

Transmission Risk of COVID-19 in High School and College Water Polo

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Abstract

Background: Concerns that athletes may be at a higher risk for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission has led to reduced participation in sports during the COVID-19 pandemic. We aimed to assess COVID-19 incidence and transmission during the spring 2021 high school and college water polo seasons across the United States.

Methods: This prospective observational study enrolled 1,825 water polo athletes from 54 high schools and 36 colleges. Surveys were sent to coaches throughout the season, and survey data were collected and analyzed.

Results: We identified 17 COVID-19 cases among 1,223 high school water polo athletes (1.4%) and 66 cases among 602 college athletes (11.0%). Of these cases, contact tracing suggested that 3 were water polo-associated in high school, and 0 were water polo-associated in college. Quarantine data suggest low transmission during water polo play as only 3 out of 232 (1.3%) high school athletes quarantined for a water polo-related exposure developed COVID-19. In college, 0 out of 54 athletes quarantined for exposure with an infected opponent contracted COVID-19. However, in both high school and college, despite the physical condition of water polo athletes, both high school (47%) and college athletes (21%) had prolonged return to play after contracting COVID-19, indicating the danger of COVID-19, even to athletes.

Conclusions: While COVID-19 spread can occur during water polo play, few instances of spread occurred during the spring 2021 season, and transmission rates appear similar to those in other settings, such as school environments.

Introduction

Concerns of sports-associated severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission has led to a reduction in sports participation during the COVID-19 pandemic. These limitations forced cancellation of high school and college sport seasons across the United States and limited sports participation around the world. For youth, these sports restrictions led to significant effects on mental and physical health.^{1,2} As a result, many advocated to restart sports in a manner that still minimized the risk of contracting COVID-19.

To facilitate restarting sports, governmental organizations risk stratified sports from those thought least and most likely to facilitate COVID-19 spread. Sports deemed less likely to facilitate transmission were allowed to continue with few restrictions, whereas those deemed riskier faced more severe restrictions. The Centers for Disease Control and Prevention (CDC) highlighted numerous factors contributing to sport risk, including physical distancing, mask usage, hand hygiene, and respiratory etiquette.³ However, these guidelines made it difficult to risk stratify some sports, such as water polo, where masks cannot be used, but play in an aquatic and, often times, chlorinated environment. As a result, recommendations for water polo varied widely. The Italian National Olympic Committee suggested water polo was among the safer

sports, ranking its risk similar to beach volleyball, whereas the state of California classified it as high risk and imposed severe restrictions.^{4,5} As a result, due to lack of data, governments were forced to make recommendations that potentially overestimated or underestimated risk.

In spring 2021, both high school and college water polo resumed to levels unprecedented during the COVID-19 pandemic. High school state-sanctioned water polo began in nine states, and the National Collegiate Athletic Association (NCAA) had an abridged men's and women's season. This served as a perfect environment to monitor COVID-19 transmission and risk with water polo. By polling coaches at both the high school and college levels, we were able to gather the first quantifiable data of water polo risk with COVID-19.

Methods

Two sets of surveys, one for high school and one for college, were constructed in REDCap (Vanderbilt University, Nashville, TN) (Appendix 1). Institutional review board (IRB) approval for use of surveys was granted (IRB #202102119).

High school coaches were informed of the study by water polo leadership in their area. Coaches interested in enrolling filled out the "General Information" survey. Every two weeks throughout the season, coaches were emailed the "14 Day Survey" to the email specified to collect data on team activities over the previous two weeks. At the end of the season, a "Final Survey" was sent to coaches.

College coaches were informed of the study by email after the conclusion of their seasons. All coaches interested in participating were able to complete the "College Water Polo" survey. Data from these surveys were collected in REDCap and then analyzed.

Results

High School Water Polo

Fifty-four high school teams, with a total of 1,223 high school athletes, from 9 different states (Florida, Georgia, California, Illinois, Michigan, Missouri, Ohio, Texas, Utah), enrolled in the study (Table 1). Of these athletes, 17 total COVID-19 cases were identified over the course of the spring 2021 season, indicating an incidence of 1.4%. Most of these cases were unrelated to in-pool activity. A total of 232 athletes were quarantined for close COVID-19 contacts during water polo practices or games. Of those athletes quarantined, only 3 (1.3%) tested positive for COVID-19, indicating very low transmission during water polo activities. Two boys' cases occurred after athletes were forced to leave an outdoor pool due to inclement weather. As athletes huddled together under a shelter, they did not wear masks, but the coaches did. Two players within 48 hours of this event contracted COVID-19. As a result, it is uncertain whether these cases were due to in-pool contact or were related to lack of masks while huddled under the pavilion.

Table 1
COVID-19 in High School Water Polo

	Boys	Girls	Co-Ed	Overall
	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>
Total Athletes	421	500	302	1,223
Teams	17	23	14	54
Athlete Exposures ^a	15,049	21,167	14,091	50,307
Total COVID-19 Cases (Percentage of Total Athletes Who Contracted COVID-19)	6 (1.4%)	9 (1.8%)	2 (0.6%)	17 (1.4%)
Cases Per 10,000 Athlete Exposures ^a	4.0	4.2	1.4	3.4
Number of Athletes Requiring > 7 Days After Quarantine End to Return to Full Activity	4 (66%)	3 (33%)	1 (50%)	8 (47%)
Total Quarantines for Water Polo Contacts	70	136	26	232
Total Positives from Water Polo Quarantines	2 (2.9%)	1 (0.7%)	0 (0%)	3 (1.3%)
^a Athlete Exposures refers to one game or practice for one athlete.				

Throughout the season, teams performed mitigation strategies to decrease COVID-19 spread (Table 2). No statistical differences were found in COVID-19 rates with these strategies given the overall low incidence. While widespread routine COVID-19 testing is certainly helpful, only one COVID-19 case was identified through this testing.

Table 2
High School Water Polo COVID-19 Mitigation Strategies

	Boys	Girls	Co-Ed	Total
	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>
Mask Usage While on Deck	15 (88%)	21 (91%)	14 (100%)	50 (93%)
Symptom Screening Before Activity	15 (88%)	18 (78%)	8 (57%)	41 (76%)
Locker Room Usage	8 (47%)	7 (30%)	8 (57%)	23 (43%)
Outdoor Pool Location	5 (29%)	4 (17%)	1 (7%)	10 (19%)
Routine COVID-19 Testing	4 (17%)	1 (2%)	1 (2%)	6 (11%)

College Water Polo

After postponing the regularly scheduled men's fall 2020 water polo season, the NCAA conducted a shortened men's season in spring 2021, running from January until March 21, 2021. A normal women's

season was held, running from January 2021 until May 16, 2021.

Thirty-six teams enrolled in our study at the conclusion of their season (Table 3). This included 602 athletes, with 66 COVID-19 cases identified over the course of the season. As part of the NCAA protocols, all schools completed some form of routine COVID-19 testing, with most teams testing three times per week (Table 4). At all institutions, contact tracing was performed to identify infection source. Interestingly, none of the 66 cases were traced to in-pool contact, with the largest percentage traced to social gatherings (Table 5). In fact, numerous instances occurred where players were in close contact in the pool within 48 hours of an individual developing COVID-19, but no cases were reported. In the women's season, 54 athletes were identified who required quarantine after an opponent developed COVID-19 within 48 hours of playing a game. In each of these cases, none of the 54 at-risk athletes developed COVID-19.

Table 3
COVID-19 in College Water Polo

	Men	Women	Overall
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Total Athletes	233	369	602
Teams	13	23	36
Total Games	77	245	322
Athlete Exposures ^a	11,214	24,748	35,962
Total COVID-19 Cases	17 (7.3%)	49 (13.3%)	66 (11.0%)
Cases Per 10,000 Athlete Exposures ^a	15.1	19.8	18.3
Number of Symptomatic Cases	8 (47%)	30 (61%)	38 (58%)
Number of Athletes Requiring > 7 Days after Quarantine End to Return to Baseline Activity Level	3 (18%)	11 (22%)	14 (21%)
Teams with Cases	7 (54%)	9 (39%)	16 (44%)
^a Athlete Exposures refers to one game or practice for one athlete.			

Table 4
 COVID-19 Testing Frequency in College Water Polo

Testing Frequency	Men <i>n</i> (%)	Women <i>n</i> (%)	Total <i>n</i> (%)
Less Than Once Per Week	0 (0%)	1 (4%)	1 (3%)
Weekly	0 (0%)	1 (4%)	1 (3%)
Two Times Per Week	2 (15%)	1 (4%)	3 (8%)
Three Times Per Week	11 (85%)	15 (65%)	26 (72%)
Four Times Per Week	0 (0%)	3 (13%)	3 (8%)
Daily	0 (0%)	2 (9%)	2 (6%)

Table 5
 Source of COVID-19 Infections

	Men <i>n</i> (%)	Women <i>n</i> (%)	Total <i>n</i> (%)
In-Water Transmission	0 (0%)	0 (0%)	0 (0%)
Social Gatherings	6 (35%)	30 (61%)	36 (54%)
Roommate	2 (12%)	11 (22%)	13 (20%)
Family	1 (6%)	3 (6%)	4 (6%)
Other	8 (47%)	5 (10%)	13 (20%)

Of the 66 cases of COVID-19 identified, 58% of athletes were symptomatic. In 21% of cases, athletes required more than seven days after quarantine to return to their previous level of activity. Again, this highlights the dangerous nature of the virus, even in young athletes. While vaccination efforts may have helped mitigate spread, > 50% of teams had less than a 50% vaccination rate by the end of the season, which is below the threshold needed for herd immunity (Table 6). Furthermore, one case occurred in an individual that had previously been vaccinated. As a result, our data again suggest that COVID-19 transmission during water polo play is unlikely in most circumstances.

Table 6
College Water Polo Vaccination Rates at End of Spring Season

Percentage Vaccinated	Men <i>n</i> (%)	Women <i>n</i> (%)	Total <i>n</i> (%)
< 25%	5 (0%)	7 (0%)	12 (33%)
26–50%	2 (15%)	7 (32%)	9 (25%)
51–75%	0 (15%)	4 (26%)	4 (11%)
76–99%	4 (7%)	5 (26%)	9 (25%)
100%	2 (46%)	0 (15%)	2 (6%)

Discussion

Since the start of the COVID-19 pandemic, more is now known about the spread of COVID-19 and those environments conducive to spread. This is also true in athletics, where more data have emerged about COVID-19 in sport. Recently, multiple studies have demonstrated minimal disease transmission in soccer.^{6,7} Understanding more about disease spread in athletics is important to allow government organizations to advise how to proceed with sports in a safe manner.

This study is the first to monitor disease and disease transmission in water polo. Because of lack of studies to this point, recommendations have been disparate across the United States and around the world. While anecdotal reports suggested little spread and risk with water polo, this study quantifies this risk. Strikingly, we demonstrate that COVID-19 risk through in-pool water polo activity, at both the high school and college level, is minimal. In fact, our data here suggests that only 1.3% of high school athletes playing water polo turned positive after an in-pool exposure and 0% of college athletes turned positive after such an exposure. Remarkably, this is even less than the 2% positivity rate reported in schools after masked exposure.⁸ Given these findings, it makes sense to advocate for a quicker return to these sports, particularly with the mental and physical health benefits they provide for athletes.

Why water polo, without masks and periods of close contact, is an inhospitable environment for COVID-19 transmission remains to be investigated. Some have suggested that the chlorinated environment, higher environmental temperature and humidity, and air circulation, whether indoors or outdoors, decrease the risk of COVID-19 spread.⁹ A recent study demonstrated the rapid inactivation of SARS-CoV-2 in properly chlorinated pools.¹⁰ However, our data suggest that lack of mask usage should not result in governmental organizations automatically assigning water polo the highest risk.

While risk mitigation techniques did not have a quantifiable effect in decreasing COVID-19 transmission, multiple coaches specifically mentioned that use of these techniques decreased spread. Given that 93%

of teams in the high school cohort wore masks on deck, this may have prevented greater incidence of COVID-19 among team members.

Vaccination continues to be important in limiting the spread of COVID-19. As vaccinations become more widely available, those who have access should continue to vaccinate to further decrease risk. However, vaccines will not entirely prevent COVID-19, as evident in the one collegiate water polo athlete in this study who contracted COVID-19 even after vaccination. Nevertheless, given the significant symptoms among those who contracted COVID-19, including those who took longer than one week to return to play, vaccination should be an important effort for those interested in protecting athletes.

Limitations

The weaknesses of this study include incomplete participation of athletes and teams competing during the spring 2021 season. While > 60% of high school teams in Missouri were included in this study and > 40% of college teams, including 50% of men's teams, many teams were unable to participate, either due to administrative prohibition or lack of knowledge of the study. However, we did survey over 1,800 total athletes from a diverse geographic area. Given this diverse cohort, it should be representative of a broader population. More studies will be needed to continue to track COVID-19 in the water polo population.

In addition, all surveys were completed by coaches. This assumes complete knowledge of athlete health and contacts by coaches involved, which sometimes was performed by other staff at the school. Additionally, this data relies on external contact tracers to determine the source of infection. Our study also relied on schools to determine who was a high-risk contact needing quarantine. Numerous coaches remarked on the inconsistency in establishing this among neighboring schools and school districts. In some instances, schools may have been more conservative given the importance of slowing COVID-19 spread, thus overestimating the number of athletes who needed to quarantine and were a high-risk contact.

Conclusion

In spite of these factors, our robust cohort is the first to demonstrate the relative safety of water polo during the COVID-19 pandemic. The findings suggest that water polo can be played safely with proper mitigation techniques outside of the pool. Furthermore, governmental organizations should ensure water polo risk classification is consistent with the data we have here – namely, that we see little transmission of COVID-19 with water polo, and risk is minimal with proper mitigation strategies.

Abbreviations

CDC, Centers for Disease Control and Prevention; COVID-19; coronavirus disease 2019; NCAA, National Collegiate Athletic Association; IRB, institutional review board; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

Declarations

Ethics approval and consent to participate

Surveys and study design were approved through Washington University School of Medicine Institutional Review Board, IRB #202102119.

Consent for publication

Not applicable

Availability of data and materials

Data was collected with identifying information and is protected from public release by the Institutional Review Board. Participants were assured that information would be released in a manner that would prevent identification, as has been done in this publication.

Competing interests

Jason Newland reports funding from the Agency for Healthcare Research and Quality, NIH, and a research grant from Merck. Mark Halstead reports funding from the American Academy of Pediatrics for development of educational presentations.

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Authors' contributions

R.J.K. conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript. C.J.K. assisted in study design. C.T. ensured study compliance with institutional requirements and assisted in IRB submission. M.E.H and J.G.N. assisted in study design and critically reviewed the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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