An Analysis of Injury Rates After the Seasonal Change in Rugby League

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Objectives: To determine whether the increase in the incidence of injury found for the first summer season in which rugby league (RL) was played in the UK was repeated in subsequent summer seasons.

Design: A retrospective and prospective cohort study design.

Setting and Participants: Injuries were recorded from all players who took part in 141 games over 3 summer seasons (1997 to 1999) for 1 professional team. These were compared against rates from previously collected data for 3 earlier winter and 1 summer season.

Assessment of Risk Factors: For each injury it was recorded in which season it occurred; how many games or training sessions, if any, were subsequently missed; the type, site and severity of injury.

Main Outcome Measures: Injuries were reported as rate per 1000 hours, also broken down into severity according to the number of games missed and whether subsequent training sessions were missed.

Results: A sustained increase in injury incidence has been found comparing summer RL over RL played in the winter. There was an increase in injury rates for all sites and types, but not all reached significance.

Conclusions: Data collected over 6 seasons indicate a higher risk of sustaining an injury playing summer RL, but the cause may be related to a combination of factors. These may include the ground or weather conditions associated with summer rugby, player characteristics or changes in the game itself and future research needs to investigate these further.

Key Words: incidence, injury, summer rugby, type, site and severity

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Rugby league (RL) is a game of skill and is probably the most physically demanding of all team games.[1] RL is a collision sport, which requires a combination of muscular strength, stamina, endurance, speed, acceleration, agility, flexibility, and aerobic endurance.[2–4] During an 80-minute game, the ball is in play for an average of 50 minutes,[1] with individual players covering 7000 to 10,000 m[5] and being involved in 20 to 40 tackles per game.[1] Consequently injuries are common.[4] By nature, RL players do not use heavy protective guarding as do other body contact sports. It has been suggested that wearing protective equipment and clothing may have adverse effects on players' heat exchange mechanisms[6–8] and may produce heat-induced injuries. Possibly 1 in 12 wear protective head guards after a concussive episode, which literature shows are ineffective for this type of protection.[9,10] Two out of 13 wear shoulder pads. Other types of neoprene knee and elbow sleeves are used only spasmodically.

Research into the incidence of injury in RL is very limited. Lower[11] reviewed injury data collection in the rugby codes using 49 references but only 3 specific to the sport of RL. A recent review looking into pooled data analysis of injury incidence in RL identified only 18 studies from the period 1985 to 2000. Of these articles, only 10 were specific to include incidence and exposure and of these 4 re-reported the same source data. Therefore, only 6 papers reported new injury incidence in RL.[12]

One of the first published studies on RL injuries was in Australia by Alexander et al[13] in 1979 reporting an incidence of 277.78/1000 hours. This study continued into 1980 reporting the incidence over 2 seasons as 224.72/1000 hours.[14] Gibbs[4] reported a prospective incidence of 44.9/1000 hours in Australia and described it as low compared with other RL studies. Gissane et al[15] conducted a study similar to that of Gibbs, but in England reporting an incidence of 173.9/1000 hours.

From the literature it can be seen that there is wide variation in injury rates for the same game even over comparable time periods. This may be explained by differences in the methodology of the studies. Alexander et al[13,14] recorded every injury, however minor. Gibbs[4] recorded only injuries occurring in matches that required at least one subsequent match to be missed. Gissane[15] recorded only injuries that led to either a game or training

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session to be missed. Thus troubles arise when trying to compare rates. However, all studies suggest a high incidence of injury exists in RL in comparison with other similar sports.

Until 1996 RL was a winter sport, played weekly between end of August and April. Summer RL was introduced during 1996 as a condensed season from March to August. Subsequent summer seasons commence during February, typically finishing the league fixtures in September, culminating in the Play offs during Mid October. Summer RL has maintained the weekly schedule of games. On average, training occurs 5 times per week.

One of the first studies assessing the effects of changing to summer play on RL injury incidence was published in 1998.[16] This compared data from 4 consecutive seasons: winter 1993/4, winter 1994/5, a condensed season in 1995/6 that finished in January, and the first summer season of March to August 1996. The incidence rate reported for the first winter season was nearly half that reported for the first summer season (363.6 and 696.8/1000 h, respectively). This equated to a player in the winter receiving an injury every 2.1 appearances to every 1.1 appearances in the summer, that is, doubling the incidence of injury. Severe injuries showed a decreasing trend from the last winter season. Despite this fact, there was still a greater number of games missed due to injury in summer than in winter even if the injuries were less severe (severity being defined as 5 or more games missed). There was also a significant increase in training sessions lost in the 1996 summer season (180/1000 h) in comparison with the average for the first 2 winter seasons (130/1000 h).

The above study showed the highest incidence of injury ever reported in English RL (462.7/1000 h). This remained true when considering game injuries alone (44.07/1000 h), that is excluding injuries occurring in training and excluding all transient injuries, defined as those injuries that did not require any subsequent games to be missed.

The conclusions from this study were that summer RL had shown an increased incidence of injury overall but a reduction in the rate of severe injuries. However, significantly more injuries were leading to loss of training days and the percentage of training injuries themselves were rising. The change in injury rates could have resulted from the reduction in time intervals between the last 3 of these seasons and from the increased frequency of play in the first summer season.

This study was designed to investigate whether the increased incidence of game injuries was also found in future summer seasons. Further, to compare the findings against injury rates from an earlier study to investigate if the injuries remained of the same site, type and were still reduced in severity.

METHODS

During the 1997, 1998, and 1999 summer seasons, data were collected on all injuries, incurred during competitive games and training sessions, for a first team squad of a British RL club. Injuries were recorded irrespective of whether the player missed a subsequent training or competitive session.

An injury was defined as pain, discomfort, disability, or illness (new or recurrent) that the player acknowledged after participating in a rugby-related activity/game, this also included any advice/intervention sought from the medical team.

All injuries were identified on game day by the physiotherapist present or were reported by the player at the next training session, usually the day after. The physiotherapist was the same person in all 3 seasons. Previous winter season data (1993 to 1995) and the first 1996 summer season data had been collected exactly in the same way, by the same physiotherapist.[8]

The diagnosis of injury was carried out by the physiotherapist in consultation with the club doctors and a team orthopedic specialist when appropriate. All game injuries were classified into transient (no games missed),[16,17] minor (1 game missed), moderate (2 to 4 games missed), or severe (5 or more games missed).[4,16] A disadvantage of this categorization is that players often play regardless of their injuries, sometimes against medical advice, which means some minor injuries are thus logged as transient. To attempt to bypass this problem, days lost to training were also recorded for all game injuries.

Other categories recorded were the month of the injury, whether the injury was new or recurrent, if it required further investigation/surgery, the activity the player was conducting at the time and his position on the field. But for the purposes of this study these were not carried forward into the analysis.

As the authors were also investigating causal factors relating to conditions on game day, only injuries occurring during games were included for the analysis. The previous winter study[8] was then reanalyzed for game injuries alone for a comparison to be made.

Analysis

Player exposure hours were calculated on the basis of each game being played by 13 players and lasting 80 minutes.[18] Incidence rates were calculated by dividing the number of game injuries per season by the exposure over that season. This was then multiplied by 1000 to give a rate expressed per 1000 hours played. SPSS (version 9.0) for windows was used for all analyses. The χ^2 statistic was used to assess the difference between observed and expected injuries and the incidence of injury was expressed in rates per 1000 hours taking player exposure into account. Expected injuries for each season were calculated as the proportion of the total injuries recorded throughout the 6 seasons that was equal to the proportion of total exposure time for that season (for each season, the expected number of injuries were calculated by multiplying the total number of injuries for all 6 seasons by the number of exposure hours in that season divided by the total number of exposure hours for all 6 seasons).

To compare the sites and types of injuries in summer versus winter seasons, an expansive injury coding system was used consisting of 24 types and 27 sites of injuries. All the seasons' data (including 1993 to 1996) were grouped so that comparisons could be made between the new and the old data. Any injuries (including training injuries) and illnesses (coughs, colds, and asthma) not related to the game (even if they caused a game to be missed) were now excluded. To compare winter with summer rates for each site or type of injury, the standard error squared (SE^2) of each rate was found. The square root of the sum of the squared standard errors (winter and summer at each site) was calculated and this figure divided into the difference between the original 2 rates of winter and summer to see if the difference was greater than chance.

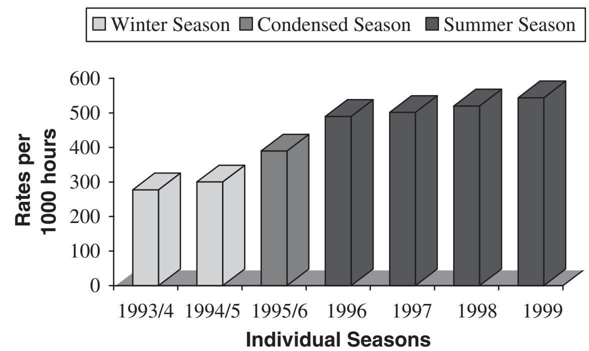

FIGURE 1. Showing injury incidence rates, expressed as rates per 1000 game hours played, per season for all seasons (1993 to 1999).

RESULTS

During this study, a total of 1262 game injuries were documented (including recurrent injuries) and 141 games were played. Individual season's total injuries are shown in Table 1, winter seasons (1993 to 1996) and the first 1996 summer season game injuries have also been included from the previous study[16] for comparison.

Figure 1 shows that the incidence of game injuries in summer RL has continued to increase from game injuries observed during the old winter seasons. Observed injuries in all seasons from 1993/4 differed significantly from expected ($\chi^2 = 95.18$, $df = 6$, $P < 0.001$) and an examination of the differences between observed and expected in each season indicated that there are more injuries than expected in the summer seasons. To test specifically for a difference between the frequency of injuries in the summer and those in the winter, observed frequencies for all the 3 winter seasons were compared with those from all the 4 summer seasons. Total injuries in the summer seasons were significantly ($\chi^2 = 113.64$, $df = 1$, $P < 0.0000001$) higher than expected taking exposure into account using the methods described above.

Figure 2 highlights that after the transitional (condensed) and the first summer season, the playing hours of the players (exposure hours) and season length have returned to that of the previous winter seasons. Thus with similar exposure hours played, injury incidence is still nearly double.

In summer play, a player can now expect to receive an injury every 1.9 hours of RL he plays. During the winter seasons, a player was injured only every 3.3 hours of play. The increasing risk of injury to players is further highlighted in Table 1. In winter a team received an injury every 16 minutes of play and in summer a team receives an injury every 9 minutes of play.

The previous work[16] had shown that although summer rugby had increased the incidence of injury these injuries were below the severe level, that is, fewer injuries were requiring 5 or more games to be missed. Table 2 summarizes the new and old data and shows that over time there is no significant difference between severe injuries in the winter compared with the summer. Neither is there any significant difference between minor injuries in the winter compared with the summer. However, there is a significant increase ($P > 0.01$, $\chi^2 = 9$, $df = 1$) in the incidence of injuries at the moderate level, that is,

TABLE 1. Injury Statistics per Season for Rates, Man Hours, Player Appearances, per Game and per Game Minutes Played

Season	1993/4 Winter	1994/5 Winter	1995/6 Winter	1996 Summer	1997 Summer	1998 Summer	1999 Summer
No. injuries observed	168	187	155	178	295	360	301
No. injuries expected	260	268	171	156	253	298	238
Injury rates per 1000 h played	277.6	300.43	389.77	490.24	501.82	520.53	544.03
95% CI	242.94-313.3	264.41-336.45	341.81-437.70	438.82-541.66	461.40-542.24	483.30-557.77	502.53-585.59
No games played	35	36	23	21	34	40	32
Exposure Hours	605.15	622.44	397.67	363.09	587.86	691.60	553.28
Man hours per injury (95% CI)	3.6 (3.3-3.9)	3.3 (3.1-3.6)	2.6 (2.3-2.8)	2.0 (1.8-2.3)	2.0 (1.8-2.2)	1.9 (1.8-2.1)	1.8 (1.7-2.0)
Player appearances per injury (95% CI)	2.7 (2.5-3.0)	2.5 (2.3-2.7)	1.9 (1.7-2.2)	1.5 (1.4-1.7)	1.5 (1.4-1.6)	1.4 (1.3-1.6)	1.4 (1.3-1.5)
Total number injuries per game (95% CI)	4.8 (4.1-5.6)	5.2 (4.5-6.0)	6.7 (5.7-7.9)	8.5 (7.3-9.8)	8.7 (7.7-9.7)	9 (8.1-10.0)	9.4 (8.4-10.5)
Game minutes played per injury (95% CI)	16.7 (16.1-17.3)	15.4 (14.8-16.0)	11.9 (11.3-12.4)	9.4 (9.0-9.9)	9.2 (8.9-9.6)	8.9 (8.6-9.2)	8.5 (8.2-8.8)

CI indicates confidence interval.

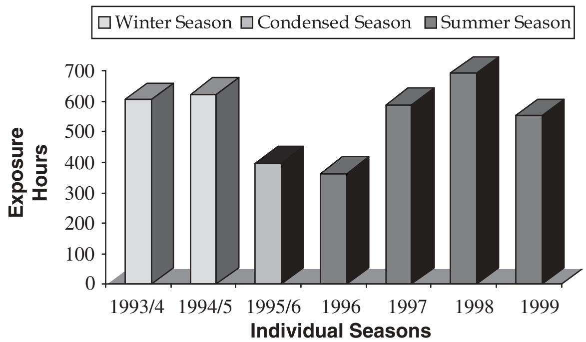

FIGURE 2. Showing player game exposure hours for each of the seasons (1993 to 1999).

requiring 2-4 games to be missed. As in the earlier study, there is still a significant ($P < 0.001$, $\chi^2 = 19.94$, $df = 1$) increase in summer rugby in the incidence of injuries leading to training days lost (Table 2).

A comparison of the site of injuries in summer with winter is shown in Figure 3. Figure 4 shows the types. Although there was an increase in rates of injuries for all sites compared with winter data, this was only significant (all probabilities smaller than $P < 0.05$) for those occurring at the knee, thigh, ankle, foot, arm, hand, trunk and head and neck (Fig. 3).

Similarly, there was an increase in rates of all types of injuries in the summer compared with winter, but this was only significant ($P < 0.001$) for hematomas, muscle/tendon/ligament strains, abrasions/lacerations, bursitis/soft tissue problems, and type "other." Those increases that did not reach significance were for fractures, dislocations, joint or knee ligament problems, bone stress reactions (such as medial tibial stress syndrome), and concussion.

DISCUSSION

This study shows that the incidence of game injuries in summer RL remains higher than that found in winter play. Therefore, it can be concluded that the increased incidence found in the first summer season cannot be explained solely in terms of the back-to-back nature of that season. As summer RL has continued, incidence of game injuries has continued to rise. Exposure hours and games played have returned to similar levels experienced in winter. These findings are consistent with those of Gissane et al.[19,20] This suggests that the increased incidence is not a factor at just one club. However, unlike the results from the earlier study[16,21] no significant difference was found between summer and winter in rates of injuries at the severe level, but there was a significant increase in the rate of moderate injuries (ie, those leading to 2 to 4 subsequent games being missed).

Minor injuries showed no significant difference from winter to summer despite the overall increased incidence observed. RL players are renowned for playing with injuries that typically require rest, as their salary and place in the next game hinge on appearance. Thus some injuries will be categorized in the transient category according to the definition, when "medically" they might be defined as minor. This is a limitation in this study of including both transient and minor categories.

However, the original aim of this study was to obtain an accurate picture of injury incidence, therefore all injuries even transient ones, were included in the analysis. These injuries are relevant, as the majority of transient injuries still require medical attention. Transient injuries require a level of input or treatment which makes

TABLE 2. Injury Cases and Injury Incidence Leading to Training Sessions and Games Missed

Season	Total Number Training Sessions Missed in Season	Total Number Game Sessions Missed in Season	Injury Cases Leading to Training Sessions Missed	Number Injuries per 1000 h Resulting in Training Sessions Missed	Injury Cases Leading to Minor Injuries (1 game Missed) [Rates/1000 h With 95% CI]	Injury Cases Leading to Moderate Injuries (2 to 4 Games Missed) [Rates/1000 h With 95% CI]	Injury Cases Leading to Severe Injuries (5 or > Games Missed) [Rates/1000 h With 95% CI]
1993/4	366	78	74	122.28	9 [14.87, 5.23-24.52]	4 [6.61, 0.15-13.07]	4 [6.61, 0.15-13.07]
1994/5	513	109	85	136.56	14 [22.49, 10.84-31.14]	7 [11.25, 2.96-19.53]	6 [9.64, 1.96-17.32]
1995/6	129	30	47	118.19	9 [22.63, 8.01-37.25]	7 [17.60, 4.68-30.53]	1 [2.51, −2.41-8.14]
1996	275	41	66	181.77	5 [13.77, 1.78-25.76]	10 [27.54, 10.71-44.37]	1 [2.75, −2.64-13.45]
1997	351	88	87	147.99	13 [22.11, 10.23-34.00]	17 [28.92, 15.37-42.47]	4 [6.80, 0.16-13.45]
1998	789	158	139	200.98	12 [17.35, 7.62-27.08]	19 [27.47, 15.29-39.65]	7 [10.12, 2.66-17.58]
1999	291	49	109	197.01	20 [36.15, 20.59-51.70]	10 [18.07, 6.97-29.17]	1 [1.81, −1.73-5.35]
Average total winter	336	72	69*	125.68*	11 [20.52, 8.52-32.53]	6* [11.19, 2.29-20.10]	4 [7.46, 0.18-14.75]
Average total summer	427	84	100*	181.94*	13 [23.50, 10.87-36.12]	14* [25.30, 12.22-38.39]	3 [5.42, −0.7-11.54]

Training sessions, usually occur 1 per day, therefore can be interpreted as days missed and sessions missed.
*Indicates significance at level $P < 0.001$.
CI indicates confidence interval.

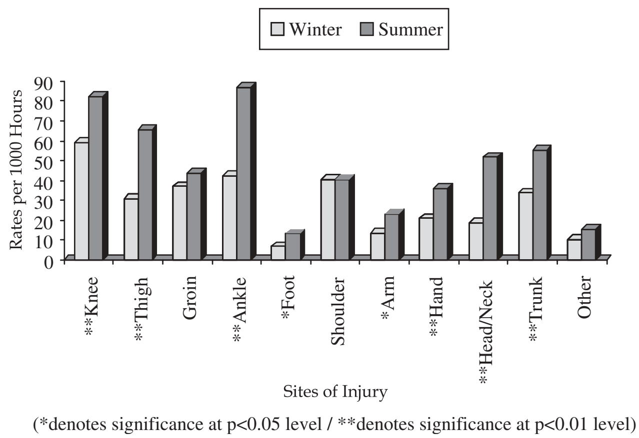

FIGURE 3. Comparison of winter with summer (in rates per 1000 player game hours) for sites of injuries sustained.

them significant in economic terms even if players continue to train and play.

The trend for the increased number of training days lost has continued. Missed training sessions affect the ability of the team to perform as a whole and potentially increasing the individual risk of sustaining an injury from playing with suboptimal fitness. Increased loss of training sessions does not necessarily translate to increased severity of injury as pressures on players described above might lead them to play a game while carrying an injury that they dare not risk training with for fear of it not resolving.

The increase in rates of injury from winter to summer was reflected in increased rates for all regions of the body and all types of injuries. However, not all these increases, for example injuries to the groin or shoulder, reached significance. Although there were significantly more injuries related to soft tissue, there was no significant increase in fractures, dislocations, or concussion. These patterns of injuries fail to throw light on any possible explanations for the increased injury rate in summer as although the increased incidence found in strains/sprains and hematomas could be related to the higher impacts, resulting from harder grounds of summer play a higher rate of fractures might also have been anticipated.

Although our analysis has compared games in winter with those in summer, visual examination indicates a year-on-year increase in injury rates since data recording commenced. However, there are insufficient data points for a time series analysis, which would have shown whether the increase during the summer seasons was more pronounced than the increase, which had already been observed over the 3 winter seasons. The fact that all the summer games followed all the winter games suggests that explanations other than seasonal may exist. It could have resulted from a combination of factors including the coincidence that the season switched from winter to summer as the game became managed more professionally. However, the fact that this change involved education and sports science becoming part of a player's training should have led to a reduction in injury incidence. There were also rule changes, but these occur in any season. Time and motion analysis might show the game is more intense in summer play. One possibility is that, with an increasing awareness of the importance of injuries, there was a qualitative change in the way injuries were recorded. However, the well-defined recording guidelines that were in place from the beginning of the study rule this out as an explanation.

This body of data collected by 1 researcher using strict recording guidelines from 1 team over several seasons has provided an opportunity to examine trends in injury rates over time. The findings are suggestive of a seasonal change but limitations in the data collected preclude the identification of causal factors nor can confounding factors be accounted for. For example, the anonymising of player information prevented the identification of recurrent injuries. Future work would investigate the role of some of these etiologic factors for example, warmer weather during the summer months; changes in the players and the game itself, and ground conditions with a study designed specifically to address these factors and eliminate any confounding variables.

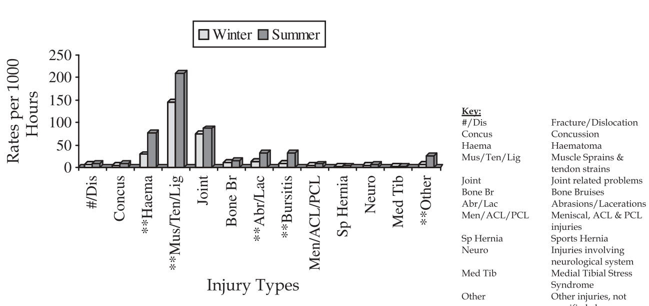

FIGURE 4. Comparison of winter with summer (in rates per 1000 player game hours) for types of injuries sustained. (**denotes significance at the $P<0.001$ level).

CONCLUSIONS

This study has found that there is still an increased incidence of injury in summer RL. Injuries occurring at the severe level are just as frequent in summer as in winter and the incidence of injuries at the moderate level has risen significantly since winter play. The incidence of injuries leading to training days lost is significantly greater in summer than that observed in the winter. There was an increase in injury rates for all sites and types, but not all reached significance. The role of possible confounding factors, for example changes in ground conditions, weather and historical changes to the game itself should be the focus of future research.

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