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Anthropometric and Physiological Characteristics of Japanese Elite Women's Rugby Sevens Players

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This study investigated the anthropometric and physiological characteristics of Japanese elite women's rugby sevens players and compared them with Japanese elite women's field hockey players. Twenty-three Japanese elite women's rugby sevens players (age 23.1 ± 4.1 years) and twenty-six elite women's field hockey players (age 24.3 ± 3.4 years) underwent measurements of body size and weight, sprint ability (30- and 50-m sprint), agility, and lower body muscular power (squat jump, countermovement jump). Standing height (165.0 ± 4.7 vs. 161.0 ± 5.9 cm), body weight (64.2 ± 7.3 vs. 57.8 ± 4.7kg), lean body weight (53.4 ± 5.0 vs. 48.5 ± 3.2 kg), countermovement jump distance (37.9 ± 4.0 vs. 34.8 ± 3.9 cm), 30-m sprint time (4.69 ± 0.16 vs. 4.82 ± 0.14 sec), 50-m sprint time (7.33 ± 0.24 vs. 7.53 ± 0.25 sec), and agility index (1.80 ±0.07 vs. 1.73 ± 0.05 a.u.) greatly differed between the rugby sevens and field hockey players, respectively. Superior straight sprint ability over distances of 30-m was a physiological characteristic of elite women's rugby sevens players. These data may assist coaches and national federations in determining individual weaknesses and designing training programs for elite women's rugby sevens teams.

Keywords: field-based team, female rugby, sprint, physical fitness, team sports

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1. Introduction

The movement profiles of field-based team sports players (e.g., rugby, soccer, and field hockey) fluctuate randomly depending on the game situation, and can include brief periods of high intensity, and longer periods of low intensity, movement. Several studies have investigated the match-play demands of field-based team sports (Gabbett, 2010; King et al., 2009; Mohr et al., 2003; Mohr et al., 2008; Spencer et al., 2004). It has been reported that elite women's field hockey players cover 6.6 km over the course of a match and spend 2.7% of total match play in high intensity activities (Gabbett, 2010). Elite women's soccer players have been reported to cover 9–11 km over the course of a match and spend almost 7.0% of total match time in high intensity activities (Mohr et al., 2008). Regulations (e.g., match duration, field size, equipment, etc.) differ between field-based team sports, and thus the physiological demands of different sports also differ.

Women's rugby sevens will be a new inclusion in the 2016 summer Olympic Games in Rio de Janeiro, and is one of the fastest growing sports worldwide. The basic rules of rugby sevens are the same as for rugby fifteens matches, except for the shorter match duration (i.e., 7-min halves with a 1-min halftime). Suarez-Arrones et al. (2012) reported that women's rugby sevens players covered an average distance of around 1500 m per 14-min match, with 9% of the time spent in high-intensity activity (> 18 km/h^{-1}). King et al. (2009) reported that Australia's National Rugby League fifteens players covered an average of around 6000 m per 80-min match. Rugby sevens is played with fewer athletes per team (e.g., soccer and field hockey have 11 players per side) and for a shorter length of time (e.g., soccer, 45-min halves; field hockey, 35-min halves) than many other sports. However, the size of the rugby sevens playing field is similar to that of other field-based team sports (the length of the field is about 100 m and the width is about 70 m). Thus, rugby sevens players spend a larger proportion of the game running at high intensity (Granatelli et al., 2014). Therefore, the physical fitness characteristics of rugby sevens players might differ from those of players of other field-based team sports. An understanding of the anthropometric and physical fitness characteristics of elite women's rugby sevens players is needed to develop training programs and guide talent identification.

The aim of this study was to understand the anthropometric and physiological characteristics of Japanese elite women's rugby sevens players. We hypothesized that elite women's rugby sevens players would have superior sprint ability relative to other elite female field-based sports players. To test this hypothesis, we used anthropometric measurements and physical fitness tests to compare Japanese elite women's rugby sevens with field hockey players during similar training periods (general preparation during national training camps).

2. Method

2.1. Experimental approach to the problem

This study was designed to determine the anthropometric and physiological characteristics of Japanese elite women's rugby sevens players. The tests were performed at an indoor athletic track. The measurements for Japanese elite women's rugby sevens players were taken in late January, 2015 and for field hockey players in mid-February, 2015. All measurements were conducted from 9 a.m. to noon.

2.2. Subjects

Twenty-three Japanese elite women's rugby sevens players (age 23.1 ± 4.1 years, Forwards: n = 11, Backs: n = 12) and twenty-six elite women's field hockey players (age 24.3 ± 3.4 years, Forwards: n = 10, Midfields: n = 5, Defenders: n = 7, Goalkeepers: n = 4) participated in this study. The mean length of athletic career for the rugby sevens players was 11 ± 6 years (range 2-19 years). Eight of the field hockey players had participated in the 2012 London Olympic Games. All participants were recruited from women's rugby sevens or field hockey squads participating in national training camps. Written consent to participate was obtained from all subjects after informing them of the purpose of the experiment, the procedure, and the possible risks. This study was approved by the Human Subjects Committee at the Japan Institute of Sports Sciences.

2.3. Anthropometric measurements

Anthropometric measurements included the following: standing height, body weight, percentage body fat, and lean body weight. Standing height was measured using a stadiometer (AD-6225A, A&D medical, Tokyo, Japan). Body weight and percentage body fat were measured using a calibrated digital weight scale and air displacement plethysmography (BODPOD, Life Measurement Inc., Concord, USA), respectively. Lean body weight was calculated as body weight minus body fat.

2.4. Sprint ability (50-m sprint test)

A 50-m sprint test was conducted to measure the sprint time of players at 30- and 50- m using an electronic timing gates system (Brower, Salt Lake, USA). The timing gates were positioned 30- and 50-m from a predetermined starting line. The players were instructed to sprint as quickly as possible along the 50-m distance from a standing start. The players started from a stationary, upright position with their front foot on the 0-m start line, parallel to the starting gate. All players performed two trials separated by more than 5 minutes. The better result for each player was used in the analysis.

2.5. Agility (4-mark box agility test, side-step test)

Player agility was evaluated using a 4-mark box agility test and side-step test. The 4-mark box agility test was conducted to measure the running time of the players in two rounds (around 25-m/round) using a stopwatch (**Figure 1**). The length of the course was 5-m and the width was 5.59-m. Four tape markers were used to mark the start, goal, and turning points. The player started at mark 1 with one foot on mark 1 and the other foot behind the mark. On the "go" command, the player sprinted to mark 2. When the player reached mark 2 they then sprinted diagonally across the center of the square to mark 3. When the player reached mark 3 they then sprinted to mark 4. When the player reached mark 4 they then sprinted diagonally across the center of the square to mark 1

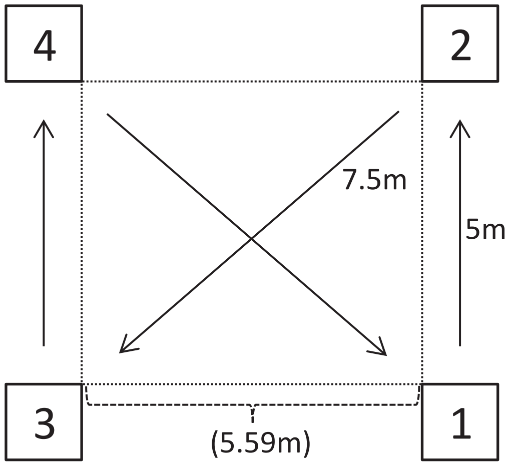

Figure 1 The 4-mark box agility test setup.

again. Players were instructed to keep sprinting as quickly as possible until two rounds were completed. The time for the 4-mark box agility test divided by the 50-m sprint time was defined as the agility index.

The side-step test consisted of three tape lines on the floor, spaced 1-m apart. The player began in a standing position on the center line and was instructed not to cross her feet while sidestepping. On the "go" command, the player sidestepped to the right until her right foot had touched or crossed the outside tape mark. The player then sidestepped to the left until her left foot had touched or crossed the outside tape mark. The player sidestepped back and forth to the outside tape mark as quickly as possible for 20 sec. One point was given per completion of each 1-m marked with tape. If the far end lines were not reached, those points were not awarded. The players performed each test twice, with more than 5 minutes between tests. The better result for each test was used in the analysis.

2.6. Lower body muscular power (squat jump test, countermovement jump test)

Lower body muscular power was evaluated by a squat jump (SJ) and counter movement jump (CMJ) test without arm swing using a switch mat system (Multi jump tester, DKH Co., Ltd, Tokyo, Japan). The players began the SJ with a knee angle of 90 degrees, without previous countermovement, and performed a vertical jump by pushing upwards, keeping their legs straight throughout. The CMJ was started from a standing position, allowing for countermovement (knee flexion) immediately before vertical impulsion. The players performed two trials of each test separated by 1 minute. The better result for each test was used in the analysis.

2.7. Statistical analysis

Only the values for outfield players were included in the analysis, goalkeepers (n = 4; field hockey) were excluded because the specific position. Not all rugby sevens players completed all tests (owing, in part, to injury); the final number of rugby sevens players that completed each test were as follows: sprint test, n = 18; 4-mark box agility test, n = 17; side-step test, n = 18; agility index, n = 16; and SJ and CMJ, n = 20. Values are expressed as means ± standard deviations (SD). Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 19.0 (IBM Corp., Armonk, NY, USA). Independent t-tests were used to assess the significance of between-group differences for all measurements. Significance was set at $P < 0.05$.

3. Results

Table 1 presents the data obtained in this study. Standing height, body weight, lean body weight, CMJ, 30- and 50-m sprint times, and the agility index significantly differed between the rugby sevens and field hockey players. Significant differences were detected between forwards and backs among rugby sevens players for body weight and lean body weight (**Table 2**). **Figure 2** shows the 50-m sprint time and agility index for all players in this study. The women's rugby sevens players tended to have superior sprint ability, but inferior agility, relative to the field hockey players (**Figure 2**).

4. Discussion

This is the first study to investigate the anthropometric and physiological characteristics of elite women's rugby sevens players. The major findings of this study were that Japanese women's rugby sevens players were taller, heavier, had greater lean mass, faster sprint times at 30- and 50-m, and better CMJ results than elite Japanese field hockey players, but the agility index of the rugby sevens players was inferior to that of the field hockey players.

The Japanese elite women's rugby sevens players were significantly taller and heavier than field hockey

Table 1 Anthropometric and physiological characteristics of Japanese elite women's rugby sevens players and field hockey players.

	Standing height (cm)	Body weight (kg)	Percentage body fat (%)	Lean body weight (kg)	30 m (sec)	50 m (sec)	4-mark (sec)	Agility index (a.u.)	Side step (point)	SJ (cm)	CMJ (cm)
Rugby	165.0	64.2	16.7	53.4	4.69	7.33	13.22	1.80	60.4	33.0	37.9
	± 4.7	± 7.3	± 3.5	± 5.0	± 0.16	± 0.24	± 0.46	± 0.07	± 4.2	± 3.5	± 4.0
(n)	23	23	23	23	18	18	17	16	18	20	20
Field hockey	161.0	57.8	15.9	48.5	4.82	7.53	13.01	1.73	59.9	31.8	34.8
(n = 22)	± 5.9	± 4.7	± 4.1	± 3.2	± 0.14	± 0.25	± 0.28	± 0.05	± 2.8	± 3.4	± 3.9
Significance	*	*	N.S.	*	*	*	N.S.	*	N.S.	N.S.	*

Values are expressed as means ± standard deviations. Differences were considered significant if $P < 0.05$. * Significant difference between Japanese elite women's rugby sevens players and field hockey players. (30 m, 30-m sprint; 50 m, 50-m sprint; 4-mark, 4-mark box agility test; agility index, 4-mark box agility test time divided by the 50-m sprint time; side step, side step test; SJ, squat jump; CMJ, countermovement jump.

Table 2 Anthropometric and physiological characteristics of forwards and backs in Japanese elite women's rugby sevens players.

	Standing height (cm)	Body weight (kg)	Percentage body fat (%)	Lean body weight (kg)	30 m (sec)	50 m (sec)	4-mark (sec)	Agility index (a.u.)	Side step (point)	SJ (cm)	CMJ (cm)
Forwards	166.2	68.2	18.1	55.7	4.74	7.39	13.37	1.81	61.1	32.9	37.5
	± 3.5	± 8.4	± 3.5	± 5.7	± 0.11	± 0.16	± 0.35	± 0.06	± 4.6	± 3.6	± 4.0
(n)	11	11	11	11	9	9	9	8	9	10	10
Backs	164.0	60.6	15.4	51.2	4.64	7.26	13.06	1.79	59.7	33.0	38.4
	± 5.5	± 3.6	± 3.1	± 3.0	± 0.19	± 0.29	± 0.54	± 0.08	± 3.7	± 3.5	± 4.2
(n)	12	12	12	12	9	9	8	8	9	10	10
Significance	N.S.	*	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Values are expressed as means ± standard deviations. Differences were considered significant if $P < 0.05$. * Significant difference between forwards and backs in Japanese elite women's rugby sevens players. (30 m, 30-m sprint; 50 m, 50-m sprint; 4-mark, 4-mark box agility test; agility index, 4-mark box agility test time divided by the 50-m sprint time; side step, side step test; SJ, squat jump; CMJ, countermovement jump.

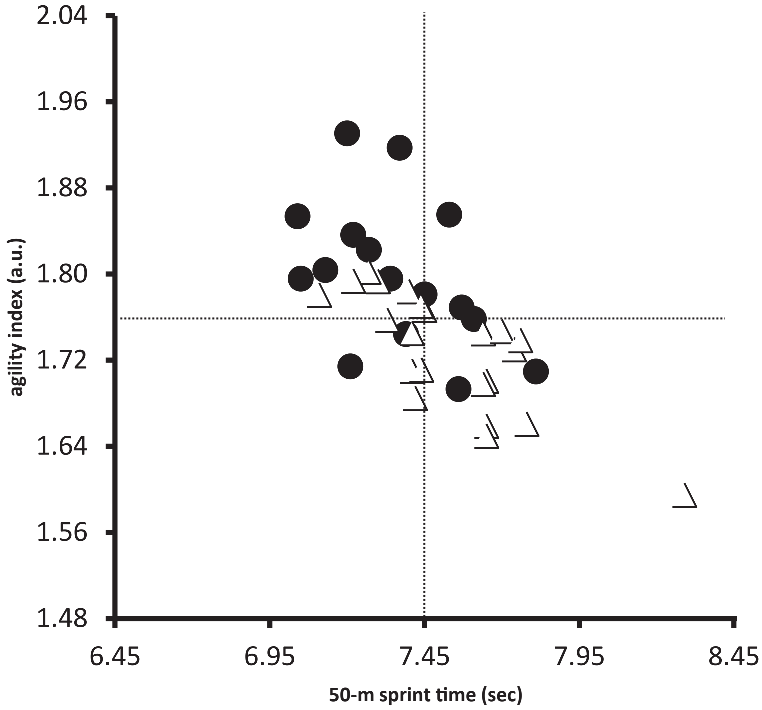

Figure 2 Relationship between 50-m sprint time and agility index; the agility index was calculated as the 4-mark box agility test time divided by the 50-m sprint time (● Japanese elite women's rugby sevens players, n = 16, △ Japanese elite women's field hockey players, n = 22).

players in this study (**Table 1**). When compared with women on the Japanese national soccer team (Hirose, 2009), the lean body weight of Japanese elite women's rugby sevens players was greater. Rugby players have been shown to weigh more than other field-based team sports players (Gabbett et al., 2008b). Owing to the high number of physical confrontations in a match, such as tackling, rucking, mauling, and scrummaging, it is likely that the larger body mass of rugby players, regardless of rugby codes, assists in developing the impact force necessary for these events. When compared with women's field hockey players, a greater body weight and lean body weight were an anthropometric characteristic of elite women's rugby sevens players.

Women's rugby sevens players in this study had faster 30- and 50-m sprint times than field hockey players (**Table 1**). Sprinting is important in rugby because speed is likely to influence the aspects of play that determine the outcome of the match (Roberts et al., 2008). Women's rugby sevens players spend 9% of match time in high-intensity (> 18 km/h^{-1}) activity, as compared with 2.7% of match time that elite women's field hockey players spend (Gabbett, 2010). Furthermore, on average, although the sprints performed by women's field hockey (Gabbett, 2010) or soccer (Datson et al., 2014) players cover an average distance of less than 20 m, the average sprint distance of women's rugby sevens players is 25.8 m and rugby sevens players are frequently required to sprint distances of more than 30 m (Suarez-Arrones et al., 2012). The larger playing area and thus space afforded to rugby sevens players might suggest that maximal speed over more than 30 m is more important in rugby than in other field-based team sports.

The agility index value of the women's rugby sevens players in this study was higher than field hockey players (**Table 1**), which suggests that they were less agile than the field hockey players. Rugby requires that players have the ability to rapidly accelerate, decelerate, and change direction (Gabbett et al., 2008a; Gabbett & Benton, 2009). Young et al. (2002) reported that agility consists of two major components: perceptual/decision making factors and speed of direction changes. Moreover, the speed of direction changes consists of three factors: strength, power, and reactive strength. The Japanese elite women's rugby sevens players in this study might be superior to field hockey players at straight sprinting but inferior when sprinting with direction changes (**Figure 2**).

As reported previously, the mean length of the athletic career for Japanese elite women's rugby sevens players was 11 ± 6 years (range 2–19 years). Some of these players have comparatively short athletic careers. For example, one participant had only been playing rugby for 4 years, and had previously been a long jumper. Some Japanese elite women's rugby sevens players may not be familiar with the specific movements in rugby, such as quick changes of direction. Further research on the agility characteristics of women's rugby sevens players is needed.

The CMJ distance achieved by the women's rugby sevens players in this study was further than that achieved by the field hockey players (**Table 1**). The capacity to rapidly generate high levels of muscular force is one of the key characteristics of successful rugby players (Gabbett et al., 2008). Several studies have assessed leg muscular power using the vertical jump test (Gabbett, 2002a; Gabbett, 2002b; Gabbett, 2007); however, no studies have examined the leg muscular power of women's rugby sevens players using the vertical jump test or CMJ test. As mentioned above, rugby players are required to have high levels of muscular strength and power to effectively perform tackling, rucking, mauling, and scrummaging during the match. Thus, high leg muscular power is an important physical fitness characteristic of elite women's rugby sevens players. In addition to leg muscular power, rugby sevens players require considerable upper-body strength and power. Further study is needed to characterize the upper-body strength and power of elite women's rugby sevens players.

In fifteens rugby, there are pronounced differences between forwards and backs in the positional roles and physical demands of play (Duthie et al., 2003). Gabbett et al. (2007) reported that body mass, skinfold thickness, sprint speed, muscular power, glycolytic capacity, and aerobic power were significantly different between forwards and backs in Australian women's fifteens rugby union players. However, the significant difference detected in this study between forwards and backs were only for body weight and lean body weight (**Table 2**). This suggests a need for relatively uniform physical fitness in sevens players, in contrast to fifteens players.

This study had two limitations. First, we did not measure sprint time over short distances, such as 10-m, or aerobic capacity. Another limitation of this study was our comparison sample was limited to Japanese elite women's field hockey players. Thus, further study is required to clarify the physical fitness characteristics of elite women's rugby sevens players in detail by comparing them to characteristics of players in another field-based team sport (e.g., soccer, basketball, or handball).

In conclusion, our results provide the first data on the anthropometric and physiological characteristics of Japanese elite women's rugby sevens players. Coaches and national federations can compare our data with data from other national and international elite women's rugby sevens players to determine individual weaknesses and design training programs.

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