Physical Qualities of International Female Rugby League Players by Playing Position

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ABSTRACT

The purpose of the current study was to investigate the anthropometric, body composition and fitness characteristics of female rugby league players by playing position. Data were collected on 27 players who were part of the English elite women's rugby league squad. Player assessments comprised anthropometric (stature and body mass), body composition (dual-energy X-ray absorptiometry) and fitness (lower-body power [countermovement jump (CMJ), 20 kg jump squat (JS) and 30 cm drop jump], 5, 10, 20, 30, and 40 m sprint, 505 agility, Yo-Yo intermittent recovery test level 1) measures. Players were classified into playing position (i.e., forwards and backs) prior to analysis. A multivariate analysis of variance (MANOVA) demonstrated significant ($p<0.05$) differences for body mass, stature, total fat, lean mass and percentage body fat between forwards and backs. Positional differences were also observed for speed, agility and lower-body power. Significant relationships were observed between total body fat and all fitness variables, and total lean mass was related to CMJ and JS peak power. This study provides comparative data for female rugby league forwards and backs. Body fat was strongly associated with performance and should therefore be considered in developing fitness characteristics. The relationship to match performance and trainability of these characteristics warrants further investigation.

Key words: anthropometry, power, fitness, playing position, body composition

INTRODUCTION

Rugby league is an intermittent, collision-based team sport played across junior and senior age categories by both sexes worldwide (21). Rugby league consists of frequent bouts of high intensity activity (i.e., sprinting) and collisions (i.e., offensive ball carries and defensive tackles) separated by bouts of low intensity activity (i.e., walking, jogging; (39)). As such, players are required to have highly developed anthropometry, and aerobic and anaerobic capacities due to the demands of match play (21). The anthropometric and fitness characteristics of junior (33, 34, 36, 37) and senior (3-5) male rugby league players are well documented. However, despite females also playing rugby league and competing within their own respective international competitions, to date the characteristics of female rugby league players have received little attention (14).

Within rugby league there are two distinct playing positions; forwards and backs. Both positions have unique anthropometric and fitness characteristics due to the requirements of the sport. Studies in male rugby league players have shown that forwards are involved in more collisions, while backs are involved in more high-speed (>5 $m.sec^{-1}$) running (39, 40). Previous studies in males (10-13, 21) have identified forwards are taller, heavier, stronger and more powerful, with higher body fat than backs. Backs are reportedly faster, more agile, with a greater aerobic capacity than forwards (21). Despite known positional differences for male rugby league players, data for female rugby league players are limited to only one study (14), with no study investigating English players. Gabbett (14) reported that female forwards were heavier and had lower 10, 20 and 40 m speed and lower maximal aerobic power than backs. Gabbett (14) also reported that the respective characteristics of Australian female rugby league players were worse than previously reported for other elite female team sports athletes.

Research examining the anthropometric and fitness characteristics of rugby league players is often limited by the assessment methods used. For example, body composition is frequently reported using sum of skinfolds, which only provide an estimate of body fat. Investigating body composition using dual-energy X-ray absorptiometry (DXA) allows the measurement of fat and lean mass for both total body and regional compartments (22). Furthermore, DXA also allows the measurement of bone mineral content (BMC), which provides an insight into the skeletal health of an athlete (16, 26), previously reported as a concern in female athletes (28). To date, no study has investigated the body composition and BMC in female rugby league players. In addition, the assessment of muscular power is often limited to field-based measures (i.e., yardstick vertical jump device; (14)) and incorporate a relatively narrow range of assessment conditions (i.e., concentric only jumps (3)). Assessments of muscular power using laboratory equipment under different loading conditions (i.e., drop jumps) not only increases the sensitivity of the measures (1), but also provide more in-depth information regarding the changes in specific physical qualities (i.e., stretch-shortening cycle function) and the potential underling mechanisms (8). Understanding muscular power in elite female rugby league players provides practitioners with an evidence base for training prescription, based on individual characteristics and groups trends.

Furthermore, although studies have analyzed the relationships between anthropometric and physical characteristics in male rugby league players (24, 36), no study to date has considered the relationships within female players, especially using DXA. Such information would be beneficial to coaches and strength and conditioning professionals for maximizing the development of anthropometric and physical characteristics and informing training programme design. Therefore, based on the lack of research evidence available within female rugby league players and no study examining the relationships between characteristics, the purpose of this study was to present the characteristics of elite female rugby league players by playing position and investigate the relationships between the measured variables. It was hypothesized that forwards have a greater body mass, stature, body fat and fat free mass than backs, and the backs would have greater power output, endurance, speed and agility than forwards.

METHODS

Experimental Approach to the Problem

The elite women's rugby league squad in England, as selected by the Rugby Football League were assessed for anthropometry (height, body mass), body composition (DXA; total and percentage body fat and lean mass, BMC, and regional fat and lean mass), speed and agility (5, 10, 20, 30, 40 m sprint and 505 agility), endurance (Yo-Yo Intermittent Recovery Test Level 1 [IRT-1]) and lower-body power (countermovement jump [CMJ]), 20 kg jump squat [JS], and 30 cm drop jump [DJ]). The training squad attended one-day training camps throughout the year and trained at their amateur clubs the rest of the time. All testing was conducted over one squad training day, providing an insight into the overall fitness characteristics of players. No strength measures were included because after discussions with the coaching staff, some players had a limited resistance training history.

Subjects

Twenty-seven (15 backs [age; 23.5 ± 4.1 years] and 12 forwards [age; 26.3 ± 6.4 years]) female rugby league players were investigated during the same squad training session in November 2014. This was at the end of their domestic amateur playing competition. All players were identified to the elite women's rugby league squad, which was the first group of players, talent identified prior to the 2017 Rugby League World Cup. Players had previously been training with their amateur clubs, and had not undertaken any structured strength and conditioning training. Players were aware of the research nature of the project, with all procedures clearly explained and written consent was obtained. Leeds Beckett University Ethics Committee approved all experimental procedures.

Procedures

All testing was completed across one testing session. Subjects were instructed to rest for 48 hours prior to the testing session and to maintain normal eating and drinking habits. Subjects arrived at the testing facility at 0830 and were assigned into three groups. Each group started on one of three stations and then moved onto the next one. The three testing stations were anthropometric and body composition (station one), speed and agility (station two) and power (station three). A 15-minute break was provided between each testing station. Anthropometric, body composition, speed, agility and power assessments were all undertaken in the morning and the endurance assessment was completed in the afternoon as one group, following a 60-minute lunch break. During the lunch break, players ate a packed lunch provided by the coaching staff, which was not influenced by the research team.

Prior to active testing protocols (i.e., speed, agility and power) a standardized warm up was completed including jogging, dynamic movements and stretches. Each test was fully explained and demonstrated prior to assessment. The lead researcher oversaw all testing. Players wore their playing boots when undertaking the speed, agility and endurance assessments, which occurred outdoor on a 3G pitch. Due to the effects of hydration status of body composition measures using DXA (29), all DXA scans were undertaken prior to the Yo-Yo test, whereby sweat losses were inevitable. All other tests would likely have a limited effect on fluid balance. Fluid was also available *ad libitum* throughout the testing, thus it was unlikely players developed a state of hypohydration (23).

Anthropometry: Height was measured to the nearest 0.1 cm using a Seca Alpha stand and body mass, wearing only underwear, was measured to the nearest 0.1 kg using calibrated Seca alpha (model 770) scales.

Body Composition: All participants were scanned in a euhydrated state (urine osmolality <700 $mOsmol \cdot kg^{-1}$ (32)). For all measurements, participants wore minimal clothing, with shoes and jewellery removed. Each participant received one total body DXA scan (Lunar iDXA, GE Medical Systems, UK) using standard or thick mode depending on body mass and stature. Participants lay in the supine position on the scanning table with their body aligned with the central horizontal axis. Arms were positioned parallel to the body, with legs fully extended and feet secured with a canvas and Velcro support to avoid foot movement during the scan acquisition. One skilled technologist led and analysed all scans following the manufacturer's guidelines for patient positioning. The regions of interest were manually placed to enable the appropriate cuts according to the manufacturer's instructions. Scan analysis was performed using the Lunar Encore software (Version 15.0).

DXA outcomes of interest were total fat mass, total lean mass, total BMC and percentage body fat. In addition to using absolute values, Z-scores were also explored to enable comparisons of body fat mass with sex and age-specific reference data in the absence of a control group. Z-scores were automatically provided by the Lunar EnCore software according to standard deviations (*SD*) above or below the reference mean. DXA calibration was checked and passed on a daily basis prior to the study and after the study using the GE Lunar calibration hydroxyapatite and epoxy resin phantom. There was no significant drift in calibration. Local precision values for our Centre (in healthy adult subjects, aged 34.6 years are CV = 0.8% for fat mass, CV = 0.5% for lean mass, and CV = 0.6% for BMC (26, 27)).

Muscular Power: Following two warm-up repetitions, subjects performed a CMJ, JS and DJ on a Kistler force platform (1000 Hz). For each CMJ, subjects were instructed to start from a standing position with hands on hips, moving to a self-selected depth and to jump as high as possible (18). Subjects performed the CMJ with their hands on their hips. For each JS, subjects started from an upright position with a 20 kg Olympic barbell positioned across the shoulders immediately above C7 (8). This was followed by a preparatory downward movement and then by a jump for maximal displacement. Although the 20 kg load which was selected for the JS is below some of the loads (40 – 100 kg) that have been used previously in highly trained individuals (5), the load was selected because of the inexperience of the female athletes in power training and has been used previously in athletes of a lower training status (3). Furthermore, absolute (i.e., 20 kg) over relative (i.e., 20% one repetition maximum) loads were preferred as training adaptations have been shown to predominantly manifest themselves as an improvement in an individual's ability to propel an absolute load (17). The DJ task involved subjects standing on a 30 cm box (20) and then being instructed to drop down off the bench onto a mark 30 cm from the box landing on both feet. On landing subjects were instructed to immediately perform a jump for maximum vertical displacement whilst keeping hands placed on hips and landing back on the force platform (20). Three maximal efforts were completed for each type of jump with 2 minutes rest between efforts. Jump height (m) and peak power output (Watts) were calculated for each CMJ and JS using BioWare software (version 5.1.3; Kistler, Winterthur, Switzerland) whilst jump height, contact time (CT) and reactive strength index (RSI) were calculated for each DJ. Jump height was calculated using the flight time (time subjects spent airborne in each jump) method (9.81 x flight time^2), contact time was the duration that the subject was in contact with the force platform during the first landing whilst RSI was calculated by dividing the jump height in the depth jump by the CT prior to the jump. Within-session reproducibility for jump height achieved during each CMJ, JS and DJ was ICC = 0.99 and CV = 1.10%, ICC = 0.97 and CV = 3.0%, and ICC = 0.95 and CV = 3.0%, respectively. The within-session reproducibility of the RSI was ICC = 0.93 and CV = 3.5%.

Speed: Sprint speed was assessed over 5, 10, 20, 30 and 40 m using timing gates (Brower Timing Systems, IR Emit, USA). Players started 0.5 m behind the initial timing gate and were instructed to set off in their own time and run maximally past the 40 m timing gate. Each player had 3 attempts, separated by a 2–3 minute rest period. Times were recorded to the nearest 0.01 seconds with the quickest of the three attempts used for the sprint score. ICC and CVs for 5, 10, 20, 30 & 40 m sprint times were ICC = 0.84 and CV = 2.9%, ICC = 0.95 and CV = 1.3%, ICC = 0.91 and CV = 1.6%, ICC = 0.89 and CV = 1.5% and ICC = 0.96 and CV = 1.2%.

Agility: The agility 505 was performed, whereby the subjects were positioned 15 m from a turning point. Timing gates were placed 10 m from the start point and 5 m from the turn point. The subjects accelerated from the start, through the timing gates, turning 180° at the 15 m mark and sprinted back through the timing gates. Subjects completed 3 alternate attempts, turning off their left and right foot, separated by a 2–3 minute rest period. Only attempts whereby the subject's foot crossed the 15 m mark were recorded. Times were recorded to the nearest 0.01 seconds with the quickest of the three attempts used. The ICC and CV for the agility 505 were ICC = 0.85 and CV = 2.0% (left) and ICC = 0.89 and CV = 2.2% (right).

Endurance: Subjects endurance capacity was assessed via the Yo-Yo IRT-1 (25), which has recently been used in rugby league (36, 37). Subjects completed 2 x 20 m shuttle runs, interspersed with 10 seconds of active recovery. As the test progresses, the speed of the shuttles increased, controlled by audio signals dictating the time in which the shuttles need to be completed. The speed of the test increased progressively with the players stopping due to volitional exhaustion or until they missed two beeps (6). The distance ran was recorded for analysis. Previous research (25) has shown an ICC and CV for the Yo-Yo IRT-1 of ICC = 0.98 and CV = 4.6%.

Data Analysis

Data are presented as mean ± *SD* by position (i.e., forwards *vs.* backs). Preliminary analyses were conducted with Kolmogorov-Smirnov tests performed on the data set to check data distribution with $p>0.05$ indicating normality. A multivariate analysis of variance (MANOVA) was used to examine the differences between playing positions. SPSS (IBM, Armonk, NY, USA) version 20.0 was used to conduct analysis with all statistical significance set at $p<0.05$. Cohen's effect size (ES) statistics (7), with 95%

confidence intervals were calculated with threshold values of $d<0.2$ (trivial), 0.2-0.59 (small), 0.6-1.19 (moderate), 1.2-2.0 (large) and >2.0 (very large). Pearson's correlations were performed to identify relationships between variables. *r* values were interpreted as 0.1-0.29 = small, 0.3-0.49 = moderate, 0.5-0.69 = large, and 0.7-0.9 = very large (7).

RESULTS

Comparisons were made between forwards and backs for all variables, with respective *p* values shown in the tables when not shown in the text (Table 1 and 2). Forwards were significantly taller (ES = 0.79), heavier (ES = 1.34), with a greater total fat mass (ES = 1.31), total lean mass (ES = 0.96) and percentage body fat (ES = 1.12) than backs. Forwards also had significantly greater fat mass in their arms (ES = 1.60) and greater fat and lean mass in their legs (ES = 0.98 – 1.20) and trunk (ES = 0.94 – 1.25) than backs. Backs had a significantly greater lean mass difference between their left and right leg (ES = 0.85) than forwards. Mean age-matched Z-scores for percentage tissue body fat were 0.7 ± 0.7 and -0.1 ± 0.4 for forwards and backs, which were significantly different (p=0.01). Mean age-matched Z-scores for BMC were 2.3 ± 1.0 and 2.2 ± 0.7 for forwards and backs, with no significant difference observed.

Backs were significantly quicker than forwards over 5, 10, 20, 30, 40 m (ES = 1.03 – 1.17), and 505 agility right and left (ES = 0.85 – 0.92). Backs jumped significantly higher than forwards during the CMJ (ES = 1.00), JS (ES = 1.11) and DJ (ES = 1.50). Backs also produced significantly greater relative power (ES = 1.30) during the CMJ and had a significantly greater RSI (ES = 1.17) on the DJ than forwards.

Correlations were explored between DXA derived body composition (total body fat and lean mass) and performance measures, shown in table 3 with associated *r* and *p* values. Significant correlations were observed between total body fat and all performance variables. All correlations were positive, except Yo-Yo, CMJ (jump height and relative peak power), JS (jump height and relative peak power) and DJ (jump height). Total lean mass was positively correlated with CMJ and JS peak power.

Correlations were then explored between laboratory (CMJ, JS and DJ) and field-based assessments (5, 10, 20, 30, 40 m, 505 agility and Yo-Yo test), shown in table 4 with associated *r* and *p* values. Significant correlations were found between CMJ and JS jump height against all field-based measures. All correlations were negative apart from the Yo-Yo test. Significant negative correlations were also found between CMJ relative peak power, JS height, JS relative peak power, DJ height and all field-based measures. DJ RSI was also significantly negatively correlated with 30 m sprint, agility and positively correlated with Yo-Yo test.

DISCUSSION

The purpose of this study was to investigate the characteristics of elite female rugby league players by playing position and investigate the relationships between the measured variables. As hypothesized, body size was greater in forwards than backs, whilst backs were quicker, more agile and had greater relative power than forwards. Contrary to the original hypothesis, there was no difference in endurance between forwards and backs. This study also showed that total body fat was correlated with all performance tests. This study is the first to show the respective positional characteristics of English female rugby league players.

The anthropometric differences between forwards and backs are consistent with previous research in female rugby league players (14), junior male (35-37) and senior male players (9). Regardless of sex, the greater body mass and stature of forwards are likely favourable for their respective positional requirements, as forwards are involved in more collisions than backs (21). The stature and body mass of players from this respective English cohort were shorter and heavier than their Australian counterparts (forwards and backs; 169.0 ± 6.6 and 166.1 ± 65.4 cm, and 75.5 ± 12.5 and 64.7 ± 7.6 kg (14)). The players in this study were also taller and heavier than South African female rugby union forwards and backs; 165.2 ± 6.5 and 160.9 ± 6.4 cm, and 78.9 ± 13.0 and 63.0 ± 6.0 kg (19). It is unclear how this would impact their rugby league on field performance. Some studies have reported that more successful male rugby league players are taller and heavier than their sub-elite counterparts (2, 3), whereas a recent study by Jones and colleagues (22) reported no difference between the stature and body mass of Super League *vs*. Championship rugby league players in England. The trainability of these traits is limited, thus these respective differences, if regarded as important for performance should be a consideration during the talent identification process.

As in male rugby league players, forwards were found to have a greater percentage body fat than backs (22, 27). The observed mean percentage body fat for backs are within healthy reference ranges as indicated by the Z-scores (38), although two players reached 1*SD* above the reference mean for body fat. There is a role for some level of fat mass in female athletes given the secretion of free concentrations of sex hormones from the adipocytes for a normal functioning menstrual cycle and for bone formation activity (30). Furthermore, fat mass may also provide direct protective effects against fracture, as reported in non-sport populations (31). Forwards had greater absolute lean mass than backs, although when performance measures were observed (CMJ height and relative peak power, JS height, DJ height and reactive strength index), forwards had lower relative scores. The greater absolute lean mass would theoretically be beneficial for forwards, given their role (i.e., high number of collisions) within a match. Total lean mass was correlated with absolute power, but a consideration for practitioners and players should be the overall body composition. Given forwards had significantly more total fat mass, significantly lower relative power than backs and total body fat was negatively correlated with all performance measures, the findings of this study suggest that some players may benefit from reducing their total body fat.

Backs were quicker than forwards over 5 – 40 m and also during the 505 agility test. It should be acknowledged that it is unlikely forwards will engage in sprints of 40 m within a match, and backs engage in more high-speed running (39) therefore this may be an explanation of the findings. The 505 agility test represents a player's ability to accelerate, decelerate, change direction and then accelerate over 5 m. Despite the criticism of agility tests lacking a reactive component (15), the movement characteristics of the 505 test are similar to those during of rugby league, due to the retreats undertaken in a match. The findings therefore suggest that practitioners working with youth or developing female rugby league positional backs should focus on speed and agility development. As momentum is a key determinant of rugby league performance (5), it may also be advantageous for forwards to develop their speed.

The speed (10, 20 and 40 m) scores in this study were quicker than those reported in Australian female rugby league forwards and backs (10 m; 2.04 ± 0.10 and 1.96 ± 0.10 seconds, 20 m; 3.60 ± 0.19 and 3.44 ± 0.14 seconds, 40 m 6.59 ± 0.41 and 6.33 ± 0.25 seconds) (14). It is unclear why the differences in speed exist, although this study does provide new reference speed data for female rugby league players. Also English female rugby league backs appear to have quicker 505 agility times, whereas forwards are slower in comparison to Australian female rugby league players (14). An explanation for this may be the power : weight ratio of forwards, thus players may benefit from either developing their muscular power or reducing their body mass (specifically body fat). Furthermore, if forwards decreased their body fat, the ratio of fat : lean mass would also likely facilitate an increase in performance as greater lean mass would translate to a greater amount of mass able to generate power. This would likely increase the ability to decelerate, change direction and accelerate.

It is unclear why there was no difference between the endurance capacity of forwards and backs. Elsewhere, studies have shown backs to have greater endurance capacities than their forward counterparts (9). This has previously been attributed to the increased running demands during match play for backs in comparison to forwards (39). To date, there are no data on the movement demands during match play for female rugby league players, thus it is unclear if positional differences in the running demands during match play exists and poses a direction for future research.

This is the first study to use laboratory-based equipment to investigate muscular power in female rugby league players. Backs produced significantly greater relative power during the CMJ and had a significantly greater RSI on the DJ than forwards. The CMJ height was greater in Australian female rugby league forwards and backs (35.1 ± 8.0 and 35.7 ± 5.9 cm; (14)) than those in the current study. The development of muscular power to increase jump height, could be recommended as a priority for players given that speed and agility were related to CMJ height, DJ height, JS height, CMJ relative peak power and JS relative peak power. Absolute CMJ and JS power showed no significant correlation to any field-based measure, thus as previously discussed an increase in muscular strength and reduction in (fat) mass would likely increase relative power scores and potentially improve field-based performance. Of consideration, DJ contact time showed no correlation to any field-based measure and DJ RSI showed significant correlations with 30 m speed and 505 agility (right and left). These observed relationships provide practitioners with information to design an appropriate testing battery. Given the similarity between CMJ and JS *vs.* field-based performance, it would appear inefficient for practitioners to include both tests within their battery.

In conclusion, this study has provided comparative data for anthropometric, body composition and fitness characteristics for female rugby league players. Backs were quicker, more agile with greater relative power, although there were no differences in endurance. Future studies evaluating the relationships of body size and composition variables to match performance and the trainability of key attributes in female players would be valuable.

PRACTICAL APPLICATIONS

Anthropometric, body composition and fitness characteristics of players have been shown to be important attributes for rugby league performance. This study provides comparative data for female rugby league players that can be used by practitioners when identifying strengths and weaknesses of players. The data may also be of use for player development staff when identifying potential talent. Furthermore, this study provides a comparative testing battery for practitioners to use when assessing the strengths, weaknesses and monitoring player development. Within international players, positional backs are quicker, more agile with greater relative power than forwards, although no difference in endurance capacity was observed. Practitioners should consider these findings when prescribe training programmes for youth and developing players, although the data presented in this study should be used as a start point for developing player targets, given the training status of this cohort. Coaches should also be aware that absolute peak power was not related to speed or agility, whereas relative power and jump height were. If players are focusing on the development of power, they should also consider their power : weight ratio. It may be appropriate for some players to develop their muscular power while also reducing their body fat. Optimizing the ratio of fat : lean mass would likely facilitate and increase performance, as greater lean mass would translate to a greater amount of mass able to generate power. It should also be noted that coaches should understand the importance of standardized testing procedures and timing if data are to be appropriately compared.

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Table 1. Mean (± Standard deviation) Anthropometric and Body Composition Profiles of International Female Rugby League Players

	Playing position		Cohen's *d* (95% CI)
	Backs (*n*=15)	Forwards (*n*=12)	
Body Mass (kg)	66.0 ± 7.3	80.7 ± 14.3[e]	1.34 (0.47 – 2.14)
Stature (cm)	163.1 ± 4.0	167.4 ± 6.8[a]	0.79 (0.02 – 1.56)
Total Fat Mass (g)	18,215 ± 4,840	26,945 ± 8,391[e]	1.31 (0.44 – 2.11)
Total Lean Mass (g)	44,092 ± 4017	49,313 ± 6,838[e]	0.96 (0.13 – 1.73)
Total BMC (g)	2,709 ± 263	2,938 ± 434	0.66 (-0.14 – 1.41)
Percentage Body Fat (%)	27.7 ± 4.8	33.5 ± 5.6[d]	1.12 (0.28 – 1.90)
Arms Fat Mass (g)	2,019 ± 453	2,910 ± 665[e]	1.60 (0.69 – 2.42)
Arms Lean Mass (g)	4,713 ± 540	5207 ± 840	0.72 (-0.09 – 1.48)
Lean Mass difference between Arms (g)	111 ± 58	163 ± 119	0.58 (-0.21 – 1.33)
Legs Fat Mass (g)	7,258 ± 1,794	10,053 ± 2,857[e]	1.20 (0.35 – 1.99)
Legs Lean Mass (g)	15,184 ± 1,834	17,506 ± 2,916[c]	0.98 (0.15 – 1.75)
Lean Mass difference between Legs (g)	330 ± 221	173 ± 127[b]	0.85 (0.03 – 0.40)
Trunk Fat Mass (g)	8,318 ± 2,832	13,373 ± 5,177[d]	1.25 (0.39 – 2.04)
Trunk Lean Mass (g)	21,870 ± 1,878	24,364 ± 3,413[c]	0.94 (0.11 – 1.70)
Lean Mass difference between Trunk side (g)	177 ± 177	377 ± 341	0.76 (-0.04 – 1.52)

Cohen's d (95% CI) shows the difference between backs and forwards [a]$p = 0.05$, [b]$p = 0.04$, [c]$p = 0.02$, [d]$p = 0.01$, [e]$p < 0.01$

Table 2. Mean (± Standard deviation) Fitness Characteristics of International Female Rugby League Players

	Playing position		Cohen's *d* (95% CI)
	Backs (n=15)	Forwards (n=12)	
5 m Speed (seconds)	1.07 ± 0.06	1.17 ± 0.11[d]	1.17 (0.32 – 1.95)
10 m Speed (seconds)	1.87 ± 0.09	2.01 ± 0.17[d]	1.07 (0.23 – 1.84)
20 m Speed (seconds)	3.36 ± 0.18	3.6 ± 0.26[d]	1.10 (0.25 – 1.87)
30 m Speed (seconds)	4.68 ± 0.25	5.05 ± 0.44[d]	1.07 (0.23 – 1.84)
40 m Speed (seconds)	6.13 ± 0.25	6.59 ± 0.61[d]	1.03 (0.19 – 1.81)
505 Agility Right turn (seconds)	2.59 ± 0.11	2.7 ± 0.15[a]	0.85 (0.03 – 1.62)
505 Agility Left turn (seconds)	2.58 ± 0.14	2.74 ± 0.21[b]	0.92 (0.10 – 1.69)
Yo-Yo IRT-1 distance (m)	728 ± 154	610 ± 292	0.52 (-0.26 – 1.28)
CMJ jump height (m)	0.29 ± 0.05	0.24 ± 0.05[c]	1.00 (0.17 – 1.77)
CMJ peak power (W)	2,827 ± 363	2,986 ± 573	0.34 (-0.43 – 1.09)
CMJ relative peak power ($W \cdot kg^{-1}$)	43.03 ± 5.18	37.12 ± 3.61[e]	1.30 (0.43 – 2.09)
20 kg Jump Squat height (m)	0.17 ± 0.04	0.13 ± 0.03[d]	1.11 (0.27 – 1.89)
20 kg Jump Squat peak power (W)	2,027 ± 270	2,304 ± 487	0.73 (-0.08 – 1.49)
20 kg Jump Squat relative peak power ($W \cdot kg^{-1}$)	30.74 ± 2.69	28.60 ± 3.24	0.73 (-0.08 – 1.49)
30 cm Drop Jump height (m)	0.25 ± 0.04	0.19 ± 0.04[e]	1.50 (0.60 – 2.31)
30 cm Drop Jump Reactive Strength Index	0.87 ± 0.31	0.58 ± 0.13[d]	1.17 (0.32 – 1.95)

Cohen's d (95% CI) shows the difference between backs and forwards [a]$p = 0.05$, [b]$p = 0.03$, [c]$p = 0.02$, [d]$p = 0.01$, [e]$p < 0.01$

Table 3. Relationships between Total Body Fat and Total Lean Mass *vs.* Fitness Characteristics

	Total body fat (kg)		Total lean mass (kg)	
	r	*p*	*r*	*p*
5 m Speed (seconds)	0.625	<0.001*	0.338	0.085
10 m Speed (seconds)	0.695	<0.001*	0.326	0.097
20 m Speed (seconds)	0.621	0.001*	0.203	0.311
30 m Speed (seconds)	0.686	<0.001*	0.301	0.128
40 m Speed (seconds)	0.666	<0.001*	0.279	0.159
505 Agility Right turn (seconds)	0.651	<0.001*	0.262	0.186
505 Agility Left turn (seconds)	0.695	<0.001*	0.229	0.085
Yo-Yo IRT-1 distance (m)	-0.764	<0.001*	-0.222	0.266
CMJ jump height (m)	-0.625	-0.001*	-0.303	0.124
CMJ peak power (W)	0.573	0.002*	0.719	0.001*
CMJ relative peak power ($W \cdot kg^{-1}$)	-0.531	0.004*	-0.254	0.201
20 kg Jump Squat height (m)	-0.438	0.022*	-0.159	0.429
20 kg Jump Squat peak power (W)	0.689	<0.001*	0.826	0.001*
20 kg Jump Squat relative peak power ($W \cdot kg^{-1}$)	-0.537	0.004*	0.013	0.950
30 cm Drop Jump height (m)	-0.391	0.044*	-0.260	0.190

* denotes a significant ($p<0.05$) relationship

Table 4. Relationships between Lower-Body Power *vs.* Speed, Agility and Yo-Yo test

	Countermovement Jump				Jump Squat				Drop Jump			
	Jump Height (m)		Relative Peak Power ($W \cdot kg^{-1}$)		Jump Height (m)		Relative Peak Power ($W \cdot kg^{-1}$)		Jump Height (m)		Reactive Strength Index	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
5 m Speed (seconds)	-0.419	0.030*	-0.442	0.021*	-0.458	0.016*	-0.451	0.018*	-0.423	0.028*	-0.331	0.091
10 m Speed (seconds)	-0.537	0.004*	-0.544	0.003*	-0.541	0.004*	-0.488	0.010*	-0.502	0.008*	-0.348	0.075
20 m Speed (seconds)	-0.439	0.022*	-0.478	0.012*	-0.525	0.005*	-0.408	0.035*	-0.502	0.008*	-0.347	0.076
30 m Speed (seconds)	-0.616	0.001*	-0.614	0.001*	-0.614	0.001*	-0.566	0.002*	-0.542	0.004*	-0.427	0.026*
40 m Speed (seconds)	-0.593	0.001*	-0.601	0.001*	-0.616	0.001*	-0.594	0.001*	-0.538	0.004*	-0.373	0.055
505 Agility Right turn (seconds)	-0.662	<0.001*	-0.550	0.003*	-0.550	0.003*	-0.701	<0.001*	-0.712	<0.001*	-0.459	0.016*
505 Agility Left turn (seconds)	-0.648	<0.001*	-0.565	0.002*	-0.565	0.002*	-0.686	<0.001*	-0.635	<0.001*	-0.447	0.020*
Yo-Yo IRT-1 distance (m)	0.464	0.015*	0.345	0.078	0.397	0.040*	0.388	0.046*	0.583	0.001*	0.436	0.023*

* denotes a significant ($p<0.05$) relationship