Title:

Training activities and injuries in English youth academy and schools rugby union

Running Title: Training injuries in English youth rugby union

Authors:

Deborah S Palmer-Green[1,2], Keith A Stokes[1], Colin W Fuller[3], Michael England[4], Simon P T Kemp[4], Grant Trewartha[1]

Affiliations:

[1] Sport, Health and Exercise Science, University of Bath, Bath, UK.

[2] Orthopaedics, Trauma and Sports Medicine, University of Nottingham, Nottingham, UK.

[3] International Rugby Board, Dublin, Ireland.

[4] Rugby Football Union, Twickenham, UK.

Corresponding Author:

Grant Trewartha,

Sport, Health and Exercise Science,

Department for Health,

University of Bath,

Bath, UK.

BA2 7AY

Tel: +44 1225 383055

Fax: +44 1225 383833

Email: g.trewartha@bath.ac.uk

Institution:

This study was performed within the Sport, Health and Exercise Science group at the University of Bath.

Acknowledgements:

We would like to thank the academy managers, medical and strength and conditioning personnel at the rugby academies of the following clubs: Bath, Gloucester, Leeds, Leicester, London Irish, Northampton, Newcastle, Sale, Saracens, Wasps and Worcester; and the rugby coaches, and medical staff at the following schools and colleges: S.W.E.R.A., Ivybridge, Barnard Castle, Bryanston, Hartpury, Hymers, Millfield, Nottingham High, and Sedbergh, without whose input during data collection this study would not have been possible.

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Footnote:
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ABSTRACT

Background: All rugby training activities carry an injury risk but in the training environment these injury risks should be more controllable than during matches.

Hypothesis/Purpose: To 1) describe the incidence, severity, anatomical location and type of youth rugby training injuries; 2) determine the injury events and type of training activities associated with injuries; and 3) compare two levels of play (professional academy v school) within English youth rugby union.

Study Design: A prospective cohort design

Methods: A 2-season (2006-2007 and 2007-2008) study recorded exposure to training activities and time-loss injuries in male youth rugby union players (age, 16 – 18 yrs) from 12 English Premiership academies (250 player-seasons) and 7 schools (222 player-seasons). Premiership academies are associated with the top-level professional clubs in England and represent the elite level of youth rugby; the School players were from established rugby-playing schools but overall considered a lower level of play.

Results: There was a trend for training injury incidence to be lower for the academy group (1.4/1000 player-hours, 95% CI 1.0 to 1.7) compared with the school group (2.1/1000 player-hours, 95% CI 1.4 to 2.9; $P = .06$). Injuries to the ankle/heel and thigh were most common in academy players, and injuries to the lumbar spine and ankle/heel region most common in school players. The training activities responsible for injury differed between the two groups: technical skills (Scrummaging) for school players and contact skills (Defence and Ruck/Maul drills) for academy players.

Conclusion: For injury risk management in youth rugby, coaches of school players should focus on the development of the correct technique during practice of technical skills such as scrummaging, weight training and skills training, and coaches of

academy players should consider the extent to which contact drills are necessary during training.

Key Terms: sport; injury; epidemiology; youth; injury risk

What is known about the subject:

Match injury rates across all playing levels of rugby union are considered high in relation to other team sports. Injury rates from rugby training are lower than match play and the injury patterns and risk factors may be different but training injuries have not been comprehensively studied in youth rugby.

What this study adds to existing knowledge:

Training injury incidence was considerably lower than the previously reported incidence of match injury in the same cohorts of players.

Training-related injuries tended to be more common at the lower level of play (school) compared with the higher level (academy).

The type of training activities undertaken within youth rugby union might contribute to training injury risk to a greater extent than the overall volume of training and the composition of training sessions in terms of contact elements should be considered carefully from an injury risk perspective.

INTRODUCTION

Training in team sports is performed to: 1) develop individual and team skills; 2) develop specific physical attributes; and 3) formulate team strategies. It may also have a role in player welfare by conditioning players to prevent injuries during competition. Rugby Union is one of the most popular team sports in the world but as a full-contact sport the inherent injury risk is substantial. In the professional game, the incidence of injury in match play has been shown to be much higher than during training, [23] which reflects the differences between match and training activities in rugby, although in a two-year injury surveillance study of elite rugby 20% of the total number of injuries occurred in the training situation due to greater exposure time to training. [2, 3] Activities occurring within the training environment are more controllable than during match play and therefore injury reduction may be more feasible in training. In order to be able to identify targets for injury reduction during training, it is important to understand which injuries occur and how they are incurred.

The nature and intensity of many of the activities performed during training differ from those during match play. This is likely to influence not only injury incidence but also the risk factors contributing to training-related as opposed to match-related injuries. [3] A number of studies have investigated injury risk during match play within youth rugby, [11, 15, 17, 19] but only a few have reported results for training injuries separately from match injuries. [1, 16] As is evident with match injury incidence, training injury incidence has been reported to increase with higher levels of competition in senior rugby union, [3, 4] but this has not been explored in youth rugby.

Therefore, the aims of this study were to: 1) describe the incidence, severity, anatomical location and type of youth rugby training injuries; 2) determine the injury events and type of training activities associated with injuries; and 3) compare two levels of play (professional academy v school) within English youth rugby union.

METHODS

The study was an observational prospective cohort design that used a questionnaire-based data collection procedure. Data collection occurred over two complete seasons (2006-2007 and 2007-2008) and involved twelve English Premiership youth academies and seven senior school rugby union teams. Individual players were squad members of their respective teams, aged 16-18 years, and all players provided written informed consent with passive consent forms sent to the players' parents / legal guardians. The two cohorts comprised 250 academy players (2006-2007: 131; 2007-2008: 119) and 222 school players (2006-2007: 139; 2007-2008: 83); with 46 academy and 10 school players participating in both seasons. There were 121 forwards and 129 backs in the academy cohort, and 122 forwards and 100 backs in the school cohort. The participant characteristics are identical to those provided previously. [19] The academy group consisted of players selected into the Premiership academies structure and so represented the potential future elite England professional senior players. The academies are not educational institutions but are 'rugby academies', the youth sections of the top-level professional rugby clubs in England, which select high-performing youth players into their structure to facilitate their rugby development. The school group comprised players from well-established rugby playing schools and so could be considered as being towards the higher end of the

secondary school playing standard in England. Nevertheless, the academy level was deemed a higher playing level.

The injury definition used was consistent with the 2007 IRB consensus statement. [8] The definition used in the study was for time-loss injuries, which were defined as 'any injury that prevents a player from taking a full part in all training and match play activities typically planned for that day for a period of greater than 24 hours from midnight at the end of the day the injury was sustained'. Recurrent injuries were defined as 'any injury of the same type and at the same site as an index (new) injury, occurring after a player's return to full participation from the index injury'. Injury severity was defined by the total number of days elapsed from the day of injury until a player returned to full fitness, with full fitness being defined as 'the player being able to take a full part in training activities typically planned for that day and available for match selection'.

Details of each individual injury were recorded on a specific form utilising the Orchard Sports Injury Classification System version 8, [21] and included information about date of injury, classification of the injury to two levels (body site, type of injury), information regarding the injury event, and date of return from injury. Weekly training exposure was calculated at a group level for each team by summing the duration of different training activities and the number of players participating in each training session. Training activities only included those sessions organised specifically by the rugby coaching team and were separated into broad categories to permit a breakdown of the proportion of time spent in each training activity. Only injuries attributed to these organised training sessions were included in the analysis.

Within academies, training exposure and injury data were collected by Strength and Conditioning Coaches and Physiotherapists. In the school setting, the first team Coach recorded training exposure and the school Nurse or Doctor recorded injury data. For each of the two seasons, Week 1 of injury surveillance was 1st July (the beginning of pre-season) with the season ending (Week 52) on 30th June. Injuries were recorded within these time periods and follow-ups continued past the end of the second season until all injuries had been resolved. Variability in quality of reporting may have occurred due to different levels of experience in the diagnosis of musculoskeletal injuries amongst the medical support available at each club; this potential bias was minimised by ensuring that a nominated medical professional (either an on-site nurse, physiotherapist or doctor) had to treat all rugby injuries. This restriction was considered important from a data quality perspective but may have biased the school cohort towards the higher end of the overall school playing population in England.

Injury incidence was reported as the number of injuries per 1000 player-training hours along with 95% confidence intervals (CIs), with injuries sustained during specific training activities reported as the number of injuries per 1000 player-training activity hours (e.g. weight training injuries per 1000 player weight training hours). Injury severity was reported as the mean and median number of days absence. Two-tailed Z tests were used to assess for significant differences in injury incidence rates between groups (academy versus school), [14] differences between severity distributions were assessed via Mann Whitney U Tests, and differences between proportions were assessed using the two-proportion z-test. Significance was accepted at $P \leq 0.05$

(equal variances assumed), and exact *P* values are reported throughout. Due to the exploratory nature of the analysis no correction was applied for multiple comparisons.

Ethical approval for the study was obtained from the institutional ethics committee.

RESULTS

The ratio of forwards to backs was not different between groups ($P = .155$). A total of 47,431 player-training hours (forwards: 22,245; backs: 25,186) were recorded for the academy group and 15,877 player-training hours (forwards: 9391; backs: 6486) were recorded for the school group over the two seasons. The average academy player (190 hours/season) therefore completed approximately two and half times the duration of training of the average school player (72 hours/season). Academy players spent relatively more time performing weight training ($P = .017$) and a trend for more time in 'prehabilitation' training ($P = .094$), whereas school players spent relatively more of their training time in rugby-specific training ($P = .002$), primarily involving activities with an element of body contact (Figure 1).

Incidence and Severity of Training Injury

The academy group sustained 64 training injuries (forwards: 27; backs 37; new: 54; recurrent: 10) and the school group 34 training injuries (forwards: 23; backs: 11; new: 27; recurrent: 7). There were a total of 1075 and 929 lost days of training and playing because of training injuries within academies and schools, respectively. The training injury incidence was numerically lower in the academy group with 1.4 injuries per 1000 player-training hours (95% CI 1.0 to 1.7), compared with the school group with 2.1 injuries per 1000 player-training hours (95% CI 1.4 to 2.9; $P = .06$) although this

difference just failed to reach the critical threshold for significance (Table 1). The rate ratio, with the school group as reference, was 0.66 (95% CI, 0.44 to 1.01). The severity of training injuries was not significantly different between groups, either considering all injuries (P = .974) or recurrent injuries only (P = .318) (Table 1).

The incidence of training injuries was significantly lower for the academy forwards (1.2/1000 player-hours, 95% CI 0.8 to 1.7) than the school forwards (2.5/1000 player-hours, 95% CI 1.5 to 3.5; P = .01) but there was no difference between academy backs (1.5/1000 player-hours, 95% CI 1.0 to 1.9) and school backs (1.7/1000 player-hours, 95% CI 0.7 to 2.7; P = .72).

Nature of Training Injury

Injury location

The lower limb was the most commonly injured body area for both academies and schools (Figure 2). Within academies, the mean severity of training injuries was highest for the lower limb and head and neck, whereas injuries to the trunk and upper limb were the most severe in the school group (Figure 2).

By individual anatomical location, the incidence of training injuries was highest to the ankle/heel and thigh within academies. In schools, the incidence of training injuries was highest to the lumbar spine, ankle/heel and shoulder, with the incidence of lumbar spine injuries significantly higher than in academies (P = .002) (Figure 3).

Injury Type

The tissues most commonly injured during training were muscle and tendon strains (academy: 0.6/1000 player-training hours; school: 0.9/1000 player-training hours) followed by ligament injuries (academy: 0.4/1000 player-training hours; school: 0.8/1000 player-training hours), for both the academy and school groups (Table 2). There were no differences in incidence rate and severity distributions when comparing between groups for specific injury types.

Injury Event

Running (Academy: 20%; School: 20%) and tackling (Academy: 20%; School: 14%) were responsible for the greatest proportion of injuries by individual event (Table 3). Although the low absolute count of injuries from each injury event category is noted, the most common specific injury diagnoses across both groups, resulting from running related activities, were lateral collateral ankle ligament sprains (n=6 of 20 injuries), hamstring strains (n=4), and adductor muscle strains (n=3). Tackling resulted in upper and lower limb injuries with over a third of all upper limb training injuries (n = 5 out of 13 total upper limb injuries) sustained by players making a tackle. There was a significantly greater proportion of injuries from the scrum event in the school group compared with the academy group ($P = .005$) and a tendency for a greater proportion of injuries from conditioning in the academy group compared with the school group ($P = .068$). There were no differences in severity distributions between the two groups for any injury event category.

Injury by Training Activity

By nominated training activity, defence training presented the highest injury incidence in academies and scrummaging training the greatest injury incidence in schools (Table

4). The incidence of injury during isolated skill (P = .12) and weight training (P = .07) tended towards being higher within schools than academies. All weight training injuries within schools occurred to the trunk (n = 3) and two out of three head and neck injuries in schools occurred during scrummaging training.

DISCUSSION

This study determined the nature of injuries and the activities associated with injury in a cohort of academy and a cohort of school (16–18 years) rugby union players. The main findings are that (1) training injury incidence was numerically lower for the academy group versus the school group (i.e., lower values at the higher level of play), (2) running and tackling are the events most commonly associated with training injuries, and (3) there was a tendency for higher injury incidence in the school group from technical skills training and weight training activities.

The incidence of training injuries was significantly lower than the corresponding match injury incidence rates for both academies (1.4 vs. 47/1000 player-match hours; P < .01) and schools (2.1 vs. 35/1000 player-match hours; P < .01). [19] Nevertheless, training injuries still accounted for 37% (academies) and 20% (schools) of all (combined match and training) injuries sustained by the players over the 2-season period. [19] Because the training environment is more controllable than the match environment, there may be a greater opportunity for injury risk reduction in this setting, making a better understanding of injury risk during training a priority.

The incidence of training injuries was numerically higher for school players than academy players, approaching statistical significance, which was in contrast to match

injury incidence reported from the same study population where match injury incidence was higher for academy players than school players. [19] Injury incidence in the present study is lower than for a similar aged cohort in New Zealand (4.3/1000 hours), [12] although a broader injury definition was employed in the earlier study. It is of note that there was a difference in injury incidence between school forwards and academy level forwards, but not between backs, suggesting that it is the training activities undertaken by school forwards which elicit higher injury risk.

In professional rugby it has been reported that higher training volumes lead to more and higher severity training injuries, suggested to be due to the accumulated effect of training load. [4] In the present study, academy players undertook on average 2.5 times the volume of training in comparison with school players, but the overall incidence of training injury was lower within academies than schools. This is likely to reflect the content of the academies training, where there was a predominant focus towards the physical development and conditioning of players, including considerable time spent on injury minimisation exercises and weight training, which are activities with a low propensity for injury. On the other hand, with less time available to train, the emphasis within schools was on rugby-related training and preparation for match play. Interestingly, the occurrence of injury in elements of training with a high technical component was greater in schools, including injuries from weight training, scrummaging and isolated skill development activities. This suggests that time spent in the development of correct technique and functional movement conditioning is important before full training activities are undertaken and there might be a need for a greater focus on this principle in school rugby.

Our findings are consistent with those of previous studies [3, 13] showing that, of all contact and non-contact injury events, running was the most common training injury event within both the professional academies and schools. This injury event accounts in part for the high proportion of lower limb injuries sustained, and these injuries were mainly ankle ligament sprains, hamstring muscle and adductor muscle strains. Studies from other sports have shown that it is possible to substantially reduce the number of non-contact lower limb injuries through injury minimisation training interventions, such as specific pre-activation warm-up protocols. [18 22] These findings are promising and it is important to determine whether similar effects can be achieved in adolescent and young adult males in a collision sport environment such as rugby.

With regard to contact events, both tackling and being tackled had comparatively high incidences of injury, within both academies and schools, which is consistent with evidence from schools rugby match play and training in Scotland [17] and senior professional rugby. [3] However, we found a difference between academies and schools in the incidence of injury during scrummaging training, with scrummaging training in schools producing one of the highest incidence rates of all training activities per unit of exposure time (total scrummaging exposure = 405 hours). In contrast, we did not record any scrum-related injuries to academy players with a total exposure of 287 hours. Caution needs to be taken in reading too much into these findings given the relatively low number of injuries and exposure, but the scrum has received a lot of attention in the context of injury risk. [7] Coaching of safe technique and training of the full scrum via staged progressions beginning with correct individual technique is emphasised in the various coach education initiatives led by national rugby unions, including ‘RugbySmart’ (New Zealand), ‘Scrum Factory’

(England), ‘Scrum Ready’ (Scotland) and ‘Força 8’ (Portugal). The RugbySmart programme, which was the precursor to other initiatives, has been evaluated and shown a reduction in moderate to serious rugby injuries in areas which were targeted by the educational programme, specifically a reduction in the number of disabling spinal cord injuries due to scrummaging. [10, 20] All coaches involved in youth rugby should subscribe to these progressive training principles, irrespective of the playing level being coached.

One of the aims of a weight training programme is to develop muscle strength and endurance to help to reduce the overall incidence of rugby injury. [9] However, high volumes of weight training have also been suggested to increase the incidence of specific training injuries, such as lumbar disc/nerve root injuries in forwards, [3, 6] potentially due to factors including sub-optimal pre-conditioning of lumbar spine stabiliser muscles, overload of the lumbar spine, poor lifting technique, and other lumbar loading activities such as scrummaging. In our study, although the overall number of injuries sustained through weight training was comparatively small, all weight training injuries in schools and half of these injuries in the academies were lumbar spine injuries. Thus, there is a basis to suggest that the preparation of players for weight training, the types of training exercises attempted, the level of supervision, and the progression of the training itself should be carefully managed from both a loading/volume and a technique point of view. [5] Further, this might require particular attention in the schools cohort where little or no pre-season conditioning or physical preparation took place and also with less strength and conditioning support provided to players.

This study only surveyed a small proportion of the youth rugby playing population in England although it did involve the majority of eligible academy level players nationally. Due to the size of the sample population and the relatively low training incidence rates, further surveillance would be required to detect small to moderate differences in overall injury risk between groups. In a cluster study of this type there is potential for variability in reporting of injury diagnoses between sites but this was minimised through ensuring consistent point of medical support for all injuries at each site and via provision of consistent guidance and regular contact between the research team and the medical professionals to promote consistency.

CONCLUSIONS

The incidence of training injuries in both the academy and school cohorts were comparable with rates determined for senior rugby union but with a trend for training injuries to be more common at the lower level of play (school) compared with the higher level (academy). For injury risk management in youth rugby, tentative recommendations would be for coaches of school players to focus on the development of the correct technique during practice of technical skills such as scrummaging, weight training and skills training, and coaches of academy players should consider the extent to which full contact drills are necessary during training.

COMPETING INTERESTS

None.

REFERENCES

1. Bird YN, Waller AE, Marshall SW, Alsop JC, Chalmers DJ, Gerrard DF. The New Zealand rugby injury and performance project: V. Epidemiology of a

season of rugby injury. *British Journal of Sports Medicine.* 1998;32(4):319-325.

2. Brooks JH, Fuller CW, Kemp SP, Reddin DB. Epidemiology of injuries in English professional rugby union: part 1 match injuries. *Br J Sports Med.* 2005;39(10):757-766.

3. Brooks JH, Fuller CW, Kemp SP, Reddin DB. Epidemiology of injuries in English professional rugby union: part 2 training Injuries. *Br J Sports Med.* 2005;39(10):767-775.

4. Brooks JH, Fuller CW, Kemp SP, Reddin DB. A prospective study of injuries and training amongst the England 2003 Rugby World Cup squad. *Br J Sports Med.* 2005;39(5):288-293.

5. Faigenbaum AD, Myer GD. Resistance training among young athletes: safety, efficacy and injury prevention effects. *Br J Sports Med.* 2010;44(1):56-63.

6. Fuller CW, Brooks JH, Kemp SP. Spinal injuries in professional rugby union: a prospective cohort study. *Clin J Sport Med.* 2007;17(1):10-16.

7. Fuller CW, Brooks JHM, Cancea RJ, Hall J, Kemp SPT. Contact events in rugby union and their propensity to cause injury. *British Journal of Sports Medicine.* 2007;41(12):862-867.

8. Fuller CW, Molloy MG, Bagate C, et al. Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union. *Clin J Sport Med.* 2007;17(3):177-181.

9. Gamble P. Physical preparation for elite-level rugby union football. *Strength and Conditioning Journal.* 2004;26(4):10-23.

10. Gianotti SM, Quarrie KL, Hume PK. Evaluation of RugbySmart: A rugby union community injury prevention programme. *Journal of Science and Medicine in Sport.* 2009;12(3):371-375.

11. Haseler CM, Carmont MR, England M. The epidemiology of injuries in English youth community rugby union. *Br J Sports Med.* 2010;44(15):1093-1099.

12. Junge A, Cheung K, Edwards T, Dvorak J. Injuries in youth amateur soccer and rugby players - comparison of incidence and characteristics. *British Journal of Sports Medicine.* 2004;38:168-172.

13. Kerr H, Curtis C, Micheli L, Kocher M, Zurakowski D, Kemp S. Collegiate rugby union injury patterns in New England: a prospective cohort study. *Br J Sports Med.* 2008;42:595 - 603.

14. Kirkwood BR, Sterne JAC. *Essential Medical Statistics*. Second ed: Blackwell Science Ltd; 2003.

15. McIntosh AS, Savage TN. *Rugby Union Injury Surveillance Study: Report on Seasons 2002-2004*: University of New South Wales; 2006.

16. McManus A, Cross DS. Incidence of injury in elite junior Rugby Union: a prospective descriptive study. *Journal of Science and Medicine in Sport.* 2004;7(4):438-445.

17. Nicol A, Pollock A, Kirkwood G, Parekh N, Robson J. Rugby union injuries in Scottish schools. *J Public Health (Oxf).* 2010.

18. Olsen OE, Myklebust G, Engebretsen L, Holme I, Bahr R. Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial. *British Medical Journal.* 2005;330(7489):449-452.

19. Palmer-Green DS, Stokes KA, Fuller CW, England M, Kemp SP, Trewartha G. Match Injuries in English Youth Academy and Schools Rugby Union: An Epidemiological Study. *Am J Sports Med.* 2013.

20. Quarrie KL, Gianotti SM, Hopkins WG, Hume PA. Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union: ecological study. *BMJ.* 2007;334(7604):1150.

21. Rae K, Britt H, Orchard J, Finch C. Classifying sports medicine diagnoses: a comparison of the International classification of diseases 10-Australian modification (ICD-10-AM) and the Orchard sports injury classification system (OSICS-8). *British Journal of Sports Medicine.* 2005;39(12):907-911.

22. Walden M, Atroshi I, Magnusson H, Wagner P, Hagglund M. Prevention of acute knee injuries in adolescent female football players: cluster randomised controlled trial. *British Medical Journal.* 2012;344.

23. Williams S, Trewartha G, Kemp S, Stokes K. A Meta-Analysis of Injuries in Senior Men's Professional Rugby Union. *Sports Med.* 2013.

FIGURE LEGENDS

Figure 1. Distribution of training activities for academies and schools

Figure 2. Body location of training injuries for academy and school players as a percentage of all injuries (mean severity in parentheses).

Figure 3. Training injury incidence (injuries per 1000 player-hours, with 95% CI) by specific anatomical location, for academies and schools. Significant difference between academy and school at ** $P \leq .01$. CI, confidence interval.

Table 1. Training Injury Incidence and Severity for Academies and Schools

	Academy		School	
Type of injury	Incidence (95% CI)	Severity, mean (95% CI) [median]	Incidence (95% CI)	Severity, mean (95% CI) [median]
New	1.1 (0.8 to 1.4)	18 (11 to 24) [9]	1.7 (1.1 to 2.3)	19 (1 to 36) [7]
Recurrent	0.2 (0.1 to 0.3)	12 (5 to 22) [7]	0.4 (0.1 to 0.8)	60 (-2 to 122) [37]
All	1.4 (1.0 to 1.7)	17 (11 to 22) [9]	2.1 (1.4 to 2.9)	27 (9 to 45) [9]

Incidence was measured as number of injuries per 1000 player-training hours; severity was measured as mean and median number of days' absence. CI, Confidence Interval

Table 2 Training Injury Type expressed as Percentage of Injuries, Incidence and Severity for Academies and Schools [a]

	Academy				School			
Injury type group	% of injuries (n=64)	Incidence (95% CI)	Severity (median)		% of injuries (n=34)	Incidence (95% CI)	Severity (median)	
CNS/PNS	8	0.1 (0.0 to 0.2)	17	(8)	6	0.1 (0.0 to 0.3)	75	(-[b])
Contusion/laceration/lesion	14	0.2 (0.1 to 0.3)	8	(8)	6	0.1 (0.0 to 0.3)	6	(-[b])
Bone stress/fractures	3	0.1 (0.0 to 0.1)	94	(-[b])				
Joint (non-bone) ligament	31	0.4 (0.2 to 0.6)	18	(9)	38	0.8 (0.4 to 1.3)	39	(7)
Muscle & tendon	41	0.6 (0.3 to 0.8)	12	(8)	41	0.9 (0.4 to 1.3)	16	(13)
Other	3	0.1 (0.0 to 0.1)	21	(-[b])	9	0.1 (0.0 to 0.3)	13	(-[b])

[a]Incidence was measured as number of injuries per 1000 player-training hours; severity was measured as mean and median number of days' absence; CNS/PNS, Central Nervous System / Peripheral Nervous System. [b]Fewer than 3 injuries in the category displayed.

Table 3. Training Injury Event expressed as Percentage of Injuries and Severity for Academies and Schools [a]

Injury Event	Academy			School		
	% of injuries (n=64)	Severity (median)		% of injuries (n=34)	Severity (median)	
Collision	5	39	(5)	6	84	(-[b])
Ruck/maul	8	9	(8)	3	1	(-[b])
Scrum				12 **	7	(6)
Tackled	13	21	(7)	9	5	(3)
Tackling	20	13	(7)	14	14	(14)
Other contact	5	30	(27)	6	13	(-[b])
All Contact	51	18	(8)	50	18	(9)
Change direction	8	10	(9)	3	19	(-[b])
Conditioning	11	22	(6)	0		
Jumping	1	24	(-[b])	0		
Running	20	15	(9)	20	17	(5)
Weights	8	12	(9)	9	80	(3)
All Non-Contact	48	16	(9)	32	35	(5)
Unknown	1			18 **		

[a]Severity was measured as mean and median number of days' absence. The specific event associated with training injury was recorded for 63 out of 64 injuries for the academy group (1 unknown event) and 28 out of 34 injuries for the school group (6 unknown events), with 100% equating to the total number of injuries. [b]Fewer than 3 injuries in the category displayed. Significant difference in proportion of injuries from the specific injury event between academy and school * at $P \leq .05$, ** at $P \leq .01$.

Table 4. Training Injury expressed as Percentage of Injuries, Incidence and Severity by Training Activity for Academies and Schools [a]

	Academy				School			
Training Activity	% of injuries (n=64)	Incidence (95% CI)	Severity (median)		% of injuries (n=34)	Incidence (95% CI)	Severity (median)	
Weight training	8	0.4 (0.1 to 0.7)	12	9	9	1.5 (0.0 to 3.1)	80	(-[b])
All rugby								
Ind. skills	5	0.8 (0.0 to 1.8)	43	(-[b])	9	2.8 (0.0 to 6.0)	57	(-[b])
Attack	27	5.8 (3.1 to 8.6)	18	(9)	14	4.1 (0.5 to 7.7)	8	(7)
Defence	28	8.2 (4.4 to 12.0)	10	(7)	14	7.4 (0.9 to 13.8)	11	(12)
Scrummaging					12	9.9 (0.2 to 19.5)	7	(6)
Ruck/maul	9	7.1 (1.4 to 12.8)	9	(-[b])	9	5.3 (0.0 to 11.3)	2	(-[b])
Lineouts	3	2.6 (0.0 to 6.1)	24	(-[b])	3	1.7 (0.0 to 5.0)	23	(-[b])
Conditioning	11	1.4 (0.4 to 2.4)	12	(-[b])	3	4.5 (0.0 to 13.4)	5	(-[b])
Unknown	9				27			

[a]Incidence was measured as number of injuries per 1000 player-training activity hours; mean and median severity was measured as number of days' absence. CI, Confidence Interval. The specific training activity being undertaken at the time of training injury was recorded for 58 of 64 injuries for the academy group (6 unknown) and 25 of 34 injuries for the school group (9 unknown), with 100% in this table equating to the total number of injuries. [b]Fewer than 3 injuries in the category displayed.

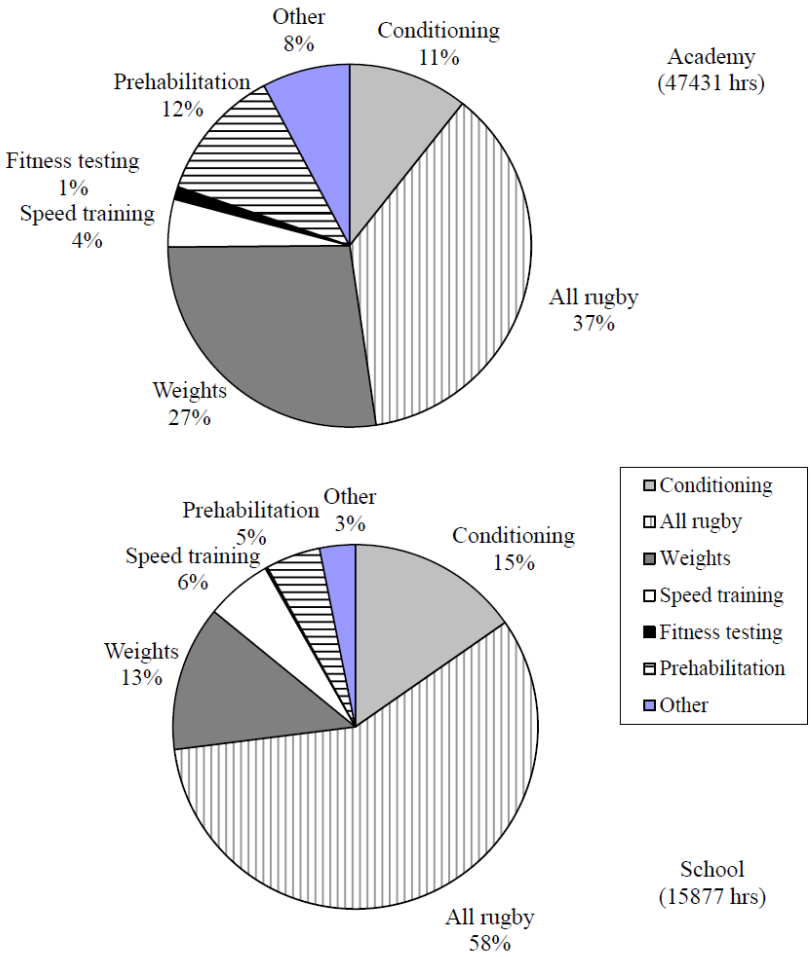
Other
8%
Conditioning
11%
Academy
(47431 hrs)
Prehabilitation
12%
Fitness testing
1%
Speed training
4%
All rugby
37%
Weights
27%
Prehabilitation
5%
Other
3%
Conditioning
15%
Speed training
6%
Weights
13%
All rugby
58%
School
(15877 hrs)
Conditioning
All rugby
Weights
Speed training
Fitness testing
Prehabilitation
Other

Figure 1

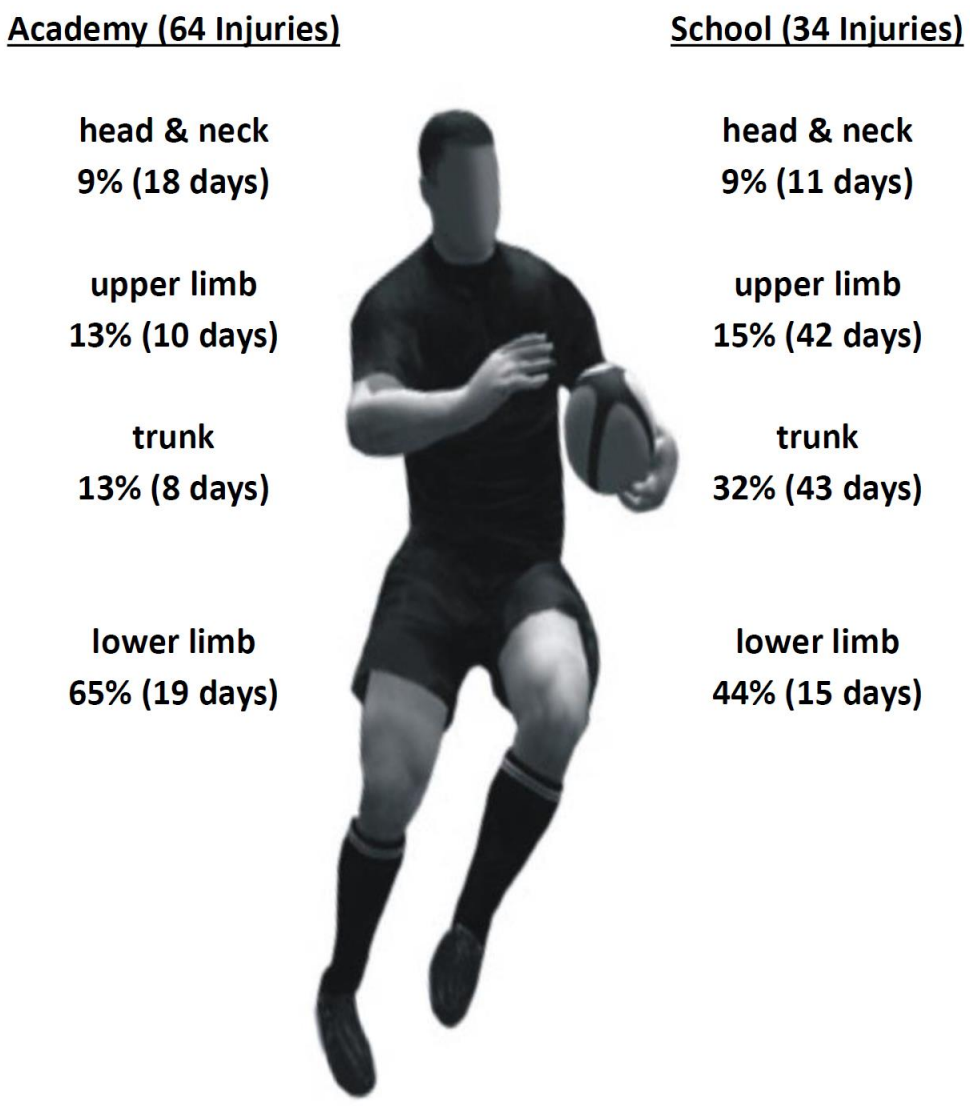
Academy (64 Injuries)
School (34 Injuries)
head & neck
9% (18 days)
upper limb
13% (10 days)
trunk
13% (8 days)
lower limb
65% (19 days)
head & neck
9% (11 days)
upper limb
15% (42 days)
trunk
32% (43 days)
lower limb
44% (15 days)

Figure 2

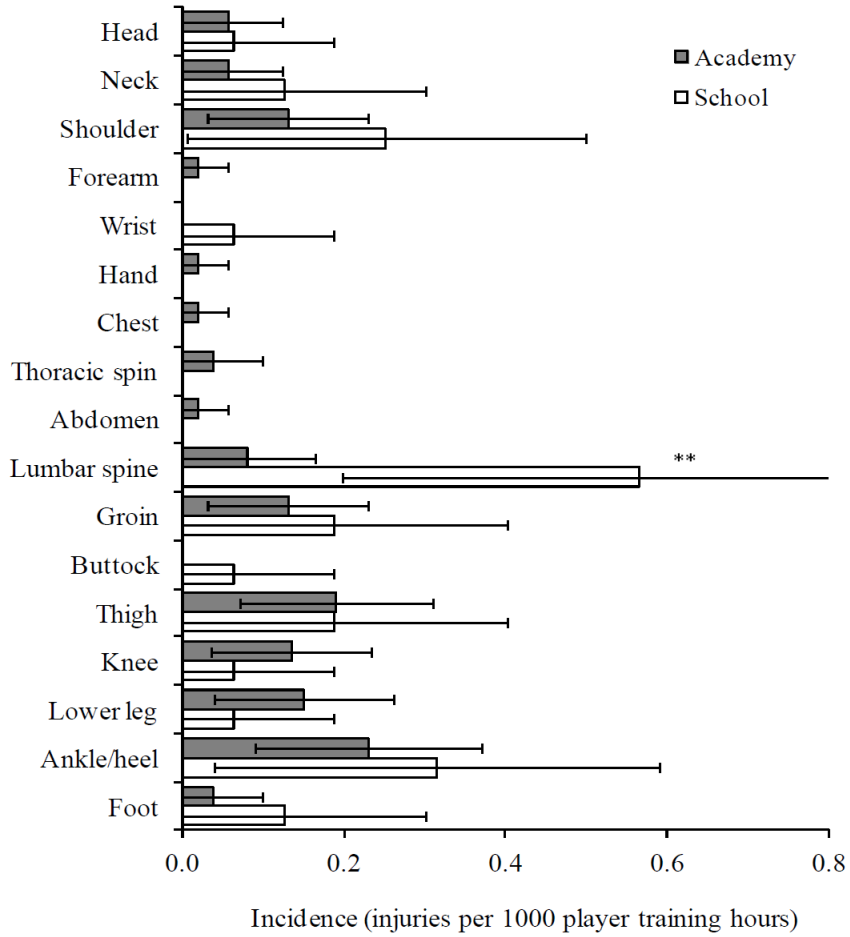
Head
Neck
Shoulder
Forearm
Wrist
Hand
Chest
Thoracic spin
Abdomen
Lumbar spine
Groin
Buttock
Thigh
Knee
Lower leg
Ankle/heel
Foot
Academy
School
**
0.0
0.2
0.4
0.6
0.8
Incidence (injuries per 1000 player training hours)

Figure 3