Influence of preseason training, fitness, and existing injury on subsequent rugby injury

A J Lee, W M Garraway, D W Arneil

Abstract

***Objectives*—To examine the influence of preseason fitness, existing injury, and preseason rugby training on subsequent injury.**

***Methods*—Players were eligible for the survey if they were a member of a Scottish Rugby Union (SRU) affiliated rugby club in the Border Reivers District of the SRU during the 1997–1998 season. A total of 803 (84%) players from 22 (88%) participating clubs provided details of rugby training, injuries sustained, and physical activity undertaken during the 16 week summer period (26 April to 16 August 1997) and their perceived fitness before the start of the season. Observers at participating clubs reported all injury episodes occurring to club players throughout the 1997–1998 season.**

***Results*—One fifth of players did not attend any rugby training during the 16 week summer period; the remainder attended a median of 14 sessions. Throughout the 1997–1998 season, 675 injury episodes occurred to 423 (53%) players during training or in matches. After adjustment for whether players held a professional contract or were amateurs, Cox regression showed a 3.9% relative increase (95% confidence interval (CI) 1.9 to 5.9%) in the risk of injury over the season for each additional preseason training week attended, and a 61% relative increase (95% CI 32 to 97%) for those players who had been injured or were carrying an injury at the end of the previous season.**

***Conclusions*—Injury risk is more likely to be related to rugby training (type of activities undertaken in rugby training, or personalities and characteristics of players undertaking training more frequently) than to overall player fitness. Players who were injured at the end of the previous season were more likely to be injured in the following season. This may be because they do not allow previous injuries to heal sufficiently before returning to the game, or the intensity of their participation may increase their risk of injury.**

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Even though participation rates in rugby union are relatively low compared with other sports in the United Kingdom, the proportion of injured players and the annual rate of adult casualty attendances per 1000 participants are high.[1 2] As well as the direct costs of medical treatment, almost three in ten players miss school or work as a result of their injury.[3] More injuries occur in the earlier part of the season,[3–6] and it has been suggested that this may be associated with preseason training and fitness.[6–9] We here examine the influence of preseason training and fitness and existing injury on subsequent injury.

Methods

The principal methods used in this survey have been reported elsewhere.[10] Players were eligible for the survey if they were a member of a Scottish Rugby Union (SRU) affiliated rugby club in the Border Reivers District of the SRU during the 1997–1998 season. In August 1997, research nurses and physiotherapists visited 22 of the 25 clubs who agreed to participate, during the week before the first match, and invited eligible players to complete a questionnaire. Players who did not attend rugby training were contacted by telephone. A total of 803 (84%) players, including all 30 players who were employed by the Border Reivers District or the SRU, supplied information on their physical activity level (none, light, medium, or heavy) and average weekly hours of manual work undertaken during the preseason period (16 week summer period from 26 April to 16 August 1997). Players also provided details of the number of weeks and sessions they had attended rugby training in preseason preparation, and the average number of weekly hours of other fitness and sporting activities undertaken during this period. Players reported if they had been injured or were carrying an injury at the end of the previous season, if an injury had delayed the start of their preseason rugby training, and if they had been injured during preseason training. Players' estimates of their perceived fitness—on a scale of 0 (not fit at all) to 10 (extremely fit)—in terms of speed, strength, and stamina were obtained.

Observers at participating clubs reported injury episodes occurring to any player who was registered with their club during the 1997–1998 season. A rugby injury was defined as an injury sustained on the field during a competitive match or during training that prevented the player from playing or training from the time of injury or from the end of the match or training session in which the injury was sustained. Players completed a diary of matches played during the first and second halves of the season in the middle and at the end of the season respectively.

VALIDATION OF QUESTIONS ON FITNESS PERCEPTION

In June 1997, 38 players being considered for the under 19 Scottish team squad participated in a validation study of the fitness perception

questions used in this survey. They completed the questions about their perceived speed and stamina, before performing two 50 m runs and a shuttle test (Multi-stage Fitness Test, National Coaching Foundation, Headingley, Leeds, UK), which involved running a distance of 20 m (repeatedly) within specific time limits (indicated by "beeps" from a prerecorded tape). The time interval allowed for the first run could be achieved by a walking pace, but the pace required became progressively faster for each successive minute (up to 20 minutes). The players had to keep within the time limits and so had to pace themselves in order to complete the test. The test was terminated for an individual player when he failed to complete the 20 m shuttle within the time allowed on two separate occasions. The number of minutes for which a player was able to complete the shuttle runs within the allotted time was noted. There was a relatively strong relation between perceived speed and the average time taken to complete the two 50 m runs (Spearman's rank correlation, $r = -0.73$, $p<0.001$) and an adequate relation between perceived stamina and the result of the shuttle test ($r = 0.54$, $p<0.001$).

STATISTICAL ANALYSIS

Fitness and sporting activities were divided into power (weight training and rock climbing) and aerobic activities (all remaining activities). Contractual playing status was defined as a binary variable relating to whether or not the player held a professional contract or was an amateur. Cox's proportional hazards regression was used to assess the effects of previous injuries and preseason physical activity in relation to time to first injury episode (from 10 August 1997, the first day on which matches were played). For the 380 players who were not injured on or before the last match of the season (9 May 1998), time to first injury episode was recorded as at least 274 days (censored times). The following variables were entered into the model in a stepwise manner at the $p = 0.05$ significance level: contractual playing status; age (<20, 20–29 or ⩾30 years on 1 August 1997); level of manual work; manual hours worked; attendance at preseason training (number of weeks and sessions of attendance, and average number of sessions per week); injury status at the end of the previous season, and before and during preseason training; weekly hours of aerobic and power activities; perceived fitness in terms of speed and stamina. Strength was not considered because the question had not been validated. Kaplan-Meier survival estimates were used to calculate the proportion of players who remained free of injury during the season for the six groups of players in fig 1. The six comparison groups were based on the final Cox regression model, with weeks of attendance at preseason rugby training divided into two categories on the basis of the median attendance of 5.5 weeks (all professional players attended for more than five weeks). Stepwise binary logistic regression was also used to assess the effects of these potential risk factors on subsequent injury status, which was defined as a binary variable relating to whether or not a player had been injured during the season. To examine the higher risk of injury in the early part of the season,[3–6] injury over the first three months was also considered. The odds ratios (ORs) and the hazard for the logistic and Cox regressions show which factors increase the risk of injury. A value of 1 implies no increased risk, and a value greater (less) than 1 implies an increased (decreased) risk of injury.

Results

CHARACTERISTICS OF PLAYERS

The mean (SD) age of the 803 rugby players was 23.9 (6.65) years (range 11–53); 59 (7.3%) were under 16 years old, 192 (23.9%) 16–19, 205 (25.5%) 20–24, 196 (24.4%)

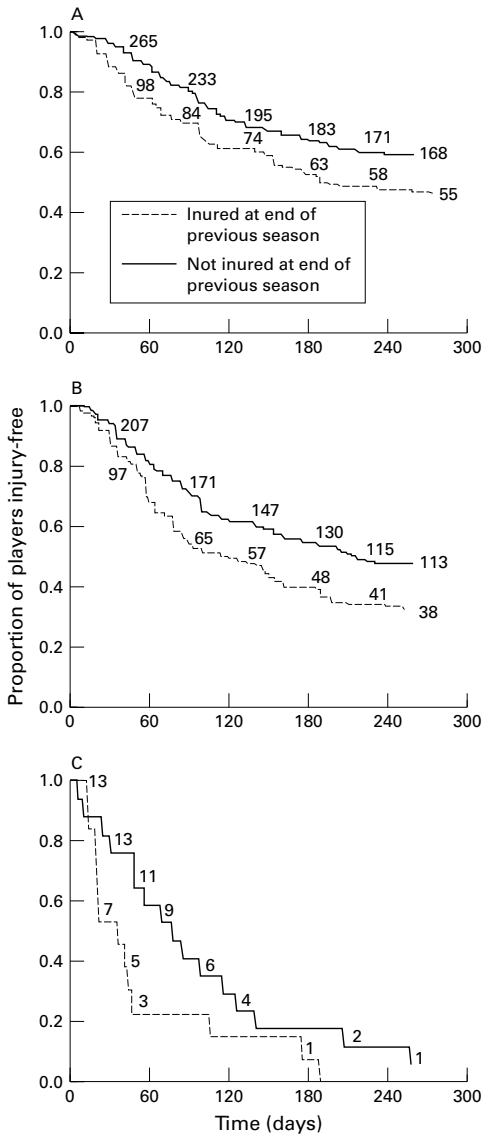

Figure 1 Proportion of rugby players who remain free of injury as the season progresses by contractual status, attendance at preseason rugby training, and injury status at the end of the previous season. (A) Amateur players who attended rugby training for less than six weeks; (B) amateur players who attended rugby training for more than five weeks; (C) professional players (who all attended rugby training for more than five weeks). The number of players still at risk of subsequent injury is given above the curves.

Table 1 Factors influencing attendance at preseason rugby training

Factor	Weeks attended				Sessions attended			
	n*	Adjusted mean†	Standard error	p Value	n*	Adjusted mean‡	Standard error	p Value
Contractual playing status								
Professional	27	13.7	0.97		27	63.1	2.58	
Amateur	753	6.1	0.27	0.000	745	14.2	0.68	0.000
Injury delaying the start of preseason training								
Yes	150	9.3	0.60		149	37.6	1.60	
No	630	10.6	0.53	0.007	623	39.1	1.42	0.240
Injured during preseason training								
Yes	117	10.4	0.62		116	40.4	1.66	
No	663	9.4	0.53	0.048	656	36.9	1.35	0.010
Physical activities over summer								
No activities undertaken	128	8.0	0.67		126	34.5	1.80	
Aerobic and/or power activities undertaken	645	10.0	0.51	0.000	639	38.9	1.35	0.001

*A small number of players did not answer all the questions and have been excluded from particular analyses.
†Adjusted for age, contractual playing status, whether an injury delayed the start of the training or not, and whether an injury occurred during preseason training or not obtained from least squares means from analysis of covariance.
‡Adjusted for age, contractual playing status, and whether an injury occurred during preseason training or not obtained from least squares means from analysis of covariance.

25–29, 99 (12.3%) 30–34, and 52 (6.5%) 35 years old or more. Of the 800 players who answered the nationality question, 776 were British, 18 were Australian or New Zealanders, two were Irish, three were African, and one was American. The usual playing positions specified by the players were reasonably representative of all playing positions: prop (14.3%); hooker (7.2%); lock forward (12.3%); wing forward (14.6%); number 8 (5.3%); scrum half (6.2%); stand off (5.7%); wing three quarters (12.8%); centre (13.8%); fullback (7.6%).

PHYSICAL ACTIVITY, RUGBY TRAINING ATTENDANCE, AND INJURY STATUS OVER THE SUMMER PERIOD

Four fifths of the players undertook preseason rugby training, attending a median of 14 sessions (n = 621, interquartile range 20). Some 83% (656/795) of players had participated in aerobic and/or power activities during the 16 week summer period, for a median of six hours a week (n = 641, interquartile range 6). About 32% of players reported that they were injured or were carrying an injury at the end of the previous season, and 27% of players either had an injury that delayed the start of preseason rugby training or suffered an injury during preseason training. Contractual playing status, having an injury that delayed the start of preseason training, having an injury during preseason training, and undertaking physical activities over summer influenced attendance at preseason rugby training (table 1).

INJURY EPISODES DURING SEASON

The frequency, nature, and outcome of injuries sustained while playing matches have been reported elsewhere in this cohort of players.[10] A total of 675 injury episodes occurred to 423 (53%) players in training or matches during the 1997–1998 season (576 in matches involving 381 players). All but one of the 30 professional players were injured. The match injury

Table 2 Relation between injury status over season and factors of interest adjusted for contractual status

Factor of interest	Injury status			
	Over whole season		First three months of season	
	OR (95% CI)	p Value	OR (95% CI)	p Value
Age on 1 August 1997				
<16 years	1.00		1.00	
16–19 years	1.26 (0.70 to 2.28)	0.443	1.98 (0.84 to 4.69)	0.120
20–24 years	1.62 (0.90 to 2.92)	0.108	2.99 (1.28 to 6.95)	0.011
25–29 years	1.98 (1.09 to 3.60)	0.025	3.70 (1.59 to 8.62)	0.002
30–34 years	1.88 (0.98 to 3.63)	0.059	3.39 (1.38 to 8.31)	0.008
⩾35 years	0.99 (0.46 to 2.11)	0.975	1.35 (0.45 to 4.02)	0.589
Level of summer manual work				
None	1.00		1.00	
Light	0.87 (0.54 to 1.40)	0.564	0.78 (0.45 to 1.35)	0.370
Medium	1.19 (0.82 to 1.73)	0.371	1.06 (0.70 to 1.61)	0.769
Heavy	1.03 (0.70 to 1.51)	0.898	0.92 (0.60 to 1.43)	0.714
Injured at end of previous season*	1.83 (1.34 to 2.50)	0.000	2.09 (1.51 to 2.91)	0.000
Had an injury that delayed start of rugby training*	1.43 (1.00 to 2.06)	0.053	1.56 (1.07 to 2.28)	0.021
Injured during preseason rugby training*	1.18 (0.79 to 1.75)	0.420	1.00 (0.65 to 1.55)	0.991
Hours of summer manual work†	1.00 (0.99 to 1.01)	0.618	1.00 (0.99 to 1.01)	0.933
Number of preseason training weeks attended†	1.05 (1.02 to 1.08)	0.001	1.05 (1.02 to 1.09)	0.001
Number of pre-season training sessions attended†	1.02 (1.01 to 1.03)	0.000	1.02 (1.01 to 1.03)	0.001
Average preseason training sessions per week†‡	1.20 (1.06 to 1.36)	0.005	1.33 (1.15 to 1.53)	0.000
Weekly hours of aerobic activities†	1.00 (0.97 to 1.03)	0.931	1.01 (0.98 to 1.05)	0.398
Weekly hours of power activities†	1.06 (1.00 to 1.13)	0.066	1.04 (0.97 to 1.11)	0.280
Perceived fitness: speed†	1.11 (1.03 to 1.21)	0.010	1.09 (0.99 to 1.19)	0.070
Perceived fitness: stamina†	1.09 (1.00 to 1.18)	0.041	1.08 (0.99 to 1.18)	0.096
Perceived fitness: strength†	1.12 (1.02 to 1.23)	0.015	1.11 (1.00 to 1.23)	0.053

*Relative to "no injury" category.
†Odds ratio (OR) based on change of one point on scale.
‡Rounded to nearest whole number.

Table 3 Cox and logistic regression models

Dependent variable	*Variables entering model*	*Global χ2**	*Coefficient (SE)*	*p Value*	*Hazard/OR (95% CI)*
Time to first injury episode	Professional player	68.6	1.025 (0.206)	0.0001	2.788 (1.861 to 4.178)
	Weeks at preseason training		0.038 (0.010)	0.0001	1.039 (1.019 to 1.059)†
	Injured at end of previous season		0.477 (0.101)	0.0001	1.612 (1.322 to 1.965)
Injury status (whole season)	Intercept	59.2	−0.454 (0.126)	0.0003	
	Professional player		2.879 (1.027)	0.0051	17.796 (2.377 to 133.2)
	Weeks at preseason training		0.052 (0.015)	0.0004	1.053 (1.023 to 1.084)†
	Injured at end of previous season		0.639 (0.162)	0.0001	1.894 (1.380 to 2.601)
Injury status (first three months)	Intercept	47.8	−1.651 (0.154)	0.0001	
	Professional player		1.138 (0.409)	0.0054	3.120 (1.399 to 6.958)
	Weeks at preseason training		0.055 (0.016)	0.0006	1.057 (1.024 to 1.091)†
	Injured at end of previous season		0.739 (0.170)	0.0001	2.094 (1.500 to 2.923)

*Based on 3 degrees of freedom, p<0.0001.
†Related to increment of one week of attendance.

incidence was highest at the beginning of the season (10 August to 31 October: 22.0 injury episodes per 1000 player hours (95% confidence interval (CI) 18.7 to 25.3); 1 November to 31 January: 14.2 (11.8 to 16.5); 1 February to 9 May: 13.1 (10.3 to 15.9)). This was also true for match period prevalence (31.6 (27.7 to 35.5), 21.8 (18.9 to 24.7), and 20.0 (16.6 to 23.5) respectively).

RELATION BETWEEN PRESEASON PHYSICAL ACTIVITY AND SUBSEQUENT RUGBY INJURY

As there was a strong relation between injury status over the season and player's contractual status (χ^2 test: 22.4, df = 1, p<0.001), estimates of injury risk were adjusted for this factor using binary logistic regression. Players who were aged 25–29 years, had an injury at the end of the previous season, attended preseason training more often, and reported an increased level of perceived fitness had a higher risk of subsequent injury (table 2).

After adjustment for contractual playing status, Cox regression showed a 3.9% (95% CI 1.9 to 5.9) relative increase in the risk of injury for each additional preseason training week attended, and a 61.2% (95% CI 32.2 to 96.5) relative increase for those players who were injured or were carrying an injury at the end of the previous season (table 3). Figure 1 illustrates the difference in the proportion of players remaining free of injury over the rugby season in players with and without these risk factors, and confirms the additive effect of these factors. Similar estimates of injury risk were obtained from the logistic regressions, with slightly higher odds ratios for injury in the first three months, except for contractual status, compared with the whole season (table 3).

The pattern of injuries differed between amateur players who attended preseason training for five or fewer weeks and more than five weeks, and between amateur players who were and were not injured at the end of the previous season (table 4).

Discussion

Apart from a presentation of a preliminary study to the Fourth World Congress of Science and Football in 1999,[11] this is the first report to examine preseason physical activity, fitness, and injury, and relate them to subsequent injury in a large cohort of adult rugby union players. It shows an increased risk of rugby injury for professional players, those who attend preseason rugby training for a longer period, and for players who were injured or were carrying an injury at the end of the previous season.

Table 4 Match prevalence of different types of injury sustained during season in amateur players

	Match injury prevalence per 1000 player hours (95% CI)			
	Not injured at end of last season		*Injured at end of last season*	
Type of injury	*<6 weeks at preseason training*	*>5 weeks at preseason training*	*<6 weeks at preseason training*	*>5 weeks at preseason training*
Head, neck, and face				
Concussion	45.2 (6.5 to 83.9)	58.6 (8.8 to 108.4)	34.6 (−3.9 to 73.1)	54.9 (12.2 to 97.6)
Fracture	17.0 (−16.1 to 50.2)	33.2 (4.6 to 61.8)	31.3 (4.3 to 58.2)	0.0 (0.0 to 0.0)
Neck dislocations, strains, and sprains	48.1 (19.0 to 77.2)	58.8 (30.9 to 86.8)	58.6 (8.8 to 108.4)	48.9 (−5.1 to 102.9)
Lacerations and contusions	39.5 (1.6 to 77.4)	51.2 (21.7 to 80.7)	23.4 (−2.8 to 49.6)	34.2 (14.4 to 54.1)
Shoulder				
Dislocations, strains, and sprains	43.0 (15.5 to 70.5)	41.2 (23.1 to 59.3)	66.5 (32.8 to 100.1)	58.7 (32.4 to 85.0)
Upper limb				
Fracture	44.7 (16.2 to 73.2)	51.7 (2.4 to 101.1)	120.0 (9.7 to 230.3)	29.0 (7.8 to 50.2)
Dislocations, strains, and sprains	30.4 (−3.5 to 64.3)	43.3 (9.4 to 77.1)	39.5 (−4.3 to 83.3)	54.9 (−5.5 to 115.3)
Lacerations and contusions	67.0 (10.3 to 123.7)	20.8 (−7.7 to 49.4)	0.0 (0.0 to 0.0)	63.8 (3.3 to 124.4)
Trunk				
Back strains and sprains	55.7 (23.7 to 87.8)	31.3 (11.2 to 51.3)	37.5 (8.1 to 66.9)	36.6 (1.4 to 71.8)
Lacerations and contusions	47.5 (6.9 to 88.1)	30.0 (−10.9 to 70.9)	0.0 (0.0 to 0.0)	132.4 (33.7 to 231.0)
Lower limb				
Fractures	0.0 (0.0 to 0.0)	44.1 (−15.7 to 103.9)	23.4 (−22.0 to 68.8)	90.0 (−7.2 to 187.2)
Dislocations, strains, and sprains				
Hip and thigh	66.9 (33.0 to 100.7)	32.0 (20.6 to 43.5)	52.4 (24.7 to 80.2)	71.8 (41.5 to 102.1)
Knee	37.3 (22.4 to 52.3)	43.9 (26.4 to 61.4)	63.2 (20.8 to 105.5)	51.2 (34.7 to 67.7)
Ankle and foot	52.0 (25.5 to 78.5)	44.1 (24.2 to 64.0)	36.5 (9.9 to 63.0)	42.5 (20.7 to 64.3)
Lacerations and contusions	56.0 (22.3 to 89.7)	45.0 (22.7 to 67.3)	187.5 (−143.8 to 518.8)	32.6 (11.7 to 53.6)
Other injuries	54.5 (29.3 to 79.7)	54.6 (34.2 to 75.0)	56.8 (8.5 to 105.2)	70.1 (28.2 to 112.0)
All injuries	18.9 (15.8 to 22.0)	22.5 (19.4 to 25.7)	27.2 (21.3 to 33.2)	36.7 (31.1 to 42.4)

As information on the level of preseason physical activity and rugby training was collected retrospectively, the accuracy of this information may have been affected by players' memory recall. The different methods of data collection may also have introduced a bias into the survey. However, the survey response rate was high (84%), and it is unlikely that such bias will unduly affect the results of the survey. Although perceived speed and stamina correlated reasonably well with the fitness test in the pilot survey, it was not possible to validate strength, which is an important component for determining fitness in rugby players. In addition, the fitness questions were only validated on a small group of under 19 players, and it is assumed that their fitness perception is reasonably representative of all rugby players. However, the level of fitness did not appear to be an important factor once other factors had been taken into consideration. We do not know whether this was because fitness was not measured scientifically or whether it is not an important factor. However, other measures of fitness (the level and weekly number of hours of manual work and weekly hours of aerobic and power activities undertaken) did not predict subsequent injury status. This suggests that the way in which fitness was measured in this study is less important than may have been expected.

Some of the univariate relations with subsequent injury could have occurred by chance because of the number of statistical tests presented (unadjusted exact p values given). However, the focus is placed on the multivariate analyses, which are completed in two different ways to assess which factors are consistently important. The factors in the multivariate models are adjusted for all other factors already in the model (univariate models adjusted for contractual playing status). Therefore the effects are independently associated with subsequent injury. For example, perceived fitness predicts subsequent injury status univariately, but is not important once contractual playing status, attendance at preseason training, and injury status at the end of the previous season has been taken into consideration.

There are many possible reasons why players who attend more preseason training weeks may have a higher risk of subsequent injury. They will probably have had more practice in rugby related manoeuvres such as tackling. This may boost a player's confidence to make more injury prone manoeuvres which less skilled players would not attempt. These players may also play more intensively. Players who attend training more frequently were more likely to undertake power activities, and players of a larger build have been found to have a higher risk of injury.[8] However, it is unclear if this is a true injury risk factor or a consequence of the relations among various other risk factors. Personality and the "need to win" could also be influences, although the former was not found to be a significant factor in injuries sustained in the tackle.[12] This could have been because opposing players in the same game are playing, in general, at the same team level, and their "need to win" could be similar. It is possible that personality and the "need to win" differs between the highest and lowest levels of play. Certainly, the injury rate differs; the present survey noted a 180% relative increase in the risk of injury for professional players. This agrees with observations made during the 1995 Rugby World Cup[13] and other surveys reporting higher injury rates among those who play at a higher team level.[5 6 14] In addition, the duration of the warm up before matches[15] and training sessions and the use of different items of protective equipment[16] could also influence the risk of injury. It was not possible to measure these factors, because of the large number of matches and training sessions covered in this survey. Injury status before and during preseason training affected attendance at preseason training. It might be expected that players injured during their preseason training would attend significantly fewer training sessions during a shorter time span than players who were not injured, but the reverse was true. Players who had an injury that delayed their preseason training did attend rugby training for significantly fewer weeks than non-injured players, but there was no difference in the number of sessions attended. Some of these players may be training more intensively to make up for weeks when they were unable to train because of injury, increasing the likelihood of future injury.[17] There was no evidence that players who attended preseason training more frequently were more likely to obtain subsequent soft tissue injuries, which may indicate overtraining. The number of hours of manual work, aerobic activities, and power activities undertaken during the summer period, level of manual work, and fitness levels before the start of the season had little effect on subsequent injury. This suggests that injury risk is related far more to rugby training (type of activities undertaken in rugby training or personalities and characteristics of players undertaking training more frequently) than to overall player fitness. This agrees with another study that found that strength and flexibility did not exert a significant role in determining injuries in a study of elite young athletes.[18] Although, the preliminary study conducted in New Zealand found that players with $\geq$40 weekly hours of strenuous activity missed more playing time through injury than those less active,[11] no associations between injury risk and the results of the fitness tests were mentioned. Residual fatigue induced by heavy preseason training rather than overtraining may make players more likely to be subsequently injured. Another study, which examined players for three consecutive seasons, has suggested that fatigue may increase injuries in amateur rugby league players.[19] Peripheral vision of rugby players may be affected by fatigue,[20] and more than half of injuries that occur in the tackle occur within the tackled player's peripheral vision (19%) or from behind him (33%).[12] However, confounding factors make it difficult to determine exactly why players who attend more weeks of preseason training have an increased risk of rugby injury.

Players who undertook no preseason preparation for the forthcoming season did not have a higher subsequent injury rate. Nevertheless, adequate preseason preparation is important, as lack of preseason training can increase the risk of subsequent injury.[7] As mentioned above, increased attendance at preseason training may not be a direct cause of increased injury risk; it is possible that other underlying factors, related to increased attendance at preseason training, increase the risk of injury. Therefore a reduction in the number of weeks that players attend preseason training may not necessarily reduce the risk of subsequent injury.

Players who were injured or were carrying an injury at the end of the previous season had a higher risk of subsequent injury. Risk of subsequent injury was also higher for previously injured players in the preliminary study in New Zealand.[11] This higher risk of subsequent injury could have occurred for similar reasons as previously mentioned. In addition, their outlook and behaviour towards rugby injury may be a factor. During the 1993–1994 season, one fifth of senior players completed the match in which they were injured.[21] Players who try to ignore their injuries or who do not seek treatment for them promptly may be more likely to be subsequently injured. These players will become prone to recurrent injuries particularly if they do not rest their injuries sufficiently before returning to play. A casual attitude to injuries has been noted in New Zealand, where 39% of players had played rugby against medical advice at some time in their careers.[22] Players could also have a higher risk of subsequent injury if they do not maintain fitness and psychological well being while they are injured.[23]

This study has found that players attending preseason training for more weeks and those injured at the end of the previous season had an increased risk of subsequent injury, but there is no clear explanation of why this is the case. Further research is required that can examine preseason fitness in a more detailed and comprehensive manner and relate it to subsequent injury.

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Take home message

Players who attend rugby training more frequently are more likely to be subsequently injured, but there is no evidence to suggest that this is because they are training too hard or too frequently. Injury risk is more likely to be related to the type of rugby training activities undertaken or the personalities and characteristics of players rather than overall player fitness. Players should be encouraged to allow their injuries to heal sufficiently before returning to the game.