

Quantification of Movement Characteristics in Women's English Premier Elite Domestic Rugby Union

by

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This study aims were to determine the positional physical requirements of English domestic women's rugby union match-play. Global positioning system data (Catapult Minimax S4) were collected at 10 Hz of 129 competitive player games from the Tyrrells Premier15 league. Players were classified according to broad (Forwards, Backs) and specific positions (front-, second-, back-row, scrum-half, inside-, and outside-backs). Total distances, maximum speed, and player loads were calculated. Mean total distance was 4982 m and was similar between the Forwards and Backs, with second-row players covering the most (5297 m) and outside-backs the least (4701 m). Inside- and outside-backs covered a significantly greater distance at high speed running (134 m; 178 m) and sprinting (74 m; 92 m) speeds, respectively, whereas the second- and back-row covered greater distances jogging (1966 m; 1976 m) and the front-row spent the greatest overall distance walking (2613 m). Outside-backs reached greater maximum speed than all other positions (24.9 km.h⁻¹). The mean player load was highest in the back-row (562 AU) and second-row (555 AU) and these were higher than the outside-backs (476 AU). These findings indicate that the demands placed on female rugby players are position specific and differ from male players. Additionally, the data are the first obtained from the 10 Hz GPS and from within English domestic women's rugby, thus adding to the overall limited data available on women's rugby union.

Key words: movement patterns, workload, Global Positioning System, positional demands.

Introduction

Rugby union is a field-based invasion sport that incorporates a series of intermittent bouts of high intensity activity, interspersed with longer periods of low intensity transitional motion between the high intensity activities. Such activity includes periods of sprinting and high-speed running, tackling, scrummaging (Bradley et al., 2018), and rucking/mauling, often with a repeated nature. This places unique biomechanical, physiological, and psychological stresses on the body during match performance. The physical demands of male rugby union have been extensively documented over the previous 20 years in the English Premiership (Cahill et al., 2013; Roberts et al., 2008), Super Rugby (Austin et al., 2011a; Owen et al., 2015), Celtic League (Jones

et al., 2015), and international matches (Coughlan et al., 2011; Quarrie et al., 2013). For example, Roberts et al. (2008) utilized time motion analysis to identify that players covered a mean total distance from 5581 to 6127 m per match, while Cahill et al. (2013) reported mean total movement distances from 5850 to 6545 m per match using 5 Hz global positioning systems (GPS), with the majority (83-86% of total distance) in the game played at low intensity speeds, with 12-15% at high intensity running and only 1% of sprinting. More recently, Jones et al. (2015) reported total match distances between 3698 and 6436 m using 10 Hz GPS devices, with 3-10% occurring at high speeds.

Women's rugby union has grown in

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popularity, despite this, to our knowledge, little attention has been given to determining the demands of the women's game, with only two published studies examining the activity profiles of female players during 15-a-side rugby union. Suarez-Arrones et al. (2014) reported mean total distance of 5820 m in a single Spanish international match, with 87% of the total spent at low intensity speeds and 3% at high intensity running or sprinting using 5 Hz GPS devices. Virr et al. (2014) examined a season of the Canadian women's league using time-motion video analysis, finding that 67-77 minutes were spent at low intensity and 13-17 minutes engaged in high intensity work per match. However, Suarez-Arrones et al. (2014) collected data from a single Spanish match that may not be representative of the demands occurring within the English women's game or across a league season. In addition, they used 5 Hz GPS devices, whereas current guidelines are that greater sampling frequencies are required to increase GPS data validity and reliability, especially at higher intensities (Scott et al., 2016). Additionally, limited numbers of players were included, with only eight in total in the study by Suarez-Arrones et al. (2014), while Virr et al. (2014) analysed four players per game.

Positional differences in movement characteristics have been found to exist in the men's game reflecting the varying roles across a rugby team (Deutsch et al., 2007; Lindsay et al., 2015; Roberts et al., 2008). The two previous studies investigating the women's game also reported differences in match-play characteristics between Forwards and Backs. For example, it was found that Backs covered greater overall distances during a match, greater distances at high intensities, completed a greater number of sprints (Suarez-Arrones et al., 2014), and as a consequence spent more time during matches in the higher intensity movement zones (Virr et al., 2014), while Forwards covered greater distances at jogging and in low intensity speed zones (Suarez-Arrones et al., 2014). Neither study described the positional differences in match demands that exist in the men's game (Cahill et al., 2013), and this study will add to the understanding of women's rugby.

Whilst the distances and intensity of activity reported in females at the international

level are similar to those produced by male rugby union players, variation does exist. It is hypothesized that match demands at the English women's club level are generally similar to female international players as physical abilities and technical skills are developed to attain the required level for selection. Knowledge of match demands encountered in the domestic competition would be beneficial for coaches to accurately develop and manage training and performance. Additionally, it is hypothesized that positional differences exist within the women's game, and as these have not been presented previously, availability of such data could allow players to utilise the positional requirements specific to themselves to develop their individual physical and physiological standard to enable progression along a player performance pathway. Therefore, the aims of the study were primarily to determine the match demands of elite English women's rugby union and to identify positional differences, and secondly, to identify whether between-player variability in match characteristics exist.

Methods

Participants

In total, data for 129 player games were collected from 14 competitive matches in the English women's premier division. Data were obtained from players who had completed >60 minutes per game (McLellan et al., 2011). Players were classified broadly (Forwards, $n = 68$; age 25 ± 5 years; body height 1.73 ± 0.06 m; body mass 79 ± 6.7 kg; and Backs, $n = 61$; age 25 ± 6 years; body height 1.65 ± 0.08 m; body mass 66 ± 4.9 kg) and considering specific positional roles (Forwards: front-row, second-row, back-row; Backs: scrum-half, inside-backs, outside-backs) in which they started each game, with only eight players actually changing their position within a game. All players provided informed consent to participate and the study was authorized by the University of Sunderland institutional ethics committee.

Design and Procedures

Each player wore a Catapult Minimax S4 GPS unit (Catapult Innovations, Melbourne, Australia) in a harness, positioned between the shoulder blades following manufacturer's guidelines, and participants were familiarized

with the device during training sessions. The Minimax S4 unit recorded player's movement at 10 Hz and physical demands using microsensor technology at 100 Hz. The reliability and validity of this device has been previously identified (Boyd et al., 2011) for field-based sports. Each unit was switched on at least 10 minutes prior to the start of each game to ensure a strong and stable signal was received and were switched off within 10 minutes of the game ending or a player being substituted. The horizontal dilution of precision (HDOP) values during game time ranged between 0.74 and 1.76 across all 14 matches indicating consistently good satellite accuracy during data collection. Kick-off time, final whistle, the end of the first half, and restart of the second half were identified with the same digital watch and recorded as Greenwich Mean Time (GMT). Half-time periods were excluded from analysis, so that data only described on-field player activity including any play stoppages. All data were downloaded using the Catapult Sprint 5.03 software (Catapult Innovations, Melbourne, Australia) with the time synchronized and data trimmed to only include on-field time. Data were then exported to Microsoft Excel 2010 (Microsoft Co., Redmond WA) for further analysis.

Measures

Total (m) and relative distances ($\text{m}\cdot\text{min}^{-1}$) were calculated at the following absolute arbitrary speed zones identical to those used by Suarez-Arrones et al. (2014) and based on the thresholds defined by Cunniffe et al. (2009) to allow subsequent comparison; 0-6 $\text{km}\cdot\text{h}^{-1}$ (walking), 6.1-12 $\text{km}\cdot\text{h}^{-1}$ (jogging), 12.1-14 $\text{km}\cdot\text{h}^{-1}$ (slow running), 14.1-18 $\text{km}\cdot\text{h}^{-1}$ (medium intensity running), 18.1-21 $\text{km}\cdot\text{h}^{-1}$ (high intensity running), >21.1 $\text{km}\cdot\text{h}^{-1}$ (sprinting), along with maximum speed ($\text{km}\cdot\text{h}^{-1}$), and percentage time (%T) spent in each zone. Physical demands were quantified from total (arbitrary units (AU)) and relative ($\text{AU}\cdot\text{min}^{-1}$) player loads (PL), and the number of repeated high intensity exercise (RHIE) efforts. The number of RHIE was identified as three or more high intensity activities (>18 $\text{km}\cdot\text{h}^{-1}$) being performed in a 21 s period (Austin et al., 2011b). In addition, work:rest ratios were calculated as the total distance covered at speeds >12.1 $\text{km}\cdot\text{h}^{-1}$ (periods of work) divided by distances at speeds <12 $\text{km}\cdot\text{h}^{-1}$ (periods of rest or recovery) as an indicator of the global match workload.

Statistical Analysis

Descriptive data were calculated as mean \pm SD. Despite repeated player performance, each player-game was considered an independent event. Therefore, between playing position differences were determined using independent measures ANOVA in SPSS v23 (IBM Co., Armonk, NY), with statistical significance set *a priori* at $p < 0.05$. Magnitude based inferences were used to identify practically important differences in physical variables. Effect size statistics (ES) were presented as Cohen's *d* (Hopkins et al., 1999) and were calculated using an effect size spreadsheet (<https://www.cem.org/effect-size-calculator>) from pooled mean values. Effect sizes were interpreted based on the following criteria: <0.2 trivial, 0.2-0.6 small, 0.6-1.2 moderate, 1.2-2.0 large, >2.0 very large (Hopkins, 2004). Variability in overall match demand characteristics was determined by calculating the between-player coefficient of variation (%CV) and presented with 90% confidence limits (CL) as an indication of the margin of error (McLaren et al., 2015).

Results

Overall match characteristics derived from the GPS and microsensor data are presented as mean \pm SD values, grouped for the full team, and the Forwards and Backs in Table 1, and between the six positional groups in Table 2.

Forwards and Backs

Forwards and Backs covered similar overall total distances (5049 ± 852 m vs. 4908 ± 985 m) and relative distances (55.8 ± 7.7 $\text{m}\cdot\text{min}^{-1}$ vs. 53.8 ± 10.3 $\text{m}\cdot\text{min}^{-1}$). Forwards covered moderately greater distance at jogging speeds ($p < 0.001$, ES = 0.83), while Backs covered moderately greater distances at high intensity running ($p < 0.001$, ES = 0.94) and sprinting speed zones ($p = 0.001$, ES = 0.91) (Figure 1). Similarly, Backs reached moderately higher speeds than Forwards (Maximum speed 23.2 vs. 20.5 $\text{km}\cdot\text{h}^{-1}$; $p < 0.001$, ES = 1.00). In terms of on-field match time, there were no differences between Forwards and Backs (90.1 ± 11.4 vs. 89.4 ± 11.5 min, respectively). Despite this, Backs spent a significantly greater proportion of the time either walking or at high intensity running (HIR), and sprinting actions (Walking: $p = 0.014$, ES = 0.47; HIR: $p < 0.001$, ES = 0.81; Sprinting: $p = 0.044$, ES = 0.43), and Forwards spent a significantly greater time at jogging

speeds ($p < 0.001$, $ES = 0.81$), with moderate effect sizes for jogging and high intensity running. Measures of match workloads were higher in Forwards than Backs, with the total and relative player loads being significantly higher (Total: $p =$

0.012; Relative: $p = 0.004$), though these had only a small corresponding effect size (Total: $ES = 0.46$; Relative: $ES = 0.53$). Finally, the number of repeated high intensity efforts did not differ between Forwards and Backs.

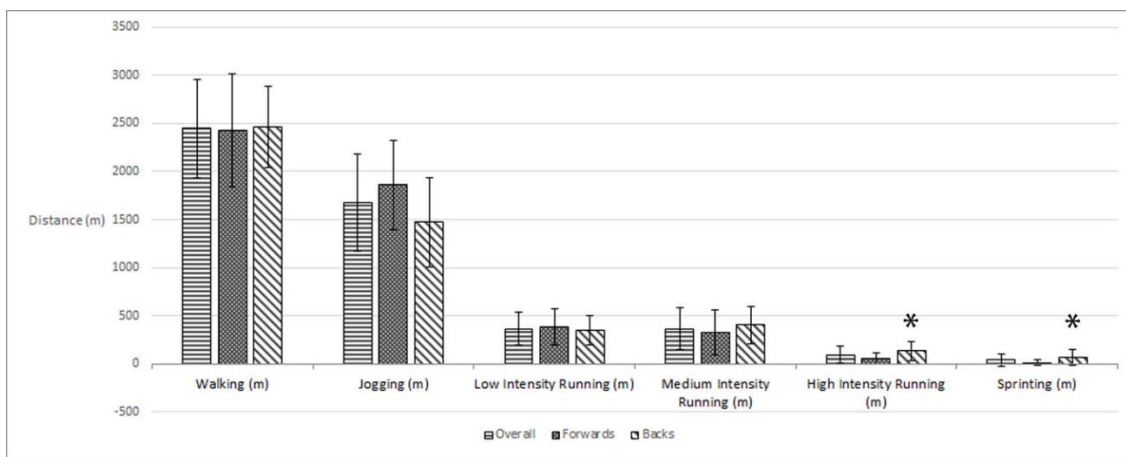


Figure 1
Total distances covered (m) in speed threshold zones based on broad positional groups.
* indicates significantly greater distance.

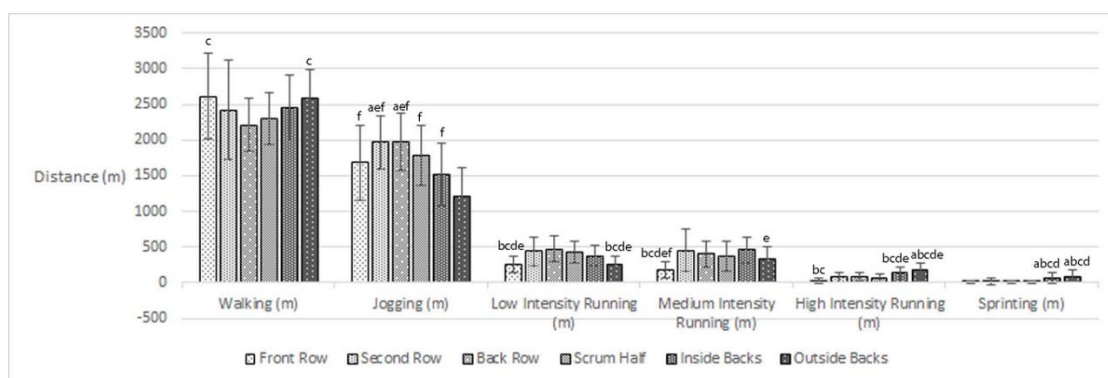


Figure 2
Total distances covered (m) in speed threshold zones based on specific positional groups.
Indicates significantly different distance from ^a front row; ^b second row; ^c back row; ^d scrum half; ^e inside backs; ^f outside backs.

Table 1

Comparison of movement patterns and player demands during match-play between Forwards and Backs (mean ± SD)

Variable	Overall	Forwards	Backs
Playing time (min)	89.8 ± 11.4	90.1 ± 11.4	89.4 ± 11.5
Total Distance (m)	4982 ± 917	5049 ± 852	4908 ± 985
Relative Distance (m·min ⁻¹)	54.8 ± 9.1	55.8 ± 7.7	53.8 ± 10.3 ^s
Maximum speed (km·h ⁻¹)	21.7 ± 3.0	20.5 ± 2.4	23.2 ± 3.0* [#]
Walking (m)	2447 ± 515	2430 ± 588	2465 ± 422
Jogging (m)	1676 ± 504	1858 ± 466	1472 ± 468 [#]
Low Intensity Running (m)	367 ± 171	382 ± 188	349 ± 150
Medium Intensity Running (m)	363 ± 218	328 ± 238	402 ± 189 ^s
High Intensity Running (m)	94 ± 87	58 ± 60	133 ± 97* [#]
Sprinting (m)	39 ± 64	14 ± 20	66 ± 78* [#]
%Time Walking	80.9 ± 5.3	79.8 ± 5.1	82.3 ± 5.2* [#]
%Time Jogging	12.3 ± 3.6	13.5 ± 3.3	10.8 ± 3.4* [#]
%Time Low Intensity Running	1.9 ± 0.9	2.0 ± 1.1	1.7 ± 0.8 ^s
%Time Medium Intensity Running	1.4 ± 0.9	1.3 ± 0.9	1.6 ± 0.9
%Time High Intensity Running	0.2 ± 0.4	0.1 ± 0.3	0.4 ± 0.5* [#]
%Time Sprinting	0.1 ± 0.0	0 ± 0	0.1 ± 0.3 ^s
Work:Rest Ratio	0.09 ± 0.04	0.09 ± 0.04	0.08 ± 0.04 ^s
Total Player Load (AU)	531 ± 97	551 ± 76	508 ± 111* ^s
Relative Player Load (AU·min ⁻¹)	5.9 ± 0.9	6.2 ± 0.7	5.7 ± 1.1* ^s
RHIE	19.2 ± 9.0	18.8 ± 9.9	19.7 ± 8.0

* Indicates significantly different from Forwards ^sIndicates small effect size difference from Forwards

[#] Indicates moderate effect size difference from Forwards

Table 2

Comparison of movement patterns and player demands during match-play between specific positional groups (mean ± SD)

Variable	Front Row	Second Row	Back Row	Scrum Half	Inside Backs	Outside Backs
Playing time (min)	89.5 ± 11.8	89.3 ± 11.3	91.6 ± 11.5	85.7 ± 11.0	89.7 ± 12.9	91.5 ± 9.6
Total Distance (m)	4783 ± 731	5297 ± 1057	5161 ± 734	4960 ± 727	5032 ± 1044	4701 ± 1055 ^b
Relative Distance (m·min ⁻¹)	53.0 ± 5.8 ^b	59.4 ± 10.3	56.1 ± 6.0	57.5 ± 7.5	54.5 ± 11.6	50.6 ± 9.6 ^{bcd}
Maximum speed (km·h ⁻¹)	19.4 ± 2.0 ^{bcef}	20.7 ± 2.4	21.6 ± 2.3	19.9 ± 2.5	23.4 ± 2.5 ^{abcd}	24.9 ± 2.3 ^{abcde}
Walking (m)	2613 ± 601 ^c	2422 ± 699	2212 ± 380	2292 ± 362	2461 ± 445	2583 ± 405 ^c
Jogging (m)	1686 ± 527 ^f	1966 ± 370 ^{aeef}	1976 ± 409 ^{aeef}	1784 ± 413 ^f	1515 ± 442 ^f	1208 ± 403
Low Intensity Running (m)	264 ± 113 ^{bcdde}	444 ± 211	473 ± 179	431 ± 149	379 ± 141	254 ± 112 ^{bcdde}
Medium Intensity Running (m)	178 ± 119 ^{bcddef}	457 ± 305	401 ± 182	375 ± 215	459 ± 183 ^f	341 ± 165
High Intensity Running (m)	24 ± 36 ^{bc}	79 ± 71	82 ± 54	61 ± 62	134 ± 88 ^{bcdde}	178 ± 103 ^{abcde}
Sprinting (m)	9 ± 20	18 ± 47	15 ± 20	10 ± 17	74 ± 76 ^{abcd}	92 ± 89 ^{abcd}
%Time Walking	81.4 ± 6.1	78.3 ± 4.4	79.1 ± 3.9	78.6 ± 5.1	82.1 ± 5.0 ^{bcd}	85.2 ± 3.7 ^{abcd}
%Time Jogging	12.8 ± 4.2	13.6 ± 2.4	14.4 ± 2.6	13.4 ± 3.0	11.2 ± 2.9 ^{bc}	8.3 ± 2.6 ^{abcde}
%Time Low Intensity Running	1.4 ± 0.7 ^d	2.3 ± 1.3	2.4 ± 1.1	2 ± 0.9	1.8 ± 0.7 ^c	1.2 ± 0.4 ^{bcdde}
%Time Moderate Intensity Running	0.7 ± 0.6 ^{bcdde}	1.7 ± 1.2	1.7 ± 0.7	1.6 ± 1.0	1.8 ± 0.8	1.1 ± 0.7 ^c
%Time High Intensity Running	0 ± 0	0.2 ± 0.4	0.1 ± 0.2	0.2 ± 0.4	0.4 ± 0.5 ^{ac}	0.5 ± 0.5 ^{abc}
%Time Sprinting	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0.1 ± 0.3	0.1 ± 0.4 ^{abc}
Work:Rest Ratio	0.06 ± 0.03 ^{bcdce}	0.1 ± 0.05	0.1 ± 0.04	0.09 ± 0.04	0.09 ± 0.04	0.06 ± 0.03 ^{bcdce}
Total Player Load (AU)	539 ± 74	555 ± 87	562 ± 71	520 ± 89	524 ± 126	476 ± 102 ^{abc}
Relative Player Load (AU·min ⁻¹)	6.1 ± 0.5	6.2 ± 0.7	6.2 ± 0.8	6.0 ± 0.9	5.8 ± 1.3	5.2 ± 0.9 ^{abcde}
RHIE	13.3 ± 8.8 ^{bcef}	23.3 ± 8.2	21.6 ± 9.6	18.5 ± 9.0	20.3 ± 8.0	19.7 ± 7.7

Indicates significantly different from ^a front row; ^b second row; ^c back row; ^d scrum half; ^e inside backs; ^f outside backs: [#] Indicates moderate/large effect size difference from other positional group

Positional Groups

Minimal differences in total distances covered within a match were found between the six positional groups, with the second-row covering the greatest distance (5297 ± 1057 m) and this was significantly greater than outside-backs (4701 ± 1055 m; $p = 0.043$, $ES = 0.56$). Significant differences did exist when movements were considered at specific speed zones (Figure 2). Generally, Forward positions covered greater distances at lower intensity speeds with the back-row covering significantly greater distances jogging and low intensity running (LIR) than both the inside- (Jogging: $p < 0.001$, $ES = 1.08$; LIR: $p = 0.03$, $ES = 0.59$), and outside-backs (Jogging: $p < 0.001$, $ES = 1.89$; LIR: $p < 0.001$, $ES = 1.46$), and the second-row also performed greater jogging ($p < 0.001$, $ES = 1.96$), and low intensity running ($p < 0.001$, $ES = 1.18$) distances than outside-backs. Scrum-halves also covered a greater distance jogging than inside- ($p < 0.07$, $ES = 0.62$), and outside-backs ($p < 0.001$, $ES = 1.41$), and low intensity running than outside-backs ($p = 0.001$, $ES = 1.39$). Conversely, both the inside- and outside-backs covered significantly greater distances at high intensity speeds (Inside: $p < 0.001-0.012$, $ES = 0.67-1.63$; Outside: $p < 0.001-0.038$, $ES = 1.12-1.39$), with significantly greater sprinting distances than all other positions (Inside: $p < 0.001-0.012$, $ES = 0.84-1.16$; Outside: $p < 0.001-0.038$, $ES = 1.03-2.13$) and achieved significantly higher maximum speeds. The front-row were distinctive as they covered significantly less distances at jogging and all running speeds than the other positions except the scrum-half at high intensity running and sprinting speeds. The workloads of outside-backs were generally lower than other positions, with significantly lower work:rest ratios than all other positions except the front-row ($p < 0.001-0.02$, $ES = 0.83-1.12$), relative player loads significantly lower than all other positions ($p < 0.001-0.019$, $ES = 0.55-1.26$), and total player loads significantly lower than Forward positions ($p = 0.004-0.025$ and $ES = 0.73-0.99$). Additionally, the work:rest ratio of the front-row was significantly lower than all other positions ($p < 0.001-0.026$ and $ES = 0.73-1.15$). Finally, the number of RHIE performed was significantly lower for the front-row compared to all positions except the scrum-half.

The between-player distance variability (%CV \pm CL) was smallest for total distance (17.1

± 10.9) with greater match-to-match variance as speed demand increased: Walking - 21.0 ± 6.6 ; Jogging - 30.1 ± 6.4 ; LIR - 46.7 ± 2.2 ; MIR - 60.1 ± 2.8 ; HIR - 93.5 ± 1.1 ; and Sprinting - 165.4 ± 0.8 ; due to the relatively shorter distances covered at higher speeds. Additionally, small variance in physical demands was observed for maximum velocity (13.8 ± 0.04) and player load (18.2 ± 1.2).

Discussion

The aims of the present study were to determine the physical characteristics of English women's rugby union and to identify positional differences.

Forwards vs. Backs

In the English women's game, the players covered a total and relative mean distance of 4982 m and $54.8 \text{ m}\cdot\text{min}^{-1}$, respectively. These distances are lower than distance reported by Suarez-Arrones et al. (2014) in a single international match by the Spanish national team. In that game players covered 5820 m or $68.5 \text{ m}\cdot\text{min}^{-1}$, with Backs covering a significantly greater distance (6356 m) than Forwards (5498 m). This indicates that total distances covered in national club level women's rugby are lower than that at the international level, and can be attributed to a higher match intensity, different tactical approaches and greater player quality and preparedness at the international level (Jones et al., 2015). However, care should be taken when making these comparisons since Suarez-Arrones et al.'s data are based on a single game, whereas current data reflect mean distance over multiple games. When speed zones are considered, inside- and outside-backs covered significantly greater distances at high intensity running and sprinting speeds, while distances at jogging and low intensity running speeds were significantly greater in Forwards. These trends were similar to those described by Suarez-Arrones et al. (2014). High speed movements often result in line breaks and scoring opportunities resulting in a high winning rate (Ortega et al., 2009) and Backs are expected to perform more frequent and longer runs and sprints than Forwards as found by Suarez-Arrones et al. (2014). This is reflected in the significantly faster maximum speeds achieved by Backs in the current study of ($23.2 \text{ km}\cdot\text{h}^{-1}$ vs. $20.5 \text{ km}\cdot\text{h}^{-1}$), and whilst this is lower than the mean maximum speed of $24.4 \text{ km}\cdot\text{h}^{-1}$ reported by

Suarez-Arrones et al. (2014) using a 5 Hz GPS system, a similar difference of approximately 2.5 km·h⁻¹ was noted between Forwards and Backs in both studies, which were smaller than positional differences of 4.1 km·h⁻¹ found in men's rugby by Cahill et al. (2013). Additionally, in the current study players spent a greater amount of time at low intensity movement speeds (walking/jogging) and less time at high intensity speeds (>18 km·h⁻¹) compared to that reported by Virr et al. (2014) in women's Canadian league rugby. Overall, players spent 93% of time at the low intensity, while Virr and colleagues (2014) reported this value at the level of 79%. The variation is most likely due to different approaches between the two studies, with Virr et al. (2014) employing time motion analysis, utilizing different speed thresholds, and counting static activities separately.

Due to limited availability of data, it is common to make comparisons to the men's game, for example English Premiership (Cahill et al., 2013; Roberts et al. 2008) or Celtic League (Jones et al., 2015). All three studies present higher overall and relative distances, and maximum speeds for Forwards and Backs indicating a higher demand occurring in the men's game. For example, male rugby players covered 17-24% greater relative distances at 64.2 m/min and 68.2 m/min (Jones et al., 2015; Cahill et al., 2013, respectively) than players in the present study (54.8 m/min). This is unsurprising due to the greater physical stature and physiological capacity of male players (Clarke et al., 2017), but should be taken into account when interpreting data from the women's game as assessing female player work-rates using male data will underestimate female players' performance. Greater knowledge of the female match demands will reduce reliance on male data and thus create a better understanding of women's rugby union. Comparing the results from the present study to the ones found by Cahill et al. (2013) indicated that distances covered at low intensity (standing and walking) differed by only 8% between female and male players. Interestingly, Forwards and Backs covered a similar total distance in the present study, unlike research from males. However, this was largely accounted for by the greater jogging distance covered by Forwards. Indeed, Backs covered 178% more combined high intensity and sprint distance (>18 km·h⁻¹) than Forwards in the

present study, whereas differences of only 35% were observed between Forwards and Backs in sprint distances covered in male players (Cahill et al., 2013), demonstrating that Backs did perform significantly more high intensity running than Forwards in women's rugby even if total distances were similar.

The player load was used as an indication of the external physical workload of each player. Mean values of 531 AU and 5.9 AU·min⁻¹ were found for the whole team. Forwards produced significantly higher total player loads (551 – 508 AU) and relative player loads (6.2 – 5.7 AU·min⁻¹) than Backs. This indicates that Forwards are placed at greater levels of physical work during the game and this is a result of participating in scrums, line-outs, and a greater number of rucks and mauls than Backs as reported by Roe et al. (2016), though this still needs quantifying in the women's game. However, the effect size of both measures was small (Total: 0.46; Relative: 0.53) indicating that there is little difference in player load between Forwards and Backs, possibly due to Backs being involved in a greater number of rucks and mauls in addition to covering more high intensity running.

Positional Groups

Positional differences were found to exist for all match demand variables. The second-row covered the greatest mean overall distance of 5297 m per match (59.4 m·min⁻¹) and these were significantly greater than outside-backs that covered the least total distance. When match time was taken into account, the back-row and scrum-half also covered greater relative distances than outside-backs. The analysis of movement distances in particular speed zones indicated that the second-row and back-row covered significantly greater distances at jogging and low intensity running than inside- and outside-backs, while inside- and outside-backs covered greater distances at high intensity and sprinting speeds and attained higher mean maximum speeds than all other positions, with outside-backs reaching the highest maximum speed of 24.9 km·h⁻¹. To our knowledge, this is the first activity data presented at the positional level for women's rugby union as neither Suarez-Arrones et al. (2014) nor Virr et al. (2014) had the required sample size to conduct such analysis, and this study provides coaches and researchers with an initial dataset to make

benchmarks. Variations are evident when compared to male positional data that found the scrum-half covered the highest relative distances and forward positions the least (Cahill et al., 2013; Roberts et al., 2015). The scrum-half is often described as a link player, following Forwards and supporting Backs, in doing so tracking the ball from phase to phase to keep the ball in play, producing the greatest distances in the men's game. It may be that the role is not so clear in women's rugby union, with plays resulting in more outcomes such as tries where the scrum half does not need to track the ball, though further research is needed. Similar positional differences exist in the other measures of the workload performed. The front-row and outside-backs had lower work:rest ratio values than all other positions, primarily due to the greater distances covered walking. For the front-row, this is usually between static activities; i.e. scrums and line-outs; and for the outside-back standing in position in the backline awaiting the ball.

Limitations

The purpose of this study was to present data on women's rugby union. Despite this, the assumptions, calculations and thresholds are based on the men's game. For example, the speed thresholds are those used by Suarez-Arrones et al. (2014), taken from the work by Cunniffe et al. (2009) from two elite male Celtic League players. It is probable that these zones are not applicable to the women's game as the maximal speeds attained are lower. This is evident with the mean maximum speed by outside-backs in the current study of 24.9 km/h, a value that is approximately 4 to 8 km·h⁻¹ lower than those reported in the men's studies (Coughlan et al., 2011; Cunniffe et al., 2009). Amending the speed thresholds to suit the physical capabilities of women may be necessary and by doing so, may change the proportion of distances and time spent in the zones that would become more accurate. Speed thresholds have been shown to be variable in women's soccer, ranging between >13-15 km·h⁻¹ for high intensity running and >20-25 km·h⁻¹ for sprinting (Bradley and Vescovi, 2015). Further research is needed to determine the effect of sex specific speed thresholds on the quantification of match performance characteristics, with some initial work on this being conducted by Clarke et al. (2014) in women's rugby sevens, where

physical demands are distinct from the 15-a-side game. Adjusting speed thresholds requires identification of maximal speed through linear sprint testing or velocity at VO_{2max} through lab-based testing, however, this is beyond the scope of the current observational study approach. Additionally, this may account for the low work:rest ratio values reported in the current study, as incorrect thresholds disproportionately increase the level of low intensity activity and decrease the high intensity activity.

Conclusions

This study presents match demands in terms of the movement characteristics and workloads performed within premier division English women's rugby union. The values in the current study were lower than those seen in the male game and marginally lower than those reported in female international rugby union and different from a Canadian league. But the data are the first obtained from 10 Hz GPS devices and from within English domestic women's rugby, thus adding to the overall limited data available on women's rugby union. This does provide an initial set of movement characteristics for the English women's game that allows future comparison with alternative teams and competitions. The findings have application to coaches and support staff, such as strength and conditioning coaches, working with female players. Generally, they covered moderately less distance per game, particularly at high speeds compared to male counterparts. Where coaches use existing values to grade player standards for selection purposes, the current data provide a more appropriate indication of female match performance than male-derived criteria. Positional differences occur in the women's game; Forwards covered greater distances at low intensity speeds, along with higher player load values, whereas Backs produced greater sprint distances and higher maximal speeds. Similar distance differences were also found within the positional groups. Thus, both sex- and position-specific data should be considered when designing conditioning programmes in rugby union, developing fitness tests and in benchmarking physical performances during competitive games.

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