Epidemiology of International Match Injuries in Scottish Rugby

Epidemiology of International Match Injuries in Scottish Rugby: A prospective cohort study

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Abstract

Fifteen-a-side rugby union ("rugby") is a full-contact sport played separately by men and women, with large injury incidences reported previously. Context specific injury surveillance fulfils governing bodies' duty of care to understand risks to player welfare, yet no contemporary match injury epidemiology studies exist for international players in Scotland. The current study therefore aimed to describe the incidence, severity, burden and nature of match injuries sustained by Scotland's men's and women's national teams. A prospective cohort study of injuries recorded in matches across the 2017/18 and 2018/19 seasons was undertaken, with injury and exposure definitions in line with the international consensus for injury surveillance in rugby. Injury incidence was 120.0 (men) and 166.7/1000 player match hours (women), injury severity was 12.0 (median) and 31.2 days (mean) for men, and 11.0 (median) and 30.2 days (mean) for women. Injury burden was 3,745 (men) and 5,040 days absence/1000 player match hours (women). Concussion was the most common specific injury for men (22.5/1000 hours) and women (26.7/1000 hours). No statistical differences were found for incidence or severity measures between sexes. Injury incidence was greater than recent Rugby World Cup studies. High incidences of concussion reinforces the need for prevention strategies targeting this injury.

Introduction

Fifteen-a-side rugby union ("rugby") is a full-contact sport played separately by men and women. Recent studies have reported high match injury incidences for rugby of 109 and 118.8/1000 player match hours for men's and women's international rugby respectively[1–4]. This is in comparison to match injury incidences in non-contact sport of 5.1 (men) and 4.5/1000 hours (women) for international volleyball[5], semi-contact sport of 31.8 (men) and 18.5/1000 hours (women) for international soccer[6], and full-contact sport of 52.1 (men) and 22.0/1000 hours (women) for international ice hockey[7,8]. High incidences of injury in international rugby is likely to be of concern to governing bodies, who have a legal duty to understand risks to player welfare, communicate risks to players and stakeholders, and attempt to mitigate injury risk to as low as practicably possible [9–14]. Professional rugby is also a business where financial growth is associated with competitive success [15,16], the chances of which can be reduced by player unavailability through injury[17,18].

Context-specific injury surveillance data which considers the intrinsic and extrinsic risks of the players in question is therefore likely of interest to national governing bodies, in order to identify the incidence, severity, burden and causes of injury. Understanding injury epidemiology and identification of hazards is the first step towards development, implementation research, and execution of risk mitigation strategies which aim to reduce risks to player welfare and improve player availability, there-by enhancing chances of team success[18–21]. Whilst national team match injuries have been reported for men [22,23] and women [2,3,24] in England and men in Wales [25], currently there are no contemporary studies of match injury epidemiology for either male (full-time professionals) or female (ranging from amateur to full time professionals) international players in Scotland. Therefore, the aim of the current study was to describe the incidence, severity, burden and nature of match injuries sustained by Scotland's men's and women's international teams across two seasons, with comparisons between sexes.

Materials & Methods

Procedures

This was a prospective cohort study of all injuries recorded in matches between 01/08/2017 – 31/05/2019 (Autumn Internationals, Six Nations, and Summer Tour). All players who participated in at least part of one match for Scotland's men's or women's international

teams were included in the study. [redacted] Ethics Committee provided ethical approval.

All injury and exposure definitions were in line with the international consensus statement for injury surveillance studies in rugby[26] (figure 1). Date of injury, date of return-to-play/training, recurrence, playing position, injury cause and mechanism and location and type by the Orchard Sports Injury Classification System (OSICS) version 10 were recorded by qualified Scottish Rugby physicians/physiotherapists. Medical data were recorded electronically via EDGE 10 (EDGE, London, UK) (2017/18) and Microsoft Excel (Microsoft, Redmond, Washington, USA) (2018/19). For injuries that were ongoing by October 2019, Scottish Rugby medical staff estimated completion dates (n=1). To ensure data reliability/validity, Scottish Rugby medical staff were introduced to definitions and protocols at a workshop prior to data collection commencing, information which was reinforced on three occasions by email throughout the study period. Injury data was collated from electronic sources at 3-month intervals and checked for: duplicate entry; date of injury vs player participation; and injury severity vs subsequent match exposure. At the end of the two year period, the data used for analysis was validated against Scottish Rugby's own records. Any ambiguous data found at any time point was queried with the practitioner(s) who had entered the data in question. Match exposure was calculated presuming 15 players (8 forwards, 7 backs) exposed to 80 minutes rugby per match (no match required extra-time). No alterations were made for players leaving the field for yellow/red card offences [26].

FIGURE 1 HERE

Statistical Analysis

Injury incidence was expressed as the number of injuries/1000 player match hours along with 95% confidence intervals (CI) and severity expressed as days (mean and median with 95% CI). Injury burden was calculated as the product of injury incidence and mean severity, and expressed as days absence/1000 player match hours (with 95% CI). Severity data is not reported where $n < 3$ injuries. Data were analysed for male and female players separately, with comparisons made between groups. Differences in player anthropometrics (mean ± SD) were assessed by unpaired t-test. Incidence rate ratios (IRR) (injury incidence; significance determined by z-test; 95% CI by error factor)[28] and Mann-Whitney U tests (median severity) were used to determine differences. Significance was accepted at $p \leq 0.05$, with any statistical

finding reported. As numerous statistical tests were conducted, some results may appear statistically significant at the $p \leq 0.05$ level by chance through type I error [27]. Exact p values are therefore reported (unless $p < 0.001$)[29,30]. Data were analysed with IBM SPSS V.26.0 (IBM, Armonk, New York, USA).

Results

A total of 60 men's players (35 forwards, 25 backs) and 37 women's players (21 forwards, 16 backs) participated in at least part of one match for Scotland international teams over the 2017/18 and 2018/19 seasons (table 1). Forwards were heavier than backs for both squads (both $p < 0.001$).

TABLE 1 HERE

Forty-eight injuries were sustained by men's players (forwards: 28, backs: 20) from 20 matches (forwards: 213.3, backs: 186.7 player match hours), whilst 50 injuries were sustained by women's players (forwards: 33, backs: 17) from 15 matches (forwards: 160.0, backs: 140.0 player match hours) (*supplemental file)*. Thirty-one men's players sustained at least one injury (51.7% of players), with four injuries the maximum number sustained by a single player (n = 2). Twenty-one women's players sustained at least one injury (56.8% of players), with seven injuries the maximum number sustained by a single player (n = 2).

Table 2 presents incidence, mean and median severity and burden of injuries by positional group and recurrence status within each cohort. Overall, injury incidence and burden were greater for women (166.7/1000 hours) compared with men (120.0/1000 hours). Forwards had the greatest incidence and burden of injuries compared with backs for both men and women. New injuries were more common than recurrent injuries for both sexes. This difference was significant for men (IRR: 6.7; 95% CI: 2.8-15.7; $p < 0.001$), but not for women (IRR: 1.7; 95% CI: 0.90-3.0; $p = 0.105$). Mean and median injury severity, and injury burden was greater for new compared with recurrent injuries for both sexes.

TABLE 2 HERE

Injury incidence, mean severity, and injury burden are presented by injury location (figure 2) and injury type (figure 3) for men and women. Lower limb injuries were most common (men: 55.0/1000 hours 95% CI: 36.2 – 83.5; women: 76.7/1000 hours 95% CI: 50.9–115.4), with the greatest mean severity (men: 46.2 days 95% CI 26.5-66.0; women: 40.5 days

95% CI 7.1-74.0) and burden (men: 2,542.5; women: 3,106.7 days/1000 hours). Joint (non-bone) and ligament injuries were most common for men (40.0/1000 hours 95% CI 24.5-65.3), and muscle & tendon injuries most common for women (63.3/1000 hours 95% CI 40.4-99.3). The greatest mean severity was due to bone injuries for both men (78.0 days 95% CI 10.8-145.2) and women (110.0 days 95% CI 9.6-210.4). The greatest burden was for joint (non-bone) and ligament injuries (men: 1,585.0; women: 1,756.7 days/1000 hours).

FIGURE 2 HERE

FIGURE 3 HERE

Figure 4 presents the most common injury diagnoses and the injuries associated with the greatest burden for each cohort respectively. Concussion was the most common injury for both men and women. Ankle sprain/ligament injuries had the greatest burden for men, whilst foot/toe fracture had the greatest burden for women, albeit from a single injury.

FIGURE 4 HERE

Figure 5 presents injury incidence, mean severity and injury burden by mechanism for men and women. Tackled injuries were most common for both men (37.5/1000 hours 95% CI 22.6-62.2) and women (43.3/1000 hours 95% CI 25.2-74.6), and the greatest mean severity (31.8 days 95% CI 15.0-48.6), and the greatest burden for men (1,192.5 days/1000 hours). The greatest mean severity for women was due to ruck injuries (35.7 days 95% CI 0.0-77.2), whilst the greatest burden was due to running injuries (1,416.7 days/1000 hours). A large number of injuries were associated with collision mechanism (intentional and unintentional) for men (32.5/1000 hours 95% CI 18.9-56.0), yet none were attributed to this mechanism for women.

FIGURE 5 HERE

Discussion

The current study aimed to describe the incidence, severity, burden and nature of match injuries in Scotland's men's and women's national squads across the 2017/18 and 2018/19

seasons. Injury incidence was reported as 120.0 (men) and 166.7/1000 player match hours (women), injury severity as 12.0 (median) and 31.2 days (mean) for men, and 11.0 (median) and 30.2 days (mean) for women. Injury burden was 3,745.0 (men) and 5,040.0 days absence/1000 player match hours (women). The majority of injuries occurred to the lower limb for both cohorts, whilst the tackle situation was responsible for the majority of injuries. Concussion was the most common specific injury for both cohorts. No statistical differences were found for any incidence or severity measures between sexes.

Match injury incidences in the current study were greater than those reported from recent Rugby World Cups of 79.4 - 90.1 (men) [30–33] and 35.5 - 53.3/1000 hours (women) [34–37], and from a recent meta-analysis of men's international rugby (109/1000 hours)[1] yet more similar to incidences of 123 (England men's international rugby 2002-2019)[22], 180 (Wales men's international rugby 2011-2014)[25], and 118.8/1000 hours (England women's international rugby 2017-2020) [2,3,24]. As a result, match injury burden for men (3,745) and women in the current study (5,040 days absence/1000 player match hours) were also both greater than values recorded at previous Rugby World Cups (men: 1,233-2,685; women: 1,865-2,180) [30–33,35–37], despite mean injury severity values which were either similar (29.8 and 28.9 days from men's Rugby World Cup 2015 and 2019) or reduced (40.9-55.0 days from 2010, 2014 and 2017 Women's Rugby World Cup) [30,33,35–37]. However, injury burden for men was more similar to the value recorded amongst Wales men's international rugby 2011-2014 of 3,240 days/1000 hours[25], suggesting differences in injury incidence may be responsible for the differences in injury burden to multiple cohort studies. Injury burden for women in the current study however remains considerably greater than reported from a single cohort (England women's international rugby 2017-2020: 2,046-3,192 days/1000 hours)[2,3,24]. Recurrent injury burden amongst this cohort was substantial in the current study (1,700 days/1000 hours), which is the main contributor to the total injury burden. Whilst this may be due to lack of ubiquitous full-time professional contracts within Scottish Women's rugby negatively affecting access to rehabilitation treatment/equipment, a review of current rehabilitation and return to play protocols for this cohort and implementation of therapeutic interventions may help to reduce injury burden, improving player welfare and availability for selection.

It has been suggested that single cohort studies may provide a more accurate description of injury incidence, as recognising, diagnosing, and reporting of injury is consistent across one medical team[25]. Single cohort studies also reflect the probability of injury from the particular

intrinsic/extrinsic risk factors present (illustrating the importance of context specific epidemiology research for national governing bodies), whilst multiple cohort studies reflect injury incidence across the game as a whole. Continuation of injury surveillance over an extended period and risk factor investigation of this population is likely to improve statistical power of findings[38], and provide potential reasons for increased injury incidence (and resultant burden) when compared with wider-scale, multiple cohort studies.

Lower limb injuries were the most common and had the greatest injury burden for both sexes, whilst injuries attributed to being tackled were also the most frequent for both men and women. Injuries occurring from being tackled also represented the greatest injury burden for men, yet running injuries had the greatest burden for women. Lower limb and injuries sustained whilst being tackled have similarly previously been found to represent a large proportion of total injuries and injury burden [2,3,24,25,31–33,35,36], reinforcing the need for risk mitigation strategies targeting these areas in international rugby. As injuries caused by non-contact mechanisms may provide greater potential for risk mitigation, investigation of risk factors around running injuries for women's players may provide a large scope to reduce overall injury burden.

Concussion was the most common specific injury for both cohorts, comparable to recent research in international rugby[24,30,33,36] which has seen a rise in reported concussion incidence[39]. This is potentially a result of increasing awareness of the injury[41] due to increased efforts from World Rugby on concussion management[42], as well as evolutions to the Head Injury Assessment protocol lowering the diagnostic threshold [66]. Recent studies in men's international rugby have reported match concussion injury incidences of 21.4 (Wales)[39] and 27.8/1000 hours (Ireland)[40], similar to the incidence of 22.5/1000 hours in the current study. However, women's concussion incidence in the current study (26.7) was greater than has been reported amongst the England women's squad 2017-2020 (14.1) [2,3,24] and the 2017 Women's Rugby World Cup (14.2/1000 hours)[36]. As definition/diagnosis of concussion follows World Rugby guidelines in each study, reasons for the greater incidence in the current study are unclear. When viewed year-by-year, concussion incidence for England Women's national team was 15.4 (2017/18)[2], 4.2 (2018/19)[3] , and 28.6/1000 hours (2019/20)[24], reflecting season-to-season variation that can occur. Concussion incidences reported in single cohort studies likely also reflect the specific intrinsic and extrinsic risk factors present to the squad [43–46], and it is possible that these factors explain differences in recorded incidences. Further injury surveillance over a greater period of time in these cohorts

will likely account for season-to-season variation and improve the statistical power of studies, highlighting the necessity for greater concussion research into the women's game. Future research should also include the investigation of potential risk factors which may result in a greater incidence of concussion compared with other cohorts, as well as long-term sequelae of concussion in general.

Several negative implications of concussion injury have been reported, such as an increased susceptibility of further concussion or musculoskeletal injury (particularly lower limb) in the short-term, and increased likelihood of common mental disorders and neurocognitive degeneration in the long-term [47–53]. Resulting player absence may also have a negative impact on chances of team success [17,18]. Injury prevention programmes targeting areas of high incidence can be proficient at reducing specific injury occurrence[58,61,63], yet evidence in rugby for concussion prevention is equivocal. Whilst a movement control injury prevention programme including neck strengthening exercises reduced concussion incidence in youth [54] and men's community rugby [55], a modification to lower the tackle height in professional rugby did not reduce concussion incidence[56]. This highlights the multifactorial nature of concussion aetiology, especially in open skills such as the tackle [44,56,57,59]. However this should not deter attempts to reduce concussion incidence in rugby: studies to further the understanding of concussion risk factors, and the efficacy and effectiveness of interventions are constantly required.

No statistical differences were found for any injury incidence or severity measures between sexes in the current study. When comparing the 2007 men's and 2010 Women's Rugby World Cup, injury incidence was statistically greater for men compared with women, whilst mean injury severity was statistically greater for women versus men[35]. Larger sample sizes used in these studies may have increased the likelihood for statistical differences to be found[38]. There was also no statistical difference in the current study for concussion incidence between sexes, mirroring what was found between the 2007 men's Rugby World Cup (2.3)[31] and 2006 Women's Rugby World Cup (3.3/1000 hours)[34]. This is despite two recent reviews suggesting that women have a greater probability of sustaining a concussion compared with men in sports where rules are identical [60,62], potentially due to differing intrinsic factors such as reduced neck muscle strength and head-neck segment stiffness in women[64,65]. Implementation of the HIA protocol (2011-2012) and its subsequent evolutions lowering the diagnostic threshold [66,67] and a resultant increase in concussion awareness has resulted in a steep rise in reported incidence[68]. Contemporary findings may therefore be a more accurate

representation of true concussion occurrence. Whilst smaller sample sizes in the current study may have reduced chances of statistical differences in concussion incidence between sexes [38], future research with larger sample sizes should look to ascertain the differences in concussion incidence between men and women in international rugby.

Limitations and Practical & Research Applications

This was a prospective study following international recommendations on injury surveillance in rugby, allowing comparison with previous studies. However, whilst all available matches were included across the data collection period, compared with some previous studies sample sizes in the current study were reduced. Continuing injury surveillance over subsequent seasons would likely improve the statistical power of data, as well as providing constant epidemiology data to inform injury mitigation practice and policy.

The current study highlighted areas to focus risk mitigation strategies upon. These were specific to the current cohort such as further investigation of injury rehabilitation/return-to-play practices and running injuries in women's rugby. Findings were also generalisable to the wider game with a large proportion of injuries and injury burden occurring to the lower limb and from being tackled, whilst concussion was the most frequently diagnosed injury, all of which is in line with previous research. Future studies investigating the efficacy and effectiveness of potential risk mitigation strategies focusing on these areas is required to improve player welfare and player availability for selection, enhancing future performance.

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Captions for Figures & Tables

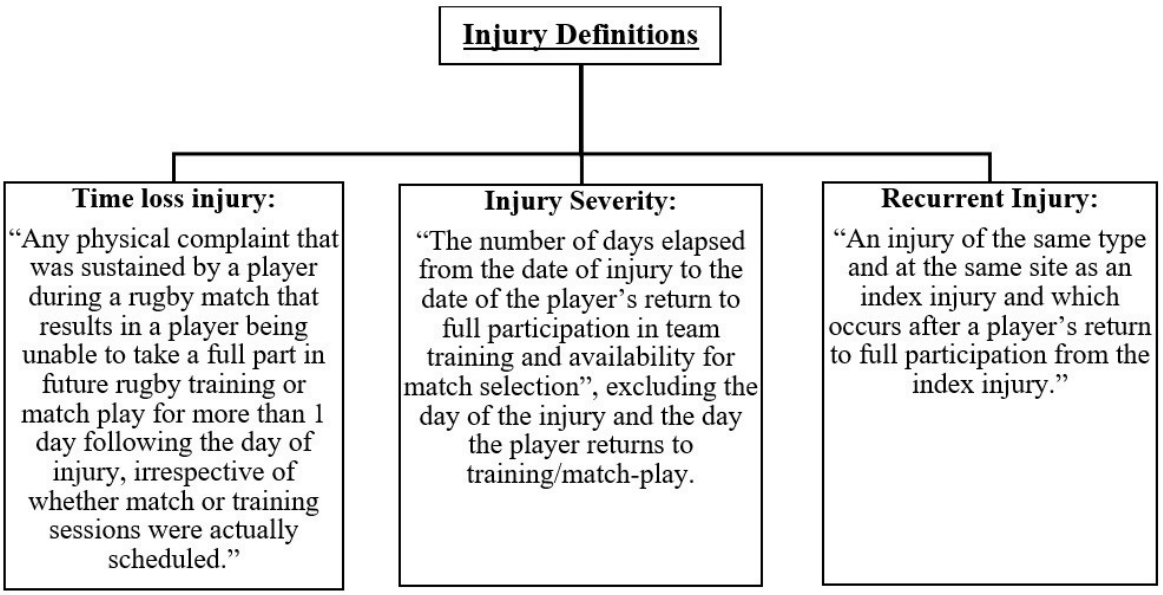

FIGURE 1: Injury definitions used in the current study, in line with the international consensus statement for injury surveillance studies in rugby[26].

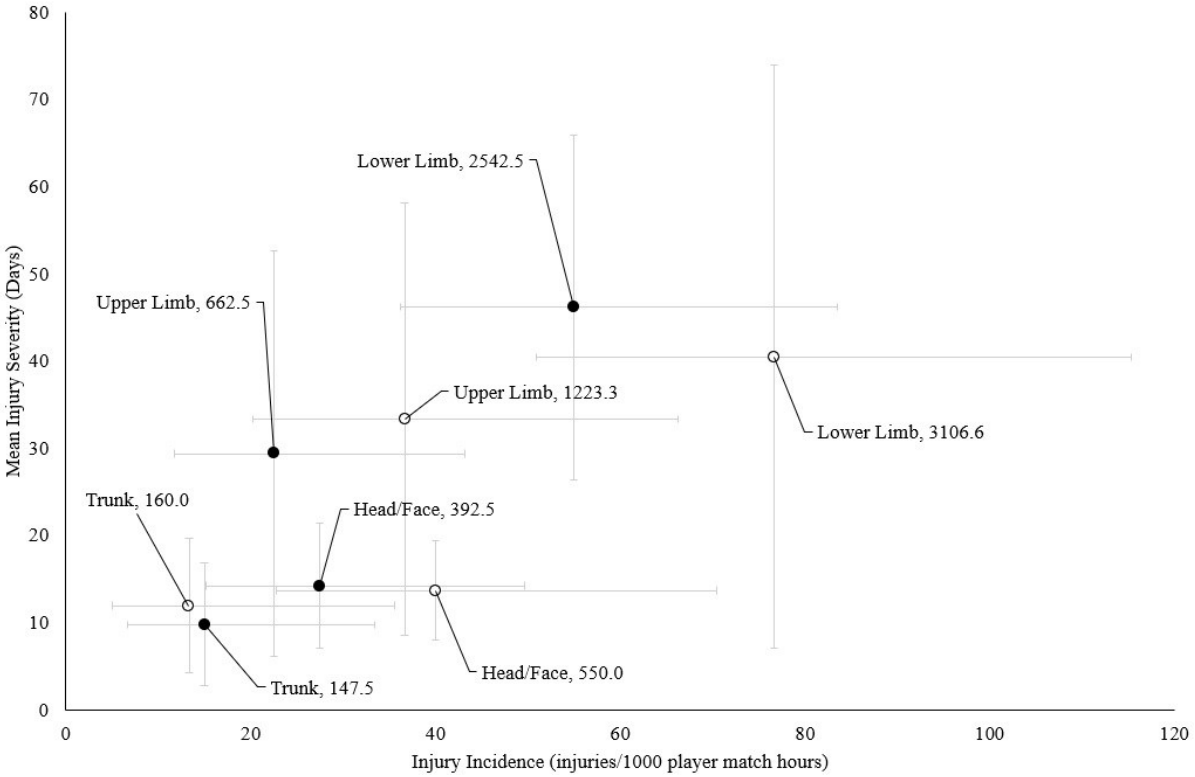

FIGURE 2: Injury incidence (with 95% CI), mean injury severity (with 95% CI) and injury burden (data label; days absence/1000 player match hours) by injury location for Scotland men's (solid dot •) and women's (white dot ◦) international teams.

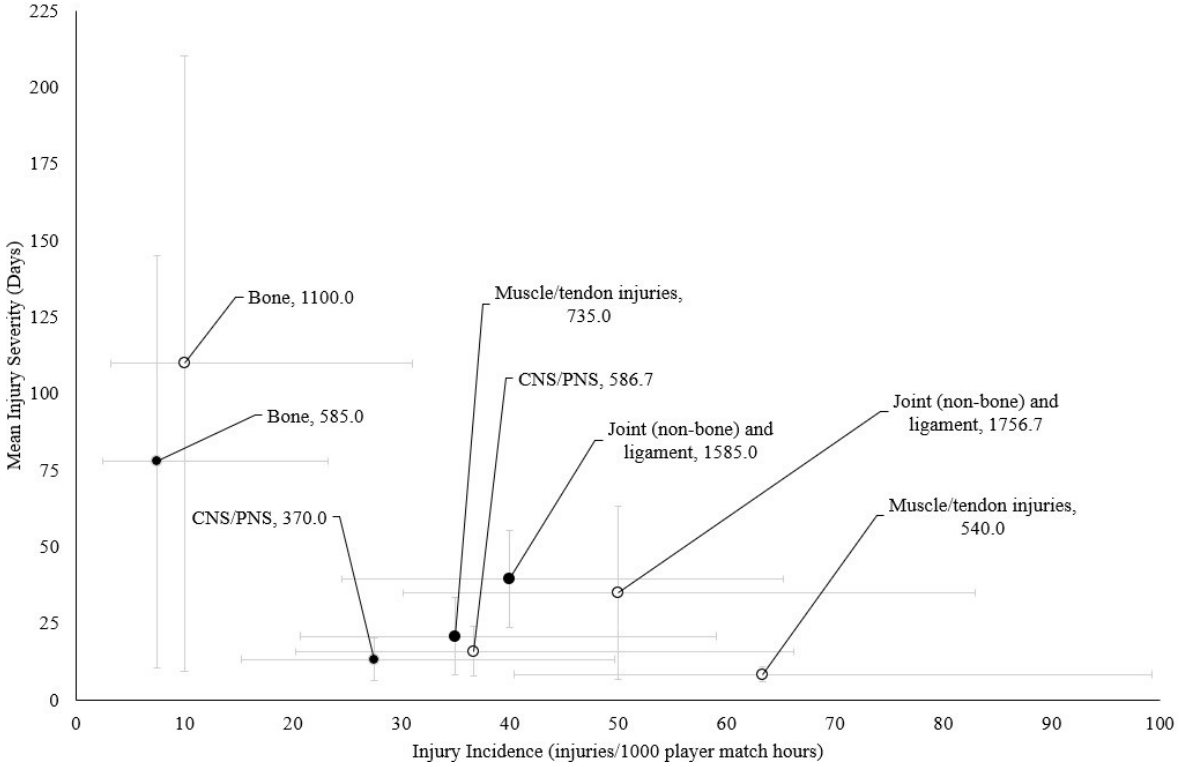

FIGURE 3: Injury incidence (with 95% CI), mean injury severity (with 95% CI) and injury burden (data label; days absence/1000 player match hours) by injury type for Scotland men's (solid dot •) and women's (white dot ◦) international teams. "Other" (men: n=2; women: n=1) and "Unknown" (men: n=2; women: n=1) injury types not shown. CNS/PNS = Central Nervous System/Peripheral Nervous System.

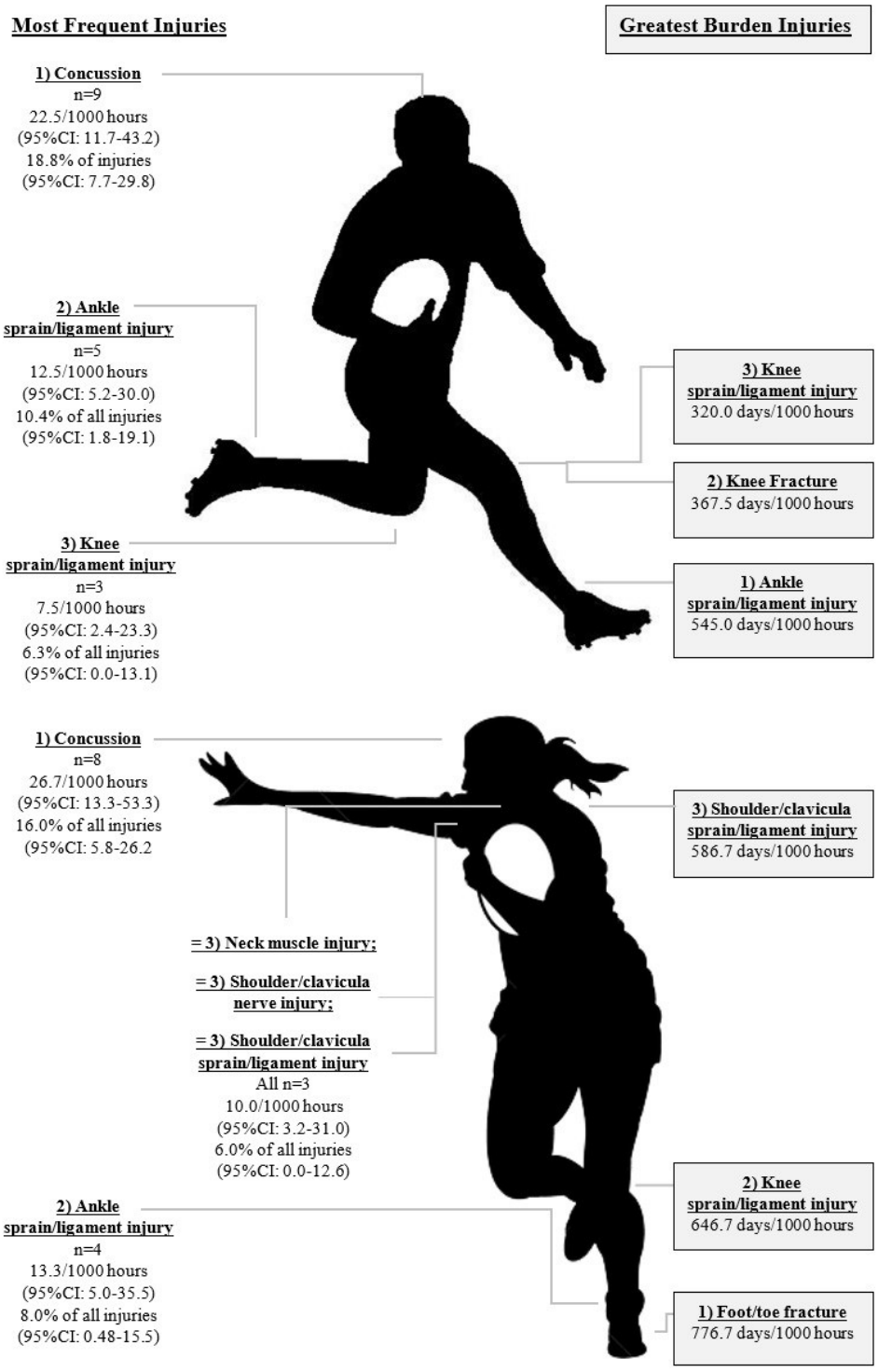

FIGURE 4: Specific match injuries with the most frequent occurrence (left hand side) and greatest associated burden (right hand side) for Scotland men's (top) and women's (bottom) international teams during the 2017/18 and 2018/19 seasons.

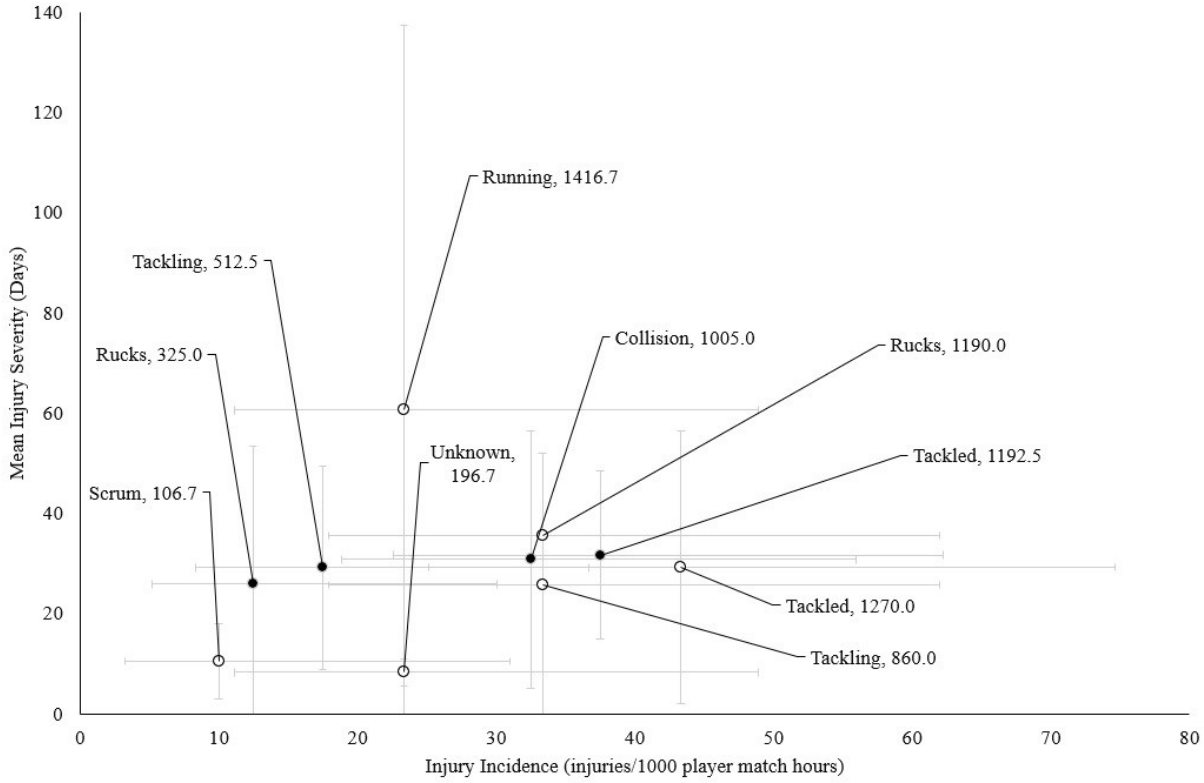

FIGURE 5: Injury incidence (with 95% CI), mean injury severity (with 95% CI) and injury burden (data label; days absence/1000 player match hours) by injury mechanism for Scotland men's (solid dot •) and women's (white dot ◦) international teams. For men, running, other, unknown injuries (all n=2), maul, restart injuries (both n=1), and scrum, lineout, and kicking injuries (all n=0) not shown. For women, collision, maul, lineout, restart, kicking, and other injuries (all n=0) not shown.

TABLE 1: Anthropometric data of forwards and backs within each cohort for the 2017/18 and 2018/19 seasons

Cohort	Season	Players (n)		Age (years)		Mass (kg)	
		F	B	F	B	F	B
Men	**2017/18**	28	23	27.1 ± 3.8	27.0 ± 3.1	113.4 ± 7.2*	92.0 ± 6.7
	2018/19	23	18	26.1 ± 3.3	26.3 ± 3.3	114.0 ± 6.8*	92.9 ± 7.3
	Combined	35	25	26.3 ± 3.6	26.6 ± 3.1	113.4 ± 6.8*	92.2 ± 6.8
Women	**2017/18**	15	14	25.6 ± 4.6	24.4 ± 2.9	81.4 ± 6.7*	68.4 ± 6.8
	2018/19	19	14	23.6 ± 3.3	24.9 ± 3.0	82.0 ± 9.3*	68.2 ± 6.3
	Combined	21	16	24.6 ± 4.4	24.7 ± 3.0	82.0 ± 9.3*	68.3 ± 6.6

*($p < 0.001$) forwards to backs within-cohort.

TABLE 2: Injury incidence, severity, and burden across 2017/18, 2018/19 and both seasons combined for each cohort

TABLE 2: Injury incidence, severity, and burden across 2017/18, 2018/19 and both seasons combined for each cohort

Cohort/Position	Injury Incidence (95% CI)	Injury Severity (days) (95% CI)		Injury Burden (95% CI)
		Mean	Median	
Men's Injuries (n)				
Position				
Forwards (28)	131.3 (90.6 - 190.1)	31.5 (14.5 - 48.4)	10.0 (5.0 - 19.0)	4,129.7 (2,851.4 - 5,981.1)
Backs (20)	107.1 (69.1 - 166.1)	30.9 (18.9 - 42.8)	22.0 (10.0 - 50.0)	3,305.4 (2,282.2 - 4,787.3)
Recurrence				
New (40)	100.0 (73.4 - 136.3)*	35.1 (22.2 - 47.9)	15.0 (8.0 - 32.0)	3,505.0 (2,420.0 - 5076.4)
Recurrent (6)	15.0 (6.7 - 33.4)	9.2 (0.38 - 17.9)	3.5 (2.0 - 33.0)	137.5 (94.9 - 199.1)
Unknown (2)	5.0 (1.3 - 20.0)	n = 2	n = 2	102.5 (70.8 - 148.5)
Total				
All (48)	120.0 (90.4 - 159.2)	31.2 (20.1 - 42.3)	12.0 (6.0 - 26.0)	3,745.0 (2,585.8 - 5,424.0)
Women's Injuries (n)				
Position				
Forwards (33)	206.3 (146.6 - 290.1)	26.7 (9.7 - 43.7)	11.0 (7.0 - 13.0)	5,512.5 (3,806.1 - 7,983.9)
Backs (17)	121.4 (75.5 - 195.3)	37.1 (0.8 - 73.3)	11.0 (3.0 - 24.0)	4,500.0 (3,107.0 - 6,517.4)
Recurrence				
New (28)	93.3 (64.4 - 135.2)	33.7 (12.3 - 55.1)	11.0 (6.0 - 18.0)	3,146.7 (2,172.7 - 4,557.4)
Recurrent (17)	56.7 (35.2 - 91.2)	30.0 (0.0 - 63.9)	8.0 (4.0 - 15.0)	1,700.0 (1,173.8 - 2,462.1)
Unknown (5)	16.7 (6.9 - 40.0)	11.6 (8.2 - 15.0)	12.0 (5.0 - 17.0)	193.3 (133.5 - 280.0)
Total				
All (50)	166.7 (126.3 - 219.9)	30.2 (13.5 - 47.0)	11.0 (7.0 - 13.0)	5,040.0 (3,479.9 - 7,299.5)

*($p < 0.001$) new to recurrent injury incidence within-cohort

SUPPLEMENT TABLE: Match injuries and exposure for each cohort across the 2017/18 and 2018/19 seasons.