Summary of Evidence Related to
Recreational, Youth, and Collegiate Sports and the Risk of COVID-19
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COVID-19 Literature Report Team:
Brandon L. Guthrie PhD, Ashley Tseng MPH, Lorenzo Tolentino MPH, Jessie Seiler MPH, Rodal Issema MPH, Molly Fisher MPH, Sherrilynne Fuller PhD FACMI, Dylan Green MPH, Diana Louden MLib, Alison Drake PhD MPH, Will Hahn MD, Jennifer M. Ross MD MPH

Recreational, youth, and collegiate sports are an important component of physical and psychological health for many people. Many sports activities have been affected by the COVID-19 pandemic, and despite many closures in response to the pandemic, sports have restarted or remained open in many settings. **This document is a brief summary of published evidence related to the role of recreational, youth, and collegiate sports in COVID-19 and SARS-CoV-2 transmission and considerations for conducting sports during the pandemic. Included are manuscripts published in peer-reviewed journals or on pre-print servers through February 24, 2021.** This summary does not consider professional sports or the role of large spectator gatherings related to sports events in driving SARS-CoV-2 transmission. References summarized in this report were drawn from the COVID-19 Literature Report (Lit Rep) team database. **References that appeared in the daily Lit Rep are marked with an asterisk***, and the summary is shown in the annotated bibliography below.

Executive Summary of Evidence Related to Recreational, Youth, and Collegiate Sports in the Context of COVID-19

- **Outbreaks of SARS-CoV-2 have been observed among youth and collegiate athletes, particularly in the context of indoor and contact sports. In documented outbreaks (e.g., hockey and wrestling), a high proportion of participating athletes have become infected (30% to 80%) and secondary transmission, particularly to household contacts, has been observed.**
- **Asymptomatic or pre-symptomatic individuals have been the source of infection in a number of SARS-CoV-2 outbreaks linked to sports events.**
- **Large scale youth sports, including team sports (e.g., soccer), have been conducted with little evidence of SARS-CoV-2 transmission. Successful examples of reopening sports have had high levels of mask usage and other risk reduction measures. The lowest incidence of COVID-19 has been observed for outdoor and non-contact sports.**
- **Outbreaks of SARS-CoV-2 have occurred within collegiate athletic teams. In many cases, it appears that transmission was driven more by social gatherings than directly through athletic activities.**
- **The American Academic of Pediatrics advises that children participating in athletic activities use cloth face masks during all indoor sports, except for swimming and diving, cheerleading, gymnastics, and wrestling. Cloth masks are also recommended for persons on the sidelines, in locker rooms, and in training sessions.**
- **There is some evidence of heart muscle inflammation following COVID-19 and SARS-CoV-2 infection among youth and collegiate athletes. The American Academy of Pediatrics has issued revised guidelines for children returning to athletic activities after COVID-19.**

Recreational Sports

Participation in recreational sports ranges from children of all ages to older adults and includes both individual and team sports. Additionally, recreational sports include activities that range from necessarily close contact between participants to individual activities with minimal contact between participants and from large teams to individual participants. Thus the potential for SARS-CoV-2 transmission linked to participation in recreational sports varies considerably. There have been a number of outbreaks of SARS-CoV-2 linked to recreational team sports (Atrubin*, Kuitunen*), but there have also been examples of successful implementation of recreational team sports with little evidence of increased risk of SARS-CoV-2 infection (Watson*). No evidence in the published or pre-print literature was identified that provides generalizable estimates of the risk of SARS-CoV-2 infection associated with participation in recreational sports overall, let alone stratified by age, type of sport, or risk mitigation protocol model. Among participants in recreational sports, fear and anxiety related to COVID-19 was highest among older adults and those who participated in group sports, according to survey results from South Korea (Choi*).

- There have been two COVID-19 outbreaks reported among **recreational hockey leagues**. The first involved a cluster of cases originating from a pre-symptomatic player (Atrubin*). The outbreak was linked to an indoor hockey game in Tampa, Florida in June 2020. The index case experienced symptoms one day after the game and subsequently had a positive antigen test. Overall, **62% (13 of 21) players experienced illness 2-5 days after the game** (8 teammates, 5 members of the other team), as did one rink staff member. Thirteen of 15 people, including the index case, had positive SARS-CoV-2 tests (11 PCR, 2 antigen). The second outbreak occurred across five U-20 hockey teams in Finland resulting from a pre-symptomatic player who developed symptoms one day after the hockey game (Kuitunen*). The index player, who was **pre-symptomatic at the time, infected 22 of 28 teammates**. The team had returned from an away trip the day before the first players had symptoms. COVID-19 was detected in both teams a few days later. During two weeks of quarantine, a total of 24 players from the two opposing teams tested positive. Some of these players infected additional players on other teams. In total, 49 infections were detected in five ice hockey teams, and six teams were in quarantine for two weeks.
- **No relationship was found between participating in US youth soccer club activities in summer 2020 and COVID-19 incidence** among players or staff (Watson*). Youth soccer clubs in the US involving 85,861 players that had restarted in-person activities reported 218 COVID-19 cases among their members. None of the cases resulted in hospitalization or death. The authors used these cases to estimate the incidence of COVID-19 among youth soccer athletes and concluded that it was lower than the overall national rate for children in the US (254 vs 477 cases per 100,000). No relationship was identified between club COVID-19 incidence and phase of return to soccer. Youth soccer clubs universally report implementing risk reduction procedures.

K-12 School-Associated Sports

K-12 school-associated sports, primarily at the middle and high school level were widely canceled in the early phase of the COVID-19 pandemic. Subsequently, school sports have been restarted, at least in some form, in many communities. With each school implementing their own model of virtual learning and reopening over the course of the pandemic, the landscape of returning to school sports has differed from school-to-school as well. **CDC guidelines for reopening K-12 schools** for in-person instruction have

emphasized the importance of **prioritizing in-person instruction over extracurricular activities**, including sports (CDC*). Well-documented outbreaks of COVID-19 have occurred in the context of school sports (Atherstone*). At the same time, many athletes have experienced an incidence of COVID-19 that is similar to what is found in the general population (Sasser*). **Outdoor and non-contact sports have been associated with a lower incidence of COVID-19** compared to indoor and contact sports (Watson*). Consideration of the risk associated with school-associated sports should consider more than just the student athletes and coaching staff, and should also include a focus on the **impacts on their household contacts**. In some situations, school sports have resulted in transmission of SARS-CoV-2 to household members (Atherstone*).

- In Wisconsin in September 2020, among 207 high schools that reinitiated sports, there were 270 COVID-19 cases among 30,074 players (809 cases per 100,000 players and 32.6 cases per 100,000 player-days) (Sasser*). The majority (55%) of cases were attributed to household contact, and 41% were attributed to contact outside sport or school. There was no difference in incidence rates between team and individual sports. 84% of schools required face masks while playing.
- A nationwide survey of 152,484 high school athletes found cumulative incidence of 1,682 COVID-19 cases per 100,000 athletes, corresponding to an incidence rate of 24.6 cases per 100,000 player-days between August and October 2020 (Watson*). Incidence was lower when sports were outdoors and non-contact; however, no differences were detected between team versus individual sports. **Face mask use was associated with a decreased incidence** in girls' volleyball, boys' basketball, and girls' basketball.
- An **outbreak arising from a Florida high school wrestling tournament** in December 2020 had an attack rate of at least 30% (38 of 126 tournament attendees who were tested) and a secondary attack rate of at least 9% (41 of 441 close contacts of the 38 COVID-19 patients). Among contacts, household members had the highest attack rate (at least 30%), test positivity rate (60%), and odds of receiving a positive test result (OR=2.7). The outbreak resulted in an estimated loss of 1,700 in-person school days due to isolation and quarantine of patients and contacts, and the death of one adult contact aged >50 years (Atherstone*).

College Sports

Outbreaks among Collegiate Athletes

On many college and university campuses, collegiate sports have restarted or have continued to be played, even when classes have been conducted in an online or remote format. Outbreaks of SARS-CoV-2 have been identified among college athletes, with **evidence of transmission among teammates** (Teran*). However, in many cases, it has been difficult to determine whether transmissions occurred during athletic activities or during other social interactions between athletes and other members of the campus community (Teran*, Atherstone*).

- An outbreak of SARS-CoV-2 occurred among members of a Chicago university's men's and women's soccer teams in August 2020, with **17 out of 45 (38%) players infected** (Teran*). **A large number of social gathers were reported by the athletes**, with minimal use of masks or physical distancing, including a birthday party, dorm and apartment visits, and an outdoor lake gathering. Four out of the 17 cases were asymptomatic and were identified after universal testing of teams was conducted.
- A modeling study indicated that transmission of SARS-CoV-2 among spectators attending college sporting events (either in person or remotely in groups) could be a driver of community

transmission (Johnson*). The focus of the model was on transmission among spectators rather than directly due to athletic activities.

Quarantine of Exposed Athletes

Quarantine protocols have been implemented among collegiate athletes who are exposed to SARS-CoV-2. Among collegiate athletes who were quarantined following exposure to COVID-19, **one quarter had a positive SARS-CoV-2 test result during quarantine with a mean of 3.8 days from quarantine start until the positive test result** (Atherstone*). Among athletes who had not received a positive test result by day 5, the probability of testing positive decreased from 27% by day 5 to <5% after day 10. More athletes reported exposure to COVID-19 at social gatherings (41%) and from roommates (32%) than they did from exposures associated with athletic activities (13%). The authors concluded that shortening the quarantine period could increase adherence, but still poses a small transmission risk.

Transmission of SARS-CoV-2 in the Context of Athletic Activities

Detailed evidence of the risk of SARS-CoV-2 transmission associated with specific exposures related to athletic activities remains limited. Based on survey results of a large number of athletes, the risk of acquiring SARS-CoV-2 appears to be lower for outdoor and non-contact sports (Watson*). There is limited evidence of possible indirect transmission of COVID-19 either through contaminated objects in the changing room or squash court or aerosol transmission in a squash court in Slovenia (Brlek).

For outdoor contact sports such as football and rugby, the evidence thus far suggests minimal in-game transmission risk. Instead, transmission events appear to be the result of high-risk behavior such as unmasked meetings in confined rooms. An investigation of a cluster of 41 SARS-CoV-2 infections that occurred within the National Football League in late September 2020 identified at least 7 cases of infection where transmission likely occurred during interactions that consisted of less than 15 minutes of cumulative interaction within 6 feet of an infected individual (Mack*). Interviews revealed that some of these brief interactions included high-risk behavior, such as unmasked meetings in small rooms while eating. These findings led to a revised definition of high-risk contact and implementation of stricter prevention protocols. Similarly, an analysis of 4 professional rugby matches in which 8 players were retrospectively found to have SARS-CoV-2 suggested that risk of in-game transmission may be minimal. While video footage analysis and GPS data show the positive players were within 2 meters of other players for up to 316 seconds during 60 interactions, only 1 of 28 identified contacts and 5 of 100 players on opposing teams had positive tests, all of which were eventually linked to either internal club outbreaks or wider-community transmission (Jones*).

Recommendations for mitigation protocols

The American Academic of Pediatrics advises that children returning to athletic activities use cloth face masks during all indoor sports, except for swimming and diving, cheerleading, gymnastics, and wrestling. Cloth masks are also recommended for persons on the sidelines, in locker rooms, and in training sessions (McBride*, American Academy of Pediatrics).

Indirect impacts

The cancellation of school sports due to COVID-19 policies has had negative effects on the mental health of athletes. A cross-sectional study of adolescent student athletes during COVID-19-related school closures and sport cancellations found adolescents who identify as female reported a higher prevalence of moderate to severe anxiety symptoms than those who identify as males (44% vs. 28%) (McGuine*). Prevalence of depression symptoms was highest among those participating in team sports (74%) and lowest for individual sports (65%), and the total quality of life score was worst for athletes from counties with the highest poverty levels.

With a decline of opportunities for children to participate in physical activity due to school closures and physical distancing measures, there has been a notable decrease in exercise during the pandemic. A survey of US parents indicated free play/unstructured activity (90%) and going for a walk (55%) as the two most common physical activities for children. Children engaged in about 90 min of school-related sitting and over 8 hours of leisure-related sitting per day. Parents of children ages 9-13 years were more likely to perceive a greater decrease of physical activity compared to parents of children ages 5-8 (Dunton*).

Returning to Physical Activity after COVID-19

Evidence of heart muscle inflammation following SARS-CoV-2 infection among youth and collegiate athletes

There have been multiple reports of evidence of heart muscle inflammation (myocarditis) among young people, including athletes, leading to concerns about the safety of returning to athletic activities following COVID-19. The actual risk to athletes remains unclear, but the American Academy of Pediatrics has issued revised guidelines for children returning to athletic activities after COVID-19 (McBride*). The guidelines suggest that children who have asymptomatic or mild COVID-19 (less than 4 days of fever) complete a brief cardiovascular evaluation with their primary care provider including assessment for chest pain, shortness of breath, palpitations, or fainting. Children with moderate or severe COVID-19 are recommended to see a cardiologist after symptom resolution and before resuming play.

- Among 26 competitive college athletes who had tested positive for SARS-CoV-2 11-53 days earlier and had not require hospitalization, 4 (15%) had cardiac MRI findings suggestive of myocarditis (heart muscle inflammation) and 8 (31%) athletes exhibited late gadolinium enhancement (LGE) without T2 elevation, suggestive of prior myocardial injury (Rajpal*). Cardiac ventricular function was within normal ranges for all athletes, as measured by cardiac MRI and transthoracic echocardiogram. The authors suggest that cardiac MRI may be a useful tool to risk-stratify athletes for return to competitive sports participation following recovery from COVID-19.
- In a cohort of 48 university student athletes who recovered from SARS-CoV-2 infection and returned to campus in July 2020 in West Virginia (30% asymptomatic), more than 1 in 3 showed signs of resolving heart inflammation on imaging studies (Brito*). Twenty-seven student athletes (56%) had cardiac abnormalities, including 19 students with late enhancement of the pericardium and associated pericardial effusion. No student athlete showed specific imaging features of ongoing myocardial inflammation.

Guidelines and recommendations for returning to sports and exercise following COVID-19 and SARS-CoV-2 infection

- A Game Plan for the Resumption of Sport and Exercise After Coronavirus Disease 2019 (COVID-19) Infection – JAMA Cardiology (May 13, 2020)
- Return-to-Play Guidelines for Athletes After COVID-19 Infection – JAMA Cardiology (Nov 4, 2020)
- Screening of Potential Cardiac Involvement in Competitive Athletes Recovering From COVID-19: An Expert Consensus Statement – JACC. Cardiovascular Imaging (Dec 11, 2020)
- Cardiopulmonary Considerations for High School Student-Athletes During the COVID-19 Pandemic: NFHS-AMSSM Guidance Statement – Sports Health (July 9, 2020)

Existing Guidelines and Other Resources

- COVID-19 Interim Guidance: Return to Sports – American Academy of Pediatrics (Dec 17, 2020)
- Operational Strategy for K-12 Schools through Phased Mitigation – CDC (Feb 12, 2021)
- COVID-19 Guidelines for Sports and Physical Activity – Missouri Medicine (May 2020)
- Playing Non-Professional Football in COVID-19 Time: A Narrative Review of Recommendations, Considerations, and Best Practices – International Journal of Environmental Research and Public Health (Jan 15, 2021)
- Creating a Safe, Return-to-Sport Environment in Upstate New York during the COVID-19 Pandemic – Current Sports Medicine Reports (Jan 5, 2021)
- Promoting Healthy Movement Behaviours among Children during the COVID-19 Pandemic – The Lancet Child & Adolescent Health (June 2020)
- Returning Athletes Back to High School Sports in the COVID-19 Era: Preparing for the Fall – Sports Health (Aug 20, 2020)
- COVID-19 Surveillance in Youth Soccer During Small Group Training: A Safe Return to Sports Activity – Sports Health

Annotated Bibliography

American Academy of Pediatrics. COVID-19 Interim Guidance: Return to Sports (Dec 17, 2020). https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/covid-19-interim-guidance-return-to-sports/

- The American Academy of Pediatrics updated guidelines December 17, 2020 for children returning to athletic activities, including recommendations for cloth face mask use during all indoor sports, except for swimming and diving, cheerleading, gymnastics, and wrestling. Cloth masks are also recommended for people on the sidelines, in locker rooms, and in training sessions. The guidelines suggest that children who have asymptomatic or mild COVID-19 (less than 4 days of fever) complete a brief cardiovascular evaluation with their primary care provider including assessment for chest pain, shortness of breath, palpitations, or fainting. Children with moderate or severe COVID-19 are recommended to see a cardiologist after symptom resolution and before resuming play.

Atherstone et al. (Jan 8, 2021). Time from Start of Quarantine to SARS-CoV-2 Positive Test Among Quarantined College and University Athletes — 17 States, June–October 2020. MMWR. https://doi.org/10.15585/mmwr.mm7001a2

- An analysis conducted by CDC with the National Collegiate Athletic Association found that among collegiate athletes exposed to COVID-19 (n=1,830), one quarter had positive test results during quarantine with a mean of 3.8 days from quarantine start until the positive test result. Among

athletes who had not received a positive test result by day 5, the probability of testing positive decreased from 27% after day 5 to <5% after day 10. More athletes reported exposure to COVID-19 at social gatherings (41%) and from roommates (32%) than they did from exposures associated with athletic activities (13%). The authors concluded that shortening the quarantine period could increase adherence, but still poses a small transmission risk.

Atherstone et al. (Jan 26, 2021). SARS-CoV-2 Transmission Associated with High School Wrestling Tournaments — Florida, December 2020–January 2021. MMWR. https://doi.org/10.15585/mmwr.mm7004e4

- An outbreak arising from a Florida high school wrestling tournament in December 2020 had an attack rate of at least 30% (38 of 126 tournament attendees who were tested) and a secondary attack rate of at least 9% (41 of 441 close contacts of the 38 COVID-19 patients). Among contacts, household members had the highest attack rate (at least 30%), test positivity rate (60%), and odds of receiving a positive test result (OR=2.7). The outbreak resulted in an estimated loss of 1,700 in-person school days due to isolation and quarantine of patients and contacts, and the death of one adult contact aged >50 years. At the time of the tournament, the county in which 7 out of 10 participating high school teams were located had a 14-day cumulative COVID-19 incidence in the highest category of transmission risk for SARS-CoV-2 (363 per 100,000), according to CDC classification.

Atrubin et al. (Oct 16, 2020). An Outbreak of COVID-19 Associated with a Recreational Hockey Game — Florida, June 2020. MMWR. https://doi.org/10.15585/mmwr.mm6941a4

- A SARS-CoV-2 outbreak was identified in an indoor hockey game in Tampa, Florida in June. The index case experienced symptoms one day after the game; 2 days later he received a positive antigen test. Overall, 62% (13 of 21) players experienced illness 2-5 days after the game (8 teammates, 5 members of the other team), as did one rink staff member. Thirteen of 15 people, including the index case, had positive SARS-CoV-2 tests (11 PCR, 2 antigen). Two on-ice referees and one spectator were asymptomatic but did not seek testing.

Brito et al. (Nov 4, 2020). High Prevalence of Pericardial Involvement in College Student Athletes Recovering From COVID-19. JACC. Cardiovascular Imaging. https://doi.org/10.1016/j.jcmg.2020.10.023

- In a cohort of 48 university student athletes who recovered from SARS-CoV-2 infection and returned to campus in July 2020 in West Virginia (30% asymptomatic), more than 1 in 3 showed signs of resolving heart inflammation on imaging studies. 27 student athletes (56%) had cardiac abnormalities, including 19 students with late enhancement of the pericardium and associated pericardial effusion. No student athlete showed specific imaging features of ongoing myocardial inflammation.

Brlek et al. (June 19, 2020). Possible Indirect Transmission of COVID-19 at a Squash Court, Slovenia, March 2020: Case Report. Epidemiology and Infection. https://doi.org/10.1017/S0950268820001326

CDC. (Feb 12, 2021). Operational Strategy for K-12 Schools through Phased Mitigation Executive Summary. https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/operation-strategy.html

- The CDC released new guidelines for reopening K-12 schools for in-person learning, noting that evidence suggests that many K-12 schools that have strictly implemented mitigation strategies have been able to open safely for in-person instruction and remain open.
- In addition to recommending specific disease prevention measures, the guidelines include the following statements: (1) K–12 schools should be the last settings to close after all other mitigation measures in the community have been employed, and the first to reopen when they can do so safely. Schools should be prioritized for reopening and remaining open for in-person instruction over nonessential businesses and activities. (2) In-person instruction should be prioritized over extracurricular activities including sports and school events. (3) Lower incidence of COVID-19 among younger children compared to teenagers suggests that younger students are likely to have less risk of in-school transmission due to in-person learning than older students. (4) Families of students who are at increased risk of severe illness should be given the option of virtual instruction regardless of the mode of learning offered. (5) Schools are encouraged to use cohorting or podding of students. (6) Schools that serve populations at risk for learning loss during virtual instruction should be prioritized for reopening. (7) When implementing phased mitigation in hybrid learning modes, schools should consider prioritizing in-person instruction for students with disabilities who may require special education and related services directly provided in school environments.

Choi and Bum. (July 6, 2020). Changes in the Type of Sports Activity Due to COVID-19: Hypochondriasis and the Intention of Continuous Participation in Sports. International Journal of Environmental Research and Public Health. https://doi.org/10.3390/ijerph17134871

- Choi et al. examined fear and anxiety about SARS-CoV-2 infection in relation to participation in sports activities among participants in South Korea and found that older adults and those who participated in group sports had the highest measures of fear and anxiety.

Dunton et al. (Dec 4, 2020). Early Effects of the COVID-19 Pandemic on Physical Activity and Sedentary Behavior in Children Living in the U.S. BMC Public Health. https://doi.org/10.1186/s12889-020-09429-3

- US parents responding to an online survey reported that the most common physical activities during April to May 2020 for children (n=211, mean age=8.3 years) were free play/unstructured activity (90%) and going for a walk (55%). Children engaged in about 90 min of school-related sitting and over 8 hours of leisure-related sitting per day.
- Parents of children ages 9-13 years were more likely to perceive a greater decrease of physical activity compared to parents of children ages 5-8.

Johnson et al. (Sept 28, 2020). Excess Risk of COVID-19 to University Populations Resulting from In-Person Sporting Events. Pre-print downloaded Sept 29 from https://doi.org/10.1101/2020.09.27.20202499

- *[Pre-print, not peer-reviewed]* A modeling study using a stochastic compartmental model showed that in-person sporting events on college campuses could increase COVID-19 cases among the campus community. Even when COVID-19 cases were controlled both on-campus and among the larger population from which visitors to campus were drawn, such events presented a risk to the

community. Depending on the scenario, and the prevalence of COVID-19, both on and off campus, the increase ranged from 25% to 822%.

Jones et al. (Nov 4, 2020). SARS-CoV-2 Transmission during Team-Sport Do Players Develop COVID-19 after Participating in Rugby League Matches with SARS-CoV-2 Positive Players. Pre-print downloaded Nov. 5 from https://doi.org/10.1101/2020.11.03.20225284

- *[Pre-print, not peer-reviewed]* Player interaction and proximity analysis of 4 professional rugby matches in which 8 players were retrospectively found to have SARS-CoV-2 suggest that risk of in-game transmission may be minimal. While video footage analysis and GPS data show the positive players were within 2 meters of other players for up to 316 seconds during 60 interactions, only 1 of 28 identified contacts and 5 of 100 players on opposing teams had positive tests, all of which were eventually linked to either internal club outbreaks or wider-community transmission.

Kuitunen et al. (Jan 11, 2021). Team-to-Team Transmission of COVID-19 in Ice Hockey Games - a Case Series of Players in Finnish Ice Hockey Leagues. Infectious Diseases.
https://pubmed.ncbi.nlm.nih.gov/33423589/

- An outbreak of SARS-CoV-2 among U-20 ice hockey teams in Finland was reported based on public statements by the local health authorities and the teams involved. One player who had asymptomatic COVID-19 infected 22 of 28 teammates. The team had returned from an away trip the day before the first players had symptoms. COVID-19 was detected in both teams a few days later. During two weeks of quarantine, a total of 24 players from the two opposing teams tested positive. Some of these players infected additional players on other teams. In total, 49 infections were detected in five ice hockey teams, and six teams were in quarantine for two weeks.

McBride. (Jan 22, 2021). New Guidelines for Children Returning to Sports after Covid-19. Journal of Pediatric Nursing. https://doi.org/10.1016/j.pedn.2021.01.013

McGuine et al. (Nov 5, 2020). The Health Of Us Adolescent Athletes During Covid-19 Related School Closures And Sport Cancellations. Journal of Athletic Training.
https://pubmed.ncbi.nlm.nih.gov/33150405

- Female adolescent student-athletes report higher levels of moderate-to-severe anxiety and all student-athletes who participate in team sports reported more frequent symptoms associated with depression compared to those participating in individual sports. A cross-sectional study of adolescent student athletes during COVID-19 related school closures and sport cancellations found adolescents who identify as female reported a higher prevalence of moderate to severe anxiety symptoms than those who identify as males (44% vs. 28%). Prevalence of symptoms associated with depression were highest among those participating in team sports (74%) and lowest for individual sports (65%), and the total quality of life score was worst for athletes from counties with the highest poverty levels.

Mack et al. (Jan 25, 2021). Implementation and Evolution of Mitigation Measures, Testing, and Contact Tracing in the National Football League, August 9–November 21, 2020. MMWR. Morbidity and Mortality Weekly Report. https://doi.org/10.15585/mmwr.mm7004e2

- Investigation of a cluster of 41 SARS-CoV-2 infections that occurred within the National Football League in late September 2020 identified at least 7 cases of infection where transmission likely

occurred during <15 minutes of cumulative interaction within 6 feet of an infected individual, as confirmed by wearable tracking devices. Interviews revealed that some of these brief interactions included high-risk behavior, such as unmasked meetings in small rooms while eating. These findings led to a revised high-risk contact definition that included ascertainment of mask use and setting in addition to duration of exposure and proximity as well as implementation of stricter protocols.

Rajpal et al. (Sept 11, 2020). Cardiovascular Magnetic Resonance Findings in Competitive Athletes Recovering From COVID-19 Infection. JAMA Cardiology. https://doi.org/10.1001/jamacardio.2020.4916

- Among 26 competitive college athletes who had tested positive for SARS-CoV-2 11-53 days earlier and had not require hospitalization, 4 (15%) had cardiac MRI findings suggestive of myocarditis (heart muscle inflammation) and 8 (31%) athletes exhibited late gadolinium enhancement (LGE) without T2 elevation, suggestive of prior myocardial injury. Cardiac ventricular function was within normal ranges for all athletes, as measured by cardiac MRI and transthoracic echocardiogram. The authors suggest that cardiac MRI may be a useful tool to risk-stratify athletes for return to competitive sports participation following recovery from COVID-19.

Sasser et al. (Feb 20, 2021). Reported COVID-19 Incidence in Wisconsin High School Athletes During Fall 2020. Pre-print downloaded Feb 22 from https://doi.org/10.1101/2021.02.18.21251986

- *[Pre-print, not peer-reviewed]* A study of COVID-19 in high school athletes in Wisconsin in September 2020 showed that 207 schools that reinitiated sports reported 270 COVID-19 cases among 30,074 players, for case and incidence rates of 809 cases per 100,000 players and 32.6 cases per 100,000 player-days, respectively. 115 (55%) cases were attributed to household contact, and 85 (41%) to contact outside sport or school. No difference in incidence rates between team and individual sports (IRR = 1.03) or between non-contact and contact sports (IRR = 0.53) were detected. 84% of schools required face masks while playing. For sports with >50 participating schools, there were no significant association between face mask use and COVID-19 incidence in cross-country running (IRR=0.71), football (IRR=1.6), boys' soccer (IRR=2.3), or girls' volleyball (IRR=1.4).

Teran et al. (Oct 27, 2020). COVID-19 Outbreak Among a University's Men's and Women's Soccer Teams — Chicago, Illinois, July–August 2020. MMWR. https://doi.org/10.15585/mmwr.mm6943e5

- An outbreak investigation among members of a Chicago university's men's and women's soccer team in August 2020 identified several social gatherings in which transmission could have occurred. The outbreak had a 38% attack proportion (17 out of 45) from the index patient in the men's soccer team. 18 social gatherings with minimal mask use or social distancing were reported over the course of the outbreak, including a birthday party, coed soccer match, dorm and apartment visits, and an outdoor lake gathering, and all 17 positive students attended at least one gathering. 4 out of the 17 cases were asymptomatic and were identified after universal testing of teams was conducted. Genomic analysis suggests a single source of introduction, with sequences belonging in the same clade that had been circulating in Chicago since March.

Watson et al. (Sept 27, 2020). COVID-19 in Youth Soccer. Pre-print downloaded Sept 28 from https://doi.org/10.1101/2020.09.25.20201616

- *[Pre-print, not peer-reviewed]* Youth soccer clubs in the US involving 85,861 players that had restarted in-person activities reported 218 COVID-19 cases among their members. None of the cases resulted in hospitalization or death. The authors used these cases to estimate the incidence of

COVID-19 among youth soccer athletes and concluded that it was lower than the overall national rate for children in the US (254 vs 477 cases per 100,000). No relationship was identified between club COVID-19 incidence and phase of return to soccer. Youth soccer clubs universally report implementing risk reduction procedures.

Watson et al. (Jan 20, 2021). The Association of COVID-19 Incidence with Sport and Face Mask Use in United States High School Athletes. Pre-print downloaded Jan 21 from https://doi.org/10.1101/2021.01.19.21250116

- *[pre-print, not peer reviewed]* A nationwide survey of 152,484 high school athletes found cumulative incidence of 1,682 COVID-19 cases per 100,000 athletes, corresponding to an incidence rate of 24.6 cases per 100,000 player-days between August and October 2020. Incidence was lower when sports were outdoors and non-contact but no differences were detected between team versus individual sports. Face mask use was associated with a decreased incidence in girls' volleyball, boys' basketball, and girls' basketball.