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Original research

Prolonged restricted training, fixture congestion and player rotation: What the COVID-19 pandemic taught us about injury risk in professional collision sport

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ABSTRACT

Objectives: The COVID-19-induced suspension of the 2019–20 professional England rugby union season resulted in players being exposed to an extended restricted training period, coupled with a congested match schedule once competition resumed. We assessed the impact of these changes on match and training injuries in the final 20-weeks of the season following competition resumption.

Design: Epidemiological study.

Methods: The 2019–20 season was compared to the previous three seasons (2016–19).

Results: There was no significant difference in the mean incidence, severity and burden of training and match injuries in 2019–20 compared to 2016–19 period mean. The 2019–20 post-suspension mean match injury rate [77/1000 h (95% CIs [confidence intervals]: 67–89)] was comparable to the 2019–20 pre-suspension [93/1000 h (95% CIs: 85–101)] and significantly lower than the 2016–19 equivalent post-suspension period [97/1000 h (95% CIs: 90–104)] IRR [incidence rate ratio] 0.8 $p=0.002$. In the 2019–20 season, there was a significantly higher rate of training injury post-suspension in comparison to pre-suspension [3.8/1000 h (95% CIs: 3.3–4.4) vs 2.7/1000 h (95% CIs: 2.5–3.1)] IRR 1.4 $p=0.005$. There was no significant difference in the overall incidence, severity or burden of injuries sustained in fixtures with shorter (<6 days) turnarounds but there was a significantly higher burden of soft tissue injuries.

Conclusions: This is the first study to assess the effect of restricted training on injury risk in collision sports. Players were at an increased risk of training injury when returning from the suspension, but 10-weeks of preparatory training meant the incidence of match injury was not higher when competition resumed.

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Practical implications

- When returning to regular team training and match play, practitioners must keep in mind that a period of time away from regular team training and match play is linked to an increased risk of training injury. However, a longer off-season, along with an adequate and gradual return to training, may result in lower match injury rates than a shorter off-season.
- The potential for positive mental and physical effects of an extended period away from sport should be considered by practitioners and policy developers.

- Greater player rotation strategies assist in alleviating an increased injury rate during periods of fixture congestion.
- These findings could be used during the development of competition fixtures and when determining the length of the off-season and pre-season periods to mitigate against injury risk.

1. Introduction

The outbreak of the Coronavirus pandemic (COVID-19) resulted in the suspension of many professional sports leagues. The 2019–20 English Premiership Rugby Union (rugby) season was three-quarters of the way through when it was suspended for 22 weeks. Given the physical nature and high collision demands of rugby match play, the development and maintenance of key physical qualities, skills, and

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decision-making ability are generally developed through structured periodized training programmes. Players are accustomed to high intensities of training¹ to ensure optimal performance and mitigate the risks of injury associated with the game.^{2,3} It is not known what effect a period of disrupted or restricted training might have on injury risk in collision sports.

In 2011, a 20-week shutdown of the National Football League (NFL) was followed by a fourfold increase in the number of Achilles tendon ruptures upon resumption of competition and higher numbers of soft tissue injuries than in any previous or subsequent seasons.^{4,5} In professional rugby union, the 5-week off-season is typically the longest period players have away from the game. Even when players have access to training facilities during this time, a greater frequency and burden of training injuries is observed in the first six weeks, in comparison to the last six weeks, of the preseason period.² As such, an extended period of restricted training may result in players being unable to maintain both the physical and psychological qualities necessary to protect against injury. Alternatively, it is possible that restricted training would allow players the opportunity for mental and physical rest and recovery, and the ability to focus on full recovery and rehabilitation of previous injury.² Coupled with appropriate reconditioning on return to training, some players may return to competition in an improved psychological and physiological state, better able to tolerate the demands of the game.

When professional leagues restarted, to facilitate timely completion of the season, matches were scheduled with shorter than normal intervals between matches. Limited time between games in football has been associated with a greater incidence of injury in weeks where more than one match was played in comparison to weeks where only one match was scheduled.^{6,8,10} The demanding physical nature of rugby match play means that players often require an extended period of time to fully recover from the match-induced fatigue and muscle damage.¹¹ Therefore, it is possible that reduced recovery between matches could increase the risk of injury and this could be particularly relevant following a period of limited training and match play.

The purpose of this study was to assess the impact of an extended period of restricted training followed by a congested fixture schedule on the incidence, severity and nature of match and training injuries in the remaining 20-weeks of the season played following the resumption of competition.

2. Methods

Each season, time-loss match and training injury data were collected as part of the Professional Rugby Injury Surveillance Project from

England's 12 Premiership rugby clubs.¹² Injury data were captured using an online injury surveillance platform, "Rugby Squad" (the Sports Office UK Ltd), according to the Consensus Statement for injury recording in rugby union.¹³ A time-loss injury was defined according to the consensus statement as any "injury that results in a player being unable to take a full part in future rugby training or match play for more than 24 hours from midnight at the end of the day the injury was sustained".¹³ Injury severity was defined as the number of days lost from match play or training.¹³ Training exposure data were collected as: *Rugby skills contact* (full-contact: contact without the use of external padding and semi-contact: contact with the use of pads/bags), *rugby skills non-contact* (without contact between players), *conditioning non-weights* (e.g., running endurance, speed/agility, power) and *conditioning weights*. The number of players and number of minutes spent performing each training type each week were captured using an online platform. Match exposure was calculated as the number of matches multiplied by the number of exposed players (15) and the match exposure time (80 min). Individual informed consent was obtained from all first-team eligible players on an annual basis. This study was approved by the University of Bath Research Ethics Approval Committee for Health (Ref: 16/17 200).

The experimental design is presented in Fig. 1. For the first 12 weeks of the 22-week COVID-induced suspension of the 2019–20 season, a nationally-enforced lockdown meant that players were unable to train together as a team, access training facilities, have in-person contact with staff, and were only permitted access to medical staff for essential treatment. Training completed during this time was done at home or in outdoor spaces, with the available equipment and space varying widely between players. Individual training exposure was not quantified during this time. Players then returned to a 10-week team training period, comprising four weeks of socially distanced training and six weeks of time-limited contact training, before competition resumed.

The 2019–20 season data was compared to the previous three seasons' (2016–19) data. The 2016–19 period was selected as the comparator as the structure of these seasons, laws of the game and reporting of injury and exposure data were similar to the 2019–20 season. Furthermore, the injury rates and patterns were consistent across the 2016–19 period. To account for the COVID19-induced match suspension period, the 2016–19 season data was divided into pre-suspension (first 280 matches of the season) and post-suspension (all remaining matches) periods equivalent to the pre- and post-suspension period of the 2019–20 season. For training injuries, the pre-suspension period included the preseason and any training done in-season over the course of the first 280 matches of the season. The

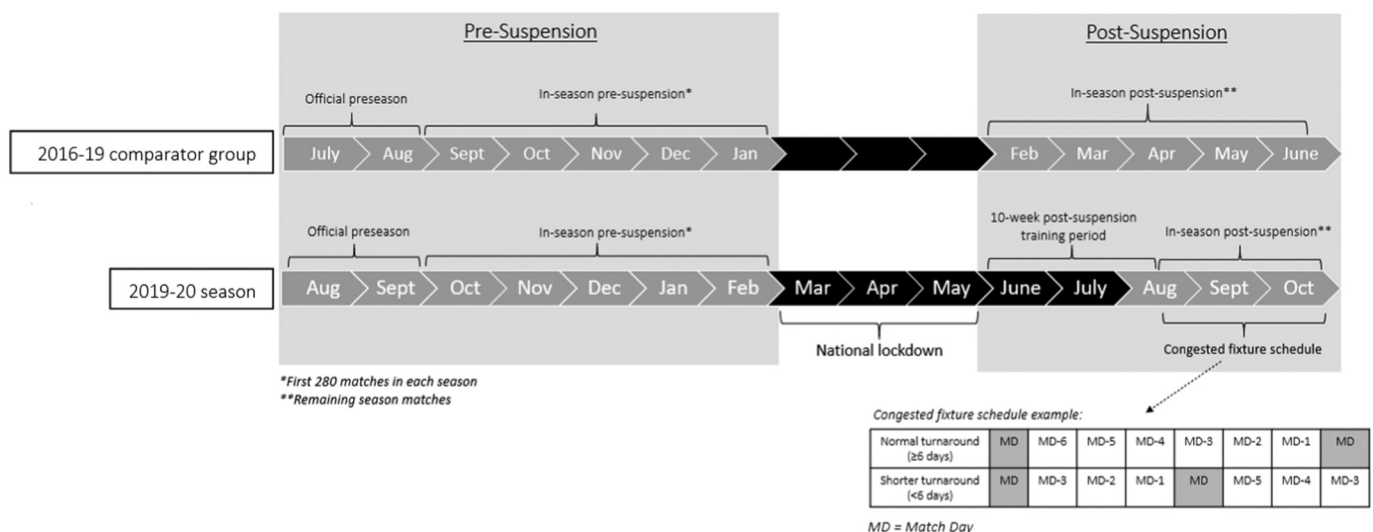


Fig. 1. Schematic of the experimental design.

post-suspension training period of the 2019–20 season included the 10-week post-suspension training block and any training completed in the remainder of the season once competition resumed. The post-suspension period of the 2016–19 period included any training completed in the remainder of the season after the first 280 matches.

To assess the influence of the congested fixture schedule introduced in the 2019–20 post-suspension period, all post-suspension fixtures were categorised as having either a *normal* (≥ 6 days) or *shorter* (< 6 days) turnaround time from the previous fixture. To identify whether player rotation between matches influenced injury incidence, each game was categorised by tertiles (*low*, *medium*, *high*), according to the number of players who played > 20 min in that and the club's previous fixture. As such, *low* rotation includes fixtures where ≥ 13 players played > 20 min in both fixtures, *medium* rotation includes fixtures where 8–12 players played > 20 min in both fixtures, and *high* includes fixtures where ≤ 7 players played > 20 min in both fixtures.

To identify any differences in training injury rates between the competitive in-season and training only phases of the 2019–20 season, the 2019–20 season was divided into four phases: 1) *Official 2019–20 pre-season* 2) *in-season-pre-suspension* (training completed in-season before the competition was suspended) 3) *10-week post-suspension training period* (training completed following the period of restricted training and before match play resumed) and 4) *in-season-post-suspension* (training completed during the in-season post-suspension period of the season once competition had resumed).

Injury incidence was calculated as the count of injuries per 1000 player hours and ninety-five % confidence intervals (CIs) were calculated using the Poisson distribution. Incidence was compared using incidence rate ratios (IRR) and p values, with Holm–Bonferroni adjustments applied to p values to offset the increased risk of a type 1 error when conducting multiple comparisons. Significance was set at $p \leq 0.05$. Mean severity was calculated as the total sum of days absent divided by the total count of injuries. Median severity was calculated as the midpoint of the range of injury severities within the dataset with interquartile range (IQR). Injury burden was calculated as the product of mean severity and incidence (days absent per 1000 player-match hours). Where a significant difference in mean burden was observed, as determined by non-overlapping 95% CIs, burden was also calculated using the median severity value to account for the positive-skewed distribution of severity data. Mean burden is presented throughout, with significance indicated only if 95% CIs did not overlap when burden was calculated with both mean and median severity. The authors acknowledge that assessing statistical difference

via overlapping confidence intervals is conservative and carries a risk for type 1 errors.¹⁴ Stata V16.0 was used for all statistical analysis.¹⁵

3. Results

Mean match injury rate in the 2019–20 season was not different from the 2016–19 period mean [88/1000 h (95% CIs: 82–95) vs 96/1000 h (95% CIs: 92–100) IRR 0.9 $p = 0.42$]. The 2019–20 post-suspension mean match injury rate was significantly lower than the 2016–19 post-suspension mean match injury rate [77/1000 h (95% CIs: 67–89) vs 97/1000 h (95% CIs: 90–104) IRR 0.8 $p = 0.002$] (Table 1), with a significantly lower rate in the first month of competition following return from suspension in comparison to the equivalent 2016–19 time point [72/1000 h (95% CIs: 57–91) vs 109/1000 h (95% CIs: 96–122) IRR 1.5 $p = 0.02$] (Fig. S1).

Within the 2019–20 season, the mean match injury rate of the post-suspension period was not significantly different to pre-suspension [77/1000 h (95% CIs: 67–89) vs 93/1000 h (95% CIs: 85–101) IRR 0.8 $p = 0.18$] (Table 1). The mean severity of contact-related match injuries sustained in the 2019–20 post-suspension period were significantly lower than pre-suspension; however, there was no significant difference in the burden (Table 1). There were no significant differences in the rate of injury by body location pre-suspension versus post-suspension (Table S1).

In the post-suspension period of the 2019–20 season, 57 fixtures (1140 exposure h) had ≥ 6 days between sequential fixtures (*normal*) and 65 fixtures (1300 exposure h) had < 6 days between sequential fixtures (*shorter*). There was no significant difference in the overall incidence, severity or burden of injuries sustained in fixtures with *shorter* vs *normal* turnaround (Table S2). Soft tissue injuries sustained in *shorter* turnaround fixtures had a significantly higher burden than those sustained in *normal* turnaround fixtures [2388 days absence/1000 h (95% CIs: 1838–3101) vs 1239 days absence/1000 h (95% CIs: 907–1692) (Table S2)].

In the pre-suspension period of the 2019–20 season, the mean number of players who played ≥ 20 min in sequential matches was 12 (tertile cut-offs: 11 and 14), compared with 9 in the post-suspension period (tertiles: 7 and 13). In the 2019–20 post-suspension period the mean number of players who played ≥ 20 min in *shorter* turnaround fixtures was 7 (tertiles: 5 and 8), whilst in *normal* turnaround fixtures it was 12 (tertiles: 11 and 15). Mean incidence of injury was not different between fixtures that had *low*, *medium*, or *high* player rotation, with or

Table 1
Incidence, severity and burden of match injuries sustained pre- and post-suspension in the 2016–19 and 2019–20 season.

	Number	Incidence (95% CI)	IRR (95% CI) p value	Mean severity (95% CI)	Median (IQR)	Mean burden (95% CI)
2016–19 OVERALL	2318	96 (92–100)		34 (33–35)	12 (6–38)	3248 (2658–3968)
2016–19 pre-suspension	1582	95 (91–100)	1.0 (0.9–1.1) $p = 0.70$	33 (31–34)	12 (5–36)	3110 (2544–3802)
2016–19 post-suspension	736	97 (90–104)		36 (34–39)	14 (6–41)	3496 (2865–4267)
2019–20 OVERALL	709	88 (82–95)		38 (35–41)	11 (5–38)	3334 (2706–4108)
2019–20 pre-suspension	521	93 (85–101)	0.8 (0.7–1.0) $p = 0.18$	40 (37–44)	11 (5–34)	3728 (3043–4568)
2019–20 post-suspension	188	77 (67–89)		32 (27–36)*	13 (6–46)	2430 (1944–3038)
2019–20 season data						
CONTACT OVERALL	523	65 (60–71)		89 (82–97)	11 (5–37)	5792 (4542–7385)
Pre-suspension	387	69 (63–76)	0.8 (0.7–1.0) $p = 0.18$	41 (37–45)	11 (5–34)	6554 (5177–8297)
Post-suspension	136	56 (47–66)		29 (24–34)*	11 (6–39)	1612 (1240–2096)
NONE-CONTACT OVERALL	92	11 (9–14)		77 (62–94)	22 (9–51)	877 (491–1566)
Pre-suspension	63	11 (9–14)	1.1 (0.7–1.7) $p = 1.0$	19 (62–101)	18 (9–47)	890 (496–1597)
Post-suspension	29	12 (8–17)		69 (48–99)	32 (14–60)	818 (464–1445)
SOFT TISSUE OVERALL	433	54 (49–59)		43 (39–47)	14 (5–46)	2305 (1765–3011)
Pre-suspension	315	56 (50–63)	0.9 (0.7–1.1) $p = 0.96$	45 (40–50)	13 (5–42)	2504 (1928–3252)
Post-suspension	118	48 (40–58)		38 (32–46)	16 (5–61)	1850 (1396–2452)
CONCUSSION OVERALL	159	20 (17–23)		16 (14–19)	8 (6–15)	316 (203–490)
Pre-suspension	114	20 (17–24)	0.9 (0.6–1.3) $p = 1.0$	17 (14–21)	8 (6–15)	352 (228–543)
Post-suspension	45	18 (14–25)		13 (9–17)	8 (6–15)	233 (147–367)

* Significant difference post- vs pre-suspension $p < 0.05$.

without adjustment for time between fixtures (i.e., *normal vs shorter*) (Table S3).

Overall mean training injury rate in 2019–20 was not different to the 2016–19 period mean. In 2019–20, there was a significantly lower injury rate in *conditioning weights* training in comparison to the 2016–19 period mean [0.2/1000 h (95% CIs: 0.1–0.3) vs 0.4/1000 h (95% CIs: 0.3–0.6) IRR 0.5 $p = 0.04$] (Table 2).

In the 2019–20 season, there was a significantly higher rate of training injuries in the post-suspension period in comparison to the pre-suspension period [3.8/1000 h (95% CIs: 3.3–4.4) vs 2.7/1000 h (95% CIs: 2.5–3.1) IRR 1.4 $p = 0.005$]. Specifically, there was a significantly higher rate of injuries sustained in *conditioning non-weights* training post-suspension in comparison to pre-suspension [9.7/1000 h (95% CIs: 7.4–12.8) vs 5.2/1000 h (95% CIs: 4.2–6.5) IRR 1.9 $p = 0.007$] (Table 3).

Dividing the 2019–20 season into the four training phases of the season revealed that the 10-week post-suspension training period had the highest mean injury rate of the four phases [4.7/1000 h (95% CIs: 4.0–5.6)] (Table 3). Within the different training types, the highest rate of training injury was in *rugby skills contact* training in the 'official 2019–20 preseason' and the '10-week training period post-suspension' phases of the season (Table 3).

Hamstring muscle injuries were the most common injury type in both the pre- and post-suspension periods in 2019–20 [Pre: 0.5/1000 h (95% CIs: 0.4–0.6) vs Post: 0.7/1000 h (95% CIs: 0.5–0.9) IRR 1.5 $p = 0.50$] (Table S4).

4. Discussion

The suspension of professional leagues due to the COVID-19 pandemic created a unique opportunity to study the influence of an extended period of restricted training and the influence of a congested match schedule on injury risk. In professional rugby in England there was an increased rate of injury when players first returned to training, but 10-weeks of preparatory training, likely alongside well-structured player management and greater player rotation, meant that the incidence of match injury when competition resumed was not higher than pre-suspension match injury rates. Scheduling of midweek matches did not result in significant differences in the overall incidence, severity or burden of injuries sustained in matches that had a shorter than normal turnaround, however there was a significantly higher burden of soft tissue injuries in fixtures with a <6 day turnaround.

In the 2019–20 season there was a significantly higher overall mean training injury rate post-suspension in comparison to pre-suspension, with the 10-week training period post-suspension being the primary contributor to this. As such, it appears that players were at an increased risk of injury when they first returned following the period of restricted training. Physical parameters such as strength, power, aerobic and anaerobic running capabilities, are relatively easier to maintain when training individually in comparison to the rugby-specific physical and mental demands of the game.² Contact events, changing direction whilst running at speed and under-pressure decision making require interaction with other players to be executed to their full capacity. It is thus likely that players returned in a deconditioned state in specific aspects of rugby-related fitness resulting in an increased risk of injury.

Despite the greater injury rate in the immediate return to training, the 10-week post-suspension training period appeared to mitigate an increased risk of injury once competition resumed, with similar post- and pre-suspension in-season training injury rates. In a typical season, the preseason period is 6–12 weeks in length, therefore, the 10-week period was similar to a full preseason. Strength and conditioning and sports science staff have extensive experience of preparing players for competition in this timeframe under normal circumstances.

The 2019–20 post-suspension match injury rate is comparable to the 2019–20 pre-suspension match injury rate and significantly lower than the 2016–19 post-suspension match injury rate. Unlike the findings of previous studies in which a higher match injury rate was observed after a prolonged break,^{9,10} the suspension of matches and regular team training in our study did not result in higher match injury rates in the first three months following the resumption of competition. While factors such as age, injury history and current injury status will have influence each player's response to the lockdown period, it is possible that the extended period of non-contact training may have served as a positive period for physical and psychosocial rest and recovery for some players.² This may have been an opportunity to focus on full recovery from previous injury or target the development of specific physical weaknesses, without the stressors of having to prepare for weekly matches. Coupled with appropriate and progressive reconditioning on return to training, this may have resulted in an improvement in physical condition and performance and reduced mental fatigue, and as such players were better able to tolerate the demands of the game. It is also possible that staff were more diligent in the prescription of prehabilitation and conditioning exercises as they were aware of the potential increased risk of injury following the suspension of competition.

It is important to note that a large points deduction for one team meant that it was certain from early in the season that they would be relegated to the second-tier competition. Knowing which team would be relegated may have resulted in teams experiencing different pressures and thus adopting different player rotation strategies, impacting individual match load. Teams may also have allowed players experiencing injury complaints greater time to recover. It is possible that clubs altered their squad size or used a wider pool of players within their squad during this period, although this was not specifically examined in the current study.

During the post-suspension period of the 2019–20 season mid-week matches were introduced. Match injury rate, severity and burden of injuries sustained in fixtures with *shorter* (<6 days) vs *normal* (≥ 6 days) turnarounds were not different. In football, increased injury rates have been reported during periods of fixture congestion in comparison to normal scheduling,^{6,8,10} attributed to the increased physical and mental load on players.^{9,10,16} In the present study, players appeared able to cope with the intensive, congested match schedule when played under the unique conditions of this period. Players were aware that this period of congestion would likely be a once-off, 10-week period, and it is possible that they were able to tolerate the increased load for a short period of time. There was also greater player rotation in shorter turnaround fixtures, reflecting careful management of players during this period.

In professional football, significantly higher rates of muscle and ligament injuries have been reported in matches with <4 days recovery compared to those with >6 days.^{9,10} In the present study, there

Table 2
Incidence, severity and burden of training injuries sustained in 2016–19 and 2019–20.

	Incidence/1000 h (95% CI)		IRR (95% CI) p value	Mean severity (days)		Median severity (days)		Mean burden/1000 h (95% CI)	
	2016–19	2019–20		2016–19	2019–20	2016–19	2019–20	2016–19	2019–20
Rugby skills contact	7.8 (7.2–8.3)	9.1 (8.1–10.2)	1.2 (1.0–1.3) $p = 0.18$	35 (33–38)	33 (30–37)	14 (6–41)	15 (7–41)	275 (136–556)	303 (158–580)
Rugby skills non-contact	1.7 (1.5–1.9)	1.9 (1.5–2.3)	1.1 (0.9–1.4) $p = 1.0$	32 (28–36)	28 (23–34)	16 (7–42)	17 (8–37)	54 (12–242)	52 (13–219)
Conditioning weights	0.4 (0.3–0.6)	0.2 (0.1–0.3)	0.5 (0.3–0.8) $p = 0.04^*$	22 (17–27)	18 (11–30)	10 (5–32)	15 (9–25)	10 (1–182)	4 (0–274)
Conditioning non-weights	6.0 (5.3–6.8)	6.4 (5.4–7.6)	1.1 (0.9–1.3) $p = 1.0$	35 (31–40)	41 (35–49)	20 (9–42)	28 (10–53)	211 (95–470)	264 (121–573)
Overall	3.1 (2.9–3.2)	3.1 (2.8–3.3)	1.0 (0.9–1.1) $p = 0.84$	34 (32–36)	34 (31–37)	15 (6–40)	18 (8–45)	105 (34–320)	104 (34–318)

* Significant difference 2019–20 vs 2016–19 $p < 0.05$.

Table 3
Incidence, severity and burden of training injuries sustained pre- and post-suspension in the 2019–20 season.

	2019–20 season phases						
	2019–20		2019–20 overall	Pre-suspension		Post-suspension	
	pre-suspension	post-suspension		Official 19/20 pre-season	In-season, pre-suspension	10-week training period post-suspension	In-season, post-suspension
NUMBER OF INJURIES							
Overall	337	197	534	137	200	140	57
Rugby skills contact	188	102	290	56	132	70	32
Rugby skills non-contact	58	37	95	25	33	23	14
Conditioning weights	9	6	15	3	6	5	1
Conditioning non-weights	82	52	134	53	29	42	10
INCIDENCE/1000 HOURS (95% CI)							
Overall	2.7 (2.5–3.1)	3.8 (3.3–4.4)	3.1 (2.8–3.3)	3.7 (3.1–4.3)	2.3 (2.0–2.7)	4.7 (4.0–5.6)	2.6 (2.0–3.3)
	IRR 1.4 (1.1–1.7) p = 0.005*						
Rugby skills contact	8.4 (7.3–9.7)	10.8 (8.9–13.1)	9.1 (8.1–10.2)	20.1 (15.5–26.1)	6.7 (5.7–8.0)	15.8 (12.5–20.0)	6.3 (4.5–9.0)
	IRR 1.3 (1.0–1.6) p = 0.32						
Rugby skills non-contact	1.6 (1.3–2.1)	2.4 (1.8–3.3)	1.9 (1.5–2.3)	2.9 (2.0–4.4)	1.2 (0.9–1.7)	2.9 (1.9–4.4)	1.9 (1.1–3.2)
	IRR 1.5 (0.9–2.3) p = 0.52						
Conditioning weights	0.2 (0.1–0.3)	0.3 (0.1–0.6)	0.2 (0.1–0.3)	0.2 (0.1–0.6)	0.2 (0.1–0.4)	0.4 (0.2–1.0)	0.1 (0.0–0.8)
	IRR 1.5 (0.4–4.8) p = 1.0						
Conditioning non-weights	5.2 (4.2–6.5)	9.7 (7.4–12.8)	6.4 (5.4–7.6)	5.2 (4.0–6.8)	5.3 (3.7–7.6)	9.2 (6.8–12.5)	12.7 (6.8–23.6)
	IRR 1.9 (1.3–2.7) p = 0.007*						
MEAN SEVERITY (95% CI)							
Overall	36 (33–41)	30 (26–34)	34 (31–37)	35 (30–42)	37 (32–43)	27 (23–32)	36 (28–46)
Rugby skills contact	37 (32–42)	27 (22–33)	33 (30–37)	37 (29–49)	37 (31–43)	21 (17–27)	39 (27–55)
Rugby skills non-contact	28 (21–36)	28 (20–39)	28 (23–34)	27 (18–39)	29 (20–40)	24 (16–36)	35 (21–59)
Conditioning weights	15 (8–30)	22 (10–49)	18 (11–30)	29 (9–89)	9 (4–20)	22 (9–52)	24
Conditioning non-weights	44 (36–55)	37 (28–48)	41 (35–49)	38 (29–50)	56 (39–80)	39 (29–53)	29 (15–53)
MEDIAN (IQR)							
Overall	18 (7–46)	20 (9–44)	18 (8–45)	24 (10–51)	14 (6–40)	19 (9–44)	25 (9–53)
Rugby skills contact	16 (7–41)	13 (7–37)	15 (7–41)	23 (14–51)	13 (6–41)	12 (7–26)	26 (9–53)
Rugby skills non-contact	17 (6–27)	17 (9–42)	17 (8–37)	17 (8–26)	16 (5–27)	14 (7–36)	24 (10–43)
Conditioning weights	10 (6–15)	24 (16–25)	15 (9–25)	25 (6–55)	9 (6–13)	24 (16–25)	24
Conditioning non-weights	28 (10–55)	32 (11–49)	28 (10–53)	28 (10–55)	27 (11–51)	34 (13–53)	15 (7–35)
BURDEN/1000 HOURS (95% CI)							
Overall	100 (31–327)	112 (41–307)	104 (34–318)	130 (46–361)	87 (24–313)	128 (52–315)	92 (27–312)
Rugby skills contact	309 (157–608)	288 (158–524)	303 (158–580)	753 (487–1166)	246 (116–524)	337 (206–552)	245 (112–534)
Rugby skills non-contact	46 (10–210)	68 (19–239)	52 (13–219)	78 (25–245)	35 (6–206)	69 (22–217)	67 (16–278)
Conditioning weights	3 (0–279)	6 (0–255)	4 (0–274)	5 (0–500)	2 (0–163)	9 (0–194)	3
Conditioning non-weights	231 (98–544)	360 (192–674)	264 (121–573)	198 (84–467)	292 (124–686)	359 (189–685)	362 (209–628)

* Significant difference post- vs pre-suspension $p < 0.05$.

was a significantly higher burden of soft tissue injury in fixtures with <6 days compared with ≥ 6 days of turnaround. Furthermore, the injury rate of *conditioning non-weights* training in the 2019–20 season was significantly higher post-suspension in comparison to pre-suspension, with 94% of the injuries in this category being soft tissue injuries. Soft tissue injuries are often considered to be partly explained by fatigue leading to biomechanical and structural changes to the muscles making them more prone to injury.^{18,20,21} Our findings suggest that players may have been beginning to show signs of fatigue accumulation and/or incomplete physical recovery during the post-suspension period of the season, where mid-week matches were played, and subsequent seasons' data will be needed to determine any medium-term impact. It should be noted that match and training exposure data was incorporated on the team level, rather than individual level, meaning it was not possible to identify if training exposure differed between match selected and non-match selected players each week. It is worth noting that it is possible that COVID-19 induced absence from training, due to infection or close contact isolation, could influence injury incidence alongside other individual risk factors, but as this was not a research question in this study, we did not capture the data required to perform the analysis.

5. Conclusion

This is the first study to assess the influence of an extended period away from match play and the influence of congested match fixtures on injury risk in collision sports. The findings support previous work

showing that a period of time away from matches and regular training is associated with an increased risk of injury when first returning to training.^{1,22} However, we found that an extended period away, coupled with an appropriate and progressive return to training resulted in a lower match injury rate than the injury rate following a regular off-season once competition resumed. In the global sports context, the potential for positive mental and physical effects of an extended period away from sport should be considered by practitioners and policy developers. While it appears that players may have been starting to show signs of fatigue accumulation towards the end of the season, when mid-week matches were played, greater player rotation strategies assisted in alleviating an increased injury rate in the short-term and suggests squad size should be a consideration by team sport practitioners when managing periods of fixture congestion.

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Declaration of interest statement

SK and KS are employed by the Rugby Football Union. MC is employed by Premiership Rugby. Funding for this study was provided by the Rugby Football Union and Premiership Rugby.

Confirmation of ethical compliance

This study was approved by the University of Bath Research Ethics Approval Committee for Health (Ref: 16/17 200). Individual informed consent was obtained from each eligible player on an annual basis for the duration of this study.

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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.2022.03.012>.

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