


Athletic disruptions caused by the COVID-19 pandemic negatively affect high school student-athletes social-emotional well-being

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Abstract

To examine whether high school student-athletes who experienced more COVID-19 disruptions had increased anxiety, increased dejection, increased anger, decreased excitement, and decreased happiness as measured by the validated Sports Emotion Questionnaire (SEQ). During the COVID-19 pandemic high school student-athletes faced disruptions which resulted in cancellation of competitions, reduced in-person training sessions, and quarantine of athletes. The impact of these disruptions on the mental health and well-being of student-athletes is unknown. An anonymous cross-sectional online survey was electronically distributed to high school student-athletes in one school district during the spring of the 2020 to 21 academic year. Basic demographic questions, sport information, and personal and team disruptions were collected. Multivariate linear regression was used to assess correlation between each emotional domain on the SEQ with independent variables such as personal or teammate quarantines, cancellations, season, sport gender, indoor or outdoor location, and level of competition. 125 surveys were returned representing 28 different sports. Student-athletes who were personally quarantined (22.4%) during their athletic season experienced greater dejection ($\beta = 0.78$, $P = .003$) and greater anger ($\beta = 0.78$, $P = .005$). Those with teammates quarantined (61.6%) experienced more anxiety ($\beta = 0.30$, $P = .048$). Spring sports, which faced fewer restrictions, were associated with less anger ($\beta = -0.48$, $P = .048$). Student-athletes who were directly affected by COVID-19 disruptions experienced increased anxiety, more dejection, and more anger. Public health authorities and school districts should minimize disruptions to athletic participation using established COVID-19 safety protocols to avoid causing harm to athletes' social-emotional well-being. If athletics must be disrupted, student-athletes should receive wellness support and virtual or remote training options.

Abbreviations: COVID-19 = CoronaVirus Infectious Disease of 2019, MSHSL = Minnesota State High School League, SEQ = Sports Emotion Questionnaire.

Keywords: adolescents, COVID-19, high school, mental health, sports medicine, student athletics

1. Introduction

The CoronaVirus Infectious Disease of 2019 (COVID-19) pandemic was a stressful time for many people around the world because of health concerns, public health restrictions, government mandates, and alterations in daily life. Depending on the specific circumstances and local governmental mandates, some individuals faced greater disruptions to their daily activities and routines than others. During the 2020-21 athletic seasons within the United States, varying COVID-19 restrictions were enforced with the intention of reducing

community transmission of the virus. Physical activity of all children fell during the pandemic, with the effect heaviest at the high school level.^[1]

All levels of athletic competition and practice were affected, from professional and Olympic competitions down to local school and youth athletics. For high-school student-athletes, these restrictions resulted in fewer scheduled competitions, fewer in-person training sessions and cancellation of many competition events involving multiple teams. As expected, these restrictions led to robust modifications to the training habits of athletes as gymnasiums, training facilities, weight rooms, and pools were closed

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for an indefinite period of time, making in-person and team-training activities difficult.^[2] As a result, athletes self-reported less time engaged in sport-specific activities and less time spent engaged in strengthening and conditioning activities compared to pre-pandemic routines.^[2] Several efforts were made to modify sporting activities to allow athletes to continue training and competing in some capacity, such as virtual practices or competitions, in which the athletes raced in their home facilities and self-reported times upon completion. Despite all precautionary efforts, many athletes still faced quarantine restrictions for COVID-19 exposure or illness. In general, there were more restrictions in the fall (Aug–Nov, 2020) and winter (Nov, 2020–Mar, 2021) seasons than the spring (Mar–Jun, 2021) season, and indoor sports tended to face more restrictions than outdoor sports, because of a higher risk and concern for transmission of the virus indoors.^[3]

Previous studies highlight a link between increased psychiatric comorbidities like anxiety, depression, and suicidality, to natural disasters such as hurricanes, earthquakes and the previous Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome outbreaks.^[4] These disruptions to daily routines, training habits and competition schedules of student-athletes during the current COVID-19 pandemic have raised concern of a subsequent negative impact on the mental health and well-being of student athletes.^[5] There is emerging evidence that college students, both athletes and non-athletes, have reported experiencing increasing amounts of stress, which appear to result in heightened states of anxiety, isolation and depression.^[6] A recent study also found greater degrees of distress in athletes competing in individual sports compared to team sports.^[7] Further, these disruptions to the training habits and competition schedules of athletes have been shown to reduce the motivation to train and level of satisfaction from training as reported by athletes competing at the collegiate level.^[2]

A growing body of literature is beginning to detail the mental health effects of the COVID-19 pandemic and subsequent sports disruptions among student-athletes. One study by McGuine et al^[8] reported higher rates of anxiety in female student-athletes and worse mental health in higher poverty areas. Two studies show that student-athletes who were able to continue sports during the pandemic had less anxiety and depression and reported higher quality of life scores versus those student-athletes who were not able to participate without interruption.^[9,10] Likewise, adults who were able to continue physical activity during the pandemic reported better mental health.^[11] Another study documents the psychological benefits that physical activity has on adolescents and their ability to manage anxiety and build self-esteem in the midst of the COVID-19 pandemic.^[12] Finally, a recently published large survey of Wisconsin high school student-athletes showed dramatically increased rates of moderate-severe depression, affecting nearly 4 in 10 student-athletes in 2020, that also corresponded with decreased physical activity and decreased quality of life.^[13]

This study examines the effects of the COVID-19 pandemic on the social-emotional status and well-being of high school student-athletes by using the Sports Emotion Questionnaire (SEQ), a validated 22 item survey, to investigate five domains of mental health; anxiety, dejection, anger, excitement, and happiness.^[14] To our knowledge, this is the first study to utilize the SEQ, a sports-specific measure of social-emotional health of athletes, during COVID-19. Our hypothesis was that student-athletes who experienced more COVID-19 restrictions would experience increased levels of anxiety, dejection, and anger while also experiencing a decrease in excitement and happiness in regard to their sports season as measured by the SEQ.

2. Methods

2.1. Setting

An anonymous cross-sectional online survey of 2068 high school student-athletes within a Southeast Minnesota school

district was conducted. The school district has three public high schools serving 5448 students in grades 9 to 12 and is the largest in the region encompassing a 35% minority population.^[15] The survey was distributed electronically online from April 2021 to August 2021 and student-athletes were asked to reflect on their previous 2020 to 2021 sport seasons.

The Minnesota State High School League (MSHSL) which governs high school athletics within the state made multiple changes to the traditional schedule and requirements for 2020 to 2021 sports, including changing season dates, starting and stopping sports mid-season, limiting competitions to local teams only, eliminating all tournaments and some post-season competition, limiting numbers of post-season participants, and enforcing masking at all times including during competition for most sports (see Table 1). These decisions were largely based upon Minnesota Department of Health Guidelines and compliance with Executive Orders issued by the Governor.^[16]

2.2. Sample size

A rough estimate of our required sample size was obtained by assuming we wished to detect a clinically significant difference in mean SEQ score of 0.5, with an estimated standard deviation of 1.0. In their original article deriving and validating the SEQ, Jones et al^[14] found the standard deviation of SEQ components ranged from 0.53 to 0.93 among test subjects. Assuming equal exposed and unexposed groups, with $\alpha = 0.05$ and Power = 0.8, 63 subjects would be required in each group for a total sample size of 126. We estimated a 20% survey completion rate, thus a total of 630 student-athletes would be required. We approached and received permission to proceed from the largest school district in our region with over 2000 student-athletes. Several other smaller surrounding school districts were also approached but declined participation citing budgetary constraints and political sensitivity.

2.3. Subjects

Student-athletes were defined as high school students in grades 9 to 12 participating in one or more MSHSL sanctioned sports during the fall, winter, or spring of the 2020 to 21 academic year. We intentionally avoided questions regarding self-identified gender or race to eliminate the possibility of this demographic information being used, in combination with the specific sport, to individually identify an athlete. An informed consent statement assured confidentiality and indicated that participation was strictly voluntary and would not affect an athlete's athletic career. Per Mayo Clinic's Institutional Review Board requirements, both parental consent and student-athlete assent were documented electronically before student-athletes were allowed to proceed with the survey instrument. The survey was reviewed and approved by both Mayo Clinic's Institutional Review Board as well as the Rochester School Board (IRB# 21-000395; Approved on 2/16/2021).

2.4. Survey instrument

Data from the survey instrument was collected using an online electronic survey distribution platform (Qualtrics™, Utah, Provo, UT). The survey instrument consisted of basic demographic questions (age, grade, high school) and a series of questions about each student-athlete's respective sport season. If athletes participated in multiple sports, they were prompted to answer an additional series of questions to reflect each sport's season. The survey instrument was pre-tested by several high school student-athletes during development for readability and usability. Certified translations of the survey and consent documents were provided in the four most common languages within the school district (English, Spanish, Somali, and Chinese). The

Table 1**MSHSL COVID-19 alterations and restrictions for 2020–2021 season.***Fall*

Cheerleading
 Cross Country, Boys & Girls
 Football
 Soccer, Boys & Girls
 Swimming & Diving, Girls
 Tennis, Girls
 Volleyball, Girls

- Football & Volleyball canceled, then moved to spring (8/4/2020), then started 2 mo late with a 6wk regular season (9/21/2020), then halted without finishing post-season play on 11/20/2020
- Late season start by 2–3wk
- Dual meets only with conference teams, no invites or tournaments w/ 3 + teams
- Abbreviated schedule/season
- Spectators not allowed
- Virtual conference/section meets (i.e., swim/run in own facility and compare times), no state meet
- Masking required at all times except in pool Practices limited to 25 athletes per session

Winter

Alpine Skiing, Boys & Girls
 Basketball, Boys & Girls
 Cheerleading
 Dance, High Kick & Jazz
 Debate
 Gymnastics, Girls
 Hockey, Boys & Girls
 Nordic Ski Racing, Boys & Girls
 One Act Play
 Swimming & Diving, Boys
 Wrestling

- Season start delayed due to school cancelation for approx. 1 mo, coaches and athletes may not have in-person contact until 12/19/2020 (this was extended to 1/4/2021)
- Dual meets only with conference teams, no invites or tournaments w/ 3 + teams
- # athletes in post-season competitions limited to 8–20 depending on sport
- Max 4 teams at section site, limited # entries
- Only 1 team advances to state from sections
- Masking required at all times except in pool or while wrestling

Spring

Badminton, Girls
 Baseball
 Clay Target
 Golf, Boys & Girls
 Lacrosse, Boys & Girls
 Music
 Robotics
 Softball, Girls
 Speech
 Synchronized Swimming, Girls
 Tennis, Boys
 Track & Field, Boys & Girls
 Visual Arts

- Recommend conference opponents only
- No tournaments
- # athletes in post-season competitions limited to 15–24 depending on sport
- Only 2 athletes/team/individual event advance to state (track)
- Only 1 team advances to state from sections
- Masking required at all times (even outdoors and during competition)

Source: <https://www.mshsl.org/sports-activity-guidance-and-information-covid-related-resources-2020-2021>.

survey included a combination of multiple-choice questions and Likert scales. Student-athletes were asked about basic demographics (age, grade, school) and which specific sports they participated in for the 2020 to 21 school year. For each sports season they participated in they were asked questions regarding their level of competition (9th Grade, B-squad, Junior Varsity, Varsity), any COVID-19 disruptions (personal quarantine, teammate quarantine, season completion), and the 22 item SEQ. The survey typically took 5 to 10 minutes to complete depending on the number of sports seasons involved. The Athletic Director's Office obtained a list of eligible student-athletes based upon registration data. From this list, the Athletic Director contacted the parent or guardian of each student athlete via a series of three email invitations to participate (one initial and two reminders at 2–3 weeks intervals). Each invitation contained an electronic link to the consent document and survey instrument.

The SEQ domains were used as the dependent variables to assess emotions related to the specific sport season.^[14] The SEQ asks respondents use a five level Likert scale ranging from not at all to extremely to identify how much they feel 22 emotional words.^[14] It was originally developed and validated to assess pre-competition sports specific emotions in five domains; anxiety, dejection, anger, excitement, and happiness by averaging individual word responses corresponding to each domain.^[14] It has also been applied successfully to measure recalled emotions in athletics.^[17] In the current study, the SEQ is used as a tool to assess recalled sports specific emotions associated with the athlete's particular sport season. Independent variables collected

by the survey instrument included the season (fall, winter, or spring), specific sport, level of participation (9th grade, B-Squad, Junior Varsity, Varsity), whether the athlete was personally quarantined due to COVID-19 during the athletic season, whether teammates were quarantined during the season, and whether the season was able to be completed (i.e., the usual final play-offs/competitions held).

2.5. Statistical analysis

Welch's *t* test (2 groups) or ANOVA (>2 groups) was used to compare the discrete independent variables (athlete quarantine, team quarantine, season completed, grade, level, and school) with the 0 to 4 scaled dependent variables consisting of the five emotional domains on the SEQ (anxiety, dejection, excitement, anger, happiness). Because each hypothesis was testing five comparisons, one for each of the SEQ emotional domains, we used the Bonferroni correction to preserve the overall alpha at <.05 yielding a *P* value < .01 to be considered as significant for each individual comparison.

Multivariate linear regression models were constructed for each SEQ domain. Independent variables considered in the multivariate analysis were season (fall, winter, spring), athlete quarantined, team quarantined, season completed, sport gender (girls/mixed or boys), sport location (indoor or outdoor), and level of competition (9th Grade/B-Squad, Junior Varsity, Varsity). Grade was eliminated to avoid multicollinearity issues with level of competition. School within the district was not a significant

predictor and was therefore dropped from the final regression model. Missing data were eliminated. Regression coefficients (β) satisfying the following equation with 95% confidence intervals were computed, P values $< .05$ were considered significant.

$$y = 0 + 1X_1 + \dots + nX_n$$

where $\begin{cases} X_i \text{ are the categorical independent variables} \\ y \text{ is the scaled sports emotion domain} \end{cases}$

All survey responses were downloaded and exported to R (version 3.6.1) for analysis.^[18]

3. Results

160 surveys were returned out of 2068 eligible student-athletes, a 7.7% response rate, during the study period from the initial invitation on 4/27/2021 thru 3 weeks after the final reminder notification on 7/14/2022. 118 student-athletes and their parent or guardian consented to participation and completed the survey, representing a 73.8% completion rate. Among these student-athletes and completed surveys, there were 125 seasons represented with complete information.

The median age of student-athletes was 16 with a range of 13 to 19. As shown in Table 2, respondents skewed towards underclassmen. Twenty-eight unique MSHSL sanctioned sports were represented, with Girls Track and Field and Football being the most common. More student-athletes reported participating in girls' sports than boys' sports, and a plurality participated at the Varsity level. Twenty-eight of 125 (22.4%) student-athletes reported being personally quarantined during their season, and 77 of 125 (61.6%) reported that a team member was quarantined during their season. Twenty three of 125 (18.4%) student athletes reported not being able to complete their athletic season due to COVID-19 restrictions.

In the bivariate analysis, there were no differences in sports emotions based upon the athletic season. Although anger did trend lower in the spring, it did not meet the Bonferroni adjusted P value for significance. Indoor sports were associated with higher feelings of dejection ($x = 1.5$ vs 0.9 , $P = .005$) and anger ($x = 1.5$ vs 0.8 , $P < .001$), but the other sports emotions were not different. Those participating in girls' sports reported higher ratings of anxiety ($x = 1.3$ vs 0.6 , $P < .001$), but the other sports emotions were not different. There were no differences in sports emotions based upon grade level or high school attended.

Student-athletes who were personally quarantined during the athletic season experienced more anxiety ($x = 1.4$ vs 0.9 , $P = .004$), more dejection ($x = 2.1$ vs 0.9 , $P < .001$), and more anger ($x = 1.9$ vs 0.8 , $P < .001$), but excitement and happiness were not affected. Those who had teammates quarantined also experienced more anxiety ($x = 1.2$ vs 0.8 , $P = .009$), more dejection ($x = 1.4$ vs 0.8 , $P < .001$), and more anger ($x = 1.3$ vs 0.7 , $P = .002$), compared to those that did not. Being able to complete their season was associated with less dejection ($x = 1.0$ vs 1.9 , $P < .001$), and less anger ($x = 0.9$ vs 1.8 , $P < .001$). There was a trend towards lower anxiety, more excitement, and greater happiness but these did not meet our Bonferroni adjusted P value for statistical significance. Figure 1A–E presents the differences in social and emotional ratings graphically, using a box and whiskers plot and highlighting the median and interquartile ranges of sports emotion scores for each domain. All of these statistically significant findings shown with a P value in red exceeded our threshold for a mean clinically significant difference in the SEQ score of 0.5 per domain.

The multivariate linear regression models of sports emotions (Table 3) indicate that student-athletes quarantined during their athletic season experienced greater dejection ($\beta = 0.78$, 95% CI: 0.27–1.28, $P = .003$) and greater anger ($\beta = 0.78$, 95% CI: 0.24–1.32, $P = .005$). While those with a teammate quarantined during the athletic season experienced more anxiety ($\beta = 0.30$, 95% CI: 0–0.61, $P = .048$).

Table 2

Characteristics of student-athletes and sports seasons.

Characteristic	N	Pct
Student-athlete (N = 118)		
Class		
Freshman	41	43.6
Sophomore	24	25.5
Junior	15	16.0
Senior	14	14.9
High school		
A	32	34.0
B	22	23.4
C	40	42.6
Season specific (N = 125)		
Season		
Fall	57	45.6
Winter	39	31.2
Spring	29	23.2
Level of competition		
9th Grade or B-Squad	23	18.4
Junior varsity	48	38.4
Varsity	54	43.2
Sport gender		
Boys or mixed	53	42.4
Girls	72	57.6
Sport primary location		
Indoor	50	40.0
Outdoor	75	60.0
Athlete quarantined	28	22.4
Team quarantined	77	61.6
Season not completed	23	18.4

Numbers and percentages may not sum to total number and 100% due to incomplete survey data and rounding.

Spring sports were associated with lower ratings of anger ($\beta = -0.48, 95\% \text{ CI: } -0.95 \text{ to } 0, P = .048$), while participation in girls' sports was associated with greater anxiety ($\beta = 0.65, 95\% \text{ CI: } 0.39\text{--}0.92, P < .001$). Junior varsity athletes reported less dejection, less anger, and more happiness while varsity athletes also had greater happiness than 9th grade or b-squad athletes.

4. Discussion

This study examined the social-emotional impact of COVID-19 related disruptions in competitive high school sports on

student-athletes. Over 1 in 5 student-athletes were personally quarantined during their sport season and they suffered greater dejection and anger as measured by the previously validated SEQ. Additionally, nearly 2/3 of student-athletes had a teammate who was quarantined during their sports season, and this correlated with greater anxiety. These findings partially support our hypothesis that COVID-19 restrictions would increase the negative emotions of anxiety, dejection, and anger. However, decreases in positive emotions of happiness and excitement did not reach statistical significance, possibly due to a smaller than anticipated sample size or more prominent effects on negative emotions.



Figure 1. Bivariate association of various variables with sports emotion domain.

Table 3
Linear regression coefficients for sports emotion models.

	Anxiety	Dejection	Anger	Happiness	Excitement
Intercept	0.72 (0.24–1.19) <i>P</i> = .003	1.50 (0.88–2.12) <i>P</i> < .001	1.44 (0.78–2.11) <i>P</i> < .001	1.78 (1.13–2.44) <i>P</i> < .001	1.84 (1.15–2.53) <i>P</i> < .001
Winter	–0.10 (–0.53 to 0.33) <i>P</i> = .633	–0.10 (–0.66 to 0.46) <i>P</i> = .715	–0.18 (–0.79 to 0.42) <i>P</i> = .554	–0.00 (–0.60 to 0.59) <i>P</i> = .992	–0.04 (–0.67 to 0.58) <i>P</i> = .892
Spring	0.10 (–0.24 to 0.44) <i>P</i> = .553	–0.41 (–0.85 to 0.03) <i>P</i> = .066	–0.48 (–0.95 to –0.00) <i>P</i> = .048	0.20 (–0.27 to 0.67) <i>P</i> = .395	0.12 (–0.37 to 0.60) <i>P</i> = .643
Athlete quarantined	0.30 (–0.09 to 0.68) <i>P</i> = .129	0.78 (0.27–1.28) <i>P</i> = .003	0.78 (0.24–1.32) <i>P</i> = .005	–0.37 (–0.90 to 0.16) <i>P</i> = .173	–0.29 (–0.85 to 0.27) <i>P</i> = .314
Team quarantined	0.30 (0.00–0.61) <i>P</i> = .048	0.26 (–0.13 to 0.65) <i>P</i> = .194	0.30 (–0.12 to 0.73) <i>P</i> = .161	–0.21 (–0.63 to 0.21) <i>P</i> = .324	–0.18 (–0.62 to 0.26) <i>P</i> = .422
Season completed	–0.13 (–0.50 to 0.23) <i>P</i> = .470	–0.45 (–0.93 to 0.03) <i>P</i> = .064	–0.31 (–0.83 to 0.20) <i>P</i> = .231	0.22 (–0.29 to 0.73) <i>P</i> = .388	0.28 (–0.26 to 0.81) <i>P</i> = .303
Girls sport	0.65 (0.39–0.92) <i>P</i> < .001	0.19 (–0.16 to 0.53) <i>P</i> = .284	0.06 (–0.31 to 0.44) <i>P</i> = .735	0.03 (–0.34 to 0.39) <i>P</i> = .881	–0.01 (–0.39 to 0.37) <i>P</i> = .957
Indoor sport	0.04 (–0.40 to 0.49) <i>P</i> = .852	0.01 (–0.57 to 0.59) <i>P</i> = .964	0.19 (–0.43 to 0.82) <i>P</i> = .542	0.11 (–0.50 to 0.73) <i>P</i> = .714	–0.01 (–0.66 to 0.64) <i>P</i> = .979
Junior varsity	–0.24 (–0.62 to 0.13) <i>P</i> = .197	–0.60 (–1.09 to –0.12) <i>P</i> = .015	–0.75 (–1.27 to –0.22) <i>P</i> = .006	0.53 (0.02–1.05) <i>P</i> = .043	0.46 (–0.08 to 1.01) <i>P</i> = .093
Varsity	–0.29 (–0.68 to 0.11) <i>P</i> = .153	–0.11 (–0.63 to 0.40) <i>P</i> = .661	–0.33 (–0.89 to 0.22) <i>P</i> = .238	0.56 (0.01–1.11) <i>P</i> = .044	0.45 (–0.12 to 1.03) <i>P</i> = .123

95% confidence intervals are shown in parenthesis. Variables with a *P* value < .05 are colored red to highlight them in the table.

In a famous 1971 psychological experiment, Weiss et al^[19] showed that rats who had no control over their stressor, suffered the greatest physiologic harm in the form of gastric ulcers. This highlights the fact that a perceived lack of control over stressors is likely to produce greater harm. Thus, the feelings of anger, dejection, and anxiety from the student-athletes in this study are understandable because while COVID-19 restrictions, quarantines, and season cancellations may have been required by public health policy, the student-athlete had little control over sudden changes in their ability to compete or even participate in their sport. While not assessed in this study, these frustrations may be magnified in high school student-athletes seeking collegiate level athletic scholarships as they fear missing valuable opportunities to showcase their talent for recruiting purposes.

Recent research has found that COVID-19 quarantines and government-enforced restrictions have changed the training habits and competition schedules of athletes, resulting in negative impacts on their emotional well-being.^[2,20] Pillay et al observed significant reductions in the training activities of elite and semi-elite South African athletes during the COVID-19 pandemic and the cancellation of all team competitions.^[20] As a result of these changes, they found that 52% of the athletes had depressive symptoms and reported a reduction in their motivation to train.^[20]

Research on the effect of the COVID-19 pandemic on high school student-athletes is evolving and our study contributes to this. A large study of Wisconsin athletes found that nearly 4 in 10 suffered moderate to severe depression during Spring 2020, which was roughly 7 times the pre-covid rate.^[13] While our survey did not measure the change from a pre-COVID baseline nor assess clinical depression; we found elevated levels of anxiety, dejection, and anger when athletes or team members were quarantined.

McGuine et al surveyed students via online social media in May 2020, finding that canceled seasons increased anxiety and

depression among athletes.^[8,21] We also found parallel results using the sports-specific SEQ which showed increased dejection and anger when seasons were not completed. Similar to our findings of greater anxiety among female athletes, these mood disorders disproportionately affected female athletes and poorer school districts.^[8] A later study survey of high school athletes in October 2020 found those who were allowed to participate in a fall sport experienced less anxiety, less depressive symptoms, and had a higher quality of life than those who were unable to participate in a fall sport.^[9] In addition, student-athletes who received more social support and connectedness with teammates experienced better mental health and well-being.^[22] These findings are congruent with our findings of increased anxiety, dejection, and anger for affected athletes. Restrictions placed on student-athletes such as limiting in-person contact between coaches and athletes, virtual post-season play, and limiting numbers of participants all acted to reduce team connectedness, potentially worsening the social-emotional health of the student-athletes without a clear public health benefit because rates of infection among athletes were lower than community transmission and were not associated with the phase of return to play.^[23] Our survey was also performed later in the pandemic suggesting that the negative social-emotional impacts have persisted.

The long-term ramifications of disruptions in sports activities for high school student-athletes and the subsequent negative impact on their social and emotional well-being are currently unknown. Unfortunately suicide-related behaviors among adolescents, especially those with no prior psychiatric history, appear to be increasing as a result of COVID-19 stressors.^[24,25] It can reasonably be hypothesized that either these COVID-19 stressors are magnified in student-athletes or active participation in athletics, which was restricted, confers resiliency. Indeed anecdotal evidence of tragedies exists.^[26]

Research indicates that regular physical activity during COVID-19 restrictions may prevent some of the negative emotional changes experienced by adolescents.^[27] Regular physical training and activity also seems to be beneficial for the overall mental health of athletes competing at the professional level as well.^[28] Fortunately, with no correlation between athletic participation and virus transmission, high school athletics has not been shown to be a major transmission risk.^[23,29] Additionally, youth sports can operate safely, with appropriate protocols in place, even in communities with high COVID-19 transmission rates.^[30]

Based upon this information, a strategy which keeps high school athletics operating with the least amount of disruption necessary using COVID-19 safety protocols minimizes cumulative risk to the student-athletes. When this is not possible due to public health concerns, the social-emotional harms of suspending athletic participation should be recognized and student-athletes should be supported by providing well-being strategies, mental health services, and virtual or remote training options. The focus should be to help student-athletes safely maintain their sense of athletic identity, while also providing the emotional support, comradery, sense of togetherness, and regular physical activity that participation in high school sports provides.

4.1. Limitations

Unfortunately, due to the complex consent arrangement required by the Institutional Review Board and the inability to target follow-up solicitations to non-responders, there was a lower number of survey respondents than initially anticipated. This reduced power hampered our ability to perform subgroup analysis and may be why changes in happiness and excitement were not detected (potential type II error). With many school boards busy adapting to COVID-19 changes and dealing with a multitude of politically divisive issues, they were reluctant to engage in scientific research surrounding the pandemic which limited our ability to obtain a geographically diverse sample.^[31]

Many COVID-19 restrictions were highly localized with states and localities having very different approaches. Further study is needed to ascertain the differential effects. Our study was conducted at a single school district in the upper mid-west where athletics were subject to two state mandated complete shutdowns with significant alterations to competitions and training for over one year. Thus, our findings may not apply to student-athletes who had differing degrees of disruption. We are hoping to remedy this fact in follow-up work by collaborating with researchers in other states.

Finally, our survey was conducted at the end of the school year and recall bias could have affected the results, particularly for fall and winter sports. However, with the exception of decreased anger in the spring season (-0.48 , $P = .048$), when the fewest restrictions were in place (see Table 1), no statistically significant differences were found based upon athletic season.

5. Conclusion

Student-athletes who were directly affected by COVID-19 restrictions such as personal or teammate quarantine experienced social-emotional upheaval in the form of increased anxiety, more dejection, and more anger than their teammates who were less affected. School districts and public health authorities must carefully balance realistic public health benefits with known harms to athletes' well-being when contemplating mandated disruptions to athletic participation. They should strive to minimize disruptions to athletics, using COVID-19 protocols to keep athletes participating whenever possible. When athletics must be disrupted, student-athletes should receive wellness support, mental health services, and virtual or remote training options.

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Author contributions

All authors have read and approve of the manuscript.

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AJ: study design, data collection, data analysis, manuscript.

JS: manuscript. JDB: study design, manuscript. MLM: study design, manuscript. NEM: study design, data analysis, manuscript. EGG: study design, data collection, manuscript. MK: study design, data collection. CAA: study design, manuscript. GMG: study design, data collection, data analysis, manuscript.

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