England Professional Rugby Injury Surveillance Project

2016 – 2017 Season Report

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The content of the report is based on data collected and analysed by Stephen West (University of Bath).

The authors would like to acknowledge with considerable gratitude, the work of the doctors, physiotherapists and strength and conditioning staff from the Premiership clubs and England teams who have recorded injury and training information throughout the project.

Executive Summary

The key findings from the 2016–17 season:

- The Professional Rugby Injury Surveillance Project (PRISP) is the most comprehensive and longest running injury surveillance project in professional rugby union. First commissioned by the Rugby Football Union (RFU) and Premiership Rugby (PRL) in 2002, PRISP monitors injury incidence (how often), injury severity (days absence) and injury burden (incidence x severity) in English Premiership Clubs and the England Senior team.

- The main objectives of PRISP are to accurately report the risk of injury in the professional game and to highlight any patterns or trends over time, allowing for the targeted investigation of specific areas of injury risk and the development of evidence based strategies to reduce injury risk.

- In the 2016-17 season, the overall incidence of match injury in the Premiership was 96 per 1000 hours (1000 hours = 25 matches). This equates to 3.8 injuries per match and 1.9 injuries per team. This figure is slightly higher than the mean for the whole of the surveillance period of 84 per 1000 hours, but remains within the limits of expected season to season variation.

- The average severity of match injuries (the time taken to return to play) for the 2016-17 season was 32 days. This is the first time this figure has risen above the expected upper limit of season to season variation. This is largely driven by the increase in injuries in the three highest severity groupings (8-28 days, 28-84 days and >84 days absence).

- For the first time hamstring injuries and concussion feature in the top three injuries resulting in more than 84 days absence. The reasons for this change in the severity profile for hamstring injury severity profile are unclear. The number of concussions requiring more than 3 months absence has also increased. This likely reflects a trend to more conservative management of players who have sustained two or more concussions in a 12-month period.

- Due to the rise in both the incidence and severity of match injuries, the burden of match injury (a combination of both incidence and severity) increased to 3054 days absence per 1000 hours for Premiership injuries which is above the upper limit of expected variation.

- For the sixth consecutive season, the most commonly reported match injury was concussion (20.9/1000 hours), contributing 22% of all match injuries. While there has been a continued focus on improving concussion awareness and promoting behavioural changes among players, coaches, referees and medical staff, together with the introduction of real-time video into the Head Injury Assessment (HIA) process, a change in the frequency and nature of game contact events cannot be excluded as a possible contributing factor to this increase and will be investigated.

- The mean severity of medically diagnosed match concussions in 2016-17 was 18 days. This rise in mean severity is largely due to a substantial increase in the incidence of a relatively small number of concussions where the time to return was more than 84 days, compared with previous seasons. Compliance with the mandatory return to play protocols for concussion was again excellent, with no players returning to play in less than six days.

- 47% of all match injuries are associated with the tackle, with 23% of all injuries associated with tackling and 24% associated with being tackled. Concussion accounted for 19% of all injuries to the ball carrier and 43% of all injuries to the tackler, highlighting the tackle as the key game event when developing concussion reduction strategies. Best practice in this area (how best to deliver optimised ball carrying and tackling with minimal risk of head contact) will be explored in a series of facilitated workshops and discussion with Premiership and England coaches, players and conditioners.

- A new directive, aimed at reducing the risk of concussion in the tackle, was issued by World Rugby setting out increased sanctions for high tackles on the 1st January 2017. When considering all players involved in a tackle (during the 2016-17 season), there was no difference in the incidence of all injuries and concussion when comparing matches played prior to the 1st of January with those played after that date. Small changes were observed in the incidence of concussion to players when categorised as the ball carrier or tackler. These differences were not significant but will continue to be monitored, along with referee application of the directive, to understand the ongoing impact of the increased sanctions.

- The profile of the five most common match and highest burden match injuries has remained similar throughout the surveillance period with

the exception of concussion. For the second consecutive year concussion, as a result of high incidence and a rising severity, is both the most common and highest burden match injury.

- The incidence of training injuries rose during the 2016-17 season, having fallen in the two previous seasons. The average severity rose to its highest recorded level at 33 days. As a result of the increase in both incidence and severity of training injury the burden of training injury rose substantially for the 2016-17 season. In total, 36% of all injuries were sustained during training. There was also a significant increase in the incidence and injury burden during full contact training. The most commonly occurring injury in full contact training was concussion. Determining training volume, intensity and activity involves balancing performance preparation with injury risk. In the 2016-17 season, we saw increases in training injury burden, match injury burden and match contact injury burden. Best practice in this area will be explored in a series of facilitated workshops and discussion with Premiership and England coaches, players and conditioners.

- During the 2016-17 season, games at three Premiership venues were played on artificial turf (Allianz Park, Kingston Park, Sixways Stadium). For the first season, the incidence and burden of match injury on artificial turf was significantly higher than that of natural grass. The burden of injuries sustained when training on artificial turf was also higher than those sustained when training on natural turf. The severity of match injuries as well as the incidence and severity of training injuries on artificial turf was not significantly different to that of natural grass. There was no significant difference in injury risk between the three artificial turf pitches. Combining the data for the four seasons of injury surveillance that have included matches played on artificial turf, neither injury incidence or severity differ between surfaces. PRISP will continue to monitor the risk during 2017/18 season and will also report on the relative risk of the common injuries on AGPs compared with natural turf.

- The incidence of match injuries for the England Senior side for the 2016-17 season was 113 per 1,000 hours with an average severity of 16 days.

- In 2016-17, 19 players retired as a result of injury.

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Introduction

The Rugby Football Union (RFU) and Premiership Rugby Ltd (PRL) first commissioned an injury surveillance study across the Premiership and England teams in 2002 that remains driven and directed towards the improvement of player welfare in professional rugby union. This report presents the Premiership-wide key findings from the 2016-17 season and compares them longitudinally with the results from 13 previous seasons. The Professional Rugby Injury Surveillance Project (PRISP) is pivotal in both providing the baseline data needed to assess trends in injury and in guiding further investigation into injuries that are common, severe or increasing in incidence.

The data collection methods for PRISP can be found towards the end of this report. Supporting tables and figures are included in the supplementary data file alongside this report, the contents of which are summarised at the end of this report.

Research Updates: 2016–17

Exploring the utility of the King-Devick concussion screening tool in professional rugby union

The aim of this study was to explore the utility of the King-Devick eye movement test for identifying players with concussion in professional rugby union. Currently, the HIA assessment tool does not include a visual based testing domain and therefore, this one-season study explored whether the King-Devick test could inform a more robust and streamlined concussion assessment tool for use in professional rugby union in order to aid the clinician in their pitch-side decision making. This study has now been submitted for publication to the British Journal of Sports Medicine and we will share a summary of the results in the 2017-18 PRISP report.

Investigating strategies used in professional rugby to manage athletes on artificial turf

This project builds upon previously published work that investigates the risk of injury on artificial turf compared with natural grass which we continue to monitor and report on within this document. This one-season study conducted by the University of Bath aimed to determine whether professional rugby clubs approach player management differently when playing on artificial turf compared to natural grass, and investigated various management strategies currently being used for this purpose. It is anticipated that this study will identify clear direction for any future research in this area. The study is currently being prepared for peer reviewed publication and the findings from this study will be included in the 2017-18 PRISP report.

The developing player study

The RFU and PRL, through the 14 Regional Academies, support the development of elite playing talent across the game. Currently, there is very little known about the playing, training and life loads of this group of developing players and the impact this has on injury risk and development rates. This study will further our understanding in these areas. This project is not due to finish until 2020 and we will provide an update on this project in the 2017-18 season report.

Project Definitions

Time-loss injury

A time-loss injury was defined as 'any injury that prevents a player from taking a full part in all training activities typically planned for that day and/or match play for more than 24 hours from midnight at the end of the day the injury was sustained'. For example, if a player was injured during a match on Saturday and he was able to take a full part in training on Monday, the incident would not be classed as an injury. If the player's training was restricted on Monday due to the injury received on Saturday, the incident would be classed as a time-loss injury and reported.

Injury severity

Injury severity was measured as time (days) lost from competition and practice and defined as 'the number of days from the date of the injury to the date that the player was deemed to have regained full fitness not including the day of injury or the day of return'. A player was deemed to have regained full fitness when he was 'able to take a part in training activities (typically planned for that day) and was available for match selection.'

Recurrent injury

An injury of the same type and at the same site as an index (original) injury and which occurs after a player's return to full participation from the index (original) injury. Manual calculation of within season injury recurrence was completed using player registration codes and Orchard Sports Injury Classification System (OSICS) codes (to two digits).

Injury incidence

The likelihood of sustaining an injury during match play or training is reported as the injury incidence. The injury incidence is the number of injuries expressed per 1,000 player-hours of match exposure (or training exposure).

Burden (days absence)

The burden of injury is a measure which takes into account both the frequency and severity of injuries. Burden is measured as the days absence per 1,000 player-hours of exposure.

Illness

Any illness (classified using the OSICS 10.1) for which the player sought consultation at his club that prevented the player from participating in training or match play for a period greater than 24 hours after the onset of symptoms.

Statistical significance

A result is considered to be statistically significant if the probability that it has arisen by chance is less than 5% or 1 in 20. In this report, statistical analysis has been performed for the match and training injury incidence and days absence. Statistical Process Charting (SPC) has been used to show the expected limits of the system with upper and lower limits set at +/- 2 standard deviations from the mean.

Key Findings

Match Injury Incidence, Severity & Burden

Likelihood or incidence of match injury

The incidence of match injury during the 2016-17 season was the third highest value seen during the study period (Figure 1a). Seven hundred and seventy-eight match injuries which prevented an athlete from participating in training or match play were recorded, which is higher than the mean of 656 per season for the surveillance period as a whole. The match injury incidence in the 2016-17 season was 96/1000 hours, or approximately 65 injuries per club. This incidence is higher than the mean incidence of 84/1000 hours for the period of 2002-2015, however remains within the expected limits of season to season variation. Table 1 provides a breakdown of match injuries by severity grouping and shows a rise across all the severity groupings compared with the 2014-15 season, with the 8-28, 29-84 and >84 days absence categories above the mean for the surveillance period as a whole. Of particular note is the increase in incidence of >84 day injuries to 10 per 1000 hours which is double that of the mean for the surveillance period.

Due to the re-inclusion of the Anglo Welsh cup, after a year's break due to the Rugby World Cup, the number of matches rose from the 359 during the 2015-16 season to 406 team matches (1 game= 2 team matches, if both clubs are involved in the injury surveillance project) during the 2016-17 season. Each club experienced 1.9 injuries per match during the 2016-17 season, compared with the 1.2 injuries per club per match in the 2015-16 season.

Severity of match injuries

The average severity of match injury for the 2016-17 season was 32 days lost per injury (Figure 1b). This figure represents the first time that the severity has risen above the expected upper limit of season to season variation. Table 1 shows the incidence of injuries associated with each of the listed severity groupings. This rise in severity above the expected limits of variation reflects the increased incidence of injuries in all severity groupings compared with the 2015-16 season but in particular a rise in the numbers of injuries resulting in 8-28, 29-84 and >84 days absence. This increase above the upper limit of seasonal variation may represent either an overall increase in the severity of match related injuries or more conservative return to play protocols being used within clubs.

Match injury burden

The increase in both the incidence and severity of injury during the 2016-17 season resulted in a large increase in the burden of match injury (a combination of both incidence and severity, Figure 1c). During the 2016-17 season, the burden of match injury was 3054 days absence per 1000 hours, which was substantially higher than the 2015-16 season (1795 days absence per 1000 hours). Furthermore, this figure was the highest seen over the surveillance period as a whole and considerably higher than the upper limit of expected season to season variation. This value equates approximately to 61 days absence per club per match.

Figure 1a

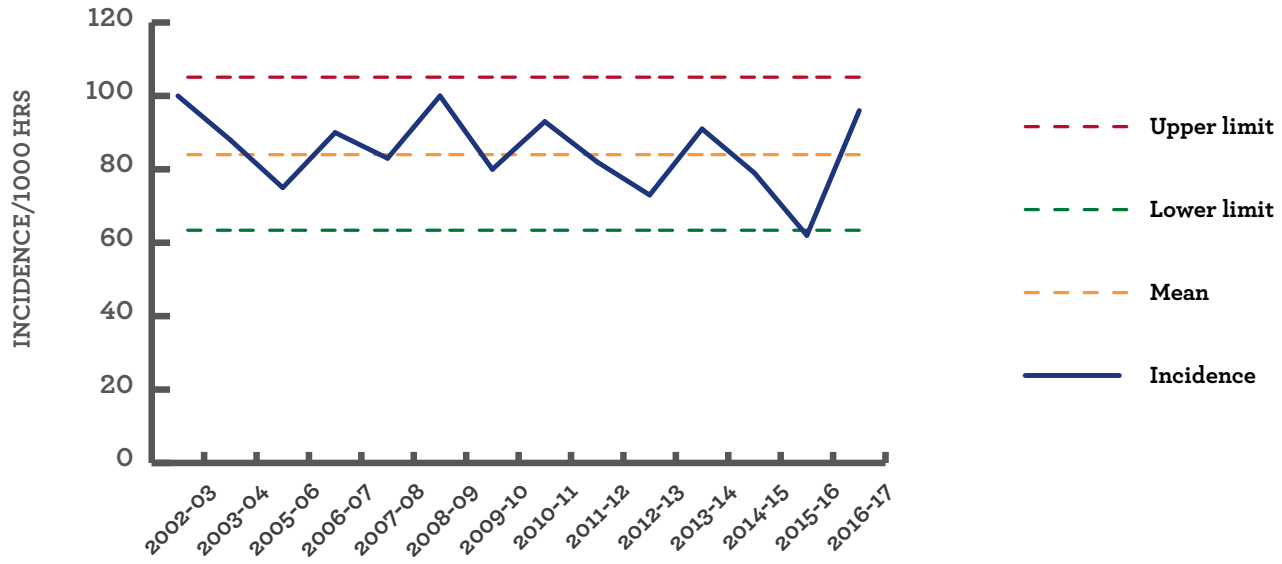

Figure 1a: Incidence rates of match injuries over the surveillance period with mean ± 2 x standard deviation shown.

Note: For a normal distribution, 95% of all data should fall between (Mean - 2 x standard deviation) and (Mean + 2 x standard deviation).

Figure 1b

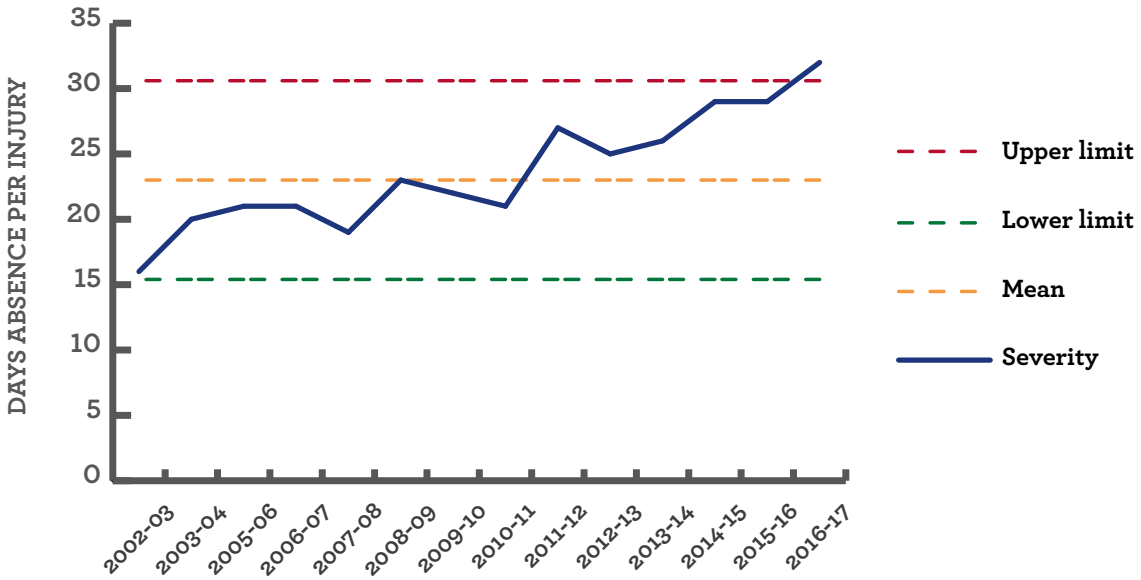

Figure 1b: Severity of match injuries over the surveillance period with mean ± 2 x standard deviation shown.

Figure 1c

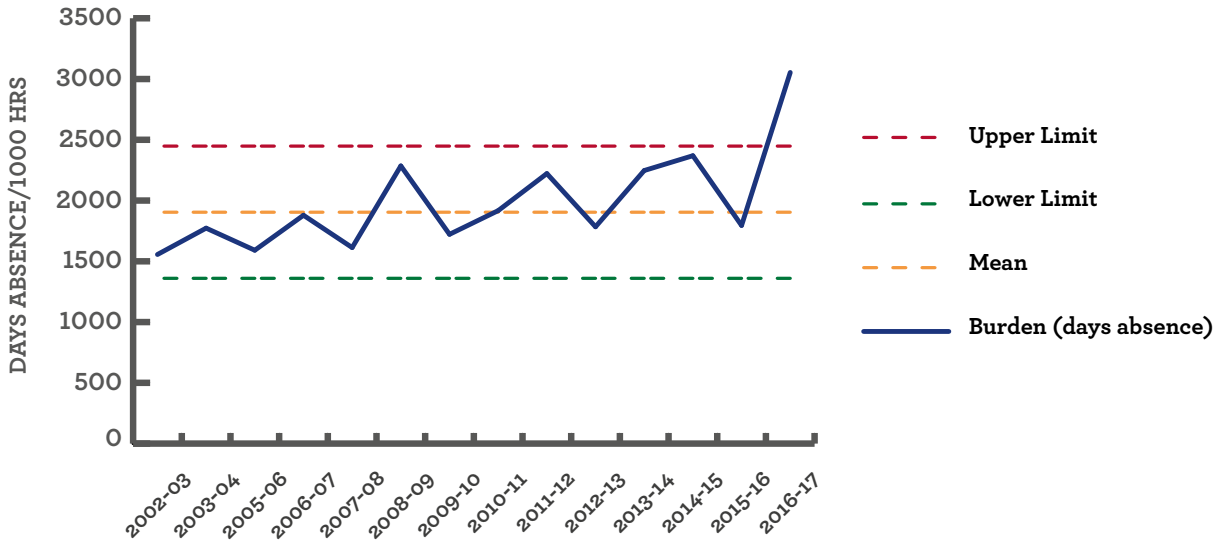

Figure 1c: Days absence/1000 hrs from match injuries over the surveillance period with mean ± 2 x standard deviation shown.

Table 1: Match injury incidence by severity grouping 2002-17 (95% CI's)

SEASON	INCIDENCE/ 1000 HRS				
	2-7 DAYS	8-28 DAYS	29-84DAYS	>84 DAYS	ALL
2002-03	57	30	9	3	100
2003-04	45	26	14	4	88
2005-06	29	29	13	3	75
2006-07	47	28	11	5	90
2007-08	39	30	10	4	83
2008-09	48	31	14	6	100
2009-10	36	29	10	4	80
2010-11	44	32	11	5	93
2011-12	34	28	13	7	82
2012-13	26	30	13	4	73
2013-14	38	33	14	6	91
2014-15	33	25	12	9	79
2015-16	23	24	11	5	62
2016-17	36	31	19	10	96
MEAN (2002-16)	38 (35-42)	29 (26-32)	12 (10-14)	5 (4-6)	84 (79-89)

Table 2 provides an overview of the three most common injuries since 2012-13 in the two highest severity categories and the associated average severity of those injuries, classed within that grouping (e.g. the average severity of concussion is the average severity of concussions within the specific severity categories, and not all concussions). This data shows that the injuries within these higher severity groupings have largely remained similar since 2012. In 2016-17, Hamstring injuries and Concussion appear in the > 84 day category for the first time.

Table 2: **The types and associated severities of 29-84 and > 84 day match injuries (2012-17)**

	29-84 DAYS			>84 DAYS	
	INJURY TYPE	AVERAGE SEVERITY		INJURY TYPE	SEVERITY
2012/13	ANKLE SYNDESMOSIS	46	2012/13	ACL	213
	HAMSTRING	47		MCL	117
	MCL	50		ANKLE SYNDESMOSIS	105
2013/14	ANKLE SYNDESMOSIS	40	2013/14	ACL	244
	HAMSTRING	40		COMBINED KNEE LIGAMENTS	191
	MCL	59		PEC TEAR	122
2014/15	HAMSTRING	49	2014/15	ACL	229
	MCL	53		ANKLE SYNDESMOSIS	119
	ANKLE SYNDESMOSIS	57		ANKLE DISLOCATION	157
2015/16	HAMSTRING	49	2015/16	PCL	137
	CONCUSSION	39		ACJ	142
	MCL	54		ACL	294
2016/17	MCL	59	2016/17	HAMSTRING	120
	CONCUSSION	43		ACL	258
	ANKLE SYNDESMOSIS	59		CONCUSSION	148

Greater than 7-day time-loss match injuries

Since the 2015-16 season, the incidence, severity and burden of greater than 7-day time loss injuries has been reported within the annual report. This not only allows for comparison between different sports but also between different levels of the game, for example, with the RFU Community Rugby Injury Surveillance Project (CRISP), which has a 7-day time-loss injury definition. This applies to both match and training injuries presented within last seasons as well as this seasons report.

The incidence of greater than 7-days match injuries saw a large increase during the 2016-17 season and exceeds the expected limits of variation at 62 per 1000 match hours (Figure 1d). This rise corresponds with the rise in the incidence in each of the three most severe injury categories outlined in Table 1. The severity of greater than 7-day injuries also rose above the expected limits of variation, with the figure reaching 47 days absence per injury during the 2016-17 season (Figure 1e). This figure rose from 42 during the 2015-16 season and is seen as 10 days more absence per injury than the mean for the surveillance period as a whole at 37 days. Figure 1f shows the overall burden of > 7-day match injuries, which for the 2016-17 season rose to 2903 days absence per 1000 hours, which is substantially higher than that of the mean for the entire study period (1664 days absence per 1000 hours).

Figure 1d

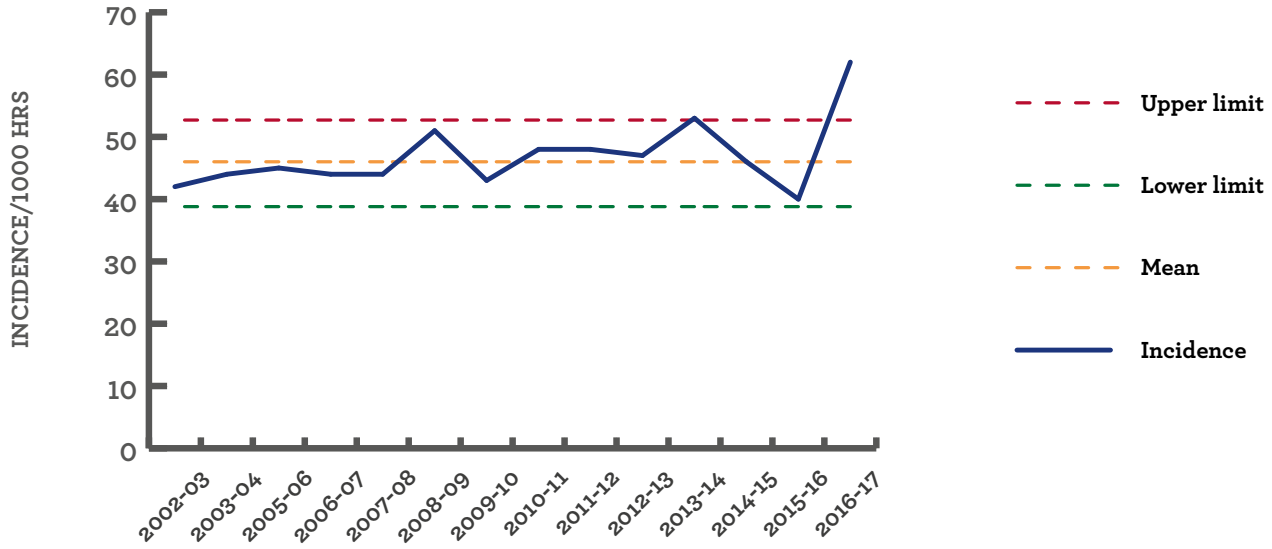

Figure 1d: Incidence rates of >7 day match injuries over the surveillance period with mean ± 2 x standard deviation shown.

Figure 1e

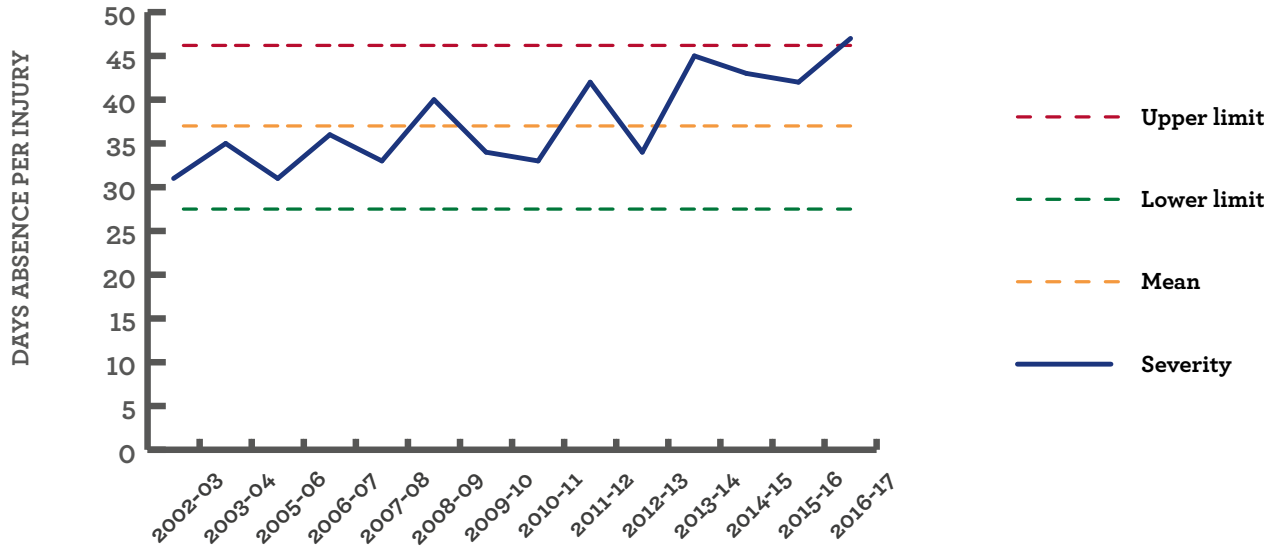

Figure 1e: Severity of >7 day match injuries over the surveillance period with mean ± 2 x standard deviation shown.

Figure 1f

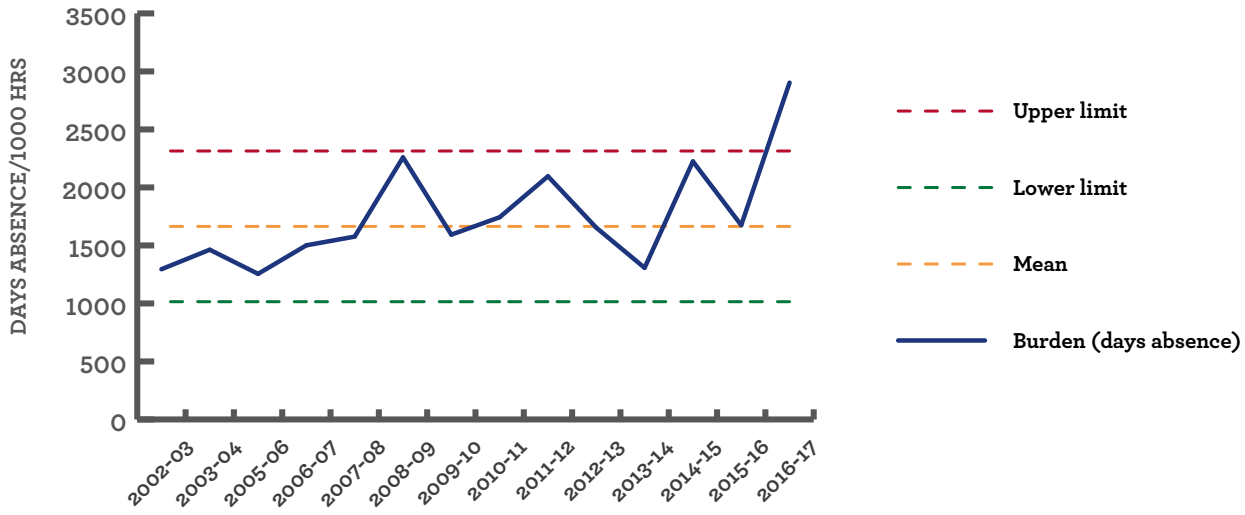

Figure 1f: Days absence/1000 h from >7 day match injuries over the surveillance period with mean ± 2 x standard deviation shown.

Training Injury Incidence, Severity & Burden

Summary of the Training injury risk

A total of 429 training injuries (36% of the total injury count for 2016-17) that led to time lost from training and/or match play were reported for the 2016-17 season. This equated to a training injury incidence rate of 2.9/1000 hours or approximately 36 injuries per club per season (a season by season breakdown can be seen in Table S2). The incidence of training injury rose for the first time in three years, however it remained within the expected limits of variation (Figure 2a).

The severity of training injuries during the 2016-17 season was 33 days absence per injury (Figure 2b). This figure is the highest severity recorded over the study period and is above the expected limits of variation. This represents the second year whereby the severity of training injuries has exceeded the upper limit of variation. Further examination of the training injuries by severity grouping (Table 3) indicates that large rises are seen in the three most severe groupings of 8-28 days, 29-84 days and >84 days. In particular, the number of 29-84 and >84 day injuries were substantially higher than the surveillance period mean, 0.61 vs 0.37/1000 hours and 0.34 vs 0.13 respectively.

The burden of training injuries (Figure 2c) rose for the first time since the 2012-13 season as a result of large increases in both the incidence and severity of training injuries during the 2016-17 season. The rise to 96 days absence/1000 hours during the 2016-17 season is substantially higher than the mean for the surveillance period (54 days absence per 1000 hours) and is above the upper limit of expected variation.

Figure 2a

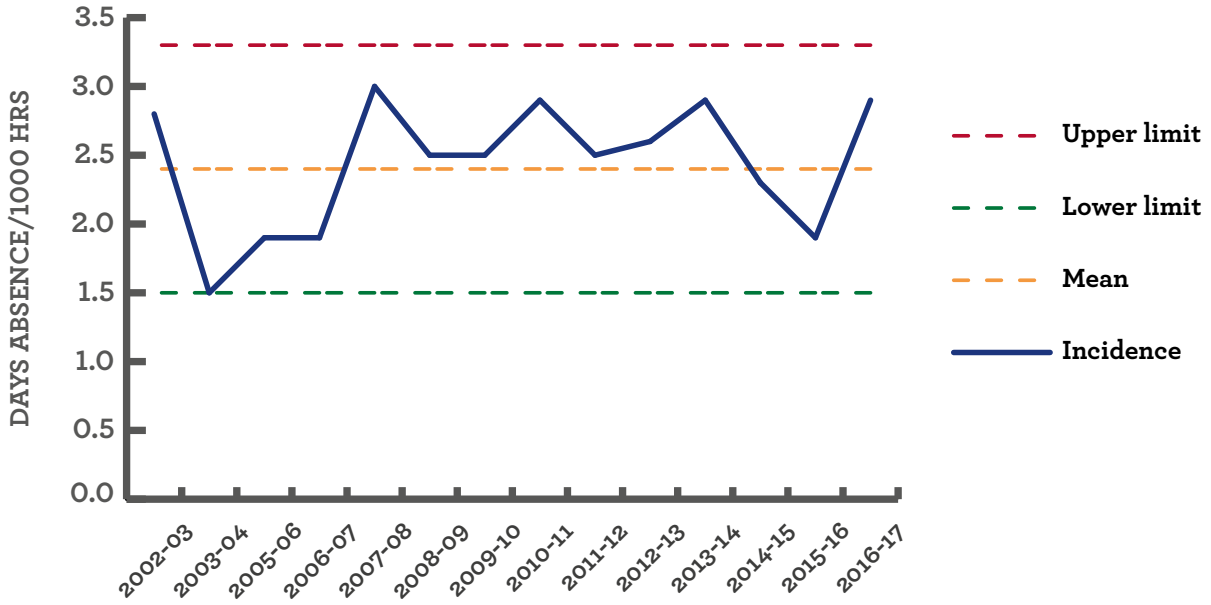

Figure 2a: Incidence rates of training injuries over the surveillance period with the mean ± 2 x standard deviation shown.

Figure 2b

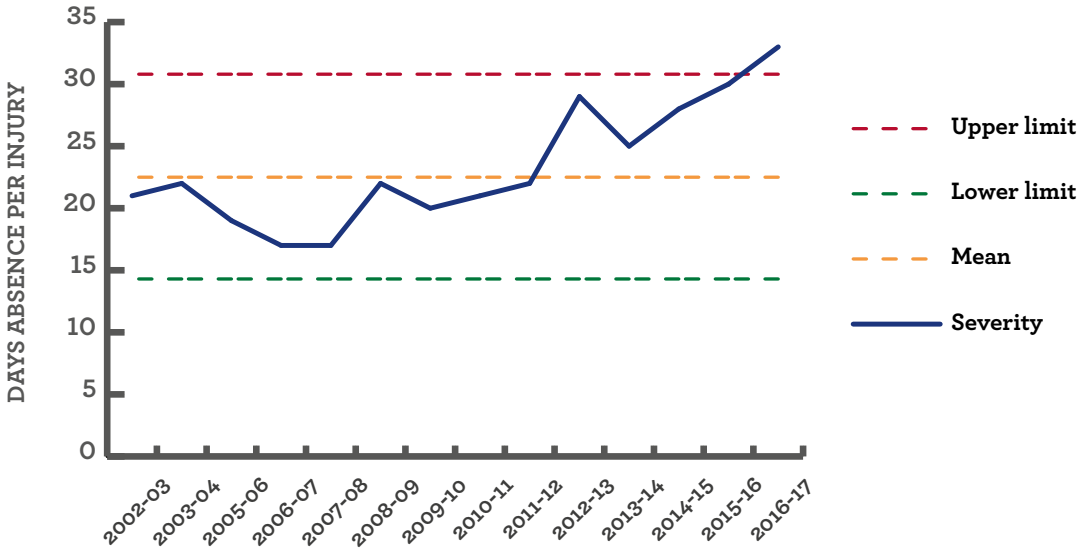

Figure 2b: Severity of training injuries over the surveillance period with mean ± 2 x standard deviation shown.

Figure 2c

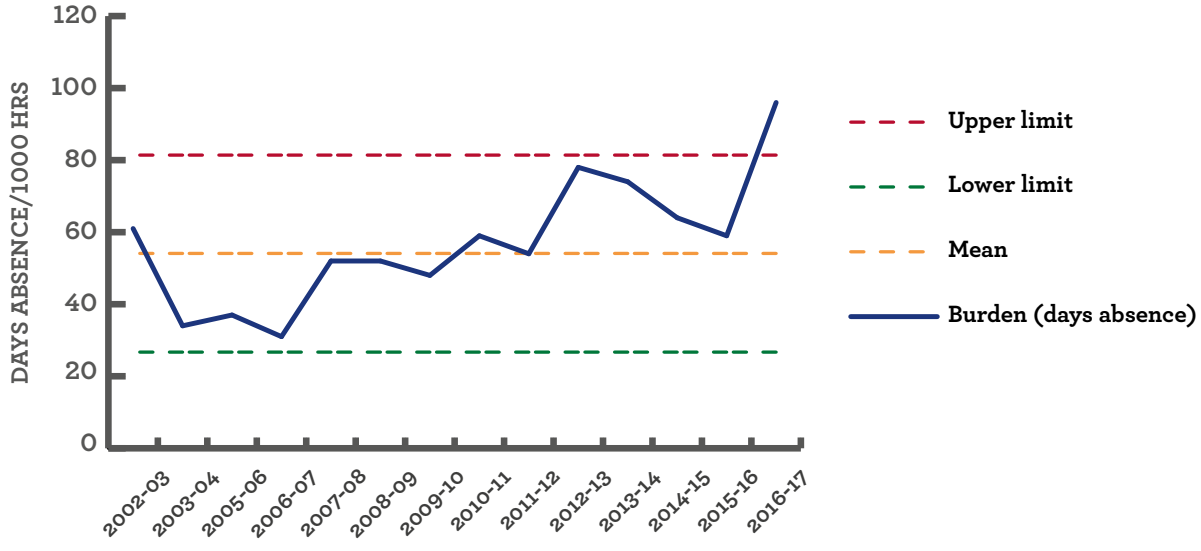

Figure 2c: Days absence/1000hrs for training injuries over the surveillance period with mean ± 2 x standard deviation shown.

Table 4 provides an overview of the three most common training injuries since 2012-13 in the two highest severity categories and the associated average severity of those injuries. This data shows that the injuries within these higher severity groupings have largely remained similar since 2012, in particular in the 29-84 day category. ACL and hamstring injuries are the injuries which appear most regularly in the > 84 day category.

Table 3: **Training injury incidence by severity grouping 2002-17 (95% CI's)**

SEASON	INCIDENCE/ 1000 HRS				
	2-7 DAYS	8-28 DAYS	29-84	>84	ALL
	DAYS	DAYS	DAYS	DAYS	
2002-03	1.13	1.29	0.42	0.18	3.02
2003-04	0.16	0.63	0.30	0.08	1.17
2005-06	1.04	0.70	0.35	0.10	2.19
2006-07	0.99	0.61	0.20	0.07	1.87
2007-08	1.26	1.08	0.38	0.07	2.79
2008-09	1.00	0.94	0.31	0.10	2.35
2009-10	1.09	0.89	0.34	0.07	2.39
2010-11	1.24	1.12	0.32	0.13	2.81
2011-12	0.87	0.97	0.30	0.14	2.28
2012-13	0.90	0.98	0.49	0.21	2.58
2013-14	0.94	1.25	0.52	0.18	2.89
2014-15	0.87	0.82	0.44	0.19	2.32
2015-16	0.47	0.86	0.43	0.14	1.90
2016-17	0.89	1.06	0.61	0.34	2.90
MEAN (2002-15)	0.92 (0.52-1.62)	0.93 (0.53-1.63)	0.37 (0.15-0.91)	0.13 (0.03-0.60)	2.4 (1.60-3.41)

Table 4: The types and associated severities of 29-84 and > 84 day training injuries (2012-17)

	29-84 DAYS			>84 DAYS	
	INJURY TYPE	AVERAGE SEVERITY		INJURY TYPE	AVERAGE SEVERITY
2012/13	HAMSTRING	33	2012/13	ACL	270
	MCL	51		HAMSTRING	149
	CALF	51		SHOULDER DISLOCATION	116
2013/14	HAMSTRING	44	2013/14	HAMSTRING	228
	CALF	41		GLENOHUMERAL JOINT SPRAIN	103
	ANKLE LIGAMENTS	40		ELBOW MUSCLE STRAIN*	204
2014/15	HAMSTRING	39	2014/15	ACL	252
	CALF	45		LUMBAR JOINT INJURY	143
	ANKLE LIGAMENTS	39		HAMSTRING	115
2015/16	ANKLE LIGAMENTS	52	2015/16	HAMSTRING	184
	HAMSTRING	51		L5/S1 DISC PROLAPSE	173
	CALF	40		REC ABDOMINIS INJURY	159
2016/17	HAMSTRING	48	2016/17	HAMSTRING	99
	CALF	49		ACL	240
	ANKLE LIGAMENTS	61		CALF	135

*Note: In the event that a large number of high severity injuries occurred only once throughout the season, but there were no injuries which occurred more than once, the injury with the highest severity has been reported.

Greater than 7-day time-loss training injuries

The incidence of greater than 7-day injuries rose during the 2016-17 season to 2.0/1000 training hours. This figure is equal to that of the upper limit of variation and is above the surveillance period mean which is 1.4/1000 hours (Figure 2d). The severity of greater than 7-day injuries rose during the 2016-17 at an average absence of 47 days per injury. This represents a value substantially higher than that of the surveillance mean at 35 days per injury. This figure also exceeds the expected limits of variation (Figure 2e). Figure 2f shows the overall burden of greater than 7-day training injuries. Given the rise in both incidence and severity above the expected limits of variation for the season, it follows that the burden for the 2016-17 has risen to 93 days absence per 1000 hours of training. This represents a value substantially higher than that of the mean for the surveillance period as a whole, which is 53 days absence per 1000 hours.

Figure 2d

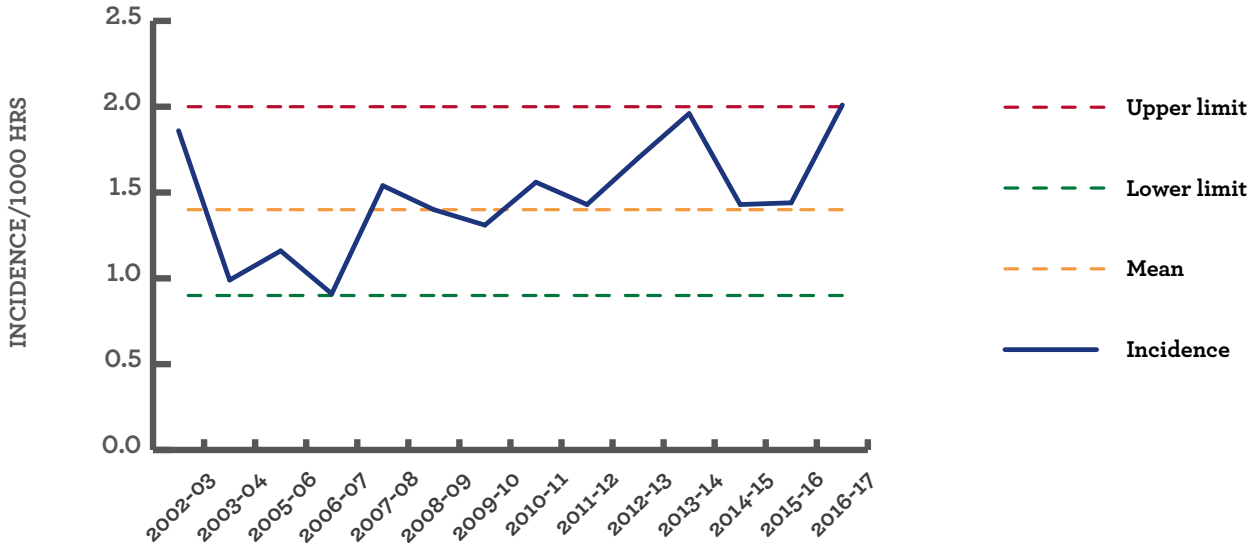

Figure 2d: Incidence rates of >7 day training injuries over the surveillance period with mean ± 2 x standard deviation shown.

Figure 2e

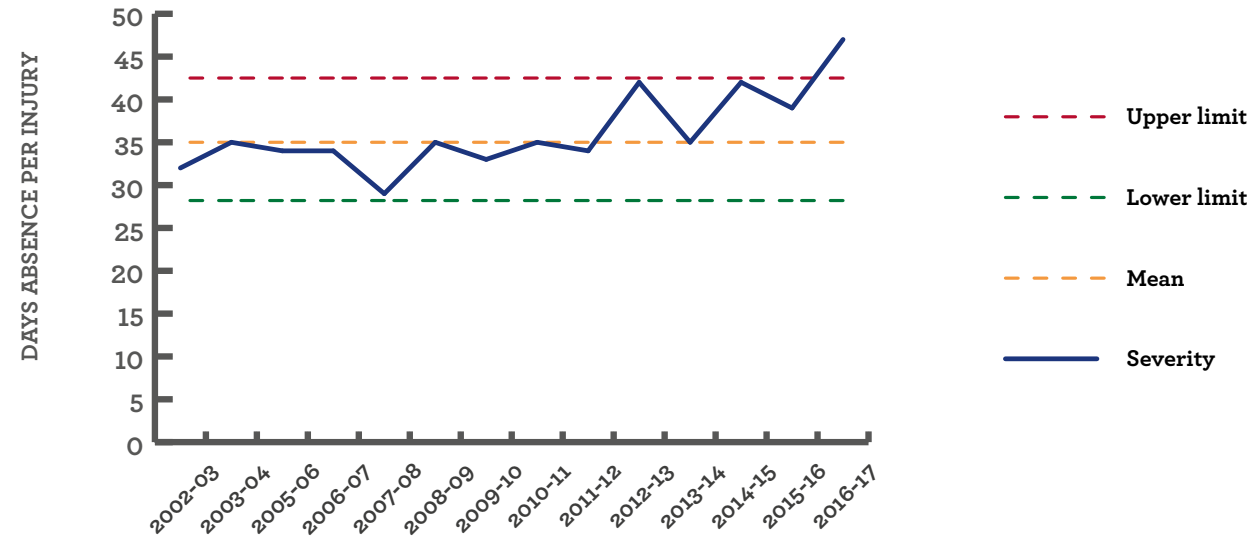

Figure 2e: Severity of >7 day training injuries over the surveillance period with mean ± 2 x standard deviation shown.

Figure 2f

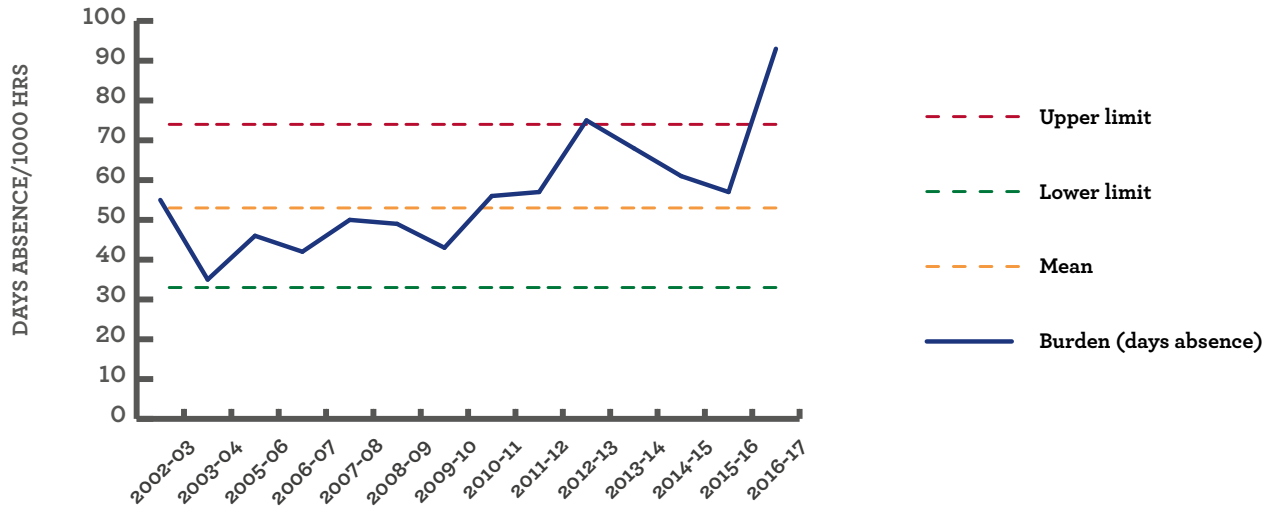

Figure 2f: Days absence/1000 hrs from >7 day training injuries over the surveillance period with mean ± 2 x standard deviation shown.

Concussion

Prevalence, incidence, severity and burden

During the 2016-17 season, 169 match concussions were reported. These concussions were sustained in the following competitions: Premiership (120), European competition (33) and Anglo Welsh Cup (16). There were 21 reported training concussions (18 in the 2015-16 season), accounting for 11% of all reported concussions, with the remaining 89% of concussions attributed to match play. During the 2016-17 season, 20% of all consented players sustained at least one concussion. Of the 20% with medically diagnosed concussions, 122 players suffered one concussion, 20 suffered two concussions, one player sustained three concussions and one player sustained four concussions. The RFU and PRL currently recommend that a specialist neurological opinion should be sought for players following a second diagnosed concussion during a 12-month period.

For the seventh consecutive season the incidence of match concussions rose (Figure 3). In 2016-17, the incidence of match concussion rose to 20.9/1000 hours match play, which is up from the 2015-16 figure of 15.8/1000 hours and substantially higher than the mean for the surveillance period (7.6/1000 hours). For the fourth consecutive season, the incidence of reported match concussions rose above the upper limit of expected season-to-season variation.

The mean severity of match concussions increased by five days to 18 days for the 2016-17 season (Figure 4). This figure is over six days higher than the mean for the surveillance period of 11.5 days absence per concussion and is also above the upper limit of expected season-to-season variation. Table 5 shows the incidence of concussion by severity groupings. From this table, it can be seen that a large amount of this rise in average severity during the 2016-17 season can be attributed to the substantial increase in the incidence of a relatively small number of concussions lasting greater than 84 days, compared with previous seasons. Despite this substantial rise in average severity, Figure 5 shows that the median days absence experienced as a result of concussion remained stable for the 2016-17 season, suggesting that the severity of the majority of concussions has not substantially changed. Finally, Figure 6 shows the percentage of players returning from concussion and the time taken to do so. This shows that 46% had returned within seven days, 89% had returned by 28 days, 96% had returned by 84 days and 4% (seven players) did not return within 84 days. Current graduated return to play guidelines after concussion dictates that players must not return to play in a period shorter than six days from the day of injury. For the 2016-17 season, no player returned to play sooner than six days, showing excellent compliance with the concussion return to play guidelines. The rising average severity of concussion may also be seen as a move towards increasingly conservative management of players diagnosed with concussion or multiple concussions.

While there has been a continued focus on improving concussion awareness and promoting behavioural changes amongst players, coaches, referees and medical staff, together with the introduction of real-time video into the HIA process, a change in the frequency and nature of game contact events cannot be excluded as a possible contributing factor to this increase and needs further investigation.

Figure 3

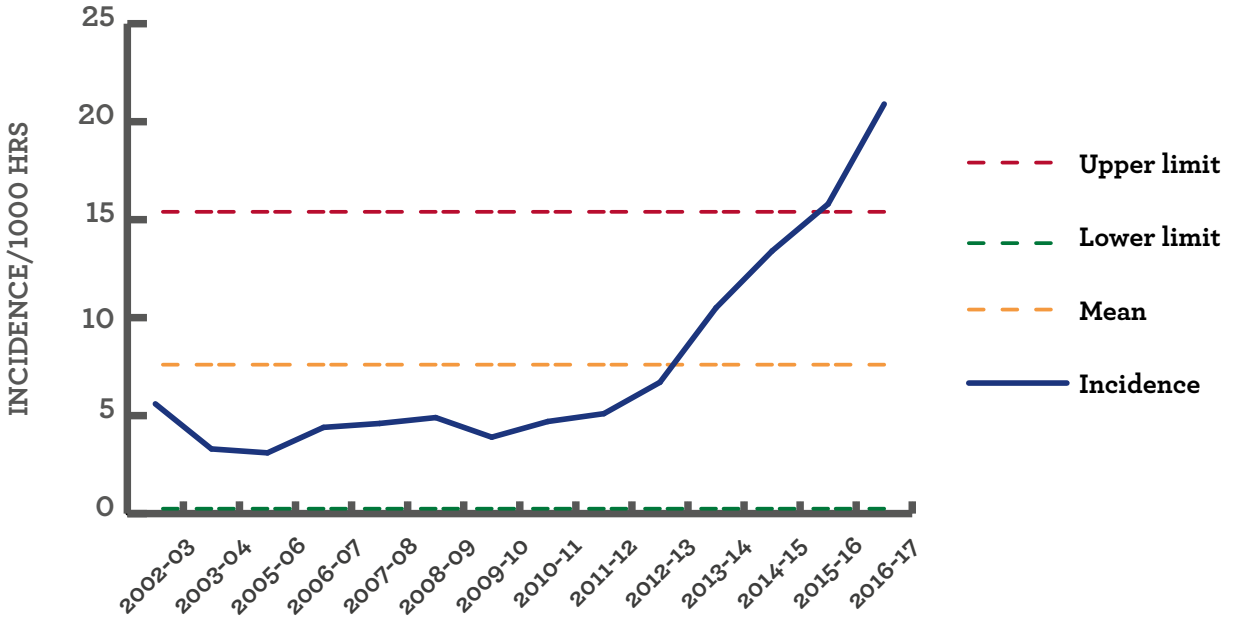

Figure 3: Incidence per 1000 player hours of reported match concussions by season with mean ± 2 standard deviations.

Figure 4

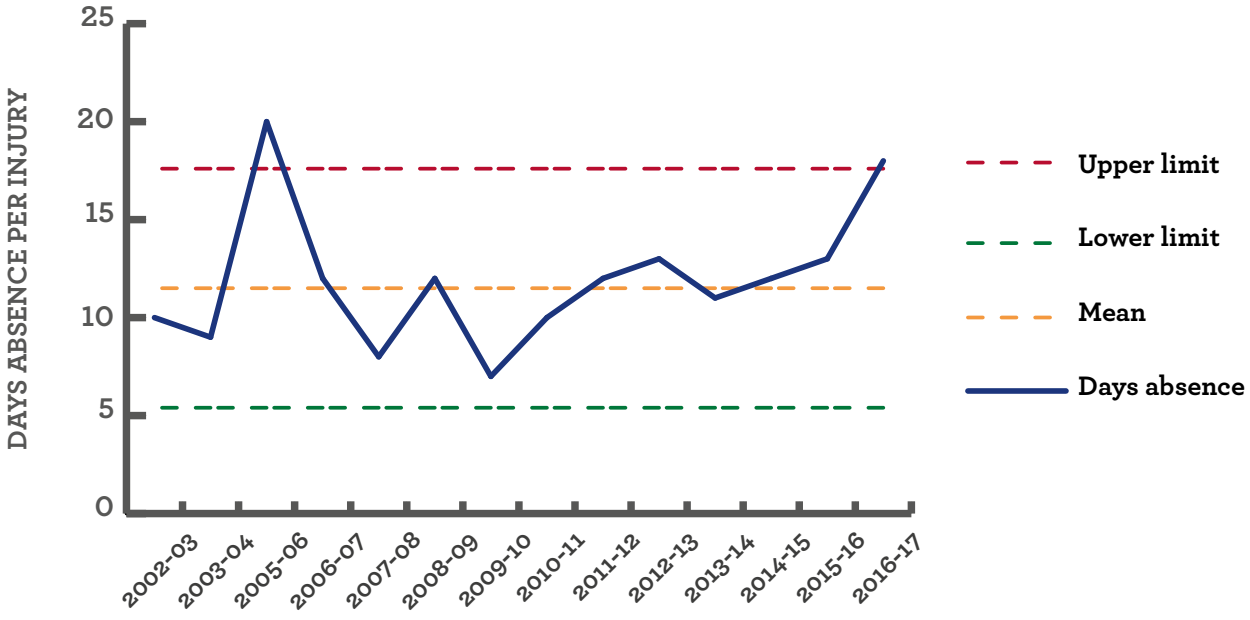

Figure 4: Mean severity (days absence) of reported match concussions by season with mean ± 2 standard deviations.

Table 5: Incidence of match concussion by severity grouping 2011-2017 (95% CI's)

SEASON	INCIDENCE/ 1000 HRS			
	2-7DAYS	8-28 DAYS	29-84 DAYS	>84 DAYS
2010-11	2.6	1.9	0.1	0.0
2011-12	2.5	2.3	0.4	0.0
2012-13	2.7	3.1	0.5	0.1
2013-14	5.0	4.8	0.5	0.0
2014-15	6.2	4.0	0.7	0.4
2015-16	7.3	7.1	1.3	0.1
2016-17	8.3	10.2	1.5	0.9
MEAN (2010-17)	4.9 (4.4-5.5)	4.7 (4.2-5.3)	0.7 (0.5-1.0)	0.2 (0.19-0.26)

Figure 5

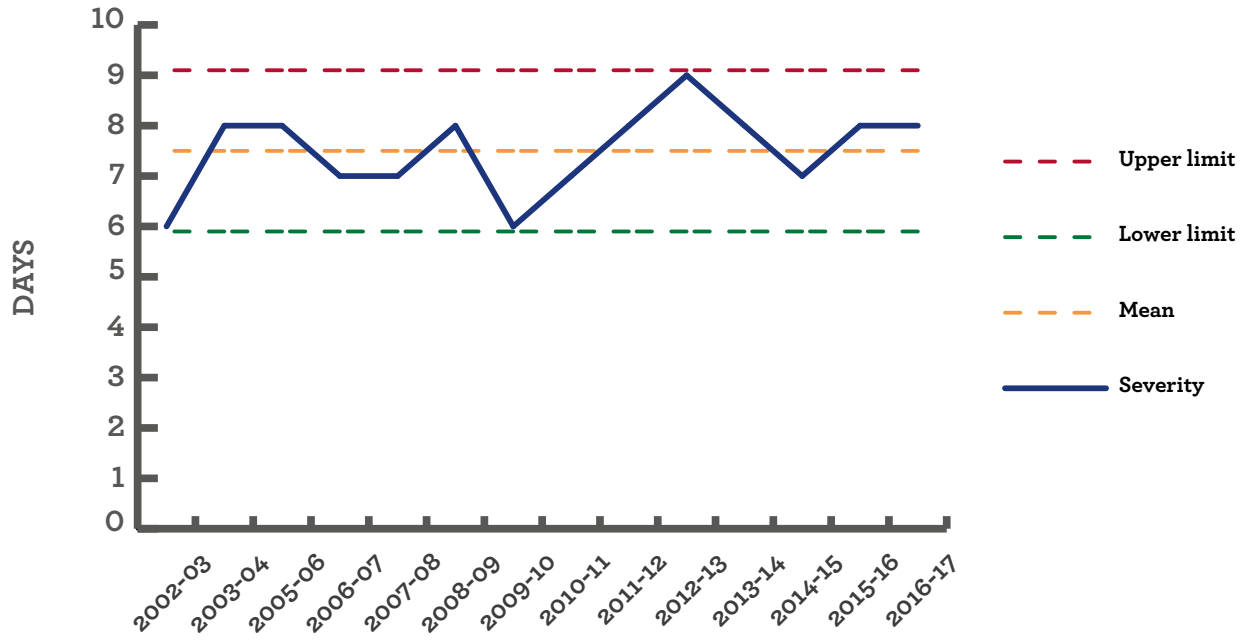

Figure 5: Median days absence per concussion over the surveillance period with mean ± 2 x standard deviation

Figure 6

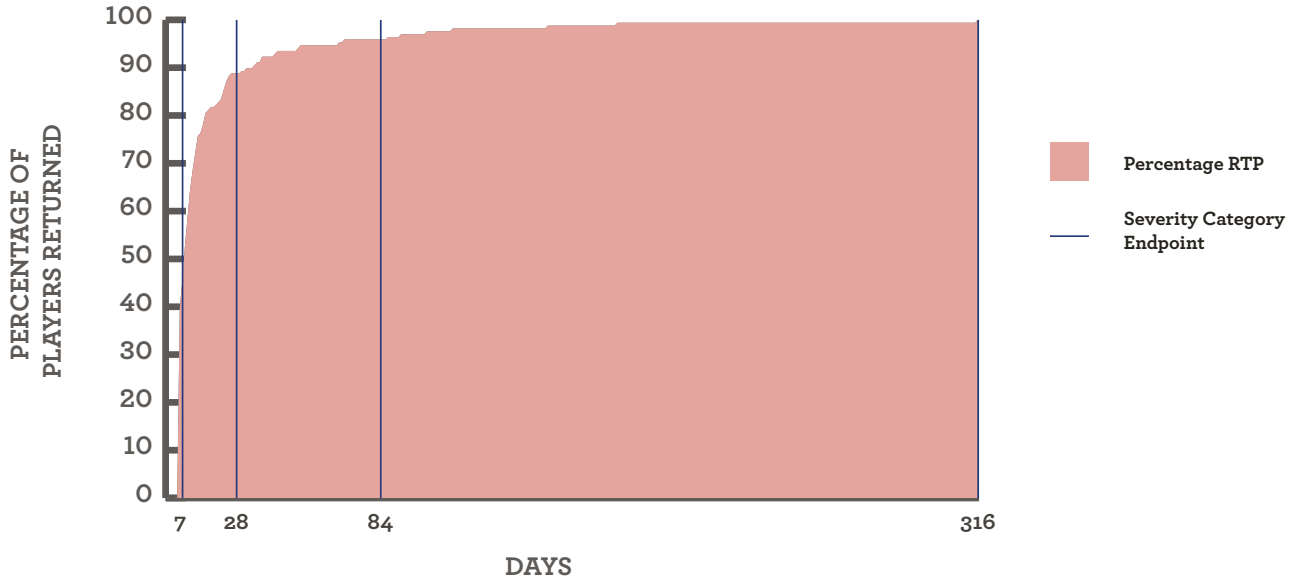

Figure 6: Percentage of players returned to play and number of days to return after match concussion.

Figure 7 shows the incidence rates of match contact injuries (excluding concussion). After two seasons of declining incidence of these injuries, the 2016-17 season saw a rise to 70.1/1000 hours, which is substantially higher than the mean for the surveillance period as a whole at 50.4/1000 hours and is above the upper limit of expected variation.

Figure 7

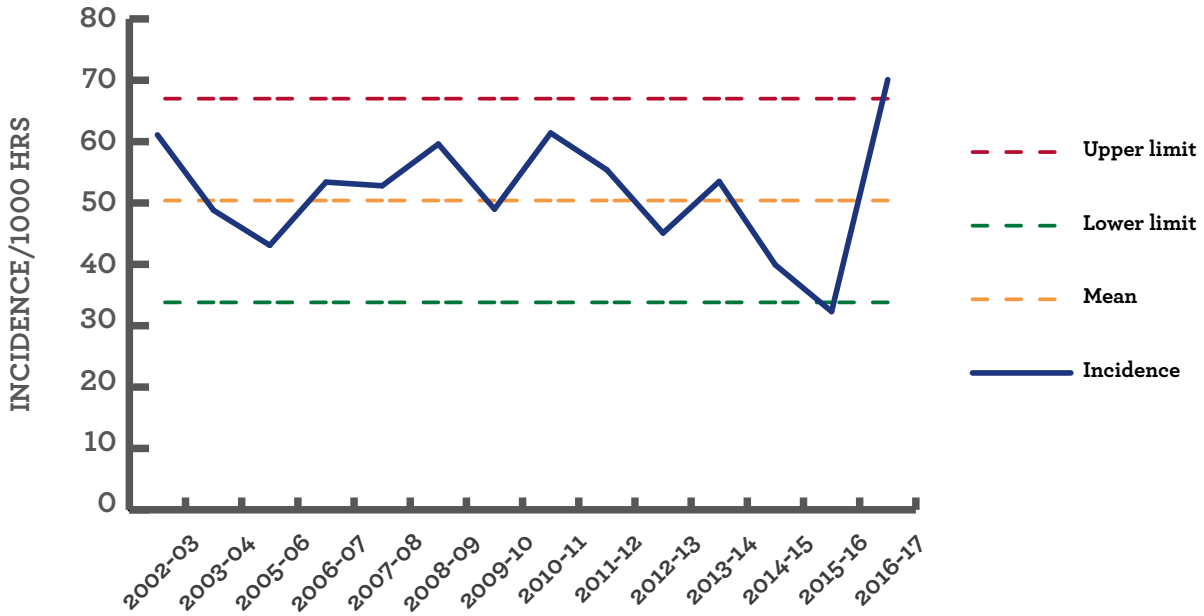

Figure 7: Incidence rates of match contact injuries (excluding concussion) over the surveillance period with mean ± 2 x standard deviation shown.

World Rugby Tackle Global Law Trials

On the 1st of January 2017, World Rugby introduced a new directive as to the penalisation and sanctioning of high tackles within the sport. While the height of the tackle remained unchanged at shoulder-height, the sanctions for reckless and accidental challenges concerning contact above that height were made more severe in an effort to mitigate concussion risk in the game.

In 2016-17 leading up to the introduction of the new directive, the incidence of tackle related injury was 43.2/1000 hours (95% CI's: 37.5-49.8) while the incidence of tackle related concussions was 12.6/1000 hours (95% CI's: 9.7-16.4). In the time after the introduction of the new directive, the incidence of tackle related injuries was 43.4/1000 hours (95% CI's: 37.3-50.5) while the incidence of tackle related concussions was 13.9/1000 hours (95% CI's: 10.6-18.2) (Figure 8).

When looking exclusively at the ball carrier, in the period pre-directive, the incidence of tackle related injury was 22.3/1000 hours (95% CI's: 18.3-27.2) while the incidence of tackle related concussion was 4.7/1000 hours (95% CI's: 3.1- 7.2). In the period post change, the incidence of tackle related injury was 22.4/1000 hours (95% CI's: 18.1-27.6), while tackle related concussion was 3.6/1000 hours (95% CI's: 2.1-6.1) (Figure 9).

When looking at the tackler specifically, in the period pre-directive, the incidence of tackle related injury was 20.9/1000 hours (95% CI's: 17.1-25.6), while the incidence of tackle related concussions was 7.9/1000 hours (95% CI's: 5.7-11.0). In the period after the new directive, tackle related injuries were 21.1/1000 hours (95% CI's: 17.0-26.2), while the tackle related concussions were 10.3/1000 hours (95% CI's: 7.6-14.0) (Figure 10).

Figure 8:

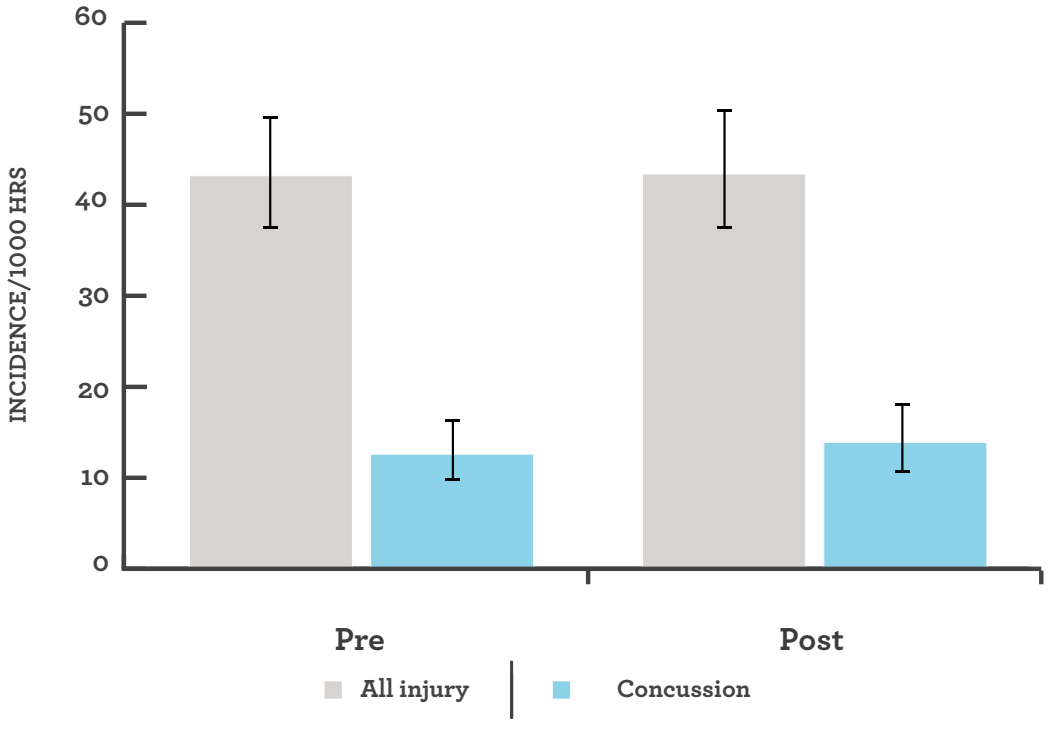

Figure 8: Incidence of all injury (grey bars) and concussion (blue bars), to both the tackling player as well as the player being tackled, pre and post the introduction of the new law trials by World Rugby and 95% confidence intervals.

Figure 9:

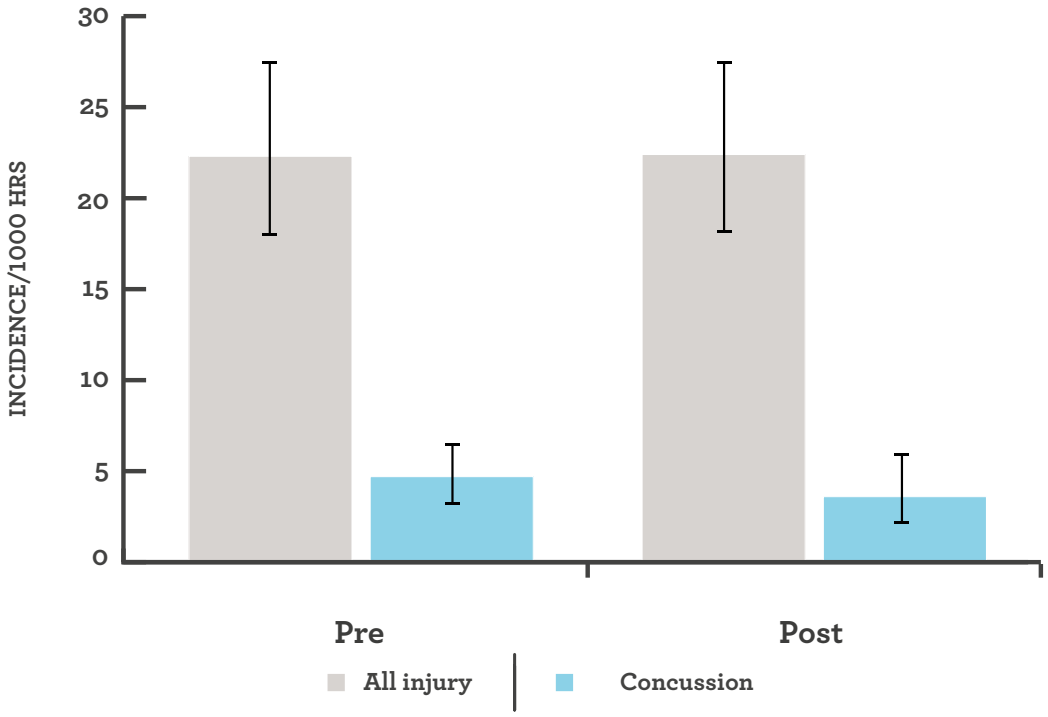

Figure 9: Incidence of all injury (grey bars) and concussion (blue bars), to the player being tackled, pre and post the introduction of the new law trials by World Rugby and 95% confidence intervals.

Figure 10:

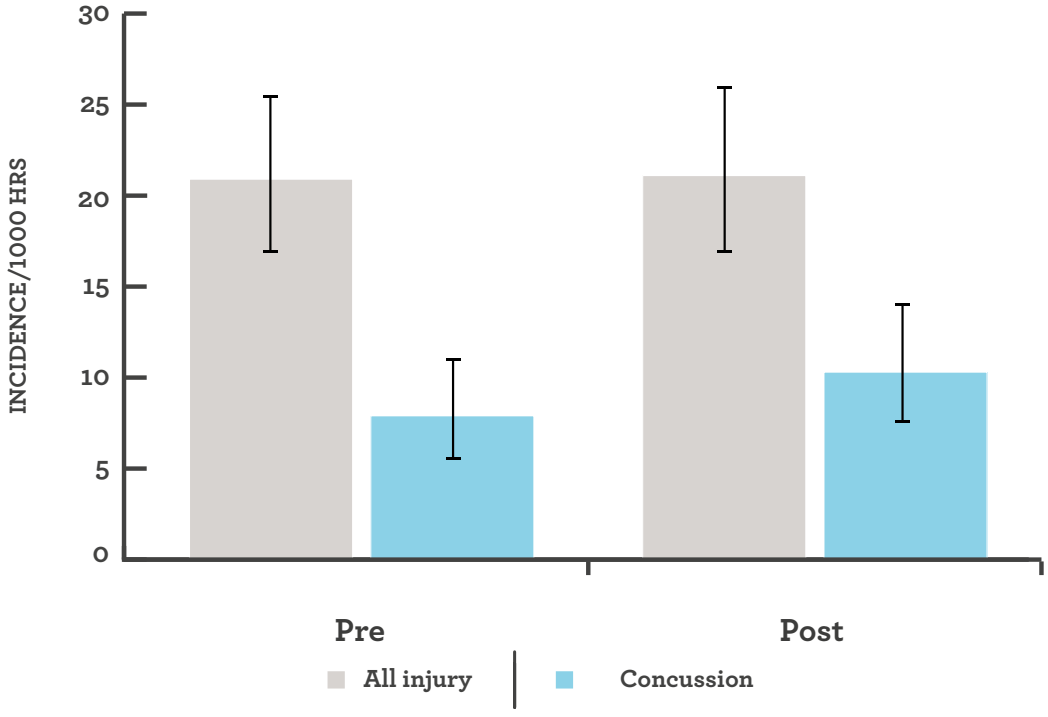

Figure 10: Incidence of all injury (grey bars) and concussion (blue bars), to the tackler, pre and post the introduction of the new law trials by World Rugby and 95% confidence intervals.

Injury Recurrence

Summary of recurrent injury incidence

The percentage of within season recurrences of injuries are reported for all injuries for the entire surveillance period, 2002-2016 (Figure 11). The within season recurrence of injury for the 2016-17 season was 6%, compared with the mean for the study period of 8%. This decrease does not however fall outside the expected limits of season-to-season variation.

Note: *Concussion was not included in the analysis of recurrent injury for consistency with data reported in previous years.*

Figure 11:

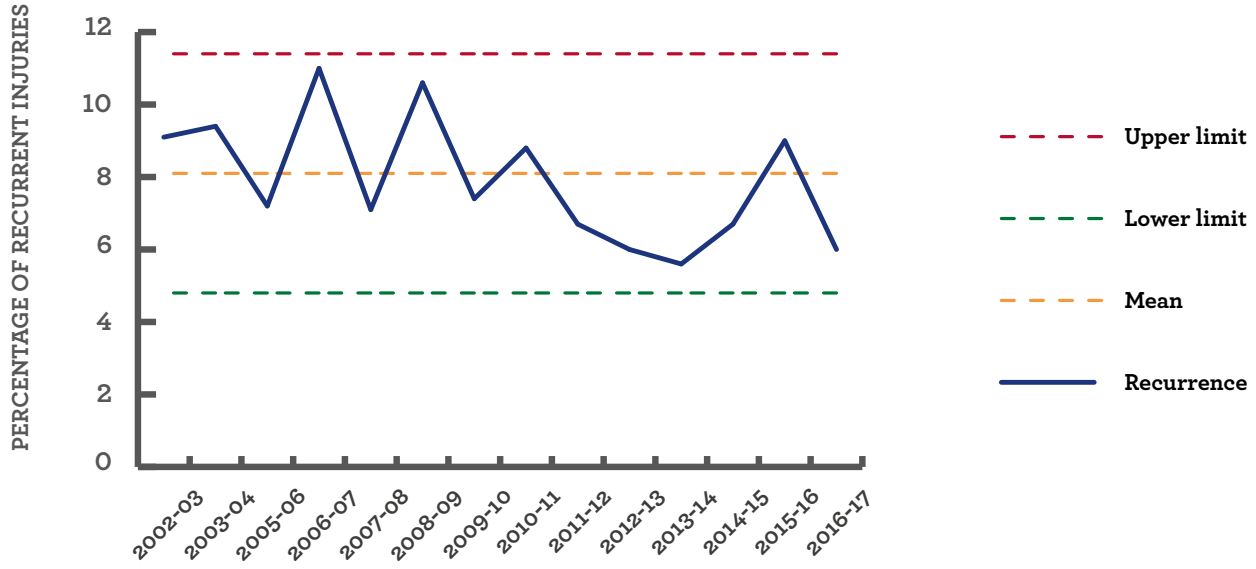

Figure 11: Percentage of all injuries classified as recurrences over the surveillance period with mean ± 2 x standard deviation shown.

Match Injury Event

Figure 12 shows the percentage of all injuries attributed to each specific match injury event for the 2016-17 season compared with the surveillance period as a whole (2002-16). The proportion of injuries associated with running was similar to that of the 2015-16 season, rising by 1% from 9% to 10% of all injuries. The proportion of injuries as a result of collision (either accidental or non-accidental) remained the same as the 2015-16 season, at 13%. The proportion of injuries associated with a "not known" event, similarly, remained the same as in the 2015-16 season at 10%. The tackle remains the match event most likely to result in an injury, with 47% of all injuries being attributed to the tackle. The tackle can be further divided into ball carrier and tackler which account for 24 and 23% respectively. During the 2016-17 season, the most common injuries as a result of tackling or being tackled were (in order):

The most common injuries as a result of tackling or being tackled:

Ball Carrier	Tackler
Concussion (19%)	Concussion (43%)
MCL Injury (9%)	ACJ Injury (6%)
Ankle Syndesmosis (7%)	Arm fracture (3%)
AC Joint (5%)	Cervical Stinger/Burner (3%)

These findings are similar to those in previous years with concussion being the most common match injury for the fourth consecutive season for both the tackler and the ball carrier. Concussion was seen in 19% of all injuries to the ball carrier, while concussion made up 43% of all injuries to the tackler.

Figure 13 outlines the incidence of match related non-accidental collisions for the 2016-17 season. During the 2016-17 season, the incidence of non-accidental collisions was 3.6/1000 hours, which is higher than the previous two seasons, but lower than that of the highest season, during the 2013-14 season (5.5/1000 hours).

Figure 12:

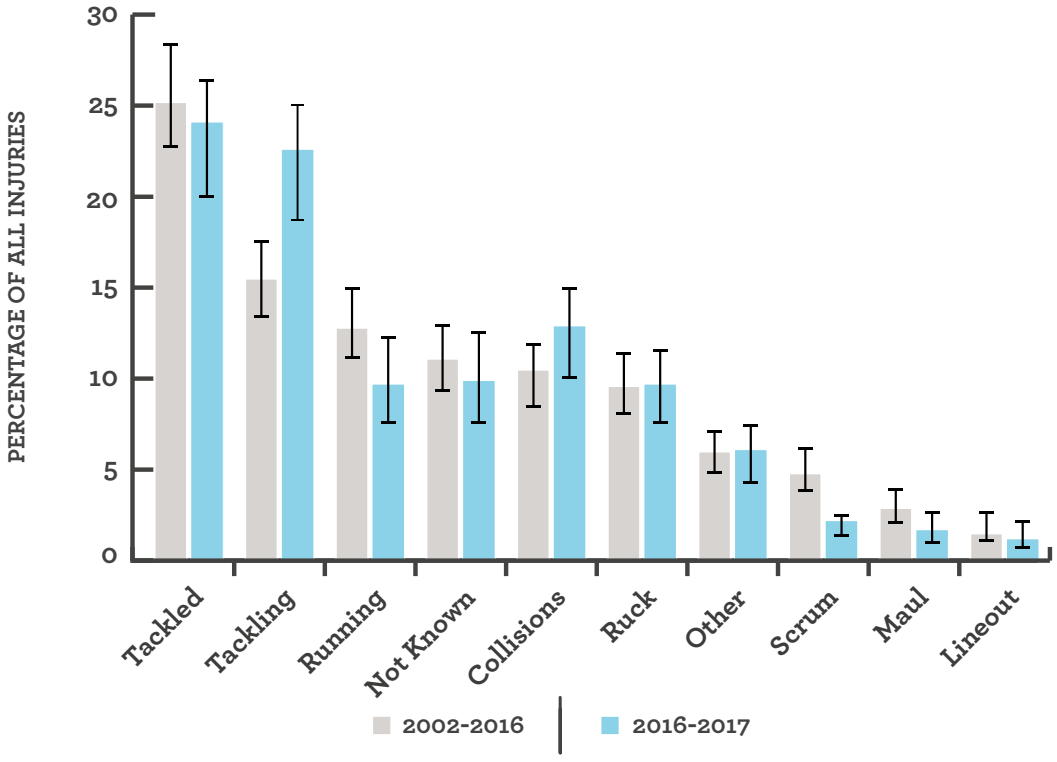

Figure 12: Percentages of match injuries by injury event. Error bars show 95% CIs.

Figure 13:

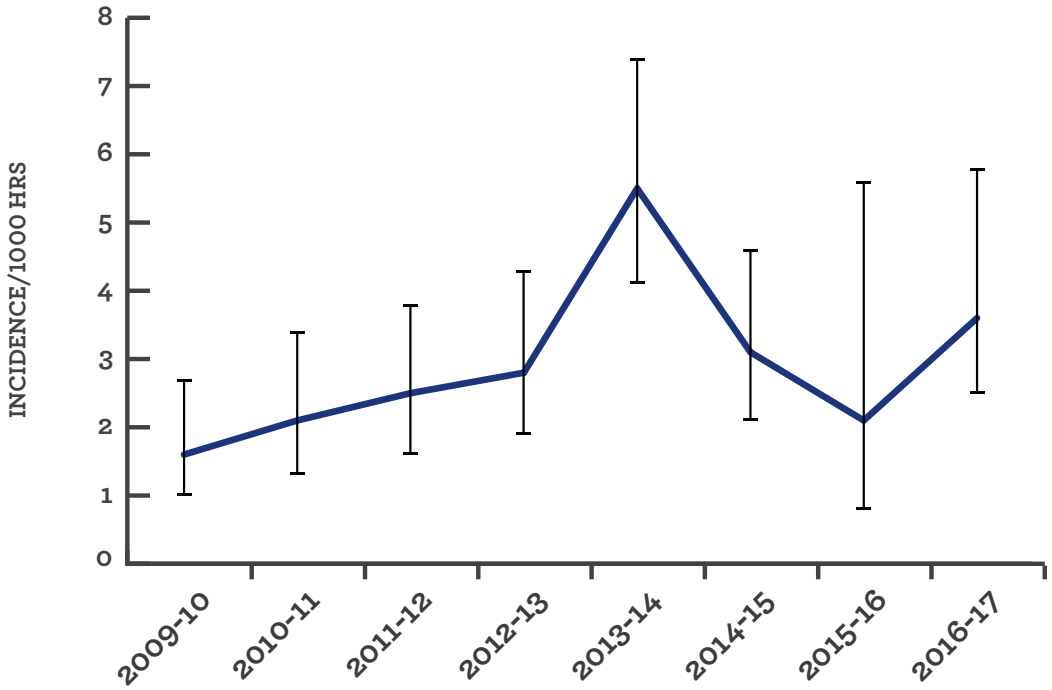

Figure 13: Incidence of injury associated with non-accidental match collisions by season. Error bars show 95% CIs.

Note: *The differentiation of accidental versus non-accidental collisions started in 2009-10 therefore, no data is available before this date. The definition for non-accidental collisions is open to the subjective interpretation of the medical staff and is not confirmed through video analysis. It must therefore be acknowledged that some of the season to season variation in these figures may be attributed to practitioner interpretation.*

Time in the Season

During the 2016-17 season, most match injuries occurred in December with 111 injuries occurring across the 12 clubs. The month with the highest incidence of injury however was that of April with an incidence of 118/1000 hours (Figure 14).

Figure 14:

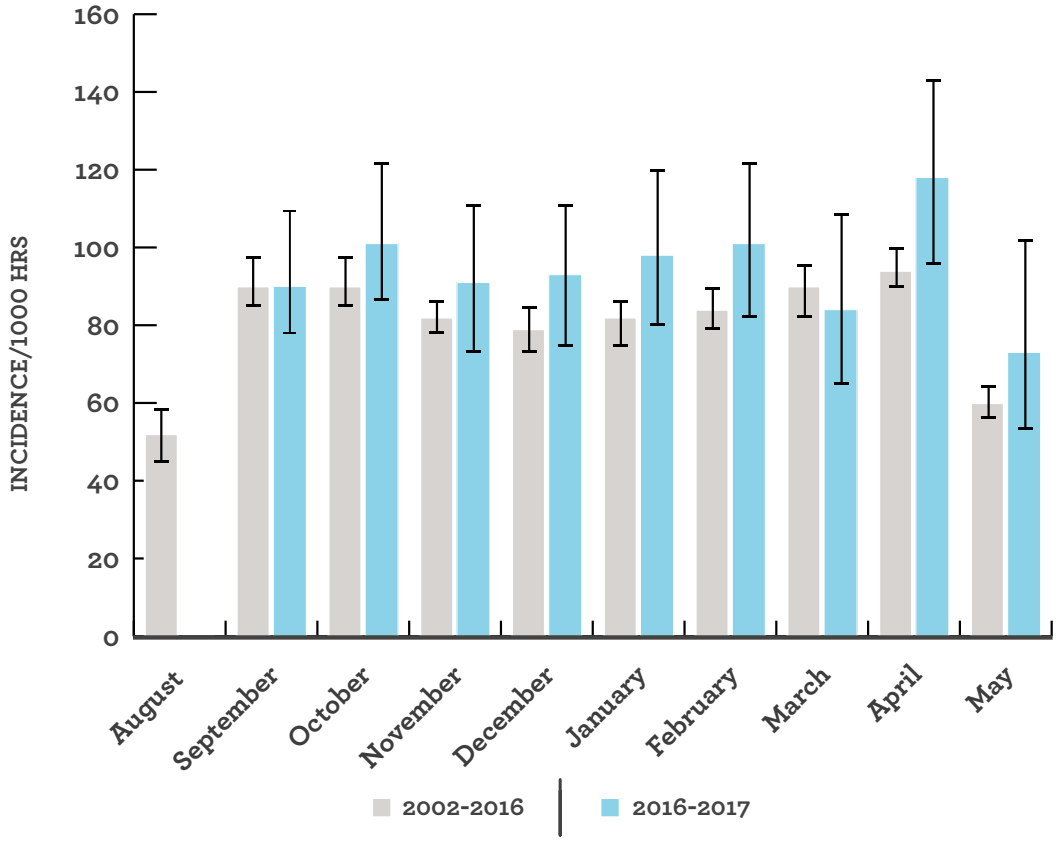

Figure 14: Match injury incidence by month. Error bars show 95% CI's.

Injuries Leading to Retirement

The Injury Surveillance Steering Group would like to thank the Rugby Players Association (RPA) for its assistance with compiling data on players who retired as a result of injury or illness.

Since 2013-14 the injury surveillance report has published the number of players who have retired with injury or illness being cited as the reason for retirement. In 2016-17, 19 players were seen to retire as a result of injury (Table 7).

The injuries, which led to players retiring from the sport, were sustained at the following body locations:

LOWER LIMB	11
THORACIC AND LUMBER SPINE	3
TRUNK	1
UPPER LIMB	1
HEAD/NECK	3

Table 7: **Number of retired players through injury and illness, 2013-17.**

SEASON	NUMBER RETIRED THROUGH ILLNESS	NUMBER RETIRED THROUGH INJURY
2013-14	2	23
2014-15	1	11
2015-16	1	10
2016-17	0	19

Injuries at the Scrum

The 2013-14 season saw the introduction of a new scrum engagement sequence ("crouch, bind, set"). The 2013-14 PRISP report presented the first season of data regarding the incidence of injury at the scrum and highlighted the importance of continued monitoring of injury rates in future seasons to understand the impact of this change upon acute injury risk. The new scrum engagement process has been shown in previously published research to reduce the impact force at engagement by approximately 20% and improve the stability of the scrum, thus hopefully leading to a reduction in chronic and catastrophic injuries caused by scrummaging. Further longitudinal research is required to ascertain the full impact of this law variation.

During the 2015-16 season, 17 injuries were attributed to the scrum, resulting in an incidence of 2.1 per 1000 hours. Combining these figures for scrum related injuries with those of previous seasons results in an incidence of 2.8/1000 hours (95% CI's: 2.2-3.5) for the period 2013-16 compared to that of the pre-law change incidence of 4.3/1000 hours (95% CI's: 3.8-4.9) (Figure 15). These figures now represent a significant reduction in the risk of scrum related injuries, since the introduction of the new scrum engagement process. The average severity of injuries for scrum related injuries was 42 days for the 2016-17 season, which was higher than the overall average of match injuries but substantially lower than scrum-related injuries in 2015-16 (55 days absence). The most common injury types encountered at the scrum were facet joint/neck ligament sprains (n=2) as well as Achilles tendon injuries (n=2). The burden of scrum injuries in 2016-17 was 89 days/1000 hours, which is substantially lower than that of the 2015-16 season at 145 days/1000 hours.

Figure 15:

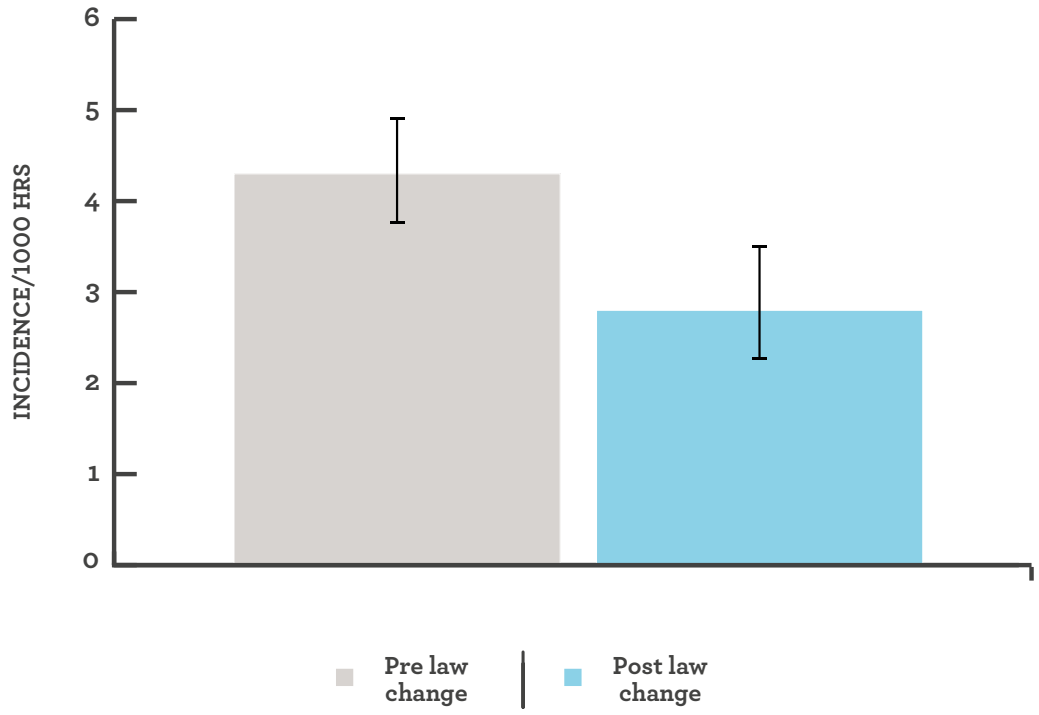

Figure 15: Incidence per 1000 player hours of match injuries associated with the scrum with 95% CI's

Artifical Turf

The RFU, PRL and RPA first commissioned a study to investigate the impact of artificial playing surfaces in this setting during the 2012/13 season, when the first artificial surface for match play was installed in the English Premiership (three English Premiership teams now play their home fixtures on artificial playing surfaces). The 2014-15 report provided a summary of the key findings from that study, showing no clear differences in the incidence severity or overall injury burden of time loss injuries. The 2014-15 report also highlighted the need for investigation into the impact of training of artificial turf. As such, the 2015-16 report, outlined the first season worth of surveillance of training exposure on artificial turf. This report provides an injury update on for the 2016-17 season in both match and training on both natural grass and artificial turf.

Match Injuries

During the 2016-17 season, 608 and 170 injuries were recorded for match play on grass and artificial turf respectively. With only three teams using artificial turf at their home venues, the exposure to this surface was far less and led to match injury incidences of 89.6/1000 hours (95% CI's: 82.8-97.0) for grass and 129.1/1000 hours (95% CI's 111.1-150.03) for artificial turf (Figure 16). The average severity for match injuries on grass was 32 days, compared with that of 37 days for artificial turf (Figure 17). The overall burden of injuries on natural grass was 2481 days/1000 hours compared with 4740/1000 days on artificial turf (Figure 18). The figures for the 2016-17 season show a significantly higher incidence and burden of injury when playing on artificial turf. This is the first season where the incidence and burden of injury on artificial turf is higher than on natural grass. Importantly, the mean incidence, severity and burden of injury for the four years investigated shows no clear differences between the two surface types and therefore more data must be collected to establish if this 2016-17 increase is more meaningful than season to season variation. In addition, a secondary per pitch analysis was also performed that showed no significant differences in the incidence of injury on the artificial surfaces at the three venues in 2016-17.

Figure 16:

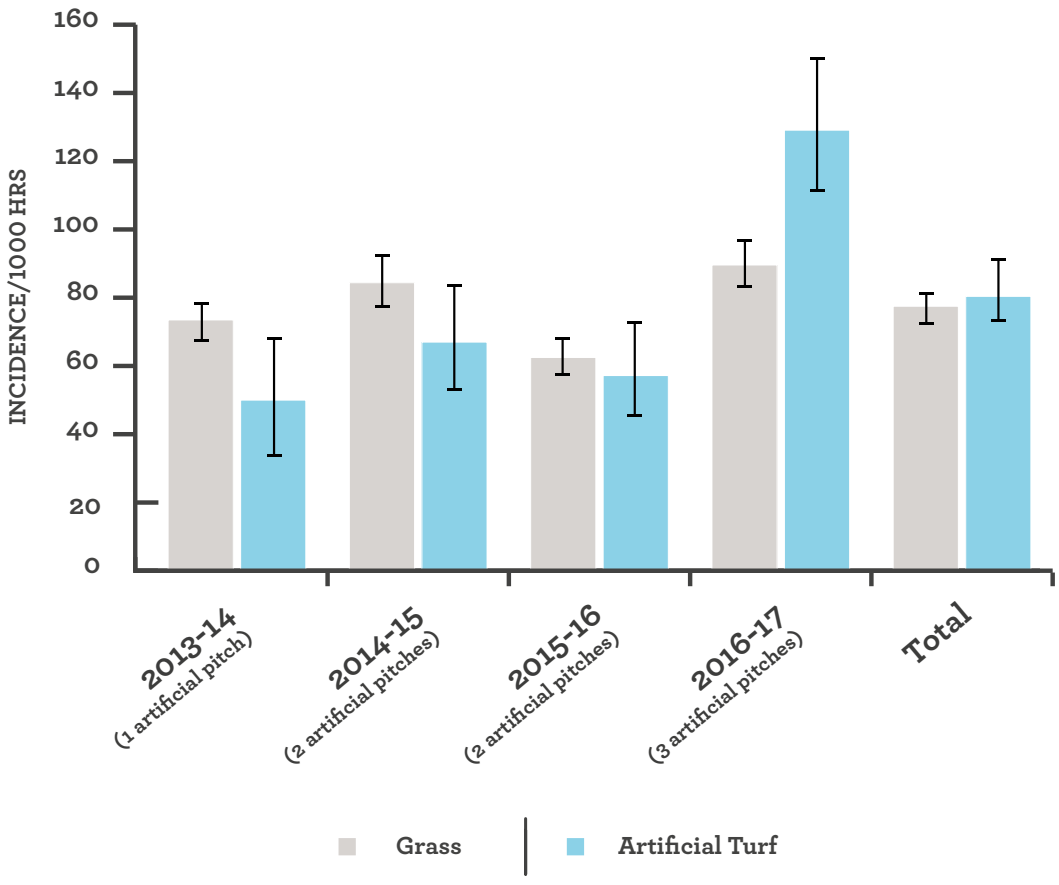

Figure 16: Incidence per 1000 player hours of match injuries on natural grass vs artificial turf with 95% CI's.

Figure 17:

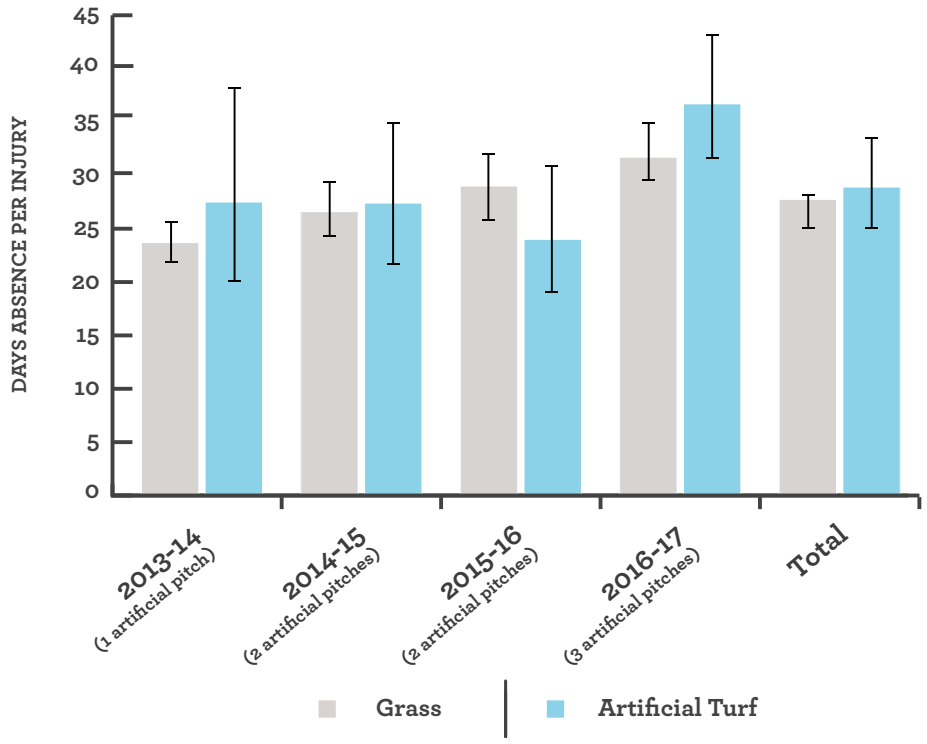

Figure 17: Mean severity (days absence) of match injuries on natural grass vs artificial turf with 95% CI's.

Figure 18:

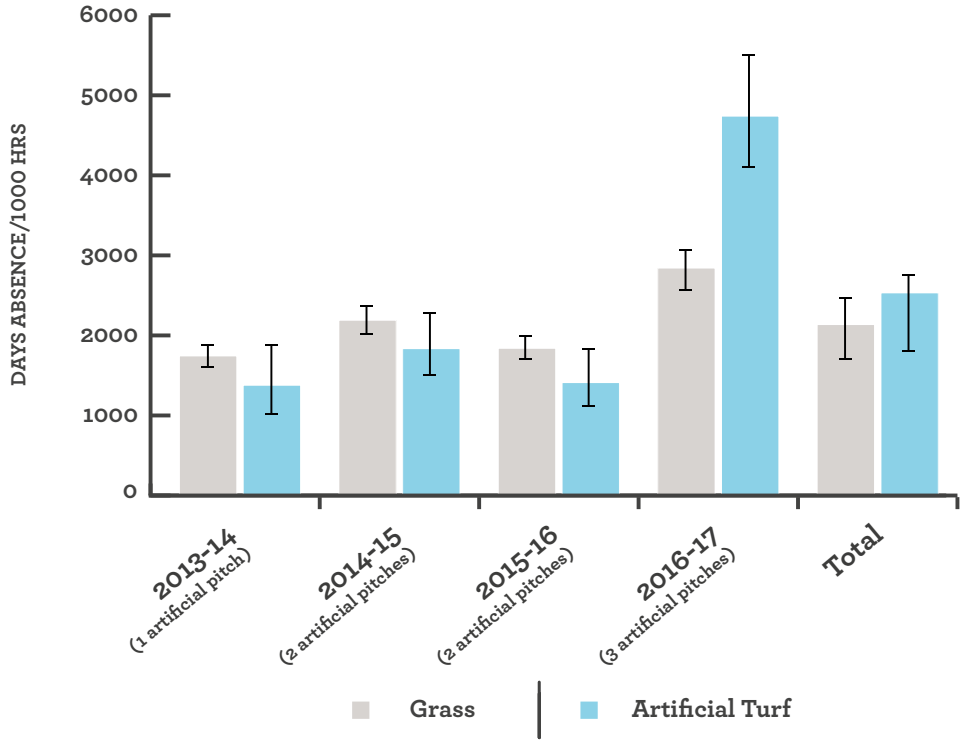

Figure 18: Days absence/1000 hours of match injuries on natural grass vs artificial turf with 95% CI's.

Training Injuries

Exposure to artificial turf during training was less than exposure to natural grass, accounting for 22% of training exposure. Three hundred and three training injuries were recorded on grass for the 2015-16 season while 83 were recorded for training on artificial turf. The incidence of training injury on grass was 4.3/1000 hours (95% CI's: 3.8-4.9) and was 5.3 (95% CI's: 4.2-6.5) on artificial turf (Figure 19). The average severity of training injuries was 34 and 40 days for grass and artificial turf, respectively (Figure 20). The burden of training injuries on natural grass was 148 days/1000 hours and 210 days/1000 hours for artificial turf (Figure 21).

Figure 19:

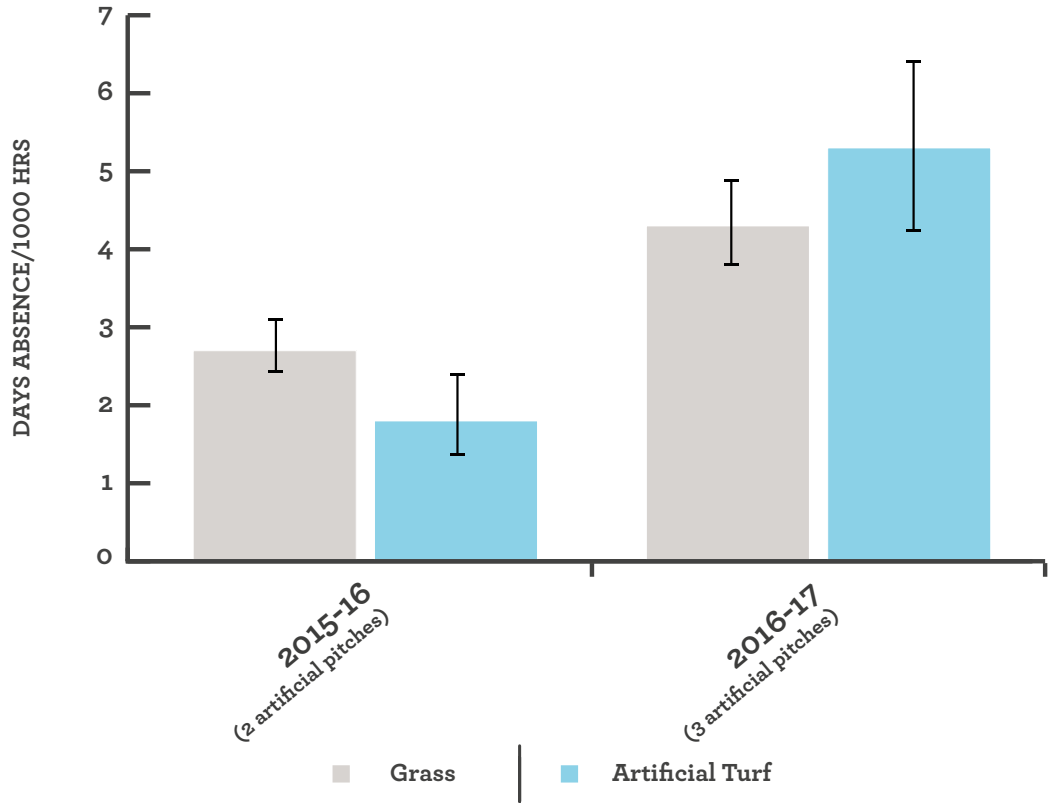

Figure 19: Incidence per 1000 player hours of training injuries on natural grass vs artificial turf with 95% CI's.

Figure 20:

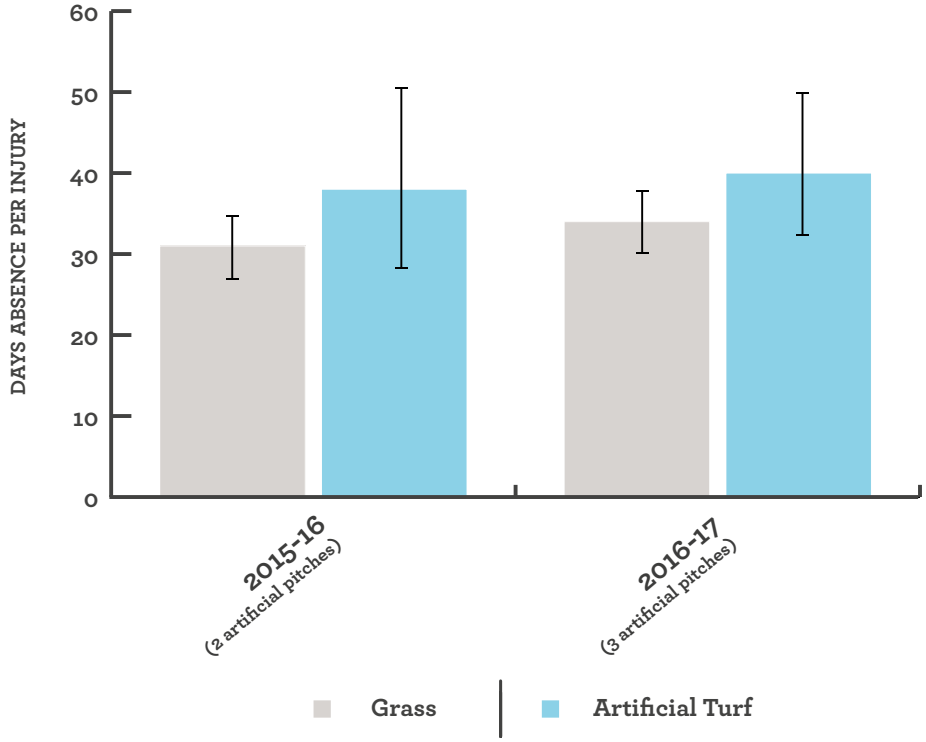

Figure 20: Mean severity (days absence) of match injuries on natural grass vs artificial turf with 95% CI's.

Figure 21:

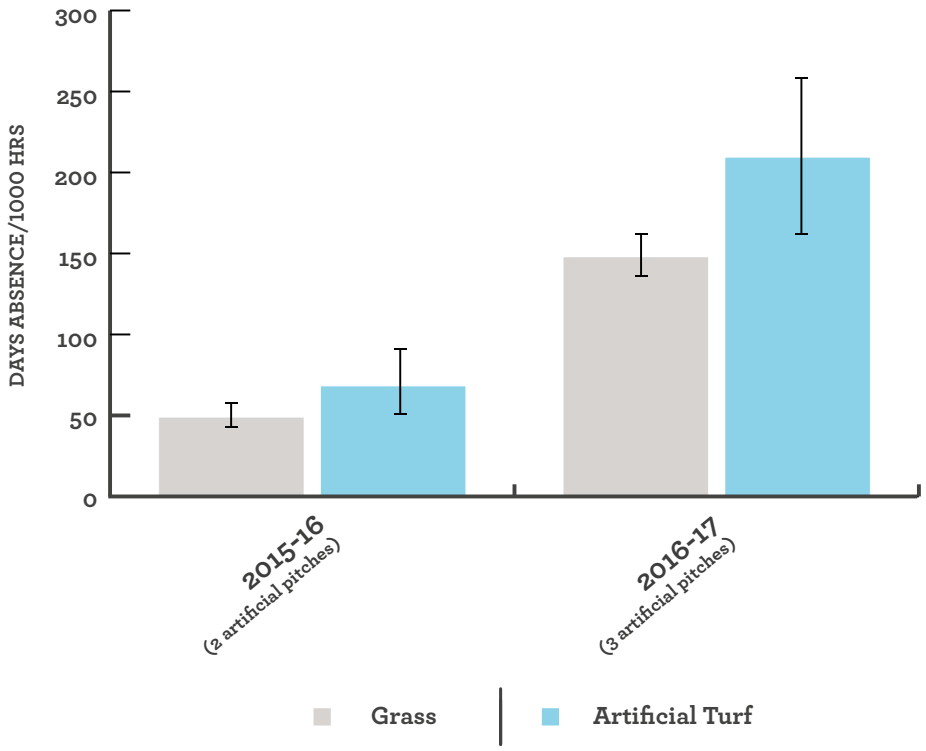

Figure 21: Days absence/1000 hours of match injuries on natural grass vs artificial turf with 95% CI's.

Training Injury Event

Figure 22 outlines the training events associated with injuries during the 2016-17 season as well as the remainder of the surveillance period (2002-16). The 2016-17 season saw an increase in the incidence of injuries associated with rugby skills contact training, with a value of 7.4 (95% CI's: 6.5-8.4) apparent for the 2016-17 season, compared with 5.1 (95% CI's: 4.8-5.3) for the period 2002-16. The incidence of injury in other training event categories remained similar to that of 2002-2016 period (further detail surrounding incidence by severity grouping can be seen in Table 3).

Figure 22:

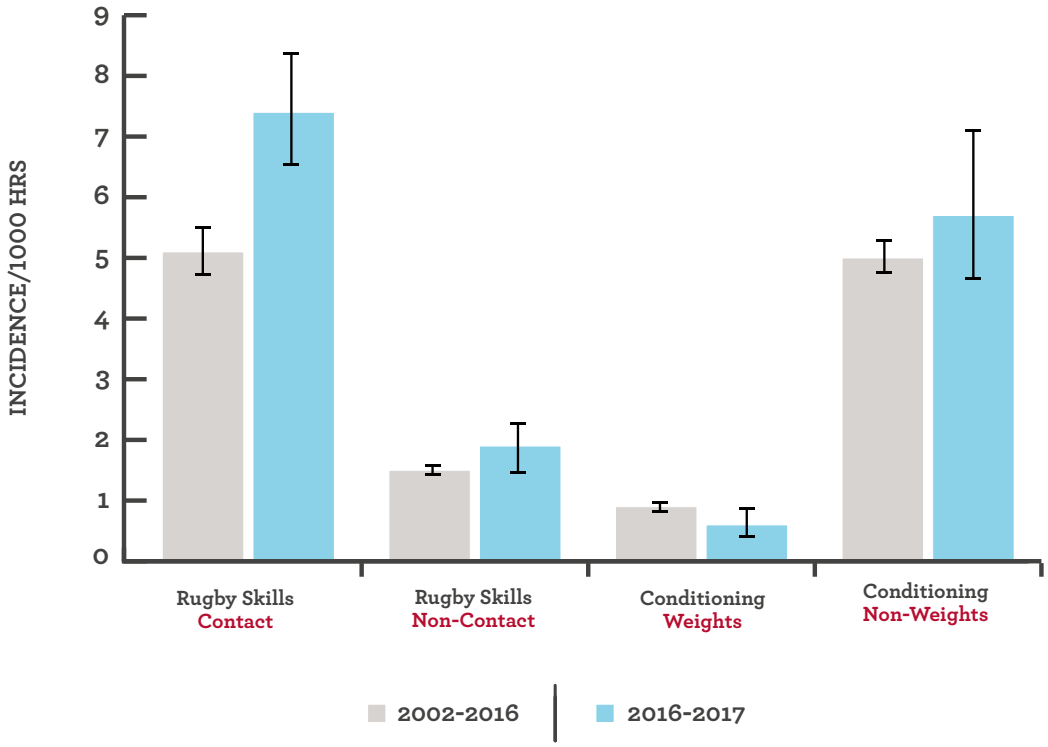

Figure 22: Incidence rates of training injuries by session type. Error bars show 95% CIs.

Given the higher incidence of contact training injuries during the 2016-17 season, further investigation was undertaken into the types of contact training, types of injury, severity of injury and mechanisms of injury seen in this category. Table 8 shows the incidence, average severity and burden of injuries associated with both "full-contact" and "semi-contact" training. During the 2016-17 season in "full-contact" training sessions, the most commonly occurring injury was concussion, while the most common injury mechanisms were accidental collisions and tackles from the side, accounting for 11% of injuries in "full-contact" sessions. In "semi-contact" sessions, hamstring injuries were the most commonly occurring injuries with running and accidental collisions being the most common injury mechanisms, accounting for 34% and 12% of injuries in "semi-contact" sessions, respectively.

Table 8: **Breakdown of incidence, severity and burden of semi and full contact training 2012-2017**

	FULL CONTACT TRAINING			SEMI-CONTACT TRAINING		
	INCIDENCE	SEVERITY	BURDEN	INCIDENCE	SEVERITY	BURDEN
2012-13	9.0	22	199	4.1	40	163
2013-14	10.8	26	278	4.5	14	64
2014-15	4.4	32	141	4.8	32	151
2015-16	11.1	28	306	3.2	25	78
2016-17	16.2	35	562	4.7	37	175

Hamstring Injuries

Hamstring injuries were surpassed as the most commonly seen training injury (Figure 24a) in 2016-17 and were also replaced as the highest burden training injury by calf injuries (Figure 24b). The incidence of match related hamstring injuries in 2016-17 was higher than that of 2015-16 (6.8/1000 hours vs 3.1/1000 hours). The incidence of training related hamstring injuries remained the same as in 2015-16 season at 0.3/1000 hours. The burden of hamstring injuries decreased slightly from 11.4 days/1000 hours in the 2015-16 season to 10.8 days/1000 hours, however remains higher than the mean for the study period as a whole (7.2 days/1000 hours). The severity of hamstring training injuries for the 2016-17 was 37 days absence per injury, compared with 33 during the 2015-16 season. This rise was also seen in the severity of match hamstring injuries which rose to 39 days average severity during the 2016-17 season. The mechanism by which these injuries occur during match play is dominated by running, with kicking, rucking and being tackled the next three most commonly seen injury mechanisms. In particular, the larger number of injuries associated with the ruck may contribute to the rise in average severity of hamstring injuries as whole, with injuries occurring from this mechanism accounting for an average of 93 days during 2016-17 compared with running injuries which had an average severity of 33 days. Furthermore, an increase in the number of hamstring injuries being surgically repaired may play a role in this increased severity, with hamstring injuries operated on during 2016-17, requiring an average of 136 days before return to play (75% of which can be attributed to a ruck mechanism). A season by season breakdown of training related hamstring injuries can be seen in Table S5.

Injury Diagnosis

Summary of the most common and highest burden match injuries

For the sixth successive season, concussion was reported as the most commonly occurring match injury (Figure 23a). As outlined in the concussion section of this report, this figure has seen a year on year rise for the past seven seasons. Hamstring injuries were the second most common match injuries with 6.8 per 1000 hours, while MCL injuries made a reappearance in the top five, after a one season absence at 4.2 per 1000 hours. AC Joint injuries and Thigh Haematomas make up the rest of the top five match injuries with an incidence of 3.7 and 3.0 per 1000 hours respectively.

The burden of match injuries (days absence per 1000 players hours) rose during the 2016-17 to 3054 days per 1000 hours (as seen in Figure 1c). For the second year in succession, concussion was seen as the highest burden of any injury at 381 days per 1000 hours (Figure 23b). This comes as a result of the higher reported incidence of concussion (Figure 3) as well as the higher reported severity for concussions (Figure 4) during the 2016-17 season. The burden of hamstring injuries during the 2016-17 season was over double that of the 2015-16 season at 253 days absence per 1000 hours. ACL, MCL and Ankle syndesmosis injuries made up the top five at 224, 163 and 96 days absence per 1000 hours respectively.

Overall the profile of the most common and highest burden match injuries has remained similar throughout the injury surveillance project with the exception of concussion.

The most common match injuries

Figure 23a:

2012–13	2013–14	2014–15	2015–16	2016–17
Concussion 6.7	Concussion 10.5	Concussion 13.4	Concussion 15.8	Concussion 20.9
Hamstring muscle 4.9	Thigh haematoma 4.2	Hamstring muscle 4.4	AC joint 3.1	Hamstring muscle 6.8
Ankle syndesmosis 3.8	MCL 3.7	Thigh haematoma 3.4	Hamstring muscle 3.1	MCL 4.2
MCL 3.6	Ankle lat. lig. 2.9	MCL 3.3	Calf muscle 2.1	AC joint 3.7
Thigh haematoma 3.3	Hamstring muscle 2.5	AC joint 2.9	Ankle lat. lig. 2.0	Thigh haematoma 3.0

Figure 23a: Ranking of the top 5 most common match injuries each season for 2012-17 with the associated incidence rates (injuries/1000 hours).

The highest burden match injuries

Figure 23b:

2012–13	2013–14	2014–15	2015–16	2016–17
Ankle syndesmosis 145 (40 days)	MCL 130 (23 days)	ACL 240 (248 days)	Concussion 199 (13 days)	Concussion 381 (18 days)
MCL 141 (41 days)	ACL 116 (244 days)	Concussion 189 (12 days)	ACL 127 (227 days)	Hamstring muscle 253 (37 days)
Hamstring muscle 130 (29 days)	Concussion 105 (11 days)	Hamstring muscle 153 (26 days)	AC Joint 114 (32 days)	ACL 224 (258 days)
ACL 108 (176 days)	Hamstring muscle 104 (21 days)	Ankle syndesmosis 142 (47 days)	Hamstring muscle 103 (33 days)	MCL 163 (38 days)
Clavicle fracture 95 (64 days)	Ankle syndesmosis 96 (39 days)	MCL 139 (34 days)	Combined knee lig 88 (221 days)	Ankle Syndesmosis 96 (54 days)

Figure 23b: Ranking of the top 5 highest burden match injuries for each season 2012-16 with the associated days absence/1000hours (Figure in brackets represents average severity for that injury type).

Summary of the most common and highest burden training injuries

The most common training injuries remained similar to that which has been seen since 2002 with calf and hamstring muscle injuries remaining the two most common. Despite this, for the first time, calf injury became the most common training injury at 0.32 per 1000 hours, while hamstring was pushed down to second at 0.29 per 1000 hours (Figure 19a). For the second year, concussion is in the top five training injuries, and jumps up one spot to 3rd most common training injury at a rate of 0.14 per 1000 hours. For the first time, calf muscle injuries rose to being the highest burden injuries, overtaking hamstrings for the first time with a burden of 11.5 days absence per 1000 hours, compared with the 10.8 of hamstring injuries (Figure 19b). For the first time, concussion appears in the top five highest burden training injuries, in at number five at 2.4 days per 1000 hours.

The most common training injuries

Figure 24a:

2012–13	2013–14	2014–15	2015–16	2016–17
Hamstring muscle 0.39	Hamstring muscle 0.40	Hamstring muscle 0.30	Hamstring muscle 0.33	Calf muscle 0.32
Calf muscle 0.29	Calf muscle 0.22	Calf muscle 0.26	Calf muscle 0.16	Hamstring muscle 0.29
Adductor muscle 0.18	Hip flexor/quad muscle 0.18	Hip flexor/quad muscle 0.12	Ankle lat lig 0.13	Concussion 0.14
Ankle lat. lig. 0.10	Ankle lat. lig. 0.13	Ankle lat. lig. 0.11	Concussion 0.11	Lumbar facet joint 0.12
Hip flexor/quad muscle 0.09	Adductor muscle 0.09	Lumbar facet joint 0.09	Quadriceps muscle 0.09	Quadriceps muscle 0.09

Figure 24a: Ranking of the top 5 most common training injuries each season 2012-16 with associated incidence rates.

Highest burden training injuries

Figure 24b:

2012–13	2013–14	2014–15	2015–16	2016–17
Hamstring muscle 9.5 (20 days)	Hamstring muscle 8.2 (28 days)	Hamstring muscle 7.2 (28 days)	Hamstring muscle 11.4 (31 days)	Calf muscle 11.5 (38 days)
ACL 6.3 (270 days)	Calf muscle 4.5 (19 days)	Calf muscle 6.3 (23 days)	Calf muscle 3.8 (24 days)	Hamstring muscle 10.8 (37 days)
Lumbar disc/nerve root 5.3 (41 days)	Lumbar disc/nerve root 3.9 (20 days)	ACL 5.3 (252 days)	Ankle lat. lig 2.3 (34 days)	ACL 6.3 (231 days)
Calf muscle 4.9 (21 days)	Ankle lat. lig 2.4 (41 days)	Lumbar disc/nerve root 5.0 (35 days)	Combined knee lig 2.3 (367 days)	L5/ S1 prolapse 2.5 (53 days)
Lumbar soft tissue 4.5 (4 days)	Shoulder Dislocation 1.9 (37 days)	Ankle lat. lig 4.6 (22 days)	L5/S1 prolapse 2.2 (172 days)	Concussion 2.4 (16 days)

Figure 24b: Ranking of the top 5 highest burden training injuries each season 2012-16 with associated days absence/1000hours. (Figure in brackets represents average severity for that injury type).

England Senior Side

Summary of England match and training injury incidence, severity and burden

The incidence of match injuries decreased for the England Senior side during the 2016/17 season (113/1000 hours) compared with the previous season (163/1000 hours) and the surveillance period as whole (128/1000 hours: Table 9). The total number of games played was 12 during the 2016-17 season, while the absolute number of match injuries acquired was 34. The average severity of match injuries during the 2016-17 season was 16 days absence, which is just under the mean for the surveillance period as a whole (19 days/1000 hours). With a reduction in the incidence and only a slight increase in severity from the previous season, the overall burden of injuries dropped from 2043 days per 1000 hours in 2015-16 to 1774 per 1000 hours in the 2016-17 season, which is substantially less than the surveillance period mean of 2311 days absence per 1000 hours.

During the 2016-17 season, the mean incidence of training injuries dropped for both rugby skills related injuries (7.7/1000 hours) and strength and conditioning (0.8/1000 hours) when compared to the 2015-16 season (Table 10). Despite this, the rugby skills injury incidence was slightly higher than that of the surveillance period average (5.9/1000 hours) while the strength and conditioning injury incidence was lower (4.6/1000 hours). The burden of training injuries rose substantially above the mean for the surveillance period for rugby skills injury to 337 days absence per 1000 hours (compared to 78 days/1000 hours), and rose slightly from 10-17 days per 1000 hours for strength and conditioning injuries. A breakdown of injury severity groupings can be seen inTable 11. The number of injuries in the 29-84 days injuries groups was substantially higher for training, which may explain the large rise in the overall burden for training injuries for the 2016-17 season.

Note: *The relatively small number of senior England training sessions included in the study each season means that the training injury risk for England should be interpreted with caution. The small sample size means that any differences in risk are much more likely to have arisen "by chance" rather than to be the result of a "true" difference, reflected in the wide 95% confidence intervals and the lack of statistical significance in the results.*

Match Injuries

Table 9: **England match injury incidence, average severity and burden since 2002-03 (95% confidence intervals shown in brackets where appropriate)**

SEASON	TOTAL NUMBER OF INJURIES	INJURIES / 1000 HOURS	INJURIES PER MATCH	AVERAGE SEVERITY	DAYS ABSENCE / 1000 HOURS	DAYS ABSENCE PER MATCH
2002-03	53	221 (169-289)	4.4	19	4264 (4010-4533)	85
2003-04*	83	207 (167-256)	4.1	11	2371 (2225-2527)	47
2005-06	30	136 (95-195)	2.7	10	1391 (1243-1556)	28
2006-07	30	136 (95-195)	2.7	28	3836 (3586-4104)	77
2007-08*	55	162 (119-205)	3.2	24	3876 (2852-4901)	78
2008-09	23	96 (57-135)	1.9	8	813 (480-1145)	16
2009-10	23	88 (52-125)	1.8	19	1712 (1012-2411)	34
2010-11	14	78 (37-119)	1.5	23	1789 (852-2726)	36
2011-12*	16	62 (31-92)	1.2	29	1754 (894-2613)	35
2012-13	31	111 (78-158)	2.2	24	2618 (1841-3722)	52
2013-14	19	86 (55-135)	1.7	20	1509 (963-2366)	34
2014-15	27	113 (78-165)	2.3	23	2604 (1786-3797)	52
2015-16*	39	163 (119-223)	3.3	13	2043(1492-2795)	41
2016-17	27	113 (78-165)	2.3	16	1774 (1217- 2587)	35
MEAN (2002-16)	34	128 (117-141)	2.5	19	2311 (2106-2537)	47

*Rugby world cup year

Training Injuries

Table 10: England training injury incidence, average severity and burden since 2002-03 (95% confidence intervals shown in brackets where appropriate)

	RUGBY SKILLS			STRENGTH AND CONDITIONING		
SEASON	INJURIES/ 1000 HOURS	AVERAGE SEVERITY	DAYS ABSENCE/ 1000 HOURS	INJURIES/ 1000 HOURS	AVERAGE SEVERITY	DAYS ABSENCE/ 1000 HOURS
2002-03	4.5 (2.6-8.0)	15	69 (60-80)	4.0 (1.0-15.9)	4	16 (8-32)
2003-04*	7.6 (5.3-11.0)	12	89 (80-99)	6.3 (3.8-10.3)	13	79 (68-90)
2005-06	0.6 (0.1-4.0)	4	2 (1-6)	-	-	-
2006-07	9.8 (5.9-16.3)	15	149 (131-169)	-	-	-
2007-08*	7.3 (4.5-10.1)	9	74 (46-103)	2.5 (0.5-4.6)	12	34 (7-61)
2008-09	6.5 (3.0-10.0)	20	135(62-209)	12.1 (4.2-20.0)	18	233 (81-385)
2009-10	5.3 (3.4-8.3)	8	46 (30-73)	4.0 (2.0-8.6)	6	26 (12-55)
2010-11	1.7 (0.8-3.5)	7	12 (6-26)	4.4 (1.8-10.5)	5	22 (9-53)
2011-12*	3.2 (1.4-5.1)	22	70 (31-110)	2.8 (0.4- 5.3)	18	51 (6-95)
2012-13	3.7 (1.6-9.0)	20	58 (24-134)	1.1 (0.2-7.8)	9	10 (1-71)
2013-14	7.9 (4.7-13.3)	11	87 (52-147)	3.9 (1.3-12.1)	14	57 (18-177)
2014-15	3.31.6-6.9	25	85 (50-145)	2.3 (0.6-9.2)	2	3 (1-80)
2015-16*	15.7 (11.6-21.3)	9	135 (99-183)	7.3 (4.7-11.3)	8	55 (36-85)
2016-17	7.7 (4.1-14.3)	44	337 (181-626)	0.8 (0.1-5.7)	17	13 (2-93)
MEAN 2002-16	5.9 (5.2-6.8)	14	78 (68-89)	4.6 (3.6-5.9)	10	45 (35-57)

*Rugby world cup year

Table 11: England match and training injuries by severity grouping, 2002-03 to 2015-16

	MATCH				TRAINING			
SEASON	2-7 DAY	8-28 DAY	29-84 DAY	84+ DAY	2-7 DAY	8-28 DAY	29-84 DAY	84+ DAY
2002-03	38	8	6	1	9	4	0	1
2003-04*	51	25	6	1	23	18	4	0
2005-06	21	6	0	3	14	0	1	0
2006-07	11	15	2	4	8	4	3	0
2007-08*	30	15	9	1	14	13	1	0
2008-09	11	7	4	1	8	6	0	1
2009-10	9	12	2	0	11	3	3	1
2010-11	4	6	3	1	6	1	0	0
2011-12*	10	1	3	2	8	7	2	1
2012-13	11	11	8	1	1	3	1	1
2013-14	11	4	4	0	21	15	4	1
2014-15	19	4	3	1	10	3	2	1
2015-16*	27	18	1	0	37	16	2	0
2016-17	19	4	3	1	4	1	5	1
MEAN (2002-16)	20 (17-22)	10 (8-12)	4 (3-5)	1 (1-2)	13 (11-15)	7 (6-9)	2 (1-3)	1 (1-2)

*Rugby world cup year

RFU Injury Surveillance Project Methods

Written informed consent was obtained from 707 registered Premiership squad players for the 2015-16 season, there were no players that formally refused consent. A total of 406 team games were included in the analyses for the 2016-2017 season.

Injuries from consented first team squad (including academy players that trained regularly with the 1st team) players sustained in training and in all matches in the Aviva Premiership and European Competitions (Champions and Challenge Cup) were included. Injuries sustained while players represented England were reported and analysed separately.

Match and training injury data, and training exposure data, were provided by all 12 Premiership clubs in 2016-2017. A complete set of data were collected from all 12 Premiership clubs and the England senior side.

Medical personnel at each Premiership club and the England senior team reported the details of injuries and illnesses sustained by a player at their club/team that were included in the study group together with the details of the associated injury event using an online medical record keeping system. Strength and conditioning staff recorded the squad's weekly training schedules and exposure on a password protected online system. Team match days were also recorded by strength and conditioning staff.

Injury and illness diagnoses were recorded using the Orchard Sports Injury Classification System (OSICS) version 10.1. This sports specific injury classification system allows detailed diagnoses to be reported and injuries to be grouped by body part and injury pathology.

The definitions and data collection methods utilised in this study are aligned with the World Rugby Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union.

Current Publications & Presentations

Further detailed information on injury risk in this cohort of players can be obtained from the following peer reviewed publications that have been produced as part of the Premiership injury surveillance project

Publications

Williams, S., Trewartha, G., Kemp, S.P.T., Cross, M.J., Brooks, J.H.M., Fuller. C. W., Taylor. A.E. and Stokes, K.A. 2017. Subsequent injuries and early recurrent diagnoses in elite rugby union players. International Journal of Sports Medicine. DOI:10.1055/s-0043-114862

Williams, S., Trewartha, G., Kemp, S.P.T., Brooks, J.H.M., Fuller. C. W., Taylor. A.E., Cross, M.J., and Stokes, K.A. 2017. How much rugby is too much? A seven-season prospective cohort study of match exposure and injury risk in professional rugby union players. Sports Medicine. DOI: 10.1007/s40279-017-0721-3

Tucker, R., Raftery, M., Kemp, S.P.T., Brown, J., Fuller, G.W., Hester, B., Cross, M.J. and Quarrie, K. (2017). Risk factors for head injury events in professional rugby union: a video analysis of 464 head injury events to inform proposed injury prevention strategies. British Journal of Sports Medicine. 51, (15): 1152-1157

Tucker, R., Raftery, M., Fuller, G.W., Hester, B., Kemp, S.P.T., and Cross, M.J (2017). A video analysis of head injuries satisfying the criteria for a head injury assessment in professional rugby union: a prospective cohort study. British Journal of Sports Medicine. 51: 1147-1151

Cross, M.J., Tucker, R., Raftery, M., Hester, B., Williams, S., Stokes, K., Mathema, P. and Kemp, S.P.T. (2017). Tackling concussion in professional rugby union: a case-control study of tackle-based risk factors and recommendations for primary prevention. British Journal of Sports Medicine. DOI:10.1136/bjsports-2017-097912

Cross, M.J., Williams, S., Kemp, S.P.T., Taylor, A.E., Fuller, C.W., Brooks, J.H.M., Trewartha, G. and Stokes, K.A. (2017). Does the reliability of reporting in injury surveillance studies depend on injury definition? (Accepted for publication)

Williams, S., Trewartha, G., Cross, M.J, Kemp, S.P.T., and Stokes, K.A. (2017) Monitoring what matters: A systematic process for selecting training load measures. International Journal of Sports Physiology and Performance. 12 (2):101-106

Williams, S., West, S., Cross, M.J and Stokes, K., 2016. Better way to determine the acute:chronic workload ratio? British Journal of Sports Medicine DOI: 10.1136/bjsports-2016-096589

MJ Cross, G Trewartha, A Smith, SPT Kemp & KA Stokes. Professional rugby union players have a 60% greater risk of time loss injury after concussion: a 2-season prospective study of clinical outcomes. British Journal of Sports Medicine 2016 50(15): 926-931

MJ Cross, S Williams, G Trewartha, SPT Kemp & KA Stokes. The influence of in-season training loads on injury risk in professional rugby union, 2015. International Journal of Sports Physiology and Performance 2016 11(3):350-355

S Williams, G Trewartha, SPT Kemp, JHM Brooks, CW Fuller, AE Taylor, MJ Cross & KA Stokes. Time-loss injuries compromise team success in elite rugby union: A 7-year prospective study. British Journal of Sports Medicine 2016 50(11):651-656

CW Fuller, AE Taylor & M Raftery. Epidemiology of concussion in men's elite Rugby-7s (Sevens World Series) and Rugby-15s (Rugby World Cup, Junior World Championship and Rugby Trophy, Pacific Nations Cup and English Premiership). British Journal of Sports Medicine 2014; 10.1136/bjsports-2013-093381

Williams, S., Trewartha, G., Kemp, S. P. T., Michell, R. and Stokes, K. A., 2016. The influence of an artificial playing surface on injury risk and perceptions of muscle soreness in elite rugby union. Scandinavian Journal of Medicine & Science in Sports, 26 (1), pp. 101-108

AE Taylor, SPT Kemp, G Trewartha & KA Stokes. Scrum injury risk in English professional rugby union. British Journal of Sports Medicine 2014; 48(13) 1066-1068

S Williams, G Trewartha, SPT Kemp & KA Stokes. A meta-analysis of injuries in senior men's professional rugby union. Sports Medicine 2013; 43(10) 1043-1055

CW Fuller, AE Taylor JHM Brooks & SPT Kemp Changes in the stature, body mass and age of English professional rugby players: A 10-year review, Journal of Sports Sciences 2012 DOI:10.1080/02640414.2012.753156

SC Cheng, ZK Sivardeen, WA Wallace, D Buchanan, D Hulse, KJ Fairbairn, SP Kemp & JH Brooks. Shoulder instability in professional rugby players-the significance of shoulder laxity. Clinical Journal of Sports Medicine 2012 Sep; 22(5):397-402

CJ Pearce, JHM Brooks, SP Kemp & JD Calder. The epidemiology of foot injuries in professional rugby union players Foot & Ankle Surgery. 2011 Sep; 17(3):113-8. Epub 2010 Mar 5

JHM Brooks & SPT Kemp Injury prevention priorities according to playing position in professional rugby union players. British Journal of Sports Medicine 2011 Aug;45(10):765-75. Epub 2010 May 19

RA Sankey, JHM Brooks, SPT Kemp & FS Haddad The epidemiology of ankle injuries in professional rugby union players. American Journal of Sports Medicine Dec 2008; 36:2415-2424

CW Fuller, T Ashton, JHM Brooks, RJ Cancea, J Hall, & SPT Kemp Injury risks associated with tackling in rugby union. British Journal of Sports Medicine 2010; 44(3): 159-167

JHM Brooks, CW Fuller, SPT Kemp & DB Reddin An assessment of training volume in professional rugby union and its impact on the incidence, severity and nature of match and training injuries. Journal of Sports Sciences 2008 26:8, 863-873

SPT Kemp, Z Hudson, JHM Brooks & CW Fuller. The epidemiology of head injuries in English professional rugby union. Clinical Journal of Sports Medicine 2008; 18:227-234

CW Fuller, JHM Brooks, RJ Cancea, J Hall, & SPT Kemp Contact events in rugby union and their propensity to cause injury. British Journal of Sports Medicine, Dec 2007; 41: 862 - 867

J Headey, JHM Brooks & SPT Kemp. The epidemiology of shoulder injuries in English professional rugby union. American Journal of Sports Medicine, Sep 2007; 35: 1537 - 1543

RJ Dallana, JHM Brooks, SPT Kemp & AW Williams. The epidemiology of knee injuries in English professional rugby union. American Journal of Sports Medicine, May 2007; 35: 818 – 830

CW Fuller, JHM Brooks & SPT Kemp. Spinal injuries in professional rugby union: a prospective cohort study. Clinical Journal of Sport Medicine, 2007; 17 (1): 10-16

JHM Brooks, CW Fuller, SPT Kemp & DB Reddin. Incidence, risk and prevention of hamstring muscle injuries in professional rugby union. American Journal of Sports Medicine, 2006; 34: 1297-1307

JHM Brooks, CW Fuller, SPT Kemp & DB Reddin. Epidemiology of injuries in English professional rugby union: part 1 match injuries. British Journal of Sports Medicine, Oct 2005; 39: 757 - 766

JHM Brooks, CW Fuller, SPT Kemp & DB Reddin. Epidemiology of injuries in English professional rugby union: part 2 training injuries. British Journal of Sports Medicine, Oct 2005; 39: 767 – 775

JHM Brooks, CW Fuller, SPT Kemp & DB Reddin A prospective study of injuries and training amongst the England 2003 Rugby World Cup squad British Journal of Sports Medicine, May 2005; 39: 288 – 293

Recent Abstracts/Presentations

Bee, W.W., Kemp, S.P.T., West, S. and Thing, J. Hand and Wrist injuries in English Professional Rugby 2011-16. Presented at: British Association of Sport and Exercise Medicine Annual Conference, Bath, 2017

West, S., Williams, S., Cross, M.J., Howells, D., Mobed, R., Kemp, S.P.T., and Stokes, K.A. 2017. Workload spikes combined with high cumulative load is associated with increased risk in elite rugby sevens players. British Journal of Sports Medicine. 51 (4): 408

Cross, M.J., Trewartha, G., Kemp, S.P.T., Fuller, C.W., Taylor, A.E., West, S., and Stokes, K.A. 2017. Concussion in rugby union: Improved reporting, a more conservative approach or an increase in risk? British Journal of Sport Medicine. 51: 309

S Williams, G Trewartha, MJ Cross, SPT Kemp, & KA Stokes. A systematic process for selecting the most appropriate training load measures for injury risk monitoring of team sport athletes via data reduction techniques. Presented at: The 2nd Aspire Academy Sports Science Conference, Doha, 2016

MJ Cross, SPT Kemp, A Smith, G Trewartha & KA Stokes. Injury risk after returning from concussion in elite rugby union players. Presented at: The 8th World Congress on Science and Football, Copenhagen, 2015

S Williams, G Trewartha, SPT Kemp, JHM Brooks, CW Fuller, A Taylor, MJ Cross, & KA Stokes. Association between injuries and team success in elite rugby union. Presented at: The 8th World Congress on Science and Football, Copenhagen, 2015

JHM Brooks, CW Fuller, SPT Kemp & DB Reddin. The Incidence, Severity and Nature of Injuries Caused by Tackling in Professional rugby union Competition. Presented (poster) at The American College of Sports Medicine Annual Meeting, 1st June 2006. Published in: Medicine and Science in Sports and Exercise 2006: 38(5) S351-352

JHM Brooks, CW Fuller, SPT Kemp. The Incidence, Severity and Nature of Groin Injuries in Professional rugby union. Presented at The American College of Sports Medicine Annual Meeting, 1st June 2006. Published in: Medicine and Science in Sports and Exercise 2006: 38(5) S351

JHM Brooks, CW Fuller, SPT Kemp & DB Reddin. The incidence, severity and nature of injuries caused by being tackled in professional rugby union. Presented (oral) at The Faculty of Sports and Exercise Medicine, Royal College of Physicians Ireland (RCPI) and Royal College of Surgeons, Ireland (RCSI) Annual Scientific Meeting, Dublin, 5th September 2005

JHM Brooks, CW Fuller, SPT Kemp. The incidence, severity, and nature of scrummaging injuries in professional rugby union. Presented (poster) at 1st World Congress of Sports Injury Prevention, Oslo, Norway 23rd-25th June 2005. Published in: Br J Sports Med 39: 377

S West, S Williams, MJ Cross, D Howells, R Mobed, SPT Kemp & K Stokes. Workload spikes combined with high cumulative load is associated with increased injury risk in elite Rugby Sevens players. Presented (Poster) IOC World Conference on Prevention of Injury and Illness in Sport, Monaco, 16th-18th March 2017

S Williams, G Trewartha, SPT Kemp, JHM Brooks, CW Fuller, AE Taylor, MJ Cross, G Shaddick & K Stokes. How much rugby is too much? A seven-season prospective cohort study of match exposure in professional rugby union players. Presented (Oral) at IOC World Conference on Prevention of Injury and Illness in Sport, Monaco, 16th-18th March 2017

MJ Cross, G Trewartha G, SPT Kemp, AE Taylor, S West & K Stokes. Concussion in rugby union: Improved reporting, a more conservative approach or an increased risk? Presented (Oral) at IOC World Conference on Prevention of Injury and Illness in Sport, Monaco, 16th-18th March 2017

MJ Cross, K Stokes, G Trewartha, CW Fuller, AE Taylor, SPT Kemp. Predicting protracted recovery in professional rugby union: what can the symptoms, signs and modifiers of concussion tell us? Presented at the 5th International Consensus Conference on Concussion in Sport, Berlin, 27th-28th October 2016

Supplementary Data

Table S1 Match injury incidence, severity and burden 2002-17

Table S2 Training injury incidence, severity and burden 2002-17

Table S3 New vs. recurrent match injury incidence, severity and burden 2002-17

Table S4 New vs. recurrent training injury incidence, severity and burden 2002-17

Figure S5 Hamstring training injury incidence and burden 2002-2017

Table S1: Match injury incidence, severity and burden 2002-17

SEASON	TOTAL NUMBER OF MATCH INJURIES	INJURIES / 1000 HRS (95% CI)	INJURIES PER CLUB PER MATCH	AVERAGE SEVERITY (DAYS) (95%CI)	DAYS ABSENCE / 1000 HRS (95% CI)	DAYS ABSENCE PER CLUB PER MATCH
2002-03	748	100 (92-107)	2	16 (15-17)	1556 (1444-1667)	31
2003-04	653	88 (82-95)	1.8	20 (19-22)	1773 (1637-1909)	35
2005-06	482	75 (68-82)	1.5	21 (19-23)	1591 (1449-1733)	32
2006-07	755	90 (84-97)	1.8	21 (20-23)	1879 (1745-2013)	38
2007-08	660	83 (77-89)	1.7	19 (18-21)	1613 (1490-1736)	32
2008-09	769	100 (93-107)	2	23 (21-25)	2285 (2123-2446)	46
2009-10	636	80 (73-86)	1.6	22 (20-24)	1722 (1588-1856)	34
2010-11	746	93 (86-99)	1.9	21 (20-23)	1917 (1779-2054)	38
2011-12	655	82 (76-88)	1.6	27 (25-29)	2222 (2052-2392)	44
2012-13	588	73 (67-79)	1.5	25(23-27)	1784 (1645-1936)	35
2013-14	739	91 (85-98)	1.8	26 (24-28)	2247 (2091-2415)	46
2014-15	645	79 (73-85)	1.6	29 (27-31)	2369 (2193-2560)	47
2015-16	447	62 (57-68)	1.2	29 (26-32)	1808 (1648-1984)	36
2016-17	778	96 (90-103)	1.9	33 (31-35)	3150 (2936-3379)	63
MEAN (2002-16)	656	84 (79-89)	1.7	23 (21-26)	1905 (1881-1929)	38

Table S2: Training injury incidence, severity and burden since 2002-17

SEASON	TOTAL NUMBER OF TRAINING INJURIES	RUGBY SKILLS			STRENGTH AND CONDITIONING		
		INJURIES / 1000 HRS (95% CI)	AVERAGE SEVERITY (DAYS)	DAYS ABSENCE / 1000 HRS (95% CI)	INJURIES / 1000 HRS (95% CI)	AVERAGE SEVERITY (DAYS)	DAYS ABSENCE / 1000 HRS (95% CI)
2002-03	159	3.3 (2.7-4.0)	28	93 (90-97)	2.3 (1.7-3.0)	13	29 (27-31)
2003-04	217	1.7 (1.4-2.0)	26	44 (42-45)	1.3 (1.1-1.6)	17	23 (22-24)
2005-06	203	2.2 (1.9-2.6)	22	49 (47-51)	1.5 (1.2-1.9)	16	24 (22-25)
2006-07	209	2.1 (1.7-2.5)	18	37 (35-38)	1.6 (1.3-2.0)	16	25 (24-27)
2007-08	318	3.2 (2.7-3.7)	19	60 (51-68)	2.7 (2.2-3.1)	15	44 (36-52)
2008-09	258	2.5 (2.1-2.9)	26	63 (53-73)	2.4 (2.0-2.9)	17	41 (34-49)
2009-10	298	2.8 (2.4-3.2)	21	59 (50-67)	2.1 (1.7-2.4)	18	37 (30-43)
2010-11	340	3.1 (2.7-3.5)	25	76 (66-87)	2.6 (2.1-3.0)	17	41 (34-48)
2011-12	323	2.7 (2.4-3.1)	26	68 (59-78)	2.2 (1.8-2.6)	18	39 (32-46)
2012-13	335	3.2 (2.9-3.6)	33	106 (93-121)	2.0 (1.7-2.4)	24	49 (41-60)
2013-14	414	3.1 (2.7-3.5)	27	84 (75-95)	2.1 (1.7-2.4)	20	40 (34-47)
2014-15	325	2.7 (2.4-3.1)	29	71(61-82)	1.9 (1.6-2.3)	23	44 (38-51)
2015-16	304	2.4 (2.1-2.7)	28	69 (61-79)	1.4 (1.1-1.7)	37	41 (34-50)
2016-17	429	4.2 (3.8-4.7)	36	153 (137-171)	1.8 (1.5-2.2)	29	51 (42-62)
MEAN (2002-16)	285	2.7 (1.9-3.8)	25	68 (63-72)	2.0 (1.4-2.9)	19	37 (34-40)

Table S3: New vs. recurrent match injury incidence, severity and burden 2002-17

SEASON	NEW INJURIES			RECURRENT INJURIES		
	INJURIES / 1000 HRS	AVERAGE SEVERITY (DAYS)	DAYS ABSENCE / 1000 HRS	INJURIES / 1000 HRS	AVERAGE SEVERITY (DAYS)	DAYS ABSENCE / 1000 HRS
2002-03	79	14	1084	19	23	438
2003-04	72	18	1333	13	33	435
2005-06	67	20	1372	10	29	279
2006-07	76	21	1574	8	33	261
2007-08	74	19	1444	9	20	169
2008-09	85	21	1800	14	34	485
2009-10	72	21	1515	8	29	207
2010-11	87	21	1776	6	25	141
2011-12	77	27	2106	5	23	116
2012-13	68	25	1659	5	26	125
2013-14	87	25	2157	4	25	90
2014-15	78	29	2300	3	31	69
2015-16	62	29	1759	<1	36	20
2016-17	94	33	3079	1.7	41	71
MEAN (2002-16)	76	22	1683	9	28	218

Table S4: New vs. recurrent training injury incidence, severity and burden 2002-17

SEASON	NEW INJURIES			RECURRENT INJURIES		
	INJURIES / 1000 HRS	AVERAGE SEVERITY (DAYS)	DAYS ABSENCE / 1000 HRS	INJURIES / 1000 HRS	AVERAGE SEVERITY (DAYS)	DAYS ABSENCE / 1000 HRS
2002-03	2.5	21	54	0.5	34	16
2003-04	1.3	21	27	0.3	36	12
2005-06	1.8	19	35	0.4	21	8
2006-07	1.7	17	30	0.2	15	3
2007-08	2.3	17	39	0.5	23	11
2008-09	2	21	41	0.4	27	11
2009-10	2.2	20	44	0.2	21	4
2010-11	2.7	20	53	0.1	58	8
2011-12	2.2	22	49	0.1	46	4
2012-13	2.6	29	69	0.1	33	4
2013-14	2.8	25	70	0.1	25	4
2014-15	2.2	28	61	0.1	33	3
2015-16	1.9	31	59	<0.1	24	0.6
2016-17	2.9	34	98	0.04	34	1.4
MEAN (2002-16)	2	22	49	0	30	7

Table S5: Hamstring training injury incidence and burden 2002-2017

SEASON	INCIDENCE/1000 HOURS	DAYS ABSENCE/1000 HOURS
2002-03	0.45	6.4
2003-04	0.21	4.2
2005-06	0.36	4.6
2006-07	0.32	5.1
2007-08	0.59	9.5
2008-09	0.36	5.0
2009-10	0.38	6.1
2010-11	0.45	6.9
2011-12	0.42	7.3
2012-13	0.39	9.5
2013-14	0.4	10.7
2014-15	0.3	7.2
2015-16	0.33	11.4
2016-17	0.29	8.3
MEAN (2002-16)	0.38	7.2


MATTHEWS
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