Injuries and Concussions in Female High School Rugby: Prevention is Worth a Try

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Abstract

Objectives: To describe injury and concussion rates and mechanisms in female high school rugby players. **Design:** Two-year prospective cohort study. **Setting:** High school rugby. **Participants:** Participants included 214 female High school rugby players (year 1) and 207 female High school players (year 2) from the Calgary Senior High School Athletics Association 2018 and 2019 rugby competition. **Intervention:** None. **Main Outcome Measures:** Match and training injury and concussion. Injury definition included any injury resulting in time loss, inability to complete a session, and/or requiring medical attention. Details of reported injuries were collected on injury report forms and validated by a certified athletic therapist on a validated online injury surveillance platform. Exposure hours for players were tracked using paper or virtual weekly exposure forms by team designates. **Results:** A match incidence rate (IR) = 93.7 injuries/1000 match hours (95% confidence intervals (CI): 78.6-11.7) and training IR = 5.3 injuries/1000 training hours (95% CI: 4.0-6.9) were estimated. The tackle accounted for 109 (70%) match and 37 (44%) training injuries. Tackling was the most frequent mechanism of injury (IR = 37.5 injuries/1000 match hours, 95% CI: 27.5-51.8 and 1.2 injuries/1000 training hours, 95% CI: 0.7-2.4). Sixty-two match concussions (IR = 37.5 concussions/1000 match hours, 95% CI: 26.8-52.3) and 16 training concussions (IR = 1.0 concussions/1000 training hours, 95% CI: 0.7-1.4) occurred. Of 78 reported concussions, 78% for match and 56% for training were physician diagnosed. Tackling was the most frequent mechanism of concussion in matches (IR = 18.1 concussions/1000 match hours, 95% CI:11.4-28.6). **Conclusions:** Injury and concussion rates in female high school rugby are high. The tackle accounted for the highest proportion of injuries. Prevention strategies (eg, tackle policy change, tackle-training programs, and neuromuscular training) should be explored to increase sport safety.

Key Words: rugby union, female, youth, sport injury epidemiology, tackle, concussion

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INTRODUCTION

Female rugby participation is high internationally (2.7 million female players worldwide) with a 56% increase since 2014.[1] In Canada, rugby player registration has increased by 44% between 2012 and 2019 with a 13% increase in youth players.[2,3] Despite the growing interest in rugby in Canada, little is known about the Canadian injury profile for female players. There is reason to suggest that the Canadian rugby context is different than in countries where the sport has a longer history of development. In Canada, for example, many players do not get their first exposure to rugby until high school (age 14-18 years). This suggests injury risk, mechanisms, and risk factors for Canadian players could differ from

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what has been previously reported from other countries. This is of relevance within female cohorts given the recent spike in participation within the female game.

Recently, within an English high school setting, a 24-hour time-loss injury rate (IR) of 53 injuries/1000 match hours (95%CI: 36-37) was reported for youth female rugby.[5] Moreover, female rugby had the highest concussion IR among 7 school sports (27 concussions/1000 match hours, 95%CI: 16-44).5

Given the limited literature in Canadian youth female rugby, alongside the growing popularity of the sport, examining the injury epidemiology for this population is pivotal to inform the development and evaluation of injury prevention strategies. The primary objective of this study is to describe match and training injury rates, types, locations, and mechanisms in high school female rugby.

METHODS

Study Design

A prospective cohort study design was used to examine injury rates, types, locations, and mechanisms for injury and concussion across 2 seasons of female high school rugby. Injury data were collected during the 2018 (year 1) and 2019 (year 2) high school rugby seasons in Calgary, Canada. This study is part of a larger cohort study across multiple youth sports (Surveillance in High Schools and Community Sport to Reduce Injuries and Concussions—SHRed Injuries—REB17-1948) and served as a pilot study for the pan-Canadian Surveillance in High Schools and Community Sport to Reduce Concussions and their Consequences (SHRed Concussions—REB18-2107) research program.

Participants

Based on 25 high schools participating in the Calgary Senior High School Athletics Association (CSHSAA), we aimed to recruit rugby teams from eight high schools. This was a convenience sample, including those who were closest to the sport medicine clinic for concussion follow-up. Permission was acquired from both participating school boards and initial contact with the schools was performed through a written letter or email to school administrations (eg, vice principal and principal). Once a school agreed to take part in the study, the assigned rugby coach or teacher designate was contacted to recruit the school rugby program.

The female high school CSHSAA rugby league includes a junior (age 15-16) and senior (age 16-18) league, with senior split into 3 divisions. Teams were placed in a division based on previous league success and school size. The playing season (mid-March to beginning of June) consisted of a regular season (~6 games) and a knock-out playoff round (~4 games). Games consisted of two 30-minute halves with no extra time. Year 1 and year 2 consisted of a 13-week playing season (year 1: 7 weeks (preseason), 4 weeks (regular season games), and 2 weeks (playoffs); year 2: 5 weeks (preseason), 6 weeks (regular season games), and 2 weeks (playoffs)). Additional exposure included exhibition games (rugby union 15s or 7s), developmental/preseason tournaments, and rugby union-7s tournaments. Recruitment to the study began in February and follow-up would occur through June to acquire any missing injury and exposure data.

Procedures

Injury surveillance was ongoing throughout the season using validated online injury surveillance.[6] Data were collected using REDCap (Research Electronic Data Capture) in year 1 and Athlete Monitoring (FITSTATS Technologies Inc) in year 2.[7,8] Each season, participants were tested at baseline, and an online player account was provided. Baseline testing included a preseason baseline questionnaire and a Sport Concussion Assessment Tool-fifth Edition (SCAT5) conducted by a trained research assistant. The baseline questionnaire included participant characteristics (eg, age, injury within the past 12 months, concussion history, previous rugby experience, playing position, protective equipment, and medical history).

Each team identified a team designate (eg, sports medicine class student, student team manager, coach) who tracked attendance at each rugby session (ie, training and match) on a paper or online weekly exposure sheet (WES). Participation (ie, full, partial [<75% of session], none])was recorded. In year 1, the team designate or study therapist initiated an injury report form (IRF) for any participant that sustained a suspected injury. In year 2, the same methodology was followed; however, a weekly Oslo Sport Trauma Research Centre Questionnaires on Health Problems (OSTRC) was added to allow participants the opportunity to self-report any injury in which case the team designate or study therapist followed up to complete an IRF.[9] IRFs contained details of the injury, return-to-play dates, and medical attention and time-loss information which were validated by a study therapist. Three injury definitions were used; (1) the "SHRed" study injury definition of "any injury that required medical attention, resulted in time-loss, and/or the inability to complete a session", (2) 24-hour time-loss, (3) a medical attention definition.[10]

Throughout the course of both seasons, a study therapist (ie, athletic therapist, physiotherapist) and school lead (ie, research assistant) completed weekly school visits. The therapist and school lead collected missing injury details for the previous week. If a participant sustained a concussion, they were referred to a sport medicine physician at the University of Calgary Sport Medicine Centre or partner community clinic for follow-up. Upon completion of the season, follow-ups were completed by phone to capture any missing injury or exposure data.

Statistical Analysis

STATA v.16 was used to conduct all statistical analyses.[11] Baseline participant characteristics were described using medians and proportions. Match and training injury locations, types, and mechanisms were combined across the 2 years and described as a frequency and IRs with 95% confidence intervals (CIs) using robust standard errors to account for clustering by team using the time-loss and "SHRed" injury definitions. The primary injury definition used for this study was the "SHRed" definition. Median (interquartile range) severity (based on reported days absent from rugby on injury report form) was reported for all injury types, locations, and mechanisms. Injury risk matrices for match and training injuries were generated by plotting the injury incidence against the geometric mean of severity and reported by the injury region (ie, head, lower extremity, and upper extremity). The median and geometric mean were

estimated because of skewed severity distribution. The 2 years of injury surveillance were compared, and the between-year IR differences (95% CI) based on injury definitions were presented.

Ethical Considerations

Ethics for this study was obtained by the Conjoint Health Research Ethics Board at the University of Calgary and the participating school boards (ie, Calgary Board of Education and Calgary Catholic School District). Dependent on the school board, player consent or player assent and parent consent were acquired before participation in the study.

RESULTS

In study year 1, 8 of 24 CSHSAA schools were invited to participate in the study. Seven teams from 5 schools agreed to participate (n = 214). In study year 2, 10 of 25 schools in CSHSAA were invited and 7 teams from 7 schools participated (n = 207). Teams from each of the three senior divisions were represented in each study year. In total, 421 player-seasons from 361 unique players were recorded. Participant demographics are described in Table 1.

Across 2 years and 421 player seasons, 17 713 player hours were reported (1654 match hours and 16 059 training hours) with 60 players participating in both seasons. There were a greater number of match hours in year 2 (947 match hours) compared with year 1 (707 match hours) because of a shorter season related to weather, whereas there was no substantial difference in training hours (year 1: 8188 training hours and year 2: 7871 training hours).

Injury

Across both years, 240 injuries were reported (57 injuries/100 player seasons) with 144 players reporting 1 injury, 40 players reporting 2 injuries, 4 players reporting 3 injuries, and 1 player

TABLE 1. Baseline Player Demographics

Year of Participation (n)	2018 (Year 1)	214
	2019 (Year 2)	207
	Missing	0
Age (yr)	Median (range)	16.6 (15.1-18.4)
	Missing	2
Grade (n [%])	10	146 (35)
	11	158 (38)
	12	117 (28)
	Missing	0
Height (cm)	Median (range)	165.1 (147.3-185.4)
	Missing	10
Weight (kg)	Median (range)	60.3 (43.7-110.3)
	Missing	12
Injury in the past 12 months (n [%])	No injury	239 (57)
	At least 1 injury	178 (42)
	Missing	4
Concussion history (n [%])	No concussion	274 (66)
	One concussion	98 (24)
	Two or more concussions	44 (11)
	Missing	5
Rugby playing experience (n [%])	No previous playing experience	174 (43)
	1 yr or greater of previous playing experience	230 (57)
	Missing	17
Playing position (n [%])	Forward	199 (52)
	Back	181 (48)
	Missing	41
Team playing division (n [%])	Junior division 1	55 (13)
	Senior division 1	86 (20)
	Senior division 2	188 (45)
	Senior division 3	80 (19)
	Others*	12 (3)
	Missing	0

** One team did not participate within the CSHSAA rugby league.*

reporting 4 injuries within a single season. Table 2 summarizes the injury definitions, injury rates, and rate differences between year 1 and year 2.

Match Injury

Across 2 seasons, 133 participants reported 155 match injuries, with 22 players sustaining 2 match injuries in 1 playing season (overall match IR = 93.7 injuries/1000 match hours, 95% CI 78.6-111.7). There was no significant IR difference between study years 1 and 2 (Table 2). The IR for injuries to the head (41.7 injuries/1000 match hours, 95%CI: 30.6-56.8) was the highest, followed by knee and ankle injuries (Table 3). The most common match injury type included concussion (40%) and ligament sprain (24%) (Table 3). Figure 1A displays the injury risk matrix for match injury by location type (head, upper extremity, and lower extremity).

Acute contact-related injuries (IR = 82.8 contact-related injuries/1000 match hours, 95% CI: 66.2-103.5) accounted for 88% of all injuries (Table 4). Tackling (tackler and ball carrier) was responsible for 70% of injuries (65.9 injuries/1000 match hours, 95%CI 51.8-72.1) with injuries to the tackler being the most common contact-related match injury mechanism (37.5 injuries/1000 player hours, 95%CI 27.1-51.8). Conversely, only 5% of injuries related to noncontact mechanisms. Figure 1B displays the injury risk matrix for training injury by location (head, upper extremity, and lower extremity).

Training Injuries

Across 2 seasons, 80 participants reported 85 training injuries, with 75 participants reporting 1 injury and 5 participants reporting 2 training injuries during 1 season (overall training IR = 5.3 injuries/1000 match hours, 95% CI 4.0-6.9). The most common training injury locations included the head (21%) and shoulder (16%) (Table 5). The most common training injury type included joint/ligament sprain (28%) and concussion (26%) (Table 5). Acute contact mechanisms accounted for 68% of training injuries, whereas noncontact and overuse injuries each accounted for 15% of all training injuries (Table 5). The most common training mechanisms included tackling (25%) and being tackled (21%).

Concussion

Over 2 seasons of play, 78 concussions were reported for 421 player seasons (18.5 concussions/100 player seasons). In matches, 62 concussions were reported (37.5/1000 match hours, 95% CI: 26.8-52.3). In year 1, the match concussion IR was 53.7 concussions/1000 match hours (95%CI: 36.7-78.6), and in year 2, it was 25.3 concussions/1000 match hours (95%CI: 16.3-39.3). The rate difference was significantly different between the 2 years of injury surveillance (rate difference: −28.4 concussions/1000 match hours, 95%CI: −50.3, −6.0) (Table 2). In training, 16 concussions were reported (1.0 concussion/1000 training hours, 95% CI: 0.7-1.4). Of the reported concussions, 78% of those from matches and 56% in training were diagnosed by a physician.

Ninety-four percent of concussions were the result of contact-related mechanisms. In matches, 79% of concussions were a result of the tackle (tackling: 18.1 concussions/1000 match hours, 95% CI: 11.4-28.6 and being tackled: 11.5 concussions/1000 match hours, 95% CI: 7.0-19.0). In training, 81% training-related concussions were related to contact mechanisms with 69% a result of the tackle (tackling: 0.2 concussions/1000 training hours, 95% CI: 0.1-0.6 and being tackled: 0.4 concussions/1000 training hours, 95% CI: 0.2-0.8).

DISCUSSION

This is the first study to describe match and training-related injury and concussion rates, injury types, locations, and mechanisms in Canadian female high school rugby players. The overall IR (93.7 injuries/1000 match hours, 95% CI: 78.6-111.7) and concussion-specific IR (37.5 concussion/1000 player hours, 95%CI: 36.8-52.8) are high compared with those previously reported. Furthermore, the tackle is responsible for a substantial portion (61% using the "SHRed" definition) of both the injuries and concussions.

Injury Rates

The injury rates in Calgary female high school rugby players are higher than time-loss IRs reported in English female high school rugby (54 injuries/1000 match hours) and the women's English professional league (36 injuries/1000 match hours).[5,12] A pooled injury incidence rate of 26.7 injuries/

TABLE 2. Match and Training Injury Rates by Injury Definition

	# Of injuries	Year 1 IR*	Year 2 IR*	Rate Difference Between Year 1 and Year 2†	Combined IR*
Match					
"SHRed"	155	100.3 (74.0-136.1)	88.7 (71.6-110.0)	−11.6 (−46.3 to 23.0)	93.7 (78.6-111.7)
Time-loss	121	86.2 (68.5-79.7)	63.4 (50.3-79.8)	−22.8 (−46.5 to 0.8)	73.1 (61.7-86.7)
Medical attention	119	83.4 (61.0-113.9)	63.4 (48.0-83.6)	−20.0 (−50.2 to 10.2)	71.9 (58.5-88.5)
Concussion	62	53.7 (36.7-78.6)	25.3 (16.3-39.3)	−28.4 (−50.8 to (−60.0))	37.5 (36.8-52.8)
Training					
"SHRed"	85	4.8 (3.9-5.7)	5.8 (3.7-9.2)	1.1 (−1.6 to 3.4)	5.3 (4.0-6.9)
Time-loss	60	3.4 (2.7-4.4)	4.1 (2.1-7.7)	0.6 (−2.0 to 3.3)	3.7 (2.6-5.3)
Medical attention	58	3.8 (2.6-5.6)	3.4 (2.5-4.7)	−0.4 (−2.1 to 1.4)	3.6 (2.8-4.6)
Concussion	16	1.1 (0.6-1.9)	1.0 (0.7-1.4)	−0.2 (−0.9 to 0.5)	1.0 (0.7-1.4)

** IR: injury incidence rate. Match IR= injuries/1000 match hours (95% confidence interval); training IR = injuries/1000 training hours (95% confidence interval).*
† Year 1 rates were used as a reference value.

TABLE 3. Match Injury by Type and Location

	"SHRed" Definition (155 Injuries)			Time-Loss Definition (121 Injuries)		
	# of Injuries (%)	IR [Injuries/1000 Match Hours (95% CI)]	Median Severity [days absent (IQR)]	# Of Injuries	IR [Injuries/1000 Match Hours (95% CI)]	Median Severity [d Absent (IQR)]
Injury location						
Head*	69 (45)	41.7 (30.6-56.8)	14 (5–27) (missing: 3)	59	35.7 (25.9-49.1)	17 (9–29) (missing: 3)
Knee	23 (15)	13.9 (9.0-21.5)	7 (2-31) (missing: 1)	20	12.1 (7.6-19.3)	8 (3-93) (missing: 1)
Ankle	14 (9)	8.5 (5.0-14.5)	5 (2–20) (missing: 1)	13	7.9 (4.5-13.7)	5 (3–25) (missing: 1)
Shoulder*	13 (8)	7.9 (3.2-18.9)	4 (1–21) (missing: 1)	10	6.0 (2.3-15.7)	5 (4-30) (missing: 1)
Neck	6 (4)	3.6 (1.3-10.2)	2 (0-5)	3	1.8 (0.6-5.3)	5 (3–7)
Wrist	5 (3)	3.0 (1.4-6.3)	0 (0-0)	1†	0.6 (0.1-4.3)	1†
Finger	4 (3)	2.4 (1.0-5.6)	33 (3-84)	3	1.8 (0.6-5.1)	60 (5-108)
Lower leg	4 (3)	2.4 (1.0-5.8)	19 (0-40)	2	1.2 (0.3-4.7)	40 (38-42)
Upper leg	4 (3)	2.4 (0.8-7.3)	4 (0-8)	2	1.2 (0.3-4.6)	8 (7–9)
Elbow	3 (2)	1.8 (0.6-5.3)	14 (0-21)	2	1.2 (0.3-4.6)	18 (14–21)
Rib	3 (2)	1.8 (0.6-5.2)	2 (0-3) (missing: 1)	2	1.2 (0.3-4.6)	3† (missing: 1)
Hand	2 (1)	1.2 (0.3-4.6)	2 (0-3)	1†	0.6 (0.1-4.3)	3†
Hip/groin	2 (1)	1.2 (0.3-4.6)	2 (0-3)	1†	0.6 (0.1-4.5)	3†
Forearm	1 (1)	0.6 (0.1-4.1)	42†	1	0.6 (0.1-4.1)	42†
Pelvis	1 (1)	0.6 (0.1-4.2)	1†	1	0.6 (0.1-4.2)	1†
Missing	1		0			
Injury type						
Concussion	62 (40)	37.5 (26.8-52.3)	14 (7–27) (missing: 2)	55	33.2 (23.6-46.8)	17 (11–29) (missing: 2)
Sprain	37 (24)	22.3 (16.9-29.6)	4 (1-30) (missing: 2)	28	16.9 (11.7-24.4)	7 (3-39) (missing: 2)
Bruise	15 (10)	9.1 (4.2-19.7)	1 (0-3)	9	5.4 (2.4-12.5)	3 (1–3)
Strain	11 (7)	6.6 (3.8-11.5)	2 (0-5)	6	3.6 (1.6-8.4)	5 (4–7)
Broken bone	8 (5)	4.8 (2.0-11.4)	42 (27-60) (Missing: 1)	8	4.8 (2.0-11.4)	42 (27-60) (missing: 1)
Bursitis	5 (3)	3.0 (1.4-6.6)	5 (1–14)	4	2.4 (1.0-5.9)	10 (3–22)
Dislocation	4 (3)	2.4 (0.8-6.7)	36 (14-459) (Missing: 1)	4	2.4 (0.8-6.7)	36 (14-459) (missing: 1)
Bleeding	1 (1)	0.6 (0.1-4.5)	0†	0	0	0
Cut	1 (1)	0.6 (0.1-4.0)	2†	1	0.6 (0.1-4.0)	2†
Tendonitis	1(1)	0.6 (0.1-4.2)	3†	1	0.6 (0.1-4.2)	3†
Others	9 (6)	5.4 (2.8-10.6)	2 (0-7)	5	3.0 (1.2-7.4)	7 (4–10)
Missing	1		0			

** Head includes the head, nose, eye, face, and jaw. Shoulder includes the shoulder girdle (ie, clavicle and scapula).*
† Only 1 value for severity. No IQR presented.

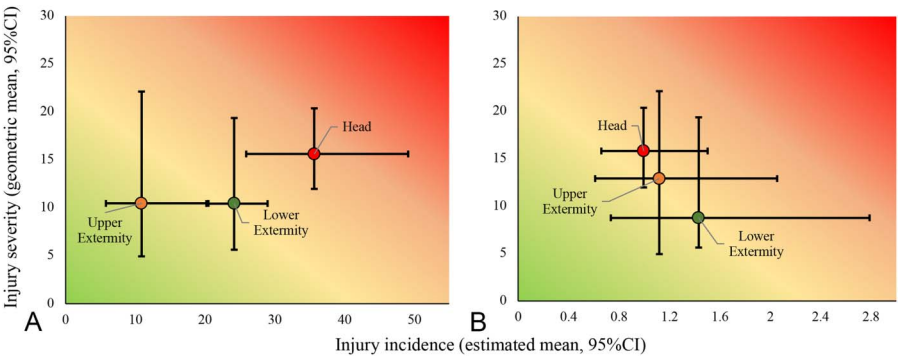

Figure 1. Match (A) and training (B) injury risk matrix for the head, lower extremity, and upper extremity regions.

TABLE 4. Mechanisms of Injury

	"SHRed" Definition			Time-Loss Definition		
	# of Injuries (%)	IR [Injuries/1000 Player hours (95% CI)]	Median Severity [d absent (IQR)]	# Of Injuries	IR [Injuries/1000 Player hours (95% CI)]	Median Severity [d absent (IQR)]
Match injury*						
Acute contact	137(88)	82.8 (66.2-103.5)	9 (2-22) (missing: 7)	108	65.3 (51.5-82.7)	14 (6-30) (missing: 7)
Tackling	62 (40)	37.5 (27.1-51.8)	13 (2-30) (Missing:2)	50	30.2 (22.5-40.6)	20 (7-42) (Missing: 2)
Tackled	47 (30)	28.4 (20.3-39.8)	5 (1-14) (missing: 3)	36	21.8 (14.5-32.6)	8 (4-21) (missing: 3)
Ruck/maul	12 (8)	7.3 (3.5-14.8)	8 (1-24) (missing: 1)	10	6.0 (2.8-13.0)	12 (4-25) (missing: 1)
Scrum	7 (5)	4.2 (1.8-10.1)	18 (0-50) (missing: 1)	5	3.0 (1.5-6.2)	40 (18-72) (missing: 1)
Other contacts*	9 (3)	5.4 (3.2-9.3)	5 (3-14)	7	4.2 (2.0-8.8)	7 (5-15)
Acute noncontact	8 (5)	4.8 (2.7-8.6)	18 (1-235)	6	3.6 (2.1-6.4)	35 (5-432)
Running	4 (3)	2.4 (1.1-5.4)	35 (16-235)	3	1.8 (0.7-4.7)	38 (31-432)
Change in speed	2 (1)	1.2 (0.3-4.8)	4 (2-5)	2	1.2 (0.3-4.8)	4 (2-5)
Other noncontacts	2 (1)	1.2 (0.3-4.5)	222 (0-443)	1†	0.6 (0.1-4.1)	443†
Overuse	6 (4)	3.6 (1.3-10.2)	2 (0-3)	4	2.4 (0.8-7.3)	3 (2-4)
Unknown	4 (3)	2.4 (1.1-5.5)	7 (2-12)	3	1.8 (0.7-4.8)	10 (3-13)
Training injury*						
Acute contact	55 (65)	3.4 (2.5-4.6)	7 (1-30) (missing: 3)	41	2.6 (1.8-3.6)	19 (5-49) (missing: 3)
Tackling	20 (24)	1.2 (0.7-2.4)	7 (0-20) (missing: 2)	14	0.9 (0.5-1.8)	8 (7-26) (missing: 2)
Tackled	17 (20)	1.1 (0.7-1.7)	21 (3-64)	14	0.9 (0.5-1.5)	47 (8-76)
Ruck/maul	6 (7)	0.4 (0.1-0.7)	4 (1-17)	5	0.3 (0.1-0.7)	5 (2-17)
Scrum	4 (5)	0.2 (0.1-0.7)	24 (1-270)	3	0.2 (0.1-0.5)	47 (1-493)
Other contacts‡	8 (9)	0.5 (0.2-1.0)	2 (0-20)	5	0.3 (0.1-0.7)	3 (2-20)
Acute noncontact	13 (15)	0.8 (0.5-1.3)	4 (2-10) (missing: 1)	11	0.7 (0.4-1.2)	4 (4-10) (Missing: 1)
Running	9 (11)	0.6 (0.3-1.0)	4 (2-5)	7	0.4 (0.2-0.8)	4 (3-6)
Change in speed	1 (1)	0.1 (0.1-0.4)	Missing	1	0.1 (0.01-0.4)	Missing
Other noncontacts	3 (4)	0.2 (0.1-0.5)	10 (4-14)	3	0.2 (0.1-0.5)	10 (4-14)
Overuse	13 (16)	0.8 (0.4-1.7)	0 (0-6)	6	0.4 (0.1-1.0)	7 (4-12)
Unknown	4 (5)	0.2 (0.1-0.6)	1 (0-2)	2	0.1 (0.03-0.5)	2 (1-2)

** Match IR = injuries/1000 match hours; training IR = injuries/1000 training hours.*
† Only 1 value for severity. No IQR presented.
‡ Other: collision, unspecified.

1000 match hours regardless of time-loss or medical attention has been estimated for rugby players younger than 21 years.[13] However, our time-loss injury rates compare with those established within an elite youth male school (77 injuries/1000 match hours).[14]

A high proportion of female players (43%) within this study reported having no previous rugby playing experience. This inexperience may help explain the high injury rates in Calgary high school female players compared with other rugby populations. Having a largely inexperienced rugby population may create a large skill discrepancy between those who have and those who have not participated in rugby before.[15] Evaluating and understanding the injury profile within this population contributes to the development of appropriate injury prevention strategies for different rugby contexts, such as that of the Calgary female high school rugby player.

Concussion

Rugby has the highest reported concussion rate in youth sport.[16] Similar to match injury, the match concussion rates for this study are some of the highest rates reported in the youth literature (year 1: 53.7 concussions/1000 match hours, 95% CI 36.7-78.6; year 2: 25.3 concussions/1000 match hours, 95% CI 16.3-39.3). Youth female rugby has also been previously shown to have the highest concussion rate in a multisport high school English cohort study (27 concussions/1000 match hours, 95%CI: 16-44).5

In this study, the concussion rate difference between year 1 and year 2 was significantly different. This was not the case when considering all injury IRs. However, given only 2 years of surveillance was completed, it is difficult to establish whether this difference in concussion IR was typical season-to-season variability or that there was a significant difference between the 2 years. Furthermore, there were differences in the structure between seasons, with adverse weather conditions shortening the first season, therefore limiting team's exposure to normal training conditions outdoors and competition exposures compared with season 2. If increased concussion rates were a consequence of the shortened season, players might have not been adequately exposed to tackling in practice and, thus, not having enough time to adapt to tackle

TABLE 5. Training Injury by Type and Location

	"SHRed" Definition (85 Injuries)			Time-Loss Definition (60 Injuries)		
	# of Injuries (%)	IR [Injuries/1000 Match hours (95% CI)]	Median Severity [d absent (IQR)]	# Of Injuries	IR [Injuries/1000 Match hours (95% CI)]	Median Severity [d absent (IQR)]
Injury location						
Head*	17 (21)	1.1 (0.7-1.6)	20 (3-47) (missing: 2)	15	0.9 (0.6-1.5)	20 (5-47) (missing: 2)
Shoulder*	13 (16)	0.8 (0.3-2.1)	7 (0-88) (missing: 1)	10	0.6 (0.3-1.5)	7 (6-95) (missing: 1)
Ankle	11 (13)	0.7 (0.4-1.3)	6 (3-44)	8	0.5 (0.3-1.0)	16 (4-48)
Knee	10 (12)	0.6 (0.3-1.3)	4 (2-14) (missing: 1)	9	0.6 (0.2-1.3)	5 (3-16) (missing: 1)
Wrist	7 (9)	0.4 (0.2-0.8)	0 (0-9) (Missing:1)	3	0.2 (0.04-0.7)	26 (9-42) (Missing: 1)
Finger	6 (7)	0.4 (0.2-0.8)	5 (0-10)	4	0.2 (0.1-0.6)	9 (5-20)
Lower leg	6 (7)	0.4 (0.1-1.1)	1 (0-6)	3	0.2 (0.05-0.7)	6 (1-12)
Elbow	4 (5)	0.2 (0.1-0.4)	0 (0-3)	1†	0.06 (0.01-0.4)	6†
Back	3 (4)	0.2 (0.04-0.7)	1 (0-28)	2	0.1 (0.03-0.5	15 (1-28)
Hip/groin	3 (4)	0.2 (0.1-0.6)	0 (0-4)	1†	0.06 (0.01-0.5)	4†
Foot	1 (1)	0.1 (0.01-0.4)	6†	1†	0.1 (0.01-0.4)	6†
Upper leg	1 (1)	0.1 (0.01-0.4)	8†	1	0.1 (0.01-0.4)	8†
Missing	3			2		
Injury type						
Sprain	24 (29)	1.5 (1.1-2.1)	4 (0-7) (Missing: 1)	16	1.0 (0.6-1.6)	7 (4-24) (Missing: 1)
Concussion	16 (20)	1.0 (0.7-1.4)	20 (5-47)	14	0.8 (0.6-1.3)	21 (11-49)
Muscle strain	13 (16)	0.8 (0.4-1.9)	3 (0-17) (Missing: 1)	8	0.5 (0.2-1.3)	6 (4-101) (Missing: 1)
Tendonitis	8 (10)	0.5 (0.2-1.4)	0 (0-5)	3	0.2 (0.1-0.5)	7 (2-12)
Broken bone	6 (7)	0.4 (0.2-0.8)	36 (10-56)	6	0.4 (0.2-0.8)	36 (10-56)
Bruise	4 (5)	0.2 (0.1-0.7)	1 (0-5)	2	0.1 (0.02-0.8)	5 (1-8)
Dislocation	3 (4)	0.2 (0.05-0.7)	3 (0-5) (Missing: 1)	2	0.1 (0.03-0.4)	5† (Missing: 1)
Joint swelling	2 (2)	0.1 (0.02-0.8)	11(4-18)	2	0.1 (0.02-0.8)	11(4-18)
Blister	1 (1)	0.1 (0.01-0.4)	6†	1	0.1 (0.01-0.4)	6†
Bursitis	1 (1)	0.1 (0.01-0.4)	2†	1	0.1 (0.01-0.4)	2†
Cut	1 (1)	0.1 (0.01-0.4)	2†	1	0.1 (0.01-0.4)	2†
Other	3 (4)	0.2 (0.05-0.8)	6 (0-14)	2	0.1 (0.03-0.5)	10 (6-14)
Missing	3			2		

** Head includes the head, nose, eye, face, and jaw. Shoulder includes the shoulder girdle (ie, clavicle and scapula).*
† Only 1 value for severity. No IQR presented.

and other important contact events of the game, particularly in those players that had no previous rugby playing experience. The addition of a self-report of injuries using an OSTRC did not lead to greater capture of concussions, with lower rates reported in year 2.

In this study, 79% of match concussions and 69% of training concussions were a result of the tackle. Skill proficiency scores have been evaluated in concussive and nonconcussive tackle events in video analysis.[17] Although no significant difference was found between proficiency scores of a concussive and nonconcussive event, scores for "head placement on correct side of ball-carrier," "shoulder usage," and "leg drive on contact" were higher for nonconcussive tackle events, which suggests tackler and ball-carrier technique should be emphasized to reduce the risk of concussion.[17] Tackler acceleration and moving at a high speed into the tackle, head contact with the opposing player's head, and tackle type have been identified as risk factors for tackle-related concussion.[18] In addition, based on tackle-related injury outcomes, higher tackle proficiency scores were associated with noninjurious outcomes.[15] This could suggest target areas to mitigate the risk of injury within the tackle at the youth level and inform coaches how to coach the tackle.

Tackle

Previously, 60% of youth female rugby injuries have been reported to be due to contact with another player.[5] However, details regarding specific rugby mechanisms of injury are limited in youth female rugby. Within an English youth male population, 51% to 57% of match injuries [19] were due to the tackle event compared with 70% of match injuries in Canadian female high school rugby.

Within the broader female rugby population, it is unclear if the tackler or ball carrier is at a higher risk of injury.[20] At the older, elite levels, the ball carrier has a higher rate of injury.[20] Although not consistent across the literature, the younger, high school population has been estimated to have a higher

proportion of injuries to the tackler.[20] This could be a result of inexperienced players not being accustomed to tackling, which is of relevance to this study population. Similar evaluations to those conducted in youth boys' rugby [21] would be valuable to establish differences in tackle-specific mechanisms in this cohort-specific context.

Canadian High School Rugby Context

Rugby has received a lot of scrutiny regarding the safety of the sport and some have gone as far to ask for the removal of tackling from school rugby.[22] During the 2019 high school season, Nova Scotia School Athletic Federation (Nova Scotia, Canada) canceled high school rugby because of safety concerns.[23] After much resistance, high school rugby was reinstated under the provincial governing body, Rugby Nova Scotia.[24] Despite there being risks associated with playing rugby, Canadian high school rugby players believe the benefits of the sport outweigh the risks.[25] Importantly, these players are receptive to evidence-informed injury prevention strategies, which should be considered before removing rugby from high schools.[25] There is a positive relationship between rugby and mental health and well-being, while providing an opportunity to participate in moderate-to-vigorous physical activity.[26] Ultimately, ensuring these young female athletes remain healthy and injury free to enjoy the many benefits associated with rugby is critical, and therefore, primary prevention strategies should be considered a top priority. Although there are no previous studies evaluating injury prevention strategies in youth female rugby, there are opportunities to develop, implement, and evaluate female youth rugby-specific prevention measures. Evidence-informed injury and concussion prevention strategies in youth sport may target sport policy/rules of the game (eg, height of the tackle), equipment recommendations (eg, mouthguards), and training strategies (eg, neuromuscular warm-up strategies and tackle training).[27–29]

Limitations

There are several limitations associated with this study. First, we were unable to control for repeat participants across the 2 years in our IR estimates because of the limited number of reported injuries within these participants. All rates considered clustering by team; however, future studies should optimally consider cluster also at the individual level to account for multiple injuries to the same player. Generalizability of these findings to all youth female rugby leagues is limited, and future studies will consider multiple jurisdictions across Canada and school and community club contexts.

CONCLUSIONS

This is the first study evaluating injury epidemiology in Canadian youth female rugby with match-related injury and concussion rates some of the highest reported in the youth game. The greatest proportion of injuries and concussions are related to the tackle. The high rates of injury and concussion in female high school rugby highlight the need for youth female injury prevention strategy development, implementation, and evaluation. Although IRs are relatively high, there are no surprising differences in the rugby injury profile compared with the previous literature within other rugby populations. Future research should target risk factor and injury prevention strategy evaluation in youth female rugby leagues to ensure enjoyment and welfare of the players involved and lifelong sport participation.

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