Emerging Evidence on COVID-19

Evidence Brief on the Risk of COVID-19 and Non-Professional Sports

Introduction

What evidence is available on the risk of transmission of SARS-CoV-2 from playing non-professional sports and has research been conducted on modified play to mitigate the transmission risk?

Governments and health authorities across the globe implemented lockdown and social distancing practices in an effort to mitigate SARS-CoV-2 spread within populations. These included closing of workplaces, schools, and other public venues, as well as the cancelling of sporting events and games. As public health measures to curb the pandemic are cautiously relaxed, many consider retuning to physical activity and sports. This evidence brief provides an overview of the published literature on SARS-CoV-2 transmission risks associated with playing non-professional sports up to August 18, 2020.

Key Points

- Two published investigations of SARS-CoV-2 outbreaks associated with recreational physical activity appear in the literature (Table 1). These transmission events were linked to indoor fitness facility settings and aerobic activities (one a Zumba class, the other playing squash) and occurred in March 2020.
- An additional 10 transmission events related to sports or exercise were identified in a COVID-19 Superspreading Events database (Swinkles, 2020).
    - Several transmission events have been reported in gyms associated with indoor classes, bonspiels, square dancing, and football. Many of these are considered high contact activities within the reporting news articles.
    - The actual sources of infection and transmission within these clusters arising from team sports events have not been identified. For example, in two curling bonspiels and one road hockey game, social activities also occurred before and/or after the game. Similarly, the source of an outbreak in a soccer team in Japan that is on-going has not been identified.
    - Activities such as running do no appear to be at high risk of transmission, a single cluster between running partners was identified.
- Computer simulations of SARS-CoV-2 aerodynamics concluded that respiratory droplets will ride a runner's slip steam and thus, one should avoid running or walking directly behind another person (Blocken, Malizia, van Druenen, & Marchal, 2020).

- Wong et al., report findings from two independent investigations applicable to participation in sports and SARS-CoV-2 transmission (Wong et al., 2020).
    - Analysis of professional soccer game video footage estimates a semi-professional soccer player spends on average 20% of the game within close contact of another player.
    - Experimental simulations of physical activity among athletes found individuals who wore a face mask recorded higher heartrates and perceived exertion compared to those not wearing a face mask.
- Helpful strategies to reduce the risk of SARS-CoV-2 transmission during sports can be found in World Health Organization (WHO) guidance documents, risk assessment tools, and published commentaries (Table 2).
    - WHO guidance outlines key considerations, risks, and mitigation based on the type of sport (i.e. the level of contact among players), size of the event, indoor/outdoor locations, venue facilities, demographics of competitors and spectators, and risk communication, and provides guidance on managing SARS-CoV-2 cases that may be identified at a sporting event (WHO, 2020a). The document is to be used in conjunction with the Key Planning Recommendations for Mass Gatherings in the Context of the Current COVID-19 Outbreak (WHO, 2020b), and Mass Gathering COVID-19 Risk Assessment Tool – Sports Events (WHO, 2020c).
    - Commentary by Carmody et al. proposes a risk assessment matrix to support decision makers on restarting sports events that is based on WHO guidance and consideration of local community transmission of SARS-CoV-2 (Carmody, Murray, Borodina, Gouttebarge, & Massey, 2020).
    - A technical note by Blocken et al. considers the process of reopening indoor exercise facilities while minimizing SARS-CoV-2 transmission. Based on the application of limited indirect evidence, the authors conclude deep exhalation and inhalation from exercise can increase respiratory aerosol emission and inhalation. As such, they advocate for the use of displacement (vs. mixing) ventilation systems, HEPA filters, and limited occupancy within indoor facilities where physical exercise is frequent (B. Blocken et al., 2020).
    - Guidance for physical educators at Chinese schools reinitiating after the COVID-19 lockdown, proposes various strategies, such as the use of drills and staggered physical activity periods, that can be adopted by non-professional sports teams to mitigate transmission risks.

Overview of the Evidence

Publications that directly report on SARS-CoV-2 and non-professional sports is sparse. As such, we applied the available evidence from indoor sports facility settings (i.e. gyms) and professional sports to deduce transmission risks. Fifteen relevant publications and guidance documents on physical activity and sports informed this review.

Among the included publications are two detailed outbreak investigations and 10 reports of SARS-CoV-2 outbreaks associated with sports or exercise from the COVID-19 Superspreading Events Database (Table 1). Although outbreak investigations can be sensitive to high risk of bias the two published investigations appear to have been carefully conducted, with robust case finding and contact tracing activities that minimize sampling bias. The Superspreading Events Databased includes COVID-19 case clusters (n>5 cases) identified from national COVID-19 dashboards and news articles, none of which provide detailed information about the transmission event. As such the information included in this database is noted to be incomplete and imperfect, and highly sensitive to multiple biases and confounders.

The observational analyses scored video footage of a soccer game and has moderate risk of investigator bias, but the reported physiologic measurements were less sensitive to such bias; it simply compared heart rate and rate of perceived exertion in those who wore masks or not. The computer simulation study to observe air flow dynamics in runners is largely theoretical and would have a low risk of bias.

The literature on strategies to mitigate infection transmission risk in non-professional sports is largely limited to commentaries and expert guidance (Table 3). This literature is grounded in available public health evidence and adopts strategies commonly used to minimize SARS-CoV-2 transmission in public settings.

Overall, there remains considerable knowledge gaps in this literature, as such current guidance largely depends on the general principles of risk assessment and mitigation and COVID-19 public health guidance.

CONTENTS

OUTBREAKS ASSOCIATED WITH PARTICIPATION IN SPORTS/PHYSCIAL ACTIVITY

There are few transmission events associated with sports in the current COVID-19 literature. This may largely be due to the public health measures that stopped most sporting activities since early in the pandemic. With the exception of the Zumba outbreak describe by Jang et al., other outbreaks lack detailed investigation or were also associated with social activities before or after the sports activity that make it difficult to attribute transmission to participation in the sport itself.

The outbreak currently on-going within a Japanese soccer team underscores how SARS-CoV-2 infections can travel within a team, and infection control guidelines and precautions should be part of return to sports plans (Swinkles, 2020).

Table 1. Twelve Outbreaks of COVID-19 Linked to Sports and Exercise

Reference	Publication Title	Key Outcomes
(Jang, Han, & Rhee, 2020)	Cluster of Coronavirus Disease Associated with Fitness Dance Classes, South Korea	Summarizes the investigation of 112 COVID-19 cases associated with Zumba classes at 12 different fitness/sports facility locations in South Korea. The primary attack rate was estimated to be 26.3% (95% CI 20.9%–32.5%) and the secondary attack rate was 4.10% (95% CI 2.95%–5.67%). The initial transmission event is assumed to have occurred among fitness instructors at a workshop, where eight of the twenty seven attendees tested positive for SARS-CoV-2. Over the following weeks the infection transmissions occurred among dance class attendees, household contacts, colleagues and acquaintances of instructors and students. 50.9% (n=63) of cases were the result of transmission from instructors and 52 cases were identified among to dance class attendees. The instructors and students met only during classes, which lasted for 50 minutes 2 times per week, and did not have contact outside of class. No cases were observed among Pilates and yoga class participants, also taught by an infected instructor in the same sports/fitness facility setting. These observations suggest the lower intensity of Pilates and yoga did not lead to the same transmission effects as those that occurred during the dance classes, whether that is due to less respiratory droplets or less air movement was not determined.
(Brlek, Vidovič, Vuzem, Turk, & Simonović, 2020)	Possible Indirect Transmission of COVID-19 at a Squash Court, Slovenia, March 2020: Case Report	A SARS-CoV-2 case cluster (n=6) linked to playing squash at a sports venue in Maribor, Slovenia is described. The index case (person A), assumed to have acquired the infection during travel to Italy developed symptoms (i.e. tiredness and fatigue) during the game of squash. Epidemiological investigations link additional cases (four confirmed and one suspect) to the same squash hall and change rooms. Case B had direct contact with the index case, as they spent time in the change room and played a squash match together. Case C and D do not report direct contact with the index case (or Case B), and are epidemiologically linked through the use of change rooms and playing in the same squash court within 20 minutes of case A and B. The remaining two cases, Case E and Case F, arrived at the sports facility approximately 1.5 hr after index case's departure. This pair of cases spoke with Case C and D outside the squash court, used the same change room and the same squash court.

		None of the cases shared sport equipment or had contact with the facility staff. No additional cases were identified.
(Swinkles, 2020)	SARS-CoV-2 Super Spreading Events Around the World	An additional 10 sports events linked to transmission have been reported in news articles, as listed in the database of COVID-19 Superspreading Events (SSE) from around the world. This information source often lacks details of the outbreak or activities that likely resulted in transmission: - 2 curling bonspiels (multiday tournament and social) in Edmonton, Canada March 14-15. 24/72 attendees developed COVID-19 and in Maryland USA March 27, ~20 cases, - Outdoor ball hockey and they "shared a drink" Racine, QC, Canada, Feb 29. 15/21 were infected with COVID-19 - Running, an infected marathon runner transmitted the virus to his running partner, in Italy, February, - Soccer team, Sagan Tosu J1, outbreak, Japan August. 11 players and coaches infected to date, - Square dancing, Lynnwood, WA, USA, February, there was little testing and no investigation. Only anecdotal information that some who were tested were COVID-19 positive (>15 people), - Two gym and one table tennis school outbreak is recorded in Japan without further details and 1 gym outbreak is recorded in Singapore.

TRANSMISSION RISK WHEN PLAYING SPORTS

Two studies provide evidence applicable to COVID-19 transmission risk during sports. One study was a video analysis of a professional football (soccer) game. It identified there was close player-to-player contact for ~19/90minutes game and approximately 52 episodes of high risk interactions (Wong et al., 2020). The use of face masks during exercise was studied under laboratory conditions and this small study concluded heart rate and perceived exertion were significantly elevated after six minutes of moderate exercise with a mask compared to not wearing a mask (Wong et al., 2020).

The other study examined aerodynamic dispersion of droplets when someone is running to assess the transmission risk if an individual is following an infected runner (Bert Blocken et al., 2020). If the individuals are running or walking fast even at 1.5 meters apart there is some risk of infectious particle exposure if the trailing person is directly behind the leading person (positioned in the slipstream). This exposure can be avoided if two runners are beside each other (1.5 meters apart) or are staggered.

Table 2. COVID-19 Transmission Risk When Playing Sports

Reference	Publication Title	Key Outcomes
(Wong et al., 2020)	Impact of the COVID-19 Pandemic on Sports and Exercise.	Video footage of professional Soccer players in Hong Kong was analysed to track players' time engaged in close body contact and frequency of behaviours that increase infection transmission risk. The analysis finds the average duration of close contact between players to be a mean of 19 minutes (range 5.9-35.5)/ 90 minute game, and each player engaged in an average of 52 episodes of increased infection transmission risk behaviour (touching eyes, mouth or nose), during a 90 minute game. The physiological effects of wearing a mask during play was also examined in laboratory settings. The heart rate and rate of perceived exertion (RPE) of participants wearing a face mask were significantly elevated compared to those without a face mask after 6 minutes of moderate exercise (heart rate of 128 beats per minute and 12.7 RPE when masked, heart rate of 124 beats per minute and a RPE of 10.8 when unmasked). Values were statistically significant, but they may not be biologically significant. The investigation concludes infection transmission risk to be high among players during a game, even without spectators. Donning of face masks during physical exercise increases the physiological burden of the body, with implications for those with multiple underlying comorbidities.
(Bert Blocken et al., 2020)	Towards Aerodynamically Equivalent COVID19 1.5 m Social Distancing for Walking and Running	Computer Fluid Dynamics study informed by previous data on droplet dispersion around a runner takes into account the potential aerodynamic effects introduced by individual movements (e.g., walking fast, running and cycling) on droplet travel distance. The study investigates whether a leading infectious person standing still and moving nearby a second susceptible person at a distance of 1.5 meters or more can pose any infection transmission risk. Although particle exposure is negligible when two people are standing 1.5 meters apart, if the individuals are running or walking fast even at 1.5 meters apart there is some risk of infectious particle exposure. The study results suggest the greatest exposure to the trailing person occurs if they are directly behind the leading person (positioned in the slipstream). Substantial droplet exposure risk reduction can be achieved by 1) avoiding to walk or run in the slipstream of the leading person,

		2) keeping the 1.5 meters distance in staggered or side by side arrangement, or 3) by keeping social distances greater than 1.5 meters when moving fast or running.

STRATEGIES AND GUIDANCE

The literature on strategies to mitigate infection transmission risk in non-professional sports includes two WHO interim guidance documents, two risk assessment tools and several expert commentaries (Table 2). Considerations of local SARS-CoV-2 transmission and case rates, risk assessments to identify potential levels of contact among players, limiting the number of players, prioritizing outdoor play and social distancing, prohibiting the shared use of sports equipment, enhanced cleaning and disinfection practices, and screening of participants to effectively identify and isolate SARS-CoV-2 cases are overarching strategies. The WHO recommends refraining from direct contact sports as they increased risk of direct exposure to infection.

Two tools for assessing COVID-19 risk in sports among spectators and participants were identified. The WHO Mass Gathering COVID-19 Risk Assessment Tool - Sports Events, provides a decision tree, risk evaluation, risk mitigation, decision matrix, and risk communication that mass sports event organizers and host countries can apply to determine infection spread associated with an event. An alternative risk matrix is presented by Carmody et al. This risk assessment tool is based on WHO interim guidance, applies local community transmission rates, and mitigation measures to calculate residual risk associated with various professional sports. The commentary by Timpka note the importance of trust, that if players think that other players are not going to abide by COVID-19 restrictions, they are also unlikely to adhere to them. This points to the importance of an excellent communication plan.

Some indirect evidence predating SARS-CoV-2, as presented in the technical note by Blocken, suggest physical activity can increase the emission and inhalation of respiratory aerosols with the potential to cause infection (B. Blocken et al., 2020). Although much of the evidence on aerosol transmission of SARS-CoV-2 is currently evolving the available evidence and outbreaks do point to elevated risks of infection transmission when performing intense physical activity in crowded indoor settings. This evidence should be weighted appropriately when considering the return to non-professional sports in indoor settings.

Table 3. Strategies to Reduce COVID-19 Transmission During Sports

Reference	Publication Title	Key Statements
(WHO, 2020a)	Considerations for Sports Federations/Sports Event Organizers when Planning Mass Gatherings in the Context of COVID-19	Provides key considerations and risk factor mitigating techniques. Recommendations are based on the consideration of contact and transmission risk within a sport, size of the event (i.e. number of attendees), the location of the event, venue facilities, the demographics of participating players, and the adoption of relevant public health guidance.

		Recommendations include daily health check for competitors, distance (at least 1 meter) separation of competitors, officials, spectators and support staff, thorough disinfection and cleaning, the prohibition of sharing equipment, utilization of outdoor venues where possible, the use of designated and physically separated seating and isolation areas to support potential case management and contact tracing activities and effective risk communication and advising individuals at increased risk of SARS-CoV-2 mortality and morbidity to not attend the sports event. Interim guidance, April 14, 2020
(WHO, 2020c)	WHO Mass Gathering COVID-19 Risk Assessment Tool – Sports Events	A formal risk assessment and risk communication tool to be used in conjunction with the, Considerations for Sports Federations/Sports Event Organizers when Planning Mass Gatherings in the Context of COVID-19, document (above). Updated July 10, 2020
(WHO, 2020b)	Key Planning Recommendations for Mass Gatherings in the Context of COVID-19	Provides guidance to host governments, health authorities and national or international organizers of mass gatherings on containing risks of COVID-19 transmission associated with mass gathering events. Interim guidance, May 29, 2020
(Carmody et al., 2020)	When Can Professional Sport Recommence Safely During the COVID-19 Pandemic? Risk Assessment and Factors to Consider	Presents a risk assessment matrix to support decision makers on restarting professional sports when COVID-19 public health measures begin to relax. In addition to leveraging the considerations outlined by WHO guidance (i.e. WHO Guidelines for Mass Gatherings, Considerations for Sports Events, and WHO Sporting Risk Assessment) the risk assessment takes local community transmission of COVID-19 into account. The basic approach is to assess risk, then consider mitigation measures, and then calculate residual risk. Based on the application of this risk assessment, professional soccer is identified to be of high residual risk, while professional golf is considered low residual risk, if appropriate infection mitigation measures are applied. Based on the application of this risk matrix the authors suggest overall risk of restarting sporting events can be low, if local community transmission is low and adequate risk mitigation

		procedures are in place. Professional soccer is assessed at high residual risk, while professional golf is considered to be of low residual risk.
(Timpka, 2020)	Sports Health During the SARS-Cov-2 Pandemic	Written prior to release of WHO guidelines, this commentary states sports organisations should address the athletes and coaches needs, while complying with social distancing and regional public health guidance on COVID-19, when developing a pandemic response strategy. Highlights the importance of trust: "If sportspeople do not believe that most others are going to play by the temporary restrictive rules, they are unlikely to adhere to them. The authors suggest sports activities should be performed outdoors in small groups and physical contact among players avoided as much as possible. Virtual competitions encouraged among athletes of individual sports.
(B. Blocken et al., 2020)	Can Indoor Sports Centers be Allowed to Re-open During the COVID-19 Pandemic based on a Certificate of Equivalence?	Identifies evidence (predating the emergence of COVID-19) that found deep exhalation (as with physical exercise) produces higher concentrations of aerosols and deep inhalation increases exposure to aerosols. Based on this the authors identify the need for good ventilation (displacement of air from floor to ceiling better than mixing), HEPA filters, applying public health measures to visitors and staff, cleansing surfaces for fomites and ensuring no contact activities. The authors also proposed the idea of a Certificate for indoor sports centers prior to reopening.
(Chen et al., 2020)	Returning Chinese School-Aged Children and Adolescents to Physical Activity in the Wake of COVID-19: Actions and Precautions	Summarizes precautions that can be taken by school administrators, physical educators and parents for physical activity as schools in China begin to come back post COVID-19 lockdown that include: - Encouraging proper social distancing (at least 1 meter), - Staggering time tables to avoid crowding, - Making hand-washing or hand sanitizer stations readily accessible, - Sanitizing all surfaces and equipment regularly, - Restricting physical activities that involve body contact and the sharing of sports equipment and water bottles.
(Peter, 2020)	Return to Play After COVID-19: A Sport Cardiologist's View	The article outlines the need for a cardiac assessment prior to a return to sports for adult COVID-19 cases noting sub-clinical cardiac injuries can occur following SARS-CoV-2 infection.

(Dores & Cardim, 2020)	Returning to Play After Coronavirus Infection: A Perspective From Pediatric Cardiologists	The article outlines the need for a cardiac assessment prior to a return to sports for pediatric COVID-19 cases following SARS-CoV-2 infection, as sub-clinical cardiac injury may be present post infection.

Methods

All of the literature on COVID-19 has been compiled and organized by the Emerging Science Group of the Public Health Agency of Canada since the beginning of the outbreak. This involves a daily scan of the literature for all published and pre-published articles. Searches to retrieve relevant COVID-19 literature are conducted in PubMed, Scopus, BioRxiv, MedRxiv, ArXiv, SSRN, and Research Square. These are cross-referenced with the literature on the World Health Organization COVID literature list, and COVID-19 information centers run by Lancet, BMJ, Elsevier, and Wiley. The daily summary and full scan results are maintained in a RefWorks database and a searchable Excel file. Each article is tagged using various foci to identify the focus of the article (e.g., epidemiology, clinical data, therapeutics etc.). Targeted keyword searching is conducted within these databases to identify relevant citations on COVID-19 and SARS-CoV-2. The search terms included in this review were sports, exercise and physical fitness/activity. Each potentially relevant reference was analyzed to confirm its relevance and data was extracted into the review. This review contains research published up until August 18, 2020.

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