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Original Research Article

Determination of Anthropometric and Physiological Performance Measures in Elite Scottish Female Rugby Union Players

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Abstract

Purpose: There is currently a notable absence of available scientific literature on Scottish women's rugby. To fulfill this niche, the aim of this study is to investigate the anthropometric, and physiological performance measures in Scottish female rugby players. **Methods:** Nineteen elite women's rugby union players from Scotland's top tier division were split into forwards and backs and underwent various anthropometric, and physical performance tests. **Results:** Mean (± standard deviation) recorded height, weight and body volume among all players is 166.11 cm ± 4.66, 73.51 kg ± 10.60 and 69.61 L ± 9.45, respectively. Average lean weight, fat weight and fat percentage is 51.18 kg ± 5.16, 22.75 kg ± 7.00 and 29.83% ± 6.43. Results from the sit and reach test, the Illinois agility test, 40m sprints and the yo-yo test are 23.18cm ± 9.23, 19.09s ± 0.85, 6.98s ± 0.38, and 35.82 $ml \cdot kg^{-1} \cdot min^{-1}$ ± 3.02 respectfully. **Conclusion:** There is no significant difference among forwards and backs in both the anthropometric and physical performance measurements, with the exception of the sit and reach test. The lack of significant difference in weight, body fat percentage and all other physiological performance measures between forwards and backs highlight the need to adapt the squad's training regime to a more positional-orientated program.

Key Words: Exercise Physiology, Female Rugby, Rugby, Anthropometry

Introduction

Rugby union is a contact sport in which participants require high levels of aerobic fitness, muscle strength and power, speed, agility and an optimal body composition[1]. Typically, players are split into forwards and backs and players will often have a unique physique, depending on the demands of the position that they play. Backline players spend more time sprinting than forwards and cover approximately 6,356m per game[2], whilst forwards spend more time in intensive non-running exertion[3] and cover approximately 5,498m per game[2]. As such, forwards are typically heavier, taller, and have a greater proportion of body fat than backs[1], and display significantly slower times in sprint and pro-agility tests[4]. The intensity of the game can be marked by the fact that rugby players spend just under half of the time between 91 and 100% of their maximum heart rate[2].

Since the professionalization of Rugby in 1995, there have been changes in both the anthropometry of the players and a dramatic increase in scientific literature on male players within the sport. This dramatic increase, has failed to crossover into the female aspect of the sport, especially in the Northern Hemisphere. Currently, there are no studies on Scottish women's rugby.

The introduction of Women's Rugby 7s to the Olympics provides an opportunity for the sport of women's rugby to increase in both participation and match attendance. Presently, Women's rugby is one of the fastest growing team sports in the world, played by more than 1.5 million females in over 110 countries[5]. In addition, the Women's 2014 Rugby World Cup was played in front of record breaking live and television audiences[5].

With increasing participation and competiveness, it would be useful for a national organization to establish anthropometrical, psychological and physiological values that help create guidelines to optimize female rugby player performance. Thus, the aim of the study is to investigate the anthropometric and physiological characteristics of elite Scottish female rugby players.

Methods

Participants

Nineteen healthy women (age: 28.7 yrs ± 7.2) participated in this study. Subjects were members of a Scottish women's premiership squad. The rugby union players of this study were defined as elite as they were in the highest rugby division in the country. As with most elite women's sport within Scotland, none of the players were paid professionals and were dependent on employment outside of rugby to generate income. All subjects received a clear explanation of the study, including the risks and benefits of participation, and written consent was obtained. The College of Medical, Veterinary & Life Sciences Ethics Committee for Non-Clinical Research Involving Human Subjects at The University of Glasgow approved all experiential procedures.

Fitness Testing Battery

All fitness testing was conducted during the 2015 BT Women's Premiership season (August to November). Players were motivated and free from injury at the time of testing. Testing was based on squad availability and the generosity of the coach to allow training time to be allocated for tests. Subjects underwent their normal pre-training routine, which included low-intensity to moderate running activities, short high-intensity sprints and dynamic stretching before each field-testing session. For field-testing, players were randomly allocated into different groups and rotated amongst various tests. Participants received verbal encouragement throughout all physiological tests to insure maximal performance. All field tests were conducted on a firm, grass surface. To allow for more participants, field-testing was conducted twice, one week apart. Individual subjects were prevented from being tested twice. Anthropometric and flexibility testing was done in a lab.

Anthropometry

Body weight, body fat percentage, body fat weight, lean weight and body volume were determined using the BodPod (Cosmed, Rome, Italy)[6], a body composition assessment system based on air displacement. Height was measured using the SECA Leicester stadiometer (seca GmbH & CO. KG, Birmingham, UK).

Speed

Speed was determined by 40m sprints. Brower TLC timing gates (Brower Timing Systems, Draper, UT, USA)[7] were placed at 0m, 10m and 40m points, and the equivalent splits from these were recorded. These distances were chosen for better comparability to other studies. Additionally, 10m and 40m can be used to determine acceleration and maximum velocity of a sprint[8]. Athletes started behind the first light gate and time was measured as a lapse between the breaks in the first and last light-beams. Subjects were asked to not decelerate until after the final light gate (40m). The test was performed three times, separated with adequate rest and the best result was recorded.

Agility

The Illinois agility run test was set up and administered using the protocol outlined by Hoffman (2006) (see figure 1) to determine agility. The subjects were instructed to lie on their stomachs with their head just behind the start line and hands placed flat on the ground. On a verbal command, the participant rose up and sprinted the course. Timing was started manually on the Brower TC Timing System[7], and timing was stopped via a light gate at the finish. Players were not advised on the best route taken through the course. The test was conducted twice with adequate rest time between each test and the best time recorded. This test was chosen due to its high reliability, reproducibility and correlation with other agility tests[10].

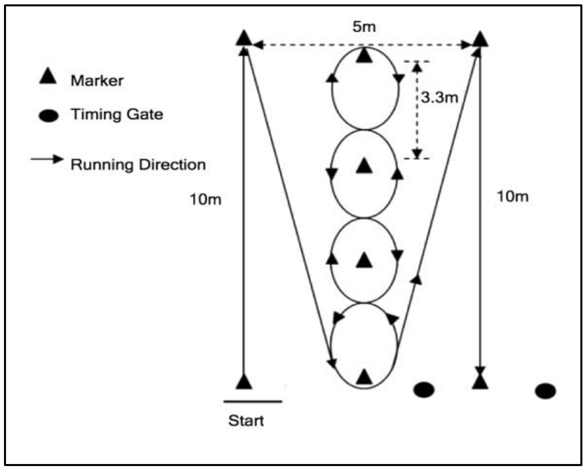

Figure 1. The Illinois agility run test.

Maximal Aerobic Capacity

The established Level 1 Yo-Yo Endurance Test[11] by Bangsbo (1994), a test similar to the 20 meter Multistage Fitness Test, was conducted in order to estimate $\dot{V}O_{2\ max}$ of the players. The test was chosen due to its intermittent nature, which is of a greater likeness to the nature of a rugby game. The test was conducted using the Beep Test App (Bitworks Engineering, UK). A 20m zone, and a 5m “rest” zone separated the field (see figure 2). Subjects stopped when fatigued or failed to reach the opposite end before the beep on two consecutive occasions.

Statistical Analysis

Statistical analyses were performed using Minitab 17.2.1 (Minitab, Inc., State College, PA, USA). All values are expressed as mean ± standard deviation. 2 sample t-tests were performed and significance was established *a priori* for all analyses at $p \leq 0.05$.

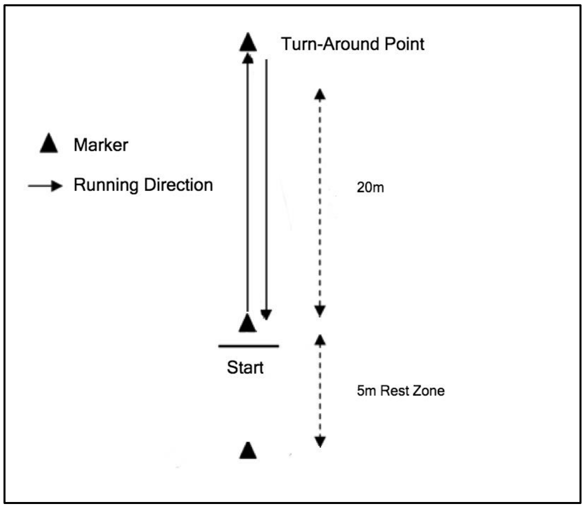

Figure 2. The Yo-Yo level 1 endurance course.

Results

Anthropometry

Average height, weight and body volume among all rugby players is 166.11 cm (n=14, ± 4.66), 73.51 kg (n=14, ± 10.60) and 69.61 L (n=11, ± 9.45), respectively. Average lean weight, fat weight and fat percentage is 51.18 kg (n=11, ± 5.16), 22.75 kg (n=11 ± 7.00) and 29.83% (n=11, ± 6.43). A detailed comparison between forwards and backs can be found in table 1.

Physiological Measurements

With regards to flexibility, the average sit and reach result was 23.18cm (n=11, ± 9.23). The average result for the Illinois agility test was 19.09s (n=15, ± 0.85). The time splits for the 0-10m, 10-40m and the total 40m sprint was 2.09s (n=15, ± 0.09), 4.88s (n=15, ± 0.32) and 6.98s (n=15, ± 0.38), respectively. Average distance in the yo-yo test was 1172m (n=12, ± 395). The average number of shuttles was 58.67 (n=12, ± 19.71). The mean estimated $\dot{V}O_{2\ max}$ was 35.82 $ml \cdot kg^{-1} \cdot min^{-1}$ (n=12, ± 3.02). A more detailed comparison of physiological values between forwards and backs can be found in table 2.

Table 1. Comparison of anthropometric results between forwards and backs.

	Forwards	Backs	p-value
Height (cm)	169.9 ± 5.0	163.9 ± 3.4	0.085
Weight (kg)	78.3 ± 9.4	68.7 ± 10.1	0.091
Body volume (L)	72.30 ± 10.5	67.6 ± 8.0	0.430
Lean weight (kg)	53.6 ± 6.9	49.2 ± 2.2	0.242
Fat weight (kg)	23.2 ± 4.9	22.4 ± 8.8	0.838

*Significant difference $p \leq 0.05$

Table 2. Comparison of performance determinants between forwards and backs.

	Forwards	Backs	p-value
Flexibility			
Sit and Reach (cm)	16.3 ± 9.1	28.9 ± 4.1	0.036*
Agility			
Illinois agility test (s)	19.2 ± 0.5	18.9 ± 1.3	0.516
Speed			
0-10m (s)	2.1 ± 0.1	2.1 ± 0.1	0.789
10-40m (s)	5.0 ± 0.2	4.8 ± 0.4	0.284
Total-40m (s)	7.1 ± 0.3	6.8 ± 0.5	0.336
Aerobic Capacity			
Estimated $\dot{V}O_{2\ max}$ ($ml \cdot kg^{-1} \cdot min^{-1}$)	35.9 ± 3.6	35.7 ± 2.1	0.890

*Significant difference $p \leq 0.05$

Discussion

With regards to anthropometrics, the results of this study shows that there is no significant difference between forwards and backs with regards to weight. This goes against the findings of previous studies[13-16]. However, the means of both forwards and backs are similar to those measured at the 2006 World Cup[16]. This suggests that there is an abnormally strong amount of variation with the studied squad, which is evident by the large standard deviation in both forwards and backs. In the discussion of height, forwards and backs again were not significantly different. This result is similar to that of previous studies[13, 15]. It is worth noting that if the same standard of significance (p-value ≤0.05) used in the present study, is applied to a previous the study[13], a weak difference can be observed (p≤0.043), where forwards are slightly taller than backs.

Similarly, forwards and backs were not significantly different in regards to body fat percentage. This could be in part due to the large standard deviation (± 8.86) in body fat percentage of the backs, as previous studies have found a difference between forwards and backs[13, 14]. South Africa's High Performance squad showed a similar mean body fat percentage among forwards (30.81 ± 4.56)[13]. However, previous results from England's Female Rugby Union backs (21.2% ± 1.7) and forwards (26.11% ± 4.56) have dramatically lower measurements[14] in comparison to those in this study. Excess fat can impair the speed and agility of a player[1]. However, consideration could be made for the impact cushioning that fat provides with regards to some of the forwards in the scrum[1].

With regards to speed, no significant differences were found between backs and forwards in both in the 10m and 40m sprints. This goes against previous findings[13], where backs were found to be significantly faster at both 10 and 40m. The same study found similar 10m results for forwards (2.08s) as the presented study, but forwards in this study ran considerably faster at 40m, a fact that suggests that the studied squad needs to approach a more position specific approach to training. This is important as a vast majority of activity lasts only a matter of seconds[3].

No significant difference was found in agility among backs and forwards. A previous study reported a significant difference in completion time among New Zealand senior forwards and backs on the study's own custom agility course[15]. This could be because of the backs' greater acceleration. This course, however, has not been validated to other agility tests. Results from a study performed on male rugby union players, showed no significant difference in agility between forwards and backs, when stratified for age[17]. Further investigation is needed to determine normative values among female rugby players, and distinction among player's position as such data is lacking in current literature.

The lack of significant difference between forwards and backs with regards to estimated $\dot{V}O_{2\ max}$ ($ml \cdot kg^{-1} \cdot min^{-1}$) contrasts with previous results in which back line players had higher levels of aerobic fitness than forward players[15, 18]. A finding not shared elsewhere in which no observable difference were reported[13]. The values obtained in this study were also lower than those of the Senior Female New Zealand Squad and South Africa's High Performance Squad for forward and back-line players (44.75 and 54.48 $ml \cdot kg^{-1} \cdot min^{-1}$ and 41.12 and 46.49 $ml \cdot kg^{-1} \cdot min^{-1}$ respectively for forwards and backs)[15, 13]. A time-motion study[3] conducted on women's rugby determined that short, but intensive bouts of exercise is the prominent form of activity performed during a match. This would suggest that energy sources are derived from stored high-energy phosphagens. The short duration of rest, under 20s, in a rugby match would also suggest an incomplete replenishment of these anaerobic pathways[3, 19], and as such, energy derived from glycolytic pathways is more significant as a game proceeds[20]. Finally, energy resulting from the aerobic metabolic pathway is important for both anaerobic and general recovery[21]. Thus, it can be said that training of the aerobic pathway could be of significant benefit to the studied squad, despite the fact that the sport of rugby relies predominantly on the anaerobic system.

Currently the relationship between flexibility and injury is contentious[22]. There is some evidence that decreased flexibility has been associated with increased unidirectional running and walking economy and may be associated with increased isometric and concentric force generation[23]. It is worth mentioning that the flexibility of the players was less than that of the forwards and backs reported elsewhere (41.07cm ± 5.30 and 39.91 cm ± 7.50, respectively)[13].

It is within the author's opinion that players should also have proper support and supervision so that they adhere to prescribed programs for optimal results. As such, strength and conditioning coaches are highly recommended. This statement is supported by previous research[24], where those who underwent resistance training with supervision had greater strength gains than those who had no supervision. Furthermore, additional studies need to be conducted to establish normative values, as well as further investigation to develop appropriate training stimuli within women's rugby.

Limitations

One limitation is the length of time needed to complete the study. It would be of greater benefit to test all subjects in the lab within a shorter period to avoid any sessional variation to anthropometry. Lack of availability from subjects also proved to be a hindrance during field-testing as the battery had to be repeated to accommodate numbers. Additionally, subjects were divided into only two groups: backs and forwards. It could be argued that this is not specific enough and it would perhaps be more beneficial to divide the team into three groups: the front five, middle five, and back five in further studies for better comparison. This is difficult to do in the present study due to statistical restraints.

Conclusion

There is no significant difference among forwards and backs in both the anthropometric and physical performance measurements, with the exception of the sit and reach test. The lack of significant difference in weight, body fat percentage and all other physiological performance measures between forwards and backs stress the need for a greater focus on position specific training. This is vital if Scottish Women's Rugby wishes to be a contender on the international scale.

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