


Youth ice hockey COVID-19 protocols and prevention of sport-related transmission

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ABSTRACT

Objectives This observational study evaluated the impact of return-to-play protocols to prevent transmission of SARS-CoV-2 in a youth ice hockey programme in Virginia Beach, Virginia.

Methods Following an outbreak of SARS-CoV-2 in November 2020, a COVID-19 Response Team evaluated the epidemiological data to identify transmission dynamics and develop enhanced protocols to prevent transmission. During the subsequent 18-week study period, incident cases were investigated to identify the likely transmission source; testing, quarantine and isolation recommendations were provided to families in accordance with Centers for Disease Control and Prevention guidelines.

Results Simple but stringent protocols were implemented among 148 youth ice hockey players ages 6–18. Players were required to arrive at the rink in full gear; locker rooms were closed, building entry was limited to one parent per player, and masks were required at all times except for players on the ice. Following implementation of the enhanced protocols, more than 500 practices and games were completed with at least 15 858 athlete-hours of exposure and no within-programme COVID-19 transmission was detected despite high community incidence and sporadic household exposures.

Conclusion This study suggests indoor youth sports can operate safely with appropriate protocols in place, even within communities of high COVID-19 transmission, even when athletes are not yet vaccinated or wearing masks during play. Transmission appears to be more likely in congested indoor areas involving adults than on the ice during play. Protocols should be developed in collaboration with programme participants. Strong collaboration in the interest of youth sports can motivate adoption of protocols which prevent within-team transmission.

INTRODUCTION

Organised youth sports provide a lifeline for many children in terms of mental and physical health benefits,¹ which is particularly critical during the current pandemic. However, even before the COVID-19 pandemic, restrictions were implemented, youth sports organisations recognised a need to address barriers to access, including increasing costs and adolescent athlete attrition due to an undue focus on competitiveness.² With pandemic restrictions in place and youth sports on hiatus, athletes reported decreased physical activity and increased anxiety and depression, particularly in areas of poverty which were already disproportionately affected by COVID-19 morbidity and mortality.² Outbreaks of

COVID-19 related to indoor youth sporting events have been reported³ and the prospect of further outbreaks, especially as more transmissible SARS-CoV-2 variants circulate, remains a significant barrier to the resumption and continuation of these practices and competitions.

Safe conduct of youth sports during the current pandemic requires adoption and adherence to simple and low-cost yet highly effective protocols which prevent transmission among players, officials and their parents. Particular concern has been raised regarding ice hockey^{4,5} despite the brevity of contact.⁶ The aim of this study was to analyse youth hockey COVID-19 transmission after a team-related outbreak in the fall of 2020 and to report the details and results of a disease transmission protocol that was developed to prevent further team-related outbreaks during the remaining 18 weeks of the season despite operating in a community with high SARS-CoV-2 incidence. After the initiation of the protocol described in this report, no practice or game-associated transmissions were identified over the 18-week study period with 23 788 athlete exposure hours despite sustained high community prevalence and 5 players and 10 family members testing positive due to community exposures.

METHODS

This observational study was conducted by the 501(c)3 not-for-profit Hampton Roads Youth Hockey Association (HRYHA, Virginia Beach, Virginia), its ice hockey director and a volunteer epidemiologist. Self-reported COVID-19 test data were collected among a cohort of 148 youth ice hockey players ages 6–18 years assigned to 12 recreational (house) and 2 select (travel) teams. Data were also collected from 32 parent coaches and player households (200 parents). Approximately 40% of the households are military-connected with only 1.3% of players having a known underlying medical condition. The 27-week season (14 September 2020–20 March 2021) planned a total of 276 games and 522 practice sessions on a smaller-than-standard rink measuring 182×79 ft. During the study period, community positivity ranged from 5.5% to 22.2%.^{7–9} Virginia Beach experienced high 7-day incidence (2771 cases, 615/100k) the week of 3 January 2021^{7–9} and ranked ninth nationally the week of 9 February 2021 (272/100k). The area remained classified as a ‘sustained hotspot’ by the US Department of Health and Human Services throughout the study period.^{7–9}

Prior to the season, HRYHA implemented protocols aligned with USA Hockey,¹⁰ Centers for Disease Control and Prevention (CDC)¹¹ and State of Virginia phase 3 guidelines.¹² Masks were enforced



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Table 1 Pre-enhanced protocols compared with the enhanced protocols used during the 18-week surveillance period

	Pre-enhanced protocols (14 September 2020–15 November 2020)	Post-enhanced protocols (16 November 2020–20 March 2021)
Masks*	<ul style="list-style-type: none"> ▶ Required for all indoors ▶ Not required on ice for players or coaches 	<ul style="list-style-type: none"> ▶ Required for coaches on ice and bench ▶ Players not required to mask on ice or bench
Locker rooms*	Open	<ul style="list-style-type: none"> ▶ Closed, all players arrive at rink fully geared up or use outdoor locker rooms ▶ Goalies assigned a locker room
Building entry*	No restrictions	<ul style="list-style-type: none"> ▶ 5 min prior to practice or game, immediate exit ▶ No hockey bags permitted in building ▶ Rain protocol: players assigned to locker rooms and separate areas throughout rink
Spectators*	No capacity limits	<ul style="list-style-type: none"> ▶ One parent per player in building for practices and games ▶ Exception if one parent volunteering on scoresheet, time clock or penalty box
Game operations*	Stop-clock periods	Switch to run-clock periods to provide additional time between games to clear out building
Travel team tournaments*	Weekend tournaments authorised	<ul style="list-style-type: none"> ▶ No overnight travel ▶ If overnight travel unavoidable, team must quarantine for 10 days on returning
Symptom screening*	CDC case definition, including fever (>38°C), cough, shortness of breath, muscle aches, change in taste/smell, etc.	<ul style="list-style-type: none"> ▶ Revised to focus on common cold symptoms: headache, sore throat, fatigue, runny nose ▶ Fever criteria reduced to >37.5°C
Distancing	Required in lobby and all off-ice areas, not required on ice	Same
Testing	Voluntary	Voluntary
Case reporting	Mandatory	Mandatory
Quarantine	Consistent with CDC guidelines; including 7 days reduced quarantine option for those with no symptoms and negative test on day 6 or 7	Same
Isolation	Consistent with CDC guidelines: 10 days from onset of symptoms or positive test	Same
Density on ice	50% (split teams, reduced ice time by half)	Maintained split teams until 4 January 2021 then returned to full density

*Major changes implemented which exceeded USA hockey, state and/or CDC recommendations. CDC, Centers for Disease Control and Prevention.

in the building, player case reporting to the hockey director was required as a condition of participation and uniform case reporting forms were used, but on-ice masking and distancing for players and coaches was not required, consistent with the WHO's recommendation¹³ against use of face masks during vigorous physical activity. In early November 2020, a team-related outbreak was associated with an indoor picture night that led to 36 confirmed SARS-CoV-2 infections (33 among players, coaches and parents, and 3 among siblings). Cases among players and adults were investigated by the epidemiologist for exposures to detect within-rink transmission, and contact tracing was conducted to prevent onward transmission. Based on this investigation, an enhanced protocol was developed (table 1), and the 27-week study period described in this report consists of two phases: (1) the first 9 weeks (14 September 2020–15 November 2020) including the outbreak investigation and new protocol development; and (2) the 18 weeks following return-to-play (16 November 2020–20 March 2021) during which time protocol adherence and effectiveness was monitored.

Outbreak investigation and protocol development

On 31 October 2020, two symptomatic parents received positive antigen test results for SARS-CoV-2, 6 days after returning from an out-of-state tournament. The two travel teams were quarantined and asked to test, report the test date, symptom onset date, test type and result. These data were entered in the line listing (online supplemental 1). Given the possibility of interaction between travel and house teams, the hockey director put the entire programme on a 14-day quarantine for testing and investigation. The hockey director notified all HRYHA households

to be vigilant for symptoms resembling the common cold and to seek testing.

During the quarantine, all HRYHA families with a symptomatic household member were asked to test and report their results to the hockey director. Families were requested to supply the following information: date of test, type of test (PCR or rapid), test result, symptomatic/asymptomatic status and date of symptom onset. Following case investigation, likely exposure source was recorded as well. Fifty-five reverse transcription-polymerase chain reaction (rtPCR) and rapid antigen tests were conducted and 36 were positive: 14 players/siblings, 14 parents and 8 coaches. The asymptomatic fraction was 14% (players/siblings); all coaches and parents reported mild symptoms. Importantly, no fever >38°C was reported. Case investigation with the two travel teams suggested initial exposures began during the tournament weekend through contact with infected adults and children. An epidemiological curve (figure 1) was created using the symptom onset date to estimate the initial spreading event based on median time to symptoms of 5 days. Specifically, counting back 5 days from the peak of the curve, picture night was identified as the likely source for the second wave of infections. Picture night was associated with increased foot traffic through the rink lobby as HRYHA families came for team and individual photos, increasing conversation among parents and players. A small break room was used for individual and sibling photos; no food or drink was involved in the event.

Parents with a child testing positive for SARS-CoV-2 consistently described the subtle symptoms as 'just like the common cold', and therefore, had not sought testing prior to the quarantine because the symptoms did not align with the CDC case

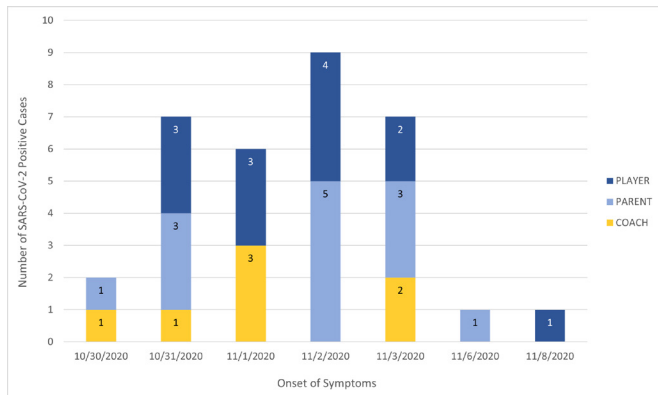


Figure 1 Outbreak epidemiology for 33 cases detected on 31 October 2020–10 November 2020 by date of symptom onset and player/parent/coach status (three positive siblings not included).

definition. Parents tended to report one or more of the following: sore throat, headache, slight cough, fatigue and feverish. Understanding that the subtle symptoms of COVID-19 in children were often undetected by parents motivated a key change in the rink's protocols to increase awareness.

New protocols developed

The hockey director formed a COVID-19 Response Team composed of the director, assistant hockey director, head coach, epidemiologist and the director of the partner rink. The goal of the enhanced protocols was to ensure players did not become close contacts of each other, thus preventing within-team transmission and avoiding full team quarantines if possible. With community COVID-19 incidence rising, it was anticipated that community exposures would be inevitable. Better distancing was needed to prevent gathering and conversation in places with poor ventilation. Vulnerabilities were assessed in the protocols when the season began. These weaknesses were discussed with the COVID-19 Response Team in the context of player and parent movement within the facility. Three high-risk transmission opportunities were identified for further mitigation: lines (while waiting to enter the ice or for drills to start), locker rooms and the lobby.

Parent and coach participation in protocol development

To engage members in this observational study, a series of video calls was organised with head coaches, then with all coaches and team managers, to develop enhanced protocols to increase distancing in the rink and reduce off-ice player contact. A volunteer physician was available to consult regarding unusual symptoms. Routine email communications to all HRYHA families provided updates and guidance. Families were encouraged to contact the hockey director or epidemiologist with any questions or feedback. An anonymous online survey was conducted at the end of the season to solicit further information regarding infections and comments from programme participants.

The new protocols included the following in addition to existing policies (table 1): split practices were continued to reduce density on the ice by 50%; families were asked to have skaters in full gear before entering the rink; rink entry was restricted to <5 min prior to practices or games; drills were selected in advance and distributed to coaches and players for review to reduce clustering during instruction; games were switched to a continuous rather than stop-clock to increase the amount of time between games for cleaning and building ventilation; bags

were prohibited in the rink to prevent changing in unauthorised areas; locker rooms were reserved strictly for single goalie use; one parent per player was permitted in the building to minimise congestion and break rooms were closed. No effort was made to space players on the bench but given coaches often yell from behind and above the unmasked players, the coaches were required to mask on the ice and bench. In the 30 min break between games, the public areas of the rink (eg, bathrooms, counters and table-tops) were cleaned according to CDC recommendations. Doors were already equipped for no-touch operation. Mask use among players on the ice was considered but not implemented, consistent with WHO guidelines¹³ given the difficulty of breathing during exertion and the challenge of hydration during fast rotations on and off the bench. Travel teams were banned from participating in 'tournament weekends'; instead, both games were played on a single day to eliminate overnight interstate travel. In the one case where that was not possible, the travel team quarantined from all ice activities for 10 days following the trip.

Team managers were consulted regarding barriers to protocol adoption. In response to this discussion, mats were placed outside the rink to facilitate parents dropping off hockey players in skates. Two outdoor 'locker rooms' were established with folding chairs and mats to facilitate high school players gearing up. Parents who volunteered for various game-related jobs, such as scoreboard, time clock or penalty box, were permitted to have a spouse enter the rink as well.

Return to play

On resumption of play the week of 16 November 2020, a revised symptom list was published, including the following subtle common cold symptoms: temperature >37.5°C, fatigue, chills, slight passing headache, sore throat, sniffles, dry cough (intermittent), focal soreness in muscles ('hot spots'). These symptoms were identified during 13 parent interviews conducted during case investigations regarding children who had tested positive during the initial outbreak. Parents were asked to look for 'the common cold'; notably, no fevers nor reports of altered taste or smell were reported among children. To boost testing uptake and prevent onward transmission, the rink invited the local health department to conduct a free testing event on-site prior to the Thanksgiving holiday and three additional asymptomatic cases were identified. These were recorded on the line list.

When a family reported a positive case or potential exposure, the director recorded the data on the line list (date of test, type of test, asymptomatic/symptomatic status, date of symptom onset, household contacts and test results, and likely exposure source) then referred the parent to the epidemiologist for contact tracing, testing recommendations and isolation and quarantine exit dates. The epidemiologist provided guidance on test selection and interpretation according to the best available CDC guidance at the time and in consultation with the local health department, which was overwhelmed with community and school-based contact tracing. For symptomatic individuals, the rapid antigen test was recommended due to the quick turnaround time; for individuals without symptoms who were least 3 days from the date of exposure, the rtPCR was recommended for its sensitivity. A negative rapid test despite symptoms prompted discussion about seeking a confirmatory rtPCR. All testing was voluntary and accessed through community resources such as public health testing, urgent care clinics and pharmacies. The epidemiologist recorded all symptom onset dates and household contacts on a whiteboard calendar, computed quarantine exit dates and texted

a picture of the white board to the family and the coach to ensure all were aware of return-to-play dates. The epidemiologist then emailed a conversation summary to the hockey director and included return-to-play dates. If potential exposures were identified during the infectious period, the team was notified, and parents were asked to self-monitor and seek testing if symptoms emerged. Given the greatly reduced likelihood of secondary transmission from an asymptomatic case (0.7%) compared with a symptomatic index case (18.0%),¹⁴ a full team quarantine was only imposed if an athlete practised or competed while symptomatic. Full team quarantines were not mandated if an athlete was asymptomatic and later found to be positive for SARS-CoV-2 because on-ice exposures, although unmasked, were considered to be low-risk interactions given the close contact is measured in seconds.⁶ Individual and family quarantines were required when contact tracing suggested an exposure to a SARS-CoV-2 positive individual.

Given the success of the post-protocol 6-week trial, the programme returned to full practice sessions the week of 4 January 2021, thus doubling the density of players on the ice during practice. It was understood that a post-holiday surge would put pressure on the protocols and the HRYHA community was reminded to be vigilant for symptoms and refrain from attending practices or games if anyone in the household became symptomatic. The protocols focused on symptom awareness given that some families experienced challenges with insurance denials for testing and paid out-of-pocket for tests. It was also understood that some fraction of cases would remain undetected. To estimate this unreported fraction, a brief online household-based survey was conducted at the end of the season (20 February 2021–13 March 2021). Invitations to participate in the survey were emailed to all HRYHA members, links were circulated via team messaging platforms, and one response per household was requested. The proportion of adults and players with a history of infection, and the proportion of adults reporting vaccination were computed.

RESULTS

Two study periods comprise this report: (1) 9-week pre-enhanced protocol period from 14 September 2020 to 15 November 2020 and (2) 18-week post-enhanced protocol period from 16 November 2020 to 20 March 2021 (figure 2). Comparing cumulative incidence during the pre-enhanced and post-enhanced protocol periods, 14 (9.5%) vs 5 (3.4%) players reported infection. Among coaches, 8 (25%) vs 1 (3.1%) reported infection. Among parents, 14 (7%) vs 10 (5.0%) reported infection. One quarantine period for both high school teams was implemented during the post-enhanced protocol period in response to

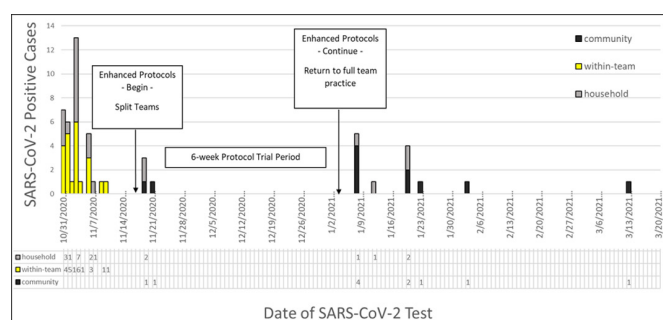


Figure 2 Likely transmission source for SARS-CoV-2 cases among Virginia Beach Youth Ice Hockey Programme, 15 September 2020–20 March 2021.

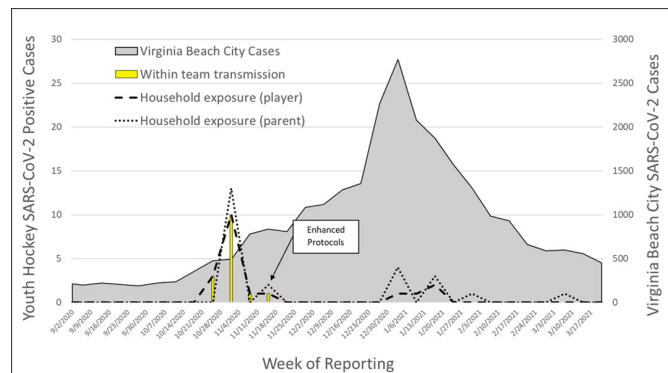


Figure 3 Enhanced protocols prevent within-team transmission despite high sustained community incidence of SARS-CoV-2 in Virginia Beach City, 15 September 2020–20 March 2021.

community exposures. Player case investigation by the epidemiologist found all five to be the result of household transmission and no onward athlete transmission was found to be linked to practices or competitions (figure 3).

In total, the programme completed 262 games and 496 practice sessions, reflecting successful completion of more than 95% of planned events. Games have 17 players per team, and 30–40 players are on the ice during practice sessions. Game and practice exposures for athletes during the 9-week pre-enhanced protocol period were 7929 athlete-hours; the 18-week post-enhanced protocol period was 15 858 athlete-hours. Altogether, game and practice athletic exposure time including both athletes and coaches was at least 9932 hours with the original protocol and 19 864 hours with the enhanced protocol.

An epidemiological review of all cases reported to the hockey director was compared with results of the brief online household survey (n=82 completed surveys, response rate 64%) to capture self-reported cases among parents and players, estimate the unreported fraction of cases, as well as vaccination coverage. Total cases reported to the director during the season were 18 players, 25 parents and 9 coaches. In the anonymous survey, 19 player cases and 53 parent cases were reported. Because the survey was anonymous, we do not know if the 19 reported player cases include all 18 reported to the director during the season. The additional 28 parent cases reported on the anonymous survey suggest that approximately 65% of parents reported their own infections to the hockey director even though reporting was only mandatory for player cases. The pre-enhanced versus post-enhanced protocol cumulative incidence decreased for players, coaches and parents despite a follow-up period that was twice as long (9 weeks vs 18 weeks, respectively) and player density during practice sessions that doubled from half capacity to typical full capacity. During this period, community transmission also declined from >600/100k and 21% positivity in early January to 123/100k and 5.5% positivity^{7–9} at the end of March (figure 3).

Potential occurrences of child-to-child transmission were investigated. During the November 2020 outbreak, 5 of the 14 player cases were among children who did not travel to the tournament but practised with the travel team the following week. Of these five players, four were members of a team with a coach who subsequently tested SARS-CoV-2 positive; coaches were not required to mask on the ice at that time and adult-to-child transmission may have occurred. It is impossible to exclude child-to-child transmission during the outbreak but following the implementation of more stringent protocols which

strictly limited off-ice interactions within the facility (ie, locker rooms and lobby), no additional player cases were found despite opportunities for transmission during the infectious period. For example, one mildly symptomatic (headache, runny nose) high school player attended practice 2 days in a row, prior to receiving a positive SARS-CoV-2 test result. The team was put on quarantine and no further symptoms or positive tests were reported. In another exposure, a coach and five high school players and one sibling went out to breakfast after a game; indoor dining was permitted under state restrictions at the time. One attendee reported a positive SARS-CoV-2 test the next day. The team was put on quarantine given that the exposure occurred not on the ice but over a prolonged period indoors, unmasked, in close proximity with uncertain ventilation. All five players exposed at breakfast tested negative on day five of quarantine.

DISCUSSION

This report suggests that indoor organised youth sports can operate safely with appropriate protocols in place within high-transmission communities at low or no cost even when athletes are not vaccinated or wearing masks during play. This is of enormous importance for youth and societal well-being because it promotes access to youth sports regardless of the socioeconomic or disease metrics in the surrounding community. The protocols were developed in close collaboration with coaches and parents, and they remained stable without need for modification throughout the rest of the 18-week observation period. One of the unique features of the protocols which make them generalisable to any community is the heightened awareness among parents regarding subtle symptoms resembling the common cold. Other low-cost interventions included reducing congestion in the building by setting up outdoor locker rooms. Finally, although some communities are considering implementing routine athlete testing, funds for this surveillance were not available and the protocols relied entirely on self-reported symptoms and tests. Importantly, and in accordance with WHO guidelines,¹³ players were not required to mask during competition and spectators from within the family were permitted provided they were masked.

No evidence of onward transmission between athletes was found after implementing the enhanced protocols despite returning to a full practice schedule with 30–40 players and 8–10 coaches on the ice at least twice weekly. The travel team met for an additional practice each week. The stricter protocols focused on preventing off-ice transmission within the facility but could not control personal time and risks outside the facility. It is thought that this strict control of interactions within the facility may be effective in managing the highest-risk time for athletes—just prior to and after practice or competition in areas with poor ventilation. Outbreaks have been related to indoor youth sports with adult spectators³ and indoor adult hockey with a symptomatic adult.⁴ Potential reasons for not finding sport-related transmission in a community of high prevalence with unmasked athletes may be due to adults and athletes being encouraged to stay home even with subtle symptoms, universal masking among adults and limiting shared indoor time to practices and competitions only. SARS-CoV-2 has also been consistently found to spread more readily from adults than children.^{14–17}

While player-to-player transmission cannot be excluded given the lack of serial asymptomatic surveillance testing, case investigations only found evidence of household transmission, and no onward transmission within the teams even after unmasked exposure to a positive case during the infectious period. This

seems to support existing literature which reports that asymptomatic COVID-19 transmission in households is estimated to occur only 0.7% of the time.¹⁴ Studies looking specifically at sport-related COVID-19 transmission have found it be unlikely in asymptomatic adults¹⁸ and exceedingly rare in children¹⁹ even in contact sports. This may be part of the reason why mask mandates have not had a detectable effect on youth sports-associated COVID-19 transmission in studies controlling for community prevalence.²⁰

Limitations

Limitations include lack of asymptomatic surveillance, lack of a control group, and voluntary reporting. During the season, 111 tests were conducted and reported to the director. The correspondence between self-reported player cases (18) and the household survey (19) suggests that the families overwhelmingly cooperated. Of all the symptomatic programme members who sought testing throughout the study period (n=42), 90% tested positive. This high positivity may have helped instil confidence in the importance of testing. The reduction in community transmission may have contributed to the declines seen following implementation of more intensive protocols. However, the anonymous survey suggests some adult cases went unreported, a finding that is consistent with the known elevated community transmission during the study period and is to be expected when testing and reporting is voluntary. A periodic anonymous survey may be a useful complement to the expectation of self-reporting to estimate point prevalence within the club. Although community COVID-19 cases began trending down in January 2021, the area remained in a high-transmission status throughout the season. Finally, this study took place prior to the emergence of the SARS-CoV-2 Delta strain.

Youth sports serve a vital function for athletes, their families, and the entire community. This report suggests that, when simple disease mitigation protocols are followed, indoor practice and competition can occur without the use of masks among unvaccinated athletes even in the setting of high community transmission. This has enormous implications for the resumption of youth sports competition worldwide.

Key messages

What are the findings?

- ▶ This study suggests indoor youth sports can operate safely with appropriate protocols in place, even within communities of high COVID-19 transmission and even when athletes are not yet vaccinated or wearing masks during play.
- ▶ No sport-related COVID-19 transmission was found during the 18-week surveillance period of more than 15 858 athlete-hours of indoor ice hockey practices and competitions, and youth were allowed to play without masks or distancing.

How might it impact on clinical practice in the future?

- ▶ Outbreaks of COVID-19 can occur among hockey players and adult coaches and parents, but the transmission appears to be more likely off the ice in areas of congestion, such as lobbies, locker rooms and lines.
- ▶ Simple mitigation strategies should be implemented to limit indoor crowding, discourage attendance with symptoms and limit adult transmission to children. Elements of this COVID-19 youth indoor sports protocol playbook could be immediately useful in communities worldwide with varying COVID-19 disease spread and vaccination metrics.

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Contributors AK, MPH, conducted the contact tracing, provided quarantine and isolation recommendations, provided protocol recommendations, conducted the epidemiological analysis, and wrote the manuscript; RA collected and stored the data; RP provided recommendations for the protocol development; TBH provided epidemiological guidance regarding the data analysis, protocol recommendations, and manuscript development. AK, MPH, is the guarantor and affirms that the manuscript is an honest, accurate and transparent account of the study being reported; no important aspects of the study have been omitted; and any discrepancies from the study have been explained. All authors took responsibility for the work.

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Patient consent for publication Not required.

Ethics approval Ethical approval for the study was not required as this study qualifies as exempt research under US Health and Human Services (HHS) §46.104 Exempt research. In addition, the members of the Hampton Roads Youth Hockey Association consented to the requirements of testing and reporting as a condition of participation in youth hockey by the governing body of the youth sports organisation (Potomac Valley Amateur Hockey Association). All data were stored on a password-protected computer owned by the hockey director and accessed only by the hockey director. All analyses were conducted in aggregate on deidentified records. Those handling player and member information were cleared for volunteer roles in the youth hockey organisation in accordance with USA Hockey regulations (SafeSport training and background check). AK, MPH, served as the volunteer epidemiologist and in addition to USA Hockey volunteer status also holds HIPAA certification.

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