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Original research

Time to level the playing field between men and women — Given similar injury incidence: A two-season analysis of match injuries in elite men and women's (Super League) rugby league

Sean Scantlebury [a,b,*], Ben Jones [a,b,c,d,e], Cameron Owen [a,b], James Brown [a,c,f], Neil Collins [a,b], Laura Fairbank [b], Kevin Till [a], Gemma Phillips [a,b,g], Keith Stokes [h,i,j], Sarah Whitehead [a]

[a] Carnegie School of Sports, Leeds Beckett University, United Kingdom
[b] England Performance Unit, Rugby Football League, United Kingdom
[c] Division of Physiological Sciences, Department of Human Biology, Faculty of Health Sciences, the University of Cape Town and the Sports Science Institute of South Africa, South Africa
[d] School of Behavioural and Health Sciences, Faculty of Health Sciences, Australian Catholic University, Australia
[e] Premiership Rugby, United Kingdom
[f] Institute of Sport and Exercise Medicine (ISEM), Department of Exercise, Sport and Lifestyle Medicine, Faculty of Medicine and Health Sciences, Stellenbosch University
[g] Hull Kingston Rovers, United Kingdom
[h] Rugby Football Union, United Kingdom
[i] Centre for Health and Injury and Illness Prevention in Sport, University of Bath, United Kingdom
[j] UK Collaborating Centre on Injury and Illness Prevention in Sport (UKCCIIS), University of Bath, United Kingdom

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ABSTRACT

Objectives: To compare match injury incidence, severity and burden in men's and women's elite rugby league.
Design: A prospective cohort epidemiological study.
Methods: Time loss match injury data were collected from all men's (11,301 exposure hours) and women's (5,244 exposure hours) Super League clubs.
Results: Injury incidence and burden were not different between men and women (mean [95 % CI]; 54 [45 to 65] vs. 60 [49 to 74] per 1000 match-hours; $p = 0.39$, and 2332 [1844 to 2951] vs. 1951 [1560 to 2440] days lost per 1000 match-hours; $p = 0.26$). However, injury severity was greater for men than women (42 [35–50] vs. 35 [29 to 42]; $p = 0.01$). Lower limbs accounted for 54 % and 52 % of injuries for men and women, with the head/face the most frequently injured location due to concussion (12 [10 to 15] and 10 [8 to 14] per 1000 match-hours for men and women). Injuries to the knee had the greatest burden for men and women (708 [268–1868] and 863 [320–2328] days lost per 1000 match-hours). Being tackled was the most common injury mechanism for men and women (28 % and 38 %) with greater burden ($p < 0.01$) than other injury mechanisms.
Conclusions: Male and female rugby league players have similar injury incidence and burden; however, injury severity was higher in men. Head/face injuries have the highest injury incidence and knee injuries have the highest burden. These injuries should be the focus for prevention initiatives at a league (via laws), player, and coach level, with equal and specific focus for both men's and women's rugby league players.

Practical implications

- Injury incidence and injury burden were similar between men and women rugby league players; however, injury severity was higher in the men's game.
- The head/face was the most injured location, and knee injuries had the highest injury burden for men and women.
- To reduce the incidence rate of head/face injuries (e.g., concussion) and the burden associated with knee injuries, future research should seek to identify causal mechanisms behind head/face and knee injuries before attempting to reduce these injuries through interventions at league (via laws), player, and coach level.

1. Introduction

Rugby league is a demanding sport comprising of frequent bouts of high intensity activity (e.g., sprinting, tackling, change of direction), separated by lower intensity activity (e.g., walking and jogging).[1] The high

* Corresponding author.
E-mail address: s.scantlebury@leedsbeckett.ac.uk (S. Scantlebury).
Social media: @SeanScants (S. Scantlebury).

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intensity activity and physical collisions (e.g., tackling, grappling) which characterise rugby league place players at risk of injury,[2] with the tackle accounting for the highest proportion of injuries.[3] There are approximately 1000 tackle events per match reported in the male game and a similar number of tackles per player per match between men (4–41 tackles) and women (4–26 tackles).[4,5] The match injury rate (2013–2015) in professional men's rugby league is ~57 per 1000 match-hours.[3] No research has quantified injuries in any senior women's rugby league competition. Data does exist in youth girls rugby league players, with an overall injury rate of ~22 per 1000 player-hours reported.[6] Across sports, concussions are a concern.[7,8] Concussion incidence increased from ~4 to 20 per 1000 match-hours between 2011 and 2020 in men's rugby union.[7,9] In women's rugby union the concussion incidence increased from ~2 to 5 per 1000 match-hours between 2012 and 2020.[10] Therefore, up to date injury surveillance is required in men's and women's rugby league to establish the current injury incidence, severity, and burden.

Although differences in injury rates and profiles have been identified between men and women in rugby union[11] and rugby sevens[12] players, this has not been studied in rugby league. Therefore, the aim of this study was to compare match injury incidence, severity and burden in men's and women's elite rugby league.

2. Method

2.1. Procedures

This prospective cohort epidemiological study was conducted over two Men's Super League (MSL) and Women's Super League (WSL) seasons (2021 and 2022). All clubs participating in the MSL and WSL were required to complete the Rugby Football League (RFL) injury surveillance as part of the medical standards. In 2021 and 2022, 11/12 and 12/12 men's and 10/10 and 12/12 women's teams inputted data. The study was approved by the Leeds Beckett institutional Research committee (111610) and consent was obtained.

2.2. Definitions and data collection

Injury and exposure data were captured by an online excel spreadsheet. All injury data were recorded by the teams' medical personnel (e.g., physiotherapists or sports therapist) responsible for injury diagnosis and treatment. Due to the differences in training environments (i.e., the MSL includes professional teams with full-time staff whereas the WSL is an amateur competition with predominantly voluntary staff), there were more medical staff to diagnose, report, treat and manage injury in the MSL compared to the WSL.

Definitions are reported in Supplementary Table 1. All definitions are consistent with the consensus statement from the Rugby Injury Consensus Group (RICG) and the 2020 International Olympic Committee (IOC) statement.[13,14] Injury characteristics (type, region, location), mechanism (activity) and time in game (quarters 1–4) were reported.

All injuries were considered an 'open case' until the club representative entered a return to play date for the individual. All open injury cases were followed up by the research team to obtain a return to play date. The number of days between injury onset and the return to play date was used to calculate injury severity. Match exposure was calculated as the number of matches played multiplied by the number of exposed players (13 per team) and the match exposure time (80 min). No adjustments were made for extra time or yellow/red cards as per recommended practice.[14] The lead researchers (SS, SW) validated match exposure data against individual club fixture lists and match reports provided by the RFL to ensure all fixtures took place. Medical personnel were encouraged to update their teams' injury surveillance spreadsheet on a weekly basis. All injury surveillance spreadsheets were screened by the lead researchers to ensure no entries were duplicated, missed, or incomplete. If a team's injury surveillance spreadsheet did not appear to be up to date, the lead researchers prompted the associated medical personnel via e-mail. Any injury entries which appeared anomalous were discussed between the lead researcher and the club representative to ensure the data collection process was as accurate as possible. If a specific variable (e.g., time in match) was not recorded for an injury entry it was treated as missing data and was excluded from the total. All concussions were required to be reported to the RFL via a head injury assessment mandatory reporting form. The head injury assessment sheet was used to validate concussion numbers to ensure no concussions were missed from analysis. This validation process was only applicable for concussions; therefore, this bias is acknowledged. Only injuries sustained during matches are reported.

2.3. Data analysis

All data analyses were conducted in RStudio (V 4.2.0, RStudio, Boston, MA, USA). Median severity and interquartile ranges were reported from the raw data. Generalised linear mixed models were used to obtain estimated means for the incidence, mean severity and burden for each sex and the injury characteristics. Models were first evaluated with a Poisson distribution, but in the event of overdispersion a negative binomial distribution was used. The *performance*[17] package was used to check model assumptions and distributions. Data were aggregated on a team level due to the collection of exposure data on a group rather than individual basis. Competition (MSL or WSL) and injury characteristic were placed in the model as fixed effects with the inclusion of an interaction and team was included as a random effect to account for clustering of observations. Match exposure per 1000 h was included in the incidence and burden models as an offset. Estimated means and 95 % confidence intervals (CIs) were reported. Pairwise comparisons were performed using a false discovery rate adjustment to account for an increased risk of type 1 errors from multiple comparisons. Significance was set at $p < 0.05$. Rate ratios (RRs) and 95 % confidence intervals were reported for comparisons in incidence rates, severity and burden. All analysis was conducted in RStudio using the *lme4*,[15] *emmeans*[16] and *performance*[17] packages.

3. Results

3.1. Overall injury incidence, severity, and burden

Table 1 displays the number of injuries, exposure hours, injury incidence, severity, and burden for the 2021 and 2022 MSL and WSL seasons. Overall, there was no significant difference in injury incidence between men and women (RR [95 % CI]: 0.89 [0.69–1.15], $p = 0.39$). Injury severity was greater for men (RR: 1.21 [1.04–1.41], $p = 0.01$). There was no significant difference in injury burden between men and women (RR: 1.19 [0.87–1.64], $p = 0.26$).

3.2. Injury region

Fig. 1 displays the number of injuries, injury incidence, severity, and burden by body region (head, upper limb, trunk, lower limb). The greatest proportion of injuries for elite men's (52 %) and women's (54 %) was to the lower limb, with greater injury incidence and burden than all other regions ($p < 0.01$). The incidence of head injuries was greater than the upper limb ($p = 0.01$) for men, and trunk for men and women ($p < 0.01$). The severity of head injuries for men was lower than all other regions ($p < 0.01$). The severity of lower limb injuries in women was higher than the head ($p < 0.01$) and trunk ($p < 0.01$). Rate ratios are presented in Supplementary Table 2.

The incidence of head (RR: 0.97 [0.67–1.41], $p = 0.89$), lower limb (RR: 0.82 [0.61–1.11], $p = 0.20$), upper limb (RR: 0.78 [0.52–1.18], $p = 0.24$), and trunk (RR: 0.66 [0.38–1.14], $p = 0.14$), injuries did not differ between men and women. However, the severity of lower limb (RR: 1.26 [1.06–1.52], $p = 0.01$), upper limb (RR: 1.50

Table 1
The number of injuries, exposure hours, injury incidence (per 1000 match-hours), mean and median severity (days lost), and burden (days lost per 1000 match-hours) for men and women by season.

Year	Men						Women					
	Injuries n (%)	Exposure (h)	Incidence (95 % CI)	Mean severity (95 % CI)	Burden (95 % CI)	Median severity (95 % CI)	Injuries n (%)	Exposure (h)	Incidence (95 % CI)	Mean severity (95 % CI)	Burden (95 % CI)	Median severity (95 % CI)
Overall	618 (100 %)	11,301	54 (45 to 65)	42 (35 to 50)*	2332 (1844 to 2951)	22 (12–52)	321 (100 %)	5244	60 (49 to 74)	35 (29 to 42)	1951 (1560 to 2440)	19 (7–29)
2022	389 (63 %)	6396	60 (47 to 76)	40 (33 to 49)*	2517 (1888 to 3356)	21 (12–47)	195 (61 %)	3137	61 (48 to 89)	30 (24 to 37)	1623 (1216 to 2166)	14 (7–26)
2021	229 (37 %)	4905	46 (36 to 60)	46 (37 to 36)	2147 (1590 to 2900)*	23 (11–55)	126 (39 %)	2107	58 (44 to 77)	42 (33 to 54)	2350 (1714 to 3223)	21 (12–36)

Significance (sig): p = ≤0.05.
* Sig different to WSL.

[1.09–2.05], p = 0.01), and trunk (RR: 2.20 [1.40–3.47], p = 0.00) injuries was greater for men compared to women. There were no significant differences in injury burden at any region between men and women (head; RR: 0.95 [0.50–1.77], p = 0.86, lower limb; RR: 1.11 [0.59–2.07] p = 0.75, upper limb; RR: 1.68 [0.90–3.15] p = 0.10, and trunk; RR: 1.40 [0.74–2.65], p = 0.30).

3.3. Injury location

The number of injuries, incidence, severity, and burden for injury location are presented in Supplementary Table 3. The three injury locations with the greatest incidence for men were the head/face (12 [9–16] per 1000 match-hours), thigh (8 [6–11] per 1000 match-hours), and knee (7 [5–10] per 1000 match-hours). Head/face injury incidence was greater than the thigh (p = 0.03) and knee (p < 0.01). The severity for knee injuries (86 [66–106] days lost) was greater than injuries to the head/face (17 [15–20] days lost, p < 0.01) and thigh (35 [27–42] days lost, p < 0.01).

For women, the head/face had the highest incidence (13 [9–18] per 1000 match-hours), followed by the knee (11 [8–15] per 1000 match-hours) and then the ankle (7 [5–11] per 1000 match-hours). The incidence of injuries to the head/face was greater than the ankle (p = 0.03) but not the knee (p = 0.48). The severity of knee injuries (76 [46–105] days lost) was greater than injuries to the ankle (27 [19–34] days lost, p = 0.01) and head/face (19 [17–21] days lost p < 0.01). No differences were found in the burden between head/face, knee and ankle injuries (p = 0.13–0.81).

There was a higher rate of ankle injuries (RR: 0.57 [0.34–0.94], p = 0.03) for women compared to men. The incidence rates of all other locations were not different between sexes. The severity of ankle (RR: 1.60 [1.11–2.29], p = 0.01) and thigh (RR: 2.47 [1.74–3.50], p < 0.01) injuries was greater for men compared to the women. There were no differences in injury burden between sexes.

3.4. Concussion

For men, there were no differences in concussion incidence or burden between years, however, concussion severity was greater in 2022 compared to 2021 (RR: 0.77 [0.63–0.94], p = 0.01) (Table 2). For women, there were no differences in concussion incidence, severity, and burden between years. There were no differences in concussion incidence or burden between men and women, however, the severity of concussion was higher for women in 2021 (RR: 0.57 [0.43–0.76], p < 0.01) and higher overall (RR: 0.71 [0.59–0.85], p < 0.01).

3.5. Injury mechanism

Table 3 displays the number of injuries, injury incidence, severity, and burden for the six injury mechanisms with the highest incidence, and a full list of injury mechanisms can be found in

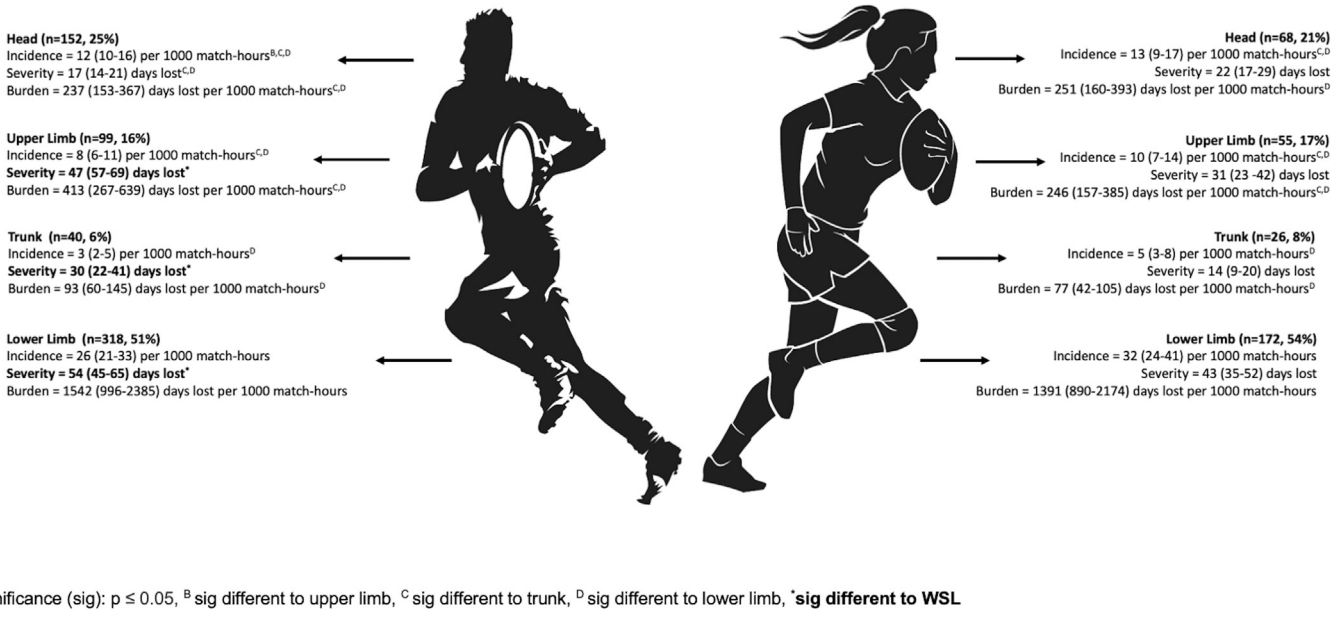

Fig. 1. The mean (95 % confidence limits) injury incidence, severity, and burden for injuries by region.

Table 2
The number of injuries, incidence (per 1000 match-hours), mean and median severity (days lost), and burden (days lost per 1000 match-hours) of concussions for men and women.

Year	Men					Women				
	Concussions n (%)	Incidence (95 % CI)	Mean severity (95 % CI)	Burden (95 % CI)	Median severity (95 % CI)	Concussions n (%)	Incidence (95 % CI)	Mean severity (95 % CI)	Burden (95 % CI)	Median severity (95 % CI)
Overall	139 (100 %)	12 (10 to 15)	16 (13 to 18)[*]	182 (132 to 250)	12 (10–15)	52 (100 %)	10 (8 to 14)	22 (18 to 27)	211 (152 to 292)	21 (20–24)
2022	79 (57 %)	12 (9 to 15)	17 (14 to 21)	161 (105 to 248)	12 (11–15)	29 (56 %)	10 (7 to 14)	21 (16 to 26)	232 (153 to 352)	21 (20–23)
2021	60 (43 %)	13 (10 to 17)	13 (11 to 16)[#,*]	190 (130 to 278)	10 (7–15)	23 (44 %)	11 (7 to 16)	23 (18 to 30)	187 (125 to 281)	23 (20–25)

Significance (sig): p = ≤0.05.
[#] Sig different to 2022.
[*] Sig different to the WSL.

Supplementary Table 4. The tackle was the most frequent injury mechanism (men: 'being tacked' = 28 %, 'tackling' = 20 %; women: 'being tackled' = 38 %, 'tackling' = 25 %), with greater incidences compared to other mechanisms ($p < 0.05$). Being tackled had the greatest injury burden for men (568 [466–691] days lost per 1000 match-hours), and women (621 [509–757] days lost per 1000 match-hours) compared to all other mechanisms ($p < 0.01$).

3.6. Time in match

Table 4 contains the number of injuries, injury incidence, severity, and burden by match quarter. For men, the injury incidence was lower in the first quarter compared to the second (RR: 0.46 [0.24–0.85], p = 0.01) and the third quarter (RR: 0.54 [0.29–1.02], p = 0.03). For women, the injury incidence in the first quarter was lower than the second (RR: 0.40 [0.19–0.88], $p < 0.01$), the third (RR: 0.31 [0.14–0.67], $p < 0.01$), and the fourth (RR: 0.35 [0.16–0.76], $p < 0.01$). Injury severity did not differ by quarter, but the burden of injuries was greater in the second quarter compared to the first for men (RR: 0.33 [0.11–0.99], p = 0.05). The severity of injuries was greater in the second (RR: 1.56 [1.17–2.08], p = 0.01) and fourth quarters (RR: 1.71 [1.28–2.28] $p < 0.01$) of men's matches compared to women.

4. Discussion

This is the first study to describe injuries in women's rugby league and compare injury epidemiology between elite men's and women's rugby league. Injury incidence (men: 54 [45–65]; women: 60 [49–74] per 1000 match-hours) and burden (men: 2332 [1844–2951]; women: 1951 [1560–2440] days lost per 1000 match-hours) were similar; however, overall injury severity was higher for men compared to women (42 [35–50] and 35 [29–42]; RR: 1.21 [1.04–1.41], p = 0.01). This was due to greater severity of ankle, elbow, lower leg, shoulder, and thigh injuries for men. The lower limb accounted for 52 % and 54 % of injuries for men and women, respectively. The head/face was the most injured location (men: 12 [9 to 16]; women: 13 [9 to 18] per 1000 match-hours) and knee injuries had the highest injury burden (men: 708 [268 to 1868]; women: 863 [320 to 2328] days lost per 1000 match-hours). Therefore, head/face and knee injuries should be the focus for prevention initiatives at a league (via laws), player, and coach level, with equal focus on both men's and women's rugby league players, targeting the specific needs of each cohort.[18]

The overall injury incidence rate for men's rugby league in this study is similar to earlier research in the MSL (2021–2022: 54 [45–65] vs. 2013–2015: ~57 per 1000 match-hours), although injury severity has increased (2021–2022: 42 [35–50] vs. 2013–2015: 34 [30–38] days lost).[3] Men's rugby union has a higher injury incidence (91 [77–106] per 1000 match-hours) compared to men's rugby league, but a lower injury severity (27 [23–32] days lost)[7] suggesting injuries in men's rugby union are more frequent but less severe than men's rugby league. There is a lack of comparable research in senior women's rugby league, however, the injury incidence in women's rugby union (39 [36–42] per 1000 match-hours) is lower than in this study but the mean severity is higher (48 [42 to 54] days lost).[10] This contrasts the findings from men's rugby league as injuries in women's rugby league appear to be more common but less severe than women's rugby union. That said, given the injury incidence in this study is similar to 2013–2015 in men, evidence-based injury prevention interventions are urgently required to reduce injury rates in rugby league.

Table 3
The number of injuries, incidence (per 1000 match-hours), mean and median severity (days lost), and burden (days lost per 1000 match-hours) for the six main injury mechanisms for men and women.

Classification	Men					Women				
	Injuries n (%)	Incidence (95 % CI)	Mean severity (95 % CI)	Burden (95 % CI)	Median severity (95 % CI)	Injuries n (%)	Incidence (95 % CI)	Mean severity (95 % CI)	Burden (95 % CI)	Median severity (95 % CI)
Being tackled	175 (28 %)	15 (10 to 23)[c,d,e]	44 (36 to 54)[*]	568 (466 to 691)[a,c,d,e,*]	24 (12–56)	121 (38 %)	22 (14 to 34)[b,c,d,e]	27 (21 to 34)	621 (509 to 757)[b,c,d,e]	18 (7–28)
Tackling	126 (20 %)	10 (7 to 16)[e]	33 (27 to 42)	315 (259 to 384)[*,e]	17 (11–36)	80 (25 %)	15 (9 to 24)[e]	34 (26 to 44)	502 (411 to 613)[e]	20 (7–31)
Collision	0 (0 %)	0	0	0	0	28 (9 %)	5 (3 to 9)[a]	48 (33 to 71)[c]	279 (228 to 342)[a,c,d,e]	14 (7–31)
Other contact	79 (13 %)	7 (5 to 11)[a,d,e,*]	41 (32 to 53)[*]	267 (219 to 326)[a,d,e,*]	24 (12–56)	15 (5 %)	3 (1 to 5)[a,d]	17 (10 to 29)	56 (44 to 70)[a,d]	13 (6–21)
Running	86 (14 %)	7 (5 to 11)	47 (36 to 60)	304 (250 to 371)[e]	27 (16–50)	31 (10 %)	6 (3 to 10)[a]	36 (25 to 52)	233 (190 to 286)[a,d]	14 (7–26)
Unknown	56 (9 %)	5 (3 to 8)	45 (33 to 60)[*]	147 (120 to 180)[*]	17 (11–46)	15 (5 %)	3 (1 to 5)	22 (13 to 37)	63 (51 to 80)	14 (10–28)

Significance (sig): p ≤ 0.05.
42 (7 %) injures in men's SL were not classified by mechanism and are quantified as missing data.
[a] Sig different to 'tackling'.
[b] Sig different to 'collision'.
[c] Sig different to 'other contact'.
[d] Sig different to 'running'.
[e] Sig different to 'unknown'.
[*] Sig different to WSL.

Table 4
The number of injuries, incidence (per 1000 match-hours), mean and median severity (days lost) and burden (days lost per 1000 match-hours) of injuries by time in match for men and women.

Time in game (min)	Men					Women				
	Injuries n (%)	Incidence (95 % CI)	Severity (95 % CI)	Burden (95 % CI)	Median severity (95 % CI)	Injuries n (%)	Incidence (95 % CI)	Severity (95 % CI)	Burden (95 % CI)	Median severity (95 % CI)
0–20	76 (12 %)	27 (19 to 38)[a,b]	40 (31 to 52)	1068 (605 to 1886)[a]	28 (12–55)	29 (9 %)	22 (14 to 35)[a,b,c]	40 (27 to 59)	854 (476 to 1531)	21 (14–36)
21–40	166 (27 %)	58 (43 to 80)	52 (42 to 64)[*]	3192 (1809 to 5632)	28 (13–62)	73 (23 %)	55 (39 to 79)	33 (25 to 44)	1560 (872 to 2792)	19 (9–28)
41–60	141 (23 %)	49 (36 to 67)	40 (32 to 50)	1991 (1128 to 3514)	21 (12–55)	97 (30 %)	72 (52 to 102)	35 (27 to 45)	2444 (1366 to 4370)	19 (7–37)
61–80	121 (20 %)	42 (30 to 58)	42 (34 to 53)[*]	1865 (1056 to 3292)	23 (11–44)	87 (27 %)	64 (45 to 91)	25 (19 to 32)	1268 (708 to 2270)	14 (6–22)

Significance (sig): $p \leq 0.05$.
114 (18 %) and 35 (11 %) injuries were not classified by time in game for the men's and women's SL respectively and are quantified as missing data.
[a] Sig different to '21–40'.
[b] Sig different to '41–60'.
[c] Sig different to '61–80'.
[*] Sig different to the WSL.

The lower limb accounted for the highest proportion of injuries for men (52 %) and women (54 %), which is consistent with earlier research in men's rugby league[3] and both men's rugby union and women's rugby union.[9,10] Injuries to the knee had the greatest burden for men and women. Previous literature has found female athletes to have a higher rate of knee injuries compared to male athletes (e.g., anterior cruciate ligament injuries).[19–21] Whilst women had a greater incidence of knee injuries compared to men (11 [8 to 15] and 7 [5 to 10] per 1000 match-hours) in this study, the difference was not statistically significant which suggests knee injuries are a concern for both groups. Research in men's rugby league has found the tackle accounts for 45.8 % of knee injuries,[22] whereas girls and women are more susceptible to non-contact mechanisms.[21] It is important to consider the impact of gender as an extrinsic determinant influencing the intrinsic factors which predispose to knee injuries.[20] For example, a relative lack of muscular strength is considered a risk factor to injury,[23] however, the environments provided for men and women rugby league players to develop strength are not equal.[23,24] Inadequate gym facilities and a lack of strength and conditioning provision are perceived to be injury risk factors for women who play rugby league.[23] Therefore, injury prevention strategies cannot simply recommend players, specifically women 'get stronger' when the current training environments may not support this.[20] Subsequently, further research is required to develop a greater understanding of the intrinsic and extrinsic factors which contribute to knee injuries in rugby league to inform context specific preventative strategies.[18]

The head/face was the specific injury location with the highest injury incidence, likely due to the incidence of concussion (Supplementary Table 3), despite 17–20 % of elite rugby league players not reporting concussion symptoms.[25] Previously concussion was found to be the injury with the highest incidence in men's rugby league (~5 per 1000 match-hours)[3] and women's rugby union (~5 per 1000 match-hours) compared to all other injuries.[10] Furthermore, a pooled analysis of match concussion incidence in women's rugby found the incidence rate in rugby league (~10 per 1000 match-hours) to be greater than rugby union 15s (~3 per 1000 match-hours), and 7s (~9 per 1000 match-hours).[26] The rate of concussion found in this study (men: 12 [10–15] per 1000 match-hours; women: 10 [8–14] per 1000 match-hours) is higher than the previously reported rates in men's rugby league from 2013 to 2015. However, the rate is consistent with those found in male rugby union (12 [9–15] per 1000 match-hours) and more recent research in men's rugby league from 2016 to 2022 (15.5 [14.2–16.9]).[7,27] The higher concussion incidence (~10.5 per 1000 hour increase) found in men's rugby league from 2016 to 2022 compared to 2013–2015 is likely indicative of the increased awareness and education resulting in more head injury assessments (HIAs).[9] The structural and operational changes (e.g., in-game assessment of HIA protocol, pitch-side video review of head injury events, independent match day doctors) seen within men's rugby union have been suggested to contribute to the greater concussion incidence compared to women's rugby union.[10] However, in the current study concussion incidence is similar between sexes despite the enhanced concussion protocols available in the men's game in comparison to the women's which utilises a 'if in doubt, sit them out' approach to concussion management. Therefore, it is possible the rate of concussion in the women's game may surpass the men's game if concussion protocols are made consistent between sexes. The potential long-term implications of concussion are concerning, albeit inconclusive,[8] with the head/face consistently shown to be the most frequent injury location during rugby matches and the reduction of the concussion should be a priority. Therefore, further research is needed to explore the causal mechanisms of concussion to inform future concussion prevention interventions.[29]

Consistent with previous research in men's rugby league,[3] and men's and women's rugby union,[7,10] injuries predominantly occurred following a tackle event. 'Being tackled' accounted for 28 % and 38 % of injuries in men's and women's rugby league respectively, whilst tackling led to 20 % of injuries in men and 25 % in women. The injury incidence of 'being tackled' and 'tackling' in women's rugby league was double those seen in women's rugby union (being tackled: 22 vs. 11 per 1000 match-hours, tackling: 15 vs. 5 per 1000 match-hours).[10] Poor tackle technique has been identified as the most important and feasible to manage the injury risk factor for women's rugby league players.[23] Therefore, improving tackle technique should be a primary focus of training in rugby league, particularly for women's rugby league players.

Fewer injuries occurred in the opening 20 min of men's and women's matches. Earlier research in men's rugby league also found injury incidence to be lowest in the first quarter of matches. Previous research indicated incidence in the fourth quarter was significantly higher than all other quarters.[3] Whilst injury incidence did not incrementally increase across quarters in this study, the lower incidence found in the first quarter of matches appears a consistent finding within rugby league research and the mechanisms behind the increased injury incidence from 20 min onwards warrant further exploration.

4.1. Limitations

Whilst the research team attempted to validate match injuries across the study period, it is acknowledged that some injuries may have not been reported contributing to an under-reporting. If only injuries of greater severity are reported, this will result in a lower incidence, and higher severity than the actual rates. Additionally, it is acknowledged that the dataset included missing/unknown information for some injury classifications (e.g., injury mechanism). The amateur nature of the WSL restricts access to appropriate medical provision,[23] therefore, training injuries were not considered in this study as medical staff were not present at all training sessions preventing accurate injury diagnosis and recording.

It is also acknowledged that the presentation of the mean severity of injury may be inflated due to the data being skewed for injuries with a large severity. However, as the data were clustered by team and therefore are non-independent, modelled means and CIs with the inclusion of random effects were deemed more robust than typical non-parametric methods.[30]

4.2. Research implications

Overall, injury incidence and injury burden were similar between men and women rugby league players. However, the injury severity was higher in the men's game. The head/face was the most injured location, and knee injuries had the highest injury burden for men and women. These are areas of priority for sports given the potential long-term effects of concussion (e.g., neurodegenerative disease),[31] and the large financial cost (e.g., surgical intervention and long-term rehabilitation)[32] and multiple negative consequences to the athlete (e.g., psychological effects, long-term health, and wellbeing issues)[33] associated with knee injuries. Therefore, due to the high incidence rate of concussion in rugby league in comparison to other collision sports[7,34] and the burden associated with knee injuries, future research should seek to identify the causal mechanisms behind concussion and knee injuries before attempting to reduce these injuries through interventions at a league (via laws), player, and coach level.[18]

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Confirmation of ethical compliance

The study was approved by the Leeds Beckett institutional Research committee (111610) and consent was obtained.

CRediT authorship contribution statement

Each of the authors was involved in the original conception of the paper. SS, NC, SW, & LF contributed to data collection and CO analysed the data. SS drafted the manuscript and all other authors provided feedback and comments to refine the final manuscript.

Data availability statement

All data relevant to the study are included in the article or uploaded as Supplementary material.

Declaration of interest statement

SS, GP, LF, CO, BJ are employed by the Rugby Football League.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsams.2024.07.001.

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