



Citation for published version:

Palmer-Green, DS, Stokes, KA, Fuller, CW, England, M, Kemp, SPT & Trewartha, G 2013, 'Match injuries in English youth academy and schools rugby union: an epidemiological study', *The American Journal of Sports Medicine*, vol. 41, no. 4, pp. 749-755. <https://doi.org/10.1177/0363546512473818>

DOI:

[10.1177/0363546512473818](https://doi.org/10.1177/0363546512473818)

Publication date:

2013

Document Version

Early version, also known as pre-print

[Link to publication](#)

University of Bath

Alternative formats

If you require this document in an alternative format, please contact:
openaccess@bath.ac.uk

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

1 Title:

2 Match injuries in English youth academy and schools rugby union

3

4 Running Title:

5 Injuries in English youth rugby union

6

7 Authors:

8 Deborah S Palmer-Green^{1,2}, Keith A Stokes¹, Colin W Fuller³, Michael England⁴,

9 Simon P T Kemp⁴, Grant Trewartha¹

10

11 Affiliations:

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

13 ² Centre for Sports Medicine, University of Nottingham, Nottingham, UK.

14 ³ International Rugby Board, Dublin, Ireland.

15 ⁴ Rugby Football Union, Twickenham, UK.

16

17 Corresponding Author:

18 Grant Trewartha,

19 Sport, Health and Exercise Science,

20 Department for Health,

21 University of Bath,

22 Bath, UK.

23 BA2 7AY

24 Tel: +44 1225 383055

25 Fax: +44 1225 383833

26 Email: g.trewartha@bath.ac.uk

27

28 Institution:

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

31

32 Acknowledgements:

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

40

41 **TITLE**

42 Epidemiological study of match injuries in English youth academy and schools rugby

43 union

44

45

46 **ABSTRACT**

47 **Background:** Numerous injury epidemiology studies have reported injury patterns in
48 senior rugby union but investigations in youth rugby are limited.

49 **Hypothesis/Purpose:** The aim of this research was to determine the incidence and
50 nature of match injuries in English youth rugby union, making comparisons between
51 two different levels of participation.

52 **Study Design:** A prospective cohort design

53 **Methods:** A two season (2006/07; 2007/08) study obtained information on injuries
54 sustained in male youth (16 – 18 yrs) rugby union players from 12 English
55 Premiership academies (n = 250) and 7 schools (n = 222). Match exposure (player-
56 hours) and injury details were recorded.

57 **Results:** Match injury incidence was 47/1000 player-hours for the academy and
58 35/1000 player-hours for the school groups; these rates were statistically different (P
59 = 0.026). The most common injury site was the lower limb and the most common
60 injury type was a ligament sprain, with injuries to the knee and shoulder region
61 resulting in the greatest burden of injury for both groups. The tackle event was the
62 most common cause of match injury for both academy (51% of injuries) and school
63 (57% of injuries) groups.

64 **Conclusion:** Overall the incidence of injury for youth rugby was lower than for
65 previous studies in senior rugby but injury patterns (location, type) and causes were
66 similar. The study confirmed that match injury incidence was significantly greater in
67 elite academy youth rugby union than schools rugby. The results suggest that specific
68 focus for injury risk management in youth rugby should be on players' tackle
69 technique, and prevention strategies for knee and shoulder injuries.

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

71 **What is known about the subject:**

72 Injury rates in senior elite rugby union are considered high in relation to other team
73 sports. Some small-scale studies on youth rugby union have suggested injury rates are
74 lower than senior rugby.

75 **What this study adds to existing knowledge:**

76 This study provides a large-scale longitudinal study of English elite youth rugby at
77 two different levels and demonstrates that injury rates are lower for youth rugby but
78 not as low as most other studies have previously found.

79 The injury incidence was 34% greater at the higher playing level of elite academy
80 rugby than school rugby but the severity of recurrent injuries was greater in schools.
81 Similar injury patterns (location, type, event) were observed between groups and to
82 senior rugby but emphasized the need to focus on reducing tackle event injuries in
83 youth rugby players

84 INTRODUCTION

85 Rugby union is one of the most popular worldwide sports, ranking second in
86 participation rates only to soccer as a football code. However, rugby union has
87 increasingly come under scrutiny from an injury perspective because the incidence of
88 injury at the professional level is one of the highest of any team sport⁵ albeit with
89 similar injury rates to other full-contact sports, such as rugby league,¹⁹ Australian
90 Rules Football,³⁶ American Football²⁵ and ice-hockey.²⁹ Compared with semi-contact
91 team sports such as soccer, rugby union has four times the incidence of injury, with
92 the potential for more serious injuries.³³ Injury incidence and severity have been
93 reported for senior amateur and professional rugby union with the consensus that
94 injury rates increase with competitive level.^{1-3, 5-7, 23, 40}

95

96 Young people are thought to be at relatively greater risk of injury if they are exposed
97 to high levels of sport participation during the time when musculoskeletal
98 developmental changes are occurring.¹⁷ Injury risk in youth sport is multi-factorial,
99 and is modified by skill level,^{9, 38} physical characteristics³⁰ and competitive
100 environment.^{38, 39} However, injury surveillance within youth age group rugby union
101 is somewhat limited in scope and scale, and comparisons suffer due to the variety of
102 methodologies employed. Existing data generally show that incidence rates in youth
103 rugby union are lower than in senior rugby union,^{20, 34} with increasing incidence in the
104 older youth age groups.^{14, 20} Injury patterns, in terms of location and types of injury,
105 are broadly similar to senior rugby.^{14, 24, 32, 34} England has the highest youth rugby
106 union participation in the world,²² but to date only small-scale injury surveillance
107 studies have been conducted within the English game at youth level.²⁰

108 Therefore, the aim of this study was to describe the nature of injuries resulting from
109 match play within English youth rugby union, including a comparison between two
110 levels of play within the same age group; namely professional academy *versus* school
111 rugby.

112

113 **METHODS**

114 The study was an observational prospective cohort design that used a questionnaire-
115 based data collection procedure. Data collection occurred over two complete seasons
116 (2006/07 and 2007/08) and involved twelve English Premiership youth academies and
117 seven senior school rugby union teams. The Premiership academy players represent
118 the elite level of youth rugby (15% of the academy cohort represented national age-
119 group teams during the study). The school players were recruited from very
120 established rugby-playing schools which generally performed well in national-level
121 schools competitions. Players participating in the study were aged 16-18 years and
122 were excluded if they had not reached 16 years by the start of the rugby season in
123 question or would have reached 19 years during the season. Written informed consent
124 was obtained from individual players and passive consent forms were sent to all
125 parents / legal guardians to provide an opportunity to opt-out. The cohorts comprised
126 250 academy players (2006/07: 131; 2007/08: 119) and 222 school players (2006/07:
127 139; 2007/08: 83), with 46 academy and 10 school players participating in both
128 seasons. There were 121 forwards and 129 backs in the academy cohort, and 122
129 forwards and 100 backs in the school cohort. Body mass and body height were
130 recorded for each player at the beginning of the season.

131

132 For the purposes of injury surveillance the start date was taken as 1st July and the end
133 date was 30th June for each season; however competitive matches (and therefore the
134 match exposure) were played between September 1st and April 30th in each season.
135

136 All injury definitions used were consistent with the 2007 IRB consensus statement.¹⁵
137 The primary injury definition used was for time-loss injuries, which were defined as
138 ‘any injury that prevents a player from taking a full part in all training and match play
139 activities typically planned for that day for a period of greater than 24 hours from
140 midnight at the end of the day the injury was sustained’. Recurrent injury was defined
141 as ‘an injury of the same type and at the same site as an index (new) injury, occurring
142 after a player’s return to full participation from the index injury’. Injury severity was
143 defined by the total number of days elapsed from the day of injury until a player
144 returned to full fitness; full fitness being defined as ‘the player being able to take a
145 full part in training activities typically planned for that day and available for match
146 selection’. Details of each individual injury were recorded on a specific form utilising
147 the OSICS version 8⁴¹ coding system, and including the date of injury, classification
148 of the injury at two levels (body site, type of injury), information on the injury event,
149 and the date of return from injury. Match exposure was calculated as the number of
150 matches multiplied by the number of registered players per team multiplied by 1.33
151 hours, with the appropriate correction applied if a team had less than 15 players
152 registered in the audit. Within academies, match exposure and injury data were
153 collected by the strength and conditioning coach and physiotherapist, respectively.
154 Within schools, the first team coach recorded match exposure and the school nurse or
155 doctor recorded injury data. One criterion used for schools to be included in the study
156 was that a nominated medical professional (either an on-site nurse, physiotherapist or

157 doctor) had to treat all rugby injuries sustained. This restriction was considered
158 important from a data quality perspective but may have biased the school cohort
159 towards the higher end of the overall school playing population in England.

160

161 Exposure and injury data for the two seasons were combined. Injury incidence was
162 reported as the number of injuries per 1000 player-match hours with 95% confidence
163 intervals (CI). Injury severity was reported as the mean and median number of days
164 absence from training and match play. Injury burden was calculated by multiplying
165 injury incidence by mean severity and presented as total days absence per 1000 player
166 hours.¹⁶ Significant differences in values for injury incidence and severity were
167 calculated using two-tailed Z tests.²⁷ Significance was accepted at $P \leq 0.05$ (equal
168 variances assumed) and exact P values are reported throughout.

169

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

171

172 **RESULTS**

173 Academy players were significantly taller ($P = 0.002$) and heavier ($P = 0.001$) than
174 school players. Forwards were significantly taller and heavier than backs for both
175 academy (height: $P = 0.001$; body mass: $P = 0.001$) and school (height: $P = 0.003$;
176 body mass: $P = 0.001$) groups (Table 1).

177

178 **Incidence and severity of match injury**

179 In total, 2343 player match hours (forwards: 1132; backs: 1211) and 109 match
180 injuries (forwards: 44; backs: 65; new: 96; recurrent: 13) were recorded for
181 academies, and 3843 player match hours (forwards: 2060; backs: 1783) and 134

182 match injuries (forwards: 69; backs: 65; new: 119; recurrent: 15) for schools during
183 the study. There were a total of 3441 and 3947 lost days of playing and training time
184 because of match injuries within academies and schools, respectively. The match
185 injury incidence was 47 injuries per 1000 player match hours (95% CI 39 to 57) in the
186 academy group, and 35 injuries per 1000 player match hours (95% CI 29 to 41) for
187 the school group. These rates were significantly different ($P=0.026$, Table 2) and the
188 rate ratio was 1.34 (95% CI 1.04 to 1.72). The mean severity of all match injuries was
189 not significantly different between academies and schools ($P = 0.617$) but the mean
190 severity of recurrent injuries was greater in schools ($P = 0.013$) (Table 2).

191

192 **Nature of match injury**

193 Injury location

194 The lower limb was the most commonly injured body area for both academies and
195 schools (Figure 1) and this was the same for forwards and backs. For the academy
196 group the mean severity of injuries was highest for the trunk, whereas injuries to the
197 upper limb were the most severe for the school group (Figure 1).

198

199 By individual anatomical location, the incidence of match injuries was highest to the
200 ankle/heel, shoulder and knee within academies, with the incidence of ankle/heel
201 injuries higher than in schools ($P = 0.02$). In schools, the incidence of match injuries
202 was highest to the shoulder and head (Figure 2a). The most severe match injuries
203 occurred to the lumbar spine and knee in academies and to the shoulder in schools
204 (Figure 2b). Combining incidence and severity to produce injury burden values as a
205 measure of the overall injury risk demonstrated that shoulder and knee injuries
206 resulted in the highest burden for both the academy and school groups (Figure 2c).

207

208 Injury type

209 The incidence of joint (non-bone) ligament injuries was higher than other injury types
210 in both academies and schools and significantly higher in academies compared with
211 schools (academy: 24/1000 player match hours; school: 14/1000 player match hours;
212 $P < 0.01$) (Table 3). There were no other significant differences between playing
213 groups.

214

215 Combining injury location and injury type for specific diagnoses, knee anterior
216 cruciate ligament (ACL) injuries for the academies and shoulder
217 dislocation/instability injuries for schools resulted in the greatest number of overall
218 days lost (Table 4).

219

220 Injury event

221 Injuries were more likely to occur during contact events (academy: 77%; school:
222 87%) (Table 5). The tackle was the event most commonly associated with injury in
223 both academies and schools, including being tackled (academy: 30% of all injuries;
224 school: 32% of all injuries) and tackling (academy: 21% of all injuries; school: 25%
225 of all injuries). Being tackled (academy: 443 days absence/1000 player match hours;
226 school: 345 days absence/1000 player match hours) and tackling (academy: 325 days
227 absence/1000 player match hours; school: 264 days absence/1000 player match hours)
228 posed the greatest injury burden during matches within both academies and schools
229 (Figure 3), possessing significantly more risk when compared with all other contact
230 events (all $P < 0.05$). Cross-referencing injuries to specific body regions and the
231 match events which caused them, being tackled was the most common cause of all

232 lower limb injuries (academy: 35% [95% CI 23 to 47]; school: 44% [95% CI 32 to
233 56] of lower limb injuries) while tackling was the most common cause of all upper
234 limb injuries (academy: 48% [95% CI 30 to 66]; school: 53% [95% CI 36 to 70] of
235 upper limb injuries). In academies, the majority of knee injuries were associated with
236 being tackled (70% of knee injuries), and this injury combination represented the
237 greatest burden. In schools, 41% of all shoulder injuries were sustained during
238 tackling and these injuries resulted in the greatest number of overall days lost.

239

240 **DISCUSSION**

241 This study determined the incidence, severity, nature and match events relating to
242 injury in English Premiership academy and school rugby union. The main findings
243 are: (i) match injury incidence was approximately 34% higher in the academy group
244 than the school group and this difference was statistically significant, (ii) severity of
245 new injuries was not significantly different between groups, but severity of recurrent
246 injuries was greater in the school group, (iii) the lower limb was the most common
247 injury location for both academy and school players, (iv) joint ligament injuries were
248 the most common type of injury and (v) the tackle was the most common injury event
249 during matches for both academy and school players.

250

251 The incidence of match injuries within this study was higher than reported in most
252 previous youth rugby union research where a similar injury definition was used. Kerr
253 *et al.*²⁶ reported 17 injuries/1000 player match hours for American collegiate (17-21
254 yrs) rugby compared with values of 47 and 35 injuries/1000 player match hours for
255 academy and school players, respectively, in the present study. In two smaller studies
256 which conformed to the IRB consensus statement for reporting injuries, the match

257 injury incidence for Scottish schools rugby with a wider age range (11-17 years) was
258 reported at 11/1000 player match hours,³⁴ although the injury rate at U17 level in a
259 single English community club was 49/1000 player match hours (approximate 95%
260 CI: 26 to 74 injuries/1000 player match hours).²⁰ Two studies published prior to the
261 IRB consensus statement reported injury incidences in youth rugby of 28
262 injuries/1000 player hours in New Zealand²⁴ and 13 injuries/1000 player hours in
263 Australia (14-16 yrs)³² but these studies combined match and training data^{24, 32} which
264 reduces the incidence value since training injury rates have consistently been reported
265 as being considerably lower.⁴

266

267 Despite the injury incidence values in the present study returning higher values than
268 most previous studies in youth rugby, the incidence in both groups were considerably
269 less than those previously reported for elite senior male rugby union, for example 91
270 injuries/1000 player hours for English Premiership club rugby⁵ and 84 injuries/1000
271 player match hours for RWC 2007.¹² A study of international level U20 rugby¹⁴
272 (higher level and older participants than the present study) returned a match injury
273 incidence rate of 57 injuries/1000 player hours, suggesting that injury rates
274 progressively increase with playing level and age. This finding is in line with most
275 other commentaries on comparative injury rates between youth and adult sport which
276 suggest that injury rates are lower for youth sport.^{24, 32}

277

278 There is a common claim that higher levels of play are associated with a higher injury
279 incidence.^{1-3, 6, 7, 23, 40} Within the present study there was a significant difference in the
280 incidence of match injuries between academies and schools, where the incidence was
281 34% higher in the professional academies. Academy players had greater height and

282 mass than their school counterparts, and larger players have been reported to have a
283 higher risk of injury.²⁸ In addition, while fitness testing data were not explicitly
284 collected in the current study, it is reasonable to assume that the professional academy
285 players were physically fitter and stronger due to more sophisticated strength and
286 conditioning programmes and more training time (on average two and a half times the
287 amount of training compared with schools players³⁷). On the one hand, better
288 conditioning and preparation could be protective for players^{8, 35} but on the other hand
289 stronger and fitter players will generate higher forces during collision phases of the
290 game and are likely to be involved in more contact events, thus exposing them to
291 more potential injury events and therefore increasing the risk of injury. Presently, it is
292 difficult to interpret clearly the independent or combined effects of playing level,
293 player size and player fitness/strength on injury risk but the present data suggest that
294 that there might be a trade-off between level of physical preparation and intensity of
295 rugby such that injury rates between playing levels are greater in higher level youth
296 rugby.

297

298 There was no difference in the overall severity of injuries sustained by academy and
299 school players, although a noticeable result was that the mean severity of recurrent
300 injuries was significantly higher in schools (46 days) compared with academies (18
301 days) despite the mean severity of new injuries being similar in schools (27 days) and
302 academies (33 days). Unlike schools, academy players did not take part in a formal
303 structured academy league season in the playing seasons studied. Hence they
304 potentially had less competitive pressure to return to match play after an index (new)
305 injury occurred. This lack of pressure is likely to allow for more lengthy
306 rehabilitation and a delay in making the decision that a player has returned to full

307 fitness. By contrast, pressure to return to play within schools competing in the
308 National Schools Cup (the primary competition for English schools rugby) may
309 reduce the time for those players to complete rehabilitation and to return to play.
310 Assuming the level of medical support is less in schools (typically nursing support
311 with visiting GPs) than in academies (typically physiotherapist support with access to
312 sports medicine trained doctors) then it might be predicted that schools would take
313 longer to return players to training and competition following injury, however school
314 players were in fact returned to play sooner than academy players (by 6 days on
315 average). This early return from injury may then be the reason for the greater severity
316 of recurrent injuries sustained in the school environment (by 28 days on average).
317 This potential issue of pressure to return to play, either from the player themselves or
318 others, is recognised as one of the ‘decision modification’ factors proposed in the
319 model of Creighton¹⁰ which needs to be taken into consideration when deciding a
320 return to participation. The present result of recurrent injury severity points to a need
321 for coaches and medical personnel at schools to consider their return to play decision
322 making processes and on average allow greater rehabilitation time for injuries before
323 players return to full training and competition.

324

325 Findings in the present study generally agree with previous research that the most
326 common location for injury is the lower limb^{3, 24} and the most common type of injury
327 is a joint (non-bone) ligament sprain.^{3, 26} When considering injuries to individual
328 body locations, the present study demonstrates an overall pattern which is also similar
329 to previous research⁵, with injuries to the knee and to the shoulder representing the
330 highest burden for both levels of play within English youth rugby union. This
331 provides useful information about the direction for future injury prevention strategies.

332

333 In terms of the events associated with match injuries, the tackle (being tackled and
334 tackling) produced the highest percentage of injuries for academy (51% of all injuries)
335 and school (57% of all injuries) players. These findings are consistent with previous
336 research where the tackle was the most common match event associated with injury in
337 both senior^{1, 3, 18} and youth rugby union,^{18, 26} with greater rates of injury reported for
338 the player being tackled.⁵ The proportion of injuries relating to the tackle event in the
339 current study may even be higher than previously found. For example Brooks et al⁵
340 returned approximately 38% of all injuries due to the tackle event for English
341 Premiership players and Fuller et al¹² returned approximately 35% of all injuries due
342 to the tackle event in RWC 2007. The burden of injuries from tackling or being
343 tackled was also significantly higher than all other injury events for both academies
344 and schools. This finding again reinforces the recommendations from previous rugby
345 injury studies which advocate that attention should be paid to the development of
346 good tackling technique,¹¹ although it must be remembered that one reason for the
347 high incidence of tackle injuries is the greater number of tackle events per game when
348 compared with other contact events.¹³

349

350 Combining the injury location and injury event data, being tackled was the greatest
351 cause of all lower limb injuries (academy: 35%; school: 44%) while tackling was the
352 greatest cause of all upper limb injuries (academy: 48%; school: 53%). Shoulder
353 injuries, in particular dislocations, were most often associated with tackling, with 41%
354 of all shoulder injuries in the school group sustained during tackling and these injuries
355 resulting in the greatest number of overall days lost. A focus on shoulder injuries is
356 important when developing preventative strategies, not just because of their incidence

357 but also their severity.²¹ Driving into another player during the tackle or falling onto
358 the shoulder or an outstretched arm in an “at threat” position of abduction and
359 external rotation have been cited as the main mechanisms for shoulder injury.³¹

360

361 With regards to methodological considerations, it is recognised that this study only
362 surveyed a small proportion of the youth rugby playing population in England
363 although it did involve the majority of eligible academy level players nationally. The
364 need for appropriate medical support to complete the injury recording probably biased
365 the school cohort to the upper end of the school rugby playing spectrum. The present
366 analysis is also restricted to match-related rugby exposure and the injuries sustained
367 as a direct result of this exposure

368

369 **CONCLUSIONS**

370 The present study found that the incidence of match injury in English youth rugby
371 union was higher than that reported in most previous studies for youth rugby but
372 lower than reported for senior elite rugby. There were differences in injury rates
373 between playing levels, with 34% higher injury incidence in the academy group.
374 Common injury locations (lower limb), types (ligament) and events (tackle) were
375 generally similar to the results reported in previous epidemiological studies for both
376 junior and senior rugby. However, some recommendations for injury risk
377 management can be specifically tailored for youth rugby union, including continued
378 attention to tackle technique along with targeted injury prevention strategies for the
379 knee and shoulder joint.

380

381 **COMPETING INTERESTS**

382 None.

383

384 **REFERENCES**

- 385 **1.** Bathgate A, Best JP, Creag G, Jamieson M. A prospective study of injuries to
386 elite Australian rugby union players. *British Journal of Sports Medicine*.
387 2002;36:265-269.
- 388 **2.** Best JP, McIntosh AS, Savage TN. Rugby World Cup 2003 injury
389 surveillance project. *British Journal of Sports Medicine*. 2005;39(11):812-817.
- 390 **3.** Bird YN, Waller AE, Marshall SW, Alsop JC, Chalmers DJ, Gerrard DF. The
391 New Zealand rugby injury and performance project: V. Epidemiology of a
392 season of rugby injury. *British Journal of Sports Medicine*. 1998;32(4):319-
393 325.
- 394 **4.** Brooks J, Fuller C. The influence of methodological issues on the results and
395 conclusions from epidemiological studies of sports injuries: illustrative
396 examples. *Sports Medicine*. 2006;36:459 - 472.
- 397 **5.** Brooks JH, Fuller CW, Kemp SP, Reddin DB. Epidemiology of injuries in
398 English professional rugby union: part 1 match injuries. *British Journal of*
399 *Sports Medicine*. 2005;39(10):757-766.
- 400 **6.** Brooks JH, Fuller CW, Kemp SP, Reddin DB. Epidemiology of injuries in
401 English professional rugby union: part 2 training Injuries. *British Journal of*
402 *Sports Medicine*. 2005;39(10):767-775.
- 403 **7.** Brooks JH, Fuller CW, Kemp SP, Reddin DB. A prospective study of injuries
404 and training amongst the England 2003 Rugby World Cup squad. *British*
405 *Journal of Sports Medicine*. 2005;39(5):288-293.

- 406 **8.** Brooks JH, Fuller CW, Kemp SP, Reddin DB. Incidence, risk, and prevention
407 of hamstring muscle injuries in professional rugby union. *American Journal of*
408 *Sports Medicine*. 2006;34(8):1297-1306.
- 409 **9.** Brust JD, Leonard BJ, Pheley A, Roberts WO. Childrens ice hockey injuries.
410 *American Journal of Diseases of Children*. 1992;146(6):741-747.
- 411 **10.** Creighton DW, Shrier I, Shultz R, Meeuwisse WH, Matheson GO. Return-to-
412 Play in Sport: A Decision-based Model. *Clinical Journal of Sport Medicine*.
413 2010;20(5):379-385.
- 414 **11.** Fuller C, Ashton T, Brooks J, Cancea R, Hall J, Kemp S. Injury risks
415 associated with tackling in rugby union. *British Journal of Sports Medicine*.
416 2010;44:159 - 167.
- 417 **12.** Fuller C, Laborde F, Leather R, Molloy M. International Rugby Board Rugby
418 World Cup 2007 injury surveillance study. *British Journal of Sports Medicine*.
419 2008;42:452 - 459.
- 420 **13.** Fuller CW, Brooks JHM, Cancea RJ, Hall J, Kemp SPT. Contact events in
421 rugby union and their propensity to cause injury. *British Journal of Sports*
422 *Medicine*. 2007;41(12):862-867.
- 423 **14.** Fuller CW, Molloy MG. Epidemiological Study of Injuries in Men's
424 International Under-20 Rugby Union Tournaments. *Clinical Journal of Sport*
425 *Medicine*. 2011;21(4):356-358.
- 426 **15.** Fuller CW, Molloy MG, Bagate C, et al. Consensus statement on injury
427 definitions and data collection procedures for studies of injuries in rugby
428 union. *Clinical Journal of Sport Medicine*. 2007;17(3):177-181.

- 429 **16.** Fuller CW, Smith GL, Junge A, Dvorak J. The influence of tackle parameters
430 on the propensity for injury in international football. *American Journal of*
431 *Sports Medicine*. 2004;32(1 Suppl):43S-53S.
- 432 **17.** Gallagher SS, Finison K, Guyer B, Goodenough S. The incidence of injuries
433 among 87,000 Massachusetts children and adolescents - results of the 1980-81
434 statewide childhood injury prevention program surveillance system. *American*
435 *Journal of Public Health*. 1984;74(12):1340-1347.
- 436 **18.** Garraway WM, Lee AJ, Macleod DAD, Telfer JW, Deary IJ, Murray GD.
437 Factors influencing tackle injuries in rugby union football. *British Journal of*
438 *Sports Medicine*. 1999;33(1):37-41.
- 439 **19.** Gissane C, Jennings D, Kerr K, White JA. A pooled data analysis of injury
440 incidence in rugby league football. *Sports Medicine*. 2002;32(3):211-216.
- 441 **20.** Haseler CM, Carmont MR, England M. The epidemiology of injuries in
442 English youth community rugby union. *British Journal of Sports Medicine*.
443 2010;44(15):1093-1099.
- 444 **21.** Headey J, Brooks JH, Kemp SP. The epidemiology of shoulder injuries in
445 English professional rugby union. *American Journal of Sports Medicine*.
446 2007;35(9):1537-1543.
- 447 **22.** IRB. www.irb.com/unions/index.html. Available at:
448 www.irb.com/unions/index.html. Accessed 15 December 2010.
- 449 **23.** Jakoet I, Noakes TD. A high rate of injury during the 1995 Rugby World Cup.
450 *South African Medical Journal*. 1998;88(1):45-47.
- 451 **24.** Junge A, Cheung K, Edwards T, Dvorak J. Injuries in youth amateur soccer
452 and rugby players - comparison of incidence and characteristics. *British*
453 *Journal of Sports Medicine*. 2004;38:168-172.

- 454 **25.** Kaplan LD, Flanigan DC, Norwig J, Jost P, Bradley J. Prevalence and
455 variance of shoulder injuries in elite collegiate football players. *American*
456 *Journal of Sports Medicine*. 2005;33(8):1142-1146.
- 457 **26.** Kerr H, Curtis C, Micheli L, Kocher M, Zurakowski D, Kemp S. Collegiate
458 rugby union injury patterns in New England: a prospective cohort study.
459 *British Journal of Sports Medicine*. 2008;42:595 - 603.
- 460 **27.** Kirkwood BR, Sterne JAC. *Essential Medical Statistics*. Second ed: Blackwell
461 Science Ltd; 2003.
- 462 **28.** Lee AJ, Myers JL, Garraway WM. Influence of players' physique on rugby
463 football injuries. *British Journal of Sports Medicine*. 1997;31(2):135-138.
- 464 **29.** Lorentzon R, Wedren H, Pietila T, Gustavsson B. Injuries in International ice
465 hockey - a prospective, comparative-study of injury incidence and injury types
466 in International and Swedish elite ice hockey. *American Journal of Sports*
467 *Medicine*. 1988;16(4):389-391.
- 468 **30.** Maffulli N. The best athletes are better. *Nature*. 1996;382(6589):294-294.
- 469 **31.** McIntosh AS, Savage TN. *Rugby Union Injury Surveillance Study: Report on*
470 *Seasons 2002-2004*: University of New South Wales; 2006.
- 471 **32.** McManus A, Cross DS. Incidence of injury in elite junior Rugby Union: a
472 prospective descriptive study. *Journal of Science and Medicine in Sport*.
473 2004;7(4):438-445.
- 474 **33.** Nicholl JP, Coleman P, Williams BT. The epidemiology of sports and exercise
475 related injury in the United Kingdom. *British Journal of Sports Medicine*.
476 1995;29(4):232-238.
- 477 **34.** Nicol A, Pollock A, Kirkwood G, Parekh N, Robson J. Rugby union injuries
478 in Scottish schools. *Journal of Public Health (Oxf)*. 2010.

- 479 **35.** Olsen OE, Myklebust G, Engebretsen L, Holme I, Bahr R. Exercises to
480 prevent lower limb injuries in youth sports: cluster randomised controlled trial.
481 *British Medical Journal*. 2005;330(7489):449-452.
- 482 **36.** Orchard J, Seward H. Epidemiology of injuries in the Australian Football
483 League, seasons 1997-2000. *British Journal of Sports Medicine*.
484 2002;36(1):39-44.
- 485 **37.** Palmer-Green DS. *Injury epidemiology and injury prevention in English youth*
486 *rugby union*, Unpublished PhD Thesis, University of Bath; 2010.
- 487 **38.** Pasque CB, Hewett TE. A prospective study of high school wrestling injuries.
488 *American Journal of Sports Medicine*. 2000;28(4):509-515.
- 489 **39.** Pinto M, Kuhn JE, Greenfield M, Hawkins RJ. Prospective analysis of ice
490 hockey injuries at the junior A level over the course of one season. *Clinical*
491 *Journal of Sport Medicine*. 1999;9(2):70-74.
- 492 **40.** Quarrie KL, Alsop JC, Waller AE, Bird YN, Marshall SW, Chalmers DJ. The
493 New Zealand rugby injury and performance project. VI. A prospective cohort
494 study of risk factors for injury in rugby union football. *British Journal of*
495 *Sports Medicine*. 2001;35(3):157-166.
- 496 **41.** Rae K, Britt H, Orchard J, Finch C. Classifying sports medicine diagnoses: a
497 comparison of the International classification of diseases 10-Australian
498 modification (ICD-10-AM) and the Orchard sports injury classification system
499 (OSICS-8). *British Journal of Sports Medicine*. 2005;39(12):907-911.

500

501 **FIGURE LEGENDS**

503 Figure 1. Body location of match injuries for academy and school players as a
504 percentage of all injuries (with mean severity in brackets).

505

506 Figure 2. Specific anatomical location of match injury for academy and school
507 players showing a) incidence (injuries per 1000 player match hours) with 95%
508 confidence intervals; b) severity (mean days absence) with 95% confidence intervals;
509 and c) burden (days absence per 1000 player match hours) with 95% confidence
510 intervals. * significant difference between academy and school at $P \leq 0.05$.

511

512 Figure 3 Match injury event burden (days absence per 1000 player match hours) with
513 95% confidence intervals, for academy and schools.

Table 1. Mean (SD) baseline characteristics for academy and school players (two seasons data combined).

		Academy	School
Height [cm]	Forwards	187.1 (7.4) **††	181.9 (6.6)††
	Backs	179.3 (6.0)	179.2 (5.4)
	All	182.7 (7.6)**	180.7 (6.2)
Body mass [kg]	Forwards	97.1 (10.5) **††	89.2 (12.3) ††
	Backs	80.3 (6.9) *	78.1 (7.2)
	All	87.8 (12.0)**	84.2 (11.7)
BMI [kg/m ²]	Forwards	27.9 (3.0) ††	26.9 (3.3) ††
	Backs	25.0 (1.7) *	24.3 (2.0)
	All	26.2 (2.7)	25.8 (3.1)
Age [years]	Forwards	17.2 (0.6) †	17.2 (0.6)
	Backs	16.9 (0.6)	17.1 (0.6)
	All	17.0 (0.6)	17.1 (0.6)

(significant difference between academy and school * at $P \leq 0.05$; ** at $P \leq 0.01$;
significant difference between forwards and backs † at $P \leq 0.05$; †† at $P \leq 0.01$)

Table 2. Match injury incidence (number of injuries per 1000 player match hours, with 95% confidence intervals) and mean (with 95% confidence intervals) and median severity in days absence, for academies and schools.

	Academy		School	
	Incidence (95% CI)	Mean Severity (95% CI) [median]	Incidence (95% CI)	Mean Severity (95% CI) [median]
New	41 (33 to 49)	33 (27 to 39) [20]	31 (25 to 37)	27 (22 to 32) [13]
Recurrent	5 (2 to 8)	18 (8 to 28) [15]*	4 (2 to 6)	46 (23 to 69) [21]
All	47 (38 to 55)	32 (26 to 38) [18]	35 (29 to 41)	30 (25 to 35) [13]

(Significant difference between academy and school * at $P \leq 0.05$)

Table 3. Match injury types expressed as percentage of injuries, incidence (number of injuries per 1000 player match hours, with 95% confidence intervals) and mean severity in days absence (with median values) by injury type for academies and schools.

Injury type group	Academy			School		
	% of injuries	Incidence (95% CI)	Severity (median)	% of injuries	Incidence (95% CI)	Severity (median)
CNS/PNS	4	2 (0 to 3)	20 (20)	9	3 (1 to 5)	16 (19)
Contusion/laceration/lesion	19	9 (5 to 13)	15 (9)	18	6 (4 to 9)	7 (5)
Bone stress/fractures	6	3 (1 to 5)	46 (33)	8	3 (1 to 4)	43 (38)
Joint (non-bone) ligament	51	24 (18 to 30) **	35 (18)	39	14 (10 to 17)	46 (25)
Muscle & tendon	18	9 (5 to 12)	39 (20)	24	8 (5 to 11)	20 (9)
Other	2	1 (0 to 2)	16 -	2	1 (0 to 2)	20 -

(CNS/PNS = central and peripheral nervous system. Median values are not presented where there were less than 3 injuries in the category displayed. Significant difference between academy and school * at $P \leq 0.05$; ** at $P \leq 0.01$)

Table 4. Match injuries causing the greatest overall total days lost for academies and schools.

Academy			School		
Injury	Number of injuries	Days Lost	Injury	Number of injuries	Days Lost
Knee ACL	3	554	Shoulder dislocation / instability	8	986
Knee meniscus / cartilage	4	367	Knee general	14	431
Shoulder rotator cuff	6	297	Wrist/Hand/Finger general	9	363

NB. 'general' injuries occur when a specific diagnosis has not been possible.

Table 5. Match injury events expressed as percentage of injuries and incidence (number of injuries per 1000 player match hours, with 95% confidence intervals) and mean severity in days absence (with median values) by injury type for academies and schools.

Injury Event	Academy			School		
	% of injuries	Incidence (95% CI)	Severity (median)	% of injuries	Incidence (95% CI)	Severity (median)
Collision	6	3 (1 to 5) ^{t,u,n}	10 (5)	4	1 (0 to 3) ^{r,t,u,n}	32 (20)
Ruck/maul	14	6 (3 to 9) ^{s,t,o}	27 (20)	16	5 (3 to 8) ^{c,s,t,o}	15 (7)
Scrum	3	1 (0 to 2) ^{r,t,u,n}	30 (27)	7	2 (1 to 4) ^{r,t,u}	30 (8)
Tackled	30	12 (8 to 17) ^{c,r,s,o}	36 (21)	32	10 (7 to 13) ^{c,r,s,o,n}	34 (14)
Tackling	21	9 (5 to 13) ^{c,s,o}	36 (18)	25	8 (5 to 11) ^{c,s,o}	33 (20)
Other contact	3	1 (0 to 3) ^{r,t,u,n}	18 (24)	3	1 (0 to 2) ^{r,t,u,n}	36 (48)
All Contact	77	32 (25 to 39)	32 (20)	87	27 (22 to 32)	30 (16)
All Non Contact	23	10 (6 to 14) ^{c,s,o}	30 (20)	13	4 (2 to 6) ^{c,t,o}	26 (11)

Pairwise comparisons for contact injury events are reported by the following convention: ^c= different from Collision; ^r= different from Ruck/maul; ^s= different from Scrum; ^t= different from Tackled; ^u= different from Tackling; ^o= different from Other; ⁿ= different from Non-contact, all at $P \leq 0.05$. The specific event associated with the match injury was recorded for 101 out of 109 injuries for the academy group and 121 out of 134 injuries for the school group, with 100% in Table 5 equating to the number of injuries with known events.

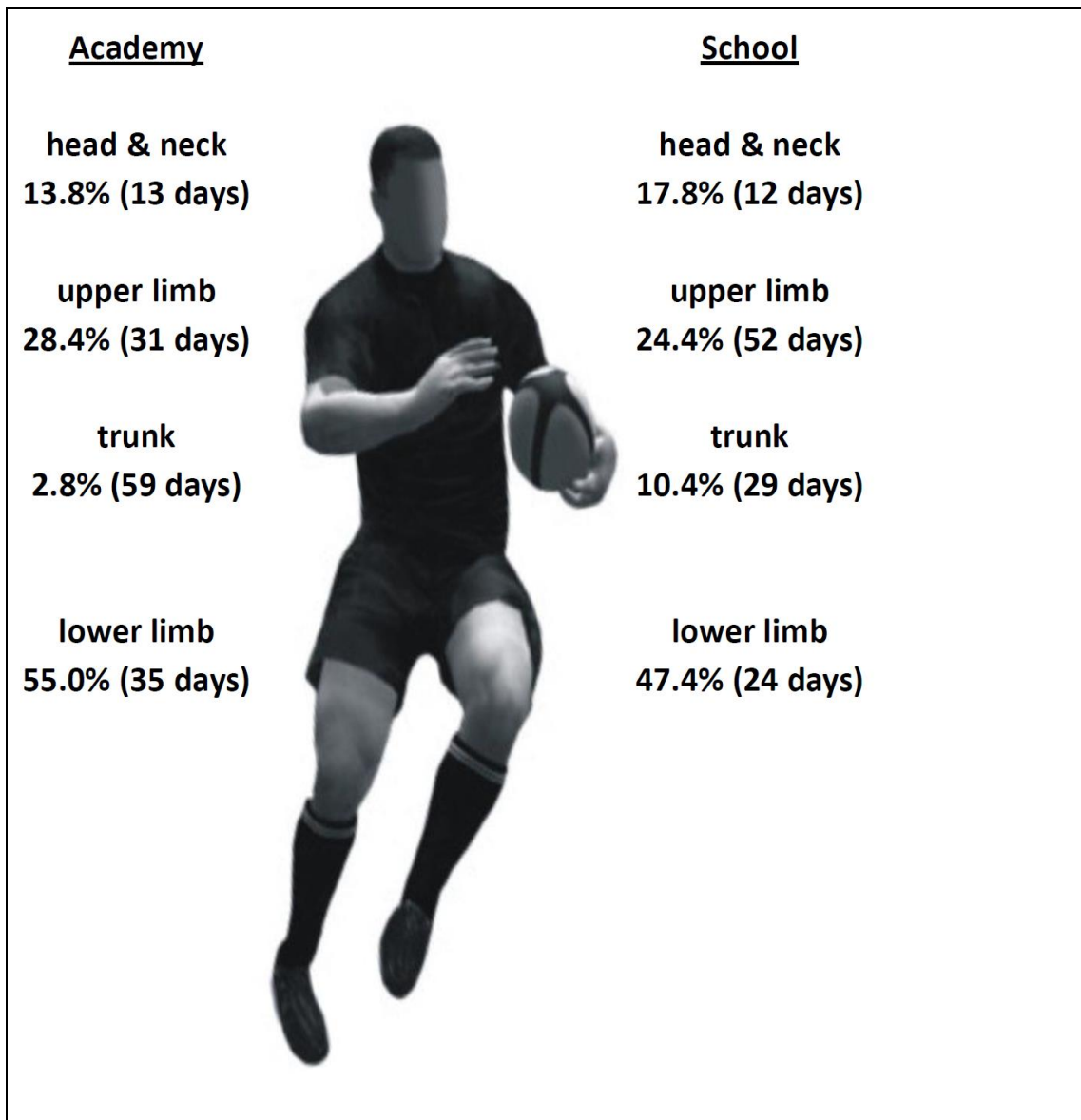
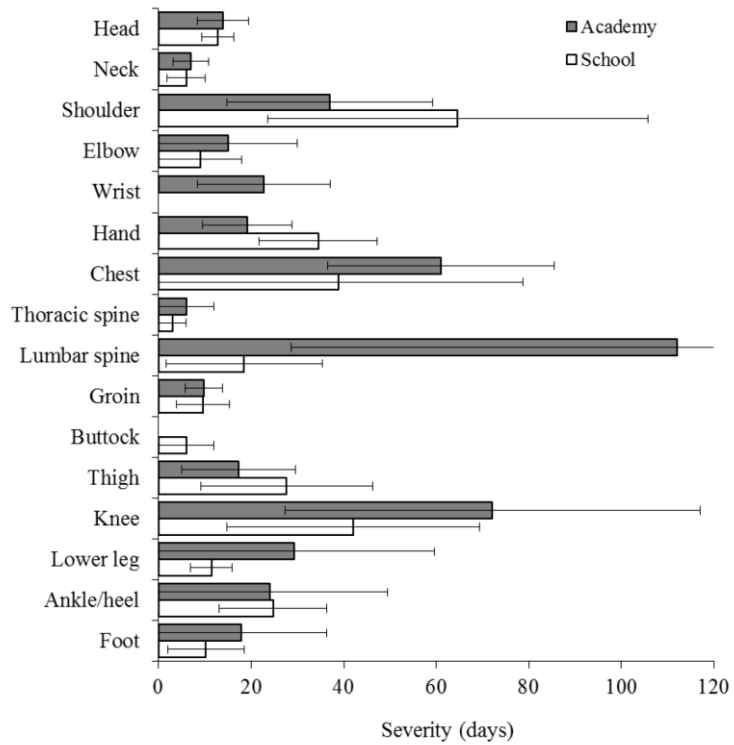
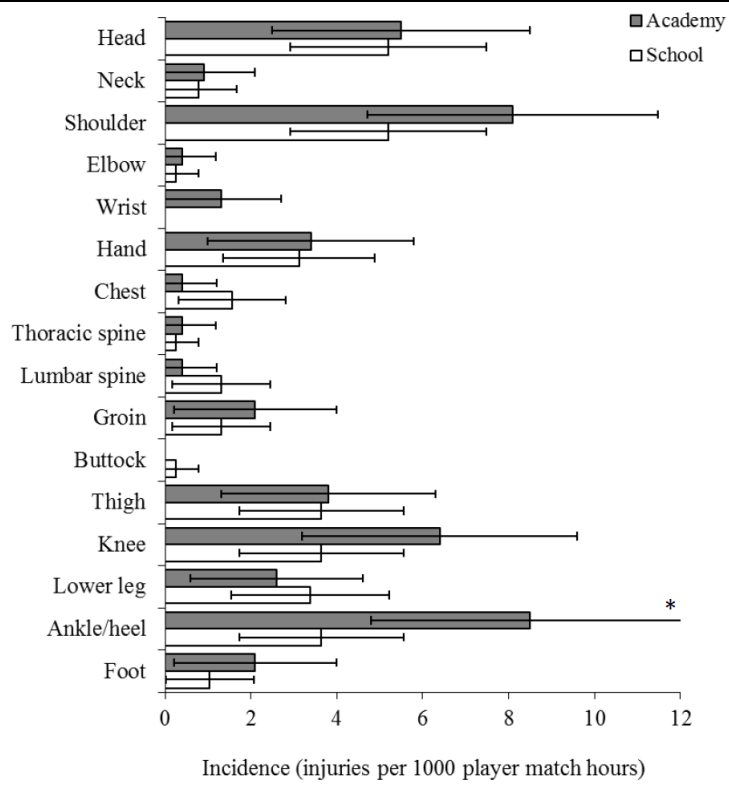


Figure 1



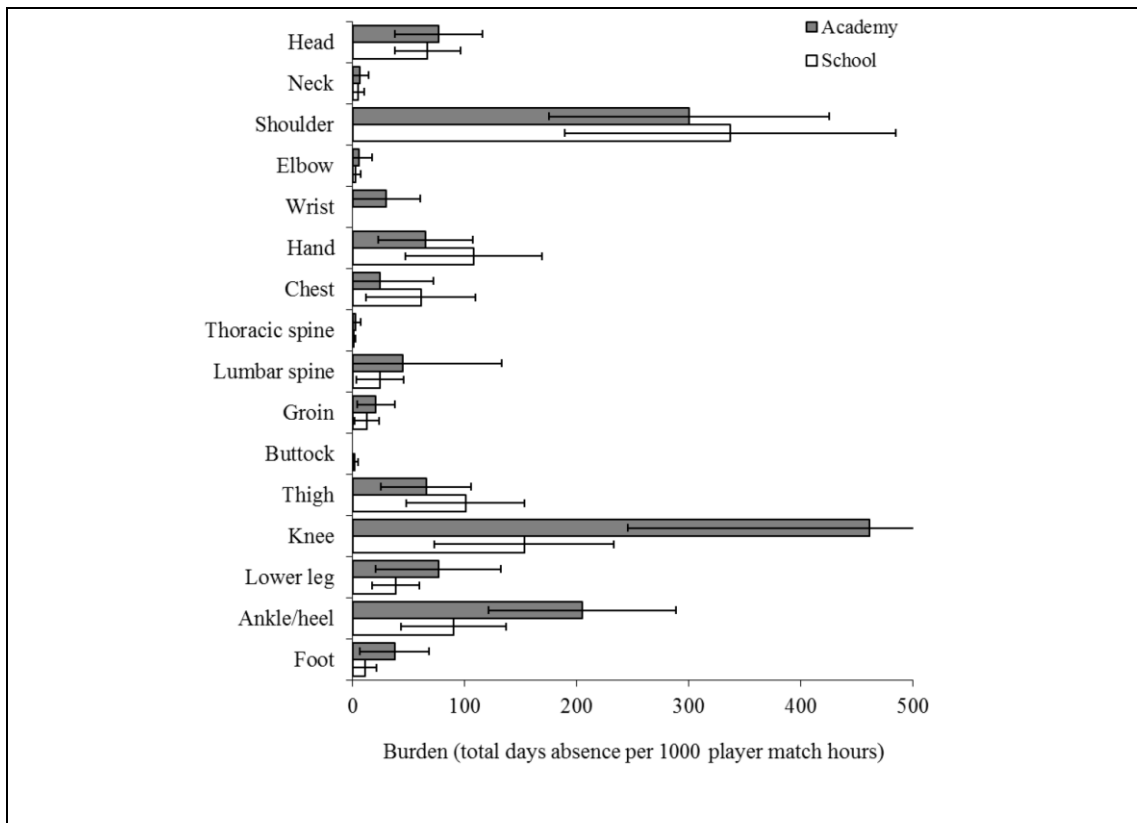


Figure 2

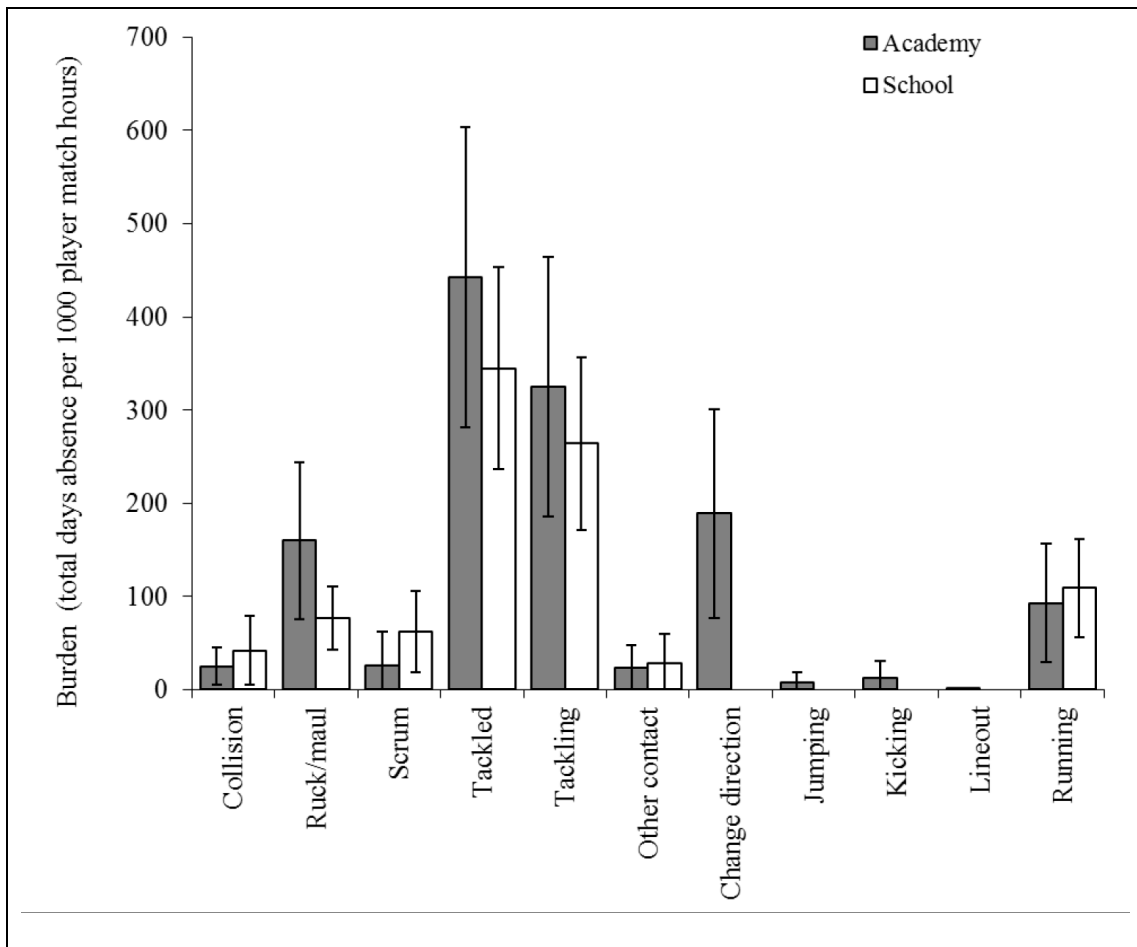


Figure 3