

Head Injuries Presenting to Emergency Departments in the United States From 1990 to 1999 for Ice Hockey, Soccer, and Football

J. Scott Delaney, MDCM

Study Objective: To examine the number and rates of head injuries occurring in the community as a whole for the team sports of ice hockey, soccer, and football by analyzing data from patients presenting to US emergency departments (EDs) from 1990 to 1999.

Design: Retrospective analysis.

Main Outcome Measures: Data compiled for the US Consumer Product Safety Commission using the National Electronic Injury Surveillance System were used to generate estimates for the total number of head injuries, concussions, internal head injuries, and skull fractures occurring on a national level from the years 1990 to 1999. These data were combined with yearly participation figures to generate rates of injuries presenting to the ED for each sport.

Results: There were an estimated 17,008 head injuries from ice hockey, 86,697 from soccer, and 204,802 from football that presented to US EDs from 1990 to 1999. The total number of concussions presenting to EDs in the United States over the same period was estimated to be 4820 from ice hockey, 21,715 from soccer, and 68,861 from football. While the rates of head injuries, concussions, and combined concussions/internal head injuries/skull fractures presenting to EDs per 10,000 players were not always statistically similar for all 3 sports in each year data were available, they were usually comparable.

Conclusion: While the total numbers of head injuries, concussions, and combined concussions/skull fractures/internal head injuries presenting to EDs in the United States are different for ice hockey, soccer, and football for the years studied, the yearly rates for these injuries are comparable among all 3 sports.

Key Words: head injuries, concussions, skull fractures, emergency department, ice hockey, soccer, football

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From the Department of Emergency Medicine, McGill University Health Centre, and McGill Sport Medicine Clinic, West Montreal, Canada.

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Reprints: J. Scott Delaney, MDCM, McGill Sport Medicine Clinic, 475 Pine Avenue West, West Montreal, Quebec, Canada H2W 1S4 (e-mail: j.delaney@staff.mcgill.ca).

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Sports-related head injuries and concussions have been the focus of much attention in recent years. Among different sports played in the United States, football has historically been considered a high-risk sport for concussion and is still believed to be responsible for the majority of sports-related concussions in the United States today.¹⁻¹⁶ Similarly, ice hockey has long been recognized as a high-risk sport for concussion.¹⁷⁻²⁹ Soccer has not always been perceived to be a high-risk sport in this regard.^{1,3,30-32} In recent years, however, research has revealed that soccer is also a high-risk sport for concussion, with concussion rates similar to those for football and ice hockey.^{10,32-43} In fact, the American Academy of Pediatrics now defines soccer as a contact/collision sport, in the same category as football and ice hockey.⁴⁴

Studies examining head injuries and concussions among different sports have traditionally focused on elite athletes in our community, whether they are competing at the high school, college, or professional level.^{2,3,6,9,10,17-21,25,29,33,34,39,40,42,45} Rates of concussions and head injuries derived from research focusing on elite athletes may not be easily extrapolated to the community as a whole. It is believed that many sports-related head injuries occur while participating in sports played at a nonelite or recreational level.^{46,47} Whether these injuries occur in an organized league or during a pick-up game, most injured recreational athletes likely do not have access to a team physician or trainer and must use the medical resources available in the community.⁴⁸ As such, many of these injured athletes will present to local emergency departments (EDs) after a head injury.⁴⁹⁻⁵³

In an attempt to get a better understanding of the total number of sports-related head injuries and concussions occurring in the community as a whole, the number of patients presenting to US EDs for 3 different sports (ice hockey, soccer, and football) from the years 1990 to 1999 was examined. Data were obtained from the records of the Consumer Product Safety Commission (CPSC) of visits to EDs in the United States for head injuries related to participation in ice hockey, soccer, or football.

In an effort to understand rates of injuries better, injury data were combined, when possible, with the annual number of

participants in each sport to calculate a rate of injury per 10,000 participants per year in the United States for each sport. This information was used to assess whether rates of head-injured and concussed athletes presenting to the EDs in the United States were comparable for the sports of ice hockey, soccer, and football.

MATERIALS AND METHODS

The CPSC collects data from selected hospital EDs from across the entire United States in an effort to estimate the total number of injuries occurring during specific activities and/or injuries occurring with specific products. The CPSC uses the National Electronic Injury Surveillance System (NEISS) as a monitoring device.

National Electronic Injury Surveillance System figures are based on a sample of participating US hospital EDs rather than a census of all US hospital EDs. The sample hospitals are chosen in an effort to make the group representative of all institutions with EDs located within the United States. After obtaining the annual data from participating hospitals, NEISS then estimates the total visits to EDs in the entire United States for each year for a particular injury. At selected hospitals, all patients who are injured while participating in a specific activity or injured while using a particular product are selected for data entry. All injuries are then classified by location, and finally by diagnosis. The body part affected may be classified as the shoulder, upper trunk, elbow, lower arm, wrist, knee, lower leg, ankle, head, face, lower trunk, upper arm, upper leg, hand, foot, mouth, neck, finger, toe, ear, or not stated/unknown. Once an area of injury has been selected, only 1 diagnosis that best describes the type of injury is chosen. The diagnosis may be amputation, concussion, contusion/abrasion, dislocation, fracture, laceration, internal injury, strain/sprain, avulsion, not stated/unknown, or other. While the term *head injury* can mean different things to different readers, it most correctly refers to a traumatic injury to the head that is usually evident on clinical examination, characterized by ecchymoses, deformity, hematoma, lacerations, deformities, or cerebral spinal fluid leakage.⁵⁴ In the NEISS data, however, *head injury* is used to describe a region or area of injury. As such, *head injury* in the NEISS data comprises all injuries to the head area, including concussions. Information about individual cases is descriptive, and injury estimates are not meant to imply that injuries were caused by a specific activity or product.

Data were obtained from NEISS via the CPSC for all head injuries presenting to US hospital EDs from 1990 to 1999 for ice hockey, soccer, and football. The data for head injuries, as well as specific diagnoses including concussions, skull fractures, and internal head injuries, were examined for each sport for the years 1990 to 1999. In 1990, NEISS was updated to take into account changes in the sampling frame from 1975 to 1985. As such, data from previous years cannot be directly compared with estimates after the 1990 update.

Information regarding the number of participants in the United States per year for ice hockey, soccer, and football was obtained from Sports Business Research Network (SBRnet). SBRnet is a fee-based Web site that gathers information about sports equipment sales, participation, broadcasting, sponsorship, and marketing.⁵⁵ Estimates for the number of participants on a national level per year in the United States are available for a variety of different activities, including sports such as ice hockey, soccer, and football. These estimates are based upon data compiled primarily from different sports associations and leagues, as well as data from different publications, government agencies, marketing research information, and the National Sporting Goods Association. More specific data collection details can be found at the Web site.

The CPSC produces generalized sampling error estimates for NEISS data by applying a nonlinear regression curve-fitting procedure to the data collected each year. The generalized sampling errors are approximate values that are derived from fitting a curve through points determined by estimates and calculated sampling errors for a defined set of product groups. The estimated relative sampling errors for NEISS injury data are a measure of the estimated sampling error of the injury data expressed as a proportion of the injury estimates. More information about NEISS sampling errors and confidence intervals (CIs) can be obtained by contacting NEISS (National Injury Information Clearinghouse, 4330 East West Highway, Washington, DC 20207; e-mail: clearinghouse@cpsc.gov).

Incidence rates were obtained by dividing the number of athletes with the injury by the total number of athletes. All rates are expressed as injuries per 10,000 athletes. CIs for all incidence rates were obtained using the method for binomial proportions. These incidence rates and their CIs for each sport were plotted over time for total head injuries, concussions, and combined concussions/skull fractures/internal injuries to the head.

The Institutional Review Board of the host institution excluded this study from undergoing application of approval for human research.

RESULTS

The cumulative numbers of total head injuries, concussions, and combined concussions/skull fractures/internal head injuries from 1990 to 1999 for ice hockey, soccer, and football are listed in Table 1. Participation rates in the United States from 1993 to 1999 for the 3 different sports are listed in Table 2. Reliable participation data were available for ice hockey and soccer from 1993 onward, while accurate data for all types of football are available only from 1995 onward.

Rates for head injuries presenting to the EDs from 1993 to 1999 are listed in Table 3. When calculating rates for the different sports, calculations were made using all participants in a sport and not just frequent participants (Table 2). All rates

TABLE 1. Cumulative Injuries Presenting to the EDs in the United States from 1990 to 1999 for Ice Hockey, Soccer, and Football*

Cumulative Injuries (1990–1999)	Ice Hockey	Soccer	Football
Total head injuries	17,008	86,697	204,802
Total concussions	4820	21,714	68,860
Total concussions, skull fractures, or internal head injuries	9883	50,035	128,968

*Source: US CPSC and the NEISS.

for football injuries were calculated using players who had played either tackle or touch football, i.e., the “football total” data from Table 2. This was done as information about whether injuries occurred in a game of tackle or touch football was not always available.

Rates for concussions presenting to the EDs from 1993 to 1999 for ice hockey, soccer, and football are listed in Table 4. Rates for the combination of concussions/skull fractures/internal injuries to the head presenting to the EDs from 1993 to 1999 for each sport are listed in Table 5. Concussions, skull fractures, and internal injuries to the head were combined, as these diagnoses are suggestive of significant damage (skull fracture) or an injury to the brain (concussion or internal injury to the head). Internal injury to the head would most often imply some internal derangement such as a cerebral bleed or contusion. Due to the limited selection of diagnoses, internal head injury was the most appropriate diagnosis available for these types of injuries. While it is very probable that a patient who had suffered a skull fracture may also have sus-

tained at least a concomitant concussion, only 1 diagnosis that best described the injury to the affected area was chosen for each area of injury.

DISCUSSION

When examining participation rates over several years, participation in soccer trended upward from 1993 to 1999, ice hockey stayed relatively constant over the same period, and participation in football as a whole declined slightly from 1995 to 1999 (Table 2). Despite this, football had the highest number of participants for each year from 1995 to 1999, soccer had the second largest number of participants during the same period, and ice hockey had the least number of participants each year data were available. Likely at least in part because of its large number of participants, football accounted for the largest total number of head injuries, concussions, and combined concussions/skull fractures/internal head injuries presenting to the EDs from 1990 to 1999 (Table 1). These data do not contradict the belief that despite equipment and rule changes over the years, football is still responsible for the majority of sports-related concussions in the United States today.^{1–4,5,56,57} In keeping with the number of participants, soccer was associated with the second largest number of head injuries, concussions, and combined concussions/skull fractures/internal head injuries presenting to EDs from 1990 to 1999, while ice hockey, with the fewest number of participants, was associated with the fewest number of all injuries from 1990 to 1999.

When one combines the total number of head injuries presenting to EDs per year with the annual number of participants in each sport, a very rough estimate of injury rates for each sport per year is possible. These rates give a better idea of the chances of sustaining a head injury that requires medical attention in an ED while participating in any of the three sports, as opposed to merely examining the total number of head in-

TABLE 2. Participation Rates for Ice Hockey, Soccer, and Football in the United States from 1993 to 1999*†

		1993	1994	1995	1996	1997	1998	1999
Ice hockey	All participants	1.70	1.90	2.50	2.10	1.90	2.10	1.90
	Frequent participants (30+ days/y)	0.40	0.50	0.80	0.70	0.50	0.90	0.70
Soccer	All participants	10.30	12.50	12.00	13.90	13.70	13.20	13.20
	Frequent participants (40+ days/y)	3.00	3.70	3.70	4.20	4.70	4.90	5.00
Football (tackle)	All participants	‡	‡	8.30	9.00	8.20	7.40	8.70
	Frequent participants (40+ days/y)	‡	‡	2.60	3.20	2.90	2.80	3.40
Football (touch)	All participants	‡	‡	12.10	11.60	11.90	9.60	11.10
	Frequent participants (40+ days/y)	‡	‡	1.70	1.70	1.90	1.30	2.00
Football total	All participants	‡	‡	20.40	20.60	20.10	17.00	19.80
	Frequent participants (40+ days/y)	‡	‡	4.30	4.90	4.80	4.10	5.40

*Data presented in millions of participants

†Source: SBRnet.⁵⁵

‡Estimates not available for this year.

TABLE 3. Rates of Head Injuries Presenting to EDs in the United States from 1993 to 1999 for Ice Hockey, Soccer, and Football (Expressed as Injuries for Every 10,000 Participants)

Year	Hockey			Soccer			Football		
	Rate	95% CI Lower Limit	95% CI Upper Limit	Rate	95% CI Lower Limit	95% CI Upper Limit	Rate	95% CI Lower Limit	95% CI Upper Limit
1993	12.42	6.73	18.11	7.44	5.48	9.39	*	*	*
1994	13.66	7.78	19.54	6.62	4.93	8.32	*	*	*
1995	7.08	3.70	10.46	7.72	5.84	9.61	9.79	7.75	11.84
1996	8.68	4.56	12.79	6.87	5.22	8.53	10.20	8.10	12.31
1997	8.09	4.12	12.05	6.33	4.74	7.91	9.44	7.44	11.44
1998	10.48	5.74	15.23	7.86	6.02	9.70	13.54	10.82	16.27
1999	10.90	5.89	15.92	9.66	7.46	11.87	13.49	10.86	16.12

*Estimates not available for this year.

juries per year. The rates for head injuries presenting to the EDs are similar for ice hockey, soccer, and football for the years that data were available for each sport. While the calculated rates for football are slightly higher than for ice hockey and soccer for each year they were available, the 95% CIs overlap for all 3 sports, except between soccer and football for the year 1998, when football was higher.

The rates of head injuries trended higher for all 3 sports from 1997 to 1999. Reasons for this rise may include chance, changes in the sports themselves, an increased awareness of head injuries in the community, and a change in the locations where medical care was sought by injured athletes. While it is unlikely that all 3 games would have changed substantially over a span of only a few years, it is possible that players had become more aggressive and thus more likely to suffer from or cause an injury. Perhaps even more probable is that, as our society's awareness of concussions and head injuries has in-

creased over the past decade, athletes and the people who care for them have become more cautious about head injuries and are more inclined to seek medical attention. Finally, the possibility that patients who would have normally been seen by a physician outside of an ED in years past were now presenting to EDs cannot be excluded. This may have occurred by choice—i.e., they wanted to be seen in the ED, or out of necessity if they did not have access to a family physician or other health care professionals.

The most dramatic change in rates of head injuries occurred in ice hockey. Ice hockey had its highest rate of head injuries in 1993 and 1994. The rate declines suddenly for ice hockey in 1995 and is almost half of what it was in 1994. In contrast, the rate of soccer head injuries trended higher from 1994 to 1995. While the overlapping CIs from year to year limit any definitive statements, reasons for the change occurring in ice hockey may include chance, but may also include

TABLE 4. Rates of Concussions Presenting to EDs in the United States from 1993 to 1999 for Ice Hockey, Soccer, and Football (Expressed as Injuries for Every 10,000 Participants)

Year	Hockey			Soccer			Football		
	Rate	95% CI Lower Limit	95% CI Upper Limit	Rate	95% CI Lower Limit	95% CI Upper Limit	Rate	95% CI Lower Limit	95% CI Upper Limit
1993	3.28	1.61	4.94	2.01	1.08	2.93	*	*	*
1994	3.49	1.71	5.27	1.60	0.85	2.34	*	*	*
1995	2.15	1.06	3.25	1.57	0.83	2.31	3.13	2.26	4.01
1996	2.23	1.09	3.37	1.63	0.90	2.36	3.39	2.48	4.31
1997	2.04	1.00	3.08	1.38	0.73	2.03	3.28	2.38	4.19
1998	2.07	1.02	3.13	2.08	1.20	2.95	5.20	3.91	6.49
1999	4.90	2.40	7.40	3.10	2.03	4.17	4.97	3.79	6.15

*Estimates not available for this year.

TABLE 5. Rates of Combined Concussions, Skull Fractures, and Internal Head Injuries Presenting to EDs in the United States from 1993 to 1999 for Ice Hockey, Soccer, and Football (Expressed as Injuries for Every 10,000 Participants)

Year	Hockey			Soccer			Football		
	Rate	95% CI Lower Limit	95% CI Upper Limit	Rate	95% CI Lower Limit	95% CI Upper Limit	Rate	95% CI Lower Limit	95% CI Upper Limit
1993	7.50	3.71	11.29	4.25	2.85	5.65	*	*	*
1994	6.97	3.47	10.47	3.65	2.48	4.81	*	*	*
1995	4.95	2.44	7.47	4.52	3.22	5.83	5.91	4.55	7.27
1996	4.63	2.27	6.99	4.00	2.85	5.15	6.84	5.30	8.37
1997	5.63	2.76	8.51	3.54	2.47	4.61	6.46	4.99	7.93
1998	4.97	2.44	7.51	4.59	3.29	5.88	9.21	7.18	11.24
1999	8.73	4.51	12.95	6.52	4.88	8.16	9.70	7.65	11.75

*Estimates not available for this year.

changes to the game itself. Although the decline in rates of total head injuries for ice hockey from 1994 to 1995 is not as obvious when examining rates for concussions and combined concussions/skull fractures/internal head injuries, rule changes had been introduced which may have affected the game. For example, while helmets with facial protection had been mandatory for minor league hockey since the mid-1970s,^{58,59} in 1994, USA Hockey instituted a rule change that made it illegal to complete a body check on an opponent who no longer had control of the puck.⁶⁰ It is also possible that certain rules that had been instituted years earlier, such as no pushing or checking from behind (1985) and the repositioning of the goal line farther away from the end boards (1989), played some role as well.

The rates for concussions and combined concussions/skull fracture/internal head injuries per 10,000 participants presenting to EDs are comparable for ice hockey, soccer, and football during the years that data were available for each sport. Similar to rates of head injuries, the rate of concussions and combined concussions/skull fractures/internal head injuries trended higher for all 3 sports from the years 1997 to 1999. As with the increase in rates of head injuries, possible explanations may include chance, changes in the game, players becoming more aggressive, a higher percentage of injured athletes presenting to EDs instead of other health care facilities, and a greater awareness of concussions. This increased awareness may have occurred in the injured athletes or their caregivers and in the medical community as well. The accepted medical definition of a concussion has broadened in recent years to include many more signs and symptoms. While in years past, a concussion was generally accepted to have occurred only if a patient sustained a traumatically induced loss of consciousness and/or posttraumatic amnesia,⁶¹ physicians now generally accept that a concussion is "any alteration in cerebral function caused by a direct or indirect (rotation) force transmitted to the

head resulting in one or more of the following acute signs or symptoms: a brief loss of consciousness, light-headedness, vertigo, cognitive and memory dysfunction, tinnitus, blurred vision, difficulty concentrating, amnesia, headache, nausea, vomiting, photophobia or a balance disturbance. Delayed signs and symptoms may also include sleep irregularities, fatigue, personality changes, an inability to perform usual daily activities, depression or lethargy."⁶² As such, a patient who may not have been diagnosed with a concussion in years past may more recently have been diagnosed as having sustained a concussion.

The increasing size and strength of athletes at an elite level is sometimes cited as a reason for rising injury rates.⁶³ Any change in the size or strength of athletes involved in a particular sport is unlikely to be dramatic over the span of a few years and is therefore doubtfully a factor in this study that covers a period of only 10 years. Also, any changes that may occur in elite athletes may not be easily extrapolated to the entire community of combined elite and recreational athletes.

The total numbers and rates of head injuries, concussions, and combined concussions/skull fractures/internal head injuries presenting to the EDs in the United States are merely a surrogate marker for the true level of these injuries occurring in the community as a whole. It should be noted that while most rates of concussions for elite athletes are often expressed as the number of concussions per 1000 athletic exposures, we have expressed our rates of injuries as the number of injuries per 10,000 participants.⁶ This makes it difficult to compare these data with studies that prospectively calculated rates of injuries among elite athletes. The calculation and tabulation of all head injuries, concussions, and combined concussions/skull fractures/internal head injuries presenting to the EDs in the United States for any sport can only be expected to be a fraction of all head injuries occurring. Often, injured athletes may not recognize that an injury has occurred and thus may not seek

medical attention^{9,10,64,65} Recent research has suggested that many sports-related concussions go unrecognized and undiagnosed.^{9,10} Some athletes may recognize that an injury has occurred but may decide not to seek medical attention.^{45,66} Others may seek medical care outside EDs. While not all head injuries and concussions present to EDs, the head injuries and concussions that do present to EDs are expected to be of a more severe nature than those that do not present to the hospital.⁶⁴

As the numbers discussed in this paper are merely surrogate markers for the true level and rates of injuries occurring annually for each sport, their accuracy and statistical significance should not be overemphasized. For example, using these numbers, the data presented in this paper reveal that for some years, rates for football head injuries, concussions, and combined concussions/skull fractures/internal head injuries are not statistically higher than those of soccer, while in other years, they are statistically higher. The results reported here should be interpreted with the understanding that the actual figures are not meant to illustrate a small statistically significant difference from year to year, or from sport to sport, but merely to analyze general trends and illustrate that, although the rates are not always statistically similar, they are usually comparable among the 3 sports. To get a better idea of the risk of 1 sport compared with another sport over a longer period of time, a regression model incorporating as much data from as many years possible would give a better representation than the results presented here. The data presented here do also illustrate the general point that, although the total numbers of injuries requiring a visit to the ED are very different for each sport, the risk for each individual participating in each sport cannot be predicted solely by the total number of injuries occurring in each sport.

The data available from the CPSC and SBRnet are crude, unadjusted figures for numbers of injured athletes presenting to the EDs per year (numerators), and the number of athletes participating in a particular sport frequently or infrequently per year (denominators). The generalized sampling errors calculated by the CPSC for the NEISS data were therefore used, although this limits the strength of the statistical conclusions.

The numerators may be biased in many ways. It is likely that the number of injuries presenting to the EDs was not homogeneous across the entire United States. Ice rinks, for example, are more commonly located in certain geographical areas of the country. This distribution affects the local participation and the number of sport-specific injuries presenting to EDs for ice hockey, while soccer and football participation and injuries presenting to EDs may be more evenly distributed across the entire country.^{60,67,68} This geographic disparity may compromise the validity of the hospital sampling method. Other information that may influence the amount of sport-specific injuries such as the skill level of local players, overall physical conditioning of the players, previous injuries, etc., was also not available from the data, and adjustments could not

be made accordingly. It is also possible that there were different thresholds for using the EDs among the different sports. Perhaps local ice rinks and indoor soccer facilities were more likely to activate local emergency medical services in the event of injury because of a fear of liability on the facilities' part. This would almost always result in an ED visit, whereas the parents or the injured athletes themselves who were injured while playing football or soccer on a public field might have been more likely to make the decision to seek medical care themselves. These people might have chosen to seek medical attention outside an ED, or they might have decided not to seek medical care. While it would be expected that most professional and university level competitions for all 3 sports would have a physician present, high school football in the United States very often has a physician present at games. As such, it is possible that athletes who sustained a head injury in these games were diagnosed and attended to on site, therefore negating the need to seek medical attention in the local EDs.

The design of the NEISS data collection system may also underestimate the total number of individual diagnoses including concussions, skull fractures, and internal head injuries, as only the 1 most accurate diagnosis may be selected for each injured body part. For example, if an injured patient presented with a large scalp laceration and a concussion, it is possible that the laceration would be considered to be the most appropriate diagnosis, and as such, while a head injury with a laceration would be recorded, the concussion would not be recorded in the NEISS database.

The denominators may be biased as well. As much of the data is obtained from leagues and sports associations, these data are likely more accurate when assessing the number of frequent participants involved in a sport. Athletes who participate regularly and often in a sport are more likely to be involved in an organized league and thus would be easier to track. Athletes who play a sport infrequently may be less likely to belong to an organized league and may be more difficult to assess precisely. Some sports leagues and organizations may be more accurate in assessing and recording participation rates than others. As discussed with the numerators, there may be variation with respect to participation rates for the 3 different sports in different geographic areas of the country. This geographic disparity may affect sampling accuracy and calculations based on these values.

The estimates for rates of head injuries, concussions, and combined concussions/skull fractures/internal head injuries presenting to the EDs in the United States may underestimate the overall risks for injury for elite athletes while overestimating the risks for recreational and infrequent participants. This likely occurs because the NEISS data collection system collects only reliable data on whether the injury occurred during participation of a specific sport. Data on whether the injury occurred during participation at an elite level, to a frequent or infrequent participant, or during contact tackle or touch foot-

ball, for example, were not always available. As such, the denominator is likely biased toward including too many athletes. An elite athlete who participates in a specific sport is more likely to be injured than an infrequent recreational athlete. Elite athletes are required to practice and play more frequently than recreational or part-time athletes participating in the same sport. Each game or practice can be considered to be an exposure to injury (often referred to as *athletic exposures*) and, as such, elite athletes have more athletic exposures and chance for injuries. The recreational or part-time participant in a specific sport would have fewer athletic exposures with less opportunity for injury and, by presumption, less overall chance of being injured while participating in a specific sport. In an effort to gauge the risk of an injury for an individual athlete for each practice or game, rates of concussions are sometimes expressed in the literature as the number of concussions per 1000 athletic exposures.⁶ An argument can be made that elite athletes who play ice hockey, soccer, or football frequently would likely play the game at a higher skill level with quicker speeds and possibly a more aggressive style, which could predispose to head injuries. Conversely, while recreational athletes who participate infrequently may play the game at slower speeds, these athletes are less skilled and thus more likely to injure themselves or others. While the overall likelihood for injury during participation in ice hockey, soccer, or football for an infrequent player may be less as the player may be exposed to the risk less frequently, these data cannot estimate the risk for each athletic exposure for different types of participants.

In conclusion, while the total numbers of head injuries, concussions, and combined concussions/skull fractures/internal head injuries presenting to the EDs in the United States are different for ice hockey, soccer, and football for the years studied, the yearly rates for these injuries are comparable among all 3 sports. This reaffirms the notion that the rates of head injuries and concussions for these sports are comparable not only in elite athletes but also in the athletic community as a whole.

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