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Injuries Sustained by Rugby Players Presenting to United States Emergency Departments, 1978 Through 2004

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Context: Although the United States has nearly 60 000 rugby players, to date no nationally representative rugby injury studies have been conducted.

Objective: To describe rugby players with injuries presenting to a representative sample of US emergency departments from 1978 through 2004.

Design: Retrospective study.

Setting: US Consumer Products Safety Commission's National Electronic Injury Surveillance System.

Patients or Other Participants: Rugby players presenting to emergency departments in participating hospitals from October 1, 1978, through December 31, 2004.

Main Outcome Measure(s): We reviewed all rugby players with injuries captured by the National Electronic Injury Surveillance System and categorized them by sex, age, injury site, and injury diagnosis.

Results: An estimated 236 539 rugby players presented to US emergency departments from 1978 through 2004. Injured athletes tended to be male (87.2%) and older than 18 years of age (86.0%). The face (20.5%), shoulder (14.1%), head (11.5%), and ankle (9.1%) were the most frequently injured sites. Strain/sprain (24.3%), laceration (22.1%), fracture (18.7%), and contusion/abrasion (16.6%) were the most common diagnoses. Males presented with more face injuries (injury proportion ratio [IPR] = 2.05, 95% confidence interval [CI] = 1.54–2.72, $P < .001$) and more lacerations (IPR = 4.23, 95% CI = 2.87–6.22, $P < .001$) and dislocations (IPR = 2.17, 95% CI 1.51–3.13, $P < .001$). Females presented with more knee injuries (IPR = 1.67, 95% CI = 1.36–2.06, $P < .001$) and more contusions/abrasions (IPR = 1.48, 95% CI = 1.14–1.92, $P < .001$) and strains/sprains (IPR = 1.39, 95% = CI 1.16–1.67, $P < .001$). Those 18 years of age or younger presented with more concussions (IPR = 1.62, 95% CI = 1.06–2.50, $P < .001$), while those over 18 presented with more lacerations (IPR = 1.83, 95% CI = 1.30–2.57, $P < .001$). In males, fractures were more common among those 18 years of age or younger (IPR = 1.47, 95% CI = 1.24–1.75, $P < .001$).

Conclusions: Rugby injury patterns in the United States differed by age and sex. Understanding such patterns should assist certified athletic trainers in developing targeted preventive interventions.

Key Words: athletic injuries, epidemiology

Rugby is a fast-paced collision sport. The 59 957 registered participants in the United States in 2002 included both males and females, youths and adults.[1] Unlike athletes in other full-contact team sports such as ice hockey and lacrosse, all rugby participants, regardless of age or sex, play by the same rules regarding player-to-player contact and use the same protective equipment. Although rugby constitutes a good form of exercise, its physical nature combined with the absence of required protective gear contributes to the high risk of injury associated with this sport.

Rugby's worldwide popularity has inspired a multitude of injury studies that include case-control[2] and prospective cohort[3–6] designs. Specific injury sites have been studied,[7–9] along with a variety of risk[10,11] and protective[12–17] factors. Authors have addressed players of all ages[3,4,18] and levels of competition, ranging from club[18] through professional.[10,15] However, with the exception of research stemming from the New Zealand Rugby Injury and Performance Project,[3,11,17,19] few groups[5,8,10,20] have assessed injuries among females. Although research has been conducted on rugby injuries in geographic locations throughout the world,[3–6,11,19,21,22] few authors have evaluated US rugby injuries. Previous investigators of US rugby injuries have either focused on specific injury sites[8,23] or specific risk[10] or protective factors.[13,20]

Our goal was to describe rugby injuries presenting to a representative sample of US emergency departments (EDs) from 1978 through 2004. This appears to be the first nationally representative study of rugby injuries in the United States, as well as the first study to compare US rugby injuries between males and females and between those 18 years of age or younger and those older than 18 years of age. The growth of the US rugby-playing population, at 10% per year, and the 36% per year increase in registration among those aged 18 years or younger warrants a closer look at US rugby injuries.[24] Assessing age and sex differences in injury patterns should allow

certified athletic trainers to develop targeted preventive interventions.

METHODS

The National Electronic Injury Surveillance System (NEISS) of the US Consumer Product Safety Commission (CPSC) collects information on people with injuries presenting to EDs at a network of 100 hospitals. In NEISS hospitals, a stratified probability sample of US hospitals with at least 6 beds and a 24-hour ED, coders were trained to review all ED records daily and to enter demographic, injury, and treatment information into the NEISS database.[25] Each case is assigned 1 or 2 CPSC-specific product codes that designate which products or activities were involved with the injury.

We evaluated all patients with rugby injuries (product code 3234) presenting to EDs in NEISS hospitals from October 1, 1978 (the date the CPSC began coding rugby injuries), through December 31, 2004. All injuries that athletes sustain while participating in rugby play or involving rugby equipment and that are evaluated at a NEISS hospital should receive this product code and be entered into the data set. To be included in our study, the injury had to occur during active rugby participation in either a structured or unstructured environment. Cases involving spectators or injuries from equipment sustained while not playing were excluded. For example, we excluded injuries involving a rugby ball hitting a fan and a player cutting himself while using a knife to remove cleat stubs. We also excluded wheelchair rugby injuries from this study. These criteria resulted in the removal of 40 cases.

The NEISS case reports contain demographic information on the injured individual, such as age, sex, and race, and information on the injury, including the injured body part, diagnosis, disposition, and a brief description of how the injury occurred. We analyzed sex, age, injury site, and injury diagnosis data. Age was dichotomized into 18 years of age or younger and older than 18 years of age. Injury site was categorized according to the 26 injury sites used by the CPSC.[26] Injury diagnosis was derived from the CPSC diagnosis and classified as strain/sprain, laceration, fracture, contusion/abrasion, dislocation, concussion, or other.[26] The institutional review board at Columbus Children's Research Institute approved this study.

We used SPSS (version 13.0; SPSS Inc, Chicago, IL), SAS (version 9.1; SAS Institute Inc, Cary, NC), and SUDAAN (version 9; RTI International, Research Triangle Park, NC) for data analysis and employed statistical weights provided by the CPSC to calculate national injury estimates. Unless otherwise stated, data presented represent national estimates. Although most calculations employing national estimates are based upon adequate numbers of actual case counts ($\geq$25), instances in which this is not true are noted. Annualized injury numbers were derived from 3-year rolling averages. For example, the estimated number of injuries occurring in 1980 was determined by averaging the estimated number of injuries occurring in 1979, 1980, and 1981. This was done to help stabilize yearly estimates based on low case counts. Trend significance of the number of rugby injuries per year was analyzed through linear regression.

Continuous variables were assessed using *t* tests. Categorical variables were assessed through injury proportion ratios (IPRs) with 95% confidence intervals (CIs); the PROC CROSSTAB procedure in SUDAAN was used to account for the complex survey design, with *P* values of $\leq$.05 considered to be significant. As an example of the IPR calculation, the formula for comparing the proportion of head injuries between males and females was as follows:

$$\text{IPR} = \frac{\text{No. male head injuries/total No. male injuries}}{\text{No. female head injuries/total No. female injuries}}$$

RESULTS

Overall Patterns of Rugby Injury

From 1978 through 2004, 4835 individuals presented to NEISS EDs with rugby injuries. This corresponds to an estimated 236 539 rugby players with injuries presenting to US EDs. Injured male players ranged in age from 3 to 64 years (mean = 23.3 $\pm$ 5.7 years) and were significantly older than injured females, who ranged in age from 8 to 71 years (mean = 21.2 $\pm$ 4.7 years) ($P < .001$). The face, shoulder, head, ankle, and knee were the most frequently injured sites, and strain/sprain, laceration, fracture, and contusion/abrasion were the most common diagnoses (Table). A total of 96.9% of injured rugby players seen were released, whereas 2.9% were admitted to the hospital or transferred to another medical facility.

Although the total number of rugby players with injuries presenting to US EDs fluctuated throughout the study period from 6000 to 13 000 injuries per year, the overall increasing trend over time was significant ($\beta_1 = 86.9$, $P = .03$) (Figure 1). By age group, the number of rugby injuries among those 18 years of age or younger increased significantly ($\beta_1 = 64.1$, $P < .001$), although no significant increase was seen among those older than 18 years of age. Thus, from 1980 through 2003, rugby ED presentations increased by an average of 86.9 yearly, including an average yearly increase of 64.1 presentations among those 18 years of age or younger. (The use of rolling averages prevents the inclusion of 1979 and 2004 in this range.)

Injured Body Site by Sex and Age

Males were most often treated in the ED for injuries to the face, shoulder, head, and ankle (Figure 2). Females were most often treated in the ED for injuries to the knee, ankle, shoulder, face, and head. Males were diagnosed with a higher proportion of injuries to the face (23.0%) than females (11.2%) (IPR = 2.05, 95% CI = 1.54–2.72, $P < .001$), whereas females were diagnosed with a higher proportion of injuries to the knee (12.6%) than males (7.5%) (IPR = 1.67, 95% CI = 1.36–2.06, $P < .001$).

Those 18 years of age or younger and those older than 18 years of age were both most likely to be treated with an injury to the face, shoulder, or head (Figure 3). Those 18 years of age or younger were treated for a higher proportion of injuries to the wrist (4.3% versus 2.2%) (IPR = 2.00, 95% CI = 1.26–3.16, $P < .001$) and lower leg (4.7% versus 2.7%) (IPR = 1.73, 95% CI = 1.13–2.65, $P < .001$), whereas those older than 18 years of age were treated for a higher proportion of injuries to the face (22.5% versus 15.3%) (IPR = 1.48, 95% CI = 1.14–1.92, $P < .001$).

Rugby Players With Injuries Presenting to US Emergency Departments, 1978 Through 2004

	Actual No. of Rugby Injuries, n (%)*	National Yearly Injury Estimates, n (%)†
Total	4835	8854
Body site injured		
Head/face/neck	1844 (38.1)	3382 (38.1)
Head	555 (11.5)	952 (10.7)
Face	989 (20.5)	1905 (21.4)
Eye‡	26 (0.5)	59 (0.7)
Ear	70 (1.4)	122 (1.4)
Mouth	104 (2.2)	188 (2.1)
Neck	100 (2.1)	156 (1.8)
Upper extremities	1449 (30.0)	2695 (30.3)
Shoulder	683 (14.1)	1257 (14.1)
Upper arm‡	8 (0.2)	15 (0.2)
Elbow	61 (1.3)	120 (1.4)
Lower arm	62 (1.3)	139 (1.6)
Wrist	122 (2.5)	215 (2.4)
Hand	146 (3.0)	259 (2.9)
Finger	367 (7.6)	690 (7.8)
Trunk	373 (7.7)	657 (7.4)
Upper trunk	241 (5.0)	411 (4.6)
Lower trunk	129 (2.7)	241 (2.7)
Groin‡	3 (0.1)	5 (0.1)
Lower extremities	1147 (23.7)	2097 (23.6)
Upper leg‡	40 (0.8)	80 (0.9)
Knee	410 (8.5)	713 (8.0)
Lower leg	135 (2.8)	270 (3.0)
Ankle	438 (9.1)	791 (8.9)
Foot	107 (2.2)	207 (2.3)
Toe‡	17 (0.4)	36 (0.4)
Other‡	22 (0.5)	55 (0.6)
Injury diagnosis		
Strain/sprain	1173 (24.3)	2055 (23.1)
Laceration	1067 (22.1)	1982 (22.2)
Fracture	903 (18.7)	1718 (19.3)
Contusion/abrasion	805 (16.6)	1494 (16.8)
Dislocation	348 (7.2)	659 (7.4)
Concussion	161 (3.3)	275 (3.4)
Other	378 (7.8)	691 (7.8)

*Individuals presenting to 100 US emergency departments participating in the Consumer Product Safety Commission's National Electronic Injury Surveillance System.[25]

†Because these numbers represent 3-year rolling averages calculated with statistical weights provided by the Consumer Product Safety Commission's National Electronic Injury Surveillance System,[25] the sums for "Body Site Injured" and "Injury Diagnosis" are similar to but do not match "Total."

‡Estimates based on <50 cases may not be reliable, and interpretation should be cautious.

Injury Diagnosis by Sex and Age

Males were most commonly diagnosed with lacerations (24.9%), strains/sprains (22.3%), and fractures (19.0%) (Figure 4). Females were most commonly diagnosed with strains/sprains (31.0%), contusions/abrasions (23.5%), and fractures (21.2%). Males were diagnosed with a higher proportion of lacerations (IPR = 4.23, 95% CI = 2.87–6.22, $P < .001$) and dislocations (IPR = 2.17, 95% CI = 1.51–3.13, $P < .001$), whereas females were diagnosed with a higher proportion of contusions/abrasions (IPR = 1.48, 95% CI = 1.14–1.92, $P < .001$) and strains/sprains (IPR = 1.39, 95% CI = 1.16–1.67, $P < .001$).

The most common diagnoses among those 18 years of age or younger were strain/sprain (26.2%), fracture (23.5%), and contusion/abrasion (19.8%). The most frequent diagnoses among those older than 18 years were laceration (24.0%), strain/sprain (22.9%), and fracture (18.6%). Those 18 years of age or younger were seen in the ED for a higher proportion of concussions (IPR = 1.62, 95% CI = 1.06–2.50, $P < .001$), whereas those older than 18 were treated in the ED for a higher proportion of lacerations (IPR = 1.83, 95% CI = 1.30–2.57, $P < .001$).

Males 18 years of age or younger presented most commonly with fractures (25.7%), strains/sprains (23.7%), and contusions/abrasions (18.8%); males older than 18 presented most frequently with lacerations (26.3%), strains/sprains (22.0%), and fractures (18.0%). Females 18 years of age or younger and those older than 18 were both most commonly diagnosed with strains/sprains (36.9% and 29.5%, respectively), contusions/abrasions (24.2% and 23.3%, respectively), and fractures (14.3% and 23.1%, respectively). In males, a higher proportion of fractures was treated among those 18 years of age or younger (IPR = 1.47, 95% CI = 1.24–1.75, $P < .001$). In females, no significant differences were noted between diagnosis and age.

DISCUSSION

As rugby participation continues to grow in the United States, the number of athletes with rugby injuries presenting to EDs will also likely increase. A better understanding of injury patterns in US rugby players can help coaches and athletic trainers to understand primary, secondary, and tertiary prevention mechanisms and, thus, may translate into increased safety. Prevention mechanisms could include development of improved protective equipment; enhanced enforcement of, or changes to, the rules of the game; better coaching of skills such as tackling (primary prevention); enhanced diagnosis of injury; increased utilization of team athletic trainers; greater use of ambulance services at tournaments (secondary prevention); and activity-focused injury rehabilitation and education about the potential dangers of returning to play before full recovery from injury (tertiary prevention).

Most athletes presenting to US EDs with rugby injuries from 1979 through 2004 were older than 18 years of age, which likely reflects the participation of more adults than children in the United States.[1] However, a lower injury rate among children is also consistent with previous rugby injury studies from New Zealand,[3] England,[18] and Argentina,[4] in which authors have reported lower injury rates among children. Although a different age categorization was employed (a child was defined as younger than 15 years of age), in an assessment of athletes with 7233 rugby players with injuries presenting to Australian EDs from 1989 through 1993,[21] the percentage of children (34.4%) was higher than in our study (14.0%). This difference likely stems from increased participation in rugby among youth in Australia compared with the United States.[1] Subjects in this Australian study also experienced higher proportions of hospitalization, with 13.1% of children and 10.9% of adults requiring hospitalization. Comparing these numbers with the 2.9% in our study indicates that US athletes with rugby injuries presenting to EDs may be less severely hurt than Australians with similar injuries.

Geographic differences appear to exist with respect to body site injured and injury diagnosis. Groups from New Zealand,[3] Argentina,[4] and South Africa[27] found the most commonly in-

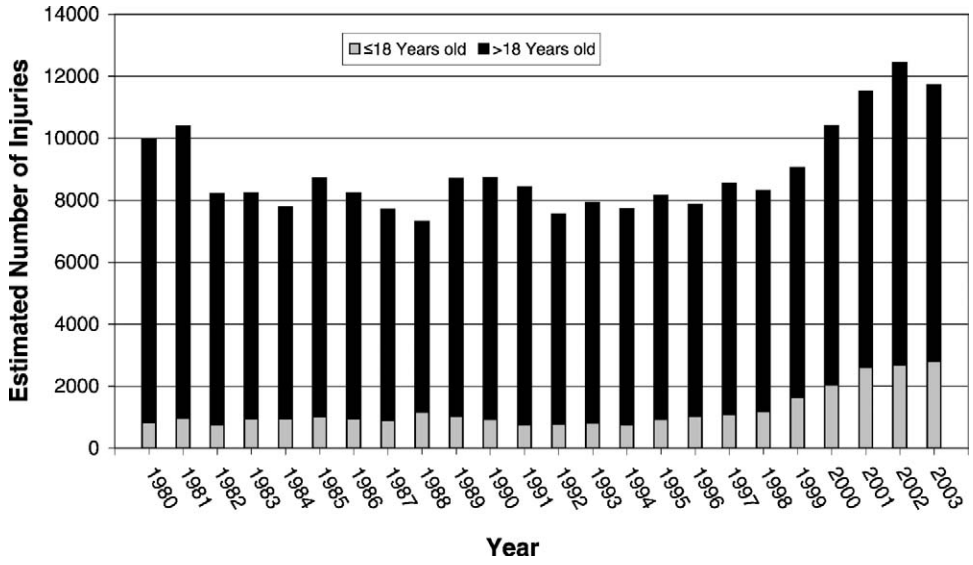
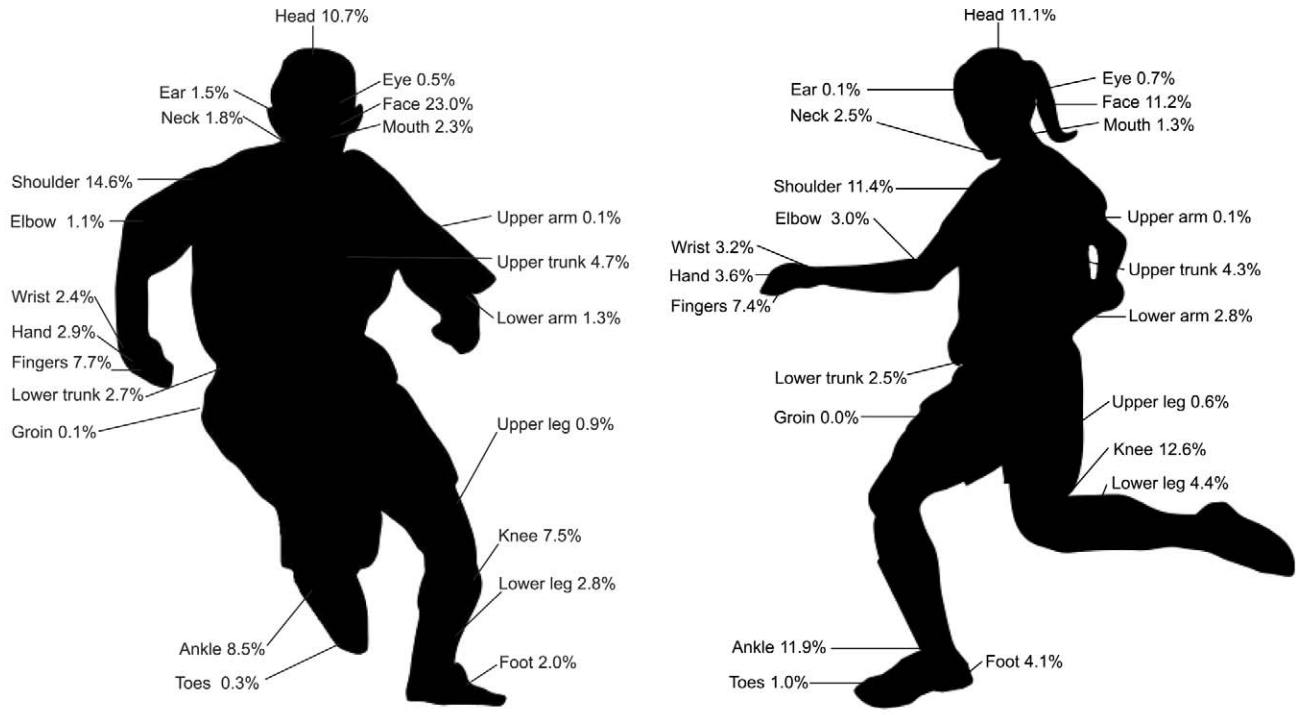


Figure 1. Estimated number of rugby players with injuries presenting to US emergency departments by year and age, 1980 through 2003. National estimates for those 18 years or younger for 1979 through 2001 are based on actual case counts below 50 and, thus, may be unstable. These numbers represent 3-year rolling averages calculated with statistical weights provided by the Consumer Product Safety Commission's National Electronic Injury Surveillance System. The rugby product code was introduced on October 1, 1978, making 1979 the first full year for rugby injury data collection and allowing 1980 to be the first 3-year rolling average.



A B

Figure 2. Sex differences in weighted case counts of rugby players with injuries presenting to US emergency departments by body site injured, 1978 through 2004. Percentages may not sum to 100% because of cases with other/unspecified injury sites. Estimates based on <50 cases may not be reliable and interpretation should be cautious. A, Male rugby players, n = 206 322. B, Female rugby players, n = 30 217.

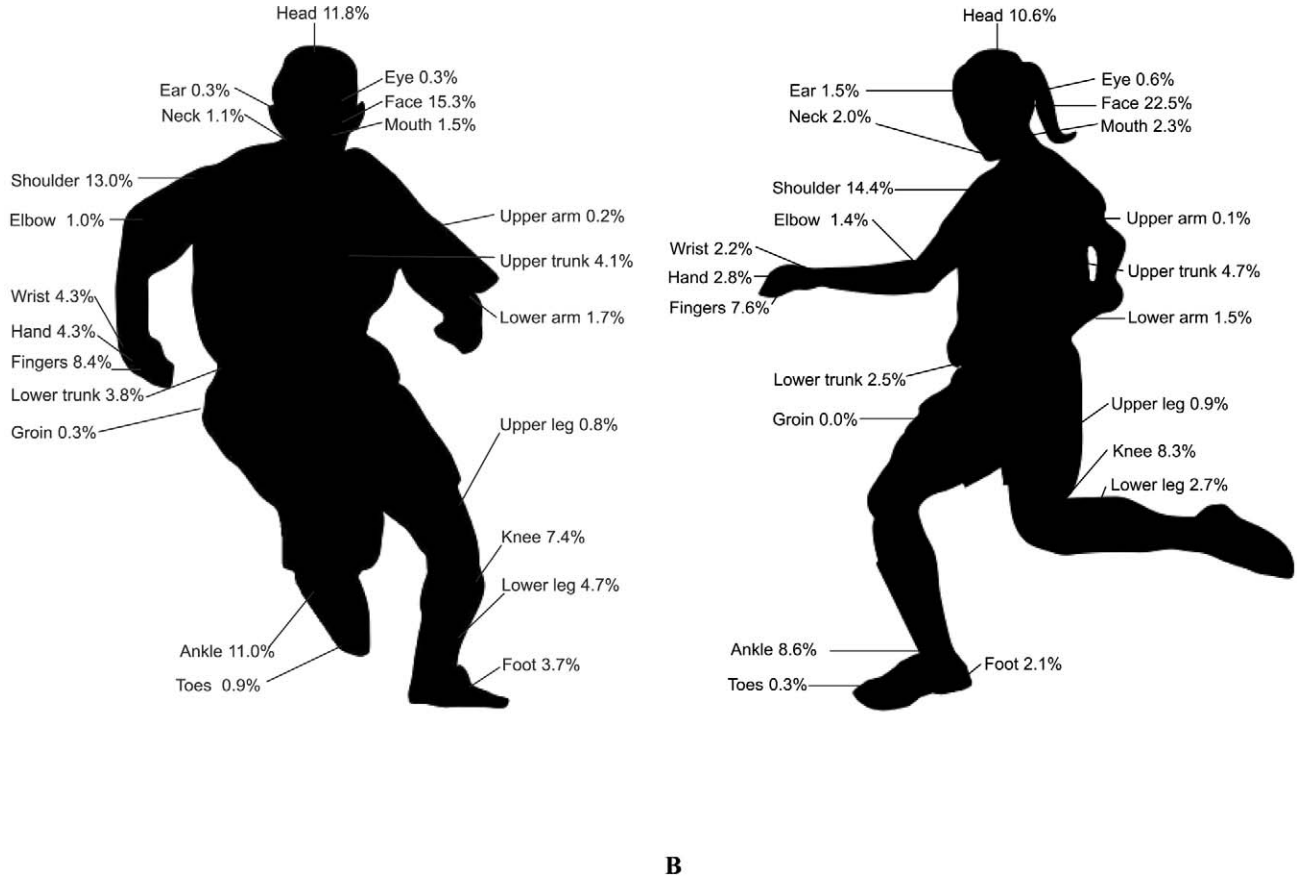


Figure 3. Age differences in weighted case counts of rugby players with injuries presenting to US emergency departments by body site injured, 1978 through 2004. Percentages may not sum to 100% because of cases with other/unspecified injury sites. Estimates based on <50 cases may not be reliable and interpretation should be cautious. A, Rugby players 18 years of age or younger, n = 33 123. B, Rugby players older than 18 years of age, n = 203 416.

jured region to be the lower extremity. The only previous authors to use ED data,[21] in an Australian study, found the most commonly injured region to be the upper extremity. We found that US rugby players injured the head, face, and neck more often than the upper or lower extremities. In studies from other countries, the most common injury diagnoses were fractures[21,27] and strains/sprains.[3,21] The most common rugby injuries diagnosed in US EDs were strains/sprains, lacerations, and fractures. These differences in injury site and diagnosis may reflect changes in rugby injury patterns over time or various styles of play across geographic regions. In addition, rugby players may carry over skills from previous sport experiences. For instance, US male rugby players may be more likely than players of other nationalities to employ tendencies learned from American football, in which helmets and face masks help to protect the head and face from injury. If these rugby players are more likely to make contact in a head-first fashion, then this could explain part of the elevated proportion of US head, face, and neck injuries.

In our study, males sustained twice as many injuries to the face and 4 times as many lacerations as females. Published data regarding the burden of injury associated with foul play, particularly in female rugby, is limited. One definition of foul play is intentionally trying to injure an opponent through prohibited activities.[10] In previous studies, the attribution of rugby injuries to foul play in male rugby has ranged from 13% to 32.7%.[3,6,28,29] In an investigation of US female rugby injuries, foul play was implicated in 24.3% of injuries.[10] Compared with non–foul-play injuries, those resulting from foul play are more likely to affect the head and face and are more often lacerations.[3] Thus, the increased incidence of face injuries and lacerations among males versus females may reflect an increased prevalence of foul play in the male game in the United States. Additional studies are needed to explore the prevalence of foul play in rugby and its association with injury.

We noted that US rugby players 18 years of age or younger were significantly more likely to be diagnosed with concussions than those older than 18 years of age. No authors to date have presented information regarding the use of protective equipment among youth rugby players in the United States. However, a New Zealand group[30] found that headgear use among schoolboys was much higher (32.6%) than headgear use among adult males (12.4%–18.0%). Previous assertions that wearing padded headgear does not reduce the incidence of injury may be supported by our finding that younger players were more likely to sustain concussions, based on the assumption that the frequency of headgear use is similar between US and New Zealand youth.[2,14,16] Studies of different types of protective equipment, such as padded headgear, among various age and sex subgroups of rugby players are needed before their effectiveness can be definitively evaluated.

Our study limitations correspond to the limitations of the NEISS data set. Athletes with rugby injuries presenting to NEISS EDs represent only the most severe rugby injuries, with only the most serious injury per individual recorded. Injury rates by age and sex could not be calculated because accurate,

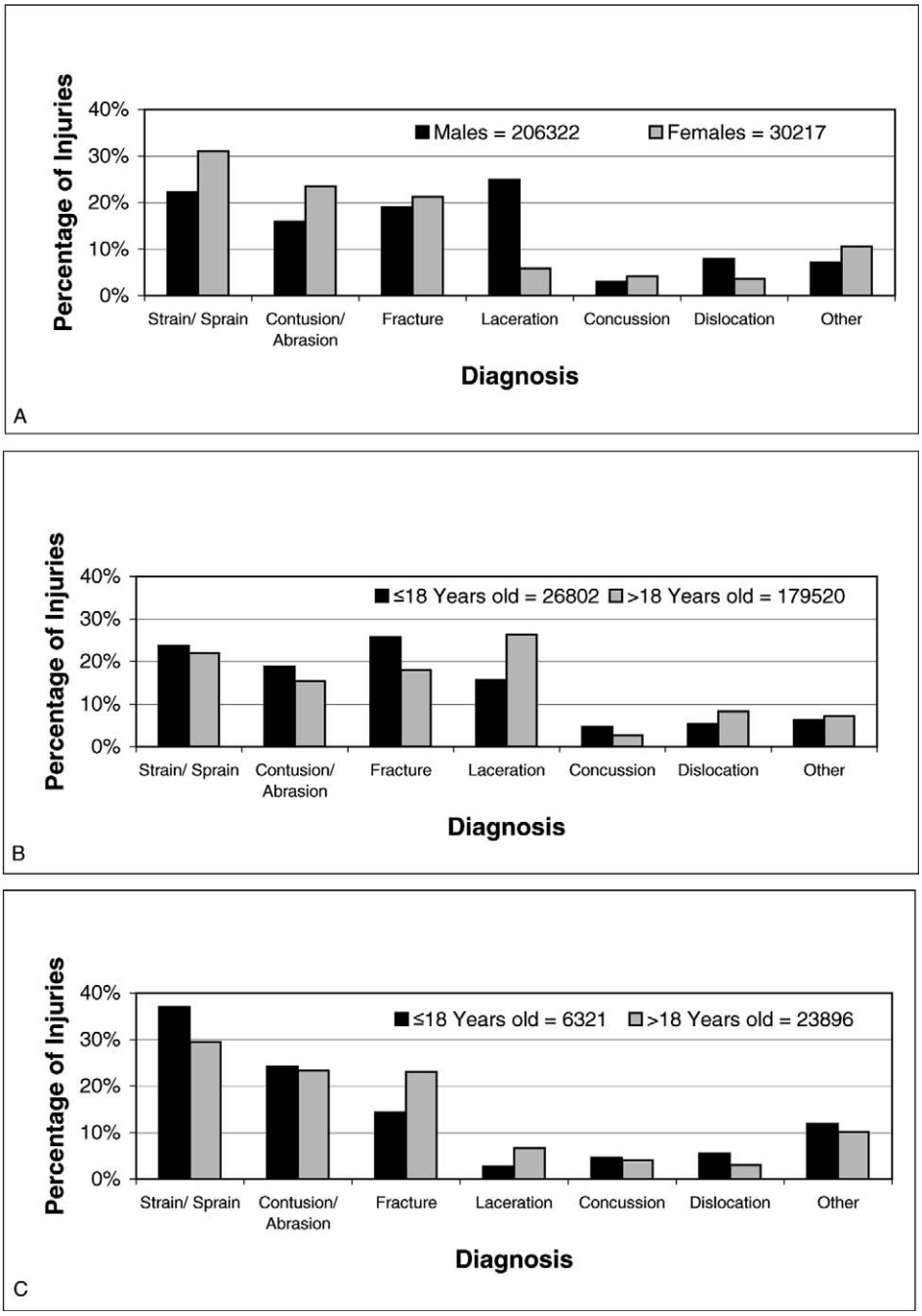


Figure 4. Sex and age differences in rugby players with injuries presenting to US emergency departments by injury diagnosis, 1978 through 2004. Estimates based on <50 cases may not be reliable, and interpretation should be cautious. A, All cases. B, Males. C, Females.

comprehensive estimates of the number of people who played rugby or the associated exposure time in the United States during each year of the study are lacking. In most cases, distinguishing between play that was unstructured (eg, backyard) and structured (eg, formal competition) was impossible. Per instruction from the NEISS coding manual, hospital staff is to record only the first emergency room visit for any particular injury,[26] making it likely that all injuries included in this study were incident injuries. However, in rare circumstances, a case may have been counted more than once if the person presented for treatment multiple times for the same injury. In addition, although data from 1978 through 2004 were combined, caution should be exercised when interpreting subsets containing small numbers of unweighted cases, as derived estimates may be unreliable.

Despite these limitations, this data set is the only nationally representative stratified probability sample of rugby injuries in the United States, and the data set's stability allows changes over time to be monitored. The utility of these data, in the absence of ongoing community-level surveillance systems for sports injuries, is important for informing prevention initiatives in sports and recreation venues. Thus, these study results provide important information on injury patterns among the rising US rugby population.

The higher proportion of head, face, and neck injuries among US rugby players compared with players from other

countries indicates that this should be one area of focus for athletic trainers. Coaches and athletic trainers should ensure that players are well instructed in the proper form for entering into scrums, tackles, rucks, and mauls and should discourage any tendencies to lead unnecessarily with the head or face. Athletic trainers should track and closely monitor concussions, especially among players 18 years of age or younger, and should not allow players with concussions to return to play prematurely. Although our results do not encourage or discourage the use of scrum caps, we recommend the use of mouth guards.

Ours is the largest reported study of injuries among US rugby players to date and the only study based on a nationally representative sample. In our review of rugby injuries treated in US EDs, we found that injuries among US rugby players are diverse in terms of injury site and diagnosis and that sex and age differences do exist. Future case-control and cohort studies evaluating such sex and age differences, as well as various risk and protective factors, should lead to a reduction in injury rates by providing data upon which athletic trainers can base the development of preventive interventions.[7,12,19]

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REFERENCES

1. International Rugby Board. *Member Unions: United States of America Rugby.* Available at: http://www.irb.com/InTouch/Regions/UnionInfo.htm?Country=USA. Accessed September 2005.
2. Jones SJ, Lyons RA, Evans R, et al. Effectiveness of rugby headgear in preventing soft tissue injuries to the head: a case-control and video cohort study. *Br J Sports Med.* 2004;38:159–162.
3. Bird YN, Waller AE, Marshall SW, Alsop JC, Chalmers DJ, Gerrard DF. The New Zealand Rugby Injury and Performance Project: V. Epidemiology of a season of rugby injury. *Br J Sports Med.* 1998;32:319–325.
4. Bottini E, Poggi EJ, Luzuriaga F, Secin FP. Incidence and nature of the most common rugby injuries sustained in Argentina (1991–1997). *Br J Sports Med.* 2000;34:94–97.
5. Carson JD, Roberts MA, White AL. The epidemiology of women's rugby injuries. *Clin J Sport Med.* 1999;9:75–78.
6. Davies JE, Gibson T. Injuries in Rugby Union football. *Br Med J.* 1978;2:1759–1761.
7. Haylen PT. Spinal injuries in rugby union, 1970–2003: lessons and responsibilities. *Med J Aust.* 2004;181:48–50.
8. Levy AS, Wetzler MJ, Lewars M, Laughlin W. Knee injuries in women collegiate rugby players. *Am J Sports Med.* 1997;25:360–362.
9. Hinton-Bayre AD, Geffen G, Friis P. Presentation and mechanisms of concussion in professional Rugby League Football. *J Sci Med Sport.* 2004;7:400–404.
10. Comstock RD, Fields SK. The fair sex? Foul play among female rugby players. *J Sci Med Sport.* 2005;8:101–110.
11. Quarrie KL, Alsop JC, Waller AE, Bird YN, Marshall SW, Chalmers DJ. The New Zealand Rugby Injury and Performance Project: VI. A prospective cohort study of risk factors for injury in Rugby Union Football. *Br J Sports Med.* 2001;35:157–166.
12. Dietzen CJ, Topping BR. Rugby football. *Phys Med Rehabil Clin N Am.* 1999;10:159–175.
13. Chapman PJ. Players' attitudes to mouthguards and prevalence of orofacial injuries in the 1987 U.S. Rugby Football Team. *Am J Sports Med.* 1989;17:690–691.
14. McIntosh AS, McCrory P. Effectiveness of headgear in a pilot study of under 15 rugby union football. *Br J Sports Med.* 2001;35:167–169.
15. Gabbett TJ. Influence of the limited interchange rule on injury rates in sub-elite Rugby League players. *J Sci Med Sport.* 2005;8:111–115.
16. Marshall SW, Loomis DP, Waller AE, et al. Evaluation of protective equipment for prevention of injuries in rugby union. *Int J Epidemiol.* 2005;34:113–118.
17. Quarrie KL, Gianotti SM, Chalmers DJ, Hopkins WG. An evaluation of mouthguard requirements and dental injuries in New Zealand Rugby Union. *Br J Sports Med.* 2005;39:650–651.
18. Lee AJ, Garraway WM. Epidemiological comparison of injuries in school and senior club rugby. *Br J Sports Med.* 1996;30:213–217.
19. Chalmers DJ, Simpson JC, Depree R. Tackling rugby injury: lessons learned from the implementation of a five-year sports injury prevention program. *J Sci Med Sport.* 2004;7:74–84.
20. Comstock RD, Fields SK, Knox CL. Protective equipment use among female rugby players. *Clin J Sport Med.* 2005;15:241–245.
21. Finch C, Valuri G, Ozanne-Smith J. Sport and active recreation injuries in Australia: evidence from emergency department presentations. *Br J Sports Med.* 1998;32:220–225.
22. Ryan JM, McQuillan R. A survey of rugby injuries attending an accident & emergency department. *Ir Med J.* 1992;85:72–73.
23. Wetzler MJ, Akpata T, Laughlin W, Levy AS. Occurrence of cervical spine injuries during the rugby scrum. *Am J Sports Med.* 1998;26:177–180.
24. USA Rugby. *USA Rugby Gains Multimillion-Dollar IRB Grant.* Available at: http://www.usarugby.org/cgi-bin/02/press/display.pl?releaseId=1077. Accessed December 2005.
25. US Consumer Product Safety Commission. *The NEISS Sample (Design and Implementation) 1997 to Present.* Available at: http://www.cpsc.gov/neiss/2001d011–6b6.pdf. Accessed July 2005.
26. US Consumer Product Safety Commission. *NEISS Coding Manual.* Available at: http://www.cpsc.gov/neiss/completemanual.pdf. Accessed March 2006.
27. Roux CE, Goedeke R, Visser GR, van Zyl WA, Noakes TD. The epidemiology of schoolboy rugby injuries. *S Afr Med J.* 1987;71:307–313.
28. Inglis GS, Stewart ID. Rugby injury survey 1979. *N Z Med J.* 1981;94:349–350.
29. Lewis E. Rugby injuries: do men and women sustain different injuries? *SportCare J.* 1994;1:8–9.
30. Marshall SW, Waller AE, Loomis DP, et al. Use of protective equipment in a cohort of rugby players. *Med Sci Sports Exerc.* 2001;33:2131–2138.