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A Substantial Proportion of Life-Threatening Injuries are Sport-Related

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Abstract

Objective—To assess the proportion of all life-threatening injuries that are sport-related.

Methods—We conducted a cross-sectional study of patients included in the National Hospital Ambulatory Medical Care Survey (NHAMCS) during the years 1999–2008. Life-threatening injuries were defined as International Classification of Diseases 9 codes: skull fracture [800.x–802.xx, 803.x–804.xx], cervical spine fractures [805.xx–806.10], intracranial hemorrhage [852.xx–853.xx], traumatic pneumothorax/hemothorax [860.00–860.05], liver lacerations [864.xx], spleen lacerations [865.xx], aortic rupture [901.0; 902.0], gastric/duodenal rupture [537.89], heat stroke [992.0], and commotio cordis/heart contusion [861.01]. Sport-related was defined by external cause of injury codes, confirmed by text search.

Results—There were 300,394 observed emergency department visits during the study period. An estimated 0.5% (95% CI, 0.5 – 0.6) of all ED visits nationally were for life-threatening injuries. Of life-threatening injuries, 14% (95% CI, 12 – 17) were sport-related, representing 926,805 sport-related, life-threatening injuries nationally. A higher percentage (32%; 95% CI, 27 – 38) of life-threatening injuries sustained by children was sport-related when compared with adults (9%; 95% CI, 7 – 11). For adults aged 19–44 years, 12% (95% CI, 9 – 15) of life-threatening injuries were sport-related. For children aged 6–18 years, 39% (95% CI, 33 – 46) of life-threatening injuries were sport-related. Nearly a quarter (23%; 95% CI, 7 – 55) of pediatric cervical spine fractures was sport-related. The percentage of cervical spine fractures that were sport-related was lower for adults (7%; 95% CI, 4 – 11).

Conclusion—Efforts should be made to prevent the number of sport-related, life-threatening injuries.

Key terms

catastrophic injury; athletics; cervical spine fracture; pediatric; intracranial hematoma

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INTRODUCTION

It has been estimated that 10% of all brain injuries and 7% of all new cases of paraplegia and quadriplegia are related to athletic activity.[1] Previous investigators have reported that sports injuries account for 8% of all emergency room visits by pediatric patients.[2] Sport-related injuries account for one fifth of injury-related visits to emergency departments (EDs) by patients aged 5–24 years.[3] Using the National Hospital Ambulatory Medical Care Survey (NHAMCS), other investigators have reported that sports activity is the most common cause of pediatric injury-related visits to EDs, particularly among older children.[4]

However, the proportion of all life-threatening injuries that are sport-related is unknown. Knowing the proportion of life-threatening injuries that are sport-related would be useful for determining resource allocation, as athletic endeavors represent a unique opportunity for injury prevention. Injuries due to falls, assaults, and motor vehicle collisions can be challenging to prevent, as the circumstances surrounding these injuries are often uncontrolled, difficult to regulate, and highly variable. Athletes, however, represent an identifiable and controllable group that is at risk for life-threatening injuries. For both recreational and competitive athletes, the type of equipment worn during athletics is standardized and can be adjusted in response to new evidence. The same can be said of training techniques. Legislating the use of protective equipment can be effective in reducing injury.[5] Furthermore, competitive athletes are governed by the rules of their respective sports which specify the elements of play that are allowed and those that are forbidden. These rules are enforced by referees, umpires, judges and various governing bodies. Requirements for participation are developed and mandated. This ability to influence and control the circumstances surrounding athletic participation makes athletes ideal targets for injury prevention. Changes to the rules, the equipment, the training of athletes, and the education of coaches have all been associated with reducing the risk of certain injuries.[167]

Therefore, if a sizable proportion of life-threatening injuries were due to athletic participation, resources devoted to the prevention of life-threatening injuries sustained by athletes could potentially reduce the overall incidence of life-threatening injuries substantially. To that end, we used the NHAMCS database to describe the proportion of all life-threatening injuries presenting to EDs in the United States (U.S.) that are sport-related.

METHODS

We conducted a retrospective, cross sectional study by examining ED visits in the NHAMCS database for the years 1999–2008. The NHAMCS is an annual survey of hospital emergency and outpatient department visits administered by the U.S. Census Bureau and designed by the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention. The survey measures ambulatory care service utilization in hospital EDs and outpatient clinics in the U.S. Data are obtained from samples of geographically defined areas, hospitals within these areas, clinics and EDs within these hospitals, and patient visits within these clinics and EDs, as components of the 4-stage probability design. A nationally representative sample of non-institutional general (medical, surgical, and children's) and short-stay hospitals, excluding federal, military, and Veterans Administration hospitals, are selected within geographically defined areas (primary sampling units) after adjustment for size. ED visits and outpatient clinics are sampled separately. Data are collected on approximately 25,000 visits annually to approximately 480 hospital emergency and outpatient departments (sampled separately) and are utilized to derive national estimates.

Visit information is collected during a randomly assigned 4-week reporting period each year by trained staff members at the sampled hospitals with monitoring by NHAMCS field representatives. Patient charts are reviewed and relevant data are abstracted using a standardized patient record form. A field representative from the U.S. Census Bureau reviews the records for missing visits or missing data. Data consistency is ensured by data processing at a central facility followed by a data management process involving edit determination and computer processing that includes automatic recoding algorithms or manual editing. The NHAMCS dataset is publicly available via the Internet. This study was approved by the authors' institutional review board.

Our analyses included all patients seen in the ED and diagnosed with a life-threatening injury as defined by the International Classification of Diseases, 9th Revision codes for skull fracture [800.x–802.xx, 803.x–804.xx], cervical spine fractures [805.xx–806.10], intracranial hemorrhage [852.xx–853.xx], traumatic pneumothorax/hemothorax [860.00–860.50], liver lacerations [864.xx], spleen lacerations [865.xx], as described by Korley et al.[8] In addition, given the recent findings of Thomas et al,[9] who reported deaths during athletics from intestinal and aortic rupture, we added traumatic aortic aneurysm or rupture [901.0; 902.0] and gastric/duodenal rupture [537.89]. Given their incidence in athletics, heat stroke [992.0] and commotio cordis/heart contusion [861.01] were also included.

We further categorized life-threatening injuries as sport-related using external cause of injury codes (E-codes) as described by Simon et al.[4] Some of the E-codes used by Simon et al, however, are not unique to sports (e.g. E880–E888, accidental falls). Therefore, visits with E-codes not unique to sports were only categorized as sport-related when a text search confirmed the injury was clearly sport-related. In order to be conservative, text search phrases that were ambiguous, such as, "running," or "wrestling," were not categorized as sport-related, as the patient may have been running to catch a bus, wrestling with a sibling, or engaged in other activities unrelated to athletics. Only specific sport-related phrases such as "running a marathon," "running at track practice," or "during a wrestling match," were categorized as sport-related.

We examined: age, gender, race, ethnicity, and geographic location (northeast, midwest, south, west). Patient race (White, Black or Other) and ethnicity (Hispanic or non-Hispanic) were determined based on the observations of hospital personnel, unless it is hospital policy to ask patients directly for this information. This is in accordance with the NHAMCS instructions to record race and ethnicity according to the "hospital's usual practice or based on your knowledge of the patient or from information in the medical record." In the categorization of race, there were small sample sizes for Asians, Native Hawaiian or other Pacific Islanders, and American Indian or Alaskan natives, so these were combined into an "other" category to provide reliable estimates. As athletics for children are often organized by level in school, we chose pediatric age categories reflective of school level: 0–5 years (preschool), 6–12 years (grade school), and 13–18 years (junior high/high school). All patients over 18 years were classified as adults.

Weights, strata, and primary sampling unit design variables provided by the NHAMCS were used for all analyses. We used descriptive statistics, with appropriate weighting, to account for the survey sampling methodology, using the *svy* commands available in Stata 10.1 (StataCorp, College Station, TX). The relationship between sport-related injury and demographic variables was examined in a univariate fashion using the svy logistic command.

RESULTS

There were 300,394 observed ED visits during the study period; 1,925 were for patients diagnosed with a life-threatening injury. After accounting for survey weighting, an estimated 0.5% (95% CI, 0.5 – 0.6) of all ED visits nationally were for a life-threatening injury. Fourteen percent (95% CI, 12 – 17) of all life-threatening injuries were sport-related, representing an estimated 926,805 sport-related, life-threatening injuries nationally during the 10 year study period. A higher percentage of life-threatening injuries sustained by children (32%; 95% CI, 27 – 38) were sport-related when compared to adults (9%; 95% CI, 7 – 11). In younger adults, ages 19–44 years, 12% (95% CI, 9 – 16) of all life-threatening injuries were sport-related.

Of life-threatening injuries to the head and neck, 39% (95% CI; 33 – 46) of those sustained by children ages 6 –18 years were sport-related, while 12% (95% CI, 9 – 15) of those sustained by adults aged 19–44 years were sport-related.

Nearly a quarter (23%; 95% CI, 7 – 55) of pediatric cervical spine fractures was sport-related. A lower percentage of cervical spine fractures sustained by adults (7%; 95% CI, 4 – 11) was sport-related, although adult athletes sustained an estimated 110,000 cervical spine fractures during the 10-year study period. Sport-related injuries accounted for 10% (95% CI, 5 – 20) of intracranial hemorrhages in adults and 4% (95% CI, 1 – 15) in children. Further demographics and results for the study population are shown in table 1.

DISCUSSION

Nearly 40% of all life-threatening injuries sustained by children between the ages of 6 and 18 years are sport-related. Approximately 1 out of every 4 cervical spine fractures sustained by pediatric patients is sport-related. These estimates are conservative, as many injuries occurring during sports activity may not have received a sport specific E-code and may not have contained a definitively sport-related phrase within the text of the verbal cause of injury. Thus, pediatric athletes, a readily identifiable population, account for a significant proportion of pediatric patients with life-threatening injuries. Although a lower percentage of life-threatening injuries sustained by adult patients was sport-related, the overall number of sport-related, life-threatening injuries sustained by adults remained substantial. Our study suggests that over 10,000 cervical spine fractures sustained by adults each year are sport-related. For those adults 19–44 years old, more than 1 in 10 life-threatening injuries are sport-related.

This represents a unique opportunity for prevention. Rule changes, protective equipment, and focused training, have each proven effective in decreasing sports injuries. [1671011] One classic example of a rule change that affected injury rates was observed in American football. In 1976, “spear tackling,” a method of tackling an opponent by striking him with the helmet of one’s head as the initial point of contact, was banned. As a result, the incidence of catastrophic cervical spine injuries decreased dramatically, and has remained low.[17]

Similarly, other interventions targeting athletes have reduced the risk of injuries. In skiing and snowboarding, the introduction of helmets has led to a decrease in major head injuries.[12–14] Preseason conditioning has been demonstrated to reduce the risk of early season knee injuries in American football.[10] The use of bicycle helmets has decreased the rates of head injuries [15] and facial injuries.[16] Legislation mandating the use of bicycle helmets has also resulted in a decrease in head injuries.[5] Furthermore, evidence suggests that the education of coaches and others involved with athletic performance training may affect injury rates. Schulz et al demonstrated that prior training on injury prevention, education

level, and experience of coaches, was associated with a reduced rate of injuries among cheerleaders.[17]

Our study suggests that nearly 90,000 sport-related, life-threatening injuries occur annually. A substantial proportion of these might be prevented if the underlying mechanisms and circumstances surrounding the injuries were known. Given the proportion of all life-threatening injuries that are sport-related, and the ability to control, at least in part, the circumstances surrounding athletic injuries, further study of life-threatening injuries that occur during sports is warranted. Specifically, the frequency of these injuries in various sports and the mechanisms by which these injuries occur should be investigated. Interventions similar to those discussed above have the potential to prevent a sizable proportion of all life-threatening injuries.

Our findings must be interpreted in light of several limitations. Although the multistage sampling techniques of the NHAMCS database are designed to make the sample representative of the entire U.S., the national estimates generated may not be completely accurate. However, the consistency and rigor of the sampling framework makes this unlikely. In addition, the 4 week sample used for NHAMCS cannot capture the natural variation in sports participation across seasons. Given the relatively low numbers of injured patients within a given sports category, we were not able to accurately estimate the number or proportion of life-threatening injuries due to specific sports. Similarly, given the low numbers of pediatric patients with cervical spine fractures, we could not derive reliable national estimates. In addition, we only reported visits from EDs. It is possible, that some patients with life-threatening injuries did not report to EDs. Given the nature of these injuries, however, we believe patients with life-threatening injuries are likely to report to EDs.

In conclusion, we found that a substantial proportion of life-threatening injuries, especially those sustained by children, are sport-related. Given the success of previous strategies in preventing sports injuries, further investigations to determine the mechanisms and risk factors associated with life-threatening injuries in sports may help to decrease the overall incidence of life-threatening injuries.

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TABLE 1

Characteristics of patients with life-threatening injuries recorded in NHAMCS and proportion that were sport-related

	Total Number Life-Threatening Injuries	Sports related, n (weighted %)	Population-based estimates of life-threatening injuries due to sports, in thousands n (95% CI)*
Age			
0–5	88	10 (6)	†
6–12	91	44 (39)	126 (78 – 175)
13–18	220	89 (39)	333 (225 – 442)
>18	1526	153 (9)	448 (331 – 564)
Gender			
Male	1190	86 (11)	655 (506 – 804)
Female	735	210 (16)	271 (191 – 352)
Race			
White	1541	240 (14)	744 (574 – 914)
Black	295	43 (14)	138 (84 – 191)
Other Race	89	13 (18)	45 (12 – 78)
Ethnicity			
Hispanic	245	36 (11)	79 (41 – 117)
Region			
Northeast	462	82 (20)	255 (161 – 351)
Midwest	437	54 (11)	177 (98 – 255)
South	624	90 (13)	272 (184 – 360)
West	402	70 (17)	222 (115 – 330)
Body region			
Head/Neck	1832	296 (14)	872 (691 – 1054)
Torso/Abdomen	93	16 (17)	†

*Please note, the individuals in the NHAMCS sample are "weighted" in order to adjust for discrepancies in characteristics between the NAHMCS sample and the overall US population. Thus, proportions within the sample do not directly correlate with proportions in the derived national estimate.

†Given the low number of observations, national estimates cannot be reliably derived.