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Inpatient and emergency department costs from sports injuries among youth aged 5–18 years

Jessica L Ryan,[1] Etienne E Pracht,[2] Barbara Langland Orban[2]

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[1]Health Sciences and Administration, University of West Florida College of Science Engineering and Health, Pensacola, Florida, USA
[2]Health Policy and Management, University of South Florida, Tampa, Florida, USA

Correspondence to
Dr Jessica L Ryan;
jryan@uwf.edu

ABSTRACT

Objective To analyse the financial costs from sports injuries among inpatients and emergency department (ED) patients aged 5–18 with a focus on Medicaid patients.

Methods Fixed-effects linear regression was used to assess the association of patient factors with cost of injury from sports. Florida Agency for Health Care Administration data from 2010 to 2014 were used, which included all inpatient and ED patients aged 5–18 years who had a sports injury.

Results Over 5 years, sports injuries in Florida youth cost $24 million for inpatient care and $87 million for ED care. Youth averaged $6039 for an inpatient visit and $439 for an ED visit in costs from sports injuries. Sports injuries for Medicaid-insured youth cost $10.8 million for inpatient visits and $44.2 million for ED visits.

Conclusion Older athletes and males consistently have higher healthcare costs from sports. Baseball, basketball, bike riding, American football, roller-skating/skateboarding and soccer are sports with high costs for both ED patients and inpatients and would benefit from prevention programmes. Injuries from non-contact sport participants are few but can have high costs. These athletes could benefit from prevention programmes as well.

What are the new findings

- Scope of sports injury costs for youth in Florida.
- Differences in healthcare costs of sports injuries between populations.
- Differences in healthcare costs of sports injuries between sports.

How it might impact on clinical findings in the near future

- Injury prevention programmes for athletes may need to be targeted differently.
- Non-contact sport participants may need specific injury prevention and recovery programmes.

INTRODUCTION

The cost of sports injuries in youth is substantial[1–6]; from 2000 to 2003, hospitalisations from youth sports injuries in the USA annually cost between $113 and $133 million.[7] Identified research gaps include the scope of costs and differences between populations.[3 7–9]

The purpose of this research was twofold. The first objective was to estimate the medical costs from sports injuries among inpatient and emergency department (ED) youth patients in Florida. The second objective was to analyse patient factors associated with cost to aid in assessing the magnitude of the problem and who is most vulnerable.

In 2012, Finch argued that one of the key reasons public health prevention programmes have not been implemented at a policy level is lack of data about the size and scope of the problem—specifically information on which groups are at risk, effective and cost-effective prevention programmes, medical treatments, cost measurements, and policy implications.[10] Finch listed three questions to determine if an issue needs to be put on a government public health agenda: (1) Is the problem large enough? (2) Which of the community members are most vulnerable? (3) Why should the government be concerned?[10] Population-level injury prevention strategies have not been applied to sport activities, resulting in current research citing a critical need to prioritise sports injury prevention in children under 15 years of age.[1 5 11 12]

An estimated 30–45 million youths in the USA play recreational and competitive sports.[13] Sports are encouraged for youth to promote physical activity and instil values such as teamwork and good sportsmanship, and many enjoy sports while gaining satisfaction and confidence from participating. However, some youth will be injured while participating in sports, with some seeking ED care or requiring hospitalisation, and a portion of these will be covered by Medicaid. In Florida, an estimated 1.7 million youth have Medicaid insurance.[14]

Approximately 3.5 million youth annually receive medical treatment for a sports injury,[15] and sports injuries account for 30%

of youth ED visits related to consumer products in the USA.[4] Previous research found that males have a higher risk of injury in team sports and females have a higher injury risk in individual sports.[16] In addition, white youth are at higher risk of sports injury.[17] Almost half (49%) of paediatric hospitalisations from sports injury were 15–18 years of age, 85% were male and 54% had a fracture.[7] Sports injuries typically have mild injury severity scores and low mortality rates; however, they can still lead to hospitalisation, disability, long-term health impact and high healthcare costs.[1 18 19] In addition, injuries acquired as youth may have a lifelong impact on a person's physical activity level and health.[6 20]

METHODS

The Florida Agency for Health Care Administration (AHCA) ED and inpatient data sets from 2010 to 2014 were used in this analysis. The data sets are mutually exclusive, so ED patients discharged into the inpatient unit of the same hospital are not included in the ED data. The data include demographic variables, up to 30 diagnoses, and external cause of injury codes (E-code) for patients who had an ED visit or admission to an acute care hospital. The AHCA also releases annual hospital financial data, which include ownership status, location and financial information. The hospital factors were merged with the patient data for each year so the model could control for differences in the 123 Florida hospitals.

Inpatient and ED patients between the ages of 5 and 18 who had a sports-related E-code were included in the analysis. Patients were categorised into age groups approximating various school divisions: elementary school included ages 5–10, middle school included ages 11–13 and high school included ages 14–18. Other patient demographics such as gender, race, ethnicity and payer type were used in this analysis. Payers are the insurance companies who pay for patients' healthcare. This study included the three main types of insurance for youth in the USA, which are commercial (private insurance companies), Medicaid (state-run insurance for youth in low-income families) and uninsured (the patient is responsible to pay their healthcare costs). Payer types and status are included in the model to capture potential differences in utilisation related to comprehensiveness of coverage and, by extension, the out-of-pocket price to the patient. For example, the uninsured may seek less care as a way to avoid paying full price at the time of delivery. Conversely, commercially insured patients may request more services as their out-of-pocket price at the time of delivery is reduced to copayment arrangements. The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) Injury Severity Score (ICISS) method was used to measure injury severity. ICISS ranges from 0 to 1, with unity indicating 100% survival and 0 implying 100% mortality. The lower the ICISS, the more severe the injury or combination of injuries. The severity variable used was ICISS multiplied by 100 in order for the model estimates to be more easily interpreted.

Patients who had an injury from a sport were identified using the following E-code fields: E006.x (individual sports), E007.x (team sports), E008.x (other sports), E886.0 (fall from sports), E917.0 (struck in sports) and E917.5 (struck and fall in sports). These include all ICD-9-CM codes that had 'sports' in the description. The inpatient data included 4658 observations and the ED data included 234 754 observations. Observations were omitted from the model analysis if they did not include an E-code for a specific, named sport, for example patients who were injured with an E-code of a general nature such as 'struck in sports' or 'other activity involving other sports'. Observations were also omitted from the model analysis if the patient did not seek treatment for one of the injuries defined in the Barell Injury Diagnosis Matrix. The Barell Injury Diagnosis Matrix is a commonly used tool in injury epidemiology that uses ICD-9-CM codes to classify injury by body region and nature of injury. Examples from those omitted observations included youth patients who were principally diagnosed with an unspecified episodic mood disorder or other cellulitis or abscess. One patient whose costs were 12 times higher than the average was omitted as a cost outlier. For the final analysis, the model included 2303 inpatient observations.

The sports E-codes were categorised according to the American Academy of Paediatrics' Committee on Sports Medicine and Fitness (2001).[21] The categories were full contact or collision sports, limited contact sports, and non-contact sports. The full contact sports group included observations with E-codes of E007.0 (American football), E007.2 (rugby), E007.4 (lacrosse/field hockey), E007.5 (soccer), E007.6 (basketball), E008.0 (boxing), E008.1 (wrestling) and E008.4 (martial arts). The limited contact group included E006.0 (roller-skating/skateboarding), E006.1 (horseback riding), E006.4 (bike riding), E007.1 (flag football), E007.3 (baseball), E007.7 (volleyball), E008.2 (racquet/hand sports) and E008.3 (Frisbee). The non-contact sports group included observations with E-codes of E006.2 (golf), E006.3 (bowling), E006.5 (jump roping) and E006.6 (non-running track and field).

The principal diagnosis code of the patients was used to create the nature of injury categories according to the Barell Injury Diagnosis Matrix. Injuries were categorised using the matrix into fractures of the skull, neck and trunk; other fractures; sprains and strains; internal; open wound; amputations; blood vessels; contusion/superficial; crush; burns; nerves; and unspecified according to the principal diagnosis code of the patient.[22] The reference group for the analysis included sprains and strains and contusion/superficial injuries. Burns, blood vessels, nerves, amputation and crush each accounted for well under 1% of the total observations. Therefore, these were added to the unspecified injury observations and this variable was called 'other injuries'.

Table 1 Demographics of financial costs for inpatient youth, 2010–2014

	Count	Inpatient: 2014 dollars	
Age		Average ($)	Sum ($)
Elementary school	639	4634	2 845 546
Middle school	1043	5457	5 598 898
High school	2479	6641	16 111 103
Gender			
Female	612	5738	3 402 635
Male	4046	6091	21 152 913
Race			
Black	1142	6571	7 418 243
Other	471	5855	2 687 512
White	3045	5831	14 449 792
Ethnicity			
Hispanic	747	5733	4 167 879
Non-Hispanic	3911	6106	20 387 668
Principal payer			
Medicaid	1767	6252	10 821 525
Uninsured	242	5433	1 282 299
Commercial	2649	5932	12 451 724
All inpatients	4658	6039	24 555 547

Table 2 Demographics of financial costs for ED youth, 2010–2014

	Count	ED: 2014 dollars	
Age		Average ($)	Sum ($)
Elementary school	43 586	342	12 724 455
Middle school	68 059	483	27 959 448
High school	122 747	449	46 399 569
Gender			
Female	51 786	327	14 076 603
Male	182 968	470	73 006 869
Race			
Black	64 849	582	33 270 537
Other	25 540	312	6 707 468
White	144 365	394	47 105 467
Ethnicity			
Hispanic	48 195	253	10 420 486
Non-Hispanic	186 559	488	76 662 986
Principal payer			
Medicaid	121 379	422	44 236 556
Uninsured	22 251	671	12 406 006
Commercial	91 124	406	30 440 910
All ED patients	234 754	439	87 083 472

ED, emergency department.

The inpatient cost model was analysed using a linear regression with residence county fixed effects, meaning the variables were analysed within each county to control for differences between counties. The dependent variable was cost of the hospital visit. This was calculated from the total charges of the visit as reported in the AHCA. The total charges were multiplied by each hospital's annual weighted cost-to-charge ratio to estimate the actual patient care cost. Cost-to-charge ratios are the reported total costs divided by the total revenue of each cost centre. Cost-to-charge ratios were calculated for each hospital for each year. The cost centre ratios were then combined for an annual weighted overall hospital cost-to-charge ratio. The costs found were then adjusted for inflation to 2014 dollars using the producer price indexes for hospital inpatient care and hospital outpatient care accordingly. The distribution of costs was highly skewed; therefore, the cost variable was transformed using the natural logarithm. Microsoft Excel 2016, Microsoft Access 2016 and SAS V.9.4 software were used in this analysis.

RESULTS

Sports injuries in youth aged 5–18 cost $24.55 million for inpatient care and $87 million for ED care in the state from 2010 to 2014. The cost of these sports injuries is broken down by demographics in table 1 for inpatient visits and table 2 for ED visits. The average cost of an inpatient visit was $6039. Sports injuries for Medicaid-insured youth cost $10.8 million for inpatient visits. The average cost of an ED visit for an injured youth from sport was $439. Sports injuries for Medicaid-insured youth cost $44.2 million for ED visits.

Tables 3 and 4 show the costs for inpatient and ED visits by sport E-code. For inpatient visits, the average cost per sport per visit ranged from $3231 (jump roping) to $28 366 (Frisbee). However, the Frisbee average was affected by the outlier observation. The next highest average cost was golf ($14 693), followed by volleyball ($12 370). American football had the highest total costs with a sum of almost $4.9 million.

For ED visits, the average ED cost per sport ranged from $189 to $655. Patients who had an E-code of 'struck in sports' had the highest average cost with $655 per injury, followed by golf ($628), fall from sports ($599) and horseback riding ($444). Correspondingly, 'struck in sports' also had the highest total cost of injury with $55.3 million over 5 years. American football had the second highest total ED costs with a sum of $11.5 million, followed by basketball with a sum of $8 million.

Table 5 provides the cost regression model of inpatient youth injured by sport, which had an overall model F value of 29 with a p value of <0.0001, meaning at least one of the predictor variables was significantly associated with cost. The r^2 for the model was 0.24. Nested models of each group of predictor variables were tested (demographics, sport, admission, injury type, injury severity and hospital factors) and all were found to be statistically significant. Younger age groups were associated with lower cost;

Table 3 Financial costs for inpatient youth by sports E-code, 2010–2014

	Count	Inpatient: 2014 dollars	
Full contact sports		Average ($)	Sum ($)
Basketball	364	5931	2 093 583
Boxing	7	4678	32 746
American football	852	5859	4 892 582
Lacrosse/Field hockey	22	5784	115 685
Martial arts	23	5423	124 737
Rugby	6	4017	24 106
Soccer	314	5502	1 639 706
Wrestling	95	7938	738 274
Limited contact sports			
Baseball	230	5063	1 139 159
Bike riding	249	7908	1 921 557
Flag football	46	5957	268 087
Frisbee	3	28 366	85 099
Horseback riding	63	6227	386 081
Racquet/Hand sports	4	6203	24 812
Roller-skating/Skateboarding	258	5592	1 425 874
School games	37	4745	166 081
Volleyball	20	12 370	321 621
Non-contact sports			
Bowling	3	4788	14 363
Golf	16	14 693	235 090
Jumping rope	2	3231	6462
Non-running track and field events	6	6633	33 165
Other			
Other sports played individually	245	6843	1 608 155
Other sports played as a team	64	5028	321 792
Other sports	108	8844	928 664
Mechanism			
Fall from sports	353	6470	2 245 043
Struck in sports	1383	5431	7 365 263
Struck in sports with fall	516	6177	3 131 919

E-code, external cause of injury code.

Table 4 Financial costs for ED youth by sport E-code, 2010–2014

	Count	ED: 2014 dollars	
Full contact sports		Average ($)	Sum ($)
Basketball	42 682	223	8 089 247
Boxing	533	247	111 090
American football	53 035	255	11 517 088
Lacrosse/Field hockey	1839	283	377 553
Martial arts	2253	242	466 115
Rugby	252	318	64 611
Soccer	19 458	248	3 994 243
Wrestling	5078	273	1 137 725
Limited contact sports			
Baseball	16 421	246	3 340 503
Bike riding	9806	337	2 814 189
Flag football	2310	269	524 042
Frisbee	182	201	31 705
Horseback riding	1088	444	403 776
Racquet/Hand sports	539	244	108 044
Roller-skating/Skateboarding	11 518	319	3 027 545
School games	2398	237	479 858
Volleyball	3894	224	690 352
Non-contact sports			
Bowling	281	189	44 228
Golf	346	628	160 109
Jumping rope	252	193	42 413
Non-running track and field events	136	218	25 947
Other			
Other sports played individually	2746	283	707 440
Other sports played as a team	2557	238	529 666
Other sports	1539	303	424 139
Mechanism			
Fall from sports	7479	599	3 497 997
Struck in sports	100 846	655	55 315 947
Struck in sports with fall	13 967	315	3 785 643

ED, emergency department; E-code, external cause of injury code.

elementary school were 27.4% less while middle school youth were 19.6% less compared with high school-aged youth. Females were found to have 10.0% lower costs than males. Elective and trauma admission were associated with 29.8% and 41.5% higher costs, respectively, compared with emergency admissions to the hospital. Increased ICISS, indicating lower severity, was associated with a 3.7% decrease in cost per ICISS unit. Non-contact sports had 57.9% higher costs per patient compared with contact sports.

DISCUSSION

Sports injuries to Florida youth aged 5–18 are associated with significant expense, totalling $112 million from 2010 to 2014. Annually, this equates to $22.3 million in healthcare costs in Florida alone and that is just for hospital care. The cost of all sports injuries for youth patients would probably be much higher if primary care, urgent care and specialist visits were included. High school-aged youth and males were two key groups that consistently

Table 5 Regression model of cost of inpatient youth injured in sport

		Parameter estimate	P value	Percentage change to cost (%)
Patient factors	**Elementary school***	**−0.320**	<0.0001	**−27.4**
	Middle school*	**−0.218**	<0.0001	**−19.6**
	Female*	**−0.105**	<0.0001	**−10.0**
	Black	0.046	0.2644	
	Other race	−0.000	0.9945	
	Hispanic	0.030	0.4760	
	Uninsured	0.025	0.7049	
	Medicaid	0.047	0.1605	
	Full contact sports	0.003	0.9352	
	Non-contact sports*	**0.457**	**0.0030**	**57.9**
	Elective admission*	**0.261**	<0.0001	**29.8**
	Urgent admission	−0.113	0.0850	
	Trauma admission*	**0.347**	<0.0001	**41.5**
	ICISS*	**−0.038**	<0.0001	**−3.7**
Nature of injury	Fractures of the skull, neck or trunk	−0.048	0.6197	
	Other fractures*	**0.309**	**0.0004**	**36.2**
	Internal injury*	**−0.526**	<0.0001	**−40.9**
	Dislocation	−0.086	0.5254	
	Open wound	0.105	0.4708	
	Other injury	−0.203	0.1435	
Hospital factors	Rural hospital	0.338	0.2551	
	Teaching hospital*	0.067	0.0685	
	For profit hospital	−0.026	0.5343	
	Government hospital*	**0.122**	**0.0221**	**13.0**

The values in bold indicate statistical significance at the $\alpha = 0.05$ level.
*Statistically significant at the α=0.05 level.
ICD-9, International Classification of Diseases, Ninth Revision; ICISS, ICD-9 Injury Severity Score.

had higher cost of sports injuries. Considering volume, sports to target for prevention programme include baseball, basketball, bike riding, American football, roller-skating/skateboarding and soccer, as each of these had the highest inpatient and ED costs over the 5-year time period studied. Youth covered by Medicaid insurance had the highest average cost for inpatient visits, indicating substantial costs to taxpayers stemming from sports injuries.

An unexpected result from this analysis was the impact of non-contact sports injuries on youth, such as injuries from bowling, golf, jumping rope, and non-running track and field events. Contact sports such as American football and soccer receive much more attention in the media as well as in scientific studies. Based on the literature review, the non-contact sports group was not expected to have severe injuries let alone statistically significant higher cost from their injuries when compared with a contact sports group. After reviewing the non-contact sports group observations, there were only 27 observations but they included severe and serious injuries. Further research is needed to determine how these injuries occurred. This may provide guidance in developing prevention programmes for youth athletes in non-contact sports.

Preventive policies and programmes for sports injury have usually been focused on a particular sport or at a local level. For instance, US soccer recently banned heading for youth in U-11 programmes and younger. American football rules have also changed over the last several decades to prevent injury; for example, spearing was banned in 1976 through 'recent return to play laws'.[23] These are examples of steps that can reduce injuries and healthcare costs. More recently, policies enacted in all 50 states educate youth athletes, parents and coaches on the signs and symptoms of concussion. These policies appear to be effective as demonstrated by increases in diagnosis of concussion in EDs.[24 25] However, these policies are only preventive in reducing subsequent injury after an initial harmful event. Policies that prevent injury in sports could potentially save youth athletes from pain and save families, insurance companies and the government from unnecessary healthcare spending.

There are limitations to this study. The analysed data were from AHCA's ED, inpatient and financial data

sets. These administrative data sets come with three inherent limitations: (1) they reflect the number of visits as opposed to the number of patients; (2) comprehensiveness of reporting depends on the availability of field space (eg, a limit of three injury mechanisms), which may result in potential under-reporting; and (3) clinical findings are not reported.[26] Furthermore, the data sets do not allow tracking of a patient over time. Any hospital transfer, readmission or follow-up visit would be entered as a new patient record, which is why the data set reflects counts of injury visits and not counts of injuries. E-codes have been estimated to be missing 30% of the time,[27] which is why sports injury and injury mechanism may be under-reported. After adjusting for under-reporting, sports injuries rose from 13.9% to 20% of hospitalisations. Their analysis estimated an additional 6%–22.9% of hospital injuries may be sports-related but not reported as such. Consequently, healthcare costs associated with youth sports injuries in the present analysis may be under-reported.

Finally, the AHCA ED data did not fit the financial cost model well; the results were not consistent, making inferences difficult. The lack of consistency in this model may be explained by the nature of the financial measurements reported by individual hospitals and by the small range of some of the variables combined with the sheer size of the data set. It is possible that additional data on the patient and their sports injury could build a more reliable model, such as height, weight, arrival by ambulance and acute versus chronic injury.

Sports are a meaningful way to exercise, maintain health, release stress and build confidence and friendships among youth. The goal is for youth to continue playing sports while lowering the risk of injury, especially as Frisch *et al*[1] found the most consistent risk factor for injury is having a previous injury.[1] Lowering the risk of sports injury would save the health of youth athletes and significant healthcare costs annually. Marshall *et al* found that one prevention programme aimed solely at youth soccer could save millions of dollars in healthcare costs annually.[28]

Future research is needed to identify and assess which prevention programmes are effective among sports and athlete groups in creating cost and time savings. Translational research is needed to find prevention programmes and policies that can be instituted at a broad level for athletes in full contact, limited contact and non-contact sports.

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