SUMMARY REPORT

RUGBY RIO™ (REPORTING INFORMATION ONLINE) HIGH SCHOOL: INTERNET-BASED SURVEILLANCE OF INJURIES SUSTAINED BY US HIGH SCHOOL RUGBY PLAYERS

2006

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Note

The analyses presented here provide only a brief summary of collected data, with the feasibility of a more-detailed presentation limited by the extensive breadth and detail contained in the dataset. The principal investigator, Dr. R. Dawn Comstock, is happy to provide further information or to discuss opportunities for others to have access to the data upon request.

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1. Introduction and Background

1.1 Project Overview

Rugby, a fast-paced collision sport with worldwide popularity, is establishing a strong base in the US. The 63,254 participants that were registered with USA Rugby in 2006 included males and females and youth as well as adults, with youth accounting for 38.9% (24,616) of all registered participants.[1] Although rugby constitutes a good form of exercise, its physical nature combined with the absence of required protective gear also presents a risk for injury. Even though several rugby research studies have evaluated various risk and protective factors or have described patterns of injury among players of varying ages and levels of competition, little has been done to calculate injury rates or compare patterns of injury among youth players in the US. A well-designed surveillance system collecting data over time can accurately monitor injury rates and patterns to assist governing bodies with identifying and addressing risk factors associated with injury.

1.2 Background and Significance

Rugby RIO™ (Reporting Information Online), a time- and cost-efficient internet-based rugby injury surveillance system, was first implemented in the US to monitor injuries during the spring 2005 high school rugby season. Funded by the United States Rugby Football Foundation (USRFF) and under the direction of Dr. R. Dawn Comstock, this project was the largest prospective study of injuries ever in this population. The data collected provided the US rugby community with a wealth of data that allowed for the calculation of injury rates and a description of rugby injury patterns. Important findings included: 1) the rate of injury in competition is higher than the rate of injury in practice, 2) the majority of injuries occurred as a result of

[1] USA Playing Numbers. International Rugby Board. Available at http://www.irb.com/en/Home/MemberUnionHomePage?UnionID=12&Tab=3. Accessed August 2006.

tackling or being tackled, and 3) one out of five injuries occurred to the head. A summary of this study's results can be found on the USA Rugby website and is available upon request.

Following the success of the study's pilot season, the USRFF provided the financial support needed to continue this project during the 2006 high school rugby season. Thus far, comparing data from 2005 and 2006 indicates that rugby injury patterns from each year were very similar, with injury rates decreasing from 2005 to 2006. Continuing this type of injury surveillance is important for providing the USRFF, coaches, and referees with research-based preventive interventions that, if implemented, can make rugby an even safer sport to play.

1.3 Specific Aims

The objective of this study was to continue the internet-based injury surveillance system, Rugby RIO^{TM} High School, to monitor the incidence of injuries among US high school rugby players and identify risk factors associated with injury. The specific aims of this study were:

A) To determine the incidence (number) of injuries among US high school rugby players.

B) To calculate the rate of injuries per 1,000 player-matches, per 1,000 player-practices, and per 1,000 player-exposures for US high school rugby players.

C) To provide detailed information about the injuries sustained by US high school rugby players including the type, site, severity, initial and subsequent treatment, outcome, etc.

D) To provide detailed information about the injury events including player demographics, position played, phase of play/activity, etc.

E) To identify potential risk or protective factors and preventive mechanisms to reduce the incidence of injuries among US high school rugby players.

F) To compare the results of Rugby RIO^{TM} High School 2006 to the results of Rugby RIO^{TM} High School 2005.

1.4 Project Design

RIO™, an internet-based sports injury surveillance system developed by Dr. Comstock at the Center for Injury Research and Policy at Columbus Children's Hospital, was utilized to perform surveillance of injuries sustained by US high school rugby players during the 2006 spring season. For the purpose of this study, a reportable injury was defined as:

A) An injury that occurred as a result of participation in an organized high school rugby match or practice and

B) Required medical attention by a club physician, certified athletic trainer, personal physician, or emergency department/urgent care facility and

C) Resulted in restriction of the high school rugby player's participation in regular school or rugby activities for one or more days beyond the day of injury.

A player-exposure was defined as one player participating in one practice or match where he or she is exposed to the possibility of athletic injury. Exposure was expressed in two parts:

A) Number of player-practices = the sum of the number of players at each practice during the past week. For example, if 20 players practiced on Monday and 18 practiced on Wednesday, the number of player-practices would equal 38.

B) Number of player-matches = the sum of the number of players at each match during the past week. For example, if there were 2 matches with 18 players participating in the first match and 16 participating in the second, the number of player-matches would equal 34.

1.4.1 Sample Recruitment

After receiving contact information for US high school rugby clubs from USA Rugby and augmenting this with contact information from Rugby Magazine, 840 US high school rugby clubs were identified. A mass e-mail was sent to those clubs with e-mail contacts informing

them of the surveillance project, inviting them to participate, and providing a link to the RIO™ site that allowed them to enroll their club in the study. At least 3 attempts were made to contact each club. Additionally, the project was promoted on the USA Rugby website (http://www.usarugby.org), the USRFF website (http://www.usrugbyfoundation.org), http://goffonrugby.com, http://www.planet-rugby.com, and on http://www.rugbyrugby.com.

It was difficult to make contact with clubs for several reasons including identified clubs that lacked an e-mail contact, club contact information that was not current, identified clubs that were actually no longer in existence, etc. For example, of the 840 identified clubs, some did not receive the initial mass e-mail because we could not find a current contact (19.3%) or the e-mail bounced back as undeliverable (15.8%). Of the remaining 545 clubs that were sent an e-mail about the surveillance project, 14.5% (n=79) enrolled their club in the study.

1.4.2 Data Collection

Each high school rugby club that expressed interest in participating in Rugby RIO™ High School was asked to designate a reporter. Desired club reporters were (listed in order of preference): a club physician, a club certified athletic trainer, another club medical personnel (e.g., nurse, EMT, etc.), a club coach, or a club manager. To enroll in the project, the designated reporter from each club accessed the internet-based surveillance system to complete a reporter background survey. This survey collected contact details and information about the club they represented (e.g. number of players, gender, etc.) as well as information about the reporter's medical training and rugby experience.

Once enrolled, every Monday throughout the study period, reporters received an e-mail reminder to enter their club's data into the surveillance system. Each participating club was asked to complete 23 weekly exposure reports: one for each week from January 16, 2006 through

June 25, 2006. Exposure reports collected exposure information (number of player-matches and player-practices) and the number of reportable injuries sustained by members of the club they represented. For each reported injury, the reporter was asked to complete an injury report. The injury report collected detailed information about the injury (e.g. site, type, severity, etc.) and the injury event (e.g. player demographics, position played, phase of play, etc.). This internet-based surveillance tool provided reporters with the ability to view all the data they had reported throughout the study as well as the option to update all injury reports with information that was not available at the time the initial report was submitted (e.g. the need for surgery, the final outcome, etc.).

1.4.3 Data Management

In an effort to decrease loss to follow-up, a log of reporters' utilization of the internet-based injury surveillance system was maintained throughout the study period. Reporters who repeatedly failed to log on to complete the weekly exposure and injury reports received a phone call or email from the Center for Injury Research and Policy reminding them to do so and assessing their willingness to continue with the study.

1.4.4. Data Analysis

Data were analyzed using SPSS software, version 14.0. Continuous variables were compared using the t-test, with $p<0.05$ considered statistically significant. Injury rates were compared using relative risks (RR) with 95% confidence intervals (CI). The relative risks assess the magnitude and direction of associations. RR > 1 indicate an association exists between a risk factor and an outcome. Such associations are considered statistically significant if the 95% CI does not include 1. Following is an example of the RR calculation comparing the rate of boys' rugby injuries to the rate of girls' rugby injuries:

$$RR = \frac{\#\,\text{boys' rugby injuries / total}\,\#\,\text{boys' rugby player - exposures}}{\#\,\text{girls' rugby injuries / total}\,\#\,\text{girls' rugby player - exposures}}$$

Injury proportions were compared using injury proportion rations (IPR) and 95% CIs. Following is an example of the IPR calculation comparing the proportion of boys' concussions to the proportion of girls' concussions:

$$IPR = \frac{\#\,\text{boys' concussions / total}\,\#\,\text{boys' injuries}}{\#\,\text{girls' concussions / total}\,\#\,\text{girls' injuries}}$$

2. Rates of Injury

Enrolled clubs reported 287 injuries (235 match injuries, 49 practice injuries, and 3 injuries occurring during an unspecified exposure) in 63,529 player-exposures (16,201 player-matches and 47,328 player-practices). (The 3 injuries occurring during unspecified exposure were excluded from rate analysis). The overall injury rate was 4.5 injuries per 1,000 player-exposures, with the overall injury rate higher among boys (4.9 injuries per 1,000 player-exposures) than girls (2.7 injuries per 1,000 player-exposures) (RR=1.81, 95% CI: 1.28-2.57).

Injury rates differed by type of exposure, with the rate higher in competition (14.5 injuries per 1,000 player-matches) than practice (1.0 injuries per 1,000 player-practices) (RR=13.80, 95% CI: 10.15-18.77). The competition injury rate was similar among girls (15.2 injuries per 1,000 player-matches) and boys (14.4 injuries per 1,000 player-matches) (RR=1.05, 95% CI: 0.71-1.56). The practice injury rate was slightly higher among boys (1.1 injuries per 1,000 player-practices) than girls (0.7 injuries per 1,000 player-practices), although this difference was insignificant (RR=1.63, 95% CI: 0.76-3.47).

Table 2.1 presents injury rate information for rugby along with the injury rate of several other high school sports. Injury rates for the other high school sports came from a CDC funded

study, High School RIO™, conducted by Dr. Comstock during the 2005-2006 academic year. Since High School RIO™ employed the same definitions of injury and exposure as the current study, injury rates can be compared directly across sports.

Table 2.1 highlights:

- The overall rate of injury was similar between boys' rugby (4.9 injuries per 1,000 player-exposures) and boys' football (4.4 injuries per 1,000 player-exposures) (RR=1.13, 95% CI: 0.99-1.29). The competition injury rate was slightly higher in boys' rugby (14.4 injuries per 1,000 player-matches) compared to boys' football (12.1 injuries per 1,000 player-competitions) (RR=1.19, 95% CI: 1.03-1.38).
- The overall rate of injury was higher in boys' rugby (4.9 injuries per 1,000 player-exposures) than boys' soccer (2.4 injuries per 1,000 player-exposures) (RR=2.00, 95% CI: 1.70-2.35). The competition injury rate was higher in boys' rugby (14.4 injuries per 1,000 player-matches) than boys' soccer (4.2 injuries per 1,000 player- competitions) (RR=3.38, 95% CI: 2.79-4.10).
- The overall rate of injury was similar between girls' rugby (2.7 injuries per 1,000 player-exposures) and girls' soccer (2.4 injuries per 1,000 player-exposures) (RR=1.16, 95% CI: 0.82-1.64). The competition injury rate was higher for girls' rugby (15.2 injuries per 1,000 player-matches) than girls' soccer (5.2 injuries per 1,000 player-competitions) (RR=2.89, 95% CI: 1.96-4.27).

Table 2.1 Rate of Injury by Sport*

	# Injuries	# Exposures	Injury rate (per 1,000 player-exposures)
Boys' rugby total	248	50,377	4.9
Competition	207	14,359	14.4
Practice	41	36,018	1.1
Girls' rugby total	36	13,152	2.7
Competition	28	1,842	15.2
Practice	8	11,310	0.7
Boys' football total†	1,880	431,242	4.4
Competition	992	82,059	12.1
Practice	888	349,183	2.5
Boys' soccer total†	372	153,400	2.4
Competition	208	49,294	4.2
Practice	164	104,106	1.6
Girls' soccer total†	334	141,581	2.4
Competition	226	43,415	5.2
Practice	108	98,166	1.1
Girls' volleyball total†	196	119,235	1.6
Competition	84	43,691	1.9
Practice	112	75,544	1.5
Boys' basketball total†	412	218,342	1.9
Competition	184	61,663	3.0
Practice	228	156,679	1.5
Girls' basketball total†	374	186,161	2.0
Competition	192	53,325	3.6
Practice	182	132,836	1.4
Boys' wrestling total†	415	166,279	2.5
Competition	158	40,220	3.9
Practice	257	126,059	2.0
Boys' baseball total†	214	179,435	1.2
Competition	113	63,871	1.8
Practice	101	115,564	0.9
Girls' softball total†	153	135,089	1.1
Competition	83	46,727	1.8
Practice	70	88,362	0.8

*Injuries reported as occurring during "other" exposures were not included in this analysis.
† Since these injury and exposure numbers are from High School RIO™ 2005-2006, a study using identical definitions of injury and exposure, direct rate comparisons to Rugby RIO™ High School can be made.

3. Injury Epidemiology

3.1 General Injury Patterns

3.1.1 Injured Player Demographics

Of the 287 reported injuries, the majority occurred among boys (n=251, 87.5%). Age, height, and weight information is presented in Table 3.1.

Table 3.1 Demographic Information of Injured Rugby Players

	Age (years)	Height (inches)	Weight (pounds)
Boys			
Mean	16.5	69.5	175.6
Minimum	14	56	100
Maximum	19	79	285
Girls			
Mean	16.2	64.6	135.6
Minimum	13	60	100
Maximum	18	72	250

Table 3.1 highlights:

- The average age was similar between injured boys (16.5 years) and injured girls (16.2 years).
- Injured boys were significantly taller on average (69.5 inches) than injured girls (64.6 inches) ($p<0.001$).
- Injured boys were significantly heavier on average (175.6 pounds) than injured girls (135.6 pounds) ($p<0.001$).

Injury diagnosis, time loss resulting from injury, and activity resulting in injury did not vary by age, height, or weight. Injured forwards were significantly taller (69.9 inches) than injured backs (68.0 inches) ($p<0.001$) and significantly heavier (190.8 pounds and 155.8 pounds,

respectively) ($p<0.001$). Further comparisons between forwards and backs are presented in section 3.2.3 “Injuries by Position”.

3.1.2 Overall Injuries

Overall, the majority of injuries were new (87.9%), with 6.8% being a recurrence of an injury from another sport, 3.6% being a recurrence of a rugby injury from the current season, 1.4% being a recurrence of a rugby injury from a previous season, and 0.4% being a recurrence of a non-sport injury. Half of all injuries were assessed by an M.D./D.D.S. (46.6%), 23.5% by an athletic trainer, and 17.8% via X-ray. The remaining 12.1% were diagnosed following an MRI or other imaging technique.

The majority of injuries occurred during the regular season (75.7%), followed by preseason (17.5%) and postseason (5.7%), with 1.1% occurring during an other/unspecified time. Half of all injured rugby players were in their first year of play (48.2%), with fewer players having played for 1 (20.1%), 2 (16.2%), 3 (13.7%), or >3 (1.8%) years. The majority of players were playing for a high school team at the time of injury (94.9%), with 4.4% playing for a club team, 0.4% for a collegiate team, and 0.4% for a select side/all star team.

The head accounted for the largest proportion of injuries (23.1%), followed in frequency by the knee (13.6%), shoulder (11.9%), ankle (10.8%), face (9.4%), and clavicle (5.9%). Blood was present with 12.2% of injuries. The most common type of injury was a strain/sprain (26.1%), followed by fracture (17.8%), concussion (17.8%), contusion (8.4%), and laceration (4.9%). Of concussions with a known grade (n=47), 78.7% were first degree, 12.8% were second degree, and 8.5% were third degree. While only 14.1% of injured players were able to return to play in 1-2 days, an additional 12.2% were able to return in 3-6 days, 24.1% in 7-9

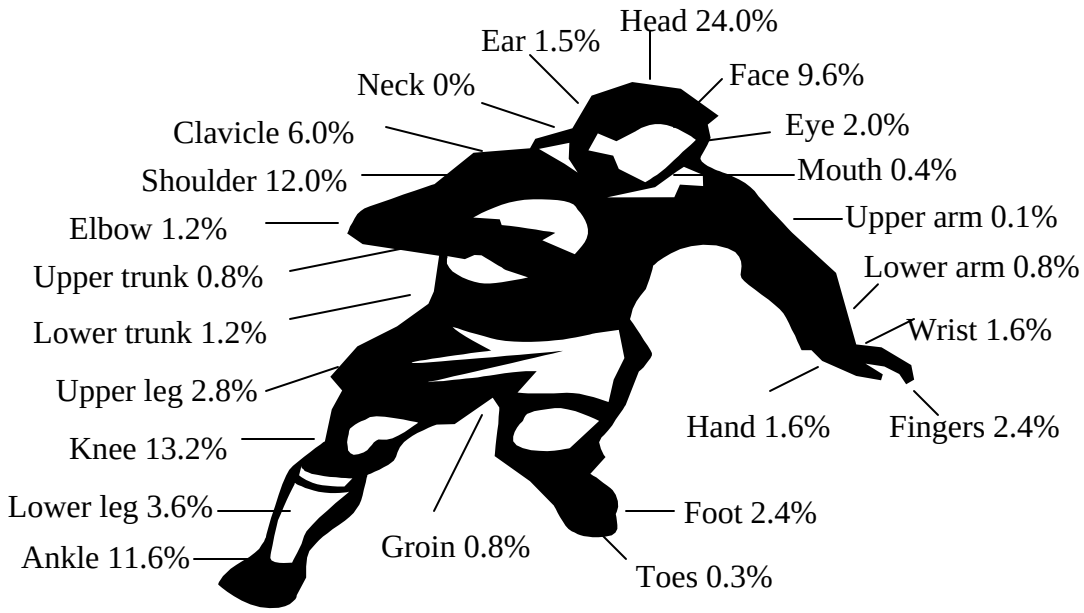
days, and 21.2% in 10-21 days. Over one-quarter of the injured (28.4%) were kept out of play for 22 days or more. Surgery was required following 10.4% of injuries.

Impact with another player was the cause of 52.5% of all injuries, with an additional 27.0% from impact with the ground/playing surface. Specifically, over half of all injuries resulted from being tackled (30.7%) or tackling (28.2%), with rucking (15.3%) and running during play (9.8%) being the next most frequent activities. Mouthguards were the most commonly used piece of protective equipment (94.4% of injured players were wearing a mouthguard), followed in frequency by scrumcaps (15.0%) and shoulder pads (12.4%).

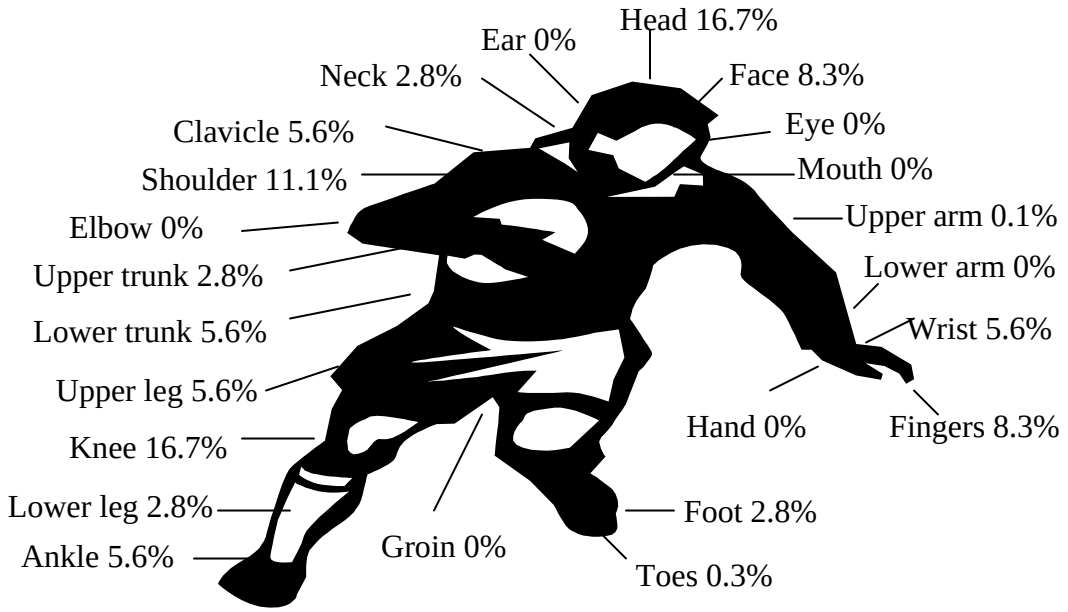
3.1.3 Boys' versus Girls' Injuries

Injuries sustained by boys and girls are compared with respect to body site injured (Fig 3.1), injury diagnosis (Fig 3.2), time loss (Fig 3.3), and disposition (Fig 3.4).

Figure 3.1 Body Site Injured by Gender



Boys, n=251

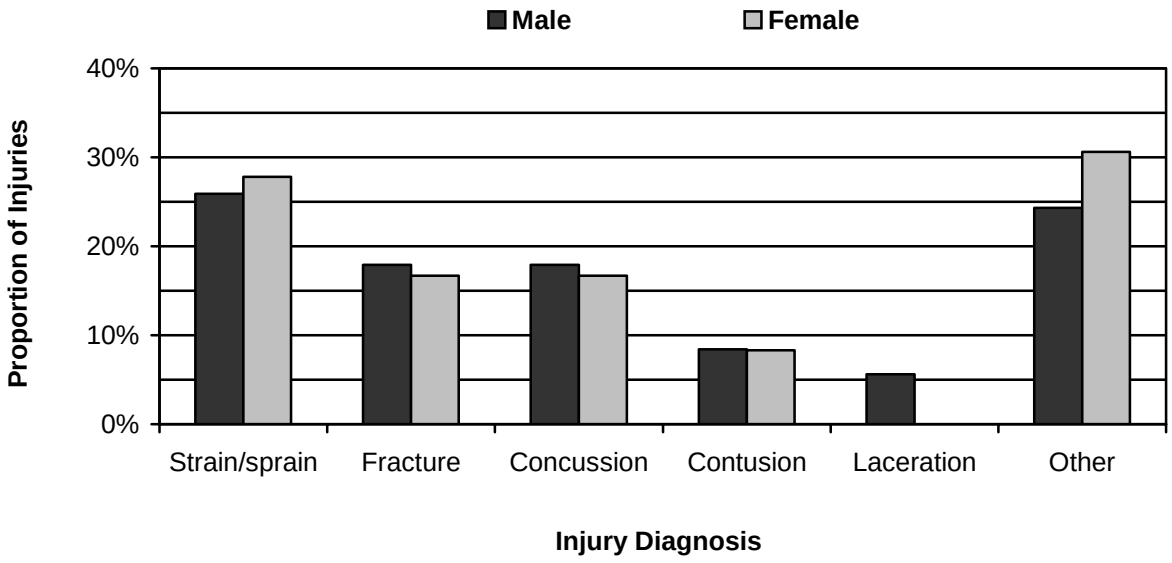


Girls, n=36

Figure 3.1 highlights:

- Girls sustained a higher proportion of trunk injuries (8.3%) compared to boys (2.0%) (IPR= 4.17, 95% CI: 1.04-16.70).
- Girls also sustained an insignificantly higher proportion of injuries to the wrist, hand, and fingers (13.9%) compared to boys (5.6%) (IPR= 2.48, 95% CI: 0.95-6.47).
- Boys sustained an insignificantly higher proportion of head injuries (24.0%) than girls (16.7%) (IPR= 1.44, 95% CI: 0.67-3.09).
- Boys also sustained an insignificantly higher proportion of ankle injuries (11.6%) compared to girls (5.6%) (IPR= 2.09, 95% CI: 0.52-8.38).
- The proportion of knee injuries was similar between girls (16.7%) and boys (13.2%) (IPR=1.26, 95% CI: 0.57-2.80).
- There was only 1 reported neck injury, sustained by a girl tackling an opponent in competition. She was diagnosed with a disk irritation and returned to play in 1-2 days.

Figure 3.2 Injury Diagnoses by Gender



*Other injuries include dislocation, hyperextension, torn cartilage, etc. None of these other individual injury diagnoses accounted for greater than 5% of total injuries.

Figure 3.2 highlights:

- Boys and girls sustained similar proportions of strains/sprains, fractures, concussions, and contusions.
- Although 5.6% of boys' injuries were lacerations, no girls sustained a laceration.

Figure 3.3 Player Time Loss Due to Injury by Gender

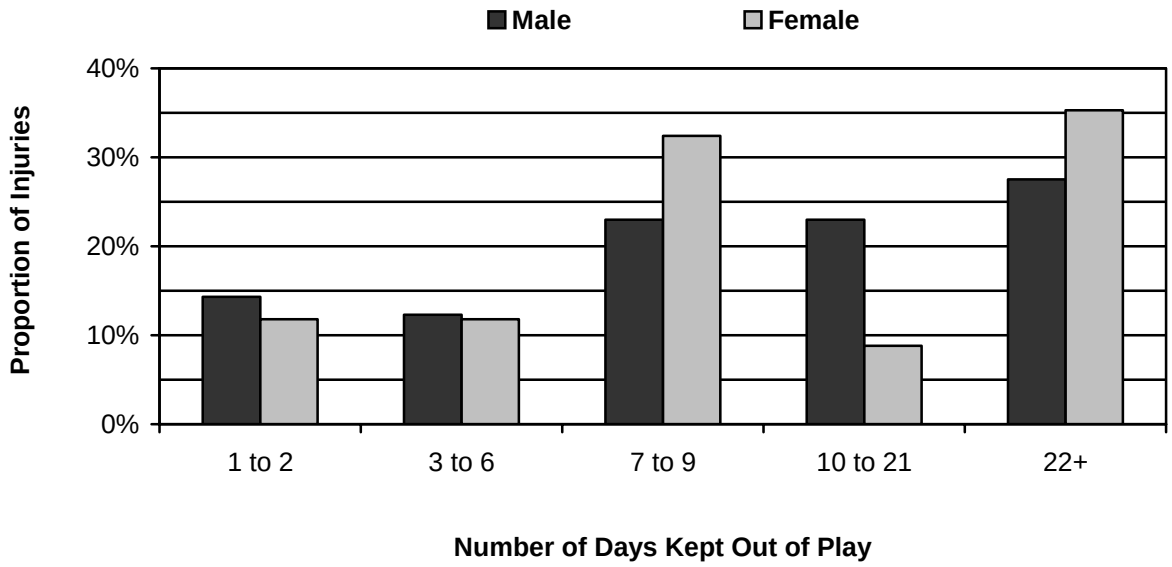


Figure 3.3 highlights:

- Boys and girls tended to experience a similar number of days lost as a result of injury.
- An insignificantly higher proportion of boys returned to play following 10 to 21 days (23.0%) compared with girls (8.8%) (IPR=2.60, 95% CI: 0.86-7.85).

Figure 3.4 Final Injury Disposition by Gender

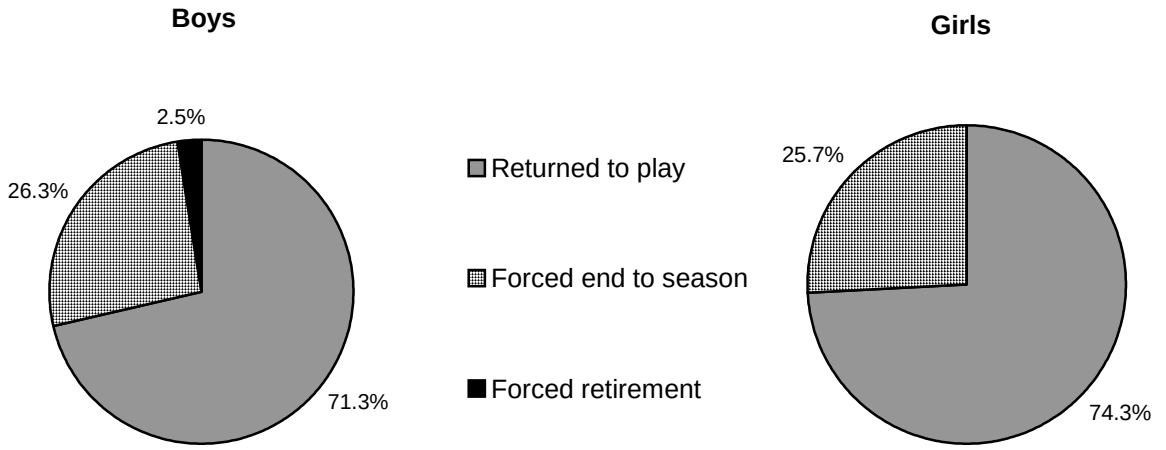


Figure 3.4 highlights:

- Overall, 71.4% of injured rugby players were able to return to play in the 2006 season, with 26.1% forced to end their season but expected to return to play in future seasons.
- There were 6 boys with injuries that were reported as resulting in their forced retirement from rugby:
    - An outside center who sustained a third-degree concussion while tackling in competition.
    - A scrum half who sustained a nerve injury to the eye following impact with the ground during a scrum in competition. This injury required surgery.
    - A flanker who sustained a complete shoulder dislocation while being tackled in competition.
    - A flanker who sustained a clavicle fracture while being tackled in competition.
    - A flanker who sustained a complete wrist dislocation while being tackled in competition. This injury required surgery.
    - A wing who sustained torn cartilage in the knee while running in practice.

Although insignificant, injured boys tended to be outside centers (11.0%) more often than girls (3.6%) (IPR=3.07, 95% CI: 0.43-21.81), while injured girls tended to be scrum halves (14.3%) more often than boys (5.9%) (IPR=2.41, 95% CI: 0.84-6.87). Also, although insignificant, boys were more likely to be injured while rucking (16.3%) than girls (8.3%) (IPR=1.96, 95% CI: 0.64-6.00), while girls sustained a higher proportion of injuries while scrummaging (8.3%) than boys (2.4%) (IPR=3.49, 95% CI: 0.91-13.33).

3.2 Associations of Interest

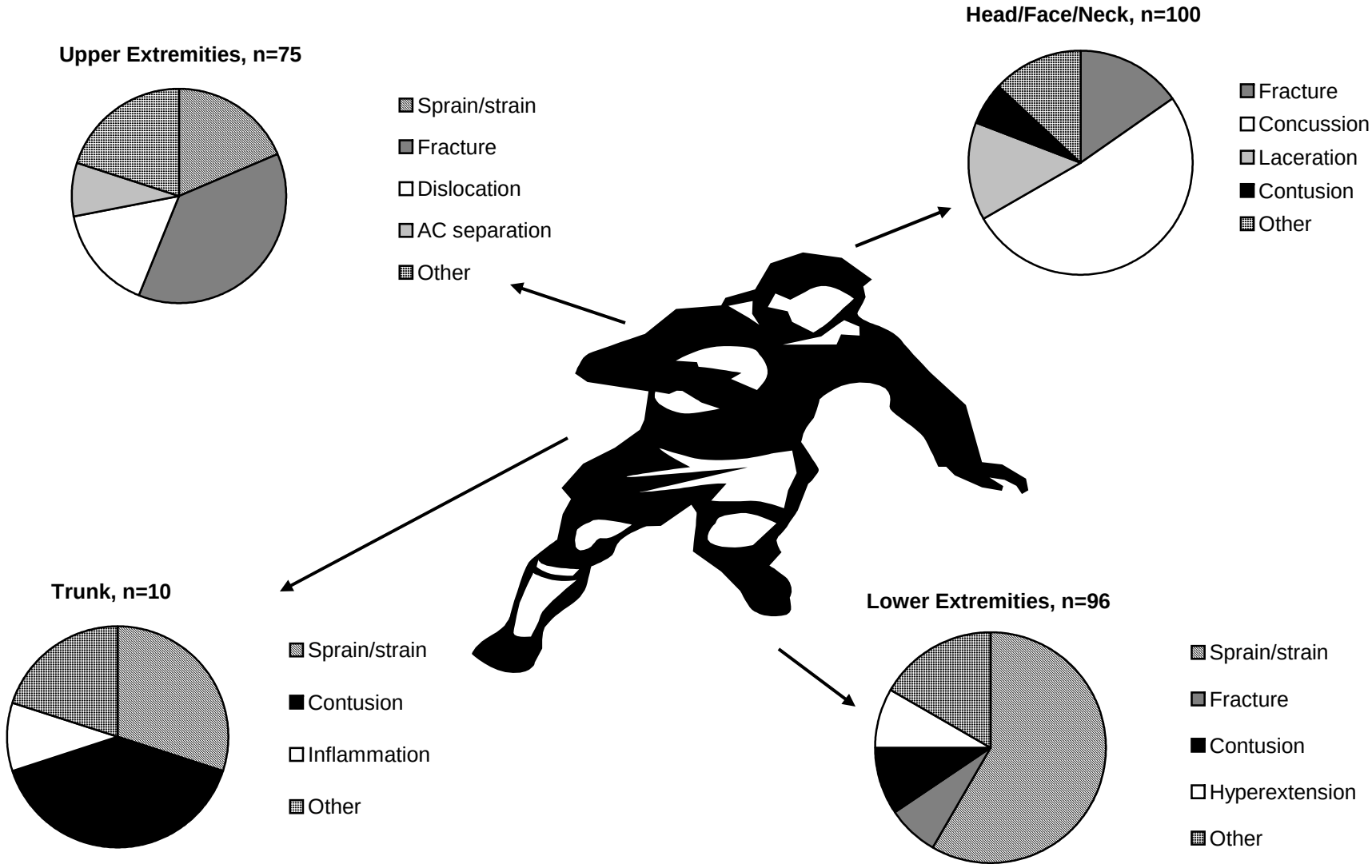
3.2.1 Relationships between Injury Diagnosis, Body Site, Mechanism of Injury, and Time Loss

Figure 3.5 presents injury diagnosis by body site, figure 3.6 presents injury mechanism by diagnosis, and figure 3.7 presents player time loss due to injury by diagnosis.

Figure 3.5 highlights:

- Half of all injuries occurring to the head/face/neck were concussions (51.5%).
- Fractures accounted for a higher proportion of upper extremity injuries (37.3%) than head/face/neck (15.2%) (IPR=2.49, 95% CI: 1.43-4.32) or lower extremity (7.3%) (IPR=5.12, 95% CI: 2.37-11.07) injuries.
- Sprains/strains accounted for a higher proportion of lower extremity injuries (58.3%) than upper extremity (18.7%) (IPR=3.13, 95% CI: 1.89-5.16) or trunk (30.0%) (IPR=1.94, 95% CI: 0.74-5.09) injuries, although the latter was insignificant.

Figure 3.5 Injury Diagnosis by Body Site



*Cases not specifying body site of injury were excluded from this analysis (n=6).

Figure 3.6 Injury Mechanism by Diagnosis

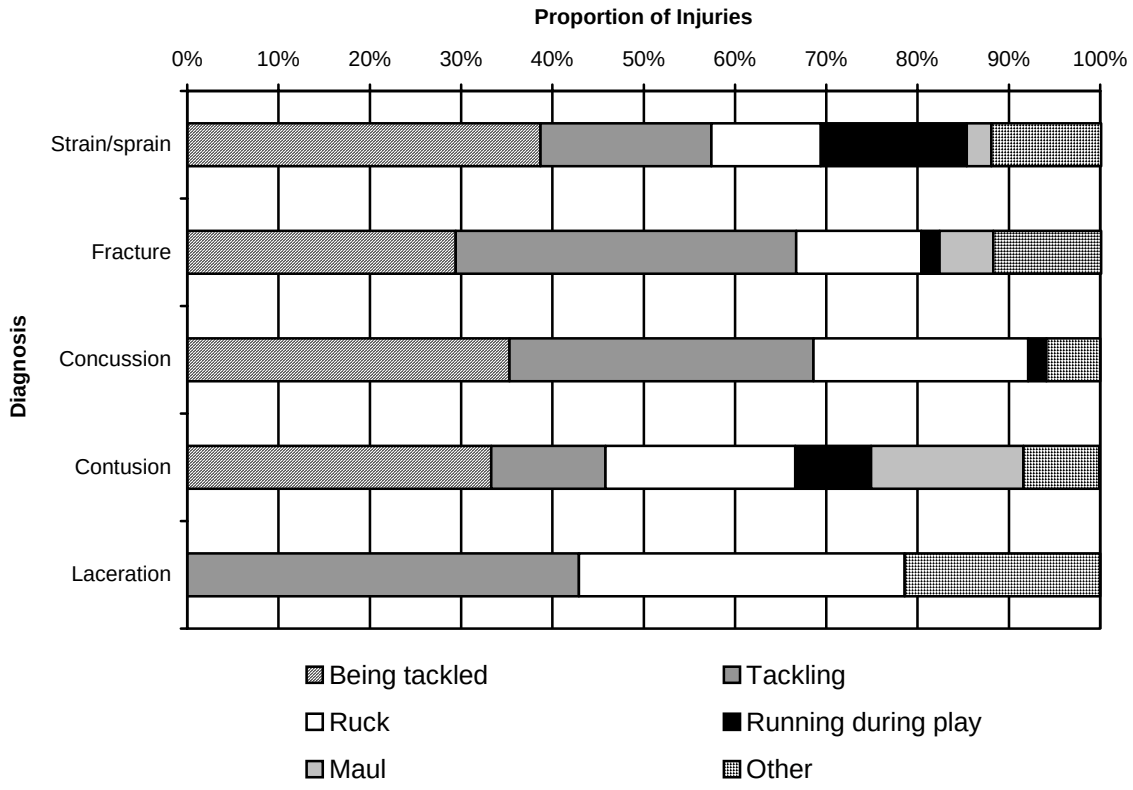


Figure 3.6 highlights:

- Being tackled and tackling caused the majority of strains/sprains (57.3%), fractures (66.7%) and concussions (68.6%).
- Rucks tended to result in lacerations (35.7%) and concussions (23.5%) most often.
- Running during play resulted in strains/sprains (16.0%) most often.
- Mauls tended to result in contusions (16.7%) most often.

Figure 3.7 Player Time Loss Due to Injury by Diagnosis

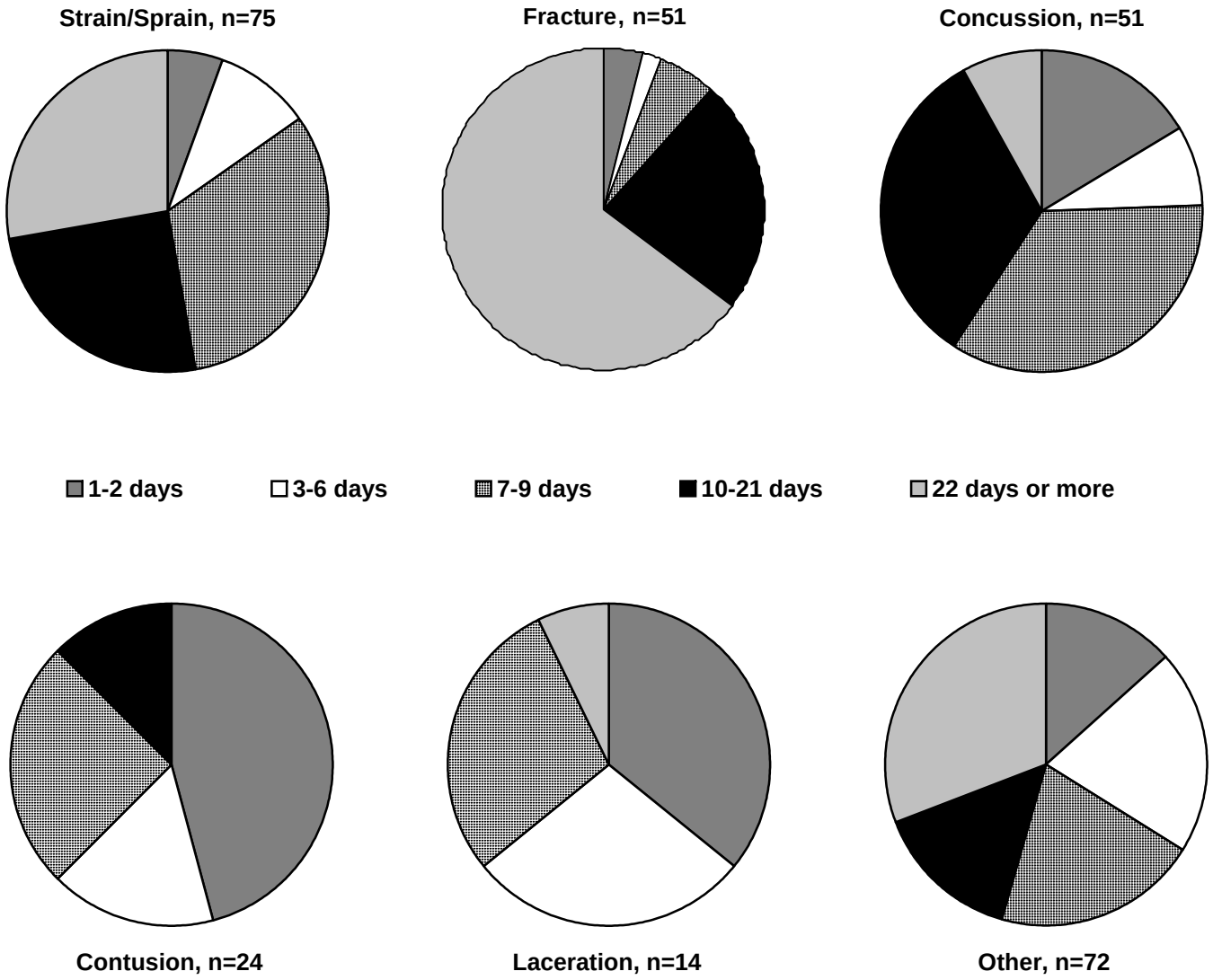


Figure 3.7 highlights:

- The majority of rugby players sustaining a fracture lost 22 days or more of play (64.7%).
- Rugby players sustaining a concussion tended to be kept out of play for 7-9 (34.7%) or 10-21 (32.7%) days.
- Over half of all rugby players sustaining a contusion (62.5%) or laceration (64.3%) returned to play within 6 days following injury.
- Approximately half of all rugby players sustaining a strain/sprain (47.2%) or other injury (54.4%) returned to play within 9 days following injury.

3.2.2 Competition versus Practice Injuries

Figure 3.8 depicts the proportion of injuries sustained during competition and practice.

Figure 3.8 Type of Exposure during which Injury Occurred

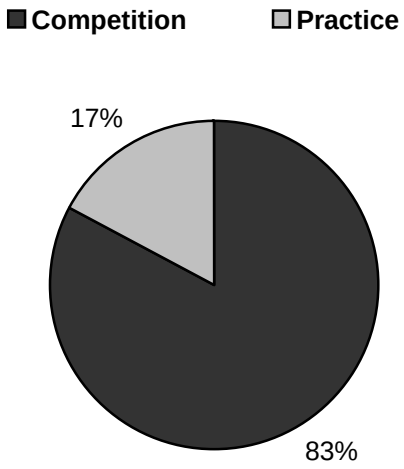
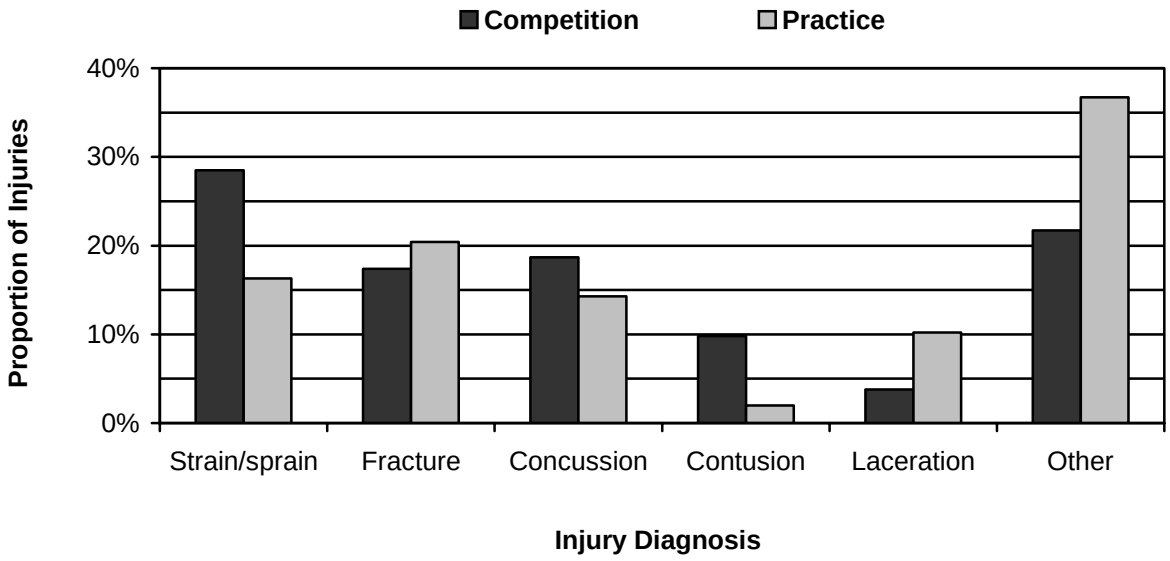


Figure 3.8 highlights:

- The majority of injuries occurred during competition, with boys sustaining 83.5% of injuries during competition and girls sustaining 77.8% of injuries during competition.

Figure 3.9 Injury Diagnosis by Type of Exposure



*Other injuries include dislocation, hyperextension, torn cartilage, etc. None of these other injury diagnoses accounted for greater than 5% of total injuries.

Figure 3.9 highlights:

- Although insignificant, injuries occurring during competition (9.8%) tended to be a contusion more often than practice injuries (2.0%) (IPR=4.80, 95% CI: 0.66-34.68).
- Strains/sprains made up a greater proportion of competition injuries (28.5%) compared to practice injuries (16.3%), although this was insignificant (IPR=1.75, 95% CI: 0.90-3.40).
- Lacerations were more common among practice injuries (10.2%) than competition injuries (3.8%) (IPR= 2.66, 95% CI: 0.93-7.61), although this was insignificant.
- Competition injuries did not differ from practice injuries with respect to the proportion of fractures (17.4% and 20.4%, respectively) or concussions (18.7% and 14.3%, respectively).

Figure 3.10 Player Time Loss Due to Injury by Type of Exposure

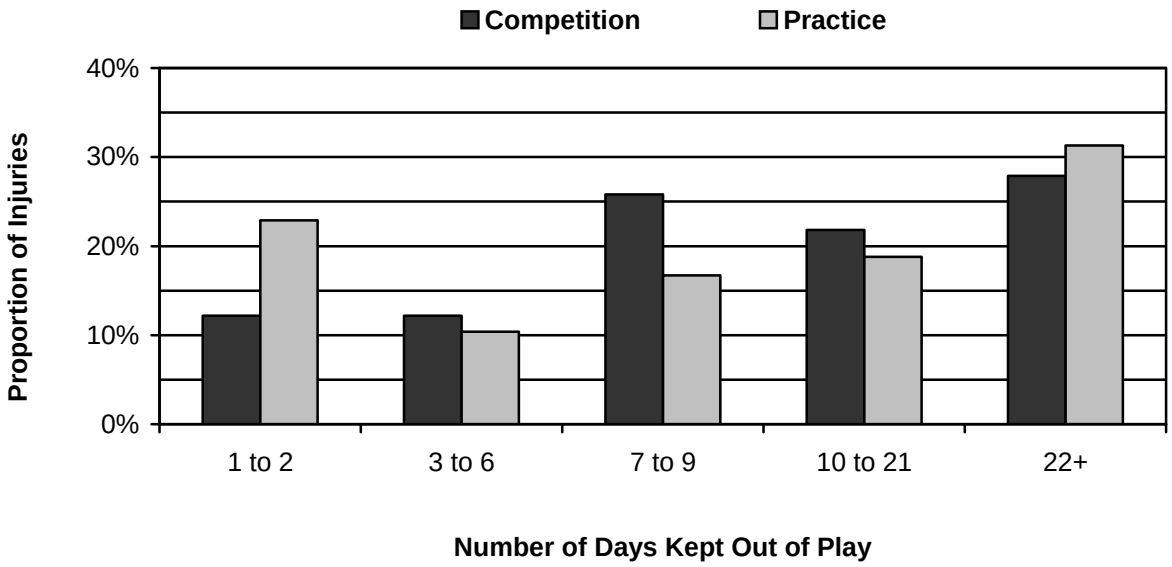


Figure 3.10 highlights:

- Competition (27.9%) and practice (31.3%) injuries were both equally likely to result in player time loss of 22 days or more.
- Injuries occurring during practice were more likely to result in 1 to 2 days loss of play (22.9%) compared with injuries occurring during competition (12.2%) (IPR=2.04, 95% CI: 1.09-3.81).
- Although injuries occurring in competition were more likely to result in 7 to 9 days loss of play (25.8%) than injuries occurring during practice (16.7%) (IPR=1.64, 95% CI: 0.84-3.22), this difference was insignificant.

Injuries occurring during competition were sustained most frequently at the beginning of the 2nd half (33.5%), with 30.0% sustained at the end of the 2nd half, 23.6% sustained at the end of the 1st half, 11.2% sustained at the beginning of the 1st half, and 1.7% sustained at other times.

Almost half of rugby players sustained injuries during a home match (48.5%), with 35.7% sustaining an injury during an away match, 15.0% during a match at a neutral site, and 0.9% unspecified.

Of those injuries occurring during competition, 5.2% were the result of foul play. Compared to other competition injuries (26.5%), foul play injuries were more likely to result in player time loss of 22 days or more (58.3%) (IPR=2.20, 95% CI: 1.30-3.73). Although insignificant, foul play injuries tended to be concussions (33.3%) more often than other injuries (18.2%) (IPR=1.83, 95% CI: 0.79-4.28) and tended to have occurred during the scrum (8.3%) more often than other injuries (3.2%) (IPR=2.62, 95% CI: 0.35-19.61).

Injuries occurring during practice were sustained most frequently during the third ½ hour (41.7%), with 33.3% sustained during the second ½ hour, 10.4% sustained during the fourth ½ hour, 8.3% during the first ½ hour, 4.2% after the first 2 hours, and 2.1% during an other/unspecified time. The majority of injuries (77.1%) were sustained during a contact practice (33.3% occurring during a full-contact drill, 22.9% during a tackling practice, and 20.8% during a full-contact scrimmage), with 22.9% sustained during a non-contact practice.

Although insignificant, competition injuries tended to result from being tackled (33.6%) more often than practice injuries (18.4%) (IPR=1.83, 95% CI: 0.99-3.39), while practice injuries resulted more often from a maul (6.1% versus 2.6%) (IPR=2.40, 95% CI: 0.62-9.26).

3.2.3 Injuries by Position

As one might expect, because certain positions have two players on the field simultaneously, props (15.8%), wings (14.6%), flankers/wing forwards (13.0%), and locks (10.5%) sustained more injuries than the other positions. In the following analyses, props,

hookers, second row/locks, #8's, and flankers/wing forwards are considered forwards while fly halves, inside centers, outside centers, wings, full backs, and scrumhalves are considered backs.

Table 3.2 Body Site Injured and Diagnosis by Position

	Backs, n=126	**Forwards, n=121**
Body Site		
Head	27.8%	20.7%
Knee	14.3%	12.4%
Shoulder	11.9%	13.2%
Ankle	7.9%	13.2%
Face	7.1%	11.6%
Diagnosis		
Strain/sprain	23.8%	28.1%
Fracture	19.0%	19.0%
Concussion	22.2%	14.9%
Contusion	9.5%	6.6%
Laceration	4.0%	5.0%

*Cases not specifying the injured player's position were excluded from analysis (n=40).

Table 3.2 highlights:

- Backs (27.8%) sustained a greater proportion of head injuries than forwards (20.7%) (IPR=1.34, 95% CI: 0.86-2.11), although this was insignificant.
- Forwards sustained a greater proportion of face injuries (11.6%) than backs (7.1%) (IPR=1.62, 95% CI: 0.73-3.60), although this was insignificant.
- Forwards sustained greater proportions of ankle injuries (13.2%) than backs (7.9%) (IPR=1.67, 95% CI: 0.79-3.53), although this was insignificant.
- Backs sustained a greater proportion of concussions (22.2%) than forwards (14.9%) (IPR=1.49, 95% CI: 0.87-2.56), although this was insignificant.

There were no differences in time loss by position. Backs were more likely to be injured while being tacked (40.5%) than forwards (22.3%) (IPR=1.81, 95% CI: 1.22-2.69). Conversely,

forwards were more likely to be injured during rucks (21.5%) than backs (11.9%) (IPR=1.80, 95% CI: 1.01-3.24).

4. Comparison to Rugby RIO™ 2005

As Rugby RIO™ High School 2006 was the continuation of Rugby RIO™ High School 2005, with both studies employing the same definitions of injury and exposure, the data from these two studies can be directly compared. The overall injury rate found in 2005 (6.6 injuries per 1,000 player-exposures) was higher than the rate found in 2006 (4.5 injuries per 1,000 player-exposures) (IPR=1.47, 95% CI: 1.25-1.72).

The injury rate per 1,000 player-exposures was higher for boys in 2005 (6.5) than in 2006 (4.9) (RR=1.32, 95% CI: 1.11-1.56). Girls also had a higher injury rate per 1,000 player-exposures in 2005 (8.1) than in 2006 (2.7) (RR=2.93, 95% CI: 1.90-4.52). The 2005 competition injury rate per 1,000 player-matches (15.9) was insignificantly higher than the 2006 competition injury rate (14.5) (RR=1.10, 95% CI: 0.92-1.31). Similarly, the 2005 practice injury rate per 1,000 player-practices was insignificantly higher (1.5) than the 2006 practice injury rate (1.0) (RR=1.46, 95% CI: 0.99-2.15).

The patterns of injury found in 2006 were similar to those found in 2005. Age, height, and weight of injured rugby players did not differ. The head, ankle, shoulder, and knee remained the most commonly injured sites, with the proportion of knee injuries increasing to 13.6% in 2006 from 8.3% in 2005 (IPR=1.65, 95% CI: 1.03-2.66). There were no significant differences between injury type, amount of time loss due to injury, the activity during which the injury occurred, and the proportion of injuries occurring in practice and competition between 2005 and 2006.

5. Reporter Compliance

During the 2006 spring season, 59 out of 79 reporters (74.7%) logged into Rugby RIO™ at least once to report injury data. Of these 59 reporters, 46 (78.0%) remained in the study through the end of their season and completed a weekly exposure report for each week they were in the study or missed only 1 or 2 weeks of reporting. The remaining 13 reporters (22.0%) either missed multiple weeks of reporting or dropped out of the study before study completion.

The non-response rate of questions in the injury report form tended to be low, with most questions having a non-response rate of less than 3%. The non-response rate was lowest for questions related to the injury, such as injury diagnosis, body site, time loss, activity, etc. It was highest for demographic questions, such as those asking for age, height, and weight.

An online "End of Season" survey gave all reporters the opportunity to provide feedback on their experiences with Rugby RIO™. This survey was completed by 18 reporters (30.5%). Average reporting times were 6.3 minutes for the weekly exposure report and 4.7 minutes for the injury report form. RIO™ was reported to be either very easy (77.8%) or somewhat easy (22.2%) to use, with reporters being mostly very satisfied (76.5%) or somewhat satisfied (17.6%) with the study and 5.9% being neither satisfied nor dissatisfied. Suggestions provided by reporters were used to improve the survey that will be used if the study is replicated during future seasons.

6. Conclusions and Recommendations for Injury Prevention

Rugby RIO™ High School 2005 and 2006 are the first studies to determine injury rates among US high school rugby players. While the rate of injury in high school rugby appears to have decreased from 2005 to 2006, the rate injury in boys' rugby is similar to the rate of injury

found in boys' football and is higher than rates of injury seen in boys' soccer, boys' basketball, boys' wrestling, and boys' baseball. The rate of injury in girls' rugby is similar to the rate in girls' soccer, and is higher than the rates of injury found in girls' volleyball, girls' basketball, and girls' softball. Future studies using nationally representative samples of US high school rugby players are needed to further compare injury rates between US high school rugby and other high school sports.

In addition to providing accurate information about injury rates, data collected by the Rugby RIO^{TM} surveillance system allowed researchers to identify risk factors associated with US high school rugby injuries, which is the first step toward making rugby a safer sport to play. Based on the findings in this summary report, several recommendations for injury prevention can be made. Governing bodies of youth rugby can work towards decreasing the rate and seriousness of high school rugby-related injuries by implementing these research-based preventive interventions.

A) Due to the large proportion of US high school rugby players sustaining injuries while tackling or being tackled in both 2005 (60.7%) and 2006 (58.9%), we once again recommend preventive interventions designed to decrease tackling-related injuries.
    a. Level 1 coaching clinics should include education about the injury risk associated with unsafe tackling and should be provided with materials illustrating proper tacking techniques.
    b. All high school coaches should be provided with materials designed to help them teach young rugby players proper tackling techniques, such as videos or written materials demonstrating proper tackling technique and "safe" tackling drills.

c. Referees should be educated concerning the injury risk associated with unsafe tackling techniques and should be encouraged to penalize unsafe tackling when warranted.

This type of education campaign has proven to be effective in the rugby community as evidenced by the dramatic decrease in catastrophic spinal cord injuries associated with unsafe scrummaging techniques following the large scale education campaign (including video distribution) combined with enhanced rule enforcement aimed at improving scrummaging safety that occurred in the late 1980s and early 1990s.

B) Since rugby players sustained the majority of injuries in competition or during full-contact practices and scrimmages in both 2005 (94.0%) and 2006 (96.1%), we again recommend preventive interventions designed to emphasize safety in practice and match settings.

   a. USA Rugby should consider developing a comprehensive online site to provide coaches and referees with easy access to materials for optimum training, coaching, refereeing, injury prevention, and injury management, similar to the Rugby Smart website developed by the New Zealand Rugby Union http://www.rugbysmart.co.nz/index.html.

   b. Level 1 coaching clinics should include education about the potential for injury in practice and should be provided with materials illustrating how to run “safe” practices. All high school coaches should be provided with materials designed to help them run “safe” practices such as practice plans incorporating proper warm up and stretching, videos or written materials demonstrating “safe” tackling drills

and other “safe” contact drills, and guides on how to run “safe” and controlled scrimmages.

c. Coaches should ensure that all players are adequately prepared for the physical nature of matches by simulating match conditions at practice, thus allowing for the proper mechanics of tackling, rucking, mauling, and scrummaging to be taught in a controlled yet realistic environment.

d. Referees societies should be encouraged to use high school rugby scrimmages as opportunities to train new referees.

C) Over 20% of injuries in both 2005 and 2006 were to the head, with concussions making up 14.2% of injuries in 2005 and 17.8% of injuries in 2006. Given this concerning increase in concussions, we once again recommend the following interventions for decreasing serious head injury.

a. Level 1 coaching clinics should include education about concussion prevention, identification, and treatment was well as guidelines for the return to play for players following concussion.

b. All high school coaches should be provided with the educational packet, “Heads Up: Brain Injury in High School Sports”, which is a free and easy-to-use tool kit for mild traumatic brain injuries developed by the Centers for Disease Control and Prevention (CDC), National Center for Injury Prevention and Control (NCIPC) (http://www.cdc.gov/ncipc/tbi/Coaches_Tool_Kit.htm).

c. All high school coaches and players should be advised that mouthguards should be used 100% of the time by all high school rugby players to prevent mouth/teeth

injuries and concussions. Coaches should ensure that players wearing protective headgear have it fit properly and securely.

d. All coaches, athletes, and referees should be encouraged to commit to reducing the frequency of illegal activity/foul play, as this was implicated in 5.2% of injuries. Injuries resulting from illegal activity/foul play were more likely to be concussions, and over half of all illegal activity/foul play-related injuries resulted in a time loss of 22 days or more. Coaches, players, and referees should be made aware of and encouraged to follow guidelines developed by the USA RUGBY Referees Association (Guidelines on the Application of the Law, Section 15) regarding recommended penalization of illegal activity/foul play (http://www.usarra.org/guidelines.html).

Like all research projects, this surveillance study had limitations. Both Rugby RIO™ 2005 and 2006 were based on small, convenience samples of US high school rugby clubs that may not fully represent the diversity of all US high school rugby clubs, with several clubs failing to report data for all weeks of the study. Despite these limitations, this study is the largest prospective study of injuries in US high school rugby to date, and the preventive interventions suggested by the data can be used to decrease injuries in this population.

7. Summary

High school sports such as rugby play an important role in the adoption and maintenance of a physically active lifestyle among millions of US adolescents. Too often injury prevention in this population is overlooked as sports-related injuries are thought to be unavoidable. In reality, sports-related injuries are largely preventable through the application of evidence-based

preventive interventions. Such preventive interventions can include educational campaigns, introduction of new/improved protective equipment, rule changes, other policy changes, etc. The morbidity, mortality, and disability caused by high school rugby-related injuries can be reduced through the development and implementation of effective prevention strategies as well as through improved injury diagnosis and treatment modalities. However, surveillance of exposure based injury rates in a nationally representative sample of high school rugby players and subsequent epidemiologic analysis of patterns of injury are needed to drive evidence-based prevention practices.

The study of high school sports-related injuries to date has largely been limited by an inability to calculate injury rates due to a lack of exposure data (i.e., frequency of participation in athletic activities including training, practice, and competition), an inability to compare findings across groups (i.e., sports/activities, genders, schools, and levels of competition), or an inability to generalize findings from small non-representative samples. The value of national injury surveillance studies that collect injury, exposure, and risk factor data from representative samples has been well demonstrated by the National Collegiate Athletic Association's Injury Surveillance System (NCAA ISS).[2] Data collected by the NCAA ISS since 1982 has been used to develop preventive interventions including changes in coaching habits, increased use of protective equipment, and rule changes which have had proven success in reducing injuries among collegiate players. For example, NCAA ISS data has been used to develop several interventions intended to reduce the number of preseason heat-related football injuries including the elimination of consecutive days of multiple practices, daily hour limitations, and a gradual increase in equipment for conditioning and heat acclimation. Additionally, several committees have considered NCAA ISS data when making recommendations including the NCAA

[2] National Collegiate Athletic Association (NCAA) Injury Surveillance System. Available at http://www1.ncaa.org/membership/ed_outreach/health-safety/iss/index.html. Indianapolis, IN: NCAA; 2006.

Committee on Competitive Safeguards and Medical Aspects of Sports' recommendation for mandatory eye protection in women's lacrosse, the NCAA Men's Ice Hockey Rules Committee's recommendation for stricter penalties for hitting from behind, checking into the boards, and not wearing a mouthpiece, and the NCAA Men's Basketball Rules Committee's recent discussions of widening the free-throw lane to prevent injuries related to player contact. Unfortunately, because an equivalent injury surveillance system to collect injury and exposure data from a nationally representative sample of high school players has not previously existed, the usefulness of currently available high school sports-related injury data has been limited.

During the 2005 and 2006 spring seasons, the success of the study presented here, Rugby RIO^{TM} (Reporting Information Online) High School: Internet-Based Surveillance of Injuries Sustained by US High School Rugby Players, demonstrated the ability to implement a national rugby injury surveillance system at the high school level. Dr. Comstock and her research staff are committed to using this study to launch a permanent national high school rugby injury surveillance system. However, funds will need to be found to implement and maintain such a system.

While the health benefits of a physically active lifestyle including full-contact sports participation are undeniable, participants are at risk of injury because a certain endemic level of injury can be expected during any physical activity, especially those with a competitive component. However, injury rates among high school rugby players should be reduced to the lowest possible level without discouraging adolescents from engaging in this important form of physical activity. This goal can best be accomplished by monitoring injury rates and patterns of injury among high school rugby players; investigating the etiology of preventable injuries; and developing, implementing, and evaluating evidence-based preventive interventions. Surveillance systems such as the model used for this study are critical in achieving these goals.