

## [ Athletic Training ]

# The Incidence of Injury Among Male and Female Intercollegiate Rugby Players

Karen Y. Peck, MEd, ATC,\*† Dana A. Johnston, MS, ATC,‡ LTC Brett D. Owens, MD,† and Kenneth L. Cameron, PhD, MPH, ATC†

**Background:** The National Collegiate Athletic Association classifies women's rugby as an emerging sport. Few studies have examined the injury rates in women's collegiate rugby or compared injury rates between sexes.

**Hypothesis:** Injury rates will differ between female and male intercollegiate club rugby players.

**Study Design:** Descriptive epidemiological study.

**Methods:** Five years of injury data were collected from the men's and women's rugby teams at a US service academy using the institution's injury surveillance system. The primary outcome of interest was the incidence rate of injury during the study period per 10,000 athlete exposures. Incidence rate ratios (IRRs) were calculated using a Poisson distribution to compare the rates by sex.

**Results:** During the study period, the overall incidence rate for injury was 30% higher (IRR = 1.30, 95% CI: 1.09, 1.54) among men when compared with women; however, the distribution of injuries varied by sex. The incidence rate for ACL injury among women was 5.3 times (IRR = 5.32, 95% CI: 1.33, 30.53) higher compared with that among men. Men were 2.5 times (IRR = 2.54, 95% CI: 1.03, 7.52) more likely to sustain a fracture. The rate of acromioclavicular joint injury was 2.2 times (IRR = 2.19, 95% CI: 1.03, 5.19) higher among men when compared with women. Men were 6.6 times (IRR = 6.55, 95% CI: 2.65, 20.91) more likely to have an open wound than women.

**Conclusion:** There are differences in injury rates and patterns between female and male American rugby players.

**Clinical Relevance:** The differences in injury patterns may reflect distinct playing styles, which could be the result of the American football background common among many of the male players.

**Keywords:** rugby; injury incidence; epidemiology; sex differences

Rugby has been played around the world since the late 1800s. In the United States, it was played at the collegiate level from the late 1800s through the early 1900s. However, a drastic decline in participation occurred in the United States with the rise of American football and the removal of rugby from the Olympics after the 1924 games. In the 1970s there was renewed interest, and the game has grown dramatically at both the high school and collegiate levels. Most notably, the women's game has grown at a quicker pace than the men's.<sup>48</sup> This unique phenomenon may be due to the synchronous timing of the growth of the game and the enactment of Title IX legislation in 1972, which provided more opportunities for women in athletics. Traditionally in athletics, men have played games first and then women have followed suit, oftentimes playing a modified form of the game. Rugby

is a unique sport because the women have always played the same exact game as men.<sup>25</sup> One possible reason for so much interest on the women's side is that rugby is one of the only games where women can compete in a collision sport on all-women teams. In addition, successful teams require a diversely skilled group of participants so the game has appeal to a broad range of athletes. Another boost for the women's game came in 2002, when the National Collegiate Athletic Association (NCAA) classified women's rugby as an emerging sport.

At present, most collegiate programs retain club rather than varsity status. As a result, they tend to have volunteer coaches, little training and conditioning support, and substandard field conditions and facilities. In addition, adequate medical coverage rarely exists, making large-scale injury surveillance extremely challenging. Furthermore, the sport of rugby is not

From †Keller Army Community Hospital, West Point, New York, and ‡US Military Academy, West Point, New York

\*Address correspondence to Karen Y. Peck, MEd, ATC, Keller Army Community Hospital, 900 Washington Rd, West Point, NY 10996 (e-mail: karen.y.peck.civ@mail.mil).

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included in the NCAA Injury Surveillance System for men or women<sup>22</sup>; injury data have not been collected at the national level. Because of the surge in popularity and the relatively high risk of injury associated with participation in this collision sport,<sup>4,8,26,27,30,31,33,54</sup> it is imperative that epidemiological studies gather injury data to better understand and mitigate risks for the athletes participating in this sport. The purpose of this preliminary study was to examine incidence rates and injury patterns between men and women competing in collegiate rugby at a single institution.

## METHODS

### Design and Setting

A longitudinal cohort study was conducted to examine the injury patterns associated with men's and women's collegiate club rugby teams using 5 years of injury data. Specifically, all incident injuries documented from the 2006-2007 academic year through to the 2010-2011 academic year were reviewed. Both teams practiced and trained at the same facilities, had access to the same coaching staff, and followed very similar practice and competition schedules. Both teams participated in competitive seasons in both the fall and spring and competed at the national level. The XV's national collegiate championships occurred in early May, and a Rugby Sevens national collegiate tournament occurred in early June. In contrast to many collegiate club programs, these teams are both well-supported with exceptional facilities, a paid coaching staff, and medical personnel experienced in the sport of rugby.

### Injury Surveillance and Definition

The military health care system is a closed system. All cadets who need medical attention are seen by providers at West Point and are tracked through the Cadet Injury and Illness Tracking System (CIITS), which has been previously described in other epidemiological studies.<sup>41,49,50</sup> Rugby players who are injured at away contests receive medical care at outside facilities but the athletic trainer assigned to rugby documents these injuries in CIITS upon their return. In addition, any follow-up visits at the academy are also documented. Therefore, it is highly unlikely that any incident injuries that occurred to rugby players were not documented in the injury surveillance system during the study period.

For the purposes of this study, incident injuries were defined as any new event that occurred during a rugby practice or match that required medical attention from an athletic trainer, physician, or other medical provider. The injury definition was not limited to time-loss injuries due to the common practice of athletes continuing to participate with minor and major injuries that transpire throughout the season. Examples of these injuries include auricular hematoma, lacerations, and finger fractures.

### Outcome Measures

The primary outcome of interest in the current study was the incidence rate per 10,000 athlete exposures (AEs) during the

study period, which is defined as the number of new cases occurring during a specific period of time in a population at risk for experiencing the injury.<sup>29</sup> Incidence rates are calculated by dividing the total number of injuries observed in a population by a measure of exposure or person-time at risk to injury.<sup>29</sup> In the current study, AE was defined as 1 athlete participating in 1 practice or game based on participation records. At the US Military Academy, all team members are required to attend all practices and games, and attendance is strictly monitored. Since the system is consistent for all cadets, it was used to calculate the men's and women's team roster days as an estimate of person-time at risk for injury utilizing the methods previously described by Mountcastle et al.<sup>38</sup> During each season, there were more men assigned to the roster than women. However, the men's team regularly scheduled competitions for multiple sides in 1 day so that the men had approximately the same number of game exposures per person as the women during the study period.

The overall incidence rate of injury by sex was calculated, along with the 95% confidence intervals, by dividing the total number of injuries by the total number of AEs and multiplying by 10,000. The incidence rates for specific injuries and conditions between men and women were compared by calculating the incidence rate ratio and 95% confidence interval. All statistical analyses were completed using Stata/SE software version 10.1 (StataCorp, College Station, Texas).

## RESULTS

During the 5-year study period, participants included 129 women and 240 men. Seventy-one members of the women's team sustained 200 injuries during 68,633 AEs documented during the study period; 151 members of the men's team sustained 459 injuries in 121,624 documented AEs. The overall incidence rate for injury was 30% higher (95% CI: 1.09, 1.54) among men when compared with women (Table 1).

In addition to finding different injury rates between men and women, there were differences in injury patterns (Figure 1). Women appear to have a higher proportion of injuries to the lower extremity while men have more injuries to the acromioclavicular (AC) joint and to the head and face (Figure 2).

The men in this study had 40 concussions while the women had 30 (Table 1). The incidence proportion of players with concussions was 8.7% for men and 15.0% for women. While these were different, they did not reach statistical significance when the incidence rate for concussion between men and women was examined (Table 1).

While the rate of injury for concussion was not statistically different, this was not true for other injuries to the head and face. Men were 6.6 times (95% CI: 2.65, 20.91) more likely to have an open wound with 58 injuries, compared with women with 5. There were 54 lacerations sustained by men, all of which were to the head, face, scalp, eye, ear, or chin. Women sustained only 5 lacerations, and all of these were to the face or scalp. The men had 2 orbit contusions and 3 orbit fractures; the women had 3 orbit contusions and no fractures.

Table 1. Incidence rates by sex for injuries overall and specific injuries of interest<sup>a</sup>

	Men			Women			IRR	95% CI	P		
	n	Exposures	IR	95% CI	n	Exposures				IR	95% CI
Overall injuries <sup>b</sup>	459	121,624	37.74	34.37, 41.36	200	68,633	29.14	25.24, 33.47	1.30	1.09, 1.54	0.002
Knee											
ACL injuries <sup>c</sup>	3		0.25	0.01, 0.72	9		1.31	0.60, 2.49	5.32	1.33, 30.53	0.008
Shoulder											
Glenohumeral instability <sup>b</sup>	25		2.06	1.33, 3.03	18		2.62	1.55, 4.15	0.78	0.41, 1.52	0.432
AC joint sprain <sup>b</sup>	35		2.88	2.00, 4.00	9		1.31	0.60, 2.49	2.19	1.03, 5.19	0.028
Head											
Concussion <sup>c</sup>	40		3.29	2.35, 4.48	30		4.37	2.95, 6.24	1.33	0.80, 2.19	0.242
Face laceration <sup>b</sup>	54		4.44	3.34, 5.79	5		0.73	0.24, 1.70	6.09	2.46, 19.52	0.001
Eye <sup>b</sup>	22		1.81	1.13, 2.74	5		0.73	0.24, 1.70	2.48	0.92, 8.39	0.054
Head other <sup>b</sup>	20		1.64	1.00, 2.54	1		0.15	0.01, 0.81	11.28	1.81, 467.78	0.001
Fracture <sup>b</sup>	27		2.22	1.46, 3.23	6		0.87	0.32, 1.90	2.54	1.03, 7.52	0.028

<sup>a</sup>All incidence rates (IRs) are expressed per 10,000 exposures to injury. CI, confidence interval; IRR, incidence rate ratio.<sup>b</sup>Women are the reference group.<sup>c</sup>Men are the reference group.

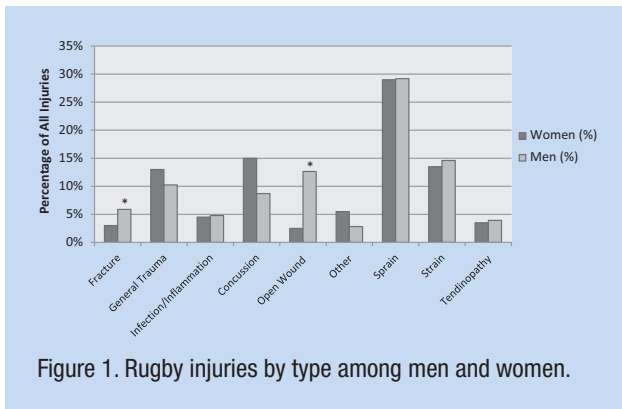


Figure 1. Rugby injuries by type among men and women.

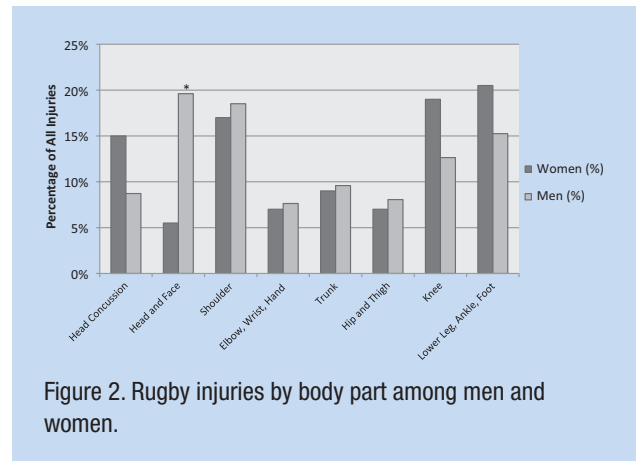


Figure 2. Rugby injuries by body part among men and women.

Men had 14 lacerations around the eye, including the eyebrow and eyelid, while the women had only 2 eyebrow lacerations. In addition, the men had 2 corneal abrasions. The men sustained 15 injuries to the ear, including 10 cases of auricular hematoma, 3 eardrum ruptures, and 2 lacerations. In contrast, the women did not report any injuries to the ear.

The men had 27 fractures, making them 2.5 times (95% CI: 1.03, 7.52) more likely to sustain a fracture than women, who had 6. The men had 7 lower extremity fractures and 7 hand fractures. They also had 13 fractures to the head and face including the nose, skull, and orbit. The women sustained 2 fractures each to the lower extremity, hand, and nose.

## DISCUSSION

Since the inception of Title IX, there has been a dramatic increase in the number of girls and women competing in sports at all levels. While this change has provided women the opportunity to enjoy all of the benefits of participation, they have also experienced athletic injuries. As these women and girls have sustained injuries, researchers have attempted to discern if there is an increased risk of injury compared with men and boys. Studies have examined differences in injury rates between sports, within sports, by body part, by injury nature, and for specific injuries, such as ACL injuries. The results have been varied but some consistent findings are beginning to emerge.

It appears that injury rates between matched sports are similar, but injury patterns may be slightly different. In addition, it appears that there are some specific injuries that may be sex-specific and not sport-specific. For example, women are more likely to sustain noncontact ACL injuries across several sports.<sup>1-3,5,17,37,39,43</sup> The current study seems to confirm this finding with female collegiate rugby players. It also appears that women may sustain concussions at different rates, exhibit different signs and symptoms, and show different patterns of recovery.<sup>6,9,11,12,16,32,42,45</sup> While this study showed similar rates of concussion, the rates of injury to the head, excluding concussion, were quite different between men and women.

The sport of rugby could be considered a matched sport that would allow for the direct comparison of injury rates. Like soccer and basketball, the rules, equipment, and playing

field for men's and women's rugby are essentially the same. However, upon closer examination, the male and female versions of this game may be played quite differently. The sport of rugby is so new in the United States that participants likely come to the game possessing varied sport experience backgrounds and skill sets.

According to USA Rugby 2011 membership data, there were 209 girls' and 676 boys' high school clubs; there were 343 women's and 511 men's collegiate rugby programs.<sup>48</sup> For women, there are more collegiate teams than high school teams; many women playing collegiate rugby have no previous rugby experience and are entirely new to the sport. It is likely that these women have prior experience in other sports such as soccer or basketball but not necessarily rugby. These prior experiences provide movement skills, defensive strategies, ball handling, and other athletic skills, but not specific rugby skills. In addition, since there are no other commonly played sports for women that include tackling, it is unlikely that these women have acquired any tackling skills. Alternatively, some men play collegiate rugby with high school experience, but many come to the game with previous experience in American football. While rugby and football are different games, the act of tackling is present in both but is executed quite differently. The rules of tackling and the amount of required protective equipment are vastly different between these 2 games.

Tackling is the most common cause of rugby injuries, in part because it is one of the most common events occurring in the game.<sup>14,15</sup> One of the differences between rugby and football tackling is the location on the body of the tackle. The "high tackle" in rugby occurs when the arms of the tackler are above the armpits of the ball carrier, and it is a penalty in the game of rugby. In contrast, the "high tackle" is legal and used quite often in football. In addition, the rugby tackler must "wrap up" and not simply hit the ball carrier, as is commonly seen in football.<sup>25</sup>

Several research studies have examined tackling in rugby to try to understand the risk and ways to mitigate risk.<sup>14,15,44,53</sup> It should be noted that all of these studies observed male players from outside the United States. Injuries were more likely when the tackle was higher on the ball carrier's body and when the

ball carrier or the tackler was moving faster rather than moving slowly or remaining stationary.<sup>14,44,53</sup> The most common injuries from tackling are to the shoulder, head, thigh, and knee.<sup>15,44,53</sup> In this study, men had 2.2 times (95% CI: 1.03, 5.19) more AC joint injuries and 11.3 times (95% CI: 1.81, 467.78) more injuries to the head, other than concussion. These disparities may be indicative of different tackling techniques used by men and women.

### ACL Injuries

Only 2 studies exclusively examined knee injury rates in the game of rugby.<sup>10,30</sup> Neither compared knee injury rates between men and women. In collegiate rugby players in the United States, women had 1.3 knee injuries and 0.36 ACL tears per 1000 exposures when injury was defined as causing the player to miss 1 game or 2 practices.<sup>30</sup> A study of professional male players in England reported an injury rate for all knee injuries of 11.0 per 1000 player hours during matches and 0.16 during practices, when injury was defined by time loss of greater than 24 hours from all rugby activity.<sup>10</sup> The knee was the most common injury location and the most severe of all injuries when defined by the number of days missed.<sup>10</sup> Also, the ACL injury rate was the lowest of all knee injuries but caused the most days missed.<sup>10</sup>

In a study of all knee injuries among high school athletes across all sports, boys showed a higher injury rate; however, girls were twice as likely to require surgery and twice as likely to sustain noncontact injuries.<sup>23</sup> In collegiate basketball and soccer players, women were more likely to tear their ACL than their male counterparts.<sup>3</sup> In cadets at military academies, ACL injury rates were higher in women, with varied differences between sports and activities.<sup>17,38</sup> The 2 sports that have been studied most extensively are basketball and soccer, with women consistently demonstrating higher ACL injury rates than men.<sup>1,3,5,36,37</sup> Higher rates among women have also been seen in alpine ski racing,<sup>46</sup> volleyball,<sup>13</sup> and team handball.<sup>39</sup>

In the current study, women were 5.3 times (95% CI: 1.33, 30.53) more likely to tear their ACL than their male counterparts. This is not surprising considering the similarities between the movements required in rugby and soccer, which has also shown higher injury rates. Both games are played in cleats on grass or turf and require players to run and change direction quickly in response to defenders. The addition of rugby to the list of sports that have an increased rate of ACL injuries for women may provide further evidence that the risk may not be attributable to the sports themselves as much as it is to physiological, anatomic, or biomechanical characteristics that may be more prevalent among women. While many ACL injury prevention programs are currently being utilized and studied with soccer and basketball players, it may be prudent to include female rugby players in these programs.

### Shoulder Injuries

Shoulder instability events are of great concern; they are typically associated with greater severity when defined by a greater time loss or as a precursor to surgery.<sup>7,20</sup> This injury also has a

high rate of recurrence.<sup>20,28</sup> The men in this study sustained 25 glenohumeral instability events while the women sustained 18, which was not statistically different (Table 1). Sex differences are seen between sports but not typically within matched sports.<sup>7,28,40</sup>

AC sprains are quite common among rugby players.<sup>51</sup> Of all players, 47% surveyed had sustained a self-reported AC joint injury in their careers.<sup>51</sup> A study of collegiate athletes found that men had a higher AC joint injury rate than women across all sports.<sup>41</sup> They also had a higher injury rate when looking specifically at the sport of rugby. The injury rate for men in the current study was 2.2 times higher than that for women (Table 1). These differences may be a result of the disparate techniques of tackling utilized by men and women.

### Fractures

Between 1968 and 1979 (before and after Title IX), larger numbers of fractures occurred in male collegiate athletes, except in gymnastics and lacrosse where women had higher rates of injury.<sup>52</sup> In high school, boys showed a higher rate of fracture in basketball and soccer.<sup>47</sup> In a different study of collegiate athletes, there were similar fracture rates between men and women except in water polo.<sup>18,52</sup> These varied results may be owing to the different populations studied. Most studies have shown higher injury rates in collision and contact sports; since men tend to participate in these sports in greater numbers, they may have a higher overall fracture rate. When examining matched sports, these differences may diminish. The current study showed that men are more likely to sustain a fracture than the women. Although the rules of rugby are exactly the same for both sexes, this disparity may be the result of the differences in the execution of the tackle or differences in the speed of play or the size of the players between the men's and women's sides.

### Head Injuries

Concussion in rugby is of great concern. In US high school male rugby players, an injury rate of 3.8 per 1000 exposures was found, as defined by the Cantu Grading Scale.<sup>34</sup> In Australian nonprofessional male rugby players, when using a medical attention definition of injury, 7.97 concussions per 1000 player-hours were reported.<sup>21</sup> In professional male players in England, an injury rate of 6.6 injuries per 1000 player-hours was reported, as defined by the inability to participate in all rugby activities for more than 24 hours.<sup>26</sup> Three studies of American rugby players show similar concussion injury rates between men and women at both the high school and collegiate levels.<sup>8,19,27</sup> However, in the UK, women had higher concussion injury rates than both men and youth.<sup>31</sup>

In this cohort of players, scrum caps are used on a limited basis. A few of the forwards routinely wear the caps to protect their ears in the scrum. Other position players wear them occasionally to protect scalp wounds while they are healing; however, the efficacy of these caps in preventing concussion remains uncertain.

Since the rules of play are the same for men and women, the stark differences in patterns of injury to the head could be attributed to differences in style of play between men and women. It appears that men may experience more contact to their head but may not sustain as many concussions as a result of these contact events.

Reporting the true incidence of concussion is difficult. It is common for players to underreport injuries because they think the injury is not serious or because they do not want to be removed from current or future contests.<sup>35</sup> Rugby's international governing body has very specific guidelines in place that address the removal of and return to play of a concussed player.<sup>24</sup> Even when athletic trainers and other medical providers are present on the sidelines, it is easy for players to hide the presence of concussion or to downplay subjective symptoms when asked.

## Limitations

The biggest limitation to this study was the imprecise exposure data, which did not account for the amount of practice time each day or for individual differences with respect to match-play minutes. The method used—the number of player-days—made it possible to compare these 2 particular men's and women's teams because it was consistent between teams. However, the injury rates may not be easily compared with results from other epidemiological studies of collegiate rugby injuries.

## CONCLUSION

This study illustrates some key differences in injury patterns between male and female American rugby players that may reflect underlying sex differences and contrasting playing styles. Specifically, male players often have an American football background where they are accustomed to tackling with helmets and protective padding, which are not used in rugby, whereas female players at the college level may have limited prior experience with collision sports and tackling.

## REFERENCES

- Agel J, Arendt EA, Bershadsky B. Anterior cruciate ligament injury in National Collegiate Athletic Association basketball and soccer: a 13-year review. *Am J Sports Med.* 2005;33:524-530.
- Arendt EA, Agel J, Dick R. Anterior cruciate ligament injury patterns among collegiate men and women. *J Athl Train.* 1999;34:86-92.
- Arendt E, Dick R. Knee injury patterns among men and women in collegiate basketball and soccer. NCAA data and review of literature. *Am J Sports Med.* 1995;23:694-701.
- Bird YN, Waller AE, Marshall SW, Alsop JC, Chalmers DJ, Gerrard DE. The New Zealand rugby injury and performance project: V. Epidemiology of a season of rugby injury. *Br J Sports Med.* 1998;32:319-325.
- Bjordal J, Arnoy F, Hannestad B, Strand T. Epidemiology of anterior cruciate ligament injuries in soccer. *Am J Sports Med.* 1997;25:341-345.
- Boden BP, Kirkendall DT, Garrett WE Jr. Concussion incidence in elite college soccer players. *Am J Sports Med.* 1998;26:238-241.
- Bonza JE, Fields SK, Yard EE, Comstock RD. Shoulder injuries among United States high school athletes during the 2005-2006 and 2006-2007 school years. *J Athl Train.* 2009;44:76-83.
- Collins CL, Micheli LJ, Yard EE, Comstock RD. Injuries sustained by high school rugby players in the United States, 2005-2006. *Arch Pediatr Adolesc Med.* 2008;162:49-54.
- Covassin T, Swanik CB, Sachs ML. Sex differences and the incidence of concussions among collegiate athletes. *J Athl Train.* 2003;38:238-244.
- Dallalana RJ, Brooks JH, Kemp SP, Williams AM. The epidemiology of knee injuries in English professional rugby union. *Am J Sports Med.* 2007;35:818-830.
- Dick RW. Is there a gender difference in concussion incidence and outcomes? *Br J Sports Med.* 2009;43(suppl 1):i46-i50.
- Dvorak J, McCrory P, Kirkendall DT. Head injuries in the female football player: incidence, mechanisms, risk factors and management. *Br J Sports Med.* 2007;41(suppl 1):i44-i46.
- Ferretti A, Papandrea P, Conteduca F, Mariani PP. Knee ligament injuries in volleyball players. *Am J Sports Med.* 1992;20:203-207.
- Fuller CW, Ashton T, Brooks JH, Cancea RJ, Hall J, Kemp SP. Injury risks associated with tackling in rugby union. *Br J Sports Med.* 2008;44:159-167.
- Fuller CW, Brooks JH, Cancea RJ, Hall J, Kemp SP. Contact events in rugby union and their propensity to cause injury. *Br J Sports Med.* 2007;41:862-867.
- Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RE. Concussion among United States high school and collegiate athletes. *J Athl Train.* 2007;42:495-503.
- Gwinn DD, Wilckens JH, McDevitt ER, Ross G, Kao TC. The relative incidence of anterior cruciate ligament injury in men and women at the United States Naval Academy. *Am J Sports Med.* 2000;28:98-102.
- Hame SL, LaFemina JM, McAllister DR, Schaadt GW, Dorey FJ. Fractures in the collegiate athlete. *Am J Sports Med.* 2004;32:446-451.
- Havkins S. Head, neck, face, and shoulder injuries in female and male rugby players. *Physician Sports Med.* 1986;14(7):111-118.
- Headey J, Brooks JH, Kemp SP. The epidemiology of shoulder injuries in English professional rugby union. *Am J Sports Med.* 2007;35:1537-1543.
- Hollis SJ, Stevenson MR, McIntosh AS, Shores EA, Collins MW, Taylor CB. Incidence, risk, and protective factors of mild traumatic brain injury in a cohort of Australian nonprofessional male rugby players. *Am J Sports Med.* 2009;37:2328-2333.
- Hootman JM, Dick M, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train.* 2007;42:311-319.
- Ingram JG, Fields SK, Yard EE, Comstock RD. Epidemiology of knee injuries among boys and girls in US high school athletics. *Am J Sports Med.* 2008;36:1116-1122.
- International Rugby Board. IRB concussion guidelines. *IRB Player Welfare Website.* Available at: <http://www.irbplayerwelfare.com/>. Accessed February 2013.
- International Rugby Board. Laws of the game rugby union. IRB Law Book. Available at: <http://www.irblaws.com/EN/>. Accessed March 2012.
- Kemp SP, Hudson Z, Brooks JH, Fuller CW. The epidemiology of head injuries in English professional rugby union. *Clin J Sports Med.* 2008;18:227-234.
- Kerr HA, Curtis C, Micheli LJ, et al. Collegiate rugby union injury patterns in New England: a prospective study. *Br J Sports Med.* 2008;42:595-603.
- Kerr ZY, Collins CL, Pommering TL, Fields SK, Comstock RD. Dislocation/separation injuries among US high school athletes in 9 selected sports: 2005-2009. *Clin J Sport Med.* 2011;21:101-108.
- Knowles SB, Marshall SW, Guskiewicz KM. Issues in estimating risks and rates in sports injury research. *J Athl Train.* 2006;41:207-215.
- Levy AS, Wetzler MJ, Lewars M, Laughlin W. Knee injuries in women collegiate rugby players. *Am J Sports Med.* 1997;25:360-362.
- Lewis E, George K. An initial investigation of injuries in women, men and youths playing Rugby Union football at the same club. *Sports Exerc Inj.* 1996;2:186-191.
- Lincoln AE, Caswell SV, Almquist JL, Dunn RE, Norris JB, Hinton RY. Trends in concussion incidence in high school sports: a prospective 11-year study. *Am J Sports Med.* 2011;39:958-963.
- Lopez V Jr, Galgano GJ, Black CM, et al. Profile of an American amateur rugby union sevens series. *Am J Sports Med.* 2012;40:179-184.
- Marshall SW, Spencer RJ. Concussion in rugby: the hidden epidemic. *J Athl Train.* 2001;36:334-338.
- McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players: implications for prevention. *Clin J Sports Med.* 2004;14:13-17.
- Messina DF, Farnley WC, DeLee JC. The incidence of injury in Texas high school basketball. A prospective study among male and female athletes. *Am J Sports Med.* 1999;27:294-299.

37. Mihata L, Beutler A, Boden B. Comparing the incidence of anterior cruciate ligament injury in collegiate lacrosse, soccer, and basketball players: implications for anterior cruciate ligament mechanisms and prevention. *Am J Sports Med.* 2006;34:899-904.
38. Mountcastle SB, Posner M, Kragh JF Jr, Taylor DC. Gender differences in anterior cruciate ligament injury vary with activity: epidemiology of anterior cruciate ligament injuries in a young, athletic population. *Am J Sports Med.* 2007;35:1635-1642.
39. Myklebust G, Maehlum S, Holm I, Bahr R. A prospective cohort study of anterior cruciate ligament injuries in elite Norwegian team handball. *Scand J Med Sci Sports.* 1998;8:149-153.
40. Owens BD, Agel J, Mountcastle SB, Cameron KL, Nelson BJ. Incidence of glenohumeral instability in collegiate athletics. *Am J Sports Med.* 2009;37:1750-1754.
41. Pallis M, Cameron KL, Svoboda SJ, Owens BD. Epidemiology of acromioclavicular joint injury in young athletes. *Am J Sports Med.* 2012;40:2072-2077.
42. Powell JW, Barber-Foss KD. Traumatic brain injury in high school athletes. *JAMA.* 1999;282:958-963.
43. Prodromos CC, Han Y, Rogowski J, Joyce B, Shi K. A meta-analysis of the incidence of anterior cruciate ligament tears as a function of gender, sport, and knee injury-reduction regimen. *Arthroscopy.* 2007;23:1320-1325.
44. Quarrie KL, Hopkins WG. Tackle injuries in professional rugby union. *Am J Sports Med.* 2008;36:1705-1716.
45. Schulz MR, Marshall SW, Mueller FO, et al. Incidence and risk factors for concussion in high school athletes, North Carolina, 1996-1999. *Am J Epidemiol.* 2004;160:937-944.
46. Stevenson H, Webster J, Johnson R, Beynonn B. Gender differences in knee injury epidemiology among competitive alpine ski racers. *Iowa Orthop J.* 1998;18:64-66.
47. Swenson DM, Yard EE, Collins CL, Fields SK, Comstock RD. Epidemiology of US high school sports-related fractures, 2005-2009. *Clin J Sport Med.* 2010;20:293-299.
48. USA Rugby. USA rugby membership statistics. Available at: <http://www.usarugby.org/>. Accessed December 2011.
49. Waterman BR, Belmont PJ Jr, Cameron KL, DeBerardino TM, Owens BD. Epidemiology of ankle sprain at the United States Military Academy. *Am J Sports Med.* 2010;38:797-803.
50. Waterman BR, Belmont PJ Jr, Cameron KL, Svoboda SJ, Alitz CJ, Owens BD. Risk factors for syndesmotic and medial ankle sprain: role of sex, sport, and level of competition. *Am J Sports Med.* 2011;39:992-998.
51. Webb J, Bannister G. Acromioclavicular disruption in first class rugby players. *Br J Sports Med.* 1992;26:247-248.
52. Whiteside JA, Fleagle SB, Kalenak A. Fractures and refractures in intercollegiate athletes. An eleven-year experience. *Am J Sports Med.* 1981;9:369-377.
53. Wilson BD, Quarrie KL, Milburn PD, Chalmers DJ. The nature and circumstances of tackle injuries in rugby union. *J Sci Med Sport.* 1999;2:153-162.
54. Yard EE, Comstock RD. Injuries sustained by rugby players presenting to United States emergency departments, 1978 through 2004. *J Athl Train.* 2006;41:325-331.

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