Soccer-Related Injuries Treated in Emergency Departments: 1990–2014

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abstract

OBJECTIVE: To investigate the epidemiology of youth soccer-related injuries treated in emergency departments in the United States.

METHODS: A retrospective analysis was conducted of soccer-related injuries among children 7 through 17 years of age from 1990 through 2014 with data from the National Electronic Injury Surveillance System. Injury rates were calculated from soccer participation data.

RESULTS: An estimated 2 995 765 (95% confidence interval [CI], 2 309 112–3 682 418) children 7 through 17 years old were treated in US emergency departments for soccer-related injuries during the 25-year study period, averaging 119 831 (95% CI, 92 364–147 297) annually. The annual injury rate per 10 000 soccer participants increased significantly, by 111.4%, from 1990 to 2014. Patients 12 to 17 years old accounted for 72.7% of injuries, 55.5% of patients were male, and most injuries occurred in a place of sport or recreation (68.5%) or school (25.7%). Struck by (38.5%) and fell (28.7%) were the leading mechanisms of injury. Injuries most commonly were diagnosed as sprain or strain (34.6%), fracture (23.2%), and soft tissue injury (21.9%), and occurred to the upper extremity (20.7%), ankle (17.8%), and head or neck (17.7%). Concussions or other closed head injuries accounted for 7.3% of the injuries, but the annual rate of concussions/closed head injuries per 10 000 participants increased significantly, by 1595.6%, from 1990 to 2014.

CONCLUSIONS: This study is the first to comprehensively investigate soccer-related injuries and calculate injury rates based on soccer participation data among children at the national level. The increasing number and rate of pediatric soccer-related injuries, especially soccer-related concussions/closed head injuries, underscore the need for increased efforts to prevent these injuries.

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Mr Smith conducted the initial data analyses, interpreted results, and wrote the manuscript draft; Mr Chounthirath participated in the conceptualization of the study, supervised and conducted data analyses, assisted with interpretation or results, and critically reviewed the manuscript; Dr Xiang participated in the conceptualization of the study, supervised all aspects of the study, and critically reviewed and revised the manuscript; and all authors approved the final manuscript as submitted.

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WHAT'S KNOWN ON THIS SUBJECT: Soccer is one of the most popular team sports in the United States, with >3 million registered soccer players <19 years of age in 2014, representing an almost 90% increase from 1990.

WHAT THIS STUDY ADDS: This study investigates pediatric soccer-related injuries and calculates injury rates based on soccer participation data at the national level. The increasing number and rate of pediatric soccer-related injuries, especially concussions/closed head injuries, underscore the need for increased prevention efforts.

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Soccer is one of the most popular team sports in the United States, with >15 million participants nationally.[1] According to US Youth Soccer, there were >3 million registered soccer players <19 years of age in 2014, representing an almost 90% increase from 1990.[2,3] High school soccer participation has more than doubled during that time period, making it one of the fastest-growing high school sports, especially among girls.[1,4] As participation in soccer has increased, so has the number of injuries associated with this sport.[5,6] An estimated 82 000 soccer-related injuries among children <15 years of age were treated in US emergency departments (EDs) in 2006.[1]

Despite soccer's popularity, published studies about the epidemiology of soccer-related injuries among children have important limitations. For example, some studies combined children and adults[6] or focused on a narrow age range, such as 13- to 17-year-olds[7] or high school students only.[4,8] Other studies combined sports,[9] were limited to a small number of EDs, teams, cities, or regions, or covered a short time period, such as 1 season.[7,10–12] Other studies were conducted in other countries and may have limited applicability to the United States.[11–13] Among the large US-based studies, 2 have used the National Electronic Injury Surveillance System (NEISS) but failed to calculate injury rates[6] or evaluate the mechanism of injury,[5,6] and 1 is more than a decade old.[5] The 2 studies that calculated soccer-related injury rates relied on population data for denominators rather than soccer participation data.[5,14] One of these studies analyzed data from the NEISS All Injury Program and covered only the year 2000.[14] Two other national studies examined soccer-related injuries only among high school students and were either limited to concussions[8] or examined a brief time period (2005–2007).[4]

To our knowledge, this study is the first to comprehensively investigate the epidemiology of US youth soccer-related injuries, including the mechanism of injury, treated in US EDs, using a nationally representative sample and calculating injury rates based on national youth soccer participation data. It evaluates these injuries over a 25-year period.

METHODS

Data Source

This study retrospectively examined soccer-related injuries (NEISS code 1267) among children ages 7 through 17 years treated in US EDs from 1990 through 2014. Data were obtained from the NEISS, which monitors consumer product–related and sports and recreational activity–related injuries treated in US EDs. The NEISS, which is operated by the US Consumer Product Safety Commission, collects data from a network of ~100 hospitals, which represents a stratified probability sample of the >5300 hospitals in the United States and its territories with a 24-hour ED with ≥6 beds.[15,16] In each participating hospital, professional NEISS coders review ED medical records for information about in-scope injury events, including patient age, patient gender, injury diagnosis, affected body region, products involved, disposition from the ED, the location where injury occurred, and a brief narrative describing the incident. If a child sustains multiple injuries, only the most severe injury is included in the NEISS database.

Injury rates were calculated from National Sporting Goods Association sports participation data[17,18] as the denominator (Supplemental Fig 5). These data are based on self-reports for people in the United States who are 7 to 17 years of age and participated in soccer at least once during a 12-month period from 1990 through 2014. Participation data were available for children 7 to 11 and 12 to 17 years of age, but not by gender for these age groups; therefore, gender-specific rates could not be calculated.

Study Variables

NEISS case narratives were reviewed to identify the mechanism of injury, which was grouped into 1 of the following categories: fell (including tripped, slipped, or fell and struck), collision (only player to player), struck by (including hit by, kicked by, stepped on, elbowed, or kneed), struck on (including ran into, hit, or kicked another player or object), struck (including unspecified contact such as "hit or struck during soccer"), twisted (including rolling or inversion or hyperextension of body region), or other. A person or object associated with the injury was classified as another player, a ball, or other (including wall, goalpost, pole, or bench). When the narrative did not specify another player, phrases such as "was elbowed," "got kneed," "was cleated," or "kicked during soccer" were assumed to involve another player.

Patient age was categorized as 7 to 11 or 12 to 17 years. Location of injury was grouped into sport or recreational place, school, or other. The injured body region was grouped into head or neck, upper extremity (including NEISS categories of shoulder, upper arm, elbow, lower arm, or wrist), hand or finger, trunk (including upper trunk, lower trunk, or pubic region), lower extremity (including upper leg and lower leg but excluding knee, ankle, or foot or toe), knee, ankle, foot or toe, or other. Injury diagnosis was grouped into concussion or other closed head injury (CHI; including internal organ injury to the head region), fracture, dislocation, sprain or strain, soft tissue injury (including NEISS categories of contusion, abrasion, hematoma, or crushing), laceration (including laceration, amputation,

nondental avulsion, or puncture), or other. Disposition from the ED was categorized as treated and released, hospitalized (including NEISS categories of treated and admitted, treated and transferred, and held for <24 hours for observation), or left against medical advice.

Statistical Analyses

Data were analyzed in SPSS version 20.0 (IBM SPSS Statistics, IBM Corporation), and SAS version 9.3 (SAS Institute, Inc, Cary, NC) software. Statistical weights provided by the US Consumer Product Safety Commission were used to calculate national injury estimates. Data reported in this article are national estimates unless otherwise specified. Preliminary inspection of the scatterplots (Figs 2, 3, and 4) indicated a shift in the rate of change after 2008. Therefore, piecewise linear regression models were used to analyze the overall, gender-specific, and age group–specific trends with 2008 as a breakpoint. The estimated annual rate of change from the regression model, denoted by m, was reported along with the P value associated with the t test used to test for its statistical significance. If a statistically significant increase occurred during both periods, only the overall percentage increase was reported. Other analyses included the Rao–Scott χ^2 test for association, which adjusted for the NEISS sample design effect, and the calculation of relative risk (RR) with a 95% confidence interval (CI). The level of significance used for all statistical tests was $\alpha = 0.05$. This study was approved by the institutional review board of the authors' institution.

RESULTS

General Characteristics

From 1990 through 2014, an estimated 2 995 765 (95% CI, 2 309 112–3 682 418) children 7 to 17 years of age were treated in US EDs for soccer-related injuries, averaging 119 831 (95% CI, 92 364–147 297) injuries annually or 141.43 (95% CI, 109.01–173.84) per 10 000 soccer participants 7 to 17 years old. Most injuries occurred at a sport or recreation place (68.5%) or school (25.7%), and 55.5% of the patients were boys (Table 1). The number of injuries peaked at ages 14 and 15 years (Fig 1), and the average age of an injured child was 13.2 years (SD 0.054; median 13.0 years; interquartile range 10.7–14.9). Children 12 to 17 years of age accounted for 72.7% of all injuries and had a higher injury rate per 10 000 participants (244.85; 95% CI, 187.91–301.79) than children 7 to 11 years of age (66.51; 95% CI, 51.17–81.85).

Injury Trends

From 1990 through 2014, the annual soccer-related injury number and rate per 10 000 participants increased significantly, by 78.4% (1990–2008: $m = 1948.2$, $P < .001$; 2008–2014: $m = 5166.2$, $P < .001$) and by 111.4% (1990–2008: $m = 1.53$, $P = .003$; 2008–2014: $m = 15.68$, $P < .001$), respectively (Fig 2). Part of this increase was contributed by the increase in concussions/CHIs, especially after 2008 (Fig 3). Over the entire study period, the annual number and rate of concussion/CHI per 10 000 participants increased significantly by 1331.7% (1990–2008: $m = 489.1$, $P < .001$; 2008–2014: $m = 2341.3$, $P < .001$) and by 1595.6% (1990–2008: $m = 0.53$, $P < .001$; 2008–2014: $m = 3.92$, $P < .001$), respectively (Fig 3).

From 1990 to 2008, the annual number of soccer injuries did not increase significantly for boys (12.2%, $m = 248.6$, $P = .073$) but increased significantly for girls (101.9%, $m = 1698.9$, $P < .001$), and from 2008 through 2014, the number of injuries leveled off for girls (2.9% increase, $m = 616.2$, $P = .178$) but increased significantly for boys (44.6%, $m = 4554.4$, $P < .001$) (Fig 2). Although the number of soccer injuries among children 7 to 11 years of age increased significantly during both periods, a significant increase in the injury rate occurred only from 2008 to 2014 (61.1%, $m = 7.29$, $P < .001$) (Fig 4). Among children 12 to 17 years old, both the soccer-related injury number and rate increased significantly during the 2 periods (Fig 4).

Mechanism of Injury and Associated Person or Object

A mechanism of injury was identified for 66.4% of soccer-related injuries, and of those, struck by (38.5%), fell (28.7%), and twisted (12.8%) were the most common mechanisms (Table 1). Collision accounted for an additional 5.6% of the injuries. A person or object was associated with 35.0% of the injuries, and of those, most were another player (63.5%) or a ball (27.9%). Among injuries associated with another player, struck by (72.0%) and collision (16.8%) were the leading mechanisms, whereas struck by (77.4%) and struck on (16.2%) were the most common mechanisms associated with ball-related injuries. Compared with the other age group, younger patients (7–11 years) were more likely to sustain an injury associated with a fall (RR 1.38; 95% CI, 1.34–1.43) or a ball (RR 1.61; 95% CI, 1.53–1.70), whereas older patients (12–17 years) were more likely to sustain an injury associated with twisting (RR 1.62; 95% CI, 1.47–1.78) or a collision (RR 2.24; 95% CI, 1.98–2.53). Female patients were more likely to experience an injury from a twisting mechanism (RR 1.36; 95% CI, 1.27–1.44) than male patients.

Injury Diagnosis and Injured Body Region

Sprain or strain accounted for 34.6% of injuries, followed by fracture (23.2%), soft tissue injury (21.9%), and concussion/CHI (7.3%)

TABLE 1 Characteristics of Soccer-Related Injuries Among Children 7 to 17 Years of Age Treated in US EDs by Age Group, 1990–2014

	Age Group					
	7–11 y		12–17 y		7–17 y	
	N (%)[a]	95% CI	*N* (%)[a]	95% CI	*N* (%)[a]	95% CI
Gender						
Male	487 121 (59.6)	375 738–598 503	1 176 231 (54.0)	922 291–1 430 170	1 663 351 (55.5)	1 304 036–2 022 667
Female	329 792 (40.4)	250 790–408 794	1 002 313 (46.0)	745 685–1 258 941	1 332 105 (44.5)	999 968–1 664 242
Subtotal[b]	816 913 (100.0)	628 501–1 005 324	2 178 544 (100.0)	1 671 919–2 685 168	2 995 456 (100.0)	2 308 880–3 682 032
Locale of injury						
Sport or recreational place	411 899 (65.1)	286 203–537 596	1 192 890 (69.8)	844 167–1 541 613	1 604 790 (68.5)	1 133 882–2 075 697
School	167 513 (26.5)	123 171–211 855	435 378 (25.5)	305 098–565 657	602 890 (25.7)	434 049–771 732
Other place	53 689 (8.5)	38 573–68 805	80 022 (4.7)	56 121–103 922	133 711 (5.7)	95 300–172 121
Subtotal[b]	633 101 (100.0)	466 080–800 123	1 708 289 (100.0)	1 260 160–2 156 419	2 341 391 (100.0)	1 732 663–2 950 118
Mechanism of injury						
Struck by	210 489 (38.0)	163 783–257 195	555 968 (38.8)	428 931–683 004	766 457 (38.5)	596 618–936 295
Fell	199 280 (35.9)	147 431–251 130	372 471 (26.0)	275 839–469 104	571 752 (28.7)	424 953–718 551
Twisted	49 139 (8.9)	36 444–61 833	205 764 (14.3)	150 906–260 621	254 902 (12.8)	188 751–321 053
Struck on	50 005 (9.0)	38 700–61 310	117 088 (8.2)	91 240–142 936	167 093 (8.4)	131 273–202 912
Collided	16 494 (3.0)	11 871–21 118	95 475 (6.7)	68 212–122 738	111 970 (5.6)	80 851–143 088
Struck	17 135 (3.1)	11 873–22 398	46 043 (3.2)	26 589–65 497	63 178 (3.2)	38 861–87 495
Other	11 955 (2.2)	9027–14 884	41 719 (2.9)	31 516–51 923	53 675 (2.7)	41 038–66 311
Subtotal[b]	554 498 (100.0)	425 305–683 691	1 434 528 (100.0)	1 088 847–1 780 210	1 989 026 (100.0)	1 522 272–2 455 780
Associated person or object						
Another player	142 835 (49.7)	110 245–175 424	523 515 (68.8)	401 231–645 800	666 350 (63.5)	514 727–817 972
Ball	110 857 (38.5)	87 479–134 235	181 720 (23.9)	139 224–224 216	292 577 (27.9)	228 558–356 596
Other	33 988 (11.8)	25 535–42 442	55 909 (7.3)	42 089–69 728	89 897 (8.6)	68 814–110 980
Subtotal[b]	287 680 (100.0)	224 433–350 926	761 144 (100.0)	584 794–937 495	1 048 824 (100.0)	814 783–1 282 865
Total (row %)	816 975 (27.3)	628 557–1 005 393	2 178 790 (72.7)	1 672 105–2 685 475	2 995 765 (100.0)	2 309 112–3 682 418
Body region injured						
Upper extremity	222 833 (27.3)	169 207–276 459	396 813 (18.2)	301 764–491 861	619 646 (20.7)	472 786–766 505
Ankle	99 479 (12.2)	75 425–123 533	432 344 (19.9)	330 428–534 259	531 823 (17.8)	407 513–656 133
Head or neck	124 239 (15.2)	93 102–155 376	404 356 (18.6)	301 808–506 904	528 595 (17.7)	396 764–660 425
Knee	75 038 (9.2)	57 577–92 499	260 526 (12.0)	197 018–324 035	335 564 (11.2)	256 302–414 827
Foot or toe	87 483 (10.7)	66 885–108 081	204 786 (9.4)	159 242–250 331	292 269 (9.8)	227 468–357 070
Hand or finger	113 490 (13.9)	86 184–140 796	174 373 (8.0)	133 210–215 537	287 864 (9.6)	220 954–354 773
Upper or lower leg	46 379 (5.7)	35 931–56 826	151 743 (7.0)	118 105–185 381	198 121 (6.6)	155 233–241 010
Trunk	42 992 (5.3)	31 931–54 054	141 842 (6.5)	109 202–174 482	184 834 (6.2)	142 189–227 480
Other	4471 (0.5)	2936–6007	10 990 (0.5)	7622–14 357	15 461 (0.5)	10 845–20 077
Subtotal[b]	816 404 (100.0)	628 195–1 004 613	2 177 773 (100.0)	1 671 221–2 684 324	2 994 177 (100.0)	2 307 849–3 680 504
Diagnosis						
Sprain or strain	242 814 (29.8)	184 537–301 092	793 437 (36.5)	605 333–981 542	1 036 252 (34.6)	793 141–1 279 362
Fracture	231 776 (28.4)	172 192–291 360	461 611 (21.2)	350 276–572 945	693 387 (23.2)	524 197–862 577
Soft tissue injury	192 396 (23.6)	151 848–232 944	463 469 (21.3)	359 957–566 982	655 865 (21.9)	514 581–797 149
Concussion/CHI	45 016 (5.5)	30 395–59 637	172 346 (7.9)	122 441–222 251	217 362 (7.3)	153 950–280 775
Other	56 598 (6.9)	38 389–74 807	139 166 (6.4)	88 981–189 350	195 764 (6.5)	128 384–263 144
Laceration	40 339 (4.9)	31 844–48 833	102 626 (4.7)	79 025–126 227	142 964 (4.8)	111 620–174 309
Dislocation	6793 (0.8)	4920–8667	43 747 (2.0)	32 376–55 118	50 540 (1.7)	37 802–63 279

TABLE 1 Continued

	Age Group					
	7–11 y		12–17 y		7–17 y	
	N (%)[a]	95% CI	*N* (%)[a]	95% CI	*N* (%)[a]	95% CI
Subtotal[b]	815 732 (100.0)	627 508–1 003 957	2 176 402 (100.0)	1 670 300–2 682 504	2 992 134 (100.0)	2 306 258–3 678 011
Disposition from ED						
Treated and released	803 271 (98.4)	618 137–988 404	2 139 216 (98.2)	1 639 686–2 638 747	2 942 487 (98.3)	2 266 201–3 618 773
Admitted	11 459 (1.4)	8244–14 675	33 107 (1.5)	26 082–40 131	44 566 (1.5)	34 685–54 447
Left against medical advice	1756 (0.2)	972–2540	5779 (0.3)	3333–8225	7535 (0.3)	4496–10 574
Subtotal[b]	2 178 102 (100.0)	1 671 436–2 684 767	816 486 (100.0)	628 203–1 004 769	2 994 588 (100.0)	2 308 047–3 681 129
Total (row %)	816 975 (27.3)	628 557–1 005 393	2 178 790 (72.7)	1 672 105–2 685 475	2 995 765 (100.0)	2 309 112–3 682 418

[a] Percentages may not sum to 100.0% because of rounding error.
[b] Subtotal may not be equal to the age group or study total because of missing values.

(Table 1). Most of the fractures were associated with a fall (44.5%) or struck by (32.2%), whereas most soft tissue injuries were associated with struck by an object or person (58.9%). Patients who were injured by being struck by an object or person were 1.61 (95% CI, 1.51–1.72) times more likely to sustain a concussion/CHI than those injured by other mechanisms. Compared with the other age group, patients 12 to 17 years of age were more likely to sustain a concussion/CHI (RR = 1.44, 95% CI, 1.31–1.58), and patients 7 to 11 years old were more likely to sustain a fracture (RR = 1.34, 95% CI, 1.29–1.39). Male patients were 3.10 times (95% CI, 2.83–3.40) more likely to sustain a laceration and 1.42 times (95% CI, 1.34–1.50) more likely to sustain a fracture than female patients. The proportion of concussion/CHI was higher among boys for patients aged 7 to 11 years (6.2% vs 4.5%) and among girls for patients aged 12 to 17 years (8.7% vs 7.3%).

The upper extremity (20.7%), ankle (17.8%), head or neck (17.7%), and knee (11.2%) were the most commonly injured body regions (Table 1). The majority of upper extremity injuries were associated with a fall (67.1%), and twisting accounted for 50.8% of ankle injuries. Patients injured by being struck by an object or person were more likely to sustain an injury to the head or neck (RR 1.94; 95% CI, 1.84–2.05), hand or finger (RR 1.81; 95% CI, 1.67–1.96), or lower extremity (RR 1.81; 95% CI, 1.67–1.96) than patients injured by other mechanisms. Female patients were more likely to experience an ankle injury (RR 1.41; 95% CI, 1.37–1.46) or knee injury (RR 1.29; 95% CI, 1.22–1.37) than male patients.

Disposition From the Emergency Department

Most children with a soccer-related injury were treated and released from the ED (98.3%) (Table 1). Among those admitted to the hospital, 70.4% were boys, and 60.6% sustained a fracture. Patients were more likely to be admitted to the hospital if they had a fracture (RR 5.10; 95% CI, 4.19–6.22) or a concussion/CHI (RR 2.06; 95% CI, 1.52–2.77) than patients with other injury diagnoses.

DISCUSSION

During the 25-year study period, almost 3 million children 7 to 17 years of age were treated for soccer-related injuries in US EDs, and the injury rate more than doubled. Our findings are consistent with those of previous studies, which showed an increase in the number of pediatric soccer-related injuries[6,19] and an increase in the number and population-based rate of soccer-related injuries among girls.[5] The increase in the number of injuries treated in US EDs is a trend that also was observed for other pediatric sports from 2001 to 2013.[19] In our study, more than two-thirds (72.7%) of injuries occurred among children 12 to 17 years of age, and the rate of injury was >3 times higher in this age group than among younger soccer participants, probably because of the more aggressive play and the higher-energy impacts associated with the older age group. Although we were not able to calculate gender-specific injury rates because soccer participation data by gender were unavailable, the number of soccer-related injuries increased for both genders, with a greater increase among girls. This result is expected, given the much larger increase in soccer participation by girls than boys during the study period.[4]

Although concussions/CHIs only accounted for 7.3% of injuries, both the number and rate increased >13-fold over the study period and contributed to the observed increase in soccer injuries overall. One study reported a similar percentage (10.8%) of concussions among high school soccer-related

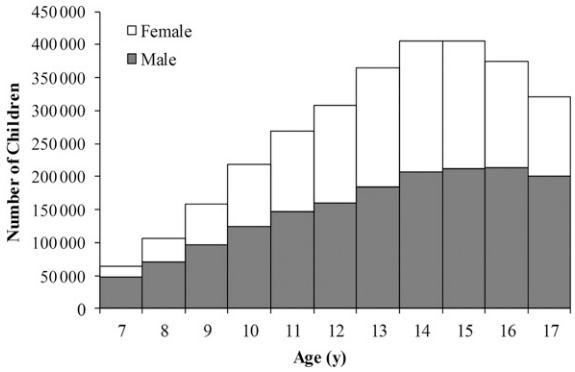

FIGURE 1
Number of children 7–17 years of age treated in US EDs for soccer-related injuries by age and gender, 1990–2014.

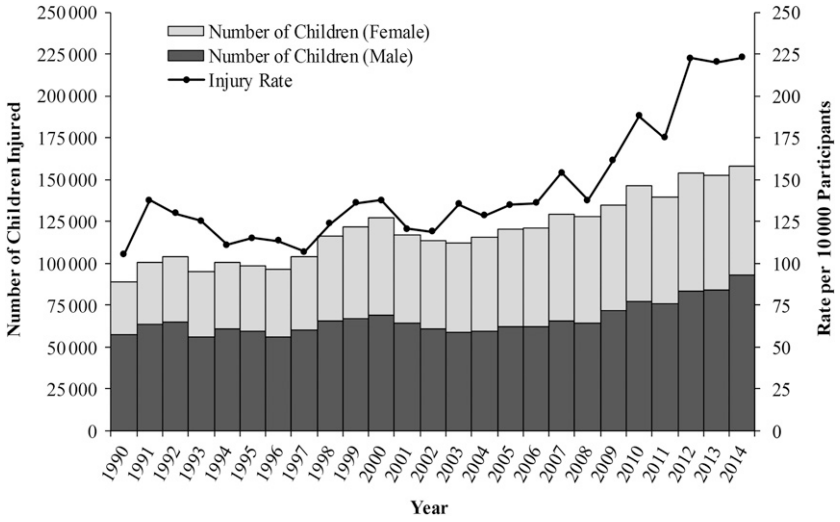

FIGURE 2
Number and rate per 10 000 soccer participants 7 to 17 years of age treated in US EDs for soccer-related injuries by year and gender, 1990–2014.

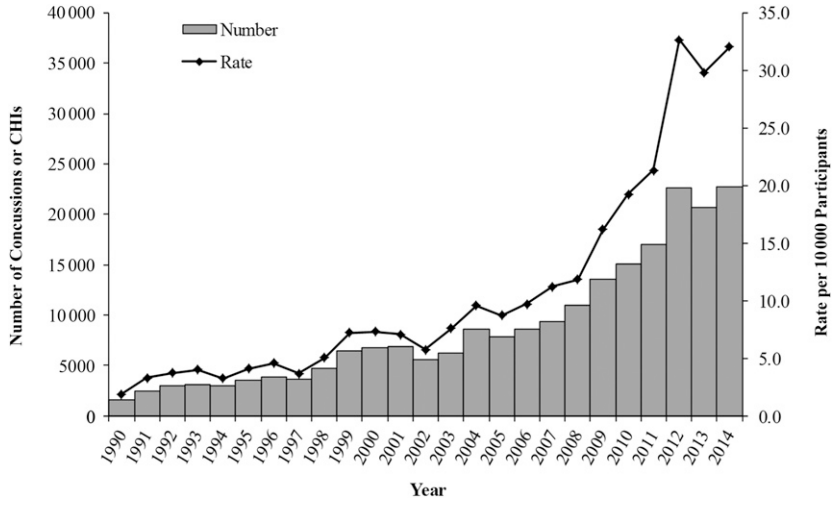

FIGURE 3
Number and rate per 10 000 soccer participants 7 to 17 years of age treated in US EDs for concussion/CHI by year, 1990–2014.

injuries during 2005 to 2007,[4] and others have reported an increase in concussions among youth athletes during the past 10 to 15 years in the United States.[20–23] The reasons for this observed increase are unknown, but several factors may have contributed. First, the incidence of concussion/CHI among youth soccer players may, in fact, be increasing. In addition, there has been a growing awareness among players, coaches, athletic trainers, medical professionals, and the public in general about the potentially serious consequences of sports-related concussion. Many states have passed youth sports concussion laws since 2009.[24] This awareness may have led to better recognition of concussions and referrals to EDs by soccer coaches and athletic trainers. Parents may have lower thresholds for taking their child to the ED for evaluation of a suspected concussion. ED medical personnel also may be diagnosing and documenting suspected concussion more often in recent years. The sharp increase after 2008 in concussions/CHIs in this study also has been observed in other youth sports,[22] especially youth football.[23]

In our study, patients with a concussion/CHI were twice as likely to be admitted to the hospital as patients with other diagnoses. This finding highlights the potential severity of these injuries. Patients 12 to 17 years of age were more likely to sustain a concussion/CHI than younger patients. The more aggressive play in this age group is a likely contributor to this finding. Injuries sustained by being struck by an object or person were more likely to occur to the head or neck region and were more likely to result in a concussion/CHI than other mechanisms of injury. According to previous studies, heading the ball and player-to-player contact were the most common activity and mechanism, respectively,

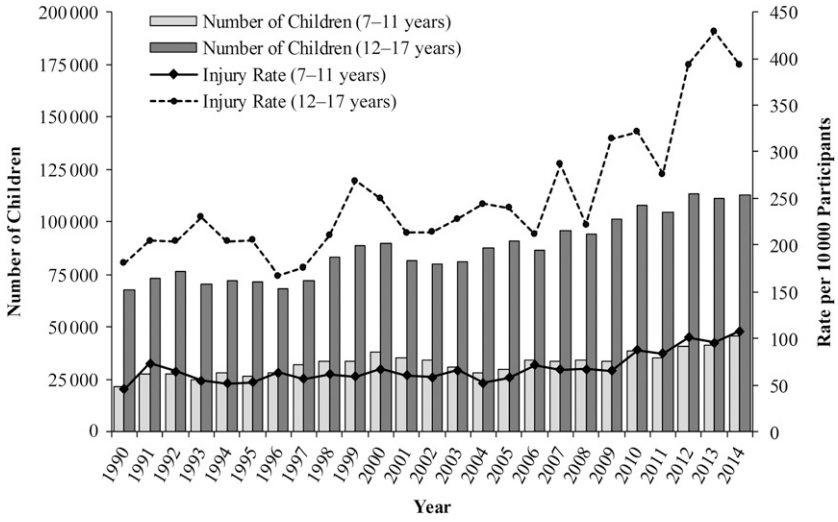

FIGURE 4

Number and rate per 10 000 soccer participants 7 to 17 years of age treated in US EDs for soccer-related injuries by year and age group, 1990–2014.

associated with concussion among high school players.[8,25] The US Soccer Federation implemented new guidelines in January 2016 that eliminate heading for children ≤10 years of age and limit the amount of heading in practice for children 11 to 13 years of age.[26] Concussions among youth athletes can have serious consequences. Young athletes recover more slowly from concussions and repeat concussions than their college counterparts.[27–29] They are at risk for second-impact syndrome if they return to play prematurely, and repetitive concussions over years may put them at risk for other neurobehavioral and cognitive changes, including chronic traumatic encephalopathy.[30,31]

Sprain or strain and fracture were the most common diagnoses, a finding that is consistent with previous studies.[4–6,14] As others have previously reported,[10,32,33] sprains or strains occurred commonly to the ankles and knees, probably because of the cutting and pivoting maneuvers that are common in soccer and because of uneven playing fields. Older patients (12–17 years of age) and girls were more likely to sustain a sprain or strain than younger patients and boys. The higher incidence of knee injuries, and anterior cruciate ligament injuries specifically, among female soccer players has been previously reported.[32,34–37] The effectiveness of prevention interventions on anterior cruciate ligament injury rates in soccer is inconsistent.[38] In contrast, 7- to 11-year-old patients and male patients were more likely to sustain a fracture than patients who were older or female. In part this difference may be due to more physical play by boys and to the fact that young children commonly fall forward onto outstretched arms, which often results in upper extremity fractures. Indeed, in this study patients 7 to 11 years were more likely to sustain an injury to the hand or finger or another part of the upper extremity than older patients. Fractures were among the most serious injuries in this study; patients with a fracture were >5 times more likely to be admitted to the hospital than patients with other diagnoses. Fractures accounted for >60% of hospital admissions.

The increasing number and rate of soccer-related injuries, especially concussions/CHIs, demonstrated in this study underscore the need for increased injury prevention efforts. Education of players, coaches, referees or officials, and parents about the importance of following the rules of the game, and enforcement of those rules, are critical first steps.[12,34,39] One study found that 12% of all soccer competition injuries were related to illegal activity, and of these 25% were concussions.[4] Concussion prevention should focus on reducing player-to-player contact, some of which results from illegal activity. Protective headgear and ball heading are areas that deserve continued research and review.[40] Return-to-play and concussion management guidelines should be followed. Low neck strength has been shown to be associated with increased risk of concussion among high school athletes.[41] Preseason neck strength screening and neck muscle strengthening interventions may be of benefit in preventing concussions. More research is needed in these areas and on the effect of state sports-related concussion laws.[42]

There are several limitations to this study. Only cases treated in EDs were included in this study. Patients treated in non-ED health care settings, and those not seeking treatment, are not captured by the NEISS database. Therefore, the number of soccer-related injuries was underestimated in this study, and study findings may not be representative of all soccer-related injuries. Furthermore, NEISS case information is limited by the information documented in ED records and NEISS case narratives. NEISS case narratives did not consistently contain detailed information about the mechanism of injury and factors contributing to the injury event. Although rates and patterns of injuries associated with practice and competition differ,[43] we were unable to determine during which of these activities the injuries included in this study occurred. Some injuries also may have involved soccer equipment, but not soccer

activity, such as tripping on a soccer ball on the ground. NEISS does not have a variable for injury severity, and the use of hospital admission as a proxy measure of severity is a limitation of this study because factors other than injury severity can influence the decision to admit to the hospital. Soccer participation data were not available by gender, which precluded calculation of gender-specific injury rates. Despite these limitations, the strength of this study lies in its use of a large, nationally representative sample over a period of 25 years and its calculation of injury rates based on soccer participation data.

CONCLUSIONS

This study is the first to comprehensively investigate soccer-related injuries and calculate injury rates based on soccer participation data among children at the national level. The increasing number and rate of pediatric soccer-related injuries, especially concussions/CHIs, underscore the need for increased efforts to prevent these injuries.

ABBREVIATIONS

CHI: closed head injury
CI: confidence interval
ED: emergency department
NEISS: National Electronic Injury Surveillance System
RR: relative risk

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