staff and practitioners. Likewise, the operators are responsible for overseeing the periodic cleaning of spaces with a greater flow of people and equipment, as well as the intensive cleaning of bathrooms, in addition to door handles and other surfaces, as well as measuring the temperature of staff members, collaborators, and practitioners at the entry, and also monitoring the actions of staff members and practitioners so guarantee they meet the biosecurity protocols. They also would be responsible for the demarcations between the pieces of equipment and spaces, in order to meet the distancing measures. It is also important to highlight that, in general, meeting the physical distance of 1.5 m is usually not a problem since many of the exercise machines already take up considerable space^{37,38}.

Indoor physical activity centers should inform the practitioners that, when using the drinking fountains, they should avoid direct contact with the surface, thus encouraging each practitioner to use their own bottle; a paper towel should be used at the end of the operation, with the possibility of disposal in a waste collector that does not require manual contact. Subsequently, hand hygiene must be completed using alcohol gel 70%. In the event that it is not possible to comply with these guidelines, it is recommended to deactivate the drinking fountains³⁷⁻³⁹.

It is recommended that the staff and practitioners, in common areas (parking lots, internal access areas, cafeterias, and etc...), wear a mask, and alcohol gel 70% must be available on each table or countertop, respecting the minimum distance of 1.5m; these are also requirements that must be met by the operators³⁷⁻³⁹.

For each indoor space, the maximum number

of practitioners should be determined taking into account the peculiarities of each space, such as ventilation and proposed activities. It is recommended to have a compulsory reservation of time slots, respecting the maximum number of people allowed in a given time, avoiding public transportation, if possible, use sanitary facilities at home and not in the center, start training only after washing hands, observing the minimum distance of 1.5m, avoid greeting others with handshakes, kisses, and hugs, and leaving the center immediately after completing the physical activity^{37,38}.

Regarding the use of masks by practitioners of physical activity, operators, staff members, and other persons who attend the centers, it is worth mentioning that a distinction must be made between the different types of masks and their effectiveness. Scientific evidence⁴⁰⁻⁴² suggests that all types of masks have reduced exposure to aerosols and respiratory droplets, proving to be relatively stable over time regarding wear and not being affected by the duration and type of activity, remembering that there is a degree of variation of effectiveness according to the type of mask.

It is necessary to highlight that the use of masks has been the subject of debates across several countries worldwide, with various radical statements for and against their use and regarding their usefulness in various situations. However, there is an agreement when it comes to protection since all the different types of masks have some protective effect. Another important issue concerns the feeling of safety and freedom that the mask provides the population, allowing them to perform daily activities⁴⁰⁻⁴⁹. Regarding the use of masks and their effectiveness for practitioners of indoor physical activity, Van der Sande et al.⁴² highlight the possibility of creating specific masks to meet the needs of different sports activities without compromising their protective effects against droplets and aerosols and being resistant to sweat without compromising the respiratory flow.

It is recommended that staff members are able to perform their activities from home, remaining home as much as possible, following recommended hygiene protocols, not sharing personal or professional utensils with other staff members, and keeping the environment and work tools clean and disinfected. For suppliers, a time must be established for deliveries, preferably before the opening and first disinfection of the facilities and equipment and/or after the closing of

the center. All individuals must wear gloves, announce where the goods are to be placed, and, if possible, completing prior disinfection of the goods³².

Considering all these recommendations based on scientific evidence, another question that can be presented is: if indoor physical activity centers are closed, would not the sweat produced by practitioners have the potential for airborne and respiratory droplets transmission of the virus? In this case, we must highlight that the main mode of transmission is direct, i.e., from person to person, through direct contact or droplets spread by the coughing and/or sneezing of an infected individual or by contact with sweat on machines, free weights, benches, treadmills, and bicycles, in which case by performing the disinfection of sites and equipment periodically it is possible to avoid this mode of transmission³⁸.

Scientific evidence has shown that temperature and humidity have proven useful to avoid or spread the virus^{50,51}. Wang et al.⁵¹ highlighted in their study that high temperatures and high humidity reduce the transmission of COVID-19. In the case of indoor physical activity centers, it is recommended to keep spaces open and/or with temperatures above 22 degrees Celsius and humidity between 50% and 80%, measures that have had effective results in reducing contamination⁵⁰.

Another matter that deserves attention is the type of ventilation of indoor physical activity centers, highlighting that ventilation is the process by which “clean” air (usually outside air) is intentionally supplied to a space and stale air is removed, a process that can be carried out by natural or mechanical means⁵².

Research carried out by Ai e Melikov⁵³ reviewed studies on the propagation area of exhaled droplets between occupants of closed spaces, focusing specifically on the dissemination of droplet nuclei from mouth/nose and nose/mouth for non-specific diseases. They emphasized the importance of internal airflow patterns and indicated that future research is necessary on three specific areas: the importance of internal airflow pattern direction, the dynamics of air transmission, and the application of Computational Fluid Dynamics (CFD) simulations.

In view of the COVID-19 pandemic, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) acknowledged the potential for transmission of aerosols that transmit COVID-19 and stated that facilities of all types should follow, at least, the latest standards and guidelines published and good

engineering practices⁵⁴. The ASHRAE standard 62.1 specifies the ventilation rates for a better indoor air quality, which are acceptable for indoor physical activity centers like gyms⁵⁵.

Therefore, it is possible to see how important it is that every protocol, when deployed, is consistently deployed and the compliance of participants monitored regarding the sanitary measures contained therein since individual responsibilities are not more important than the common welfare.

CONCLUSIONS

As mentioned at the beginning of the article, when analyzing the clinical course and risk factors for COVID-19, we identified that several matters around the practice of physical activities during the current pandemic require a more in-depth approach. It is necessary to consider the positive effects of these activities in the general population, according to their degree of risk and comorbidities. One thing is for sure based on scientific evidence: the prophylactic and therapeutic effects of regular physical activity on the health and quality of life of the population.

Thus, we believe that, based on the evidence presented in this study, it would be possible to reopen indoor and outdoor physical activity centers safely, through certifications issued by technical and health organizations, while respecting the existing biosecurity measures. Aiming not to interrupt or completely change the lifestyle of individuals during the COVID-19 pandemic and allowing them to maintain an active lifestyle, which is very important for the health of the population in general. Particularly for individuals in risk groups, people must follow the determinations of the health authorities and practice physical activities at home guided by a physical education professional duly qualified and authorized.

Conflicts of interest

The researchers involved in the work declare there are no conflicts of interest.

Acknowledgments

The present study was carried out with the support of the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* – CAPES) - Funding Code 001.

Author's Contribution

All authors have contributed equally to the work.

REFERENCES

- Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. *Acta Biomed.* 2020;91(1):157-60.
- Silva CMS, Andrade AN, Nepomuceno B, Xavier DS, Lima E, Gonzalez I, et al. Evidence-based physiotherapy and functionality in adult and pediatric patients with COVID-19. *J Hum Growth Dev.* 2020;30(1):148-55.
- Bogoch II, Watts A, Thomas-Bachli A, Huber C, Kraemer MUG, Khan K. Potential for global spread of a novel coronavirus from China. *J Travel Med.* 2020;27(2):taaa011.
- Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, et al. Genomic characterization and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. *Lancet.* 2020;395(10224):565-74.
- Zbinden-Foncea H, Francaux M, Deldicque L, Hawley JA. Does high cardiorespiratory fitness confer some protection against proinflammatory responses after infection by SARS-CoV-2? *Obesity (Silver Spring).* 2020;10.1002/oby.22849.
- World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. Geneva: World Health Organization; 2020. [cited 2020 Jul 4]. Available from: <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-COVID-19---11-march-2020>
- European Centre for Disease Prevention and Control. COVID-19 Situation update 19 May 2020, dataset collected 6:00-10:00 CET. Solna: European Centre for Disease Prevention and Control; 2020. [cited 2020 May 19]. Available from: <https://www.ecdc.europa.eu/en/COVID-19-pandemic>
- Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet.* 2020;395(10223):514-23.
- World Health Organization. Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. Geneva: World Health Organization; 2020 [cited 2020 Jul 4]. Available from: www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-COVID-19-implications-for-ipc-precaution-recommendations
- Liu Y, Ning Z, Chen Yu, Guo M, Liu Y, Gali NK. Aerodynamic analysis of SARS-CoV-2 in two Wuhan hospitals. *Nature.* 2020;582(7813):557-60.
- Asadi S, Bouvier N, Wexler AS, Ristenpart WD. The coronavirus pandemic and aerosols: does COVID-19 transmit via expiratory particles? *Aerosol Sci Technol.* 2020;0(0):1-4.
- Cai J, Sun W, Huang J, Gamber M, Wu J, He G. Indirect virus transmission in cluster of COVID-19 cases, Wenzhou, China, 2020. *Emerg Infect Dis.* 2020;26(6):1343-5.
- Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC. Pathophysiology, transmission, diagnosis, and treatment of coronavirus disease 2019 (COVID-19): a review. *JAMA.* 2020. doi: 10.1001/jama.2020.12839.
- Blocken B, van Druenen T, van Hooff T, Verstappen PA, Marchal T, Marr LC. Can indoor sports centers be allowed to re-open during the COVID-19 pandemic based on a certificate of equivalence? *Build Environ.* 2020;180:107022.
- Liu W, Zhang Q, Chen J, Xiang R, Song H, Shu S, et al. Detection of COVID-19 in children in early January 2020 in Wuhan, China. *N Engl J Med.* 2020;382(14):1370-1.
- Murthy S, Gomersall CD, Fowler RA. Care for critically ill patients with COVID-19. *JAMA.* 2020. doi: 10.1001/jama.2020.3633.
- Yang J, Zheng Y, Gou X, Pu K, Chen Z, Guo Q, et al. Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: a systematic review and meta-analysis. *Int J Infect Dis.* 2020;94:91-5.
- Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet.* 2020;395(10223):497-506.
- Kim Y, Lee E. The association between elderly people's sedentary behaviors and their health-related quality of life: focusing on comparing the young-old and the old-old. *Health Qual Life Outcomes.* 2019;17(1):131.
- Chen P, Mao L, Nassis GP, Harmer P, Ainsworth BE, Li F. Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions. *J Sport Health Sci.* 2020;9(2):103-4.
- Halabchi F, Ahmadinejad Z, Selk-Ghaffari M. COVID-19 epidemic: exercise or not to exercise; that is the question! *Asian J Sports Med.* 2020;11(1):e102630. doi: 10.5812/asjasm.102630.
- Simpson RJ, Katsanis E. The immunological case for staying active during the COVID-19 pandemic. *Brain Behav Immun.* 2020;87:6-7.
- Laddu DR, Lavie CJ, Phillips SA, Arena R. Physical activity for immunity protection: inoculating populations with healthy living medicine in preparation for the next pandemic. *Prog Cardiovasc Dis.* 2020;S0033-0620(20)30078-5.
- Pratt M, Ramirez Varela A, Salvo D, Kohl III HW, Ding D. Attacking the pandemic of physical inactivity: what is holding us back? *Br J Sports Med.* 2020;54(13):760-2.
- Kohl HW 3rd, Craig CL, Lambert EV, Inoue S, Alkandari JR, Leetongin G, et al. The pandemic of physical inactivity: global action for public health. *Lancet.* 2012;380(9838):294-305.
- Ozemek C, Lavie CJ, Rognmo O. Global physical activity levels: need for intervention. *Prog Cardiovasc Dis.* 2019;62(2):102-7.
- World Health Organization. Physical inactivity: a global public health problem. 2020. Geneva: World Health Organization; 2020. [cited 2020 Jul 4]. Available from: https://www.who.int/dietphysicalactivity/factsheet_inactivity/en/
- Lavie CJ, Ozemek C, Carbone S, Katzmarzyk PT, Blair SN. Sedentary behavior, exercise, and cardiovascular health. *Circ Res.* 2019;124(5):799-815.
- Sociedade Brasileira de Medicina do Exercício e do Esporte. Informe 4 da Sociedade Brasileira de Medicina do Exercício e do Esporte (SBMEE) - Perguntas mais frequentes sobre exercício físico e a COVID-19. São Paulo: SBMEE; 2020. [cited 2020 Jul 4]. Available from: www.medicinadoesporte.org.br/wp-content/uploads/2020/04/informe130420.pdf
- Pitanga FJG, Beck CC, Pitanga CPS. Should physical activity be considered essential during the COVID-19 pandemic? *Int J Cardiovasc Sci.* 2020;33(4):401-3.
- Lima JHV, Oliveira Araújo RM, Cortez ACL. Diferenças entre os treinos alodinâmicos e isodinâmicos no ganho de massa muscular: uma revisão sistemática. *Fitness & Performance J.* 2014;(1):7-13.
- United Nations. United Nations sustainable development goals. Available from: <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>
- Van Der Merwe FJG. British and South African soccer on the western front during World War I. *South Afr J Res Sport Phys Educ Recreat.* 2013;35(2):197-209.
- Waquet A. Sport in the trenches: the new deal for masculinity in France. *Int J Hist Sport.* 2011;28(3-4):331-50.
- Nyenhuis SM, Greiwe J, Zeiger JS, Nanda A, Cooke A. Exercise and fitness in the age of social distancing during the COVID-19 pandemic. *J Allergy Clin Immunol Pract.* 2020;8(7):2152-5.
- Rubin GJ, Wessely S. The psychological effects of quarantining a city. *BMJ.* 2020;368:m313.
- NOC*NSF. Protocol responsible physical exercise [in Dutch]. Arnhem: NOC*NSF; 2020. [cited 2020 Jul 14]. Available from: https://nocnsf.nl/media/2669/nocnsf_protocol_verantwoord-sporten-v3.pdf
- NL Actief Protocol responsible physical exercise - Branche: fitness [in Dutch]. Conceptversion. 2020. [cited 2020 Jul 14]. Available from: www.nlactief.nl
- BRASIL. Ministério da Educação. Protocolo de biossegurança para retorno das atividades nas Instituições Federais de Ensino. Brasília: Ministério da Educação; 2020. [cited 2020 Jul 14]. Available from: <https://vps3574-publiccloud.com.br/cartilhario.pdf>
- Chen CC, Willeke K. Aerosol penetration through surgical masks. *Am J Infect Control.* 1992;20(4):177-84.
- He X, Reponen T, McKay RT, Grinshpun SA. Effect of particle size on the performance of an N95 filtering facepiece respirator and a surgical mask at various breathing conditions. *Aerosol Sci Technol.* 2013;47(11):1180-7.
- van der Sande M, Teunis P, Sabel R. Professional and home-made face masks reduce exposure to respiratory infections among the general population. *PLoS One.* 2008;3(7):e2618.
- Zhai J. Facial mask: a necessity to beat COVID-19. *Build Environ.* 2020;175:106827.
- Dwyer C, Aubrey A. CDC now recommends Americans consider wearing cloth face coverings in public. Washington: National Public Radio - NPR; 2020 April 3. [cited 2020 Jun 13]. Available from: <https://www.npr.org/sections/coronavirus-live-updates/2020/04/03/826219824/president-trump-says-cdc-now-recommends-americans-wear-cloth-masks-in-public>
- Elegant NX. Why the U.S. is changing its mind on coronavirus face masks. *Fortune.* 2020 Apr 3. [cited 2020 Jun 13]. Available from: <https://fortune.com/2020/04/03/coronavirus-face-mask-cdc/>

46. Feng S, Shen C, Xia N, Song W, Fan M, Cowling BJ. Rational use of face masks in the COVID-19 pandemic. *Lancet Respir Med*. 2020;8(5):434-6.
47. The Bulletin. Coronavirus in Belgium: what are the rules on wearing masks? Brussels: The Bulletin; 2020 May 9. [cited 2020 Jun 13]. Available from: <https://www.thebulletin.be/coronavirus-belgium-should-we-be-wearing-masks-0>
48. UNITED STATES OF AMERICA. Food and Drug Administration. N95 respirators, surgical masks, and face masks. Silver Spring: FDA; 2020. [cited 2020 May 12]. Available from: www.fda.gov/medical-devices/personal-protective-equipment-infection-control/n95-respirators-and-surgical-masks-face-masks
49. Howard J, Huang A, Li Z, Tufekci Z, Zdimas V, van der Westhuizen HM. Face masks against COVID-19: an evidence review. Preprints. 2020. doi: 10.20944/preprints202004.0203.v1.
50. Moriyama M, Hugentobler WJ, Iwasaki A. Seasonality of respiratory viral infections. *Annu Rev Virol*. 2020. doi: 10.1146/annurev-virology-012420-022445.
51. Wang J, Tang K, Feng K, Lin X, Lv W, Chen K, et al. High temperature and high humidity reduce the transmission of COVID-19. 2020. SSRN. 2020. Available from: <https://ssrn.com/abstract=3551767>
52. Air Infiltration and Ventilation Centre (AIVC). International Energy Agency. What is ventilation? AIVC; 2020. [cited 2020 May 11]. Available from: <https://www.aivc.org/resources/faqs/what-ventilation>
53. Ai ZT, Melikov AK. Airborne spread of expiratory droplet nuclei between the occupants of indoor environments: a review. *Indoor Air*. 2018;28(4):500-24.
54. American Society of Heating, Refrigerating and Air-Conditioning Engineers. (ASHRAE). Environmental Health Committee (EHC) emerging issue brief. Pandemic COVID-19 and airborne transmission. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers; 2020. [cited 2020 Jun 8]. Available from: <https://www.ashrae.org/file%20library/technical%20resources/COVID-19/eiband-airbornetransmission.pdf>
55. American Society of Heating, Refrigerating and Air-Conditioning Engineers. (ASHRAE). The standards for ventilation and indoor air quality. ANSI/ASHRAE Standard 62.1-2019. Ventilation for acceptable indoor air quality. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers; 2019. [cited 2020 Jun 8]. Available from: <https://www.ashrae.org/technical-resources/bookstore/standards-62-1-62-2>

