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Soccer-related Injuries Presenting to US Emergency Departments:

Nationwide Emergency Department Sample 2010-2013

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Nursing

by

Gerardo Flores

2021

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ABSTRACT OF THE DISSERTATION

Soccer-related Injuries Presenting to US Emergency Departments:
Nationwide Emergency Department Sample 2010-2013

by

Gerardo Flores

Doctor of Philosophy in Nursing

University of California, Los Angeles, 2021

Professor Dorothy J. Wiley, Chair

Soccer-related injuries are a health and healthcare concern in the United States (U.S.), and while interest dates to 1994, injuries continue to be a health concern with increased participation. Consequently, to describe baseline characteristics for future comparisons, it is important to describe the breadth and scope of health and healthcare outcomes that are attributed to soccer (injuries) among visiting U.S. EDs, including hospitalization, cost, and length of stay, with special interest in patient-level and hospital-level features, as well as geographic region, population density, mechanism of injury, and place of injury effects on outcomes. Our aim was to determine features of soccer-related injuries amenable to injury prevention strategies to reduce cost and healthcare utilization across the US ED's. We evaluated a weighted sample of 480,580 for child, adolescent and adult soccer-related injuries in U.S. EDs to address the following aims:

Aim 1 (First publication): Describe soccer-related concussions, intracranial injuries (ICI), and all-other soccer injuries. We also aimed to describe healthcare utilization, cost and length of hospital stay of soccer-related injuries. A third aim was to determine independent predictors (e.g. age, gender, and other individual and well as hospital-level) of concussions, ICI, and all-other

soccer injuries leading to ED visits. Study methods and findings are presented and discussed in “*Soccer-related injuries utilization of U.S. emergency departments for concussions, intracranial injuries, and other-injuries in a national representative probability sample: Nationwide Emergency Department Sample, 2010 to 2013*” submitted for peer review on March 2, 2021.

Findings Summary for Aim 1: Generally, 98% of soccer-related ED visits resulted in routine (treat-and-release) visits. However, the odds of transfer to a short-term hospital following ED evaluation and treatment was more than 37-fold higher for soccer-injured youth and adults diagnosed with ICI when compared to all-other soccer injuries; additionally, these patients showed 28-fold higher odds of being admitted for inpatient care at the ED-affiliated hospital. For concussion, soccer-injured patients with concussion showed nearly 1.5-fold higher odds of being transferred to a short-term hospital than did those with any other soccer injury. Soccer-related ED visits cost more than 700 million in U.S. dollars from 2010 to 2013.

Aim 2 (Second publication): Describe soccer-related injuries evaluated in U.S. ED’s by age. We also analyzed ED disposition and total healthcare charges for ED visits and inpatient care and resources, by age category. Study methods and findings are presented and discussed in “*Soccer-related injuries in U.S. emergency departments across the age spectrum: Nationwide Emergency Department Sample, 2010 to 2013*” submitted for peer review on March 28, 2021

Findings Summary for Aim 2: Males accounted for the majority of the ED visits across the age spectrum, from youth to older age, but the difference narrowed among 12 to 17 years of age. Private insurance payers significantly comprised >50% of payers for soccer-related injury ED care across all age groups; and the patients in the highest income brackets had significantly higher proportional distribution of ED visits in each age group, ranging from 29.6% in 25 to 34 years of age to 67.4% in those 45+ years of age. Of the \$700 million dollars charged, youth players 12 to 17 year olds account for nearly *half* of all soccer related ED visits and total charges, with most of the charges (83%) from the ED (rather than inpatient charges, 17%). In older players 45+ years of age, inpatient charges (rather than ED charges) account for approximately half of all

charges. To conclude, socioeconomic indicators, such as income and access to private insurance, may drive decisions to attend to the ED in U.S. soccer players after an injury. Players 12 to 17 years of age account for the greatest impact of ED utilization and cost, while cost for those 45+ years of age may be costly given the disproportional inpatient charges.

Aim 3 (Third publication): Describe and establish independent predictors of soccer-related injury ED visits resulting in hospitalization (vs not) across individual cofactors, treatment centers characteristics, geographic regions and population density, as well as mechanism of injury and place of injury. We also aimed to describe ED charges, inpatient charges, and hospital length of stay in soccer injuries. Study methods and findings are presented and discussed in “*Soccer-related injuries disposition in U.S. emergency departments: Nationwide Emergency Department Sample, 2010 to 2013*” pending submission for peer review.

Findings Summary for Aim 3: Males were nearly 2-fold more likely to be hospitalized compared to females. Soccer players with other form of payment were 68% more likely to be hospitalized compared to those with private insurance; once models were adjusted, differences were not noted between public insurance and uninsured compared to private insurance. Injury diagnoses more likely to be hospitalized compared to not having that diagnosis were concussions (68%), intracranial injuries (59-fold), fractures (5.74-fold), and internal injuries (86-fold); least likely to be hospitalized were sprains and strains (3.44-fold), wounds (58%), and contusions (2.12-fold). Upper extremities were 3.7-fold less likely to be hospitalized than those without upper extremity injuries. Soccer players that experienced an injury due to a fall, struck by hit or thrown ball with subsequent fall, or in a residential institution were more likely to be hospitalized than those without a fall, not struck by hit or thrown ball with subsequent fall, or not in a residential institution, 2.33-fold, 2.71-fold, and 7.04-fold respectively. From >\$700 million, nearly 75% of the cost, over U.S. \$521 million in the 4-year period, of soccer-related injuries resulted from treat-and-release ED visits. The mean of total ED charges was highest among hospitalized ED soccer-injured patients,

compared to those not hospitalized from 2010 to 2013: ranging from US\$2,117-US\$2,425 (Hospitalized) and US\$1,415-US\$1,770 (Not-hospitalized), respectively.

In conclusion, given that soccer-related injuries have become a health, healthcare utilization, and cost concern, the current studies allowed insight into soccer related injuries in meaningful ways, including (Aim 1) concussions, ICI, and all-other injury; (Aim 2) a lifespan analysis, from childhood to older age; and (Aim 3) the differences between those hospitalized (vs not). Generally, the studies looked at descriptors, hospitalization, ED and inpatient charges, and hospital length of stay, across individual-level, hospital-level, and multiple injuries in soccer-related injuries. The finding helped determine multi-level features susceptible to targeted injury prevention intervention to minimize the price on human suffering, healthcare cost, and utilization, within soccer injuries leading to an ED visit.

The dissertation of Gerardo Flores is approved.

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University of California, Los Angeles

2021

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2005	California State University, Fullerton. Fullerton, CA	Physical Therapist Aide
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2013-2015	Mayday Award – Pain Research
2013	CA Wellness Foundation Scholarship
2014-2015	NAHN United Health Foundation Diverse Scholar Scholarship
2014	UCLA Graduate Summer Research Mentorship Program
2014	GNSA-Uniform Advantage Scholarship
2014-2015	Audrienne H. Moseley Scholarship
2014-2015	NAHN United Health Foundation Diverse Scholar Scholarship
2015-2016	NAHN United Health Foundation Diverse Scholar Scholarship
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Chapter 1

Soccer-related injuries utilization of U.S. emergency departments for concussions, intracranial injuries, and other-injuries in a national representative probability sample:

Nationwide Emergency Department Sample, 2010 to 2013

Soccer is the most popular sport in the world, with an estimated 265 million soccer players worldwide, nearly 4% of the world's 7.4 billion population (1, 2). The United States (U.S.) ranks second worldwide, in recreational, non-recreational, and professional soccer participation, with continued increase in participation from 10.3 million in 1993, 13 million in 1999, to over 24 million current adult and youth players (1, 3, 4). Registered youth participation in organized soccer leagues in the US increased 88% in just over 25 years, with over 3 million U.S. youth participating in soccer in 2014 vs 1.6 million in 1990 (1, 5). With increased U.S. soccer participation since the early 1990's, soccer-related injuries have become more common and are of interest to minimize human suffering, disability, healthcare costs, and utilization.

The spectrum of soccer-related injuries varies widely from sprains and strains to traumatic brain injuries (TBI), with great and different concerns seen between concussions and other intracranial brain injuries (ICI), due to the potential for long-term effects and chronic disability. Data suggest that participation in sports contribute to an estimated 1.6 to 3.8 million TBI's annually, with the majority of sports-related TBI's diagnosed as mild, 85-86% (6-8). The prevalence of mild-TBI are conservative estimates as many go unreported (6-8). The lasting adverse effects of TBI's can result in poor school health (9-12). Children that suffered a mild-TBI exhibit a 9-fold higher rate of disability, when compared to moderate- and severe-TBI, and receive federally mandated programs for disability, such as special education, learning assistance, learning and attention issues accommodations, as well as tutoring, occupational, physical, and speech therapy (13). In addition, when compared to controls, children with TBI received more mandated services after

12-months (13). For that reason, there is an interest in describing and comparing soccer-related concussion, ICI, and all-other soccer injuries.

The Nationwide Emergency Department Sample (NEDS) datasets includes national probability sample representative of soccer-related injuries leading to U.S. emergency department (ED) visits. This national representative sample allows analysis of individual-level (e.g. age, gender, insurance coverage, household income), timing (e.g. day of the week, month of the year), hospital-level (e.g. teaching status, trauma designation), geographic region and population density characteristics, mechanism and place of injury, and healthcare utilization characteristics of soccer-injuries.

The primary purpose of this study was to describe soccer-related concussions, ICI, and all-other soccer injuries. A secondary purpose was to describe healthcare utilization, cost and length of hospital stay of soccer-related injuries. A third purpose was to determine independent predictors (e.g. age, gender, and other individual and well as hospital-level) of concussions, ICI, and all-other soccer injuries leading to ED visits.

Methods

Exemption from the University of California, Los Angeles Institutional Review Board was obtained to conduct a secondary analysis from a pre-existing dataset (2017; IRB#17-000777).

Study design and sample

The study examined emergency department visits for soccer-related visits using discharge data from the NEDS, Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality (14). The 2010 to 2013 NEDS datasets provide serial cross-sectional characteristics of adults and children treated in a stratified sample of rural, suburban and urban U.S. hospital-affiliated ED's. Of these, we evaluated data for all soccer-related injuries, including

concussions and ICI treated at ED's. NEDS has been described extensively elsewhere (14). Briefly, NEDS provides national estimate of all-payer, population-level data for U.S. ED visits for four U.S. regions (north, south, east, west), urban and rural locations, and care setting characteristics including teaching and non-teaching hospitals; private, public or government ownership; and level of trauma care provided in the affiliated ED's. NEDS sites are selected from stratified and clustered eligible U.S. ED's, and a 20% weighted random sample of treated individuals are selected for record abstraction. Weighted sampling allows generalizability to the U.S. population. The NEDS dataset includes 100% of records selected. Records are not linked at the individual level over time or across institutions; consequently, individuals may contribute more than one study visit annually or over many years, and it does not allow tracking of individuals over time. Over the study period, illnesses and injuries were coded using International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) codes for each ED visit. NEDS provides 1 to 15 diagnosis (outcome) codes, ≤ 4 external cause of injury codes (E-codes), as well as hospital and patient characteristics. Subjects with an E007.5 ICD-9 E-code were selected for the analysis. Data for 480,580 weighted individual soccer-injury ED visits completed from 2010 thru 2013 were evaluated for associations between sociodemographic, hospitalization, and care-costs characteristics for concussive and ICI in comparison to all other soccer injuries.

Variables

Subjects were classified into three groups, concussion, ICI, or all-other-soccer injuries based on the 15 ICD-9 provider coded diagnoses placed in the medical record. For all soccer-related injuries, the prevalence of ICI, with or without concussion, and concussion alone were compared to all-other soccer-related injuries. Only 6% (85/1369) of ICI-diagnosed patients were diagnosed with both concussion and ICI; due to the scarce data, we included cases with both concussion and ICI into the ICI group. Descriptors, disposition, diagnostic outcomes, mechanism

of injury, place of injury, healthcare utilization, and independent predictors were analyzed between concussions, ICI, and all-other soccer injuries.

Descriptors included year, gender, age, median household income, primary payer, month of the year of ED visit, day of the week of ED visit, hospital region, hospital teaching status, hospital trauma designation, hospital population density based on location, and whether (or not) presenting with multiple injuries for all soccer-related injuries in NEDS. NEDS includes age in years for cases presenting to the ED and gender as male or female. Age in years were categorized as: ≤ 6 years of age (y/o), 7-11 y/o, 12-17 y/o, 18-24 y/o, 25-34 y/o, 35-44 y/o, 45+ y/o. NEDS estimates patient median household income from the patient's residential zip codes and provides a variable that categories patients into four-quartiles from the poorest to the wealthiest populations, 0 - 25th, 26th - 50th, 51st - 75th, and 76th - 100th. The primary payers included (1) public health insurance, (2) private health insurance, (3) self-pay (e.g. uninsured), and (4) other (e.g. worker's compensation, other government programs such as CHAMPUS, CHAMPVA, Title V). We also looked at the 12-months of the year as well as the day of the week (weekday versus weekend) to determine at what period in time soccer-related injuries are most likely to occur. The hospital characteristics included (1) *geographical region* (Northeast, Midwest, South, and West); (2) *teaching designation* was categorized into a dichotomous variable, where metropolitan non-teaching hospitals were combined with all non-metropolitan hospitals, to maintain confidentiality of patients due to the scarce number of non-metropolitan teaching hospitals (metropolitan teaching status versus metropolitan non-teaching hospitals or non-metropolitan); (3) *hospital trauma designation* was generally categorized into trauma vs not trauma, but we had to keep a third level on this variable (non-trauma and trauma level III) as NEDS purposefully collapsed any stratum that had less than two trauma hospitals to maintain hospital confidentiality; (4) *hospital population density* was divided into large-metropolitan (≥ 1 million residents) versus other population density areas, such small metropolitan, micropolitan,

and urban-rural, we took this approach as there was scarce data in some of these areas, since 90% of the ED visits occurred in metropolitan (small and large) areas. We also examined if presenting with multiple injuries (vs not) changed the effect of presenting to the ED with a soccer-related injury.

Other descriptors of interest included hospital disposition, such as routine visits, transfer to short-term hospital, transfer to other facility (includes skilled nursing facilities, intermediate care facilities, and other types of facilities), home health care, leave against medical advice, admitted as inpatient to the same hospital, and died in emergency department. Disposition refers to the destination of the patient upon discharge directly from the ED. This excludes the destination of patients following discharge from a hospitalization; inpatient admission. For example, a patient that was admitted as an inpatient to the same hospital as the ED, could later be discharged home or left against medical advice during hospitalization. We only examined disposition upon discharge from the ED, not inpatient stay. We were interested in understanding the destination of people with soccer-related injuries from ED.

ICD-9-CM codes were used to explore the effects of mental health conditions on concussions, ICI, and all-other injuries. There was special interest in Attention Deficit Disorders and other mental health conditions, categorized as binary variables (yes or no).

ICD-9-CM codes were also used to identify the location of injury, mechanism of injury, and place of injury, which were coded as binary variables (yes or no). We looked at head and neck, trunk, upper extremity, and lower extremity injury locations. Based on the available administrative data, mechanism of injury was determined using three binary variables, yes vs. no: 1) falls; 2) struck by hit or thrown/kicked ball, without subsequent fall; 3) struck by hit or thrown/kicked ball, with subsequent fall. Place of injury was determined using six binary variables: 1) Home, 2) recreational and sports facility, 3) street and highway, 4) public institution (e.g. school), 5) residential institution, and 6) other (e.g. beach).

Descriptors for healthcare utilization included cost and length of inpatient stay. NEDS includes two different variables for cost: total charges for ED services, and total charges for those hospitalized (ED and inpatient services). ED charges were analyzed for all soccer related injuries. For those hospitalized, combined ED and inpatient charges (e.g. inpatient charges), as well as hospital length of stay were analyzed. NEDS charges are in U.S. dollars and allowable charges range from \$75 to \$75,000 in 2010, and \$100 to \$950,000 from 2011 to 2013; any case outside of the allowable charges were excluded from analysis by design. The length of stay is calculated by subtracting the discharge date from the admission date and it is reported in days, from 0 to 365 days. Any same-day admissions are coded as 0. Also note, NEDS reports as invalid any inpatient admissions that exceed the maximum allowed length of stay; as a result, these cases are excluded from the analysis.

Sociodemographic, timing of the injury, geographic and health care resources, as well as multiple injuries (vs not) were used as independent predictors variables for adjusted logistic regression models.

Analysis

NEDS provides a stratum and cluster variable; we included these variables on our analyses to account for the effects of sampling, as well as a weight variable to report weighted national estimates from probability sample. SAS statistical software was used to manage data, conduct statistical analyses of weighted frequencies, charges sum, means, as well as adjusted logistic regression analyses of independent predictors of injury for concussions, ICI, and all-other soccer-related injuries.

Tabular and descriptive analysis were used to report weighted frequencies and percentages for categorical variables: socio-demographics, geographic and health care resources, disposition, mental health conditions, injury location, mechanism of injury, and place of injury. Given the scarce data of some categories for disposition, inferential analyses were not

conducted. For all other categorical variables, chi-square statistics were used to determine if there are significant differences between levels on outcome of interest (concussion, ICI, and all-other soccer injuries). Significance was set at $p \geq .05$.

Sum of charges and means in U.S. dollars, with standard deviations, were calculated for ED charges and inpatient charges for concussions, ICI, and all-other injuries related to soccer. Tabular analysis on excel were conducted to determine percentages of total ED visits, ED charges, and total inpatient charges across diagnostic outcomes.

Adjusted odds ratios with 95% confidence intervals were calculated for concussions and intracranial injuries, with all-other injuries as a comparison. Generally, the variable level with the greatest proportion of ED visits was set as the reference group, with the exception of year and month of the year with the reference group set as year 2010 and January, respectively.

Results

All soccer-related injuries represent 480,580 of U.S. Emergency Departments (ED) visits evaluated between 2010 to 2013, which account for less than 1% of all-injuries and all ED visits, and nearly 11% of all-sports injuries. Our analysis targeted all soccer-related injuries. Among soccer-related injuries presenting to U.S. ED's, the majority were male (304,175 [63.3%]), with 12-17 y/o representing the largest age group (234,133 [48.7%]). The largest proportion of patients belonged to the highest median household income (176,537 [37.3%]), presented with private medical insurance (293,418 [61.2%]), and in the beginning of the season, September (61,314 [14.5%]). With the general characteristics of all soccer injuries in mind, differences were noted when soccer-injuries were categorized into concussions, intracranial injuries (ICI), and all other-soccer injuries.

Period effects are notable among soccer-related concussions, ICI, and all other-soccer injuries. Generally, all-other soccer injuries accounted for 93.76% of ED visits and increased

annually from 2% to 11%, with the largest increase, 11%, from 2011 to 2012 and smallest increase, 2%, from 2012 to 2013. Concussions totaled nearly 6% of all soccer injuries and increased annually from 5% to 24%. For example, the greatest increase in soccer-related concussion prevalence, 24%, was shown in 2011. The smallest increase, 5%, was shown in 2012. Conversely, ICI were rare in these data, 0.28%, and over this period, the prevalence of ICI decreased annually. Year to year, ICI prevalence decreases 1% to 24%. Overall, the notable period effects were taken into consideration for adjusted logistic regression, as well as gender and age.

Males were nearly three-fold more likely to be diagnosed ICI, and nearly two-fold more likely to present with any non-cranial injury than females. Albeit statistically significant, concussions among males (54%) and females (47%) were less disparate than gender specific ratios for ICI (76% vs. 24%) and other non-cranial injuries (64% vs. 36%). However, concussions make up a larger percentage of female injuries (7.5%) than males (5%). The highest proportion of injuries occurred in the 12-17 y/o for all other-soccer injuries, concussions, and ICI (Table 1). Overall, the odds of ED evaluation or treatment for concussion was highest for 12-17 y/o youth, compared to every other age group, ranging from 1.5- to 4-fold higher odds (Figure 1). Alternatively, 12-17 y/o youth evidenced higher odds for ICI only in comparison to 7-11 year olds (OR=1.85 (1.15, 3.03) (Figure 1).

Table 1. Associations between sociodemographic, geographic and health care resources for a population-based sample of Americans presenting to U.S. Emergency Departments for evaluation and care for soccer related injuries (weighted case estimates and proportional distributions based on probability sampling)

Characteristics	All other injuries		Concussions		Intracranial injuries		p-value
	n	%	n	%	n	%	
Number of soccer injuries	450,587	93.76%	28,624	5.96%	1,369	0.28%	
Year							<0.0001
2010	102,290	22.70%	5,447	19.03%	414	30.20%	
2011	107,588	23.88%	6,548	22.88%	379	27.67%	
2012	119,090	26.43%	8,130	28.40%	290	21.17%	
2013	121,619	26.99%	8,499	29.69%	287	20.96%	
Gender							<0.0001
Male	287,821	63.88%	15,311	53.50%	1,043	76.17%	
Female	162,715	36.12%	13,310	46.50%	326	23.83%	
Age							<0.0001
≤ 6 y/o	8,711	1.93%	297	1.04%	21	1.52%	
7-11 y/o	78,749	17.48%	3,232	11.29%	101	7.36%	
12-17 y/o	214,309	47.56%	19,251	67.25%	573	41.81%	
18-24 y/o	65,742	14.59%	3,659	12.78%	255	18.62%	
25-34 y/o	47,291	10.50%	1,381	4.82%	244	17.82%	
35-44 y/o	24,735	5.49%	566	1.98%	111	8.10%	
45+ y/o	11,037	2.45%	239	0.84%	65	4.78%	
Median Household Income							<0.0001
0-25th percentile	69,853	15.73%	3,210	11.36%	203	15.13%	
26th-50th percentile	91,765	20.67%	4,783	16.93%	318	23.69%	
51st-75th percentile	119,326	26.88%	7,265	25.71%	291	21.73%	
76th-100th percentile	163,011	36.72%	12,997	46.00%	529	39.45%	
Primary Payer							<0.0001
Public	105,529	23.49%	3,959	13.90%	184	13.56%	
Private	271,207	60.36%	21,333	74.91%	878	64.68%	
Self-pay	51,429	11.45%	1,943	6.82%	195	14.37%	
Other	21,166	4.71%	1,245	4.37%	100	7.39%	
Month of the year							<0.0001
January	20,018	5.08%	1,363	5.25%	65	5.36%	
February	21,888	5.55%	1,347	5.18%	63	5.19%	
March	30,912	7.84%	1,948	7.50%	150	12.39%	
April	39,908	10.12%	2,614	10.06%	99	8.15%	
May	41,702	10.57%	2,623	10.10%	123	10.20%	
June	28,374	7.19%	1,244	4.79%	121	9.97%	
July	24,024	6.09%	906	3.49%	84	6.93%	
August	31,951	8.10%	1,792	6.90%	102	8.42%	
September	56,801	14.40%	4,367	16.81%	146	12.09%	
October	52,688	13.36%	4,500	17.32%	144	11.87%	
November	28,841	7.31%	2,010	7.74%	89	7.36%	
December	17,283	4.38%	1,266	4.87%	25	2.06%	
Day of the week							0.25
Weekday	280,543	62.26%	17,757	62.03%	788	57.56%	
Weekend	170,038	37.74%	10,868	37.97%	581	42.44%	
Hospital region							<0.001
Northeast	84,130	18.67%	5,719	19.98%	188	13.72%	
Midwest	96,089	21.33%	6,722	23.48%	270	19.68%	
South	105,512	23.42%	7,108	24.83%	443	32.38%	
West	164,856	36.59%	9,076	31.71%	469	34.22%	
Hospital Teaching status †							0.55
Non-teaching	264,233	58.64%	16,884	58.98%	732	53.46%	
Teaching	186,354	41.36%	11,741	41.02%	637	46.54%	
Hospital Trauma Designation							<0.01
Not trauma	192,797	42.79%	11,376	39.74%	500	36.52%	
Trauma level I, II, and III	171,958	38.16%	12,076	42.19%	587	42.87%	
Non-trauma and trauma level III	85,832	19.05%	5,173	18.07%	282	20.62%	
Hospital Location ‡ ‡							0.001
Large Metro	265,113	58.84%	15,789	55.16%	877	64.06%	
Other	185,473	41.16%	12,835	44.84%	492	35.94%	
Multiple Injuries							<0.0001
Yes	56,509	12.54%	8,615	30.10%	751	54.82%	
No	394,078	87.46%	20,010	69.90%	619	45.18%	

‡, non-metropolitan hospitals collapsed into non-teaching, as teaching hospitals are rare in non-metropolitan areas

‡ ‡, Not large metropolitan hospitals collapsed into other, due to scarce data in individual categories

Generally, higher socio-economic status was associated with increased likelihood of attending the ED following a soccer-related injury, especially when diagnosed with a concussions or ICI. However, when diagnosed with ICI, the likelihood is not as prominent. Overall, patients reporting the highest income, 76th-100th percentile, or private insurance were treated in the ED for soccer-related injuries (Table 1). Patients diagnosed with concussions admitted to the ED were generally wealthier (46.0%) or were insured privately (74.9%), respectively; however, the wealthiest and privately insured soccer-related ED-evaluated patients represented only 36.7% and 60.36% of those treated for all other (soccer) injuries. Nearly 40% of soccer-related ICI diagnoses reported the highest income level; as well, 64.68% were privately insured.

Trends demonstrated that competitive play, such as the beginning of league and weekend games may increase the likelihood of soccer-related injury ED visits. During the month of September (beginning of soccer league season) all other-soccer injuries were nearly three-fold higher when compared to January when the soccer season is near the end, whereas concussions were over three-fold, and ICI over two-fold when comparing September and January. In some months, the likelihood was nearly six-fold, such as ICI in September compared to December. While not significant, the majority of injuries occurred Monday through Friday, during weekday play compared to play occurring on Saturday or Sunday, weekend days. However, play falling on weekend days resulted in a higher proportion of all soccer-related injuries for all-other, concussion-, and ICI-related injuries when compared to weekday play: 52%, 53%, and 84%, respectively. Although the month and day of the week may influence soccer-related ED visits, number of presenting injuries may also be contributors.

Concussions and ICI demonstrated notable differences in likelihood of presenting to U.S. ED's with multiple injuries following soccer play. For example, concussions were significantly nearly three-fold more likely to present with multiple injuries when compared to all other-soccer injuries; whereas ICI are over seven-fold more likely to present to the ED with multiple injuries

(Figure 1). Interestingly, similarly as multiple injuries, concussions and ICI also demonstrated notable differences in disposition.

Generally, 98% of soccer-related ED visits resulted in routine (treat-and-release) visits (Table 2). Yet, soccer-related concussion and ICI were more likely to result in hospitalization when compared to all other-soccer injuries. When compared to ED visits that ended in release to the community, concussions showed nearly 1.5-fold higher odds of transfer to a short-term hospital than did visits related to all other-soccer injuries, OR=1.46, (1.27, 1.68). There was no difference in odds of being admitted as an inpatient to the same hospital (vs routine) between concussions and all other-soccer injuries, OR = 0.95, 95% CI [0.85, 1.07]. ICI diagnosis carried a 37-fold (95% CI [31.89, 44.39]) higher odds of transfer to a short-term hospital (vs. treat and release) compared to any other soccer injury; similarly, ICI-diagnosed patients showed over 28-fold (95% CI [25.11, 32.93]) higher odds of (same-hospital) admission to inpatient care.

Table 2. Associations between disposition of adults and children evaluated in emergency departments for soccer-related injuries using a weighted, population-based sample of visits abstracted from hospital-affiliated emergency department medical records, 2010-2013 (weighted case estimates and proportional distributions based on probability sampling)

	All other injuries		Concussion		Intracranial injuries	
	n	%	n	%	n	%
Disposition from Emergency Department						
Routine (i.e., treat and release)	441,823	98.08%	28,009	97.85%	883	64.49%
Transfer to short-term hospital	2,390	0.53%	221	0.77%	180	13.13%
Transfer other	400	0.09%	28	0.10%	17	1.23%
Home health care	149	0.03%	-	-	0	0.00%
Against medical advice	670	0.15%	54	0.19%	0	0.00%
Admitted as inpatient to same hospital	5,041	1.12%	304	1.06%	290	21.16%
Died in emergency department	-	-	0	0.00%	0	0.00%

- = Unable to report to maintain confidentiality, ≤10 cases

Mental health conditions and mechanism of injury varied between all other-soccer injuries, concussions, and ICI (Table 3). ICI were over three-fold more likely to be identified with other mental health conditions when compared to all other injuries; and over two-fold more likely when compared to concussions. Patients diagnosed with concussion were two-fold more likely to have ADD as a diagnosis when compared to all-other-soccer injuries; and 36% higher than ICI. When looking at mechanism of injury, all other-soccer injuries were 32% more likely to present following

a fall and 70% more likely to be struck by or hit with a ball (with subsequent fall) than all other-soccer injuries.

Table 3. Associations between body injury location, mental health diagnosis, mechanism of injury, and place of injury for a population-based sample of Americans presenting to U.S. Emergency Departments for evaluation and care for soccer related injuries (weighted case estimates and proportional distributions based on probability sampling)

Characteristics	All other injuries		Concussions		Intracranial injuries		p-value
	n	%	n	%	n	%	
Mental health conditions							
ADD	3,353	0.7%	388	1.4%	14	1.0%	<0.0001
Other mental health	10,602	2.4%	866	3.0%	103	7.5%	<0.0001
Injury Location							
Head and neck	74,183	16.5%	28,625	100.0%	1,369	100.0%	N/A
Trunk	21,395	4.7%	508	1.8%	-	-	<0.0001
Upper extremities	132,181	29.3%	489	1.7%	25	1.8%	<0.0001
Lower extremities	208,981	46.4%	387	1.4%	19	1.4%	<0.0001
Mechanism of injury							
Fall	96,960	21.5%	4,660	16.3%	173	12.6%	<0.0001
Struck by hit or thrown ball, with no subsequent fall	175,358	38.9%	15,818	55.3%	804	58.7%	<0.0001
Struck by hit or thrown ball, with subsequent fall	23,652	5.2%	4,608	16.1%	192	14.0%	<0.0001
Place of injury							
Home	7,886	1.8%	206	0.7%	18	1.3%	<0.0001
Recreational/Sports facility	216,736	48.1%	14,134	49.4%	719	52.5%	0.19
Street/Highway	992	0.2%	81	0.3%	0	0.0%	N/A
Public institution (e.g. school)	16,854	3.7%	1,291	4.5%	45	3.3%	0.03
Residential institution	928	0.2%	24	0.1%	-	-	0.02
Other (e.g. beach)	15,610	3.5%	893	3.1%	38	2.8%	0.27

- = Unable to report to maintain confidentiality, ≤10 cases; N/A = unable to calculate significance since some cells equal zero; Note, all variables are dichotomous (yes vs. no), which means some cases may present with multiple injuries. For example, a case may present with a head/neck injury as well as a lower extremity injury. Furthermore, we are only reporting the "yes" percentages for each variable (for example, concussions with other mental health diagnosis is 3% vs. 97% without other mental health diagnosis [which sums to 100%], but we only report the 3%).

Adjusted logistic regression models demonstrated notable differences in odds of presenting to the ED with a soccer-related concussion and ICI compared to all other-soccer injuries by year, gender, and age. For example, soccer concussions (vs. all-other soccer injuries) adjusted odds ratios, with 2010 as the reference year, increased yearly (Figure 1), from 1.13-fold to 1.30-fold. ICI (vs all other-soccer injuries) odds ratio decreased between 1.20-fold to 1.85-fold annually over the observation period. Females had significantly higher odds of presenting with a concussion than all-other soccer injury, OR = 1.16 (95% CI [1.09, 1.24]), but nearly two-fold lower odds of presenting with an ICI, OR = 0.56 (95% CI [0.40, 0.79]). As for age, 12-17 y/o had higher odds of presenting with a concussion across all age groups; for example, they were 1.49-fold and over 4-fold higher odds when compared to 18-24 or 45+ y/o patients with soccer-related injury. The odds of ICI were not significantly different when 12-17 y/o were compared to most other age

groups; however, youth 7-11 y/o showed lower odds of ICI than 12-17 y/o (OR=0.54, 95% CI [0.33, 0.87]).

With the exception of ICI, higher socioeconomic status in the form of income and insurance coverage may influence whether or not Americans present to ED following a soccer-related concussion. Generally, ED visits for highest income earners (76th-100th percentile) had higher odds of presenting to the ED following a concussion compared to those reporting \leq 25th, 26th-50th, and 51st-75th percentiles, with odds of 1.45-fold, 1.42-fold, and 1.22-fold, respectively. Privately-insured individuals showed nearly two-fold higher odds of presenting to the ED with a soccer-related concussion, vs all-other injuries, than those with public insurance; and 1.37-fold higher compared to self-pay. There was no significant difference in odds of presenting to the ED with a soccer-related concussion (vs all-other injuries) between privately insured individuals and other forms of payer. Noteworthy, there was no significant differential odds of presenting with an ICI compared to all-other injuries between the highest household income quartile or other forms of insurance also did not show significant odds differences of presenting with an ICI to the ED when compared to all-other injuries, with the exception of public insurance which showed 1.72-fold lower odds.

Odds of concussions compared to all-other soccer injuries was lower in June and July, 1.41-fold and 1.56-fold, respectively, when compared to January. Generally, the differences in odds of presenting to the ED with a concussion or ICI did not vary across weekdays and weekends, and relationships between regions, types of hospitals, trauma-designated centers, and large metropolitan population densities were small relative to their comparators (Figure 1).

ED visits with concussions or ICI were associated with multiple injuries. When compared to all-other soccer injuries, those with concussion or ICI were nearly three- and seven-fold more likely to present with multiple injuries (i.e., OR = 2.92, 95% CI [2.70, 3.16]; OR = 7.55, 95% CI [5.73, 9.94], respectively).

Americans spent more than \$700 million (U.S.) across four years, 2010-2013, for soccer-related injuries presenting to ED's. Generally, total charges per person for ICI visits were more than 7-fold higher than those for all-other injuries. When compared to cost for concussion, ICI costs were over 5-fold higher. Total charges, per person, were 40% higher for concussion-affected youth and adults than for all-other soccer injuries. For total inpatient care of soccer-related injuries, ICI charges were more than 2-fold higher than for similarly hospitalized patients with concussion. Inpatient length of stay was 34% longer for ICI-affected patients injured in soccer play than all-other soccer injuries and nearly 3-fold longer than those suffering concussion.

Table 4. Charges and length of stay for a population-based sample of Americans presenting to U.S. Emergency Departments for evaluation and care for soccer related injuries (weighted case estimates and proportional distributions based on probability sampling)

Characteristics	All other Injuries		Concussions		Intracranial injuries	
	\$	SD	\$	SD	\$	SD
Total charges per person, in thousands	1,434.24		2,017.89		10,613.59	
ED charges, in million						
Total charges	479.43	(23.03)	51.66	(2.70)	0.34	(0.34)
Mean	1,515	(33.71)	2,379	(89.04)	3,300	(234.30)
Inpatient charges						
Total charges, in million	166.82	(10.55)	6.10	(1.08)	14.19	(4.27)
Mean	34,317	(1,301)	20,303	(2,120)	49,822	(13,582)
Inpatient length of stay						
Mean, days (SD)	2.55	(0.09)	1.23	(0.13)	3.43	(0.78)

Discussion

This study described (1) soccer-related concussions, ICI, and all-other soccer injuries leading to U.S. ED visits, as well as (2) healthcare utilization, and (3) analyzed independent predictors of concussions, ICI, and all-other soccer injuries leading to ED visits. To our knowledge, this is the first study that provides U.S. national estimates of ED visits, using a stratified and clustered probability weighted sample of hospital-owned ED's, for soccer-related concussions, ICI, and all-other soccer injuries. The findings of the study are important for policy makers, clinicians, coaches and families involved in soccer communities, as well as future research that may help reduce soccer-related injuries and ED utilization.

The data demonstrated a steady increase of concussions and all-other soccer injuries leading to U.S. ED visits over the four-year period; interestingly, ICI showed a steady decline over

time. Other data have shown similar results; for example, trends from 1990 to 2003 in non-stratified analysis determined an overall increase in soccer-related incidence rate (IR), 1.6/1,000 of ED visits vs 1.7/1,000 ($p = 0.78$), respectively (15). Other have shown that soccer-related TBI injury rates nearly doubled between 2001 and 2012, and account for 2.9% all of soccer-related ED visits in 5-9 y/o, followed by 1.5% in 10-14 y/o, and reaches 3.7% peak in 15-19 y/o (16, 17). In a more recent analysis, soccer-related injury rates increased over 100% in a 25-year period, whereas concussion/closed head injuries increased by 1595% over the same period (18). The increased ED rates of soccer-related concussion may be attributed to a combination of increase in soccer participation, greater awareness and detection of concussions in soccer, and broader definition of concussion in sport (1, 3, 4, 19-21). In contrast to other findings, the NEDS data set demonstrated steady decline of ICI over time. It was also noted that concussions make up a larger percentage of female injuries than males; these findings can be interpreted in context of higher rates of concussion in females. Incidence studies of sports concussions per 'athlete exposures' (games or practices) have demonstrated that for sports with similar rules for both genders, such as soccer, the rates of concussion are higher in females than males (22-25). Further research is needed to better understand the reason for the decline of soccer-related ICI as a diagnostic outcome over time, as well as individual differences.

Generally, diagnoses of soccer-related concussions and ICI (compared to all-other injuries) are uncommon in ED visits. Soccer-related concussion rates vary from 1.38 to 3.10/10,000 participants, and account for less than 4% of ED visits (3, 10, 16). However, in the estimated 3.4 million sports- and recreation-related TBIs, among 15-19 y/o males and females, soccer-related TBI's were proportionally in the top four sport-related activities leading to TBI ED visits (17). In this study, concussions leading to ED visits accounted for nearly 6% of all soccer-injuries, whereas ICI accounted for 0.28%. Nevertheless, generally, the results demonstrate that most soccer-related injuries that lead to ED visits can be treated outside of the ED, as the majority are treat and release.

Soccer-related hospitalization is rare for concussions and all-other injuries, but not for ICI. The data showed that less than 2% of cases presenting to ED's after a soccer-related injury are hospitalized; surprisingly nearly 35% of soccer-related ICI ED visits result in hospitalization. To our knowledge, there is no study that has described ICI proportion of hospitalization, most focus on disposition of general injuries. Others have similar results, with less than 2% ED visits resulting in hospitalization (10, 15, 16, 26). This evidence suggests that the public may inadvertently misuse U.S. ED for non-emergent injuries that can be treated in other settings, such as outpatient or in-field, which may be due to public misunderstanding of ED use or lack of access to appropriate treatment centers. There may be some factors that future studies may consider and incorporate, which are not available in this administrative data. For example, weekday injuries may have more access to their primary care providers clinic, which means player will not go ED, and weekend injuries may not be able to see primary care provider, which may more likely result in ED visit. Moreover, the literature does not report the prevalence or rate of soccer-related hospitalizations due to brain trauma, which may account for a large number of needed hospitalizations, as well as high cost to the public.

Soccer-related injuries are a financial burden to the public. The unique contribution of this work is the inclusion of total charges and length of stay of soccer-related concussions, ICI, and all-other injuries leading to U.S. ED visits; To our knowledge, no other study has looked at charges and length of stay in soccer-related injuries. ICI inpatient length of stay was nearly 3-fold compared to concussions, and 34% higher than all-other injuries. As it relates to financial cost, soccer-related injuries charges average approximately \$180 million annually in ED visits (and hospitalization resulting from the ED visit). The cost ranged depending on the reason for the visit, with ICI total charges per person more than 5-fold higher than concussions, and 7-fold higher than all other soccer injuries. Interestingly, nearly all the charges for ICI resulted from inpatient charges (97.7%), whereas the majority of charges for concussions (89.4%) and other-injuries (74.2%) were from ED charges. It should be noted that the soccer-related injury charges are limited to U.S.

ED visits (and any additional care and services resulting from the ED visit), cost reported in this study do not include any charges that may be incurred in other forms of health care and treatment for injuries, such as outpatient clinics, over the counter medications and treatment, and rehabilitation (e.g. physical therapy), among others. The cost of soccer-related injuries is higher than reported, and this analysis only focuses on ED visits in an effort to provide information to policy-makers and clinicians that specialize in ED settings.

Adjusted logistic regression models showed that indicators of higher socio-economic status, median household income and private insurance, were predictors of visiting an ED following a soccer-related concussion, which is often seen as a serious injury with sequelae, as compared to all-other injuries. Interestingly, those with ICI tended to visit ED regardless of socioeconomic indicators. To further expand, the data suggests that Americans are more likely to attend the ED for soccer-related injury if they have higher income or private insurance, especially if it is a concussion or ICI (e.g. head injury); but if it is perceived as being a more severe injury, such as with ICI, those with lower socioeconomic status, i.e. income and primary payer status, are also more like to visit the ED. For example, compared to patient in the 76th to 100th median household income quartile, those in the 0 to 25th median household income quartile were 45% less like to present to an ED following a concussion (vs all-other injuries); Yet, compared to patient in the 76th to 100th median household income quartile, those in the 0 to 25th median household income quartile were as likely to present to an ED following an ICI (vs all-other injuries). This may be due to the seriousness of injuries with ICI; Hence, people may be more willing to attend the ED visit regardless of cost given the potential seriousness sequelae.

Concussions and ICI may present with multiple injuries when compared to all-other injuries. However, the difference when compared to other-soccer-injuries is greater for ICI than concussions. Concussions were nearly 3-fold more likely to present to the ED with multiple injuries when compared to all-other injuries; whereas, ICI were more than 7-fold more likely to present

with multiple injuries. Clinicians should assess for multiple injuries when a patient presents with a head injury such as a concussion and ICI.

Limitations

The unique contribution of this work is the inclusion of descriptors, disposition, total charges, and length of stay of soccer-related concussions, ICI, and all-other injuries leading to U.S. ED visits. These methods of analysis allowed greater generalizability and uncover preventable injury patterns susceptible to targeted public health interventions. Nonetheless, limitations reflect that ED data may under-estimate the prevalence and rate of certain soccer-related injuries experienced in the field, as affected individuals may not present to the ED (27), and does not distinguish injuries related to different forms of soccer play, field-soccer vs futsal vs indoor. Unfortunately, the NEDS dataset does not include differences in forms of soccer-play, or exposure measures, e.g. head and lower extremity impacts. As a result, analyses were limited to the administrative data available in NEDS, and differences in forms of soccer play were not considered. Furthermore, the cross-sectional design of administrative data limits causation directionality between variables; in addition, incidence rate cannot be determined. It is important to note that results should be taken with caution, and future research should think of ways to determine if the magnitude of the ED numbers may be driven by participation numbers, including the gender and age effects. To better understand the epidemiology of U.S. ED soccer-related injuries hospitalization, cost, and length of stay, future studies should consider analyzing difference of field-injury exposure in different forms of soccer play (e.g. field-soccer, futsal, indoor), as well as prospective data collection that considers soccer participation compared to injury.

In conclusion, given that soccer-related injuries have become a health and healthcare utilization and cost concern, the current study allowed insight into soccer related concussion, ICI, and all-other injury descriptors, hospitalization, ED and inpatient charges, and hospital length of

stay, across individual-level, hospital-level, and multiple injuries in soccer-related injuries. The finding helped determine multi-level features susceptible to targeted injury prevention intervention to minimize the price on human suffering, healthcare cost, and utilization, within concussions, ICI, all-other soccer injuries leading to an ED visit.

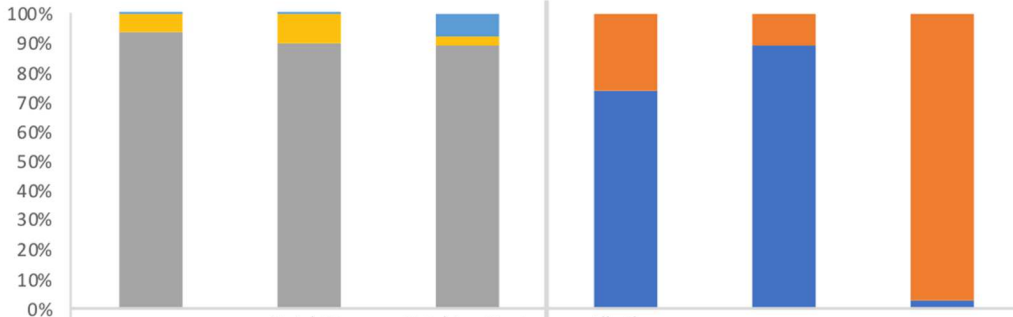
Figure 1. Adjusted odds ratios of sociodemographic, geographic and health care resources for a population-based sample of Americans presenting to U.S. Emergency Departments for evaluation and care for soccer related injuries (weighted case estimates and proportional distributions based on probability sampling) --- reference group is all-other-injuries

Characteristics	Concussions				Intracranial injuries							
	OR	95% CI		Less likely	More likely	OR	95% CI		Less likely	More likely		
		Low	High	0.1	1	10		Low	High	0.1	1	10
Year												
2010	ref						ref					
2011	1.13	1.01	1.27				0.83	0.54	1.28			
2012	1.28	1.15	1.43				0.60	0.39	0.93			
2013	1.30	1.16	1.46				0.54	0.34	0.86			
Gender												
Male	ref						ref					
Female	1.16	1.09	1.24				0.56	0.40	0.79			
Age												
≤ 6 years	0.47	0.36	0.61				1.02	0.37	2.82			
7-11 years	0.50	0.46	0.55				0.54	0.33	0.87			
12-17 years	ref						ref					
18-24 years	0.67	0.61	0.73				1.06	0.73	1.53			
25-34 years	0.37	0.32	0.42				1.25	0.83	1.90			
35-44 years	0.27	0.22	0.33				1.04	0.62	1.75			
45+ years	0.25	0.18	0.33				1.27	0.64	2.50			
Median Household Income												
0-25th percentile	0.69	0.61	0.78				0.82	0.53	1.28			
26th-50th percentile	0.70	0.63	0.78				1.10	0.76	1.57			
51st-75th percentile	0.82	0.75	0.88				0.78	0.56	1.08			
76th-100th percentile	ref						ref					
Primary Payer												
Public	0.52	0.47	0.57				0.58	0.38	0.89			
Private	ref						ref					
Self-pay	0.73	0.64	0.83				0.91	0.62	1.34			
Other	0.87	0.75	1.01				1.49	0.86	2.59			
Month of the year												
January	ref						ref					
February	0.89	0.76	1.06				0.93	0.43	1.99			
March	0.89	0.75	1.04				1.48	0.81	2.71			
April	0.93	0.79	1.08				0.79	0.39	1.60			
May	0.91	0.78	1.05				0.97	0.48	1.93			
June	0.71	0.59	0.85				1.31	0.68	2.49			
July	0.64	0.53	0.78				1.03	0.50	2.12			
August	0.85	0.72	1.00				0.94	0.49	1.79			
September	1.02	0.88	1.17				0.89	0.48	1.66			
October	1.15	1.00	1.32				0.89	0.48	1.66			
November	1.04	0.89	1.22				0.99	0.52	1.87			
December	1.13	0.94	1.36				0.46	0.18	1.21			
Day of the week												
Weekday	ref						ref					
Weekend	0.95	0.90	1.01				1.14	0.90	1.46			
Hospital region												
Northeast	1.06	0.93	1.21				0.66	0.40	1.10			
Midwest	1.11	0.99	1.26				0.92	0.60	1.41			
South	1.25	1.09	1.43				1.33	0.81	2.18			
West	ref						ref					
Hospital Teaching status												
Metropolitan non-teaching	ref						ref					
Metropolitan teaching	1.00	0.89	1.11				1.15	0.80	1.63			
Hospital Trauma Designation												
Not trauma	ref						ref					
Trauma	1.21	1.09	1.34				1.27	0.91	1.78			
Non-trauma and trauma	1.01	0.87	1.18				1.19	0.72	1.97			
Hospital Location												
Large Metro	ref						ref					
Other	1.14	1.03	1.26				0.78	0.53	1.13			
Multi-injury												
Yes	2.92	2.70	3.16				7.55	5.73	9.94			
No	ref						ref					

Note. ICI only account for 0.3% of total ED visits (when compared to all-other-injuries, 93.7%; and concussions, 6%), however, ICI account for 7.6% of all total inpatient charges, which is nearly 343-fold higher than expected.

The majority of charges for concussions and other-injuries are from the ED, 89.4% and 74.2%, respectively. However, the majority of charges for ICI are inpatient stay, 97.7%.

Figure 2. Total emergency department (ED) visits, total ED charges, and inpatient charges for a population-based sample of Americans presenting to U.S. Emergency Departments for evaluation and care for soccer related concussions, intracranial injuries (ICI) and all-other injuries, as well as proportion of inpatient vs. ED charges within those diagnoses (national weighted case estimates)



	Total ED visits	Total ED charges	Total inpatient charges	All other injuries	Concussions	ICI
Intracranial Injuries	0.3%	0.1%	7.6%			
Concussions	6.0%	9.7%	3.3%			
All other injuries	93.7%	90.2%	89.1%			
Inpatient charges				25.8%	10.6%	97.7%
ED charges				74.2%	89.4%	2.3%

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Chapter 2

Soccer-related injuries in U.S. emergency departments across the age spectrum:

Nationwide Emergency Department Sample, 2010 to 2013

Currently, soccer is the world's most popular sport with 265 million involved in play worldwide, which account for 4% of the global population (1, 2). In the U.S., soccer participation has increased over time and now ranks second worldwide (1-4). Across the age-span, U.S. participation in organized soccer play has more than doubled over 24 years from 10.3 to >24 million (1, 4). Higher U.S. soccer participation has yielded a greater number of soccer-related injuries that may impact healthcare utilization. For example, overall, soccer injuries among 5 to 19-year-old (y/o) and 20 to 49 y/o adults have increased over a 13-year period (5, 6). Some groups may be more vulnerable to higher injury rates, especially across the age spectrum. The rate of emergency Departments (ED) visits for soccer injuries is nearly 4-fold greater for 10 to 14 and 15 to 19 year olds, when compared to 5 to 9 year olds: 3.1 and 3.1 vs. 0.8/1,000 persons, respectively (5). Healthcare utilization and related costs of Emergency Departments (ED) care for soccer-related injuries is important to U.S. payers, providers, public, and healthcare institutions.

To explore soccer-related injury patterns evaluated in domestic hospital-affiliated EDs, we examined data collected by the U.S. Healthcare Cost and Utilization Project (HCUP), Nationwide Emergency Department Sample (NEDS), a national probability sample weighted to be representative of U.S. populations and communities. NEDS has been described extensively in peer-reviewed databased articles and government report (7-10). Briefly, NEDS captures health-related diagnostic outcomes, including soccer injuries, as well as important individual- and hospital-characteristics that may confound our assessment of relationships that might lead to spurious conclusion. NEDS captures geographic and population density variability for ED visits completed across the U.S.

The primary purpose of this study is to describe soccer-related injuries evaluated in U.S. ED's by age, with special interest paid to individual and hospital characteristics, geographic locations, diagnostic outcomes, and mechanism and place of injury. ED disposition and total healthcare charges for ED visits and inpatient care and resources, by age category was performed. Thus, data for a weighted sample of 480,580 for child, adolescent and adult soccer-related injuries evaluated in U.S. EDs were evaluated.

Methods

The study protocol was reviewed by the University of California, Los Angeles Institutional Review Board. The study was evaluated as *not* human research and exempt from IRB review (IRB#17-000777).

Study design and sample

The study examined ED visits for soccer-related visits using discharge data from the Nationwide Emergency Department Sample (NEDS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality (9). The study design and sample have been described extensively elsewhere (11). Briefly, the NEDS is a stratified and weighted sample of rural, suburban, and urban U.S. hospital-affiliated ED's collected as a serial cross-sectional survey across four years, 2010 to 2013. Soccer-related injuries were identified using the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) external cause of injury codes (E-codes). NEDS includes ≤ 4 external cause of injury codes (E-codes), and any visit coded as an ICD-9 E-code E007.5 was identified as a soccer injury.

Variables

Subjects were classified into seven age categories: ≤ 6 , 7 to 11, 12 to 17, 18 to 24, 25 to 34, 35 to 44, ≥ 45 years of age. Individual- and hospital-level characteristics, diagnostic outcomes,

mechanism and place of injury, and multiple injuries were described across the different age categories; these variables have been described extensively elsewhere (11). More specifically, the year, month of the year, and day of the week when the injury occurred were described. Gender, median household income, primary payer status, and multiple-injuries (vs not) were individual-level characteristics of interest. Hospital characteristics of interest included geographical region, teaching (vs not) status of the hospital, trauma-level designation, and geographical population-density.

For disposition, patients treated-and-released from the ED were compared collectively to those not treat-and-released. Soccer players that were not treated-and-released from the ED included admissions to same hospital, transfer to another hospital, and “other” disposition that included transferred to another facility, such as skilled nursing facility or long-term care, left against medical advice, unknown destination, and death.

Injury diagnosis, body location, mental health diagnosis, mechanism of injury, and place of injury were of interest. Injury diagnosis ranged from intracranial injuries, fractures, wounds, internal injuries to sprains and strains. We grouped injury body locations as head and neck, trunk, upper, and lower extremities. We reported comorbid mental health diagnoses for post-traumatic stress disorder, attention deficit disorder, and all other psychiatric diagnoses according to the ICD-9 diagnostic codes (12). To understand the situational features of injuries, we report descriptive statistics for soccer-related falls, hit by ball with subsequent fall (or not), and whether the injury occurred at home, recreational facility, institutional facility, or any other place.

Total charges for ED and hospitalization services across age groups were analyzed. These variables are described extensively elsewhere (11). Briefly, total charges, in U.S. dollars, are rounded to the nearest dollar. Generally, as all ED activities incur cost, NEDS reports ED visits showing zero cost as missing. Also, we excluded all cases with cost estimates reported by NEDS as *inconsistent* with expected charges, i.e., evaluated as too high or too low beginning in

2011 as reported by NEDS (13). As a result, although we report cost for soccer-related ED visits, the estimates may be imprecise.

Statistical Analyses

Descriptive and tabular statistics and graphical analyses explored the data. Using visual representation for individual- and hospital-level characteristics, we evaluated the proportional distribution of sociodemographic and institutional features of treatment centers and patient disposition and charges were reported across seven age groups (Figures 1, 2). For individual-level and hospital-characteristics 100% stacked charts of variables was used (Figure 1). We compared proportional distributions reflecting different overall age-group population sizes for soccer-related injuries that were treated-and-released from the ED, direct hospitalization or transfer to another hospital, and *other* outcomes, including death, using a combination of pie and stacked bar charts. Proportional stacked charts and line charts show the relationships of ED charges and inpatient services charges. All analyses accounted for the effects of sampling, stratum and cluster variables provided by NEDS using statistical programs available through SAS (Version 9.4, Cary, North Carolina). The NEDS weight variable adjusts for sampling to produce regional and nationally representative estimates (14). For bivariate statistics, chi-square was used, and significance was set to $p \leq 0.05$. Thus, to describe characteristics of soccer-related injuries evaluated in U.S. EDs we analyzed a total of 480,580 weighted visits registered between January 1, 2010 to December 31, 2013 in index hospitals.

Results

Of the nearly half-million visits, year, sex, income, and day of the week, and hospital location distributions significantly differed by age, $p < 0.0001$. In general, younger people are increasingly represented in the later years (Figure 1). ED visits by males comprised more than

half of all ED visits in each age group, ranging from 53% to 84.1%, $p < 0.0001$ (Figure 1). Adults and children with higher median household income formed a greater proportion of those evaluated in EDs with soccer-related injury, across the age spectrum. For example, soccer-related ED visits among 12 to 17-year olds showed a monotonic increase from 14%, to 20.4%, 26.1%, and 39.5% for lowest to highest income quartiles, respectively, $p < 0.0001$. Furthermore, the highest proportion of ED visits were charged as private insurance claims, ranging from 50.4% among children < 6 years of age to 67.4% among those 45 years and older, $p < 0.0001$. Public insurance was the second most common payment form for 0 to 17-year olds soccer-injury ED patient visits, but much less often used by adults, ranging 9.6% to 13.7%. Self-pay was second most frequent payment form among adults, ranging from 13.9% to 31.4% (Figure 1). Although nearly 11% to 13% of soccer-related injuries were reported daily during the week, totaling 54.7% to 63.3% overall, soccer injuries treated in EDs were 50% higher on weekend days, nearly 18% to 23% of the week's total soccer injuries were evaluated daily each weekend day, $p < 0.0001$. For example, among adults > 45 years, approximately 2,568 injury-related visits per weekend day were completed in comparison to 1,241 injuries/day during the workweek (Figure 1). Across age categories, the vast majority of soccer-related injury ED visits occurred in metropolitan areas 87.8% to 93.4%, with micropolitan accounting for 3.5% to 7.1% of most of the remaining proportions, $p < 0.0001$.

Payment and teaching status characteristics for ED care varied significantly across the age spectrum ($p < 0.0001$). For example, 5.5% to 6.9% of adult age groups were self-paid care, while only 3.3% to 4.1 of children showed self-pay as their source of payment, $p < 0.0001$. Nonetheless, while estimates varied over age groups, private insurance payers comprised $> 50\%$ of payers for soccer-related injury ED care, $p < 0.0001$ (Figure 1). In addition, $> 50\%$ of soccer-injured children and adults are cared for in non-teaching hospitals, $p < 0.0001$ (Figure 1).

The majority of soccer-related injury patients in U.S. EDs are treated and directly released from the ED, no matter the age. For example, nearly all ≤ 6 (96.8%), 7 to 11 (98.6%), and 12 to

17 (98.4%) year olds were released directly from the ED; However, among adults, direct release from the ED decreased somewhat monotonically: 18 to 24 (97.8%), 25 to 34 (96.5%), 35 to 44 (96.6%), and ≥ 45 -year olds (95.5%), $p < 0.0001$ (Figure 2).

Concussion and intracranial injury prevalence varied by age. The highest prevalence of injury was muscle sprain and strain (13.7% to 36.6%) and fractures (18.2% to 36.2%) across age groups (Table 1). Although rarely diagnosed among 0 to 44-year olds ($\leq 0.5\%$), prevalence of internal injuries was 6.5% among adults ≥ 45 (Table 1). Generally, mental health conditions were rare, but other mental health condition (other than PTSD and ADD) is prevalent in 18 to 24 (4.1%), 25 to 34 (6.3%), 35 to 44 (5.9%), and 45+ y/o (6.2%). Injuries in recreational and sport facilities were the most prevalent across all age groups, ranging from 42.9% to 51.1% (Table 1).

Table 1. Descriptive sociodemographic, geographic and health care resources for a population-based sample of Americans presenting to U.S. Emergency Departments for evaluation and care for soccer-related injuries by age categories (weighted case estimates and proportional distributions based on probability sampling)

Characteristics	≤ 6 yo		7 - 11 yo		12 - 17 yo		18 - 24 yo		25 - 34 yo		35 - 44 yo		45+ yo	
	# affected	%	# affected	%	# affected	%	# affected	%	# affected	%	# affected	%	# affected	%
Injury diagnosis														
Intracranial Injuries **														
Concussion	297	3.3	3232	3.9	19251	8.2	3659	5.3	1381	2.8	566	2.2	239	2.1
Other intracranial injuries	21	0.2	101	0.1	573	0.2	255	0.4	244	0.5	111	0.4	65	0.6
Other injuries	8711	96.5	78749	95.9	214309	91.5	65742	94.4	47291	96.7	24735	97.3	11037	97.3
Fractures **	3270	36.2	25111	30.6	49789	21.3	12598	18.1	11526	23.6	6261	24.6	2969	26.2
Dislocation **	97	1.1	690	0.8	5667	2.4	3929	5.6	3562	7.3	1736	6.8	871	7.7
Sprains and strains														
Anterior cruciate ligament ^	0	0.0	0	0.0	180	0.1	116	0.2	68	0.1	56	0.2	14	0.1
Other sprains and strains **	1233	13.7	21933	26.7	81321	34.7	25483	36.6	17207	35.2	9002	35.4	3250	28.7
Internal injuries ^	0	0.0	24	0.0	429	0.2	144	0.2	105	0.2	121	0.5	741	6.5
Wounds **	1250	13.8	3812	4.6	11293	4.8	7685	11.0	5308	10.9	2340	9.2	1255	11.1
Superficial injuries **	236	2.6	1272	1.5	3337	1.4	1300	1.9	857	1.8	384	1.5	241	2.1
Contusions **	1509	16.7	16835	20.5	45362	19.4	11438	16.4	7583	15.5	3877	15.3	1898	16.7
Injury Location														
Head and neck **	2536	28.1	14128	17.2	54900	23.4	16764	24.1	9440	19.3	4260	16.8	2148	18.9
Trunk **	227	2.5	2566	3.1	10454	4.5	2971	4.3	2886	5.9	1871	7.4	2399	21.1
Upper extremities **	3847	42.6	36037	43.9	61695	26.4	12555	18.0	9788	20.0	5638	22.2	3129	27.6
Lower extremities **	2085	23.1	26943	32.8	102230	43.7	35266	50.6	25356	51.8	12716	50.0	4784	42.2
Mental health conditions														
PTSD ^	0	0.0	-	-	24	0.0	0	0.0	25	0.1	0	0.0	-	0.0
ADD **	23	0.3	966	1.2	2340	1.0	312	0.4	102	0.2	-	-	-	-
Other mental health diagnosis **	27	0.3	477	0.6	2893	1.2	2884	4.1	3086	6.3	1497	5.9	706	6.2
Mechanism of injury														
Fall **	3601	39.9	23554	28.7	48139	20.6	10936	15.7	8489	17.4	4647	18.3	2427	21.4
Struck by hit or thrown ball, no fall **	2713	30.1	32504	39.6	96924	41.4	28283	40.6	18254	37.3	9181	36.1	4114	36.3
Struck by hit or thrown ball, with fall **	592	6.6	4937	6.0	15746	6.7	3385	4.9	2176	4.4	1029	4.0	587	5.2
Place of injury														
Home **	777	8.6	2055	2.5	2645	1.1	858	1.2	741	1.5	675	2.7	359	3.2
Recreational/Sports facility **	3873	42.9	37605	45.8	111324	47.5	35342	50.7	25009	51.1	12864	50.6	5567	49.1
Street/Highway ^	33	0.4	153	0.2	422	0.2	191	0.3	153	0.3	66	0.3	54	0.5
Public institution (e.g. school) **	294	3.3	5128	6.2	10923	4.7	1407	2.0	292	0.6	88	0.3	57	0.5
Residential institution ^	0	0.0	37	0.0	191	0.1	185	0.3	301	0.6	158	0.6	88	0.8
Other (e.g. beach)	419	4.6	2778	3.4	7731	3.3	2505	3.6	1790	3.7	946	3.7	372	3.3

yo = years old

- = unable to report as required by NEDS to maintain confidentiality due to low frequencies

^ = unable to perform statistical analysis for significance due to low frequencies in some age categories

* = p<0.01

** = p<0.0001

Note. All statistical analyses for significance were performed using dichotomous variables (yes/no) between affected soccer players vs not affected in the specific variable across age groups, with the exception of intracranial injuries which had three-levels (concussions, other intracranial injuries, other injuries).

The total cost of soccer-related injuries ED visits in the U.S. surpassed \$700 million dollars from 2010 to 2013. The majority of the soccer-related ED visit injuries charges were for ED services (\$534.1 million; 74%) and some for inpatient services (\$187.1 million; 26%). Nearly half of all charges were incurred in youth players between 12 to 17 years of age. Generally, although the per visit charges increased with age, the proportion of charges spent on ED visits, an outpatient care area, is inversely associated with age. Put another way, the cost of soccer-related injuries is driven largely by inpatient care for adults ≥ 25 years of age (Figure 3). Similarly, in general, the proportion of total inpatient charges increased with age (Figure 3); for example, in adult soccer players 45+ y/o nearly half (49%) of total charges incurred were from inpatient stay, whereas in youth players 7-11 y/o the majority (87%) of total charges were from ED rather than inpatient.

Discussion

The study described soccer-related injuries evaluated in U.S. ED's, ED disposition, and total healthcare charges for ED visits and inpatient care and resources by age from 2010 to 2013. This study provides U.S. national estimates of soccer-related injuries that lead players to visit U.S. hospital-owned ED's in a stratified and clustered probability weighted sample. Our study findings suggest tailored injury-prevention programs and resources for ED care may improve outcomes for soccer-related injuries.

Overall, our population-based findings show ED visits for soccer injuries steadily climbed between 2010 and 2013. For example, the proportion of soccer injuries overall decreased slightly for 25 to 34 y/o between 2010 and 2013; while 35 - 44 y/o showed little difference in the running average. Our findings are similar to other investigator reports. For example, a team of investigators report soccer injuries among children and young and middle-aged adults were inversely associated with time, over 13 years (6). Some variability in ED visits for soccer injuries

in our data may relate to the enactment of the Patient Protection and Affordable Care Act (ACA) in 2010, when the rate of uninsured Americans decreased nearly 10% across the country over the ensuing four years (15). For example, this report shows the prevalence of soccer-injury ED treatment among youth ≤ 6 years of age increased 63% during the 2010-2013 interval. Much of this change occurred in 2011. Thus, the increase in soccer-related ED visits may be largely attributable to the system features, such as greater access allowed by the enactment of the ACA, which seems to parallel larger ED visit utilization post-ACA enactment (16).

These data also suggest males are more likely to utilize U.S. EDs for soccer-injuries across all age groups. Other investigators report similar findings. For example, soccer-related injury incidence rates (IR) in U.S. EDs it is higher among males when compared to female. However, the IR in males varied little when rates for 1990 and 2003 are compared, while females IRs increased: for males, IR=2.04/ vs 1.8/ ($p=0.16$); for females, 1.14/ vs 1.63/1,000 visits ($p<0.0001$), respectively (17). Nonetheless, our analyses show that 12-17 y/o females accounted for nearly half of soccer-related ED injury visits while females >45 y/o represented fewer than one-fifth of visits. There are other published epidemiological data from similar time range, 2010-2016, for pediatric and teen traumatic brain injury specifically in sports- and recreation-activities that show higher rates of injuries in middle- to late-teens when compared to younger age groups; and also show a gender disparity, with males showing higher rates of injuries compared to females (18).

Socioeconomic markers, such as household income and insurance status, seemed to affect access to an ED following a soccer-related injury, across all age groups; the greatest proportion of ED visits were among those in the highest median household income bracket and those with private insurance. To our knowledge, there no studies that have looked at the distribution of soccer-related ED visits across household income and insurance status in different age groups. Household income and insurance status have been examined for tackle football. Interestingly, although tackle football players in the highest income bracket and with private

insurance also account for the highest proportion of ED visits, the distribution of ED visits for tackle football players is not as pronounced for median household income compared to soccer players (19). For example, ED visits in football players in the highest median household income bracket across different age groups ranges from 23.14% to 24.34% (19); whereas ranges of soccer-players were 29.6% to 47.5% in the same income brackets. One can speculate that tackle football injuries are more severe than soccer-related injuries, which leads football players to attend the ED regardless of household income; however, further research is needed to establish evidence. Regardless of sport, there seems to be a benefit of being in the highest income bracket and having private insurance. Future research can analyze if having higher income or private insurance would lead to proportionally fewer ED visits for minor injuries, which could be taken care of in a private clinic setting that might not be as readily available to those who are under-insured; In addition, those in lower socioeconomic status may either do not show up for care for minor injuries or disproportionately use the ED for injuries of increasing severity.

A high proportion of soccer-related injuries U.S. ED visits are treat-and-release across all age groups. Generally, evidence suggests soccer-related injuries hospitalization account for less than 3% of ED visits, which is consistent with this analysis (5, 6, 17). In this analysis, most age groups had less than 3% of soccer players admitted for inpatient treatment and care. There seems to be some variability between age groups. For example, others have found that males between 45-49 y/o experienced nearly 4.5% of hospitalization (6), similar to our findings among adults 45 years and older. This evidence suggests that older age groups may experience further likelihood of hospitalization, which may be due to severity of injuries, underlying comorbid conditions, or other reasons; thus, further research is needed to understand the differences in likelihood of hospitalization in different age groups.

The cost of soccer injuries, which only account for U.S. ED visits in this study and neglects other costs such as outpatient primary care visits, physical therapy, occupational therapy, home

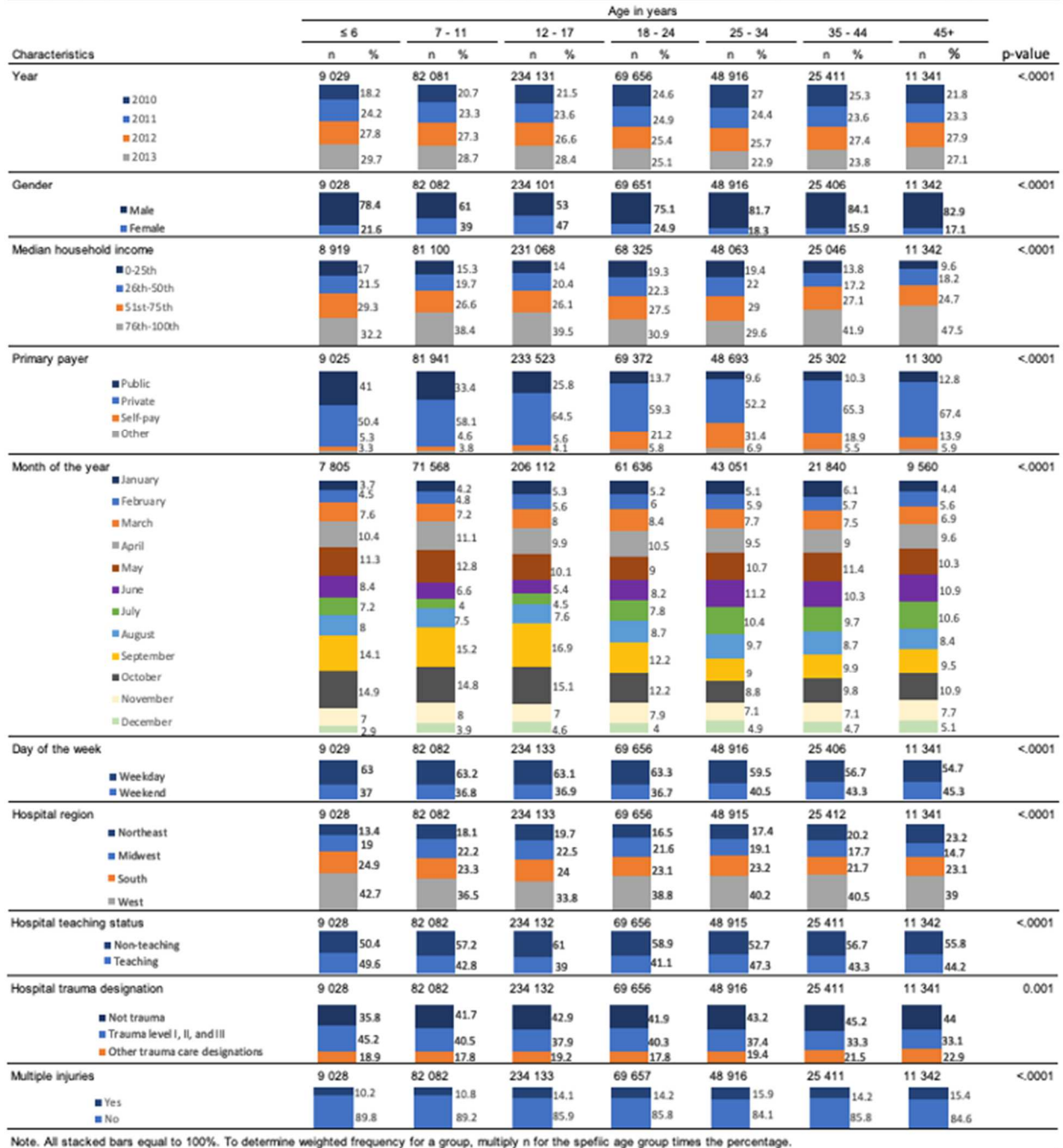
health nursing care, among others, are a financial burden to the public; with youth soccer players between 12-17 y/o accounting for a large number of ED visits and charges. To our knowledge, no other study has analyzed soccer-related U.S. ED visit charges in different age groups, which is a unique contribution of this analysis. Soccer-related U.S. ED visits charges totaled more than \$700 million over a four-year period, with 12-17 y/o nearing \$318 million of the total charges. Generally, the average annual charges were \$180 million for all soccer-related visits. The largest proportion of charges were for ED services, rather than inpatient services, but there was some difference between age groups. For example, in the 45+ age category, inpatient charges accounted for nearly half of the total charges. These analyses provide a glimpse of the financial impact of soccer-related visits; however, members of the soccer community, clinicians, and policy makers should approach this with caution since additional charges (e.g. outpatient treatment and care, rehabilitation) as well as lost productivity are not accounted in these analyses.

These data presented analytic challenges that limit the findings. These analyses only allowed for a general snapshot of soccer-related ED visits, it ignores soccer participation in the general population that can provide rate of injury for soccer players. The administrative data and descriptive design of the analyses only allows for a cross-sectional snapshot of variables, without directionality of causation between variables. Furthermore, the analyses do not control for the effects between variables that often results from adjusted regression analyses. The data also account only for soccer-related ED visits, and does not capture soccer injuries that do not present to the ED. For example, some injured soccer players may seek out urgent and primary care clinics, while some may not seek healthcare at all. In addition, some effects reported may be due to factors unmeasured, such as change in insurance coverage that made ED visits more feasible for some families. For example, we cannot separate the possibility that soccer injuries deserving an ED visit increased from greater access to services provided by the ACA. As a result, although these analyses provide a clear snapshot of soccer-related injuries leading to ED visits in different age groups, this snapshot underestimates the prevalence of injuries and extent of injuries

experienced by soccer players. It should also be noted that excessively low or high charges, were set as inconsistent, which may grossly further underestimate the true cost of soccer related ED visits.

To conclude, this work provided a general description of soccer-related ED visits across age groups between 2010 and 2013. The study also provided disposition of soccer players once they visit an ED after an injury, as well as the charges for ED and inpatient services in the different age categories. The findings helped better understand the presentation of soccer injuries and how resources can be allocated to minimize charges in certain age groups. However, additional research is needed that focuses on multi-level adjusted regression models in different age groups, which can uncover preventable aspects of soccer injuries amenable to targeted intervention based on age.

Figure 1. Descriptive presentation of sociodemographic, geographic and health care resources for a population-based sample of patients presenting to U.S. Emergency Departments for evaluation and care of soccer related injuries by age categories, from 2010 to 2013 (weighted case estimates and proportional



Note. All stacked bars equal to 100%. To determine weighted frequency for a group, multiply n for the specific age group times the percentage.

Figure 2. Nationally representative weighted *proportional distribution* of 1) disposition, treat and release versus not -- pie chart, and 2) Not treat and release emergency department (ED) visits that were hospitalized in same hospital, hospitalized in same hospital, or transferred to another hospital -- stacked bar, in soccer players that visited U.S. ED's for an injuries during soccer play, from 2010 to 2013: Nationwide Emergency Department Sample. P-value < .0001

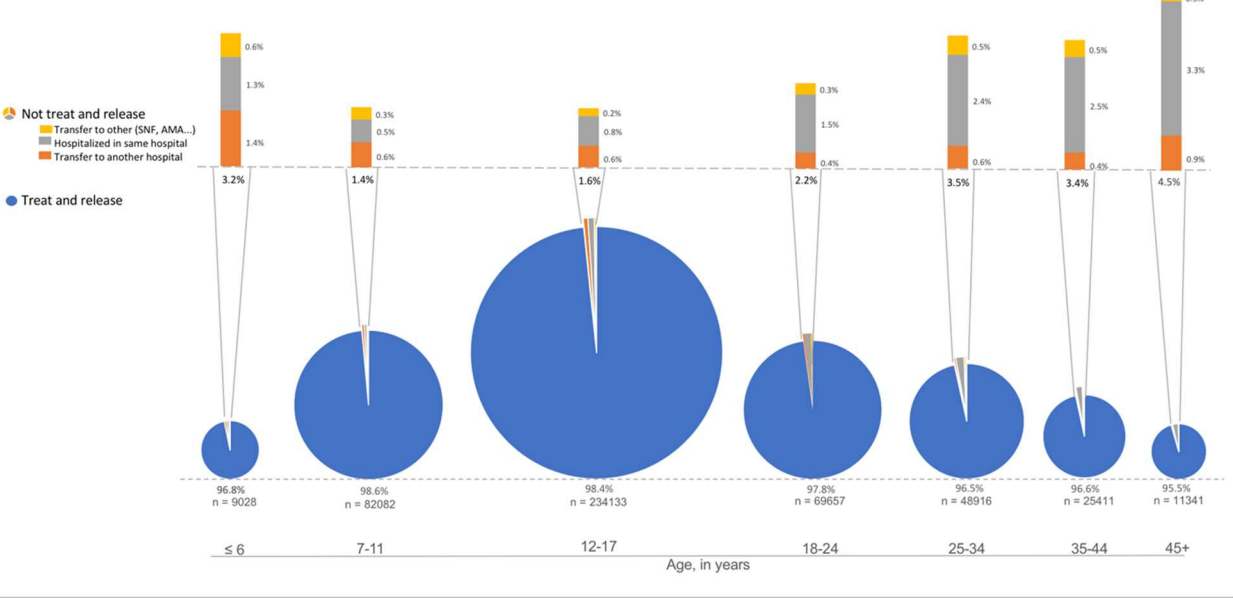
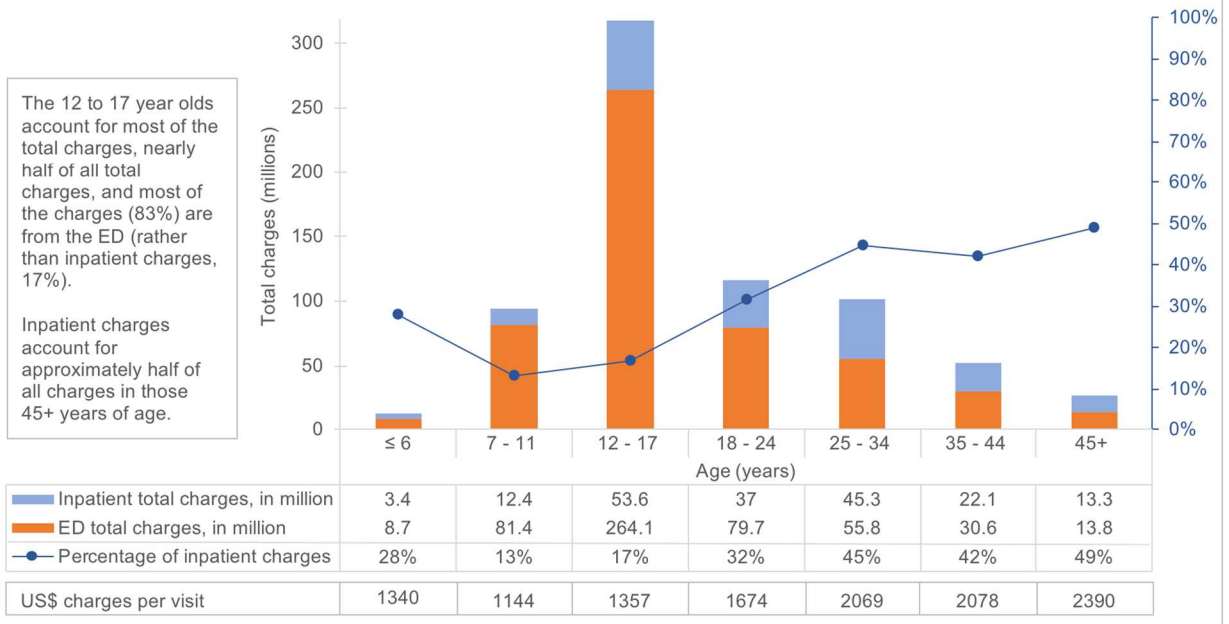


Figure 3. Soccer-related emergency department (ED) visits inpatient and ED charges by age categories for a population sample presenting to U.S. ED's from 2010 to 2013



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Chapter 3

Soccer-related injuries disposition in U.S. emergency departments:

Nationwide Emergency Department Sample, 2010 to 2013

Soccer-related injuries are a health and healthcare concern in the United States (U.S.), and this concern may be growing with increased participation. Soccer participation has reached 265 million across the globe, nearly 4% of the entire world population. In the U.S. the participation has grown more than 88% to more than 24 million participants over a 24 year period (1-5). In general, soccer-related injuries account for more than 123,000 – 145,000 emergency department (ED) visits annually, with a rate of 2.36 injuries per 1,000 player, and an average of over 1,000 annual hospitalizations, with males nearly 59% more likely to be hospitalized than females, OR = 1.59; 95% CI: 1.39, 1.81 (6-8). Considering the increased participation in U.S. soccer and the impact of injuries associated with participation, it is important to describe the breadth and scope of health and healthcare outcomes that are attributed to soccer (injuries) among those presenting to U.S. EDs, including hospitalization, cost, and length of stay, with special interest in patient-level and hospital-level features, as well as geographic region, population density, mechanism of injury, and place of injury effects on outcomes.

To analyze soccer-related injury ED visits that include age, gender, income, anatomic sites, diagnostic outcomes, and external causes of injury (individual cofactors), as well as hospital treatment centers, geographic and population density features in domestic hospital-affiliated ED'S, data collected by the U.S. Healthcare Cost and Utilization Project (HCUP), Nationwide Emergency Department Sample (NEDS) were evaluated. NEDS has been described extensively in peer-reviewed articles as well as reports (9, 10). Briefly, NEDS data are from a stratified probability-weighted data that represent the US populations presenting to ED. NEDS captures ED visits that do not result in hospitalization as well as those that result in hospitalization. NEDS

also captures individual- and hospital-characteristics, such as hospital ownership, trauma designation, teaching status, geographic region, and population density, and accounts for these characteristic differences by providing a clustering and stratum variable that can be used when performing the analyses; a weight variable is provided for national U.S. estimates.

To fill the gap in the literature, the primary purpose of this study was to describe and establish independent predictors of soccer-related injury ED visits resulting in hospitalization (vs not) across individual cofactors, treatment center characteristics, geographic regions and population density, as well as mechanism of injury and place of injury. A secondary purpose was to describe ED charges, inpatient charges, and hospital length of stay in soccer injuries. The aim is to determine features of soccer-related injuries amenable to injury prevention strategies to reduce cost and healthcare utilization across the U.S. ED's.

Methods

An Institutional Review Board exemption to conduct a secondary analysis was obtained from the University of California, Los Angeles (2017; IRB#17-000777).

Study design and sample

The study examined emergency department visits that did not result in hospitalization as well as those that resulted in hospitalization for soccer-related visits from the Nationwide Emergency Department Sample (NEDS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality (9). The study design and sample have been described extensively elsewhere in a peer-viewed article (11). In brief, this is a multi-year cross-sectional population-based study. NEDS is national representative sample of hospital-affiliated ED's across the U.S. NEDS collects administrative data of U.S. ED's, then clusters and stratifies ED's by U.S. regions, population density, and hospital-characteristics; a 20% sample from clustered and stratified ED records are randomized for data extraction and available to

researchers. All records of the 20% sample are extracted, and a weight variable provided for national estimates of all U.S. ED visits. NEDS also provides International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM), including ≤ 15 ICD-9 diagnostic outcomes and ≤ 4 external cause of injury codes (E-codes). In this study, any ED visit with an ICD-9 E-code of E007.5 was identified as a soccer injury and included for analysis, all other visits were excluded.

Variables

The outcome variable was disposition from the ED: not-hospitalized versus hospitalized. The descriptor, independent, and predictor variables included individual- and hospital-level characteristics, as well as ICD-9 diagnostic designation, anatomical location of injury, mechanism of injury, and place of injury; these variables have been described extensively elsewhere (11). Briefly, characteristic variables include age, gender, median household income, primary payer, month and date of the injury, as well as different hospital characteristics. ICD-9 external cause of injury (e-codes) were used to determine the context (e.g. anatomical location, mechanism, and place) of the injury.

ED charges, inpatient charges, and hospital length of stay in soccer injuries were also of interest. Variables for total charges for ED services, and total inpatient charges have been described extensively elsewhere (11). Briefly, total charges are reported in U.S. dollars and include ED and inpatient charges of patients that came in through the ED, which excludes any direct inpatient admit charges. NEDS established length of stay by subtracting admission date by the discharge date, which means that same-day admission and discharge were coded as zero.

Analysis

For all analysis, a cluster and stratum variable were used to account for the effects of sampling; a weight variable was also used to allow for population-based U.S. national estimates of soccer injuries. SAS statistical software was used for data management and output of weighted frequencies, as well as sums, means, interquartile for charges and length of stay; these have also

been described extensively elsewhere (11). Tabular and descriptive analysis were used to report group means and standard error for continuous variables, and frequencies and percentages for categorical variables. Chi-squares were used to determine if there are significant differences between categorical variables on disposition, not-hospitalized vs. hospitalized. Significance was set at $p \leq 0.05$.

Adjusted logistic regression models were used to determine independent predictors of hospitalization (hospitalized vs. not hospitalized) among cases presenting to the ED following a soccer-related injury in the U.S. An age category variable was included in the model: ≤ 6 years of age (y/o), 7-11 y/o, 12-17 y/o, 18-24 y/o, 25-34 y/o, 35-44 y/o, 45-54 y/o, 55-64 y/o, and 65+ y/o. The reference group for year of ED visit was 2010, whereas the reference for all other variables (except injury diagnosis, injury location, mechanism of injury, and place of injury) were the group with greatest proportion of all soccer-related ED visits. Injury diagnosis, injury location, mechanism of injury, and place of injury are binary variables (yes vs no), for these variables the cases categorized as “no” were the reference group. Odds ratios estimates along with 95% confidence intervals were reported. A 5% level of significance (LOS, $\alpha < 0.05$) was used to identify independent predictors.

Results

A total of 480,581 weighted- visits of U.S. soccer players for soccer-related injuries were identified and analyzed from 2010 to 2013.

Descriptive and bivariate analyses: Disposition

General descriptive statistics showed soccer-related ED visits increased yearly, although the increase was not significant, ranging from approximately 2-11% increase each year from 2010 to 2013 (Table 1). Soccer-related injury visits presenting to the US ED's encountered over a 20%

increase over a four-year period, 2010 to 2013. The data also show that, between 2010 and 2013, 98.1% to 98.3% of soccer-related ED visits were treat-and-release. Male patients were more than two-fold likely to be hospitalized than females.

Characteristics	Not Hospitalized		Hospitalized		P-value
	n	Column %	n	Column %	
All ED visits	472155		8426		
Year					0.87
2010	106126	22.5%	2025	24.0%	
2011	112535	23.8%	1980	23.5%	
2012	125364	26.6%	2146	25.5%	
2013	128130	27.1%	2275	27.0%	
Gender					< 0.0001
Male	297465	63.0%	6710	79.7%	
Female	174638	37.0%	1712	20.3%	
Median Household Income					0.17
0-25th percentile	71822	15.4%	1444	17.5%	
26th-50th percentile	95124	20.4%	1742	21.1%	
51st-75th percentile	124657	26.8%	2226	27.0%	
76th-100th percentile	173693	37.3%	2844	34.4%	
Primary Payer					< 0.0001
Public	108008	22.9%	1663	19.8%	
Private	288686	61.3%	4733	56.3%	
Uninsured	52255	11.1%	1312	15.6%	
Other	21807	4.6%	705	8.4%	
Day of the week					0.0076
Weekday	294122	62.3%	4967	58.9%	
Weekend	178028	37.7%	3459	41.1%	
Hospital region					0.02
Northeast	89047	18.9%	990	11.7%	
Midwest	101136	21.4%	1945	23.1%	
South	110980	23.5%	2083	24.7%	
West	170992	36.2%	3408	40.4%	
Hospital Teaching status ⁺					0.03
Metropolitan non-teaching or non-metro	277421	58.8%	4428	52.6%	
Metropolitan teaching	194734	41.2%	3998	47.4%	
Hospital Trauma Designation					< 0.0001
Not trauma	202044	42.8%	2629	31.2%	
Trauma level I, II, and III	179935	38.1%	4686	55.6%	
Non-trauma and trauma level III	90175	19.1%	1112	13.2%	
Hospital Location					0.13
Not micropolitan or metropolitan	11423	2.4%	158	1.9%	
Micropolitan (urban core ≥ 10,000 residents)	29564	6.3%	371	4.4%	
Metropolitan, large and small (>1 million)	421505	89.6%	7745	91.9%	
Small metropolitan and micropolitan ⁺⁺	7739	1.6%	104	1.2%	
Non-metropolitan, micropolitan/non-urban ^{**}	154	0.0%	47	0.6%	
Injury diagnosis ^{***}					
Concussion (vs no)	28123	6.0%	528	6.3%	0.63
Intracranial injuries (vs no)	400	0.1%	275	3.3%	< 0.0001
Fractures (vs no)	106107	22.5%	5421	64.3%	< 0.0001
Dislocation (vs no)	16232	3.4%	321	3.8%	0.44
Sprains and strains (vs no)	159218	33.7%	588	7.0%	< 0.0001
Internal injuries (vs no)	343	0.1%	552	6.6%	< 0.0001
Wounds (vs no)	32619	6.9%	324	3.8%	< 0.0001
Superficial injuries (vs no)	7454	1.6%	173	2.1%	0.12
Contusions (vs no)	87982	18.6%	526	6.2%	< 0.0001
Unspecified (vs no)	69315	14.7%	465	5.5%	< 0.0001
Injury Location					
Head and neck (vs no)	102505	21.7%	1672	19.8%	0.08
Trunk (vs no)	21048	4.5%	865	10.3%	< 0.0001
Upper extremities (vs no)	130989	27.7%	1705	20.2%	< 0.0001
Lower extremities (vs no)	205344	43.5%	4043	48.0%	0.001
Unspecified (vs no)	5047	1.1%	75	0.9%	0.47

Mechanism of injury					
Fall (vs no)	99214	21.0%	2579	30.6%	< 0.0001
Struck by hit or thrown ball, no fall (vs no)	188917	40.0%	3062	36.3%	0.005
Struck by hit or thrown ball, with fall (vs no)	27460	5.8%	992	11.8%	< 0.0001
Place of injury					
Home (vs no)	7976	1.7%	134	1.6%	0.73
Recreational/Sports facility (vs no)	227100	48.1%	4489	53.3%	0.02
Street/Highway (vs no)	1046	0.2%	27	0.3%	0.37
Public institution (e.g. school) (vs no)	17895	3.8%	294	3.5%	0.53
Residential institution (vs no)	831	0.2%	130	1.5%	< 0.0001
Other (e.g. beach) (vs no)	16255	3.4%	286	3.4%	0.93
‡ = non-metropolitan hospitals collapsed into non-teaching, as teaching hospitals are rare in non-metropolitan areas; ‡ ‡ = NEDS collapsed category to maintain confidentiality; *** Individual patients often presented with >1 diagnosis; Bold = p ≤ 0.05					

Data demonstrate that weekend play increased the likelihood of hospitalization following a soccer-related ED visit (Table 1). The data showed ED visits related to soccer injuries are 15% more likely to result in hospitalization if it occurs in the weekend, when compared to weekday injuries. Although the day of the week may influence disposition, hospital level differences may also be contributors.

Data also showed significant differences in hospital-level characteristics (Table 1). For example, characteristics of injuries vary over hospital region, hospital teaching status, and trauma designation. The West (vs other regions) region of the US encountered 6-18% greater likelihood of soccer-related ED visits, and trauma designated (vs non-trauma) hospitals had a nearly 2-fold greater likelihood of being hospitalized, whereas non-teaching designated hospitals (vs teaching) demonstrated 0.78 times less likely to be hospitalized. These preliminary results hint at the need to include hospital level characteristics as well as injury diagnosis.

Sprains and strains accounted for the greatest proportion of soccer-related U.S. ED visits, 33.25%, followed by fractures (23.21%) and contusions (18.42%), respectively (Table 1). However, sprains and strains injuries were disproportionately less likely to be hospitalized. For example, those diagnosed with sprains and strains were 5-fold less likely to be hospitalized than concussion diagnosis; the same was not seen among fractures, where 64.3% were hospitalized, which was 13-fold higher than sprains and strains. Interestingly, although there was only a small proportion of intracranial injuries and internal injuries presenting to the ED, 0.1% and 0.2%,

respectively, they were 110-fold and 167-fold more likely to be hospitalized when compared to sprains and strains. These subpopulations merit a greater in-depth analysis to determine clinical presentation, mechanism of injury and circumstances surrounding the injuries that lead to ED visits and likely hospitalization.

There are some differences in hospital- vs. treat-and-release disposition between anatomical injury sites (Table 1). The greatest proportion of ED soccer-related ED injuries were located in the lower extremity (LE), 43.57% of all injuries. Although LE injuries had the highest proportion (48%) of hospitalization, injuries to the trunk were two-fold more likely to be hospitalized when compared to LE. It is interesting to note that trunk injuries follow similar pattern as internal injuries. Also, unexpectedly, head and neck injuries were 20% less likely to be hospitalized when compared to LE. This may be a result of the public's greater caution taken when a head and neck injury is suspected, and attending the ED visit more readily. Regardless, the effects of all injury locations will be considered when assessing predictive models of ED disposition (hospitalized vs not hospitalized).

Descriptive analyses: Charges and length of stay

Estimates suggested soccer-related injuries cost more than \$700 million U.S. dollars over 4 years, 2010 to 2013 (Table 2). Interestingly, nearly 75% of the cost, over U.S. \$521 million in the 4-year period, of soccer-related injuries resulted from treat-and-release ED visits. The mean of total ED charges was highest among hospitalized ED soccer-injured patients, compared to those not hospitalized from 2010 to 2013: ranging from US\$2,117-US\$2,425 (Hospitalized) and US\$1,415-US\$1,770 (Not-hospitalized), respectively. Furthermore, for those hospitalized, the mean total charges, including ED and inpatient charges, ranged from U.S. \$30,607 to \$36,434 dollars, approximately 15-times higher than mean ED charges, which reflects the higher cost of inpatient admissions. In addition to the cost of hospitalization, hospitalized patients with soccer-

related injuries can expect to remain inpatient for approximately 2 days, with a mean length of stay range of 2.42 days to 2.75 days across the 4-year period, 2010-2013 (Table 2).

Table 2. Descriptive statistics of soccer-related injuries utilization and charges for ED visits and hospitalization in the U.S. from 2010 to 2013: Nationwide Emergency Department Sample

Characteristics	Year			
	2010	2011	2012	2013
Not-hospitalized soccer-related ED visits				
Total ED charges, \$ million (SE)	108.5 (6.9)	114.1 (8.5)	138.5 (10.3)	160.6(12.7)
Mean, \$ (SE)	1,415 (36)	1,446 (41)	1,587 (67)	1,770 (87)
Median, \$ (IQR low: high)	1,079 (729: 1,591)	1,101 (704: 1,673)	1,150 (756: 1,814)	1,288 (785: 2,013)
Hospitalized soccer-related ED visits				
Total ED charges, \$ million (SE)	2.6 (0.28)	3.1 (0.44)	3.2 (0.37)	3.7(0.46)
Mean, \$ (SE)	2,117 (159)	2,241 (187)	2,425 (216)	2,342 (216)
Median, \$ (IQR low: high)	1,458 (924: 2,527)	1,566 (962: 2,532)	1,645 (1,049: 2,715)	1,813 (1,064: 2,539)
Total inpatient charges, \$ million (SE)	43.0 (4.9)	45.0 (5.2)	50.0 (5.9)	50.0 (5.4)
Mean, \$ (SE)	30,607 (2,307)	35,150 (2,103)	36,434 (4,228)	35,368 (2,640)
Median, \$ (IQR low: high)	22,036 (12,068: 37,392)	27,081 (15,239: 45897)	26,603 (15,055: 44,504)	26,552 (16,143: 44,075)
Length of stay				
Mean, days (SE)	2.52 (0.19)	2.75 (0.17)	2.42 (0.15)	2.44 (0.22)
Median, days (IQR low: high)	1.32 (0.52: 2.52)	1.52 (0.68: 2.78)	1.28 (0.51: 2.39)	1.34 (0.50: 2.47)

SE = standard error; IQR = Inter-quartile range; ED = Emergency Department; \$ = U.S. dollar

Adjusted logistic regression models: Disposition

Adjusted logistic regression models demonstrated differences in hospitalization as it relates to gender, primary payer, hospital trauma designation (Figure 1), injury diagnosis, injury location, mechanism of injury, and place of injury (Figure 2). Males were nearly 2-fold more likely to be hospitalized compared to females. Soccer players with other form of payment were 68% more likely to be hospitalized compared to those with private insurance; once models were adjusted, differences were not noted between public insurance and uninsured compared to private insurance. Injury diagnoses more likely to be hospitalized compared to not having that diagnosis were dislocation (67%), concussions (67%), intracranial injuries (59-fold), fractures (5.74-fold), and internal injuries (86-fold); least likely to be hospitalized were sprains and strains (3.44-fold), wounds (58%), and contusions (2.12-fold). Upper extremities were 3.7-fold less likely to be hospitalized than those without upper extremity injuries. Soccer players that experienced an

injury due to a fall, struck by hit or thrown ball with subsequent fall, or in a residential institution, which ranges from dormitories and boarding schools to prisons, were more likely to be hospitalized than those without a fall, not struck by hit or thrown ball with subsequent fall, or not in a residential institution, 2.33-fold, 2.71-fold, and 7.04-fold respectively.

Discussion

The study (1) described soccer-related injury ED visits in non-hospitalized and hospitalized soccer players, and established independent predictors of hospitalization, as well as (2) described ED charges, inpatient charges, and hospital length of stay of injured soccer players that attended to a U.S. ED after an injury. The findings allowed us to determine features of soccer-injuries that can be used to establish targeted injury prevention strategies to reduce cost and ED utilization in the U.S.

In general, soccer players that seek ED services are treated and released from the ED, while a small percentage are hospitalized. Over a four-year period, from 2010 to 2013, 98.1% to 98.3% of soccer players were treated and released from the ED, whereas only 1.7% to 1.9% of soccer players were hospitalized, suggesting an over-use of US ED's for soccer-related injuries, which may easily be addressed in other less costly settings, such as outpatient clinics or soccer-field. These findings are similar to other findings of disposition of ED visits of soccer players following an injury during soccer play, with authors reporting 2% or less of the ED visits resulting in hospitalization (6, 8, 12, 13). The findings from these and other studies suggest that perhaps the soccer community may be over-utilizing the ED for injuries that can be treated in less costly settings, such as outpatient clinics or on-the-field, which can reduce healthcare costs to the public and overcrowding of ED's.

Soccer-related injuries come at a high financial and resource cost related to ED and hospital inpatient services. To the authors knowledge, there are no studies that have analyzed a

population database of ED and inpatient charges to soccer players that sought ED services following a soccer-related injury. Surprisingly, soccer injuries cost the public more than \$700 million dollars over a four-year period, but it is worth noting that these charges only accounted for ED visits and neglect other forms of healthcare utilization, such as ambulatory surgery, physical therapy, and occupational therapy, to name a few. As expected, mean inpatient charges were much higher, 15-fold, than ED charges, which reflects the higher cost of inpatient admissions. Also, in practical terms, the high cost of hospitalization after a soccer-related injury can ruin financial stability of patients with substandard health insurance coverage or without coverage. Although the length of stay helps capture healthcare utilization, it is limited to hospital use and does not capture any outpatient follow-up visits or rehabilitation visits, which will add to resource utilization and cost. Additionally, lost productivity is not taken into account in the analysis due to data limitations. However, it is important to note that lost productivity due to soccer-related injuries will increase financial burden to the individual and the public, which merits further consideration of cost analysis.

Adjusted logistic regression models showed an age effect on hospitalization. Generally, the likelihood of hospitalization increased with age, with the exception of youngest soccer players; which can be described as bimodal with the oldest and youngest being more likely to be hospitalized. For example, those 65+ y/o were more than 8-fold more likely to be hospitalized than 12-17 y/o, whereas 7-11 y/o were 33% less likely to be hospitalized than 12-17 y/o. As part of the bimodal vulnerability, those ≤ 6 y/o, which were 60% more likely to be hospitalized than soccer player 12-17 y/o. A study of pediatric soccer-related ED visits also found that younger children, in that study ≤ 4 y/o, were more likely to be hospitalized than older children (8). However, interestingly, others that investigated soccer-injuries in children and adults have found that soccer-related injury hospitalization percentage does not progressively increase with age and varies between males and females. For example, males hospitalization percentage starts to

progressively dip in childhood and begins to increase for those 20-24 y/o, peaks at 25-29 y/o, and again begins to dip up to 40 to 44 y/o, until the greatest peak is reached in those 45-49 y/o; for females, hospitalization percentage starts to progressively dip in childhood, then finds a small peak in those 15-19 y/o, and again begins to dip up to 25-29 y/o, until it suddenly spikes and reaches the greatest peak in those 30-34 y/o, and again progressively dips without increasing again (7). The differences in results between other studies and this study may be due to age categories chosen and statistical methods used; other authors categorized ages into smaller ranges and gender, which may allow to see more subtle differences of hospitalization in different groups. It should also be noted that their analyses were descriptive percentages, where this study used adjusted logistic regression models that could change the effects of age on hospitalization after adjusting for other variables. Nevertheless, there seems to be an age effect on hospitalization for soccer injuries, as well as gender.

Adjusted regression models showed a gender effect on hospitalization; males were more likely to be hospitalized. Male soccer players presenting to the ED after an injury during soccer play were more than two-fold likely to be hospitalized than female soccer players. These results are consistent with current peer-reviewed articles that analyzed the hospitalization differences between males and females using different age categories; males consistently show higher likelihood of hospitalization after sustaining a soccer injury (7, 8, 14). These results suggest that 1) males are attending the ED with more severe injuries, which may require injury prevention programs that are tailored to minimize the severity of injury, or 2) females are more likely to attend the ED for injuries that may not require hospitalization, which suggests that access to less costly settings may be beneficial, while considering injury diagnosis, mechanism of injury, and place of injury as these may modify the odds of hospitalization.

Some types of injury diagnosis, mechanism of injury, and place of injury showed increased hospitalization odds, while others showed decreased odds after regression models adjusted for other variables. Diagnostic outcomes such as concussions, intracranial injuries, fractures, and

internal injuries significantly increased the odds of hospitalization, suggesting that greater attention should be given to these diagnoses to reduce disability, healthcare utilization and financial cost. Generally, it seems that sprains and strains, wounds, and contusions may be cared for in other settings, rather than the ED as they are often treated and released from the ED. Soccer players that experienced an injury due to a fall, struck by hit or thrown ball with subsequent fall experienced increased odds of hospitalization. More research is warranted to determine which soccer players are experiencing falls during soccer play, e.g. older adults, and how the falls occur. Unfortunately, no research was found that analyzed odds of hospitalization between diagnostic outcomes, and mechanism of injury (e.g. falls), which limited the ability to assess the results of this study to others. Similar to these findings, others have found that residential institutions had a higher odd of hospitalizations after a soccer injury when compared to other locations of play (15).

Limitations

The limitations related to the use of secondary data analysis of the NEDS have been explained elsewhere (11). Briefly, cross-sectional secondary analysis of administrative data does not allow determination of directionality of causation between variables. In addition, the data do not capture injuries of soccer players that do not attend to the ED and seek other forms healthcare or do not seek care; this underestimates the prevalence of soccer injuries, and data do not account for different forms of soccer play (e.g. indoor, futsal, grass). Nevertheless, the findings contribute to the literature of soccer injuries that result in ED visits.

In conclusion, the study contributed to the body of knowledge of soccer-related injuries; specifically, it provided descriptors and independent predictors of hospitalization (vs not) of soccer players that attended an ED after an injury. The study uniquely provided evidence of odds of hospitalization for diagnostic outcomes. It also provided a general understanding of ED charges, inpatient charges, and hospital length of stay of injured soccer players that sought ED services. In general, the findings paved the way for additional research that can further hone on targeted

variables amenable to interventions that can prevent soccer injuries, improve health outcomes, lessened healthcare utilization and reduce financial cost to the public.

Figure 1. Adjusted odds ratios of hospitalization (vs not) for sociodemographics, payer status, and hospital characteristics of soccer players visiting the US Emergency Departments following a soccer-related injury from 2010 to 2013: The Nationwide Emergency Department Sample.

Characteristics	OR	95% CI		Less likely to be hospitalized		More likely to be hospitalized	
		Low	High	0.1	1	1	10
Year							
2010	Ref						
2011	0.93	0.73	1.19				
2012	0.91	0.72	1.16				
2013	0.99	0.77	1.26				
Age							
≤ 6 years of age	1.60	1.19	2.14				
7-11 years of age	0.75	0.63	0.90				
12-17 years of age	Ref						
18-24 years of age	1.12	0.96	1.31				
25-34 years of age	1.69	1.44	1.98				
35-44 years of age	1.78	1.46	2.19				
45-54 years of age	2.40	1.81	3.19				
55-64 years of age	1.78	1.00	3.18				
65+ years of age	8.82	4.86	16.01				
Gender							
Male	Ref						
Female	0.51	0.44	0.59				
Median Household Income							
0-25th percentile	1.03	0.85	1.25				
26th-50th percentile	0.98	0.82	1.17				
51st-75th percentile	0.98	0.84	1.15				
76th-100th percentile	Ref						
Primary Payer							
Public	0.89	0.75	1.07				
Private	Ref						
Uninsured	1.06	0.88	1.29				
Other	1.68	1.29	2.18				
Day of the week							
Weekday	Ref						
Weekend	1.14	1.02	1.27				
Hospital region							
Northeast	0.59	0.45	0.76				
Midwest	0.86	0.55	1.36				
South	0.99	0.83	1.17				
West	Ref						
Hospital Teaching status *							
Metropolitan non-teaching or non-metro	Ref						
Metropolitan teaching	1.02	0.73	1.42				
Hospital Trauma Designation							
Not trauma	Ref						
Trauma	2.03	1.54	2.69				
Non-trauma and trauma level III	0.90	0.71	1.15				
Hospital Location							
Not micropolitan or metropolitan	1.34	0.87	2.06				
Micropolitan (urban core ≥ 10,000 residents)	1.11	0.78	1.59				
Metropolitan, large and small (>1 million)	Ref						
Small metropolitan and micropolitan	0.46	0.27	0.77				
Non-metropolitan, micropolitan/non-urban	1.06	0.25	4.43				

Figure 2. Adjusted odds ratios of hospitalization (vs not) for injury diagnosis, injury location, mechanism of injury, and place of injury of soccer players visiting the US Emergency Departments following a soccer-related injury from 2010 to 2013: The Nationwide Emergency Department Sample. Analyses were also adjusted for sociodemographics, payer status, and hospital characteristics. All variables were dichotomous (yes vs no), reference group for adjusted regressions was "no"

Characteristics	OR	95% CI		Less likely to be hospitalized		More likely to be hospitalized	
		Low	High	0.1	1	1	10
Injury diagnosis							
Concussion (ref: no)	1.67	1.17	2.39				
Intracranial injury, except concussion (ref: no)	59.15	35.45	98.68				
Fractures (ref: no)	5.74	3.98	8.28				
Dislocation (ref: no)	1.67	1.17	2.37				
Sprains and strains (ref: no)	0.29	0.21	0.39				
Internal injuries (ref: no)	86.60	50.40	148.80				
Wounds (ref: no)	0.63	0.45	0.88				
Superficial injuries (ref: no)	1.55	1.03	2.32				
Contusions (ref: no)	0.47	0.34	0.65				
Unspecified (ref: no)	0.50	0.35	0.72				
Injury Location							
Head and neck (ref: no)	0.96	0.65	1.41				
Trunk (ref: no)	1.16	0.77	1.75				
Upper extremities (ref: no)	0.27	0.17	0.41				
Lower extremities (ref: no)	1.36	0.94	1.97				
Unspecified (ref: no)	1.83	1.04	3.23				
Mechanism of injury							
Fall (ref: no)	2.33	1.95	2.78				
Struck by hit or thrown ball, no subsequent fall (ref: no)	1.18	1.02	1.38				
Struck by hit or thrown ball, subsequent fall (ref: no)	2.71	2.19	3.35				
Place of injury							
Home (ref: no)	0.99	0.61	1.61				
Recreational/Sports facility (ref: no)	1.35	1.01	1.82				
Street/Highway (ref: no)	1.71	0.68	4.31				
Public institution (e.g. school) (ref: no)	1.27	0.89	1.82				
Residential institution (ref: no)	7.04	3.94	12.58				
Other (e.g. beach) (ref: no)	1.10	0.68	1.80				

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