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Mental Health, Physical Activity, and Quality of Life of US Adolescent Athletes During COVID-19–Related School Closures and Sport Cancellations: A Study of 13 000 Athletes

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Context: In the spring of 2020, US schools closed to in-person teaching and sports were cancelled to control the transmission of coronavirus disease 2019 (COVID-19). It is critical to understand the mental and physical health of adolescent athletes during this time.

Objective: To describe the health of athletes during COVID-19–related school closures and sport cancellations.

Design: Cross-sectional study.

Setting: A national sample recruited via social media.

Patients or Other Participants: A total of 13 002 US adolescent athletes (age = 16.3 ± 1.2 years, females = 52.9%, males = 47.0%) completed an anonymous online survey.

Main Outcome Measure(s): Demographic information collected was sex, grade, sport(s) played, and zip code. Assessments used were the General Anxiety Disorder 7-Item for anxiety, Patient Health Questionnaire 9-Item for depression, the Pediatric Functional Activity Brief Scale for physical activity, and the Pediatric Quality of Life Inventory 4.0 for quality of life. Mental health, physical activity, and health-related quality-of-life variables were compared among sex, grade, sport(s) played, and poverty level using means and 95% confidence intervals (CIs) from the survey-weighted analysis of variance.

Results: Females reported a higher prevalence of moderate to severe anxiety symptoms (females = 43.7% versus males = 28.2%). The Pediatric Functional Activity Brief Scale score was highest (best) for grade 9 (mean = 14.5, 95% CI = 14.0, 15.0) and lowest for grade 11 (mean = 10.9, 95% CI = 10.5, 11.3). The prevalence of depression symptoms was highest in team sport (74.1%) and lowest in individual sport (64.9%) participants. The total Pediatric Quality of Life Inventory score was lowest (worst) for athletes from counties with the highest poverty levels (high: mean = 74.5, 95% CI = 73.7, 75.3; middle: mean = 78.9, 95% CI = 78.0, 79.8; and low: mean = 78.3, 95% CI = 77.4, 79.1).

Conclusions: The health of US adolescents during the COVID-19–related school closures and sport cancellations varied to differing degrees depending on sex, grade level, type of sport participation, and level of poverty. Health policy experts should consider these findings in the future when creating and implementing policies to improve the health of adolescents in the United States.

Key Words: public health, disparity, socioeconomic status, anxiety, depression

Key Points

- Adolescent athletes' mental health and well-being during the COVID-19 outbreak differed a great deal depending on their sex, grade, sport(s) played, and level of poverty.
- Females, athletes in grade 12, team sport participants, and athletes from areas with a higher percentage of poverty reported increased mental health symptoms, as well as lower physical activity and quality-of-life scores.
- Post–COVID-19 policies need to be implemented to improve the health of adolescent athletes in the United States.

An estimated 8.4 million (55%) of the 15.3 million US high school students participate in interscholastic athletics.[1,2] High school athletics play an important role in improving the short-term and long-term health of these students.[3–10] During the winter and spring of 2020, the novel SARS-CoV-2 coronavirus and the resultant disease, coronavirus disease 2019 (COVID-19), reached pandemic proportions in the United States. In an effort to slow the spread of COVID-19, high schools across the United States were closed to in-person teaching, and many extracurricular activities such as high school interscholastic sports were cancelled.[11] Experts have suggested that school closures may have profound societal, economic, and psychosocial consequences for students and need to be studied further.[12–15] Although evidence to date has indicated that the restrictions associated with COVID-19 have had significant negative effects on the mental health of adults and specific populations of children, we are aware of

no prior researchers who have evaluated the physical and mental health of adolescent athletes in the United States during the pandemic.[16–18]

Before the school closures and sport cancellations during the 2019–2020 academic year, 18 000 US high schools offered interscholastic athletics programs.[19] Organized sport participation is recognized as having profound positive influences on the health and well-being of adolescent students. High school athletes often reported higher academic achievement, greater levels of physical activity, decreased levels of anxiety and depression, and better quality of life than students who did not participate in athletics.[3–5,8–10,20–22] The benefits of sport participation vary, depending on factors such as age, sex, and the type of sport(s) played.[23–25] Finally, investigators[26,27] have pointed out that the strategies to limit the spread of COVID-19 may affect youth to differing degrees on the basis of socioeconomic characteristics.

It is imperative to recognize that adolescent athletes represent a large, unique population of students with specific health attributes; therefore, we need to study and describe the health of this population while also considering individual characteristics and attributes. The purpose of our study was to describe the mental health, physical activity, and health-related quality of life (HRQoL) of US adolescent athletes in May 2020 when school closures and sport cancellations were implemented. We also aimed to assess whether health and well-being differed by sex, grade, type of sport(s) played, and socioeconomic status.

METHODS

This study was approved by the University of Wisconsin–Madison Institutional Review Board in April 2020. Recruitment of US adolescent athletes (males and females, grades 9–12, aged 13–19 years) to participate in the study was via social media (Facebook, Twitter) and completion of an anonymous online survey in May 2020. To ensure widespread national distribution and recruitment for the study, we provided the social media links to sports medicine provider colleagues across the United States and to the National Federation of State High School Associations (NFHS), which passed the links to each US state high school athletic association.

The survey consisted of 69 items and included a section on the demographics of the participant, followed by 3 validated instruments used to measure physical activity, mental health, and HRQoL in adolescents. Demographics requested were the participant's age, grade, school size, school funding source, and zip code as well as a list of all the high school and club (ie, not affiliated with their school) sports in which he or she competed during the previous 12 months. The type of high school sport participation was classified as either an individual sport or a team sport. For an individual sport, the athlete primarily performed alone for the school team (eg, cross-country, golf, swimming, tennis) while competing against opposing teams. Team sports involved group participation (eg, baseball, basketball, soccer) while competing against opposing teams. The percentage of athletes under age 18 years in poverty for each county (% $<$ 18) was determined by using each participant's zip code to identify the county of residence and the % $<$ 18 reported by US census data.[28] The remainder of the survey assessed mental health, physical activity level, and HRQoL.

Mental Health

The General Anxiety Disorder 7-Item (GAD-7) and Patient Health Questionnaire 9-Item (PHQ-9) surveys were used to evaluate anxiety and depression symptoms. Both questionnaires ask participants to rate the frequency of anxiety or depression symptoms, respectively, experienced in the past 2 weeks. The GAD-7 scale is a valid, reliable, and sensitive measure of anxiety symptoms that can differentiate between mild and moderate GAD in adolescents.[30] Scores range from 0 to 21, with a higher score indicating increased anxiety. In addition to the total score, GAD-7 categorical scores of 0 to 4, 5 to 9, 10 to 14, and 15 to 21 correspond to *no*, *mild*, *moderate*, and *severe* anxiety symptoms, respectively.[29,30] The PHQ-9 is a 9-item screening questionnaire for depression symptoms with scores ranging from 0 to 27; a higher score indicates a greater level of depression. The PHQ-9 has demonstrated high sensitivity and specificity for depression screening in adolescent patients aged 13 to 17 years.[31] In addition to the total score, PHQ-9 categorical scores of 0 to 4, 5 to 9, 10 to 14, 15 to 19, and $\geq$20 correspond to *minimal or none*, *mild*, *moderate*, *moderately severe*, and *severe* depression symptoms, respectively.[31,32]

Physical Activity

Physical activity level was assessed with the Hospital for Special Surgery Pediatric Functional Activity Brief Scale (PFABS).[20,33] This validated 8-item instrument was designed to measure the activity of active children between 10 and 18 years old during the past month. Scores range from 0 to 30, with a higher score indicating greater physical activity.[20,33]

Health-Related Quality of Life

The HRQoL was measured with the Pediatric Quality of Life Inventory 4.0 (PedsQL). The 23-item PedsQL questionnaire assesses HRQoL during the previous 7 days. Physical and psychosocial subscale summaries, as well as the total score, range from 0 to 100, with a higher score indicating greater HRQoL. The PedsQL has been validated for use in children aged 2 to 18 years.[34,35]

Statistical Analyses

Statistical analyses were performed for participants who provided valid, complete surveys. Recruits were excluded if they did not complete the entire survey, were not in grades 9 to 12, or indicated they did not participate in club or interscholastic sports. Demographic variables and individual sport participation were summarized as either mean $\pm$ standard deviation or n (%) overall and by study respondents for sex, grade in school, type of sport participation, and county poverty level. We divided the data into tertiles, with participants categorized as residing in a low-level, middle-level, or high-level % $<$ 18 county. The 2018–2019 sport participation statistics compiled by the NFHS were used to calculate survey weights to ensure that the respondents' sport participation matched that of the

entire population of US high school athletes.[19] These percentages were used to assess the likelihood that each survey respondent could have been randomly selected from the nationwide population of athletes. Survey weights were calculated as the inverse of the percentage likelihood of being sampled with the weights for multiple sport athletes on the basis of their most common sport played.

Means and 95% confidence intervals (CIs) for the cohort and by demographic group were estimated by survey-weighted analysis of variance (ANOVA) models separately for the mental health, physical activity, and HRQoL measures. Although these measurements tend to be non-normally distributed, the ANOVA model is robust to deviations from normality, especially in large sample sizes.[36] A weighted ordinal logistic regression model was applied to estimate the percentages of level of anxiety (GAD-7) and depression (PHQ-9) by group. All models controlled for region of the country (West, Southwest, Midwest, Southeast, and Northeast) as a fixed covariate.

Analyses were conducted in R for statistical computing (version 3.5; the R Foundation for Statistical Computing, Vienna, Austria). We did not report P values for comparisons between groups due to the large sample size, which resulted in each comparison being statistically significant ($P < .001$). We recommend that the results be assessed in terms of clinical relevance rather than statistical significance.

RESULTS

A total of 13 002 US adolescent athletes (age = 16.3 ± 1.2 years, female = 52.9%, male = 47.0%, other-prefer to not say = 0.1%) completed the survey. Participants indicated they resided in 825 unique counties in 46 states. Due to the convenience sampling design, information regarding the response rate was unavailable. The highest proportion of participants was from the Midwest (n = 9124, 70.2%), followed by the West (n = 2507, 19.3%). The county median (interquartile range) % < 18 was 12.6% (95% CI = 9.0%, 18.8%).

Most participants (n = 11 334, 87.2%) reported attending a publicly funded school. The median school enrollment was 864 (95% CI = 412, 1515) students.

Approximately 33.6% (n = 4064) competed in a single school sport, whereas the remaining competed in 2 or more sports. The most popular individual school sport was track and field (n = 4386, 33.5%), and basketball (n = 3593, 27.6%) was the most popular team sport. In addition to competing for their school teams, 59% (n = 7673) competed in a club sport outside their school setting. Running was the most popular individual club sport, with 574 (4.4%) participants, whereas basketball (n = 1606, 12.4%) was the most popular club team sport. Summaries of the sports played by the participants are found in Supplemental Tables 1 and 2 (found online at http://dx.doi.org/10.4085/1062-6050-2020-20.S1).

Sex

Females demonstrated a higher prevalence of moderate to severe anxiety symptoms than males (42.3% versus 25.4%, respectively) and a higher GAD-7 score (mean = 8.5, 95% CI = 8.3, 8.8 versus mean = 6.3, 95% CI = 6.0, 6.6, respectively; Table 1). Similarly, females endorsed a higher PHQ-9 score than males (mean = 9.7, 95% CI = 9.4, 10.4 versus mean = 7.3, 95% CI = 7.0, 7.7, respectively) and a higher prevalence of depression symptoms (75.7% versus 59.7%, respectively), as well as moderate to severe depression symptoms (43.7% versus 28.2%, respectively). Lower PFABS scores were provided by females (11.0, 95% CI = 10.6, 11.4) than males (13.7, 95% CI = 13.3, 14.1) as were lower total PedsQL scores (females = 74.6, 95% CI = 73.8, 75.4; males = 79.8, 95% CI = 79.0, 80.6).

Grade Level

Athletes in grade 12 reported a higher prevalence of moderate to severe anxiety and higher GAD-7 scores than athletes in grades 9, 10, and 11 (Table 2). Similarly, the grade 12 participants displayed the highest prevalence of moderate to severe depression and highest PHQ-8 score. Conversely, grade 9 participants exhibited the lowest GAD-7 score and lowest PHQ-9 score. Grade 9 participants also described the lowest prevalences of moderate to severe anxiety and moderate to severe depression. The lowest PFABS scores were noted in grade 11 athletes, whereas the highest scores were in grade 9 participants. The highest total PedsQL scores were found in grade 9 participants and the lowest scores in grade 12 participants.

Individual Versus Team Sport

Team sport athletes reported the highest prevalence of moderate to severe anxiety and highest GAD-7 scores, whereas individual sport athletes reported the lowest prevalence of moderate to severe anxiety and lowest GAD-7 scores (Table 3). The team sport participants had the highest prevalence of moderate to severe depression and PHQ-9 scores. Athletes who participated in both individual and team sports demonstrated the highest PFABS score, and the team sport athletes, the lowest score. The team-only sport participants provided the lowest PedsQL score; athletes who competed only in individual sports or in both individual and team sports endorsed higher and similar PedsQL scores.

Poverty Level of % < 18

Participants were classified as residing in a low poverty level (% < 18 range = 2.5%–10.9%, n = 4296), middle poverty level (% < 18 range = 10.95–17.7%, n = 4424), or high poverty level (% < 18 range = 17.7–44.5%, n = 4264) county. Athletes from counties with the highest poverty levels exhibited the highest prevalences of moderate to severe anxiety and moderate to severe depression and highest GAD-7 and PHQ-9 scores (Table 4). Conversely, the athletes from counties with low and middle poverty levels displayed similar percentages of moderate to severe depression symptoms, as well as similar GAD-7 and PHQ-9 scores. Athletes from counties with the highest poverty level showed the lowest PFABS scores and total PedsQL scores. In comparison, the athletes from counties with low and middle poverty levels demonstrated similar PedsQL scores.

DISCUSSION

To our knowledge, this is the first study to quantify the mental health status, physical activity level, and HRQoL of

Table 1. Demographic Information and Health Scores for US Female and Male Adolescent Athletes

Variable	All Participants (N = 13 002)	Females (n = 6885)	Males (n = 6117)
Age, y[a]	16.3 ± 1.2	16.2 ± 1.2	16.3 ± 1.1
Grade, n (%)			
9	3089 (23.8)	1641 (23.8)	1448 (23.7)
10	3419 (26.3)	1821 (26.4)	1598 (26.1)
11	3743 (28.8)	1892 (27.5)	1851 (30.3)
12	2751 (21.2)	1531 (22.2)	1220 (19.9)
Region, n (%)			
Midwest	9124 (70.2)	4776 (69.4)	4348 (71.1)
Northeast	279 (2.1)	165 (2.4)	114 (1.9)
Southeast	946 (7.3)	492 (7.1)	454 (7.4)
Southwest	146 (1.1)	46 (0.7)	100 (1.6)
West	2507 (19.3)	1406 (20.4)	1101 (18.0)
County % in poverty, mean ± SD	15.1 ± 6.5	15.1 ± 6.4	15.0 ± 6.6
General Anxiety Order 7-Item			
Total score[b]	7.6 (7.3, 7.9)	8.5 (8.3, 8.8)	6.3 (6.0, 6.6)
Anxiety categories, %[c]			
None	31.5 (31.3, 31.7)	25.9 (25.7, 26.1)	43.0 (42.7, 43.4)
Mild	31.8 (31.6, 32.0)	31.8 (31.6, 32.0)	31.7 (31.5, 31.9)
Moderate	20.1 (19.9, 20.3)	22.5 (22.3, 22.7)	15.1 (14.9, 15.2)
Severe	16.6 (16.5, 16.8)	19.8 (19.6, 20.0)	10.3 (10.1, 10.4)
Patient Health Questionnaire 9-Item			
Total score[b]	8.7 (8.4, 9.0)	9.7 (9.4, 10.0)	7.3 (7.0, 7.7)
Depression categories, %[c]			
Minimal or none	29.6 (29.4, 29.9)	24.7 (24.4, 24.9)	40.3 (40.0, 40.6)
Mild	30.9 (30.8, 31.1)	30.6 (30.4, 30.8)	31.5 (31.3, 31.7)
Moderate	20.0 (19.8, 20.2)	22.0 (21.9, 22.2)	15.7 (15.6, 15.9)
Moderately severe	13.6 (13.4, 13.7)	15.7 (15.6, 15.9)	9.0 (8.8, 9.1)
Severe	5.9 (5.8, 6.0)	7.0 (6.8, 7.1)	3.5 (3.4, 3.6)
Pediatric Functional Activity Brief Scale Total score[b]	12.1 (11.7, 12.5)	11.0 (10.6, 11.4)	13.7 (13.3, 14.1)
Pediatric Quality of Life Inventory 4.0[c]			
Total score	76.7 (76.0, 77.5)	74.6 (73.8, 75.4)	79.8 (79.0, 80.6)
Physical score	80.3 (79.5, 81.0)	77.9 (77.1, 78.6)	83.8 (82.9, 84.6)
Psychosocial score	74.8 (74.0, 75.6)	72.9 (72.0, 73.7)	77.7 (76.8, 78.6)

[a] Reported as mean ± SD.
[b] Reported as estimated mean (95% confidence interval).
[c] Reported as estimated % (95% confidence interval).

US adolescent athletes after the widespread implementation of policies (cancellation of in-person school and organized sports) to reduce the spread of COVID-19. Our findings suggest that during this period, athletes who were female, were in grade 12 (ie, higher grade level), participated in team sports, and resided in a county with a higher level of poverty experienced greater symptoms of anxiety and depression, lower levels of physical activity, and decreased HRQoL.

Females Versus Males

Females reported higher levels of anxiety and depression as well as lower physical activity and HRQoL scores than males, which is consistent with previous research[37,38] in adolescents. Although we found that between-sexes differences still existed, the levels of depression and anxiety were significantly higher for both females and males than those identified earlier.[37,38] Breslau et al[37] analyzed data from a national cross-sectional survey and indicated that the prevalence of depression in girls 14 to 17 years old was higher than for boys in the same age range (girls = 12.3%, boys = 4.2%). In contrast, the prevalence of depression in our study was 6 times higher in females and 14 times higher in males. Among 445 elite young adult soccer athletes, 6 (1.4%) demonstrated at least moderate anxiety based on the GAD-7.[38] In comparison, using the same measure, 37% of our sample described at least moderate anxiety. With regard to HRQoL, Lam et al[21] collected data on 2600 high school athletes and observed higher total PedsQL scores in males (males = 90.3 ± 9.3, females = 87.9 ± 11.0). Notably, the total PedsQL scores in our investigation were 11 points lower in males and 13 points lower in females than the data from Lam et al. Fabricant et al[20] found that young athletic males had higher PFABS scores than females (16.6 ± 8.4 versus 14.2 ± 8.4, respectively). These results are approximately 3 points (20% higher) than the scores for our male and female participants. Worse physical activity scores among females is a particular concern because females have shown even worse physical activity levels outside of school physical activity than males.[39]

We readily acknowledge that the sex differences we report may not be solely due to the cancellation of in-person school attendance and sports. Factors such as a lack of social interaction, increased economic uncertainty, and social media access may all play roles in the health of young individuals during the COVID-19 pandemic.[13–15] Detailing the effects of these other factors is beyond the scope of this study and deserves future attention by researchers. Nonetheless, we have identified worse mental health, physical activity, and quality-of-life scores than

Table 2. Demographic Information and Health Scores for US Adolescent Athletes by Grade Level

Variable	Grade			
	9 (n = 3089)	10 (n = 3419)	11 (n = 3743)	12 (n = 2751)
Age, y[a]	14.8 ± 0.5	15.8 ± 0.5	16.8 ± 0.5	17.8 ± 0.5
Sex: female, n (%)	1641 (53.1)	1821 (53.3)	1892 (50.5)	1531 (55.7)
Region, n (%)				
Midwest	2173 (70.3)	2403 (70.3)	2626 (70.2)	1922 (69.9)
Northeast	59 (1.9)	67 (2.0)	74 (2.0)	79 (2.9)
Southeast	222 (7.2)	230 (6.7)	269 (7.2)	225 (8.2)
Southwest	43 (1.4)	43 (1.3)	31 (0.8)	29 (1.1)
West	592 (19.2)	676 (19.8)	743 (19.9)	496 (18.0)
General Anxiety Order 7-Item				
Total score[b]	6.4 (6.0, 6.7)	7.4 (7.1, 7.7)	7.6 (7.3, 7.9)	8.7 (8.3, 9.0)
Anxiety categories, %[c]				
None	41.0 (40.6, 41.4)	33.1 (32.8, 33.5)	30.5 (30.2, 30.8)	22.6 (22.3, 22.9)
Mild	31.9 (31.7, 32.1)	32.6 (32.4, 32.8)	32.5 (32.3, 32.7)	30.5 (30.3, 30.7)
Moderate	15.9 (15.7, 16.1)	19.3 (19.1, 19.5)	20.5 (20.3, 20.7)	23.9 (23.7, 24.2)
Severe	11.1 (10.9, 11.3)	14.9 (14.7, 15.2)	16.6 (16.3, 16.8)	23.0 (22.7, 23.3)
Patient Health Questionnaire 9-Item				
Total score[b]	7.4 (7.0, 7.7)	8.8 (8.5, 9.2)	8.5 (8.1, 8.8)	9.9 (9.6, 10.2)
Depression categories, %[c]				
Minimal or none	37.6 (37.2, 38.0)	29.7 (29.3, 30.0)	29.7 (29.4, 30.1)	22.0 (21.7, 22.3)
Mild	31.6 (31.4, 31.8)	31.4 (31.2, 31.6)	31.4 (31.3, 31.6)	29.2 (29.0, 29.4)
Moderate	16.9 (16.7, 17.1)	20.1 (19.9, 20.3)	20.1 (19.9, 20.3)	23.1 (22.9, 23.3)
Moderately severe	10.0 (9.8, 10.1)	13.2 (13.0, 13.4)	13.2 (13.0, 13.4)	17.6 (17.4, 17.8)
Severe	4.0 (3.9, 4.1)	5.6 (5.5, 5.7)	5.6 (5.4, 5.7)	8.1 (8.0, 8.3)
Pediatric Functional Activity Brief Scale total score[b]	14.5 (14.0, 15.0)	12.8 (12.3, 13.2)	10.9 (10.5, 11.3)	11.2 (10.8, 11.6)
Pediatric Quality of Life Inventory 4.0[b]				
Total score	81.6 (80.7, 82.5)	77.7 (76.8, 78.6)	75.7 (74.8, 76.5)	73.6 (72.8, 74.5)
Physical score	84.9 (84.0, 85.8)	82.8 (81.9, 83.7)	78.0 (77.2, 78.9)	77.5 (76.6, 78.3)
Psychosocial score	79.8 (78.8, 80.8)	75.0 (74.0, 76.0)	74.4 (73.4, 75.3)	71.6 (70.6, 72.6)

[a] Reported as mean ± SD.
[b] Reported as estimated mean (95% confidence interval).
[c] Reported as estimated % (95% confidence interval).

were previously noted among both male and female adolescent athletes.

Grade Level

Mental health, physical health, and HRQoL worsened with increasing grade in school. The results of earlier investigations of worsening health and age were mixed. Breslau et al[37] reported that the prevalence of depression in girls peaked at 13.2% at age 15 and then declined to 10.6% by age 17. In contrast, the prevalence of depression in boys increased from age 14 (3.7%) to peak at age 17 (4.9%). Fabricant et al[20] determined that PFAB scores declined steadily from 15.4 ± 8.0 (age = 14 years) to 12.8 ± 8.5 (age = 18 years old). Lam et al[21] identified similar total PedsQL scores for athletes aged 14 to 18 years, with a range from 89.4 ± 9.6 to 90.5 ± 10.2. It should be noted, however, that our grade 12 participants presented worse mental health, physical activity, and HRQoL scores compared with earlier literature.

Although we cannot definitively identify the specific underlying mechanism for this finding, it is possible that the loss of social connections due to school and sport cancellations were felt the most by older adolescent athletes. Whereas younger student-athletes may be able to envision continuing their careers in upcoming school years, seniors were confronted with the fact that their high school and scholastic sport experiences had suddenly ended. Few high school athletes (5%–6%) continue competing in sports while in college.[40] As a result, the large majority of grade 12 athletes may be facing the reality that their sport career has suddenly and unexpectedly ended months earlier than anticipated. Transitions out of competitive sport are known to be more difficult for athletes who were not able to plan for them.[41] In addition, it may be assumed that athletes in grade 12 were affected by the cancellation of various school-related activities, including the end of classes, other extracurricular activities, and events such as graduation.

Type of Sport Participation

The mental and physical health of the participants during the COVID-19 pandemic differed according to their type of sport. Specifically, team sport athletes reported worse symptoms of depression and anxiety, lower levels of physical activity, and worse HRQoL than athletes who were involved in individual sports or in both individual and team sports. In other studies,[24,25] individual sport athletes displayed higher rates of depression than team sport athletes. Our contrary findings may be due to the possibility that individual sport athletes were able to continue participating in their sports when physical-distancing restrictions were put in place and, thus, were not affected to the same extent as team sport athletes. In many states, individual sport activities such as running, golf, or tennis were still available to these athletes outside the school setting. However, team sports such as baseball, softball, and soccer were restricted from practice and competition. Team sport athletes likely experienced greater limitations as demonstrated by reduced physical activity PFABS scores.

Table 3. Demographic Information and Health Scores for US Adolescent Athletes by Type of Sport Participation[a]

Variable	Type of Sport(s)		
	Individual (n = 2252)	Individual and Team (n = 4493)	Team (n = 6257)
Age, y[b]	16.4 ± 1.2	16.2 ± 1.2	16.3 ± 1.2
Sex: female, n (%)	1305 (57.9)	2152 (47.9)	3428 (54.8)
Grade, n (%)			
9	435 (19.3)	1169 (26.0)	1485 (23.7)
10	569 (25.3)	1198 (26.7)	1652 (26.4)
11	656 (29.1)	1292 (28.8)	1795 (28.7)
12	592 (26.3)	834 (18.6)	1325 (21.2)
Region, n (%)			
Midwest	1464 (65.0)	3181 (70.8)	4479 (71.6)
Northeast	48 (2.1)	92 (2.0)	139 (2.2)
Southeast	176 (7.8)	228 (5.1)	542 (8.7)
Southwest	30 (1.3)	39 (0.9)	77 (1.2)
West	534 (23.7)	953 (21.2)	1020 (16.3)
General Anxiety Order 7-Item			
Total score[c]	6.7 (6.4, 7.1)	7.1 (6.7, 7.4)	8.1 (7.8, 8.4)
Anxiety categories, %[d]			
None	38.0 (37.6, 38.4)	35.4 (35.0, 35.8)	27.8 (27.6, 28.0)
Mild anxiety	32.0 (31.8, 32.2)	32.2 (32.0, 32.3)	31.6 (31.4, 31.8)
Moderate	17.3 (17.1, 17.5)	18.4 (18.2, 18.6)	21.7 (21.5, 21.9)
Severe	12.8 (12.6, 13.0)	14.0 (13.8, 14.3)	18.9 (18.7, 19.1)
Patient Health Questionnaire 9-Item			
Total Score[c]	7.9 (7.6, 8.3)	8.0 (7.7, 8.4)	9.2 (8.9, 9.5)
Depression categories, %[d]			
Minimal or none	35.1 (34.7, 35.5)	33.7 (33.3, 34.1)	26.3 (26.1, 26.5)
Mild	31.6 (31.4, 31.8)	31.6 (31.4, 31.8)	30.6 (30.4, 30.8)
Moderate	17.8 (17.6, 18.0)	18.4 (18.2, 18.5)	21.3 (21.1, 21.5)
Moderately severe	11.0 (10.8, 11.2)	11.5 (11.4, 11.7)	15.1 (14.9, 15.2)
Severe	4.5 (4.4, 4.6)	4.8 (4.7, 4.9)	6.7 (6.6, 6.8)
Pediatric Functional Activity Brief Scale total score[c]	13.0 (12.5, 13.4)	14.2 (13.7, 14.7)	11.1 (10.7, 11.5)
Pediatric Quality of Life Inventory 4.0[c]			
Total score	79.6 (78.7, 80.5)	79.4 (78.5, 80.4)	74.8 (74.0, 75.6)
Physical score	83.3 (82.4, 84.2)	83.0 (82.1, 84.0)	78.3 (77.5, 79.1)
Psychosocial score	77.6 (76.6, 78.6)	77.5 (76.5, 78.6)	72.9 (72.1, 73.8)

[a] Individual sports included bowling, cross-country, diving, golf, gymnastics, swimming, tennis, track, and wrestling in the past 12 months. Team sports included baseball, basketball, cheer, field hockey, football, lacrosse, ice hockey, rugby, soccer, softball, and volleyball in the past 12 months. Participants in both individual and team sports included athletes who competed in at least 1 individual and 1 team sport during the past 12 months.
[b] Reported as mean ± SD.
[c] Reported as estimated mean (95% confidence interval).
[d] Reported as estimated % (95% confidence interval).

In addition, team sports may incorporate more social connections that were lost during the COVID-19 restrictions and were therefore associated with worse mental health and HRQoL.[42] If individual sport athletes were able to continue participating in their sports during the study period, they may have been less affected by the loss of athletic identity than team sport athletes. Moving forward, sports medicine professionals may want to use these results to advocate for team sport athletes to transition to more individual sports if their team sports are prohibited as a way to limit the spread of COVID-19.

Poverty Level

It has been suggested[13,15,43,44] that many of the restrictions during the COVID-19 pandemic will have disproportionate effects on individuals of low socioeconomic status. Our data reflected that as the level of poverty increased among adolescent athletes, symptoms of anxiety and depression increased, physical activity decreased, and HRQoL decreased. Our findings are consistent with those of previous authors[42,43] during nonpandemic times, which showed that low socioeconomic status was a predictor for decreased nonorganized physical activity among adolescents. In the United States, individuals from low-income areas have reduced access to club sports.[45,46] The effects on mental and physical health we identified are complex and may be due to a combination of many factors that disproportionately affect individuals of low socioeconomic status.[47] It is still important to note that the cancellation of school sports may have a differential effect on the health of athletes depending on their level of poverty. Whereas the mechanisms are speculative, our results nonetheless suggest that moving forward, we should prioritize increased access to physical activity and sports for these adolescents.

Limitations

This study had several limitations. First, the data were self-reported in online surveys and not the result of clinical examinations conducted by health care providers. None-

Table 4. Demographic Information and Health Scores for US Adolescent Athletes by % < 18 Poverty Level

Variable	2.5%–10.9% (n = 4296)	10.9%–17.7% (n = 4442)	17.7%–44.5% (n = 4264)
Age, y[a]	16.3 ± 1.2	16.3 ± 1.2	16.3 ± 1.2
Sex: female, n (%)	2240 (52.1)	2410 (54.3)	2235 (52.4)
Grade, n (%)			
9	1000 (23.3)	1086 (24.4)	1003 (23.5)
10	1171 (27.3)	1128 (25.4)	1120 (26.3)
11	1204 (28.0)	1280 (28.8)	1259 (29.5)
12	921 (21.4)	948 (21.3)	882 (20.7)
Region, n (%)			
Midwest	3309 (77.0)	3093 (69.6)	2722 (63.8)
Northeast	120 (2.8)	93 (2.1)	66 (1.5)
Southeast	119 (2.8)	251 (5.7)	576 (13.5)
Southwest	0 (0.0)	5 (0.1)	141 (3.3)
West	748 (17.4)	1000 (22.5)	759 (17.8)
General Anxiety Order 7-Item			
Total score[b]	7.1 (6.8, 7.4)	7.3 (7.0, 7.6)	8.1 (7.8, 8.4)
Anxiety categories, %[c]			
None	33.1 (32.8, 33.4)	32.6 (32.3, 33.0)	28.6 (28.3, 28.9)
Mild	31.9 (31.8, 32.1)	31.9 (31.7, 32.1)	31.5 (31.3, 31.7)
Moderate	19.4 (19.2, 19.6)	19.6 (19.4, 19.8)	21.3 (21.1, 21.5)
Severe	15.6 (15.4, 15.8)	15.9 (15.6, 16.1)	18.5 (18.3, 18.8)
Patient Health Questionnaire 9-Item			
Total score[b]	7.8 (7.4, 8.1)	8.1 (7.7, 8.4)	9.6 (9.3, 10.0)
Depression categories, %[c]			
Minimal or none	32.8 (32.5, 33.1)	31.8 (31.5, 32.1)	23.9 (23.6, 24.1)
Mild	31.5 (31.3, 31.7)	31.5 (31.3, 31.7)	29.8 (29.6, 30.0)
Moderate	18.7 (18.5, 18.9)	19.1 (18.9, 19.3)	22.2 (22.0, 22.4)
Moderately severe	12.0 (11.8, 12.1)	12.4 (12.2, 12.6)	16.6 (16.4, 16.8)
Severe	5.0 (4.9, 5.1)	5.2 (5.1, 5.3)	7.6 (7.4, 7.7)
Pediatric Functional Activity Brief Scale total score[b]	12.2 (11.7, 12.6)	12.5 (12.0, 12.9)	11.9 (11.5, 12.3)
Pediatric Quality of Life Inventory 4.0[b]			
Total score	78.3 (77.4, 79.1)	78.9 (78.0, 79.8)	74.7 (73.9, 75.5)
Physical score	80.9 (80.0, 81.7)	82.8 (82.0, 83.7)	78.6 (77.8, 79.4)
Psychosocial score	76.9 (75.9, 77.8)	76.8 (75.8, 77.8)	72.6 (71.7, 73.5)

[a] Reported as mean ± SD.
[b] Reported as estimated mean (95% confidence interval).
[c] Reported as estimated % (95% confidence interval).

theless, our sample was large, and although our results differed from previously reported normative values in this population, they aligned with current research in mental health during the COVID-19 pandemic.[17,18,26–32] Our work may validate reports[13,15,44,48] from experts who stated that COVID-19 will affect the mental health of youth. Second, we acknowledge possible response bias in our participants. We cannot know for certain whether the sample represented all US adolescent athletes or was biased toward athletes who were more likely to respond if they experienced the most profound effects on their health. Third, due to the survey delivery method, our sample may be biased toward athletes from higher socioeconomic families with easy access to Internet services and social media platforms. We could not eliminate this bias, but we described the results according to the % < 18 for each county to account for athletes from lower socioeconomic levels. Fourth, the lack of national representative data for healthy adolescent athletes before COVID-19 is problematic. We recognize this and stress that a comparison of our data with previous data should be undertaken with caution. Furthermore, not all regions of the United States were represented equally in our sample: 90% were from the Midwest and West. However, we used the NFHS distribution of athletes from across the entire United States to calculate sample weights and thereby mitigate the possible effects of selection bias. This increased the representativeness of our results to the entire US adolescent athlete population. Finally, additional variables, such as participation in other cocurricular activities and missing school-related events, were not accounted for in our study and could have confounded the results.

CONCLUSIONS

The mental health, physical activity, and HRQoL of US adolescents during the COVID-19–related school closures and sport cancellations varied depending on sex, grade level, type of sport participation, and level of poverty. Specifically, female athletes, athletes in grade 12, team sport participants, and athletes from areas with more % < 18 poverty described greater symptoms of anxiety and depression, lower levels of physical activity, and lower HRQoL in May 2020. Public health officials need to consider these differences when evaluating steps to limit the spread of COVID-19 across the United States. In further investigations, researchers should assess whether the data we reported continue to apply to adolescent athletes and if the health of these individuals may be improved by targeting sports and exercise opportunities to them.

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