SUMMARY REPORT

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

2005

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1. Introduction and Background

1.1 Project Overview

US rugby is at a crossroads. Unprecedented opportunities for growth have presented themselves with the rapid increase in the number of high school rugby participants. However, these opportunities, as well as the general opinion regarding rugby among the US population, are threatened by concerns about the risk of injury associated with playing rugby. Although rugby does pose a relatively high risk of injury to participants, as do all contact sports, the few studies that have directly compared rates of injury in rugby to rates of injury in other contact sports such as football or ice hockey have indicated that rugby is as safe or safer than other contact sports. Unfortunately, these studies have been based on small samples and/or non-US rugby playing populations. US rugby must address concerns about the safety of the game by collecting accurate injury data through a well-designed injury surveillance system. In addition to providing accurate information about injury rates, data collected by such a surveillance system will enable US rugby to identify and address risk factors associated with injury, which is the first step toward making rugby a safer sport to play.

1.2 Background and Significance

The first step toward prevention of sports related injuries is the collection of accurate data. Sports injury surveillance systems are effective tools for collecting reliable data upon which injury prevention research can be based, and safety rules and policies can be developed and evaluated. For example, the National Collegiate Athletic Association (NCAA) Injury Surveillance System (ISS), which was developed in 1982 to provide current and reliable data on injury trends in intercollegiate athletics, provides data that the NCAA Committee on Competitive Safeguards and Medical Aspects of Sports and the NCAA Rules Committees use to strengthen

health and safety guidelines.[1] For example, NCAA ISS data has been used to decrease football injuries by changing spring football practice rules, to decrease women's lacrosse eye injuries by mandating the use of eye protection, and to decrease heat related injuries through education of coaches, athletic trainers, and athletes.[1] Similarly, catastrophic high school sports injury data gathered by the National Center for Catastrophic Sport Injury Research (NCCSIR) led to the identification of racing starts as the source of most catastrophic swimming injuries.[2] This led the National Federation of State High School Association's Swimming and Diving Rules Committee to rule that in pools with water depth less than three and one-half feet at the starting end, swimmers must start races in the water.[2] These example illustrate the potential for injury reduction via evidence-based preventive interventions based on ongoing injury surveillance.

In *Enhancing Safety in Youth Rugby*, the USARFU Medical and Risk Management Committee noted, "the key to preventing injuries in any sport is identifying and addressing the risk factors associated with it."[3] A well-designed injury surveillance system is the most effective way to monitor rugby injuries while identifying risk factors associated with playing rugby. Although many researchers have studied rugby injuries, few studies have been based on prospective population based injury surveillance systems because development of such systems has, for the most part, previously been considered prohibitive in terms of the time and cost involved with data collection. To date, the most successful rugby injury surveillance program has been the New Zealand Rugby Injury and Performance Project (RIPP).[4-9] First implemented in 1993, and most recently implemented as part of the 2000 New Zealand RugbySmart program,[10] this surveillance system collected data throughout the rugby season via telephone interviews with participating players. Although RIPP is considered a successful method of

measuring and monitoring injury incidence and injury prevention behavior over time, this telephone-based surveillance system is labor intensive and costly.

The time- and cost-efficient RIO™ (Reporting Information Online) internet-based surveillance system is the logical, technological evolution of the telephone-based RIPP surveillance system. The United States Rugby Football Foundation (USRFF) provided Dr. R. Dawn Comstock with the funding support needed to implement the RIO™ surveillance system in the current project, RUGBY RIO™ High School, to monitor injuries among high school rugby players during the 2005 high school rugby season.

1.3 Specific Aims

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

1. To determine the incidence (number) of injuries among US high school rugby players.
2. 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.
3. To provide detailed information about the injuries sustained by US high school rugby players including type, site, severity, initial and subsequent treatment/care, outcome, etc.
4. To provide detailed information about the injury events including player demographics, position played, phase of play/activity, etc.
5. To identify potential risk or protective factors and preventive mechanisms to reduce the incidence of injuries among US high school rugby players.

1.4 Project Design

RIO™ (Reporting Information Online), an internet-based sports injury surveillance system developed by Dr. Comstock at the Center for Injury Research and Policy at Columbus Children's Hospital and The Ohio State University, was utilized to perform surveillance of injuries sustained by US high school rugby players. For the purpose of this study, a reportable injury was defined as:

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

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

C) Results 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.

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, 731 US high school rugby clubs were identified. A mass e-mail was sent to those clubs with e-mail contacts. This e-mail informed them of the surveillance project, invited them to participate, and provided 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 and in Rugby Magazine.

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 731 identified clubs, some did not

receive the initial mass e-mail because we could not find a current contact (14.1%), the e-mail bounced back as undeliverable (15.9%), and spam-blockers or system problems (3.4%). Ultimately, 553 clubs received an e-mail about the surveillance project, 14.1% (n=78) of whom enrolled 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 club reporter. Desired club reporters were (listed in order or preference): a club physician, a club certified athletic trainer, another club medical personnel (i.e., nurse, EMT, etc.), a club coach, or a club manager. While clubs were asked to utilize the same reporter throughout the season, a backup reporter was identified for each club. If the club reporter dropped out of the surveillance program, the backup reporter was asked to assume those duties. 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 information and information about the club they represented (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 21 weekly exposure reports: one for each week from February 7th through June 27th, 2005 that collected exposure information (number of player-matches and player-practices) and the number of reportable injuries sustained by members of the club they represented. In addition, for each reported injury, reporters completed an injury report. The injury report collected detailed information about the injury (site, type, severity, etc.) and the injury event (player demographics, position played, phase of play, etc.). The internet-based

surveillance tool provided reporters with the ability to view all 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 (i.e., the need for surgery, the ultimate outcome, etc.)

At the conclusion of the study, reporters received an email that allowed them to complete an anonymous on-line survey to gauge their satisfaction with the internet-based surveillance tool. The end of study survey collected information about burden of reporting (i.e. time it took to complete the weekly exposure and injury report forms, ease of use, etc), suggestions for revising the weekly exposure and injury report forms, and overall satisfaction with the internet-based surveillance system.

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. Each week, reporters who failed to log on to complete the weekly exposure and injury reports were sent an e-mail reminding them to do so. Reporters who repeatedly failed to log on to complete the weekly exposure and injury reports received a phone call from the Center for Injury Research and Policy to assess their willingness to continue participation. Attempts were made to replace reporters who chose to discontinue participation, who could not be reached by phone, or who failed to complete the weekly exposure and injury report for 3 consecutive weeks with their club's backup reporter. The RIO^{TM} system was kept open throughout July 2005 to allow reporters to catch up on their reporting and "close out" their accounts. At least 3 attempts were made to contact each reporter who had not completed every week to encourage them to complete their data entry.

1.4.4 Data Analysis

Data were analyzed using SPSS software, version 13.0. Statistical analyses included the Chi-square test with Yates' correction and t-tests. Relative risks (RR) with 95% confidence intervals (CI) were calculated to 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. P-values <0.05 were considered statistically significant.

2. Demographics and Response Rates

2.1 Reporter and Club Demographics

Overall, 78 individuals registered their rugby club to participate in RUGBY RIO^{TM} High School by completing the reporter background survey. (All data for the reporter background survey can be found in Appendix A.) Reporters ranged in age from 17 through 69 with a mean age of 41.4 years (SD: 10.4). Most of the reporters were male (82.1%) and were the club's coach (74.4%). The majority of reporters had played (89.7%) or coached (82.1%) rugby, with fewer reporting having refereed (51.3%). The majority of clubs did not have a club doctor (83.3%) or trainer (70.5%). Of the 77 reporters who reported club size, mean size was 35.6 players (range: 16-156 players; SD: 20.1). These 77 clubs provided information for 2,738 US high school rugby players. Enrolled clubs included both boys' (82.1%) and girls' (17.9%) rugby clubs.

2.2 Weekly Exposures

The weekly exposure report asked the reporter for their reporter id, number of player-matches, number of player-practices, and the number of injuries sustained during the week. Appendix B lists all questions contained in the weekly exposure report as well as the data collected. The number of player-practices was calculated by summing the number of players

present at each practice; number of player-matches was calculated similarly. For example, if the first practice had 20 players and the second practice had 15 players, the number of player-practices would equal 35. If there were three practices and the first practice had 10 players, the second practice had 15 players, and the third practice had 12 players, the number of player-practice would equal 37. The average number of overall players-practices per club per week was 38.6 (range: 0-410; St. Dev: 53.3). The average number of overall player-matches per club per week was 17.8 (range: 0-463; St. Dev: 32.0).

Because clubs across the US begin and end their seasons at different times during the calendar year, not every club had players playing or practicing each week during the study period. In addition, some clubs enrolled after the study had begun, and a few clubs dropped out of the study after they had enrolled. Overall, 62 (79.5%) of the 78 enrolled clubs reported at least one week of data with an average of 42.4 clubs (range: 37 to 48) reporting each week. The median number of weekly reports completed by each club was 19 (range: 1 to 21).

2.3 Injury Reports

Reporters were asked to complete one injury report form for every injury reported in the weekly exposure report. Of the 334 injuries reported on the weekly exposure report, reporters completed 303 injury report forms (90.7%). The injury report collected detailed information about the injury (site, type, severity, etc.) and the injury event (player demographics, position played, phase of play, etc.). Appendix C lists all questions contained in the injury report form along with a breakdown of the number and percentage of each possible response. Detailed data collected via injury reports are presented in sections 4.1-4.3.

2.4 End of Study Survey

Only fifteen reporters (19.2% of enrolled clubs) completed the end of study survey. All data for the end of study survey can be found in Appendix D. On average, each week, it took reporters 7.6 minutes to complete the weekly exposure report and 6.2 minutes to complete the injury report forms. The majority of reporters (73.3%) found the internet-based surveillance reporting system to be very or somewhat easy to use, and 80.0% were very or somewhat satisfied with system. Only two reporters found the system somewhat or very difficult to use. 26.7% of reporters thought it would have been helpful to receive training on the internet-based surveillance system. Other suggestions to improve ease of use included providing reporters with PowerPoint slides as a training aid and adding injury category definitions to the website. 40.0% of reporters had at least one difficulty using system, most of which consisted of technology problems that were resolved. Two clubs gave suggestions for additional questions to be added to the injury report form including player experience, participation in other sports, how often the player practices, and severity of diagnosis. Of the 13 reporters who answered the question regarding future participation, all were willing to participate in RUGBY RIO^{TM} High School in future seasons.

3. Rates of Injury

Enrolled clubs reported 334 injuries during 50,244 total high school rugby exposures, which included 34,409 practice exposures, and 15,835 match exposures. The overall injury rate among US high school rugby players was 6.6 injuries per 1,000 total rugby exposures. While the overall injury rate was slightly higher among girls (8.1 injuries per 1,000 total rugby exposures) than boys (6.5 injuries per 1,000 total rugby exposures), the difference was not statistically significant (RR: 1.3; 95% CI: 0.9-1.7; p=0.2).

Injury rates differed by type of rugby exposure with reported injury rates of 1.5 injuries per 1,000 rugby practice exposures compared to 15.9 injuries per 1,000 rugby match exposures. For both boys and girls, the injury rate per 1,000 practice exposures was low (1.4 and 1.6, respectively). Girls sustained a higher injury rate per 1,000 match exposures (25.4) than boys (15.0) (RR: 1.7; 95% CI: 1.2-2.4; $p<.05$).

4. Injury Epidemiology

4.1 General Epidemiology

Results from Appendix C are presented for high school rugby players overall as well as separately for boys and girls. Following is a summary of the collected data.

4.1.1 Injured Player Demographics

Of the 303 reported injuries, 262 (86.5%) injured athletes were male and 41 (13.5%) were female. Table 4.1 compares age, height, and weight of the injured players by gender.

Table 4.1 Age, Height, and Weight of Injured Players by Gender

	Overall	**Boys**	**Girls**
Age			
Mean	16.5 years	16.6 years	16.3 years
Range	14-19	14-19	14-18
St. Dev.	1.2	1.2	1.3
Height			
Mean	69.1 inches	69.7 inches	65.6 inches
Range	60-77	60-77	60-70
St. Dev.	3.1	2.9	2.4
Weight			
Mean	170.2 lbs	174.8 lbs	140.0 lbs
Range	105-280	116-280	105-175
St. Dev.	30.7	29.7	17.8

Table 4.1 highlights:

- Overall, the average age of the injured athletes was 16.5 years (range: 14-19).

- The average height and weight was 69.1 inches (range: 60-77) and 170.2 pounds (range: 105-280) respectively.
- Injured boys and girls were similar in mean age.
- As one might expect, injured girls were on average shorter and lighter than boys.

There were no significant differences in injury diagnosis, time loss, and final injury disposition (i.e. outcome) for younger and older players. Similarly, injury patterns did not seem to vary by height. The average weight of injured forwards (181.4 pounds) was greater than backs (158.4 pounds). Differences in injury patterns for forwards and backs are further examined in 4.2.2.

4.1.2 Overall Injuries

Overall, among both boys and girls, injuries were most commonly a new injury (86.5%) rather than a recurrence or complication of a previous injury. The most common body sites injured were the head (20.8%), ankle (15.8%), shoulder (13.9%), and knee (8.3%). The most common injury diagnoses were ligament sprains (incomplete tears) (16.8%), fractures (14.5%), and concussions (14.2%). The majority of injuries occurred as a result of impact with another player (51.2%) and impact with the playing surface or ground (24.1%). More specifically in regards to phase of play, 31.0% of injuries occurred while the player was being tackled, 29.7% occurred while the player was tackling, 12.9% occurred in rucks, and 10.2% occurred while running in play.

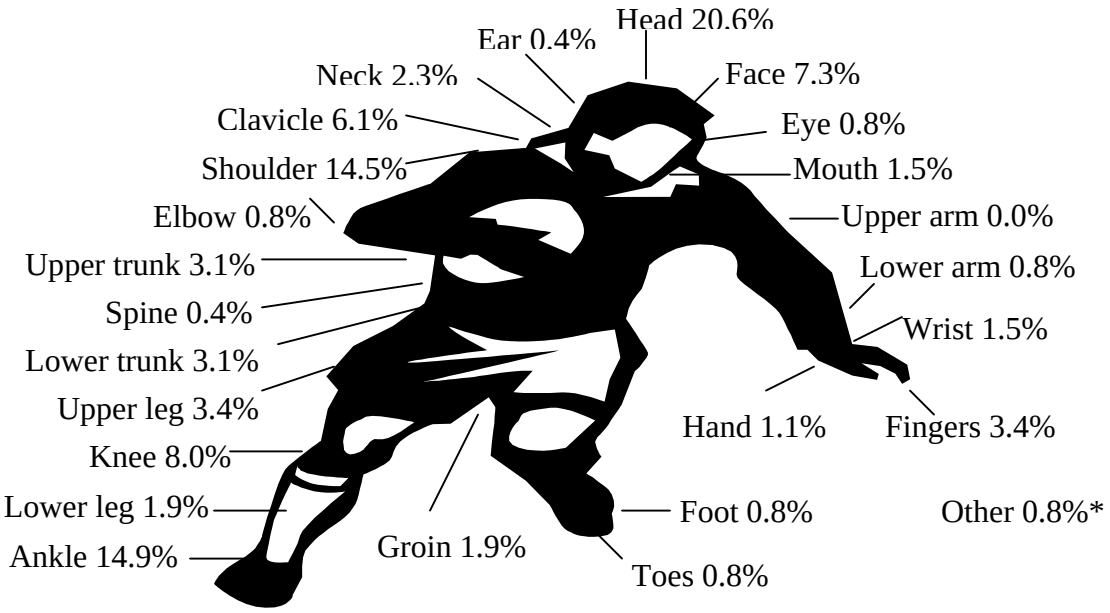
Just over half of all injuries (51.8%) kept athletes out of play for 10 or more days with 27.4% of injuries forcing the athlete to end their 2005 rugby season and 1.7% of injuries forcing the athlete to end their rugby career. Of those injuries that occurred during a competition, 4.8% were related to illegal activity/foul play. In regards to protective equipment, 95.0% of players

were wearing a mouthguard when injured, 11.6% were wearing a scrumcap, and 9.6% were wearing shoulderpads. More specifically, of the players who sustained a head injury, all were wearing a mouthguard and 6.3% were wearing a scrumcap. Three of the 4 players who sustained a mouth or tooth injury were wearing a mouthguard at the time of injury. 9.5% of players who sustained a shoulder injury were wearing shoulderpads.

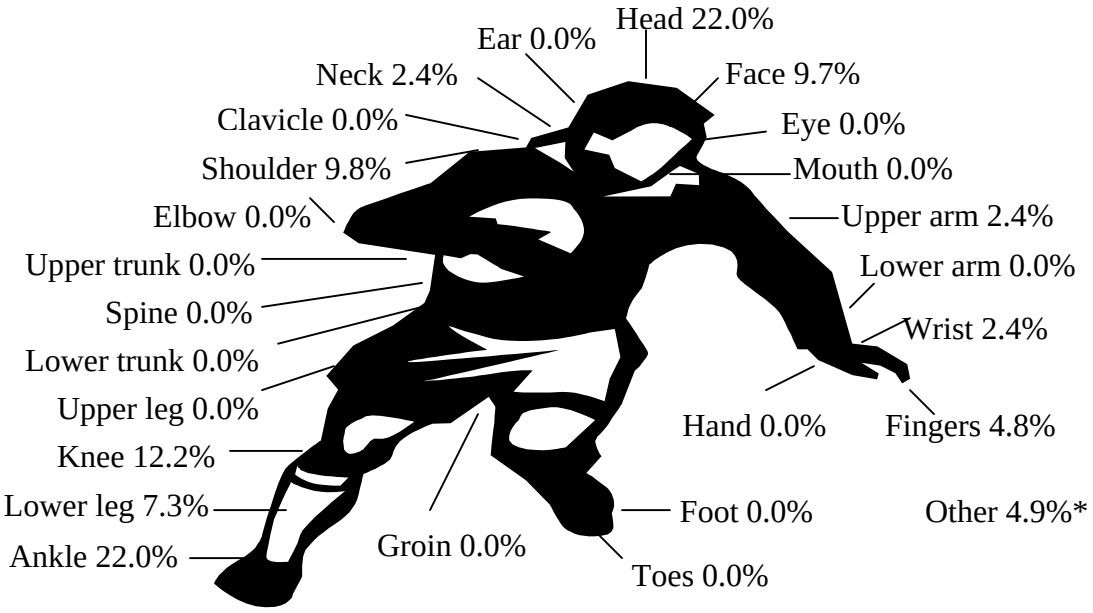
4.1.3 Boys' versus Girls' Injuries

The majority of completed injury reports were for boys (86.5%). Figure 1 provides the proportion of injuries by body site for both genders.

Figure 4.1: Gender Differences by Body Site Injured



Male Rugby Players, n=262



Female Rugby Players, n=41

*Does not equal 100.0 due to rounding

Figure 4.1 highlights:

- Although the difference was not statistically significant, boys tended to experience a greater proportion of shoulder and clavicle injuries than girls
- Again, although the difference was not statistically significant, girls tended to experience a greater proportion of ankle, lower leg, and knee injuries than boys
- For both boys and girls, approximately 20% of injuries were to the head

Figure 4.2 highlights some differences and similarities in injury diagnoses by gender.

Figure 4.2 Common Injury Diagnoses by Gender

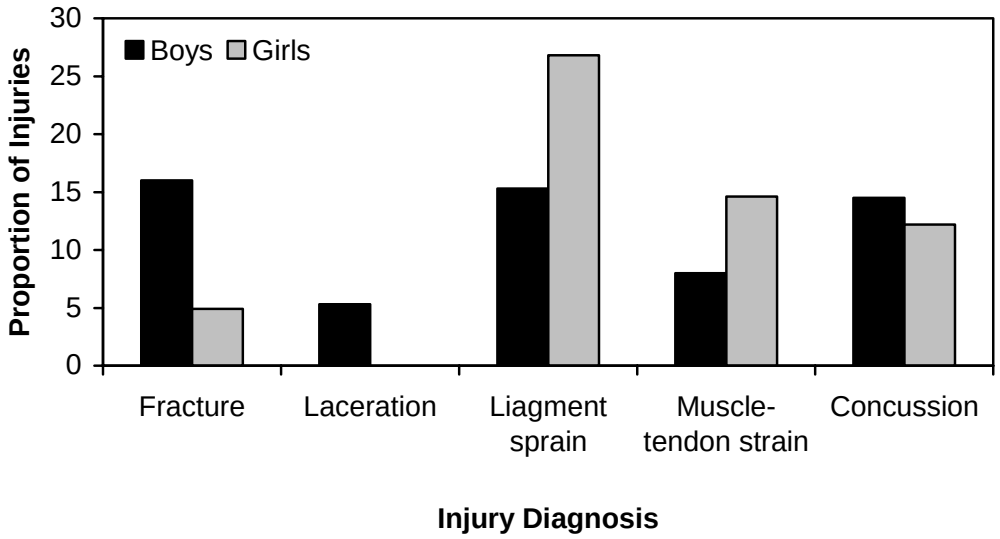


Figure 4.2 highlights:

- Although not statistically significant, boys tended to experience a greater proportion of fractures (16.0%) than girls (4.9%)
- Boys sustained all of the reported lacerations (5.3% of injuries among boys)

- Girls tended to experience a greater proportion of ligament sprains (incomplete tear) (26.8% versus 15.3%) and muscle-tendon strains (incomplete tears) (14.6% versus 8.0%) than boys
- Boys and girls sustained a similar proportion of concussions (14.5% and 12.2%, respectively)

Figure 4.3 Amount of Time Loss by Gender

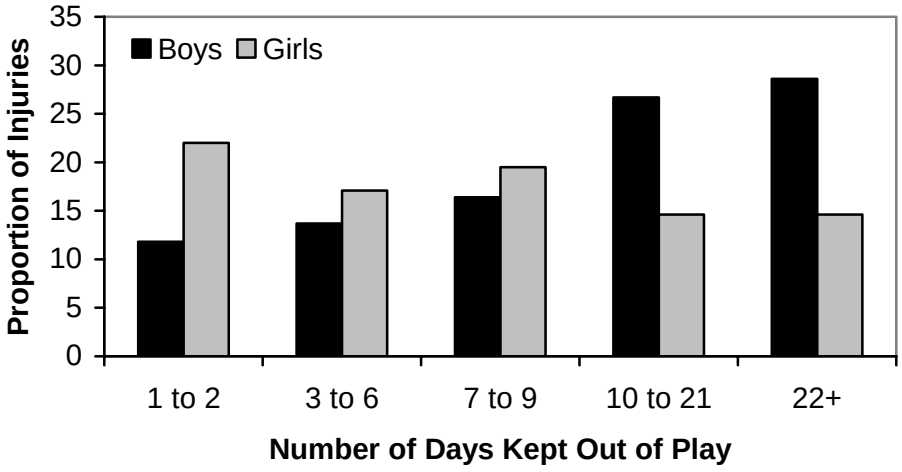


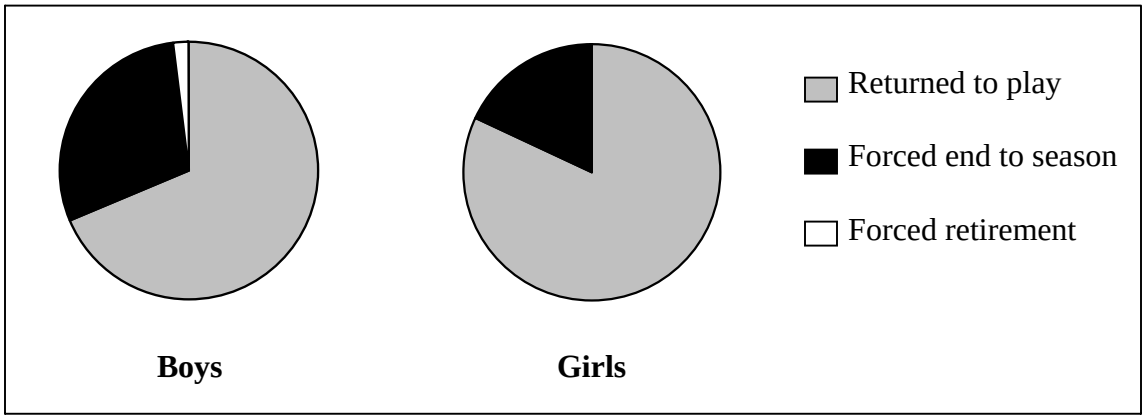
Figure 4.3 highlights:

- Although not statistically significant, girls tended to experience a greater proportion of injuries that kept them out of play for a shorter period of time than boys
- Boys (55.3%) experienced a greater proportion of injuries that kept them out of play longer (10 or more days) than girls (29.2%) (RR: 1.7; 95% CI: 1.1-2.7; p=0.01)

Among both boys and girls, injuries that kept athletes out of play longer were ligament sprains (incomplete tears), concussions, and fractures. Nearly 10% of injuries among boys required surgery while none of the injuries sustained by girls required surgery. Although not statistically significant, girls tended to experience a greater proportion of higher degree

concussions (33.3%) than boys (15.2%). As shown in Figure 4.4 below, boys tended to experience a greater proportion of injuries that forced an end to the 2005 season (29.0%) compared to girls (17.1%) or forced an end to their rugby career (1.9% and 0.0% respectively).

Figure 4.4 Final Injury Disposition by Gender



The five injuries that forced retirement from playing rugby included:

- A nerve injury in the neck that resulted from an impact with another player during a scrum
- An ankle fracture that resulted from rotation around a planted foot (no apparent contact)
- A clavicle fracture that resulted from the impact with the ground while tackling
- A clavicle fracture and dislocation that resulted from being punched
- A shoulder injury that resulted from an impact with another player while being tackled

Phase of play and athlete position when the injury occurred were similar for boys and girls. Among both boys and girls, the most common mechanisms of injury were impact with another player (51.2%) and impact with the playing surface or ground (24.1%). While 79.9% of injuries occurred when there was no precipitation, girls tended to experience more injuries in the

rain or snow and on a wet/muddy field (29.2%) compared to boys (16.4%). For more severe injuries (i.e. a time loss of 10 or more days), 41.7% of injuries sustained by girls occurred during the rain or on a wet field compared to 19.0% of injuries sustained by boys.

4.2 Associations of Interest

4.2.1 Competition versus Practice Injuries

The majority of injuries occurred during competitions (83.2%) and in the regular season (75.6%). Of those injuries that did occur in practice (n=51), 33.3% were sustained during noncontact practice, 15.7% were sustained during tackling practice, and 48.9% were sustained during full contact drills/scrimmages. While more injuries occurred during competition than practice, competition and practice injuries were similar in several respects including no statistical significant differences:

- in the proportion of head, shoulder, and knee injuries
- in the proportion of concussions
- in the proportion of injuries resulting from impact with another player
- in amount of time loss

Differences in competition and practice injuries included:

- Although not statistically significant, a greater proportion of injuries sustained in competition (34.5%) resulted from being tackled than in practice (13.7%)
- A greater proportion of injuries in practice (23.5%) occurred while running during play compared to injuries in competitions (7.5%) (RR: 3.1; 95% CI: 1.6-6.0; $p<0.01$).
- A greater proportion of practice injuries (19.6%) resulted from no apparent contact than competition injuries (4.0%) (RR: 4.9; 95% CI: 2.2-11.3; $p<0.01$)

- A greater proportion of ankle injuries occurred in practice (27.5%) than in competition (13.5%) (RR: 2.0; 95% CI: 1.2-3.5; p=0.02)
- A greater proportion of fractures occurred in practice (21.6%) than in competition (13.1%) (RR: 2.1; 95% CI: 1.1-3.9; p=0.04)

4.2.2 Injuries by Position

As one might expect, because certain positions have two players on the field simultaneously, wings (15.5%), flankers/wing forwards (13.9%), second row/locks (13.9%), and props (13.2%) sustained more injuries than other positions. In the following analyses, props, hookers, second row/locks, #8's, and flanker/wing forwards are considered forwards while fly halves, inside centers, outside centers, wings, full backs, and scrumhalves are considered backs.

Table 4.2 Body Site Injured and Diagnosis by Position

	Forwards, % (n=155)	**Backs,** % (n=135)*
Body Site Injured		
Head	25.8%	16.3%
Ankle	18.1%	14.1%
Shoulder	9.0%	18.5%
Knee	6.5%	10.4%
Diagnosis		
Laceration	7.7%	1.5%
Muscle-tendon strain	13.5%	3.7%
Concussion	16.1%	12.6%
Dislocation	1.9%	8.9%
Fracture	9.7%	16.3%

*No response for position: n=13 (4.3%)

Table 4.2 highlights:

- Although not statistically significant, forwards tended to experience a greater proportion of head injuries (25.8%) than backs (16.3%)
- Although not statistically significant, forwards tended to sustain a greater proportion of ankle injuries (18.1%) than backs (14.1%)

- Backs experienced a statistically significantly greater proportion of shoulder injuries (18.5%) than forwards (9.0%) (RR: 2.1; 95% CI: 1.1-3.8; p = 0.03)
- Although not statistically significant, backs tended to sustain a greater proportion of knee injuries (10.4%) than forwards (6.5%)
- Forwards experienced a significantly greater proportion of lacerations (7.7%) than backs (1.5%) (RR: 5.2; 95% CI: 1.2-22.9; p=0.03)
- Forwards also sustained a significantly greater proportion of muscle-tendon strains (incomplete tears) (13.5%) than backs (3.7%) (RR: 3.7; 95% CI: 1.4-9.4; p<0.01)
- Although forwards tended to experience a greater proportion of concussions (16.1%) than backs (12.6%), the difference was not statistically significant
- Backs experienced a significantly greater proportion of dislocations (8.9%) than forwards (1.9%) (RR: 4.6; 95% CI: 1.3-15.9; p=0.02)
- Although not statistically significant, backs also tended to sustain a greater proportion of fractures (16.3%) than forwards (9.7%)

In addition to these differences, forwards (21.3%) also sustained significantly more injuries in rucks (RR: 7.2; 95% CI: 2.6-19.8; p<0.01) than backs (3.0%). Conversely, backs (40.7%) sustained a significantly greater proportion of injuries while being tackled than forwards (25.2%) (RR: 1.6; 95% CI: 1.2-2.3; p<0.01). Although the differences were not significant, backs also tended to experience more injuries resulting from tackling (35.6%) and running during play (13.3%) than forwards (24.5% and 7.1%, respectively). Injuries sustained by forwards and backs were similar in time loss and final injury disposition. For both forwards and backs, approximately 26% of injuries forced the athlete to end their 2005 rugby season.

4.2.3 Concussions

Concussion was reported as the primary diagnosis in 14.2% of all reported injuries. While the majority of concussions were 1st degree (82.6%), 15.4% were 2nd degree and 1.9% were 3rd degree. [1] Among injuries with concussion reported as the primary diagnosis, 14.0% were related to illegal activity/foul play. Figure 4.5 provides the proportion of concussions by activity.

Figure 4.5 Concussions by Activity when Injured

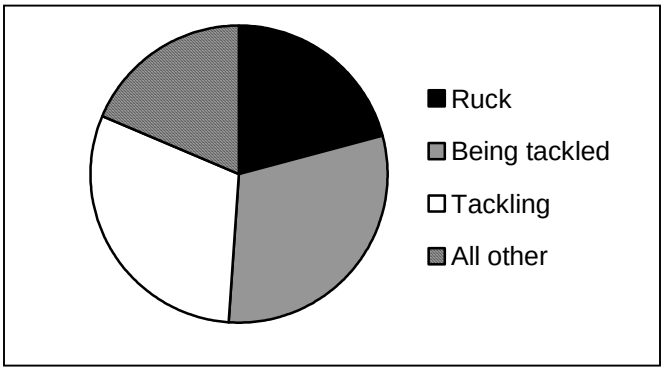


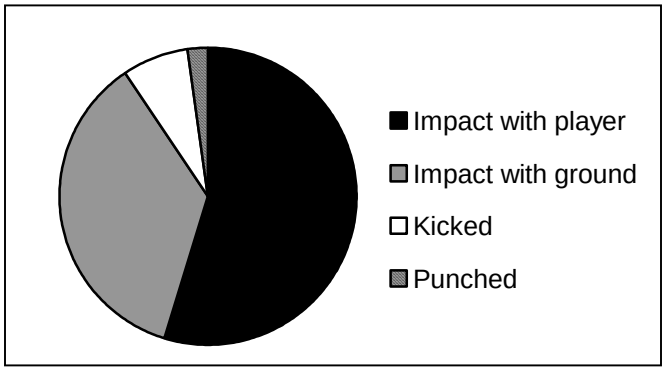
Figure 4.5 highlights:

- 81.3% of concussions resulted from only three activities
  - 20.9% of concussions occurred during a ruck
  - 30.2% of concussions occurred while being tackled
  - 30.2% of concussions resulted from tackling
- Other activities that resulted in a concussion included scrum (2.3%), maul (2.3%), running during play (4.7%), gathering the ball from the ground (2.3%), and other (2.3%)

[1] Concussion was reported as the primary diagnosis in 43 injuries. As seen in question 21 of the injury report form (Appendix C), there were 9 additional concussions that were either not reported as the primary diagnosis or were one of the no responses for diagnosis.

As shown in Figure 4.6 below, over half of all concussions resulted from impact with another player (53.5%).

Figure 4.6 Concussions by Mechanism of Injury



35.0% of concussions resulted in a time loss of 7 to 9 days and 41.9% resulted in a time loss of 10-21 days. One out of every five concussions (20.9%) forced the athlete to end their 2005 rugby season. In regards to protective equipment, 4.7% of concussions occurred while the injured player was wearing a scrumcap. All players who experienced a concussion were wearing at mouthguard at the time of injury.

4.2.4 Injuries Attributed to Illegal Activity/Foul Play

Boys sustained all reported injuries attributed to illegal activity/foul play (n=12). Injuries related to illegal activity/foul play were similar across age, time in competition, match location, and time loss. Forwards experienced 66.7% of all illegal activity/foul play-related injuries. As shown in Figure 4.7 and Table 4.3, the majority of injuries attributed to illegal activity were injuries to the head, were concussions, and resulted from an impact with the playing surface/ground.

Figure 4.7 Injuries Attributed to Illegal Activity/Foul Play by Body Site Injured

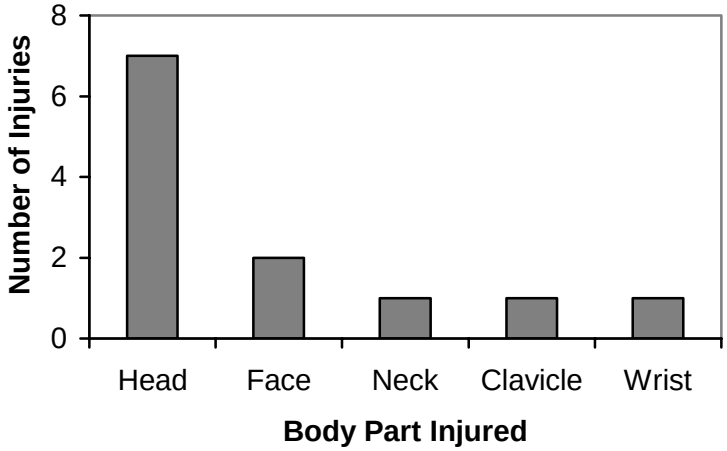


Table 4.3. Diagnoses and Mechanisms of Injuries Related to Illegal Activity/Foul Play

	Injuries, % (n)
Injury Diagnosis	
Concussion	50.0% (6)
Contusion	16.7% (2)
Hyperextension	8.3% (1)
Fracture	8.3% (1)
Laceration	8.3% (1)
Nerve Injury	8.3% (1)
Mechanism	
Impact with ground	58.3% (7)
Kicked	16.7% (2)
Impact with player	8.3% (1)
Other	16.7% (2)

Illegal activity/foul play-related injuries occurred while the injured athlete was being tackled (36.3%), in rucks (27.2%), in scrums (18.1%), tackling (9.1%), and receiving a kick-off (9.1%). Of the 12 injuries related to illegal activity/foul play, two injuries forced the athlete to end their season and one forced the athlete to retire from rugby.

4.3 Other Information Collected by the Surveillance System

Examining specific injury details is a very important part of further identifying and developing points of injury prevention.

4.3.1 Additional Information

Additional valuable information was gained from the narratives reporters were able to provide when they chose the "other" answer category. For example,

- One reporter described an injury that occurred after a tackle when the injured player was on the ground and the opposing player kneed him. The reporter felt the play was illegal; however, because it was not penalized by the referee, the reporter did not report the injury as occurring due to illegal activity/foul play.
- A tackling injury occurred when the injured athlete tackled with his head down and took a knee to the head.
- A player was tackled, head butted from behind, and then thrown on the ground resulting in a concussion
- A player was injured after using an improper tackling technique (tackled with head and not shoulder, with head down)
- A player was injured when he was hit on the side of knee by another player's head as a maul collapsed

4.3.2 Severe Injury Details

While the majority of the reported injuries were relatively minor and allowed players to return to play in the 2005 season, there were a few severe injuries reported. One of the most severe injuries reported occurred when a girl sustained a bruised brain stem while being tackled. Her initial symptoms included nausea and time disorientation. She then lost the use of her right

hand and leg, and her nerves were unable to hold her eye in position. She was admitted to the hospital for several days but fortunately has since made a full recovery. Another severe injury occurred when a player was punched with force causing both a fracture and dislocation of the clavicle, which lodged behind the sternum. Two surgeries were required to pull the clavicle out from behind the sternum and hold it into place.

Of the injuries that resulted in a time loss of 22 or more days (n=81), over two-thirds resulted from tackling (34.6%) and being tackled (33.3%). More specifically, 50.6% resulted from impact with another player and 23.5% resulted from impact with the playing surface/ground. Injuries with the longest time loss were most commonly to the knee (14.8%), shoulder (13.6%), and clavicle (13.6%). Forwards (39.5%) and backs (51.9%) sustained a similar proportion of these injuries. In regards to final injury disposition, 6.2% of injuries that resulted in 22 or more days of time loss forced the player to retire from playing rugby.

5. Comparing Injury Rates

5.1 US High School Injury Rates Compared to Other US Youth Sports

As previously discussed, in the present study, the overall injury rate among US high school rugby players was 6.6 injuries per 1,000 total rugby exposures. For boys, the injury rate ranged from 1.4 injuries per 1,000 practice-exposures to 15.0 injuries per 1,000 match-exposures, with an injury rate of 6.5 injuries per 1,000 total rugby exposures. For girls, the injury rate ranged from 1.6 injuries per 1,000 practice-exposures to 25.4 injuries per 1,000 match-exposures, with an injury rate of 8.1 injuries per 1,000 total rugby exposures.

There is a growing body of literature on the rate of sport-related injuries sustained by children and adolescents in sports.[11] In Table 5.1, we chose the most directly comparable prior studies with respect to age group, injury definition, and exposure units to compare the injury

rates of US high school rugby to other US adolescent sports. Caution should be used when comparing injury rates across sports as rates are affected by study sample size, injury definitions, and exposure units. In general, US high school rugby tends to have lower injury rates than US youth football and ice hockey, higher injury rates than basketball and soccer, and similar injury rates for wrestling.

Table 5.1 Comparison of US High School Rugby Injury Rates to Other US Youth Sports

Sport, Author, and Year*	Exposure	Injury Definition	Overall Injury Rate	Boys' Injury Rate			Girls' Injury Rate		
				Overall	Game	Practice	Overall	Game	Practice
Rugby									
Current project	1,000 athlete-exposures	Occurs during a rugby match or practice, requires medical attention, and restricts participation for one or more days	6.6	6.5	15.0	1.4	8.1	25.4	1.6
Football									
Gomez, 1998[12]	1,000 player-hours	Not stated	-	5.7	-	-	-	-	-
Powell, 1999[13]	1,000 athlete-exposures	Results in time lost (unable to participate in current practice or game)			26.4	5.3			
Turbeville, 2003[14]	1,000 game-exposures	Results in time lost (missing practice or game)			13.1				
Ice Hockey									
Roberts, 1999[15]	1,000 player-hours	Results in a stoppage of play or a player requesting an evaluation	-	117.3	-	-	50.5	-	-
Stuart, 1995[16]	1,000 player-hours	Kept a player out of practice or competition for 24 hours or required team physician attention	-	9.4	96.1	3.9	-	-	-
Stuart, 1997[17]	1,000 player-hours	Kept a player out of practice or competition for 24 hours or required team physician attention	-	34.4	-	-	-	-	-
Basketball									
Gomez, 1996[18]	1,000 player-hours	Occurred during organized practice or competition, resulted in missed practice or game time, required physician consultation, or involved the head or face					4.0		

Messina, 1999[19]	1,000 player-hours	Occurred during organized practice or competition, resulted in missed practice or game time, required physician consultation, or involved the head or face		3.2			3.6		
Soccer									
Kucera, 2005[20]	1,000 athlete-exposures	Player misses all or part of a practice or competition	4.6	4.3	-	-	5.3	-	-
Wrestling									
Pasque, 2000[21]	1,000 athlete-exposures	Any condition limiting function that resulted in the athlete seeking medical care, caused a practice or match to be discontinued, and resulted in the athlete's non-participation for at least 1 day	-	6.0	-	-	-	-	-

*Readers should refer to each article to review the study sample size and age range of athletes

High School RIO™, another project currently under the direction of Dr. Comstock, is utilizing the same online injury surveillance system, injury definition, and exposure calculations to track injuries across 9 high school sports including football, volleyball, boys' soccer, girls' soccer, wrestling, boys' basketball, girls' basketball, baseball, and softball in a nationally representative sample of 100 US high schools during the 2005/2006 academic year. During the first 12 weeks of a 42-week study, the preliminary data shows a US high school football injury rate of 13.9 injuries per 1,000 athlete-competitions and 2.8 injuries per 1,000 athlete-practices. While the US high school football competition injury rate is slightly lower than rugby, the practice injury rate is slightly higher. The preliminary overall US high school soccer injury rates for boys (3.2 injuries per 1,000 athlete-exposures) and girls (3.3 injuries per 1,000 athlete-exposures) are lower than the US high school rugby injury rates in the current study.

5.2 US High School Rugby Injury Rates Compared to Youth Rugby in Other Countries

While there is a growing body of literature on the rate of youth rugby-related injuries in other countries, this is the first large-scale study of US high school rugby injuries. In Table 5.2, we chose the most directly comparable prior studies with respect to age group and exposure units to compare the US high school rugby injury rate to injury rates of youth rugby in other countries. Again, caution should be used when comparing injury rates across countries as rates are affected by study sample size, injury definitions, and exposure units. In general, the injury rate among US high school rugby players tends to be lower than injury rates in other countries.

Table 5.2 Comparison of US High School Rugby Injury Rates to Other Countries' Youth Rugby Injuries

Author and Year*	Country	Age	Exposure	Overall Injury Rate	Boys' Injury Rate			Girls' Injury Rate		
					Overall	Game	Practice	Overall	Game	Practice
Current project	US	High school	1,000 athlete-exposures	6.6	6.5	15.0	1.4	8.1	25.4	1.6
Davidson, 1987[22]	Australia	11-19 years	Per 1,000 player-hours	-	17.6	-	-	-	-	-
Garraway and Macleod, 1995[23]	Scotland	<16/18-19	Per 1,000 player-hours	-	3.4/ 8.7	-	-	-	-	-
Bird, 1998[8]	New Zealand	Youth	Per 1,000 player-matches	-	-	62.0	-	-	47.0	-
Roux, 1987[24]	South Africa	High school	Per 1,000 player-hours	-	7.0	-	-	-	-	-
Durie and Munroe, 2000[25]	New Zealand	High school	Per 1,000 player-hours	-	27.5	-	-	-	-	-
Sparks, 1981[26]	United Kingdom	13-18	Per 1,000 player-hours	-	19.8	-	-	-	-	-
Sparks, 1985[27]	United Kingdom	13-18	Per 1,000 player-hours	-	19.4	-	-	-	-	-
Nathan, 1983[28]	South Africa	10-19	Per 1,000 player-hours	-	-	8.2	-	-	-	-
Junge, 2004[29]	New Zealand	14-18	Per 1,000 match-hours	-	-	129.8	-	-	-	-
Weir, 1996[30]	Ireland	Mean age = 14	Per 1,000 player-hours	6.0	-	-	-	-	-	-
McManus, 2004[31]	Australia	<16	Per 1,000 player-hours	-	13.3	-	-	-	-	-

* Readers should refer to each article to review the study definition of injury and study sample size

6. Conclusions and Recommendations for Injury Prevention

The 2005 RUGBY RIO™ surveillance project is the first study to determine injury rates among US high school rugby players. While it is important to consider differences in sample sizes, injury definitions, and exposure calculations, US high school rugby seems to have similar or lower injury rates than other US contact sports. In general, we found that the US high school rugby tends to have lower injury rates than US youth football and ice hockey. We also found that in general, the injury rate among US high school rugby players tends to be lower than injury rates among young rugby players in other countries. Future studies using nationally representative samples of US high school rugby players are needed to further compare US high school rugby injury rates with injury rates of other US high school sports and youth rugby rates in other countries.

In addition to providing accurate information about injury rates, data collected by the RUGBY RIO™ surveillance system allowed us 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 our findings, we can make several recommendations for injury prevention.

• First, because US high school rugby players sustained the largest proportion of injuries while tackling or being tackled, and most of the injuries that forced retirement from rugby were related to tackling or being tackled we recommend preventive interventions designed to decrease injuries associated with the tackle.

- Level 1 coaching clinics should include education about the injury risk associated with unsafe tackling and should be provided with materials illustrating proper tackling techniques.

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

• Second, we recommend preventive interventions designed to emphasize safety in practice settings. While we expected the patterns of injury to vary greatly for practices and competitions, they did not. In fact, a greater proportion of fractures occurred in practice than in competition. The vast majority of practice injuries occurred during tackling practice, other contact drills, and scrimmages.

- 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.

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

• Third, we recommend preventive interventions designed to decrease serious head injury, including concussion. One out of five injuries sustained by US high school rugby players were injuries to the head, resulting in at 43 reported concussions. Additionally, one of the most severe injuries captured by the surveillance system, an injury resulting in hospitalization of the player for several days was a bruised brain stem.

- Level 1 coaching clinics should include education about concussion prevention, identification, and treatment as well as guidelines for athletes return to play following concussion.
- All high school coaches should be provided with the educational packet, "Heads Up: Brain Injury in Your Practice," 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/doc.do/id/0900f3ec80017619).
- All high school coaches and athletes should be advised that mouthguards should be used 100% of the time by all high school rugby players to prevent both concussions and mouth/teeth injuries.
- Additionally, all coaches, athletes, and referees should be encouraged to commit to reducing the frequency of illegal activity/foul play as half of all injuries related to illegal activity/foul play were concussions. Coaches, players, and referees should be educated about the dangers of illegal activity/foul play. Furthermore, referees should be made aware of and encouraged to follow guidelines developed by the USA

RUGBY Referees Association (Guidelines on the Application of 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. For example, the current study was based on a small sample of US high school rugby clubs that may not fully represent the diversity of all US high school rugby clubs. Several additional questions missing from this study should be added to future injury report forms including amount of player experience (i.e. number of years played), participation in other contact sports, and how often the player practices specific skills or plays a specific position. Also, while internet-based surveillance systems are time- and cost- efficient, there can be technical difficulties associated with using the internet. However, to combat these issues, we have made several improvements to the internet-based surveillance system since the RUGBY RIO™ High School project. For example, in the RUGBY RIO™ surveillance project, the link provided in the weekly email was tied to the reporter's email address. In the updated RIO™ surveillance tool, the link in the weekly email simply sends the reporter to a home page where they can log into the surveillance system thereby reducing the risk of technical difficulties and eliminating loss to follow-up when individuals change e-mail addresses. In current RIO™ projects, we assign reporters a unique reporter ID which can be retrieved from the Center for Injury Research and Policy if forgotten to eliminate missing or incorrectly entered reporter ID's. We have also developed a training packet that includes step-by-step instructions on how to use the internet-based system that is e-mailed or mailed to reporters and is followed by a 10 to 15 minute personal telephone training session to continue to increase reporter's ease of use and compliance. The assigned reporter ID's are now provided in the training packet for the reporter's future reference. These improvements to the

RIO™ surveillance tool have increased reporter satisfaction while also increasing data collection.

As rugby becomes more and more popular among US high school athletes, the importance of injury surveillance and the development of evidenced-based preventive interventions to decrease injury rates increases. Ongoing surveillance in a small (50 to 100 clubs) but nationally representative sample of US high school rugby clubs would allow USRFF and USA RUGBY to estimate national injury rates, to monitor injury trends over time, and to evaluate the effectiveness of preventive interventions. A small monetary or equipment incentive provided to participating clubs would likely be an effective method of increasing participation and ensuring complete compliance. Concerns among the general US public over the risk of injury associated with rugby will undoubtedly continue. To ensure the continued growth of youth rugby in the US these concerns must be addressed. The data collected via this surveillance study, Rugby RIO™ High School, and presented here provide the opportunity to evaluate patterns of injury in US high school rugby and to compare US high school rugby injury rates to injury rates in other US youth sports and in youth rugby in other countries. We strongly recommend that this pilot surveillance study be followed up with the implementation of a multi-year US high school rugby injury surveillance project.

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Appendix A: **RUGBY RIO™ High School Reporter Background Survey**

RUGBY RIO™ High School Reporter Background Survey

1. Reporter ID: _____
   Please create your own reporter ID. You can use anything you would like. However, you will need to use this reporter ID all season. We suggest something easy to remember like the first three letters of you last name and the last four digits of your social security number. If you forget your reporter ID at anytime during the season, please contact Dawn Comstock at (614) 722-2400.

2. Phone #: _____

3. E-mail: _____

4. Age (in years): _____

Mean	41.4 years
Range	17-69
St. Dev.	10.4
No response	0.0% (0)

5. Gender:

Male	82.1% (64)
Female	16.7% (13)
No response	1.3% (1)

6. Will you be reporting for a boys' or girls' high school rugby club?
   We would like to keep each club separate so when we analyze the data, we will be able to determine the average number of injuries per club. If you work with more than one club, we would like you to please create a unique reporter ID for each club. To be able to create additional reporter ID's for other clubs that you work with, please contact Dawn Comstock or Christy Knox at rugbyrio@ccri.net or at (614) 722-2400.

Boys'	82.1% (64)
Girls'	17.9% (14)

7. What is your role with the club?

Club physician (M.D. or D.D.S.)	2.6% (2)
Club certified athletic trainer	2.6% (2)
Another club medical personnel (i.e. nurse, EMT, etc)	3.8% (3)
Club coach	74.4% (58)
Club manager	9.0% (7)
Other	6.4% (5)
No response	1.3% (1)

8. Does your club have a club physician (M.D. or D.D.S)?

Yes	15.4% (12)
No	83.3% (65)
No response	1.3% (1)

9. Does your club have a club certified athletic trainer?

Yes	29.5% (23)
No	70.5% (55)

10. Have you ever played rugby?

Yes	89.7% (70)
No	7.7% (6)
No response	2.6% (2)

11. Have you ever coached rugby?

Yes	82.1% (64)
No	14.1% (11)
No response	3.8% (3)

12. Have you ever been a rugby referee?

Yes	51.3% (40)
No	46.2% (36)
No response	2.6% (2)

13. How many players are on your club? _____
We understand that the size of some clubs may change over time. Please report the number of active players currently in your club.

Sum	2,738
Mean	35.6
Range	16-156
St. Dev.	20.1
No response	1.3% (1)

14. Secondary reporter phone #: _____

15. Secondary reporter e-mail: _____

Appendix B: RUGBY RIO™ High School Weekly Exposure Report

RUGBY RIO™ High School Weekly Exposure Report

1. Reporter ID: _____
   Remember, this is the reporter ID that you created while enrolling in Rugby RIO™ High School. Your reporter ID should be something easy to remember like the first three digits of your last name and the last four digits of your social security number. If you forgot your reporter ID, please contact Dawn Comstock at (614) 722-2400 or at rugbyrio@ccri.net

2. Number of player-practices: _____
   The sum of the number of players at each practice. For example, if the first practice had 20 players and the second practice had 15 players, the number of player-practices would equal 35. If there were three practices and the first practice had 10 players, the second practice had 15 players, and the third practice had 12 players, the number of player-practice would equal 37.

	Overall	Boys	Girls
Sum	34,409	30,041	4,368
Mean*	38.6	40.0	31.7
Range	0-410	0-410	0-408
St. Dev	53.3	55.4	39.2

*Mean player-practices reported per club per week

3. Number of player-matches: _____
   The sum of the number of players in each match. For example, if 15 players played in the first match and 18 players played in the second match, the number of player-matches would equal 33.

	Overall	Boys	Girls
Sum	15,835	14,494	1,341
Mean*	17.8	19.3	9.7
Range	0-463	0-463	0-80
St. Dev	32.0	34.1	13.5

*Mean player-matches reported per club per week

Definition of Injury:

A) An injury that occurs as a result of participation in an organized high school rugby match or practice and
B) Requires medical attention by a club physician, certified athletic trainer, personal physician, or emergency department/urgent care facility and
C) Results 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.

4. Number of injuries: _____

After completing this survey, you will be linked to an injury report form. Please fill out a separate injury report form for each injury.

	Overall	Boys	Girls
Sum	334	288	46
Mean*	0.4	0.4	0.3
Range	0-8	0-8	0-3
St. Dev	0.9	0.9	0.7

*Mean injuries reported per club per week

Appendix C: RUGBY RIO™ High School Injury Report Form

RUGBY RIO™ High School Injury Report Form

Injuries are defined as:

A An injury that occurs as a result of participation in an organized rugby match or practice and

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

C. Results in restriction of the rugby player's participation in rugby activities for one or more days beyond the day of injury.

1. Reporter ID: _____

Remember, this is the reporter ID that you created while enrolling in Rugby RIO™ High School. Your reporter ID should be something easy to remember like the first three digits of your last name and the last four digits of your social security number. If you forgot your reporter ID, please contact Dawn Comstock at (614) 722-2400 or at **rugbyrio@ccri.net**

2. Injured player ID code: _____

Please create a unique identifier for the injured player. Similar to a CIPP#, this player ID code will be used to track all injuries sustained by the player over the course of the season. The unique identifier should be something easy for you to remember but should retain the players' confidentiality. We suggest something like the first two letters of the player's last name and the last four digits of his or her social security number. It is important to capture all injuries so we can learn as much as possible about high school rugby injuries.

No response	5.0% (15)
# players who sustained >1 injury	23

3. Level of club playing for at time of injury:

	Overall	Boys	Girls
Club	2.0% (6)	2.3% (6)	0.0% (0)
Collegiate	0.0% (0)	0.0% (0)	0.0% (0)
High School	96.0% (291)	95.4% (250)	100.0% (41)
Youth	1.7% (5)	1.9% (5)	0.0% (0)
Select side/All-star	0.0% (0)	0.0% (0)	0.0% (0)
No response	0.3% (1)	0.4% (1)	0.0% (0)

4. Age: _____years

	Overall	Boys	Girls
Mean	16.5 years	16.6 years	16.3 years
Range	14-19	14-19	14-18
St. Dev	1.2	1.2	1.3

	Overall	Boys	Girls
14	5.3% (16)	4.2% (11)	12.2% (5)
15	17.8% (54)	17.9% (47)	17.1% (7)
16	22.8% (69)	23.7% (62)	17.1% (7)
17	27.4% (83)	26.3% (69)	34.1% (14)
18	24.4% (74)	25.2% (66)	19.5% (8)
19	1.3% (4)	1.5% (4)	0.0% (0)
No response	1.0% (3)	1.1% (3)	0.0% (0)

5. Height: _____inches

	Overall	Boys	Girls
Mean*	69.1 inches	69.7 inches	65.6 inches
Range	60-77	60-77	60-70
St. Dev	3.1	2.9	2.4

*No response: 8.3% (25)

6. Weight: _____pounds

	Overall	Boys	Girls
Mean*	170.2 lbs	174.8 lbs	140.0 lbs
Range	105-280	116-280	105-175
St. Dev	30.7	29.7	17.8

*No response: 7.6% (23)

7. Gender

Male	86.5% (262)
Female	13.5% (41)

8: Date of injury (month/day): _____

January 2005	0.6% (2)
February 2005	10.2% (31)
March 2005	22.4% (68)
April 2005	41.9% (127)
May 2005	20.1% (61)
June 2005	1.3% (4)
Other	0.3% (1)
No response	3.0% (9)

9. Injury occurred during:

	Overall	Boys	Girls
Preseason	14.5% (44)	15.3% (40)	9.8% (4)
Regular season	75.6% (229)	74.8% (196)	80.5% (33)
Postseason	7.6% (23)	7.3% (19)	9.8% (4)
Other	1.7% (5)	1.9% (5)	0.0% (0)
No response	0.7% (2)	0.8% (2)	0.0% (0)

10. Injury occurred in:

	Overall	Boys	Girls
Competition	83.2% (252)	83.2% (218)	82.9% (34)
Practice	16.8% (51)	16.8% (44)	17.1 (7)

11. Time of injury:

	Overall	Boys	Girls
Competition (n=252)			
Beginning of 1st half	13.5% (34)	14.2% (31)	8.8% (3)
End of 1st half	24.6% (62)	22.0% (48)	41.2% (14)
Beginning of 2nd half	34.1% (86)	35.8% (78)	23.5% (8)
End of 2nd half	25.0% (63)	24.8% (54)	26.5% (9)
Pregame	0.4% (1)	0.5% (1)	0.0% (0)
Overtime	1.2% (3)	1.4% (3)	0.0% (0)
No response	1.2% (3)	1.4% (3)	0.0% (0)
Practice (n=51)			
First ½ hour	15.7% (8)	13.6% (6)	28.6% (2)
Second ½ hour	33.3% (17)	36.4% (16)	14.3% (1)
Third ½ hour	31.4% (16)	29.5% (13)	42.9% (3)
Fourth ½ hour	15.7% (8)	18.2% (8)	0.0% (0)
> 2 hours into practice	3.9% (2)	2.3% (1)	14.3% (1)

12. Where did this injury occur? (**GAME ONLY** (answer only if injury occurred in match))

	Overall	Boys	Girls
Home match	44.8% (113)	42.7% (93)	58.8% (20)
Away match	31.7% (80)	33.9% (74)	17.6% (6)
Neutral site	19.0% (48)	18.3% (40)	23.5% (8)
Other	1.2% (3)	1.4% (3)	0.0% (0)
No response	3.2% (8)	3.7% (8)	0.0% (0)

13. Was this injury directly related to action that was ruled illegal activity/foul play by a referee or disciplinary committee? (**GAME ONLY** (answer only if injury occurred in match))

	Overall	Boys	Girls
Yes	4.8% (12)	5.5% (12)	0.0% (0)
No	93.7% (236)	92.7% (202)	100.0% (34)
No response	1.6% (4)	1.8% (4)	0.0% (0)

14. Injury occurred in: (**PRACTICE ONLY** (answer only if injury occurred in practice))

	Overall	Boys	Girls
Noncontact practice	33.3% (17)	34.1% (15)	28.6% (2)
Tackling practice	15.7% (8)	13.6% (6)	28.6% (2)
Full contact scrimmage (15 on 15)	13.7% (7)	15.9% (7)	0.0% (0)
Full contact drill (2 participants)	3.9% (2)	4.5% (2)	0.0% (0)
Full contact drill (3 to 8 participants)	13.7% (7)	11.4% (5)	28.6% (2)
Full contact drill (9 to 15 participants)	17.6% (9)	18.2% (8)	14.3% (1)
Other	2.0% (1)	2.3% (1)	0.0% (0)

15. This injury is a:

	Overall	Boys	Girls
New injury	86.5% (262)	87.4% (229)	80.5% (33)
Recurrence of rugby injury from previous season	1.3% (4)	1.1% (3)	2.4% (1)
Recurrence of rugby injury from current season	3.6% (11)	3.1% (8)	7.3% (3)
Complication of previous rugby injury	0.0% (0)	0.0% (0)	0.0% (0)
Recurrence of other-sport injury	5.9% (18)	5.7% (15)	7.3% (3)
Recurrence of nonsport injury	0.7% (2)	0.8% (2)	0.0% (0)
Complication of previous nonrugby injury	1.0% (3)	0.8% (2)	2.4% (1)
No response	1.0% (3)	1.1% (3)	0.0% (0)

16. Weather/field conditions:

	Overall	Boys	Girls
No precipitation	79.9% (242)	82.4% (216)	63.4% (26)
Rain	6.9% (21)	5.7% (15)	14.6% (6)
Snow	2.6% (8)	3.1% (8)	0.0% (0)
Indoor	1.3% (4)	0.8% (2)	4.9% (2)
No precipitation but wet field/mud	8.6% (26)	7.6% (20)	14.6% (6)
No response	0.7% (2)	0.4% (1)	2.4% (1)

17. How long did this injury keep athlete from participating in rugby? (If end of season, give best estimate)

	Overall	Boys	Girls
1-2 days	13.2% (40)	11.8% (31)	22.0% (9)
3-6 days	14.2% (43)	13.7% (36)	17.1% (7)
7-9 days	16.8% (51)	16.4% (43)	19.5% (8)
10-21 days	25.1% (76)	26.7% (70)	14.6% (6)
22 days or more	26.7% (81)	28.6% (75)	14.6% (6)
No response	4.0% (12)	2.7% (7)	12.2% (5)

18. Injury occurred during: (While we understand that phases of play rapidly change, please choose the phase of play that you feel played the biggest role. For example, if you were participating in a line out that turned into a ruck and while you were on the ground, you were stepped on or kicked, please report ruck.)

	Overall	Boys	Girls
Scrum	2.3% (7)	1.9% (5)	4.9% (2)
Line out	1.0% (3)	0.8% (2)	2.4% (1)
Ruck	12.9% (39)	14.1% (37)	4.9% (2)
Maul	3.3% (10)	3.4% (9)	2.4% (1)
Being tackled	31.0% (94)	30.9% (81)	31.7% (13)
Tackling	29.7% (90)	29.4% (77)	31.7% (13)
Running during play	10.2% (31)	9.9% (26)	12.2% (5)
Gathering ball from the ground	2.6% (8)	2.3% (6)	4.9% (2)
Kicking	0.7% (2)	0.8% (2)	0.0% (0)
Conditioning, sprints	0.7% (2)	0.8% (2)	0.0% (0)
Conditioning, weight training	0.0% (0)	0.0% (0)	0.0% (0)
Conditioning other	0.3% (1)	0.0% (0)	2.4% (1)
Other	4.3% (13)	4.6% (12)	2.4% (1)
No response	1.0% (3)	1.1% (3)	0.0% (0)

19. **Principle** body site injured (for 1-8, complete Head-Injury Information; for 26 or 27, complete Knee-Injury information) (If more than one body site was injured during the same injury event, please choose the most severely injured body site. For example, if a player sustains a wrist fracture and a chin laceration, please choose wrist.)

	Overall	Boys	Girls
Head	20.8% (63)	20.6% (54)	22.0% (9)
Eye	0.7% (2)	0.8% (2)	0.0% (0)
Ear	0.3% (1)	0.4% (1)	0.0% (0)
Nose	5.0% (15)	4.6% (12)	7.3% (3)
Face	2.3% (7)	2.3% (6)	2.4% (1)
Jaw	0.3% (1)	0.4% (1)	0.0% (0)
Mouth	1.0% (3)	1.1% (3)	0.0% (0)
Teeth	0.3% (1)	0.4% (1)	0.0% (0)
Neck	2.3% (7)	2.3% (6)	2.4% (1)
Shoulder	13.9% (42)	14.5% (38)	9.8% (4)
Clavicle	5.3% (16)	6.1% (16)	0.0% (0)
Upper arm	0.3% (1)	0.0% (0)	2.4% (1)
Elbow	0.7% (2)	0.8% (2)	0.0% (0)
Forearm	0.7% (2)	0.8% (2)	0.0% (0)
Wrist	1.7% (5)	1.5% (4)	2.4% (1)
Hand	1.0% (3)	1.1% (3)	0.0% (0)
Thumb	2.0% (6)	1.9% (5)	2.4% (1)
Finger	1.7% (5)	1.5% (4)	2.4% (1)
Upper back	0.3% (1)	0.4% (1)	0.0% (0)
Spine	0.3% (1)	0.4% (1)	0.0% (0)
Lower back	2.3% (7)	2.7% (7)	0.0% (0)
Ribs	2.0% (6)	2.3% (6)	0.0% (0)
Sternum	0.3% (1)	0.4% (1)	0.0% (0)
Pelvis, hips, groin	1.7% (5)	1.9% (5)	0.0% (0)
Upper leg	3.0% (9)	3.4% (9)	0.0% (0)
Knee	8.3% (25)	7.6% (20)	12.2% (5)
Patella	0.3% (1)	0.4% (1)	0.0% (0)
Lower leg	2.6% (8)	1.9% (5)	7.3% (3)
Ankle	15.8% (48)	14.9% (39)	22.0% (9)
Foot	0.7% (2)	0.8% (2)	0.0% (0)
Toe	0.7% (2)	0.8% (2)	0.0% (0)
Spleen	0.3% (1)	0.4% (1)	0.0% (0)
Other	1.3% (4)	0.8% (2)	4.9% (2)

21. This athlete was diagnosed as having: (**HEAD INJURY** (answer only if response in question 19 was 1-8))

	Overall	Boys	Girls
1° cerebral concussion	46.2% (43)	48.8% (39)	30.8% (4)
2° cerebral concussion	8.6% (8)	7.5% (6)	15.4% (2)
3° cerebral concussion	1.1% (1)	1.3% (1)	0.0% (0)
No cerebral concussion	36.6% (34)	36.3% (29)	38.5% (5)
Unknown	6.5% (6)	5.0% (4)	15.4% (2)
No response	1.1% (1)	1.3% (1)	0.0% (0)

22. Was a mouthpiece (MP) worn? (**HEAD INJURY** (answer only if response in question 19 was 1-8))

	Overall	Boys	Girls
MP worn-dentist-fitted	9.7% (9)	11.3% (9)	0.0% (0)
MP worn-self-fitted	88.2% (82)	86.3% (69)	100.0% (13)
MP not worn	2.2% (2)	2.5% (2)	0.0% (0)
Unknown	0.0% (0)	0.0% (0)	0.0% (0)

23. Type eye injury: (**HEAD INJURY** (answer only if response in question 19 was 1-8))

	Overall	Boys	Girls
Orbital fracture	1.1% (1)	1.3% (1)	0.0% (0)
Cornea	0.0% (0)	0.0% (0)	0.0% (0)
Ruptured globe	0.0% (0)	0.0% (0)	0.0% (0)
Soft tissue	2.2% (2)	2.5% (2)	0.0% (0)
None	77.4% (72)	75.0% (60)	92.3% (12)
Other	2.2% (2)	1.3% (1)	7.7% (1)
No response	17.2% (16)	20.0 (16)	0.0% (0)

24. Indicate ALL knee structures injured (check all that apply): (**KNEE INJURY** (answer only if response in question 19 was 26 or 27))

	Overall*	Boys	Girls
Collateral	20.0% (5)	25.0% (5)	0.0% (0)
Anterior cruciate	28.0% (7)	25.0% (5)	40.0% (2)
Posterior cruciate	0.0% (0)	0.0% (0)	0.0% (0)
Torn cartilage (meniscus)	8.0% (2)	10.0% (2)	0.0% (0)
Patella and/or patella tendon	12.0% (3)	10.0% (2)	20.0% (1)

*Answers are not mutually exclusive

25. **Primary** type of injury: (If more than one diagnosis applies, please choose the most severe. For example, if a player sustains both a concussion and a head laceration, please choose concussion.)

	Overall	Boys	Girls
Abrasion	0.0% (0)	0.0% (0)	0.0% (0)
Contusion	9.6% (29)	9.5% (25)	9.8% (4)
Laceration	4.6% (14)	5.3% (14)	0.0% (0)
Puncture wound	0.0% (0)	0.0% (0)	0.0% (0)
Bursitis	0.3% (1)	0.0% (0)	2.4% (1)
Tendonitis	0.3% (1)	0.4% (1)	0.0% (0)
Ligament sprain (incomplete tear)	16.8% (51)	15.3% (40)	26.8% (11)
Ligament sprain (complete tear)	2.3% (7)	2.3% (6)	2.4% (1)
Muscle-tendon strain (incomplete tear)	8.9% (27)	8.0% (21)	14.6% (6)
Muscle-tendon strain (complete tear)	0.0% (0)	0.0% (0)	0.0% (0)
Torn cartilage	0.3% (1)	0.4% (1)	0.0% (0)
Hyperextension	3.6% (11)	3.8% (10)	2.4% (1)
AC separation	4.3% (13)	5.0% (13)	0.0% (0)
Dislocation (partial)	5.0% (15)	5.0% (13)	4.9% (2)
Dislocation (complete)	0.3% (1)	0.4% (1)	0.0% (0)
Fracture	14.5% (44)	16.0% (42)	4.9% (2)
Stress fracture	1.0% (3)	0.8% (2)	2.4% (1)
Concussion	14.2% (43)	14.5% (38)	12.2% (5)
Heat exhaustion	0.3% (1)	0.4% (1)	0.0% (0)
Heatstroke	0.0% (0)	0.0% (0)	0.0% (0)
Burn	0.0% (0)	0.0% (0)	0.0% (0)
Inflammation	2.3% (7)	1.9% (5)	4.9% (2)
Infection	0.0% (0)	0.0% (0)	0.0% (0)
Hemorrhage	0.0% (0)	0.0% (0)	0.0% (0)
Internal injury (nonhemorrhage)	0.3% (1)	0.4% (1)	0.0% (0)
Nerve injury	1.3% (4)	1.5% (4)	0.0% (0)
Blisters	0.0% (0)	0.0% (0)	0.0% (0)
Boil(s)	0.0% (0)	0.0% (0)	0.0% (0)
Hernia	0.0% (0)	0.0% (0)	0.0% (0)
Foreign object	0.0% (0)	0.0% (0)	0.0% (0)
Avulsion (tooth)	0.3% (1)	0.4% (1)	0.0% (0)
Other	5.9% (18)	5.0% (13)	12.2% (5)
No response	3.3% (10)	3.8% (10)	0.0% (0)

26. Did a laceration or wound that resulted in oozing or bleeding occur as a part of this injury?

	Overall	Boys	Girls
Yes	9.6% (29)	9.9% (26)	7.3% (3)
No	88.8% (269)	88.2% (231)	92.7% (38)
No response	1.7% (5)	1.9% (5)	0.0% (0)

27. Did this injury require surgery?

	Overall	Boys	Girls
Yes, in-season	6.6% (20)	7.6% (20)	0.0% (0)
Yes, postseason	1.7% (5)	1.9% (5)	0.0% (0)
No	91.4% (277)	90.5% (237)	97.6% (40)
No response	0.3% (1)	0.0% (0)	2.4% (1)

28. Describe the joint surgery:

	Overall	Boys	Girls
Arthrotomy	0.3% (1)	0.4% (1)	0.0% (0)
Diagnostic arthroscopy	0.0% (0)	0.0% (0)	0.0% (0)
Operative arthroscopy	2.0% (6)	2.3% (6)	0.0% (0)
Other	5.9% (18)	6.9% (18)	0.0% (0)
No joint surgery	91.7% (278)	90.5% (237)	100.0 (41)

29. Method used to assess injury (best assessment procedure):

	Overall	Boys	Girls
Clinical exam by athletic trainer	28.4% (86)	26.3% (69)	41.5% (17)
Clinical exam by M.D./D.D.S	43.9% (133)	45.0% (118)	36.6% (15)
X-ray	15.2% (46)	16.8% (44)	4.9% (2)
MRI	4.0% (12)	3.4% (9)	7.3% (3)
Other imagery technique	0.7% (2)	0.4% (1)	2.4% (1)
Surgery	0.0% (0)	0.0% (0)	0.0% (0)
Blood work/lab test	0.0% (0)	0.0% (0)	0.0% (0)
Other	6.9% (21)	7.3% (19)	4.9% (2)
No response	1.0% (3)	0.8% (2)	2.4% (1)

30. Playing surface:

	Overall	Boys	Girls
Natural grass	87.5% (265)	87.0% (228)	90.2% (37)
Artificial grass	9.2% (28)	9.2% (24)	9.8% (4)
Non-grass surfaces (e.g. gym floors, etc.)	0.7% (2)	0.8% (2)	0.0% (0)
Other	1.3% (4)	1.5% (4)	0.0% (0)
No response	1.3% (4)	1.5% (4)	0.0% (0)

31. Injury mechanism: (While multiple factors may play a role in an injury, please choose the mechanism that you feel played the biggest role in the injury. For example, if a player was driven into a post by a tackler and the player sustains a head laceration, please choose impact with equipment /post/Russel ropes rather than impact with another player.)

	Overall	Boys	Girls
Heat illness	0.3% (1)	0.4% (1)	0.0% (0)
Impact with playing surface/ground	24.1% (73)	22.9% (60)	31.7% (13)
Impact with another player	51.2% (155)	53.1% (139)	39.0% (16)
Impact with equipment/post/Russel ropes	0.3% (1)	0.0% (0)	2.4% (1)
Stepped on/fallen on	6.3% (19)	6.5% (17)	4.9% (2)
Kicked	2.3% (7)	1.9% (5)	4.9% (2)
Punched	1.0% (3)	0.8% (2)	2.4% (1)
Sprints/running	3.0% (9)	2.7% (7)	4.9% (2)
No apparent contact (rotation around planted feet)	5.9% (18)	5.7% (15)	7.3% (3)
No apparent contact (other)	0.7% (2)	0.8% (2)	0.0% (0)
Other	3.6% (11)	3.8% (10)	2.4% (1)
No response	1.3% (4)	1.5% (4)	0.0% (0)

31. Position played at time of injury (check all that apply):

	Overall	Boys	Girls
Prop	13.2% (40)	13.4% (35)	12.2 % (5)
Hooker	7.6% (23)	7.3% (19)	9.8% (4)
Second row/lock	13.9% (42)	12.6% (33)	22.0% (9)
#8	2.6% (8)	2.3% (6)	4.9% (2)
Flanker/wing forward	13.9% (42)	13.7% (36)	14.6% (6)
Scrum half	4.3% (13)	4.6% (12)	2.4% (1)
Fly half	5.0% (15)	5.7% (15)	0.0% (0)
Inside center	6.9% (21)	6.1% (16)	12.2% (5)
Outside center	6.9% (21)	7.3% (19)	4.9% (2)
Wing	15.5% (47)	16.4% (43)	9.8% (4)
Full back	5.9% (18)	6.1% (16)	4.9% (2)
No response	4.3% (13)	4.6% (12)	2.4% (1)

32. Protective equipment worn at time of injury: (check all that apply)

	Overall*	Boys	Girls
Mouthguard	95.0% (288)	94.3% (247)	100.0% (41)
Scrum cap/padded headgear	11.6% (35)	11.8% (31)	9.8% (4)
Shoulder pads	9.6% (29)	11.1% (29)	0.0% (0)
Elbow/knee pads	1.0% (3)	1.1% (3)	0.0% (0)
Shin guards	0.7% (2)	0.8% (2)	0.0% (0)
Ankle braces	2.3% (7)	1.5% (4)	7.3% (3)
Neoprene sleeves	0.7% (2)	0.8% (2)	0.0% (0)
Tape on ears	1.0% (3)	1.1% (3)	0.0% (0)
Grease (Vaseline, etc)	0.0% (0)	0.0% (0)	0.0% (0)
Athletic tape on ankles, knees, wrist, fingers, etc.	6.9% (21)	6.1% (16)	12.2% (5)

*Answers are not mutually exclusive

33. Final disposition of injury:

	Overall*	Boys	Girls
Fatality	0.0% (0)	0.0% (0)	0.0% (0)
Permanent disability	0.0% (0)	0.0% (0)	0.0% (0)
Forced retirement from playing rugby	1.7% (5)	1.9% (5)	0.0% (0)
Forced end to season but future play expected	27.4% (83)	29.0% (76)	17.1% (7)
Returned to play in the 2005 season	68.6% (208)	67.2% (176)	78.0% (32)
No response	2.3% (7)	1.9% (5)	4.9% (2)

Appendix D: RUGBY RIO™ High School End of Study Survey

RUGBY RIO™ High School End of Study Survey

1. Approximately how much time, on average, each week did it take you to complete the weekly exposure report (in minutes)?

Mean	7.6 minutes
Range	1-15
St. Dev.	5.6
No response	6.7% (1)

2. Approximately how much time, on average, did it take you to complete an injury report form for each injury (in minutes)?

Mean	6.2 minutes
Range	2-20
St. Dev.	5.4
No response	6.7% (1)

3. How easy or difficult was the internet-based system to use?

Very difficult	6.7% (1)
Somewhat difficult	6.7% (1)
Neither difficult nor easy	13.3% (2)
Somewhat easy	26.7% (4)
Very easy	46.7% (7)

4. Are there any questions you would like to see deleted from either form?

Yes	26.7% (4)
No	60.0% (9)
No response	13.3% (2)

5. If yes, please briefly describe the questions you would like to see deleted and why.

No suggestions for specific questions to be deleted offered

6. Are there any additional questions you would like to see added to either form?

Yes	13.3% (2)
No	60.0% (9)
No response	26.7% (4)

7. If yes, please briefly describe the questions you would like to see added and why.

Suggestions included amount of player experience, participation in other sports, how often the player practices, and severity of diagnosis (i.e. severity of contusion).

8. Do you think it would have been helpful if you had received training on the internet-based surveillance system?

Yes	26.7% (4)
No	66.7% (10)
No response	6.7% (1)

9. If yes, please briefly describe what type of training would have been helpful?

Suggestions included step-by-step instructions including screen shots and examples, a better explanation of ability to add injuries to particular weeks, and more detailed instructions for enrolling.

10. Overall, how satisfied or dissatisfied were you with the internet-based surveillance system?

Very dissatisfied	6.7% (1)
Somewhat dissatisfied	6.7% (1)
Neither dissatisfied or satisfied	6.7% (1)
Somewhat satisfied	53.3% (8)
Very satisfied	26.7% (4)

11. Did you experience any difficulties using the internet-based surveillance system (such as not receiving a weekly email, receiving too many emails, not being able to log into the system, the system not accepting the data that you entered, etc.)?

Yes	40.0% (6)
No	53.3% (8)
No response	6.7% (1)

12. If yes, please briefly describe the difficulties you experienced.

Reported difficulties included not being able to access the website and not receiving an email.

13. If you had difficulties using the internet-based surveillance system, did you contact researchers about the problem?

Yes	46.7% (7)
No	20.0% (3)
N/A (no difficulties)	20.0% (3)
No response	13.3% (2)

14. If you have any suggestions for improving the internet-based surveillance system, please describe briefly.

    Suggestions included providing reporters with PowerPoint slides or other help pop-ups as training aids, adding injury category definitions to the website, and purchasing software that would sum the number of injuries for the reporter.

15. Would you be willing to serve as a reporter for a follow-up injury surveillance project during the 2006 season (please briefly describe why or why not)?

Yes	86.7% (13)
No	0.0% (0)
No response	13.3% (2)

    Reasons for wanting to participate again included the system's ease of use, having scientific support to back the claim that rugby is not as dangerous as the public may think, and helping to prevent injuries.