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Sport and Recreation Related Concussion in Children: National Concussion Surveillance System

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Abstract

Introduction: Concussion sustained during sport and recreational activities are a concern for young athletes. The purpose of this study was to estimate past 12-month sport and recreation-related (SRR) traumatic brain injuries (TBIs) among a sample of children.

Methods: Pilot data from the Centers for Disease Control and Prevention (CDC)'s National Concussion Surveillance System (NCSS) were analyzed. NCSS utilized a cross-sectional random-digit-dial telephone survey using computer-assisted telephone interviewing to collect self/proxy-reported data in 2018-2019. Adults with children aged 5–17 in the household were asked about head injuries sustained by their children. Estimates were stratified by sociodemographic and injury circumstance characteristics. Data analysis occurred April 2022-July 2023.

Results: Utilizing a tiered case definition developed by CDC, an estimated 6.9% (95% CI, 6.0%-7.8%) of the sample's 5–17-year-old children sustained at least one *probable* or *possible* SRR-TBI in the previous 12 months; 3.3% (95% CI, 2.7%-4.0%) of the children sustained at least one *probable* SRR-TBI. An estimated 63.6% (95% CI, 58.1%-69.0%) of all reported TBIs were attributed to SRR activities. Of the SRR-TBIs reported, 41.1% (95% CI, 33.0%-49.2%) were experienced while playing contact sports. Symptoms did not resolve for 8 or more days or had not resolved at the time of the interview for 18.1% (95%CI, 13.0%-23.1%) of the children's most recent SRR-TBI.

Conclusions: Many proxy-reported TBIs among children aged 5–17 years were due to sport and recreational activities. Athletic trainers and health care providers can play a role in the prevention, identification, and management of SRR-TBIs in their respective environments.

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Keywords

concussion; traumatic brain injury; epidemiology; surveillance; survey

Introduction

Traumatic brain injury (TBI), including concussion, among children is an ongoing concern as indicated by the high rate of emergency department (ED) visits for this population.[1,2] Caused by an impact to the head or body, a TBI sustained during childhood can affect subsequent learning at school[3] as well as lead to potential long-term adverse emotional, cognitive, and psychological effects.[4, 5, 6, 7, 8]

One common cause of TBI among children is sport and recreational activity. Approximately 3.88 million ED visits for sport- and recreation-related (SRR)-TBIs among children occurred in the United States during 2001 through 2018.[9] From 2010-2016, estimates of ED visits for SRR-TBIs among children revealed the highest rates were among males and children aged 10–14 and 15–17 years.[10] Activities associated with the highest number of ED visits for SRR-TBI among children included football, basketball, and soccer.[10]

Surveillance of TBI, including SRR-TBI, has occurred through analysis of health care administrative datasets and focused on rates of TBI-related ED visits. However, not all children with a suspected TBI seek care in an ED. Parents of children with suspected mild TBI/concussion may choose not to seek care for their child because they view the injury as mild[11] or may seek care at clinical settings other than the ED[12], making it difficult to accurately estimate incidence of TBI among this young population.[13] Research examining point of entry for an initial visit for concussion care found that in a large, urban, pediatric health care system, over 75% of concussions were treated outside the ED (i.e., primary care and specialty care)[12] and suggests that ED visit-based surveillance systems capture less than 25% of all pediatric concussions. An alternative approach to capture the burden of youth SRR-TBIs is through examination of the High School Reporting Information Online (HS-RIO) database. HS-RIO is a web-based sport concussion surveillance system permitting athletic trainers to submit comprehensive information on injured high school student-athletes that participated in an organized school-based sport. Although HS-RIO provides useful information that is reported by athletic trainers on sports-related TBIs in schools, this surveillance system does not capture TBIs sustained outside of organized, school-based sports (e.g., recreational leagues) or SRR-TBIs sustained in children below the high school grade level.

National surveys that collect self- or proxy-reported information on TBI are another approach to comprehensively quantify incidence and prevalence of TBI due to all causes, including sports and recreation in children. The National Survey of Children's Health[14], National Health Interview Survey,[15] and Monitoring the Future Survey[16] are designed to capture national lifetime concussion/head injury prevalence among children. Although each survey is administered annually, not all surveys ask about concussion/head injury each year and are limited in the amount of information collected on mechanism of injury and injury circumstances. Given limitations in current youth sports-related concussion surveillance and

responding to the 2014 Institute of Medicine (IOM) report, *Sports-Related Concussions in Youth: Improving the Science, Changing the Culture*[17], the Centers for Disease Control and Prevention (CDC) conducted a pilot administration of a National Concussion Surveillance System (NCSS) to collect child (and adult) TBI data via a self-report survey.

Primary goals of the NCSS pilot were to evaluate the methodology of collecting self-reported information on TBIs and to develop and test a tiered case definition for self-reported TBI surveillance.[18, 19, 20] The NCSS pilot survey collected data on the signs and symptoms consistent with TBI, mechanism (e.g., sports and recreation, falls,) and intent of injury (unintentional versus intentional), and impact on respondent's social/school/work functioning. Aims of the current study are to describe parent proxy-reported SRR-TBIs among children in the United States.

Methods

Study Population

NCSS survey methodology was described elsewhere.[18, 20] Briefly, a pilot of a random-digit-dial (RDD) telephone survey using computer-assisted telephone interviewing was employed. The non-institutionalized population aged 18 years and older residing in the 50 states and the District of Columbia in 2018-2019 were included in the NCSS sampling frame. Although sampled adults were surveyed directly, respondents with children aged 5–17 years in the household were asked about head injuries sustained by these children. The current study describes responses from adult respondents that affirmed that "they were a parent or guardian of one or more children, aged 5–17 years, in the household" and knew health and activity information for each child (N=3,557); referred hereafter as "parent-proxy respondents." Over 10,000 U.S. adults completed surveys with an overall response rate of 8.4%.

Measures

Parent-proxy respondents were asked two questions to determine whether their child had sustained a head injury in the preceding 12-months: "In the last year, that is since [date 1 year ago from interview date inserted] was your child examined in a doctor's office, clinic, hospital or elsewhere because of a head injury?" and "In the last year, that is since [date 1 year ago from interview date], did your child experience any other injuries to their head that you did not see a doctor about?" If the adult respondent indicated that their child experienced at least one head injury and subsequently endorsed at least one sign or symptom (out of 12 assessed, Appendix 1) that resulted from the child's head injury, the respondent was asked: "Did your child experience this head injury while playing a sport, or while engaged in physical fitness or a recreational activity for fun or competition?" and "Which activity was your child doing at the time of the head injury?" Based on the response to this second question, interviewers selected one of 122 different activity options, ranging from aerobics/cardio to Zumba. For this analysis, SRR categories included "contact sports" (such as football and basketball), "limited contact sports" (such as baseball and softball), "non-contact sports" (such as cricket and tennis), and "recreation" (such as dancing and

walking). Activities were coded into one of these four categories from previous studies.[21, 22] Six percent of activities were endorsed as "other specified" and the research team back-coded these into the aforementioned categories. Additionally, the NCSS survey captured detailed data on recurrent/multiple TBIs within the past 12-months due to all causes among the same respondent.

Following a "yes" response about whether the child sustained a head injury in the preceding 12-months, parent-proxy respondents were asked 12 yes/no questions regarding signs and symptoms that may have occurred as a result of the child's head injury. Depending on which signs and symptoms were endorsed, each head injury was classified as either a *probable* TBI or *possible* TBI. *Probable* TBIs were those in which the child sustained a head injury and experienced difficulty remembering, loss or consciousness, or three or more symptoms from the *possible* TBI tier. *Possible* TBIs were those in which the child sustained a head injury and experienced 1 (but less than 3) symptoms: being dazed/confused/trouble thinking straight, nausea, headache, dizziness/clumsiness/balance problems, blurred or double vision, trouble concentrating, difficulty learning or remembering new things, sensitivity to light or noise, change in mood or temperament, and/or change in sleep/more tired than usual. Detailed information on the development of the case definition for NCSS was described elsewhere.[20] To ensure presentation of stable estimates for injury circumstance characteristics (e.g., contact level of sport, activity endorsed, and outcomes), we describe characteristics of the combined category of *probable* and *possible* SRR-TBIs. In this paper, the combined category of *probable* and *possible* SRR-TBIs will be referred to as 'SRR-TBIs' from this point forward unless specifically defined individually.

For each child's most recent SRR-TBI reported via parent-proxy, four outcomes were assessed. These outcomes included: time to symptom resolution (1 day, 2-7 days, 8+ days/ currently experiencing symptoms), whether medical evaluation was sought (yes/no), and extent of impact on social and school functioning (i.e., Likert scale comprising of not at all, slightly, moderately, quite a bit, or extremely).

Statistical Analysis

Data analysis occurred April 2022-July 2023. Descriptive statistics (unweighted and weighted frequencies, weighted percentages, and 95% confidence intervals (CIs)) were calculated to describe parent-proxy reported SRR TBIs overall and by demographic characteristics. The NCSS used a complex, disproportionate stratified sample design for respondents who completed the survey by landline and a random sample design for those who completed it by cellphone. Iterative proportional fitting (or raking) was used to weight NCSS data. Survey weights were computed to correct for disproportionate sampling probabilities introduced by the sampling design and to correct for differences in the demographic characteristics of the sample versus the population. Weighting targets were based on age, sex, race/ethnicity, and home ownership, marital status (adults only), and educational attainment (adults only). All estimates met the National Center for Health Statistics data presentation standards for percentages and means.[23] All analyses were performed in SAS 9.4 (SAS Institute, Cary, North Carolina) and SUDAAN (RTI International, Research Triangle Park, North Carolina) and took into consideration the

complex survey design. The pilot NCSS survey was approved (OMB control No: 0920-1240) to support TBI case ascertainment and measure development. Although it was determined that IRB approval was not required because the project was deemed not research, the survey protocol was approved by ICF's IRB. Weighted estimates from this pilot were not intended to produce nationally representative estimates of TBI.

Results

The study describes data from a sample of 3,557 children ages 5-17 years via parent-proxy respondents. An estimated 6.9% (95% CI, 6.0%-7.8%) of children sustained at least one SRR-TBI during the preceding 12 months; using more restrictive criteria, 3.3% (95%CI, 2.7%-4.0%) of children sustained at least one *probable* SRR-TBI during the preceding 12 months (Table 1). An estimated 6.1% (95% CI, 4.7%-7.6%) of children aged 5-9 years, 7.9% (95% CI, 6.1%-9.7%) of children aged 10-12 years, and 7.1% (95% CI, 5.6%-8.5%) of children aged 13–17 years sustained a SRR-TBI during the past year. An estimated 7.7% (95% CI, 6.4%-9.0%) of males sustained a SRR-TBI in the past year, while 6.1% (95% CI, 4.9%-7.3%) of females reported the same.

Among children who experienced at least one SRR-TBI, 13.1% (95% CI, 10.7%-15.4%; data not shown; see supplemental material for description) had multiple SRR-TBIs in the past 12 months. Allowing for the possibility of multiple TBIs being reported for a child, an estimated 48.8% (95% CI, 40.5%-57.1%) among children aged 5–9 years were SRR-TBIs, 72.8% (95% CI, 63.8%-81.8%) among children aged 10–12 years were SRR-TBIs, and 77.4% (95% CI, 69.5%-85.4%) among children aged 13-17 years were SRR-TBIs (Table 2).

Contact level of sport differed among the SRR-TBIs reported by parent-proxy respondents (Table 3). Of all the SRR-TBIs reported (including multiple per child), 41.1% (95% CI, 33.0%-49.2%) were experienced while playing contact sports (e.g., football, lacrosse, rugby), 24.1% (95% CI, 16.6%-31.5%) while playing limited contact sports (e.g., baseball, softball, cheerleading), 13.1% (95% CI, 8.3%-17.8%) while playing non-contact sports (e.g., cricket, tennis, golf), 14.5% (95% CI, 9.1%-19.9%) while engaged in a recreational activity (e.g., dancing, walking, aerobics), and 7.2% (data not shown) playing an "other" activity where sport contact level was unknown. Further, the common types of sport and recreational activities leading to an SRR-TBI varied by gender. Among all SRR-TBIs with a known contributing sport or activity among boys, football (18.3%, 95% CI, 11.7%-24.9%), soccer (10.7%; 95% CI, 5.4%-15.9%), and baseball (10.4%; 95% CI, 5.0%-15.7%) were the most common activities (data not shown). Among all SRR- TBIs with a known contributing sport or activity among girls, soccer (20.5%; 95% CI, 12.4%-28.8%; data not shown; see supplemental material for description) was the most common activity.

Among children's most recent SRR-TBI, 41.4% (95% CI, 34.7%-48.2%) had symptoms that resolved in one day, 30.3% (95% CI, 23.8%-36.9%) resolved within 2 to 7 days, and 18.1% (95% CI, 13.0%-23.1%) had symptoms last more than eight days or were yet to resolve (Table 4). The mean time to symptom resolution was six days, among those injuries where symptoms had resolved by the time of the interview. Nearly two-thirds (62.1%; 95% CI, 55.5%-68.8%) of most recent SRR-TBIs were evaluated by a medical professional,

paramedic, or athletic trainer. Of the most recent SRR-TBIs that were initially evaluated 68.1% (95% CI, 59.6%-76.6%; data not shown) were evaluated at the time and place of head injury, 16.3% (95% CI, 9.6%-22.9%) at a doctor's office or clinic, and 15.7% (95% CI, 8.9%-22.4%) at the ED or hospital. For approximately 10% of children's most recent SRR-TBIs, their parent reported moderate to extreme effects on school and social functioning.

Discussion

Study findings indicate that in 2018-2019 about 6.9% of children aged 5-17 years were reported by their parent-proxy to have sustained at least one SRR-TBI in the preceding 12 months. Nearly half of these TBIs were considered a *probable* SRR-TBI. This study likely captured concussions that go unevaluated, as well as those where evaluation occurred outside of the ED (e.g., on the sideline, urgent care). This hypothesis is supported by previous research that found over 75% of concussions were initially treated outside the ED[12] when assessed in a large, urban, pediatric health care system. In response to addressing the 2014 Institute of Medicine report[17] recommendation the NCSS pilot sought to fill the gaps in current TBI surveillance by developing a more comprehensive surveillance system.

The Youth Risk Behavior Survey (YRBS) surveys high school students on whether they sustained a concussion due to SRR in the preceding 12 months. The concussion definition provided in YRBS aligns most closely with the combined *probable* and *possible* NCSS case definition that classifies a TBI as having sustained a head injury and attributing one or more signs and symptoms to the head injury. In 2019, the self-reported prevalence of SRR concussion among high school students was 15.1%[24]; the 12-month NCSS estimate, reported by parents among a slightly different 13–17-year-old age group, was 7.1%. The difference between NCSS and YRBS estimates may be due to differences in direct vs. parent-proxy reporting and suggests higher estimates based on adolescent self-report relative to parent-proxy reporting.

Earlier studies found higher rates of TBI in sports in which collisions among athletes more commonly occur, such as in football, soccer, lacrosse, and ice hockey versus noncontact sports.[25, 17, 26] Similarly, this analysis found three times as many SRR-TBIs were reported to have occurred in contact sports versus noncontact sports or recreation-related activities. Consideration of noncontact youth sport options, such as flag football, is one strategy supported by the American Academy of Pediatrics to reduce the risk of injury.[27] Examination of primary prevention strategies such as modification of playing rules or techniques, enacting state laws and sports program policies and reducing sports-specific risk factors are needed to fill research and practice gaps in sport-related concussion prevention.[28, 17, 29, 30]

Examining the most recent SRR-TBI reported by parent-proxies in relation to a range of outcomes, it appears the NCSS pilot captured mostly mild injuries among children 5-17 years. For many, symptoms resolved within a week and suggests a faster time to symptom resolution than reported in prospective studies or medical samples.[31,32, 33] Despite positive findings, for approximately 1 in 10 most recent SRR-TBIs, parents reported moderate to

extreme effects on their child's school and social functioning. It is important to identify and manage a brain injury of any severity occurring in a child as early identification and treatment can help improve short- and long-term outcomes.[34] A TBI affects children differently than adults because it can impact their brain development during key timeframes that may alter developmental trajectories over their life span.[35, 36]

There are known ways to identify, manage, and minimize the risk of concussion among children. Athletic trainers and health care providers play a role in the identification and prevention of SRR-TBIs in their respective environments. Over two-thirds (70%) of U.S. public secondary schools have some athletic training services available to athletes,[37] and a pilot study of online concussion reporting in New Jersey public high schools found certified school athletic trainers reported more concussions and concussion symptoms among injured student-athletes when compared with school nurses.[38] Emergency physicians and sports medicine providers are vital in the implementation of evidence-based practices that promote prevention of SRR-TBIs. Bazarian and colleagues[39] outline preventive strategies ranging from patient education on risks of concussion (primary prevention), diagnosis and management of the initial SRR-TBI (secondary prevention), and education on long term-complications due to repeat head impact exposures (tertiary prevention) which can be enacted during the ED visit. Similarly, a commentary on the CDC's Pediatric mild TBI Guideline provided practice takeaways that sports medicine providers can implement including: pre-participation athletic examinations, not routinely performing neuroimaging for diagnostic purposes, using age-appropriate validated symptom assessments, monitoring for persistent symptoms, and supporting return to activity.[40] The Concussion in Sport Group released an international consensus statement summarizing evidence and practice recommendations for health care professionals caring for athletes at risk of sports-related concussion that can be adapted for different sport, clinical, and cultural environments.[41, 42]

Limitations

First there is potential for recall bias, telescoping, and social desirability given data collection was based on proxy-report. Second, the TBI case definition used was originally piloted in adult survey respondents and the degree to which it applies to children is unknown. However, the TBI case definition applied to this data is consistent with those published elsewhere.[43, 44] Third, there is potential of underreporting of TBIs by parent-proxies as in some cases parents may be unaware of their child's injury. This suggests that the estimates reported may be underestimates. Finally, the low response rate and non-response bias could have impacted estimates presented. However, demographic comparisons of NCSS respondents to the U.S. Census Bureau's estimates revealed similar demographic distributions.

Conclusions

These results demonstrate that many proxy-reported TBIs among children aged 5–17 years were due to sport and recreational activities and that contact sports were the leading contributing sport type. Further refinement of primary prevention strategies can help ensure that children stay active and injury free.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Demographics of parent-proxy[a] reported TBI[b] (any cause) and due to SRR activity[c]

Characteristic	Unweighted number of proxies reporting TBI	Weighted % of children with a TBI[d]	Unweighted number of proxies reporting SRR-TBI	Weighted % of children with an SRR-TBI[d]	Weighted % 95% CI (LB, UB)
Total TBI	381	10.4%	262	6.9	6.0, 7.8
Probable TBI	185	4.9%	130	3.3	2.7, 4.0
Possible TBI	196	5.5%	132	3.6	2.9, 4.2
Age group, years					
5-9	144	11.8%	75	6.1	4.7, 7.6
10-12	100	10.6%	75	7.9	6.1, 9.7
13-17	137	8.8%	112	7.1	5.6, 8.5
Probable TBI					
5-9	48	4.2%	18	1.7	0.8, 2.5
10-12	52	5.1%	40	4.0	2.7, 5.3
13-17	85	5.5%	72	4.6	3.4, 5.7
Possible TBI					
5-9	96	7.6%	57	4.5	3.2, 5.7
10-12	48	5.5%	35	3.9	2.6, 5.3
13-17	52	3.3%	40	2.5	1.6, 3.3
Sex					
Male	217	11.7%	149	7.7	6.4, 9.0
Female	164	9.0%	113	6.1	4.9, 7.3
Probable TBI					
Male	110	5.7%	77	3.9	2.9, 4.8
Female	75	4.1%	53	2.8	2.0, 3.6
Possible TBI					
Male	107	6.0%	72	3.9	2.9, 4.8
Female	89	4.9%	60	3.3	2.4, 4.2
Race and Ethnicity					
White, Non-Hispanic	245	11.0%	173	7.6	6.5, 8.7
Other[e]	105	8.9%	72	5.8	4.4, 7.2
Missing	31	17.6%	17	9.9	4.8, 15.1
Probable TBI					
White, Non-Hispanic	119	5.4%	87	3.8	3.0, 4.6
Other[e]	47	3.7%	31	2.4	1.4, 3.4
Missing	19	11.2%	--	--	--
Possible TBI					

Characteristic	Unweighted number of proxies reporting TBI	Weighted % of children with a TBI[d]	Unweighted number of proxies reporting SRR-TBI	Weighted % of children with an SRR-TBI[d]	Weighted % 95% CI (LB, UB)
White, Non-Hispanic	126	5.7%	86	3.8	3.0, 4.6
Other[e]	58	5.2%	41	3.4	2.3, 4.5
Missing	--	--	--	--	--

Abbreviations: TBI= traumatic brain injury; SRR= sport or recreation; CIs= confidence intervals; LB=lower bound; UB=upper bound

[a]Parent-proxy respondents are adults that affirmed yes “they were a parent or guardian of one or more children, aged 5–17 years, in the household” and knew health and activity information for each child (N=3,557).

[b]Parent-proxy respondent reported at least one sign or symptom for their child's head injury experienced due to any cause or sports and recreational activity 12 months prior to interview. Respondent level analysis that does not account for multiple head injuries to be reported per respondent.

[c]SRR injuries where the activity reported for the injury was a sport or recreation and excludes activities such as "jumping on the bed" or "being a boy".

[d]Estimates were weighted to correct for disproportionate sampling probabilities introduced by the sampling design and to correct for differences in the demographic characteristics of the sample versus the population.

Probable TBIs were those in which the child sustained a head injury and experienced difficulty remembering, loss or consciousness, or three or more symptoms from the “possible TBI” tier.

Possible TBIs were those in which the child sustained a head injury and experienced being dazed/confused/trouble thinking straight, nausea, headache, dizziness/clumsiness/balance problems, blurred or double vision, trouble concentrating, difficulty learning or remembering new things, sensitivity to light or noise, change in mood or temperament, and/or change in sleep/more tired than usual.

[e]Other race category includes respondents who selected more than 1 racial category; Black, Non-Hispanic; Asian, Non-Hispanic or Hispanic.

--Suppressed estimate that did not meet the National Center for Health Statistics data presentation standards for percentages and means.

Table 2.

Injury[a] level description of parent-proxy[b] reported TBIs[c] (any cause) and due to SRR[d] activity

Characteristic	Unweighted number of TBIs	Unweighted number of SRR-TBIs	Weighted % of TBIs due to SRR[e]	Weighted % 95% CI (LB, UB)
Total TBI	452	300	63.6	58.1, 69.0
Probable TBI	211	148	67.0	59.2, 74.8
Possible TBI	241	152	60.7	53.7, 67.7
Age group, years				
5-9	174	86	48.8	40.5, 57.1
10-12	116	85	72.8	63.8, 81.8
13-17	162	129	77.4	69.5, 85.4
Probable TBI				
5-9	54	--	--	--
10-12	59	46	78.5	66.6, 90.3
13-17	98	81	79.9	69.5, 90.3
Possible TBI				
5-9	120	65	52.7	43.1, 62.2
10-12	57	39	67.6	54.3, 80.9
13-17	64	48	73.4	61.4, 85.3
Sex				
Male	253	168	62.9	55.9, 69.9
Female	199	132	64.5	56.2, 72.7
Probable TBI				
Male	123	87	67.4	57.5, 77.3
Female	88	61	66.5	54.4, 78.6
Possible TBI				
Male	130	81	59.0	49.7, 68.4
Female	111	71	62.8	52.5, 73.1

Abbreviations: TBI= traumatic brain injury; SRR=sport or recreation; CIs= confidence intervals; LB=lower bound; UB=upper bound

[a] Injury level analysis of SRR-TBIs classified as *probable or possible* TBI and accounts for multiple SRR-TBIs reported per respondent.

[b] N=3,557 sampled adult/parent-proxy reporting.

[c] Parent-proxy respondent reported at least one sign or symptom for their child's head injury experienced due to any cause or due to sports and recreational activity 12 months prior to interview.

[d] SRR injuries where the activity reported for the injury was a sport or recreation and excludes activities such as "jumping on the bed" or "being a boy".

[e] Estimates were weighted to correct for disproportionate sampling probabilities introduced by the sampling design and to correct for differences in the demographic characteristics of the sample versus the population.

Probable TBIs were those in which the child sustained a head injury and experienced difficulty remembering, loss or consciousness, or three or more symptoms from the “possible TBI” tier.

Possible TBIs were those in which the child sustained a head injury and experienced being dazed/confused/trouble thinking straight, nausea, headache, dizziness/clumsiness/balance problems, blurred or double vision, trouble concentrating, difficulty learning or remembering new things, sensitivity to light or noise, change in mood or temperament, and/or change in sleep/more tired than usual.

Table 3.

Characteristics of parent-proxy* reported TBIs^ due to SRR activity# by contact level of sport

	Contact Sports[d]			Limited Contact Sports[e]			Noncontact Sports[f]			Recreation		
Characteristic	**Unweighted number of TBIs**	**Weighted % of TBIs[g]**	**Weighted % 95 CIs (LB, UB)**	**Unweighted number of TBIs**	**Weighted % of TBIs[g]**	**Weighted % 95 CIs (LB, UB)**	**Unweighted number of TBIs**	**Weighted % of TBIs[g]**	**Weighted % 95 CIs (LB, UB)**	**Unweighted number of TBIs**	**Weighted % of TBIs[&]**	**Weighted % 95 CIs (LB, UB)**
Overall	132	41.1	33.0, 49.2	71	24.1	16.6, 31.5	33	13.1	8.3, 17.8	41	14.5	9.1, 19.9
Age group, years												
5-9	20	24.6	12.2, 36.9	18	18.9	9.3, 28.5	16	20.7	9.9, 31.5	25	28.6	14.6, 42.7
10-12	40	44.8	30.1, 59.4	16	17.5	8.6, 26.4	--	--	--	--	--	--
13-17	72	52.9	38.3, 67.5	37	32.7	17.0, 48.5	--	--	--	--	--	--
Sex												
Male	86	47.9	36.4, 59.3	34	19.8	12.1, 27.6	18	12.7	6.4, 19.0	17	11.8	4.4, 19.2
Female	46	32.6	21.1, 44.0	37	29.4	15.6, 43.2	15	13.5	6.0, 20.9	24	17.9	10.0, 25.9

Abbreviations: TBI= traumatic brain injury; SRR=sport or recreation; CIs= confidence intervals; LB=lower bound; UB=upper bound

[a]Parent-proxy respondents are adults that affirmed yes “they were a parent or guardian of one or more children, aged 5–17 years, in the household” and knew health and activity information for each child (N=3,557).

[b]Parent-proxy respondent reported at least one sign or symptom for their child's head injury experienced due to any cause or sports and recreational activity. Injury level analysis of SRR-TBIs classified as *probable or possible* TBI and accounts for multiple SRR-TBIs reported per respondent.

[c]SRR injuries where the activity reported for the injury was a sport or recreation and excludes activities such as "jumping on the bed" or "being a boy".

[d]= football, basketball, rugby, field hockey, soccer, lacrosse, wrestling, ice hockey, boxing, futsal and martial arts with opponents

[e]= baseball, softball, cheerleading, diving, floor hockey, Field events (High jump, Pole vault), kickball, and skiing

[f]= cricket, tennis, table tennis, badminton, golf, bowling, bowls, croquet, pool, snooker, bossaball, darts, curling, tug of war, bodybuilding, swimming, diving, gymnastics, sprinting, running, track and field, bicycle race, rowing, archery, footgolf, fistball, shooting sports (e.g., rifle shooting competitions)

[g]Estimates were weighted to correct for disproportionate sampling probabilities introduced by the sampling design and to correct for differences in the demographic characteristics of the sample versus the population.

--Suppressed estimate that did not meet the National Center for Health Statistics data presentation standards for percentages and means.

Table 4.

Estimated parent-proxy[a] reported outcomes for most recent TBI[b] due to SRR activity[c]

Outcomes	Unweighted number	Weighted %[d] or mean	Weighted % 95% CI LB, UB
Most Recent SRR-TBI Characteristic	248		
Time to Symptom Resolution, Mean[e]	215	6.0	4.3, 7.7
Time to Symptom Resolution, %			
1 day	105	41.4%	34.7%, 48.2%
2-7 days	73	30.3%	23.8%, 36.9%
Symptoms yet to resolve or 8+ days	50	18.1%	13.0%, 23.1%
Case, unknown duration	20	10.2%	5.6%, 14.8%
Evaluated for TBI			
Evaluated for TBI	142	62.1%	55.5%, 68.8%
Not Evaluated for TBI	93	37.9%	31.2%, 44.5%
Extent of Impact: Social Functioning			
Not At All (1) or Slightly (2)	209	84.7%	79.8%, 89.6%
Moderately (3) or Quite A Bit (4) or Extremely (5)	27	9.7%	5.8%, 13.7%
Don't Know, Refused, Missing	*f*	*f*	*f*, *f*
Extent of Impact: School Functioning			
Not At All (1) or Slightly (2)	206	84.0%	79.2%, 88.9%
Moderately (3) or Quite A Bit (4) or Extremely (5)	30	10.4%	6.6%, 14.2%
Don't Know, Refused, Missing	*f*	*f*	*f*, *f*

Abbreviations: TBI= traumatic brain injury; SRR=sport or recreation; CIs= confidence intervals; LB=lower bound; UB=upper bound

[a]Parent-proxy respondents are adults that affirmed yes “they were a parent or guardian of one or more children, aged 5–17 years, in the household” and knew health and activity information for each child (N=3,557).

[b]Parent-proxy respondent reported at least one sign or symptom for their child's head injury experienced due to any cause or sports and recreational activity. Most recent head injury level analysis of SRR-TBIs classified as probable or possible TBI and does not account for multiple head injuries per respondent.

[c]SRR injuries where the activity reported for the injury was a sport or recreation and excludes activities such as "jumping on the bed" or "being a boy".

[d]Estimates were weighted to correct for disproportionate sampling probabilities introduced by the sampling design and to correct for differences in the demographic characteristics of the sample versus the population.

[e]Mean time to symptom resolution was calculated among respondents with resolved symptoms.

[f]Suppressed estimate that did not meet the National Center for Health Statistics data presentation standards for percentages and means.