Title: The physical characteristics of match-play in English schoolboy and academy rugby union

Preferred Running Head: School and academy rugby match-play

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Abstract

The aim was to compare the physical characteristics of under-18 academy and schoolboy rugby union competition by position (forwards and backs). Using a microsensor unit, match characteristics were recorded in 66 players. Locomotor characteristics were assessed by maximum sprint speed (MSS) and total, walking, jogging, striding and sprinting distances. The slow component (<2 $m.s^{-1}$) of PlayerLoad™ (PL_{slow}), which is the accumulated accelerations from the three axes of movement, was analysed as a measure of low-speed activity (e.g., rucking). A linear mixed-model was assessed with magnitude-based inferences. Academy forwards and backs *almost certainly* and *very likely* covered greater total distance than school forwards and backs. Academy players from both positions were also *very likely* to cover greater jogging distances. Academy backs were *very likely* to accumulate greater PL_{slow} and the academy forwards a *likely* greater sprinting distance than school players in their respective positions. The MSS, total, walking and sprinting distances were greater in backs (*likely-almost certainly*), while forwards accumulated greater PL_{slow} (*almost certainly*) and jogging distance (*very likely*). The results suggest that academy-standard rugby better prepares players to progress to senior competition compared to schoolboy rugby.

Keywords: Player development; team sports; GPS; player load

Introduction

England has the greatest rates of participation in rugby union (Freitag, Kirkwood, & Pollock, 2015). Age-grade players e.g., under-18 (U18) can play concurrently in several standards including: amateur clubs, county representative, schools, regional academies and international competitions. During what is a key phase of athlete development, understanding the physical match characteristics to which age-grade players are exposed at different playing standards is important for physical preparation and long-term player development (Hartwig, Naughton, & Searl, 2011; Tucker, Raftery, & Verhagen, 2016).

Physical match characteristics of senior rugby union have been well documented (Cahill, Lamb, Worsfold, Headey, & Murray, 2013; Quarrie, Hopkins, Anthony, & Gill, 2013; Roberts, Trewartha, Higgit, El-Abd, & Stokes, 2008) and used to design match-specific protocols for training purposes (Roberts, Stokes, Weston, & Trewartha, 2010). Characteristics include the quantification of locomotor and contact exposures (Lindsay, Draper, Lewis, Giesey, & Gill, 2015; Quarrie et al. 2013). Practitioners have often used these data to make inferences about age-grade players. Understanding the multifaceted nature of age-grade rugby, that is, numerous standards and age groups is complex and research has been limited. A recent study using U20 international-standard players demonstrated that locomotor characteristics such as total distance covered, are greater in backs than forwards (6230 ± 800 vs. 5370 ± 830 m, effect size [ES] = 1.10) and are also comparable to distances covered in senior rugby (Cunningham et al., 2016; Reardon, Tobin, & Delahunt, 2015). However, because of the inclusion criteria in this study (>60 mins playing duration) and similar studies playing time, previous research has likely underestimated the physical characteristics of playing an entire match (Cahill et al., 2013; Read et al., 2017; Reardon et al., 2015). Furthermore, given that older age-grade players have substantially greater physical attributes such as stature, body mass and strength than younger age-grade players (U21 *vs.* U18; Darrall-Jones, Jones, & Till, 2015), it is necessary to investigate physical characteristics of U18 rugby so as to inform match-specific training. Previous research has also highlighted that the disparity in physical match-play characteristics between forwards and backs is less at U16 than U20 and thus warrants investigation in U18 players (Read et al. 2017).

Besides international competition, academy rugby is perceived by coaches to be the highest standard of rugby union in the U18 age group in England (England Rugby, 2010). Each academy has approximately three players each year graduate from the U18 academy to professional first team squads (England Rugby, 2014). Despite this, research thus far has examined only county representative and international standards in England (Cunningham et al., 2016; Read et al., 2017). There are 14 regional academies in England that are embedded in professional clubs and the U18 age group play six competitive matches a year against other academies from either the north or south regions of the country. Concurrently in this age group, players often play for their schools, yet the match characteristics to which players are exposed in these two playing standards are not yet established. In addition, despite this playing structure and the recent interest in schoolboy rugby (Carter, 2015; SportCIC, 2016; Tucker et al., 2016), assessments of demands on U18 age-grade players are scant. Evaluation of U18 match-play will identify demands of match play and evaluate current playing pathways as progression to older age-grade and higher-standard rugby.

The primary aim of the current study was to compare physical characteristics of English U18 rugby union match-play from two playing standards i.e., regional academy vs. school, for forwards and backs. Second, the study aimed to compare forwards and backs in the same playing standard for academy and school rugby union match-play.

Methods

Participants

In total, 66 players were recruited from two playing standards (regional academy and schools), providing 95 observations. See Table 1 for player characteristics. An entire season of academy matches were assessed (six matches), with a matched number of school games. All matches were played from October to February. The players were recruited from one regional academy hence, repeated observations of individual players were made. In total, there were 45 observations from seven forwards (range = 1-4 matches, 21 observations) and 12 backs (range = 1-4 matches, 24 observations). There were no repeated observations from the school players (25 forwards and 25 backs, 50 observations) as the matches were assessed from six schools. Three players represented both standards. The repeated observations of players in the regional academy group and the inclusion of the same players in the regional academy and school groups were accounted for in the statistical analysis (Wilkinson & Akenhead, 2013). Ethics approval was granted from Leeds Beckett University institutional ethics committee.

***** INSERT TABLE ONE NEAR HERE *****

Procedures

During matches, each player wore a microsensor unit (Optimeye S5, Catapult Innovations, Melbourne, Australia) that contained a 10 Hz global positioning system (GPS) and a tri-axial accelerometer, gyroscope and magnetometer sampling at 100 Hz. The units were placed in a pocket in the vest provided by the manufacturer and worn so it was situated between the scapulae. All players were accustomed to wearing the units prior to the data collection, during a training session. The mean ± standard deviation (SD) number of satellites connected during all data collection was 14.7 ± 0.8, while the horizontal dilution of precision was 0.87 ± 0.15.

The error of measurement (coefficient of variation; CV) for 10 Hz GPS units is reported as 8.3, 4.3 and 3.1% for speeds between 1-2.9, 3-4.9 and 5-8 $m \cdot s^{-1}$, respectively, with the inter-unit reliability also established for the same speeds as 5.3, 3.5 and 2.0% (Varley, Fairweather, & Aughey, 2012). Additionally, Optimeye S5 GPS units have recently shown a *small* typical error of the estimate (1.8%) with a radar gun for assessing maximum sprint speed (MSS; Roe et al., 2016a). The accelerometer in the unit is also reliable (CV for within: 0.9–1.1%; and between: 1.0–1.1%; Boyd, Ball, & Aughey, 2011).

The data were downloaded using the manufacturer's software (Sprint 5.1.7, Catapult Innovations, Melbourne, Australia) so only data from playing time were included. All players played the entire game, which at the U18 age grade is 35 min per half plus added time. Locomotor characteristics were total distance covered, and split into pre-determined speed thresholds for adolescent rugby union players: walking (0–1.94 m·s^{-1}), jogging (1.95–3.33 m·s^{-1}), striding (3.34–5.83 m·s^{-1}) and sprinting (>5.84 m·s^{-1}; Hartwig et al., 2011). The MSS each player achieved during a match was also downloaded. PlayerLoad^{TM} slow (PL_{slow}) contains data for only low-speed activities (<2 m.s^{-1}) and is accumulated through accelerations recorded in the three principal axes of movement. It was downloaded as a proxy measure for the frequency and magnitude of low-speed exertions (e.g., scrummaging and rucking) involved in rugby union (Roberts et al., 2008) that GPS or video analysis cannot provide. The measure is related (r = 0.79) to collisions during adolescent rugby union match-play (Roe, Halkier, Beggs, Till, & Jones, 2016b).

Statistical Analysis

All data were log-transformed to reduce bias from non-uniformity error and because of repeated measures in the sample, were analyzed using a linear mixed-model (SPSS v.22, NY: IBM Corporation). Players 'group identity' (i.e., academy or school and forwards or backs) was treated as fixed-effects and random-effects were the 'individual players' and 'matches'. Because of the small sample size (*n* = 3) no additional analysis was completed on the players that represented both standards. Magnitude-based inferences identified practical importance via a spreadsheet (Hopkins, 2007). The chances of match-play physical characteristics being less, similar or greater than the smallest worthwhile change (SWC; 0.2 x between-subject standard deviation) were calculated and assessed qualitatively as follows: 25-74.9%, *possibly*; 75-94.9% *likely*; 95-99.5%, *very likely*; >99.5%, *almost certainly* (Hopkins, Marshall, Batterham, & Hanin, 2009). Where the confidence interval crossed both the upper and lower boundaries of the SWC, the difference was reported as *unclear* (Batterham & Hopkins, 2006). Descriptive data are reported as mean ± SD, whereas differences between groups are expressed as percentages with a 90% confidence limit.

Results

Differences between playing standards and positions for total distance, MSS and PL_{slow} are shown in Figure 1, while the same analysis is displayed in Figure 2 for walking, jogging, striding and sprinting distance.

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***** INSERT FIGURE TWO NEAR HERE *****

Discussion

The purpose of this study was to compare physical characteristics of U18 rugby union match-play and hence, investigate the magnitude of difference between two playing standards (academy and school) and positions (forwards and backs). The main findings of the study were that academy players covered greater total and jogging distances than schoolboy players. Academy backs had greater PL_{slow} and the academy forwards did more sprinting than school players in their respective positions. For positional comparisons, backs had greater total distance, MSS, walking and sprinting distance, while forwards had greater PL_{slow} and jogging distance. Overall the results highlight that academy rugby is more physically demanding than school rugby and players should be conditioned to meet the additional demands during training for progression to senior rugby. Coaches should be aware that academy rugby provides the greater physical challenge given that players can play in both standards concurrently at U18.

Total distance was *almost certainly* and *very likely* greater in academy forwards and backs than school players in the same position. Jogging distance was also *very likely* greater in both academy positions and indicates that some aspects of the locomotor characteristics are greater in academy rugby. A positive association between fitness (maximal aerobic speed) and distance covered by rugby players during match-play has been shown (Swaby, Jones, & Comfort, 2016). Academy players' greater fitness could be because of the greater intensity of their training (Phibbs et al., 2017), although no data are available to directly support this in age-grade rugby union. There are several *unclear* results of comparisons between the two playing standards in both positions because of the large confidence intervals. However despite this, all of the mean differences indicate the academy-based measures are greater while there are no mean values that are greater for the school players.

Notably, academy forwards showed a *likely* greater difference in sprinting distance than school forwards while academy backs had a *very likely* greater difference in PL_{slow}. The PL_{slow} and sprinting distance are typically key measures for forwards and backs, respectively. However, PL_{slow} for backs and sprinting distance for forwards differed between academy and school. These findings suggest that academy players are prepared to a higher physical standard. This reflects outcomes of a recent study that examined training practices of these two groups (Phibbs et al., 2017). Phibbs et al. (2017) showed that during academy training sessions players covered greater total distance (4176 ± 433 vs. 2925 ± 467 m, ES = 2.70), had more high-speed running (1270 ± 288 vs. 678 ± 179 m, ES = 2.40) and PL (424 ± 56 vs. 270 ± 42 AU, ES = 3.00). Furthermore, academy players dedicate twice the duration (13 vs. 27%) of their training time to resistance training than school players (Palmer-Green et al., 2015). This is reflected in the greater body mass of the academy players in this study and is likely to influence the physicality of match-play. Playing styles of the teams were not considered in this study and the impact these have on physical characteristics during rugby union match-play is unknown.

Differences in MSS between the academies and schools for forwards and backs remain unknown because of the *unclear* results. However, it should be noted that MSS during a match is likely to be influenced by the number of opportunities to achieve this such as linebreaks. Values in this study are less than previously reported for academy players during testing (forwards: 7.0 ± 0.7 vs. 8.1 ± 0.4, ES = 2.00; backs: 8.1 ± 0.4 vs. 8.6 ± 0.4 $m \cdot s^{-1}$, ES = 1.25; Darrall-Jones, Jones, & Till, 2016). In addition, variability of measures is greater in the school groups, which suggests the academy players are homogeneous. However, the inclusion of six schools and the variations in coaching and playing styles might also have influenced the variability in the school groups. Future research should examine the variability of physical performance during match-play in these groups to identify smallest worthwhile change.

Results of the current study showed that forwards from the academy (5461 ± 360 m) and school (4881 ± 388 m) were *likely* and *very likely* to cover less total distance than academy (5639 ± 368 m) and school backs (5260 ± 441 m). Distances covered by school players are substantially less than previously reported for international U20 players (forwards: 5370 ± 830, ES = 0.98; backs: 6230 ± 800 m, ES = 1.94) and Pro 12 rugby players (forwards: 5639 ± 762, ES = 1.52; backs: 6172 ± 767 m, ES = 1.82) (Cunningham et al., 2016; Reardon et al., 2015). Academy backs also have less total distance than older age-grade players (Cunningham et al., 2016) and one study of senior players (Reardon et al., 2015), whereas the forwards are similar to data reported in these studies. This suggests less disparity in locomotor characteristics between forwards and backs when players are younger, which increases as players get older. This has also been shown in a similar recent study (Read et al., 2017). This could be attributable to inferior technical ability (e.g., catch and pass ability) at younger age groups and it is hypothesised that this leads to fewer involvements from the backs and explains the lack of disparity between forwards and backs in locomotor characteristics. Furthermore, physical preparation of rugby players during training could be more position-specific as age increases.

The distribution of distance into speed thresholds accentuated differences in locomotor characteristics between forwards and backs. Backs were *likely* and *very likely* to cover more walking distance, while also *likely* and *almost certain* to complete more sprinting distance than forwards in the academy and school groups, respectively. Conversely, forwards were *very likely* to cover more jogging distance in both playing standards. The difference in striding distance was *unclear* between academy players while it was *possibly* greater only in school backs. These differences represent comparable patterns from previous studies (Austin, Gabbett, & Jenkins, 2011; Quarrie et al., 2013) that have suggested searches for open space by backs and the subsequent repositioning in the field explain these findings (Cahill et al., 2013; Read et al., 2017). While players should experience all speeds and train multiple energy systems, these data suggest that backs should use a polarised method to replicate the characteristics of match play by focusing on high speeds interspersed with low speeds, whereas forwards should engage more in ‘middle ground’ speeds. Because of the use of arbitrary speed thresholds, the greater sprinting distance is also likely to be associated with the *very likely* and *almost certainly* higher MSS achieved by the backs in academy and school groups, respectively.

Our findings are consistent with recent studies that showed greater low-speed activity measured via PL_{slow} in forwards than backs, with *almost certain* differences both for the academy and school (McLaren et al., 2016; Read et al., 2017). The difference between forwards and backs is likely because of more tackles (0.15 ± 0.08 vs. 0.11 ± 0.11 $n.min^{-1}$, ES = 0.42) and rucks (0.33 ± 0.25 vs. 0.13 ± 0.09 $n.min^{-1}$, ES = 1.33), as well as the addition of scrums (Lindsay et al., 2015). However, information on age-grade players is scarce (Tucker et al., 2016). Despite the correlation between PL_{slow} and collisions (r = 0.79), the measure will accumulate during any activity <2 $m.s^{-1}$ and an algorithm specific to collisions in rugby union is needed. In summary, differences in physical characteristics in U18 rugby union match-play between forwards and backs means that practitioners no longer have to make assumptions from senior data. Future research should use larger sample sizes that would improve analyses of individual positions or positional sub-categories (e.g., front row, second row, etc).

A limitation of this study is the small sample of matches and observations. However, it includes one full season of matches from the academy league in England. In addition, it is acknowledged that data from several academies would improve representation of the characteristics and a combination or comparison of academies and schools from the north and south of the country would further enhance this. The concept of analysing match performance from players competing in several playing standards concurrently to assess if and why changes occur from a physical, technical and tactical perspective warrants further investigation.

Conclusion

This study quantifies the physical characteristics of U18 rugby union match-play and is the first investigation to compare regional academy and school playing standards in age-grade rugby. These data highlight that academy players experience greater match-play demands than school players and should be conditioned to meet these demands. As players can play in both standards concurrently, coaches should be aware of the impact on acute fatigue and long-term player progression of rugby union players. Findings from the locomotor and low-speed activity characteristics of forwards and backs reaffirm the characteristics of these positional groups in age-grade players and highlight the need for training to be position specific. Future studies should investigate if players exhibit lower, similar or greater technical performances (e.g., catch and pass ability, decision making) when playing concurrently in different standards of age-grade rugby.

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Figure 1. Differences in total distance (A), maximum sprint speed (B) and PlayerLoad™ slow (C) between playing standards and positions during under-18 rugby union match-play. Differences are shown using magnitude based inferences and percentage differences ±90% confidence limits. ↑ = Forwards are greater than backs or academy are greater than school. ↓ = Forwards are lower than backs or academy are lower than school.

Figure 2. Differences in walking (A; 0-1.94 $m.s^{-1}$), jogging (B; 1.95-3.33 $m.s^{-1}$), striding (C; 3.34-5.83 $m.s^{-1}$) and sprinting (D; >5.84 $m.s^{-1}$) distance (m) between playing standards and positions during under-18 rugby union match-play. Differences are shown using magnitude based inferences and percentage differences ±90% confidence limits. ↑ = Forwards are greater than backs or academy are greater than school. ↓ = Forwards are lower than backs or academy are lower than school.

Table 1. Anthropometric characteristics for under-18 rugby union players in two playing standards and positions.

	Academy	School
Forwards		
Age (years)	17.4 ± 0.7	17.6 ± 0.7
Stature (cm)	188.2 ± 7.7	180.7 ± 7.4
Body mass (kg)	95.5 ± 7.5	90.2 ± 10.0
Backs		
Age (years)	18.0 ± 0.7	17.3 ± 0.6
Stature (cm)	180.7 ± 5.6	180.3 ± 6.4
Body mass (kg)	83.5 ± 9.6	77.4 ± 9.0

Data are presented as mean ± standard deviation.