HHS Public Access

Author manuscript

Brain Inj. Author manuscript; available in PMC 2021 February 23.

Published in final edited form as:

Brain Inj. 2020 February 23; 34(3): 357–362. doi:10.1080/02699052.2020.1723165.

Examination of sports and recreation-related concussion among youth ages 12–17: results from the 2018 *YouthStyles* survey

Kelly Sarmiento, **Jill Daugherty**, **Lara DePadilla**, **Matthew J. Breiding**

Division of Injury Prevention, Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Atlanta, Georgia, USA

Abstract

Background: This paper sought to examine the frequency of self-reported sports- and recreation-related (SRR) concussion, as well as care-seeking behaviors and potential activity restrictions after concussions, in a sample of youth.

Methods: A sample of 845 youth ages 12–17 years responded to the web-based *YouthStyles* survey in 2018. The survey measured the frequency of self-reported lifetime SRR concussion, the setting of their most recent SRR concussion, whether a doctor or nurse evaluated them, and the types of activity restrictions they experienced.

Results: Forty-three percent of youth surveyed sustained their most recent concussion while playing on a sports team, 21.1% while playing on a community-based team, and 36.0% while engaged in a sport or recreational activity. Nearly half (45.3%) reported having to miss playing sports or participating in physical activity for at least one day; about two in ten (19.7%) reported having to miss time on their phone or computer for at least one day.

Conclusion: Despite wide-spread efforts to promote protocols for SRR concussion among youth, a third of participants in this study did not seek medical care and more than half did not miss at least one day of sports or physical activity participation following a concussion.

Keywords

Concussion; sport; recreation; youth; team

Introduction

A concussion is a type of traumatic brain injury (TBI) caused by a bump, blow, or jolt to the head or elsewhere in the body that leads to a transmitted force to the brain. Concussions are a commonly-reported injury among children who participate in sports- and recreation-related (SRR) activities. Combining findings from three national databases (MarketScan,

CONTACT Kelly Sarmiento KSarmiento@cdc.gov Division of Injury Prevention, Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Atlanta, Georgia, USA.

Disclosure statement

The authors report no conflicts of interest.

National Electronic Injury Surveillance System, and National High School Sports Related Injury Surveillance System, Reporting Injury Online), Bryan et al. (1) estimate that 1.1 to 1.9 million children ages 18 and under sustain a SRR concussion each year in the United States. However, due to the absence of a national concussion surveillance system, the field is lacking in information about concussions sustained in settings outside of school-based sports, particularly community-based sports leagues and SRR activities outside of school- and community-based sports leagues (2).

A concussion can lead to a broad range of symptoms that can affect a child cognitively, psychologically, and emotionally. While most youth who sustain a concussion have a good recovery and are asymptomatic within 4 weeks, some experience persistent symptoms for months or longer (3–6). In its 2018 Report to Congress on TBI in children, the Centers for Disease Control and Prevention (CDC) describe the increased vulnerability of children to the short-term effects of TBI, as well as the potential manifestation of problems later in life following this injury (7–12). To reduce the risk of adverse outcomes, children with a possible concussion should seek care from a licensed healthcare provider to ensure appropriate diagnosis and management of the injury.

Following diagnosis of a concussion, there are several recommendations related to how healthcare providers should manage a youth's return to activities, such as sports and school. Both the CDC and the American Academy of Pediatrics recommend that healthcare providers prescribe rest immediately after the injury while symptoms are most severe and to limit activities that may exacerbate symptoms (3,13). Based on their symptomology, healthcare providers may also recommend that their young patient miss 2–3 days of school as bright lights, loud noises, and screen usage in schools may worsen symptoms early on (13). However, following this 2–3 day period, healthcare providers should prescribe a return to school with gradual light non-sports physical activity, such as taking a short walk (14–17). To help reduce the emotional symptomology (e.g. sadness, nervousness, or irritability) that may be present following a concussion, healthcare providers should assess for and discuss the importance of social support during recovery (3). Multiple studies on concussion and returning to sports after a concussion outline the importance of ensuring that youth with a suspected concussion are removed from sports the day of the injury and until approved to return to sports by their healthcare providers (3,18–20). Once approved to return to sports, youth should follow a 6-step protocol that generally takes days or weeks to complete (19,21). However, Bryan et al. (1) suggest as many as half (53%) of the estimated SRR concussions that occur each year include children who are not seen in a medical setting for their injury, and thus may not receive proper guidance on returning to sports.

The purpose of this paper is to expand the existing knowledge of SRR concussion among youth using a large convenience sample of U.S. youth ages 12 to 17 years. Self-reported history of lifetime SRR concussion was assessed, and among those reporting a concussion, the following information was solicited about their most recent SRR concussion: time since most recent SRR concussion, setting in which it occurred, whether they were assessed by a doctor or nurse, and the types of activities they missed for at least one day.

Methods

This study used data from Porter Novelli's 2018 *YouthStyles* survey. Porter Novelli Public Services is a public relations firm contracted by CDC to design and implement the *YouthStyles* survey. The *YouthStyles* survey is part of a series of web-based surveys conducted each year to gather insights about American consumers, including information about their health attitudes and behaviors. Broadly, the *YouthStyles* survey explores relationships with friends, health behaviors, sources of influence, media habits, and media usage.

Between June 2018 and July 2018, youth ages 12 to 17 residing with parents who are members of GfK's KnowledgePanel® were invited to answer the *YouthStyles* survey. GfK's KnowledgePanel® adult *SummerStyles* members are randomly recruited using probability-based sampling and include respondents regardless of whether or not they have landline phones or Internet access. If needed, households are provided with a laptop computer and access to the Internet. The panel is continuously replenished and maintains approximately 55,000 panelists. Adult *SummerStyles* panel members participated in a corresponding survey immediately prior to their child's *YouthStyles* participation and provided electronic consent for the youth to participate. Respondents were not required to answer individual questions and could exit the survey at any time for any reason. A total of 845 youth (out of 1,759 sampled parents) qualified, resulting in a completion rate of 48.0%. Households that completed both the adult and youth surveys received reward points worth approximately $10 and were entered into a monthly sweepstakes. The resulting data were weighted to match the U.S. Current Population Survey proportions for sex, age, race/ethnicity, number of youth ages 12 to 17 in the household, household income, parent education level, census region, metro status, and whether or not the household had internet access prior to joining the panel.

CDC was provided a license to access data from the 2018 *YouthStyles* survey post-collection from Porter Novelli, and analysis of these data was exempt from institutional review board approval because personal identifiers were not included in the data file. Five questions about concussion in sports were included in the 2018 *YouthStyles* survey. The first of the five questions participants answered focused on lifetime concussion prevalence. The respondent was first provided a definition of concussion: "A concussion is when a blow or a jolt to the head causes problems such as headaches, dizziness, being dazed or confused, difficulty remembering or concentrating, vomiting, blurred vision, or being knocked out." The respondent was then asked one of two different versions of a question on their lifetime history of concussion (question 1a or 1b). Participants were randomly assigned either answer question 1a or 1b. Questions 1a and 1b were adapted from a survey question contained in the *Youth Behavior Risk Factor Survey* (YRBS) (22). The first version (question 1a) stated: "During your lifetime, how many times did you have a concussion from playing a sport or being physically active?" Response options ranged from "0 times" to "4 or more times." The second version of the question (question 1b) included the same text as version 1a; however, question 1b included the prompt: "Please include concussions even if you did not go to see a doctor or nurse."

Respondents who answered “yes” to question 1a or 1b were directed to answer a series of four follow-up questions (questions 2–5). These questions were designed to gather more information about the participant’s specific concussion experiences. Length of time since their most recent concussion was measured with the question “How long ago was your most recent concussion from playing a sport or being physically active?” Response options were “During the past year,” “Between one and three years ago,” and “More than three years ago.” The setting of the activity at the time of their most recent concussion was measured with the question “What were you doing when you had your most recent concussion from playing a sport or being physically active?” Response options were “I was playing on a sports team run by my school,” “I was playing on a sports team being run by a community group,” and “I was playing a sport or being physically active for fun or exercise, but not as part of a school or community sports team.” To measure care-seeking behaviors following their most recent concussion, respondents were asked to answer “Yes” or “No” to the following question, “Did a doctor or nurse check you for your most recent concussion?” Finally, types of activities respondents missed because of their concussion was measured with the question, “Did you have to miss any of the following things you normally do because of your most recent concussion?” Response options include: “I could not use my phone or computer for at least one day,” “I could not hang out with my friends for at least one day,” “I could not go to school at least one day,” “I could not play sports or participate in physical activity for at least one day,” and “None of these.” Respondents could choose more than one activity unless they selected “None of these.”

Data analysis

All data were analyzed using SAS 9.4 (SAS Institute Inc., Cary, North Carolina, USA). Upon initial analysis, questions 1a and 1b did not result in a significantly different percentage of respondents reporting lifetime concussion so the two sub-samples (those who answered 1a and those who answered 1b) were combined for this analysis. Frequency distributions were calculated for each concussion-related question by sample demographic characteristics (sex, age, race/ethnicity, educational attainment of household, and U.S. region). Chi-square tests of significance were run as post-hoc analysis to determine whether there were significant differences in healthcare usage and missed activities by setting of activity for the most recent concussion. For chi-square tests that indicated significant differences for variables with more than two levels, differences in proportions with a Bonferroni adjustment for multiple comparisons were run for pairwise comparisons using SPSS.

Results

Table 1 describes the demographics of the adolescent sample. The sample was evenly split between male (49.9%) and female (50.1%) respondents and had a relatively equal representation by age. Approximately two-thirds (64.4%) of the *YouthStyles* sample were non-Hispanic white, 7.8% were non-Hispanic black, 12.2% were non-Hispanic other, and 15.6% were Hispanic. When looking at the educational attainment of their’ parents, nearly half had a bachelor’s degree or higher (44.4%). Another one-third (33.1%) of households had at least some college. Finally, about a third (34.2%) of the households in the *YouthStyles*

sample were located in the South, 26.4% in the Midwest, 20.7% in the West, and 18.7% in the Northeast.

Fourteen percent (n = 118) of the youths surveyed reported experiencing a sports- or recreation-related concussion in their lifetime (Table 2). Of those who had sustained an SRR concussion, about two-thirds (63.6%) experienced just one SRR-concussion and one-third (36.4%) experienced two or more SRR-concussions in their lifetime. Also, among those who reported an SRR concussion, about 41% indicated that their most recent SRR concussion happened more than three years ago, while 35.9% reported that it happened between one and three years ago, and 23.1% said it happened within the last year. Forty-three percent of respondents reported that their most recent SRR concussion was sustained while they were playing on a sports team run by their school. Another 21.1% reported experiencing their most recent SRR concussion while they were playing on a sports team being run by a community group, while a little more than a third (36.0%) reported that it happened while engaged in a sport or recreational activity not affiliated with a school or community team. Over two-thirds (69.2%) of respondents indicated that a doctor or nurse assessed them for their most recent SRR concussion. Post-hoc analysis (not shown) demonstrated that the vast majority of youth in school-based sports (85.7%) saw a doctor or nurse about their concussion, while just over half of youth who played either a community (56.5%) ($p = .0065$) or non-team sport (56.1%) sought care ($p = .0018$).

Finally, about half of respondents indicated that they had to miss at least one activity during their concussion recovery. Nearly half (45.3%) reported having to miss playing sports or participating in physical activity for at least one day and 19.7% reported having to miss phone or computer use and school and 18.8% reported not hanging out with friends for at least one day. Post-hoc analyses (not shown) revealed that a lower percentage of youth who were doing a non-team activity when injured missed one day of sports (19.5%) than either youth playing on a school-based sports team (65.3%) ($p < .001$) or youth who were playing on a community team (56.5%) ($p = .0025$).

Discussion

In this study, 14% of participants self-reported an SRR concussion in their lifetime. This is consistent with a previous study by Donnell et al. (23) that used a similar study methodology with data from 2014, and also found that 14% of youth and high school athletes reported they may have had a previous concussion. In contrast, a 2018 CDC study analyzed data from the YRBS found that 15.1% of high school students reported having sustained at least one SRR concussion during the 12 months preceding the survey (24). Taking into account the time frame of interest, this is much higher than in the current study, which found that overall, only 3% of youth reported experiencing an SRR concussion in the last year. It is possible that asking about SRR concussion in one's lifetime first and then discerning the timing of the concussion with a follow up question impacts a respondent's recollection of the recency of the injury. Jobe, Tourangeau, and Smith (25) examined the effect of participants' memory and the concept of "telescoping." Telescoping occurs when survey participants perceive recent events as being more remote than they are and distant events as being more recent than they are (26). In the case of concussions, it may be that certain

respondents recall their concussion happening more recently than it actually did, which could potentially inflate past-year estimates.

Other studies on lifetime SRR concussion have found much higher prevalence than the current study. For example, McDonald, Burghart, and Nazir (27) assessed the concussion reporting behaviors among female high school athletes and found that approximately 40% of athletes reported a suspected concussion during their lifetime. A cross-sectional survey by Register-Mihalik et al. (28), using a convenience sample of high school athletes from nine different states, found that more than half (53%) of athletes recalled sustaining at least one possible concussion during their years playing high school sports. High school students who play on sports teams are at greater risk for concussion (24), and this may contribute to the higher prevalence estimates in these studies relative to the current study.

Over the last decade, wide-spread efforts have sought to enhance concussion safety for the approximately 8 million youth who participate in high school sports, the 60 million youth who participate in organized youth sports programs, and the millions of others who participate in recreational, or non-team based sports, each year (29,30). One of the most prominent of these efforts was the introduction of state-level concussion in sports policies in all 50 states and the District of Columbia between 2009 and 2013 (31,32). These policies, commonly referred to as “Return-to-Play” laws, primarily focus on school-based sports programs and seek to promote concussion education, ensure that a youth with a possible concussion is removed from play, and that an athlete with a concussion receives medical clearance prior to returning to play (31,32). Still, findings from this study suggest that many youth do not seek care for their injury and may return to play too soon.

A third of participants in this study did not seek medical care from a doctor or nurse for their SRR concussion. Importantly, post-hoc analyses showed relative differences in care-seeking behaviors between youth in school versus community sports, and non-team-based sports and physical activities. The focus of Return-to-Play laws, commonly on school-based programs, may be one reason for this difference. To assess the effectiveness of Return-to-Play laws on high school athletes with concussions, Yang et al. (33) examined data from the High School Reporting Injury Online system both prior to and after the introduction of Return-to-Play laws across the country. In this study, the authors found that rates of initial concussions increased and rates of recurrent concussions decreased following implementation of these laws. Based on these findings, Yang et al. (33) suggest that these laws may have led to improved identification and care-seeking by high school athletes. An assessment of Return-to-Play laws by Gibson et al. (34) also found that states with legislation showed a greater increase in concussion-related healthcare utilization among youth aged 12 to 18 years compared states without legislation.

Approximately half of the athletes in this study reported having to miss playing sports or participating in physical activity for at least one day. Nearly two-thirds of students who were playing on a school-based sports team when injured missed at least one day of sports. As discussed above, the frequent focus of Return-to-Play laws on school-based sports may have led to relatively higher adherence to return-to-play protocols among school-based sports programs. In addition, the greater likelihood of well-trained adults (such as coaches,

spectators, and sports officials)— in particular athletic trainers— at school-based sporting events may affect care-seeking behaviors. Kroshus et al. (35) found that when athletic trainers are present at high school sporting events, concussion identification and response is improved. These findings suggest that more needs to be done outside of the school sports setting to ensure that youth who sustain a concussion do not return the same day and that they not be allowed to return to play until cleared by a medical provider.

It is recommended that youth rest for a period of time early in recovery when symptoms are severe; however, youth should engage in light activities soon after the injury, as long as these activities do not exacerbate symptoms. Grool et al. (15) conducted a prospective cohort study of 3,063 children ages 5 to 18 years and found that earlier initiation of physical activity following a concussion (e.g., within 7 days) decreased the risk for postconcussive symptoms at 28 days after the injury. Almost 20% of athletes in this study reported missing “hanging out with friends” for at least one day. While it is unclear from this study how long the youth missed hanging out with friends, or if they felt isolated or disconnected from peers during their recovery, there is growing concern about the onset or increase in depressive symptoms following an SRR concussion (36–38). Further research and attention to social isolation during concussion recovery, and whether healthcare providers discuss this concern with their young patients, may be warranted.

Broader education among healthcare providers and the use of detailed discharge instructions for patients with a concussion are potential opportunities to support a positive return to activity process and promote social connectedness. Zuckerbraun et al. (39) found that the use of patient discharge instructions is beneficial to concussion management – resulting in increased patient follow-up with primary care and more accommodations designed to support children returning to school. As part of its guideline development, CDC recommended the distribution of discharge instructions that address social, family, and school support, and include positive messages related to concussion prognosis. Along with the release of its guideline, CDC created discharge instructions that include a return to activity protocol describing a process for children to return to school and sports, as well as tips for parents and others to support children during recovery.

Finally, the results of this study also have implications for surveillance of youth SRR concussion and point to significant gaps in current estimates. Surveillance of youth SRR concussion has largely focused on organized, school-based sports, typically at the high school level (40). This study found that among a wider age range—youth 12–17 years of age—approximately 57% of the most recent SRR concussions reported were sustained outside of organized, school-based sports. Other methods of youth SRR surveillance collect data from the healthcare setting, such as emergency department visits resulting from SRR concussions (41). The current study found that nearly 31% of the youth in the sample were not evaluated by a doctor or nurse following their most recent SRR concussion. Taken together, these findings suggest the need for more comprehensive surveillance of SRR concussion in order to fill these sizable gaps and better represent the full public health burden of SRR concussion among youth. Pursuant to a recommendation from the National Academy of Medicine (formerly the Institute of Medicine) to produce more comprehensive estimates of SRR concussion, CDC is currently piloting the National Concussion

Surveillance System, which aims to address the gaps in current SRR concussion surveillance (2,42).

This study is subject to limitations. First, the *YouthStyles* survey is comprised of a convenience sample and has a limited number of participants. Thus, the results may not be generalizable to the overall population of youth in the United States. Second, the questions in the survey did not examine the number of days of restriction (only one or more days). Third, data in the survey is based on self-report and subject to recall bias. However, the data do provide preliminary findings that can be used to inform larger, more robust studies.

Conclusion

Despite wide-spread efforts to promote protocols for SRR concussion among youth, a third of participants in this study did not seek medical care, and more than half did not miss at least one day of sports or physical activity participation following a concussion. There were higher levels of care-seeking and refraining from same-day return to play following a concussion among athletes in school-based sports compared to those in community and non-team-based sports and physical activities. This suggests that youth who participate in community or non-team-based sports and physical activities may benefit from targeted messaging related to secondary and tertiary prevention of concussion.

Funding

No funding was received for development of this manuscript.

References

1. Bryan MA, Rowhani-Rahbar A, Comstock RD, Rivara F. Seattle sports concussion research collaborative. sports and recreation related concussion in US youth. Pediatrics. 2016; 138(1):pii: e20154635. doi:10.1542/peds.2015-4635. [PubMed: 27325635]
2. Bell JM, Breiding MJ, DePadilla L. CDC's efforts to improve traumatic brain injury surveillance. J Safety Res. 2017;62:253–56. doi:10.1016/j.jsr.2017.04.002. [PubMed: 28882274]
3. Lumba-Brown A, Yeates KO, Sarmiento K, Breiding MJ, Haegerich TM, Gioia GA, Turner M, Benzel EC, Suskauer SJ, Giza CC, et al. Centers for disease control and prevention guideline on the diagnosis and management of mild traumatic brain injury among children. JAMA Pediatr. 2018;172(11):e182853. doi:10.1001/jamapediatrics.2018.2853. [PubMed: 30193284]
4. Barlow KM, Crawford S, Stevenson A, Sandhu SS, Belanger F, Dewey D. Epidemiology of postconcussion syndrome in pediatric mild traumatic brain injury. Pediatrics. 2010;126(2):e374–e381. doi:10.1542/peds.2009-0925. [PubMed: 20660554]
5. Yeates KO, Taylor HG, Rusin J, Bangert B, Dietrich A, Nuss K, Wright M, Nagin DS, Jones BL. Longitudinal trajectories of post-concussive symptoms in children with mild traumatic brain injuries and their relationship to acute clinical status. Pediatrics. 2009;123(3):735–43. doi:10.1542/peds.2008-1056. [PubMed: 19254996]
6. Babikian T, Satz P, Zaucha K, Light R, Lewis RS, Asarnow RF. The UCLA longitudinal study of neurocognitive outcomes following mild pediatric traumatic brain injury. J Int Neuropsychol Soc. 2011; 17(5):886–95. doi:10.1017/S1355617711000907. [PubMed: 21813031]
7. Anderson VA, Catroppa C, Dudgeon P, Morse SA, Haritou F, Rosenfeld JV. Understanding predictors of functional recovery and outcome 30 months following early childhood head injury. 2006; 20(1):42–57. doi:10.1037/0894-4105.20.1.42.

8. Centers for Disease Control and Prevention. Report to Congress: The Management of Traumatic Brain Injury in Children. Atlanta, GA: National Center for Injury Prevention and Control; Division of Unintentional Injury Prevention; 2018.
9. Yeates KO, Swift E, Taylor HG, Wade SL, Drotar D, Stancin T, Minich N. Short-and long-term social outcomes following pediatric traumatic brain injury. J Int Neuropsychol Soc. 2004;10 (3):412–26. doi:10.1017/S1355617704103093. [PubMed: 15147599]
10. Bedell GM, Dumas HM. Social participation of children and youth with acquired brain injuries discharged from inpatient rehabilitation: A follow-up study. Brain Inj. 2004;18(1):65–82. doi:10.1080/0269905031000110517. [PubMed: 14660237]
11. Yeates KO, Taylor HG. Behavior problems in school and their educational correlates among children with traumatic brain injury. Exceptionality. 2006;14(3):141–54. doi:10.1207/s15327035ex1403_3.
12. Rivara FP, Koepsell TD, Wang J, Temkin N, Dorsch A, Vavilala MS, Durbin D, Jaffe KM. Incidence of disability among children 12 months after traumatic brain injury. Am J Public Health. 2012; 102(11):2074–79. doi:10.2105/AJPH.2012.300696. [PubMed: 22994196]
13. Halstead ME, McAvoy K, Devore CD, Carl R, Lee M, Logan K; Council on Sports Medicine and Fitness; Council on School Health. Returning to learning following a concussion. Pediatrics. 2013;132(5):948–57. doi:10.1542/peds.2013-2867. [PubMed: 24163302]
14. Centers for Disease Control and Prevention. Caring for your child's concussion. 2018 https://www.cdc.gov/traumaticbraininjury/pdf/pediatricmtbiguidelineeducationaltools/2018-CDC_mTBI_Discharge-Instructions-508.pdf.
15. Grool AM, Aglipay M, Momoli F, Meehan WP, Freedman SB, Yeates KO, Gravel J, Gagnon I, Boutis K, Meeuwisse W, et al. Association between early participation in physical activity following acute concussion and persistent postconcussive symptoms in children and adolescents. JAMA. 2016;316(23):2504–14. doi:10.1001/jama.2016.17396. [PubMed: 27997652]
16. Lempke L, Jaffri A, Erdman N. The effects of early physical activity compared to early physical rest on concussion symptoms. J Sport Rehabil. 2019; 28(1):99–105. doi:10.1123/jsr.2017-0217. [PubMed: 28952910]
17. Thomas DG, Apps JN, Hoffmann RG, McCrea M, Hammeke T. Benefits of strict rest after acute concussion: a randomized controlled trial. Pediatrics. 2015; 135(2):213–23. doi:10.1542/peds.2014-0966. [PubMed: 25560444]
18. Giza CC, Kutcher JS, Ashwal S, Barth J, Getchius TS, Gioia GA, Gronseth GS, Guskiewicz K, Mandel S, Manley G, et al. Summary of evidence-based guideline update: evaluation and management of concussion in sports report of the guideline development sub-committee of the american academy of neurology. Neurology. 2013;80(24):2250–57. doi:10.1212/WNL.0b013e31828d57dd. [PubMed: 23508730]
19. McCrory P, Meeuwisse W, Dvořák J, Aubry M, Bailes J, Broglio S, Cantu RC, Cassidy D, Echemendia RJ, Castellani RJ, et al. Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016. Br J Sports Med. 2017;51(11):838–47. doi:10.1136/bjsports-2017-097699. [PubMed: 28446457]
20. Harmon KG, Drezner JA, Gammons M, Guskiewicz KM, Halstead M, Herring SA, Kutcher JS, Pana A, Putukian M, Roberts WO. American medical society for sports medicine position statement: concussion in sport. Br J Sports Med. 2013; 47 (1):15–26. doi:10.1136/bjsports-2012-091941. [PubMed: 23243113]
21. Centers for Disease Control and Prevention. Returning to sports and activities. Atlanta, GA: National Center for Injury Prevention and Control; 2018.
22. Centers for Disease Control and Prevention. Youth Risk Behavior Surveillance System (YRBSS). 2018 [accessed 2019 Mar 27]. https://www.cdc.gov/healthyyouth/data/yrbs/index.htm.
23. Donnell Z, Hoffman R, Sarmiento K, Hays C. Concussion attitudes, behaviors, and education among youth ages 12–17: results from the 2014 YouthStyles survey. J Safety Res. 2018;64:163–69. doi:10.1016/j.jsr.2017.12.001. [PubMed: 29636165]
24. DePadilla L, Miller GF, Jones SE, Peterson AB, Breiding MJ. Self-reported concussions from playing a sport or being physically active among high school students—United States, 2017.

MMWR Morb Mortal Wkly Rep. 2018; 67(24):682–85. doi:10.15585/mmwr.mm6724a3. [PubMed: 29927909]

25. Jobe JB, Tourangeau R, Smith AF. Contributions of survey research to the understanding of memory. Appl Cogn Psychol. 1993;7(7):567–84. doi:10.1002/(ISSN)1099-0720.
26. Telescoping ZS. Encyclopedia of survey research methods 2008. 3 27, 2019 http://methods.sagepub.com/reference/encyclopedia-of-survey-research-methods/n579.xml.
27. McDonald T, Burghart MA, Nazir N. Underreporting of concussions and concussion-like symptoms in female high school athletes. J Trauma Nurs. 2016; 23(5):241–46. doi:10.1097/JTN.0000000000000227. [PubMed: 27618372]
28. Register-Mihalik JK, Guskiewicz KM, McLeod TC, Linnan LA, Mueller FO, Marshall SW. Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. J Athl Train. 2013; 48(5):645–53. doi:10.4085/1062-6050-48.3.20. [PubMed: 23848520]
29. National Federation of State High School Associations. High school participation increases for 29th consecutive year. 2 25 2019 https://www.nfhs.org/articles/high-school-sports-participation-increases-for-29th-consecutive-year/.
30. National Council of Youth Sports. Enhancing the youth sports experience. 2 25, 2019 http://www.ncys.org/about/about.php.
31. Harvey HH. Reducing traumatic brain injuries in youth sports: youth sports traumatic brain injury state laws, January 2009–December 2012. Am J Public Health. 2013; 103(7):1249–54. doi:10.2105/AJPH.2012.301107. [PubMed: 23678903]
32. Harvey HH, Koller DL, Lowrey KM. The four stages of youth sports TBI policymaking: engagement, enactment, research, and reform. J Law Med Ethics. 2015; 43(Suppl 1):87–90. doi:10.1111/jlme.12225.
33. Yang J, Comstock RD, Yi H, Harvey HH, Xun P. New and recurrent concussions in high-school athletes before and after traumatic brain injury laws, 2005–2016. Am J Public Health. 2017; 107(12):1916–22. doi:10.2105/AJPH.2017.304056. [PubMed: 29048967]
34. Gibson TB, Herring SA, Kutcher JS, Broglio SP. Analyzing the effect of state legislation on health care utilization for children with concussion. JAMA Pediatr. 2015; 169(2):163–68. doi:10.1001/jamapediatrics.2014.2320. [PubMed: 25531065]
35. Kroshus E, Rivara FP, Whitlock KB, Herring SA, Chrisman SPD. Disparities in athletic trainer staffing in secondary school sport: implications for concussion identification. Clin J Sport Med. 2017; 27(6):542–47. doi:10.1097/JSM.0000000000000409. [PubMed: 28742604]
36. Stazyk K, DeMatteo C, Moll S, Missiuna C. Depression in youth recovering from concussion: correlates and predictors. Brain Inj. 2017; 31(5):631–38. doi:10.1080/02699052.2017.1283533. [PubMed: 28326857]
37. Stein E, Howard W, Rowhani-Rahbar A, Rivara FP, Zatzick D, McCarty CA. Longitudinal trajectories of post-concussive and depressive symptoms in adolescents with prolonged recovery from concussion. Brain Inj. 2017; 31(13–14):1736–44. doi:10.1080/02699052.2017.1380843. [PubMed: 29115868]
38. Ellis MJ, Ritchie LJ, Koltek M, Hosain S, Cordingley D, Chu S, Selci E, Leiter J, Russell K. Psychiatric outcomes after pediatric sports-related concussion. J Neurosurg Pediatr. 2015; 16(6):709–18. doi:10.3171/2015.5.PEDS15220. [PubMed: 26359916]
39. Zuckerbraun NS, Atabaki S, Collins MW, Thomas D, Gioia GA. Use of modified acute concussion evaluation tools in the emergency department. Pediatrics. 2014; 133(4):635–42. doi:10.1542/peds.2013-2600. [PubMed: 24616361]
40. Marar M, McIlvain NM, Fields SK, Comstock RD. Epidemiology of concussions among United States high school athletes in 20 sports. Am J Sports Med. 2012; 40(4):747–55. doi:10.1177/0363546511435626. [PubMed: 22287642]
41. Sarmiento K, Thomas KE, Daugherty J, Waltzman D, Haarbauer-Krupa JK, Peterson AB, Haileyesus T, Breiding MJ. Emergency department visits for sports- and recreation-related traumatic brain injuries among children - United States, 2010–2016. MMWR Morb Mortal Wkly Rep. 2019; 68(10):237–42. doi:10.15585/mmwr.mm6810a2.

42. National Research Council and Committee on Sports-Related Concussions in Youth. Sports-related concussions in youth: improving the science, changing the culture. National Academies Press: 2014.

Table 1.

YouthStyles 2018 sample description.

	No lifetime concussions		At least one lifetime concussion	
Characteristic	**Frequency**	**Percent**	**Frequency**	**Percent**
Sex				
Males	355	49.0	67	56.8
Females	369	51.0	51	43.2
Total	*724*	*100.0*	*118*	*100.0*
Age				
12	118	16.3	8	6.8
13	104	14.4	22	18.6
14	121	16.7	14	11.9
15	126	17.4	19	16.1
16	115	15.9	28	23.7
17	140	19.3	27	22.9
Total	*724*	*100.0*	*118*	*100.0*
Race/ethnicity				
Non-Hispanic White	468	64.6	76	64.4
Non-Hispanic Black	58	8.0	8	6.8
Non-Hispanic Other[a]	83	11.5	18	15.3
Hispanic	115	15.9	16	13.6
Total	*724*	*100.0*	*118*	*100.0*
Household educational attainment				
Less than high school or high school diploma	161	22.2	26	22.0
Some college	245	33.8	34	28.8
Bachelor’s degree or higher	318	43.9	58	49.2
Total	*724*	*100.0*	*118*	*100.0*
Region				
Northeast	132	18.2	25	21.2
Midwest	192	26.5	30	25.4
South	255	35.2	33	28.0
West	145	20.0	30	25.4
Total	*724*	*100.0*	*118*	*100.0*

[a]Includes those who answered that they were “non-Hispanic, 2 or more races”

Table 2.

Frequency of lifetime SRR concussion and circumstances associated with most recent SRR concussion.

	Total	
	Frequency	**Percent**
Lifetime SRR Concussion		
Yes	118	14.0
No	724	86.0
Number of lifetime concussions[a]		
1	75	63.6
2 or more	43	36.4
Length of time since most recent SRR concussion[a]		
During the past year	27	23.1
Between one and three years ago	42	35.9
More than three years ago	48	41.0
Setting of most recent SRR concussion[a]		
I was playing on a sports team run by my school	49	43.0
I was playing on a sports team being run by a community group	24	21.1
I was playing a sport or being physically active for fun or exercise, but not as part of a school or community sports team	41	36.0
Evaluation by a doctor or nurse after most recent SRR concussion[a]		
Yes	81	69.2
No	36	30.8
Missed activities as a results of most recent SRR concussion[a,b]		
Phone or computer for at least one day	23	19.7
Hanging out with my friends for at least one day	22	18.8
School for at least one day	23	19.7
Playing sports or participate in physical activity for at least one day	53	45.3
None of these	54	46.2

[a]For those who have indicated they have experienced at least one concussion in their lifetime

[b]Percentage who answered “yes” to each item; response choices are not mutually exclusive except for the “none of these” option