Materials : Women's Football (Women's Soccer)

Physical Characteristics of Collegiate Women's Football Players

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The purpose of this study was to examine physiological characteristics of different positions in collegiate women's football players. Twenty-one female players (age: 19.4±0.9 years old, 5 forwards, 6 midfielders, 8 defenders, 2 goalkeepers) belonging to the Aichi women's football division I league participated in this study. Three types of vertical jumps, maximal anaerobic power, 20m sprint, step-50, and Yo-Yo intermittent recovery test level 1 were measured before the 2012 season. There was no significant difference among different positions because players had various playing experience in this team. In this study, physical performance, especially repeated intense performance, should be improved in order to increase the competitive standard.

Keywords: Women's football, Yo-Yo intermittent recovery test, Anaerobic Power, Agility, Speed

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1. Introduction

Football is a sport played between two teams on a pitch measuring 105 m long and 68 m wide. Within a set period of time, players attempt to score in a fluid environment. It is, therefore, important that players have the ability to make decisions, recognize space and players, and coordinate physical movement within a limited time and space. During each 90-minute game, average per-player ball possession is approximately two minutes (Kubo, 2010). In the remaining time, players stand, walk, jog, stride or run at low speed, sprint, and turn (Gabbett & Mulvey, 2008; Mohr, et al., 2008). For this reason, players require intermittent endurance and aerobic capacity for long distances, and anaerobic capacity for sprinting as well as short rests and light movements (Hoshikawa, et al., 2006). Improved game performance involves the physical as well as technical and tactical, which are factors that determine game outcome.

A number of recent studies have clarified physical characteristics in women's football in Europe and the U.S. (Anderson, et al., 2010; Gabbett, 2010; Kirkendall, 2007; Krustrup, et al., 2010; Krustrup, et al., 2005; Miler, et al., 2007; Sedano Campo, et al., 2009; Thorpe & Ebersole, 2008; Vescovi & McGuigan, 2008). However, similar studies are extremely limited in Japan (Hamada, et al., 1997; Hirose, 2009; Tsuda, 2010). Hirose (2009) reported the importance of improving speed and power, issues for Japanese players that were identified during the Beijing Olympics, and the importance of enhancing endurance and agility, which are their current strong points in international competition. The improvement of game performance in women's football requires studies on the physical aspects over a wide range of competitive levels in each category, including junior, youth, and university. In addition, it is also extremely important for coaches in each category to employ physical data in the training plans designed to develop players.

This study was conducted to examine the physical characteristics of collegiate women's football players by position through physical fitness tests focusing on the items indicated by Japan Football Association (JFA) physical measurement guidelines (Yasumatsu, 2005).

2. Method

2.1. Subjects

Subjects were 21 female players (5 forwards, (FW)

6 midfielders (MF), 8 defenders (DF), 2 goalkeepers (GK)) belonging to Aichi women's football division I league. Measurements were conducted immediately before in-season for 2012. Mean age, height, body weight (BW), BMI, body fat, and fat free mass (FFM) were 19.4±0.9 years old, 159.1±4.7cm, 54.7±5.1kg, 21.6±1.6kg/m^2, 24.7±3.1%, and 41.1±3.1kg, respectively. The years of football experience varied significantly; however, the mean years of experience was 6.0±4.1years (**Table 1**). Before measurement, we explained the purpose of this study and the protection of individual information. We also explained the possible psychological and physical pain that may occur prior to obtaining consent. This study was also approved by the Research Ethics Review Board of Aichi Toho University.

2.2. Measurement items

(1) Squat Jump (SJ)

Subjects started in a squat position with their hands on their hips and thighs parallel to the floor. We asked subjects to jump without swinging arms or counter movements. We measured jumps three times with Multi Jump Tester (IFS-031D, Ver.2 manufactured by DKH), and recorded the highest jump for analysis (Yasumatsu, 2005).

(2) Counter Movement Jump (CMJ) without Arm Swing

Subjects bent knees from a standing posture with both hands on their hips until the thighs become parallel to the floor, jumped using counter movement without swinging arms. We measured the jump three times with the same device used for SJ, and recorded the highest one for analysis.

(3) Counter Movement Jump with Arm Swing (CMJAS)

Subjects jumped with counter movement while swinging arms from a standing position. We measured the jump three times with the same device used for SJ, and recorded the highest one for analysis. We also calculated peak power (PP) of SJ, CMJ, and CMJAS utilizing Johnson & Bahamonde's formula (Johnson & Bahamonde, 1996).

(4) Maximal Anaerobic Power

We conducted a maximal anaerobic power test to measure maximal pedaling power (W). Testing included three periods of 10-second maximal pedaling with two-minute rest intervals utilizing a bicycle ergometer, Powermax-VII manufactured by Combi (Ichihashi, et al., 2004).

Table 1 Physical Characteristics of Collegiate Women's Football Players by Position (Mean±SD)

Variable	Position				Total
	FW	MF	DF	GK	
N	5	6	8	2	21
Age (years)	19.2±0.8	19.5±1.0	19.5±1.1	19.0±0.0	19.4±0.9
Height (cm)	157.4±4.7	160.4±5.0	158.7±4.8	161.7±6.2	159.1±4.7
Body Mass (kg)	54.2±3.7	54.1±4.8	54.0±5.9	60.6±5.7	54.7±5.1
Body Fat (%)	24.1±3.4	23.8±1.6	24.7±3.3	28.5±4.1	24.7±3.1
Fat Free Mass (kg)	41.1±1.4	41.2±3.6	40.5±3.8	43.2±1.6	41.1±3.1
BMI (kg/m^2)	21.9±2.1	21.0±1.4	21.4±1.5	23.2±0.4	21.6±1.6
Playing Experience (years)	6.0±5.2	5.7±4.4	6.9±4.0	3.5±0.7	6.0±4.1

FW: Forwards
MF: Midfielders
DF: Defenders
GK: Goalkeepers

(5) 20m Sprint

The 20m sprint was measured with a reflection-type sports timer system, ZYT-COM1 manufactured by Uesaka T · E. We placed a switch box at a starting point, asked subjects to leave the switch at will to start, and measured the time required to sprint 20m with an infrared reflection type sensor. The 20m sprint was measured twice and the best time was recorded for analysis. Rest time between measurements was three minutes.

(6) Step 50

We measured step 50 times twice with the same device and procedures used for 20m sprint. We recorded the best time for analysis. The rest time between measurements was three minutes.

(7) Yo-Yo Intermittent Recovery Test Level 1

We conducted Yo-Yo intermittent recovery test level 1 (Yo-Yo IR1) as repeated high-intensity running performance indices (Krustrup, et al., 2003).

2.3. Statistical analysis

We performed one-way analysis of variance to clarify differences in measurements by position. When the difference was significant, we employed the Tukey method as a multiple comparison test. Significance was set at 5%, and all analyses were performed with Microsoft Excel 2007.

3. Results

With regard to the performance on the three types of jumps, GK scored higher in height and peak power; however, no significant difference were noted among positions (**Table 2**). For maximal anaerobic power by bicycle ergometer, 20m sprint, and step 50, MF scored higher in anaerobic power, speed, and agility; however, no significant difference was noted among positions (**Table 2**).

In regard to repeated high-intensity running performance, DF scored higher; however, no significant difference was noted among positions (**Table 2**).

Table 2 Characteristics of Collegiate Women's Football Players by Position (Mean±SD)

Fitness Tests	Position				Total
	FW	MF	DF	GK	
	N=5	N=6	N=8	N=2	N=21
SJ					
Height (cm)	24.8±4.8	25.0±4.3	26.5±3.1	26.7±1.6	25.7±3.7
Peak Power (W)	1512.6±388.7	1477.9±474.8	1611.9±419.4	1987.1±126.6	1585.7±412.5
CMJ					
Height (cm)	25.7±4.5	27.5±4.7	28.2±3.2	29.1±3.3	27.5±3.8
Peak Power (W)	1586.4±356.3	1675.4±538.1	1745.5±444.2	2175.5±6.7	1727.7±438.8
CMJAS					
Height (cm)	31.5±6.6	31.5±3.6	32.1±3.7	35.7±5.0	32.1±4.4
Peak Power (W)	2040.1±516.8	1989.4±468.7	2021.4±451.3	2689.6±145.4	2083.3±472.1
Anaerobic Power					
Peak Power (W)	529.6±94.4	587.0±85.3	554.4±117.9	589.5±23.3	561.1±95.1
Peak Power per BW (W/kg)	9.7±1.4	10.8±0.8	10.2±1.5	9.75±0.5	10.2±1.2
20m Sprint (sec)	3.82±0.24	3.73±0.12	3.76±0.16	3.75±0.31	3.76±0.17
Step 50 (sec)	16.23±0.69	15.90±0.57	15.96±0.55	16.70±0.16	16.08±0.59
Yo-Yo Intermittent Recovery Test (m)	760.0±215.4	820.0±316.7	1095.0±324.2	600.0±169.7	889.5±321.7

SJ: Squat Jump
CMJ: Counter Movement Jump
CMJAS: Counter Movement Jump with Arm Swing

4. Discussion

Linear sprinting, agility, and jump performance in women's field testing are independent locomotor skills (Vescovi & McGuigan, 2008). In this study, we conducted field testing to examine the physical characteristics of collegiate women's football players. As a result, no significant difference was noted among positions in jump performance, maximal anaerobic power, speed, and agility. These results support the study carried out by Kubo (2010), which reported no difference among positions in agility, sprinting speed, and power of subjects except repeated high-intensity running performance. Meanwhile, in male junior, university, and professional football players, a wide range of differences has been reported in physical characteristics by position (Sporis, et al., 2009; Silvestre, et al., 2006; Gil, et al., 2007). As seen above, although some difference was noted in the physical characteristics of male football players by position, no difference was noted in the physical characteristics of women's football players by position. The reasons are thought to be the years' experience playing football among subjects of this study, and the different positions played according to the conditions of each team. In addition, no difference among positions may have become a characteristic of collegiate women's football players. Further examination of difference by position in different categories and levels is required in the future.

Among the three jump performances (SJ, CMJ, and CMJAS), SJ revealed the lowest score followed by CMJ (27.5±3.8cm), and CMJAS (32.1±4.4cm). According to the report on Nadeshiko Japan (Hirose, 2009), CMJ was 30.8±3.4cm and CMJAS was 35.0±3.8cm, which showed a similar tendency with the results in this study. However, CMJ and CMJAS in this study were approximately 11% and 8% lower than those in the report on Nadeshiko Japan. A study on the comparison of jump performances in junior and senior women's players in the Spanish League reported that senior players were significantly high (Mujika, et al., 2009). The result suggested the possibility that physical development in players may also have an influence on jump performance and difference in the level of performance.

No studies have compared maximal anaerobic power in women's football players. The maximal anaerobic power in this study was 561.1±95.1W, and the maximal anaerobic power per BW was 10.2±1.2W/kg. According to a method of assessment that classifies maximal anaerobic power into seven levels (Elite, Excellent, Above Average, Average, Below Average, Fair, and Poor) with the Wingate Test targeting both male and female players in National Collegiate Athletic Association (NCAA) Division I (Zupan, et al., 2009), which is different from the protocol of this study, the women's team in this study can be classified as Average for the maximal anaerobic power, and Above Average for the maximal anaerobic power per BW. This revealed that the absolute value of the maximal anaerobic power is important for ball kicking, or plays associated with physical contact, and that the absolute value of the maximal anaerobic power per BW is important for transferring body weight (Sanbongi & Iwamoto, 2009). These suggested that the improvement of maximal anaerobic power in collegiate women's football players could contribute to the improvement of football skills such as kicking and heading closely related to maximal anaerobic power.

The speed of women's football players was measured for a wide range of distances (10m, 20m, 25m, 20-30yd, and 50m) (McCurdy, et al., 2010; Polman, et al., 2004; Stolen, et al., 2005; Tsuda, 2010; Vescovi & McGuigan, 2008). In football games, 96% of sprint bouts are shorter than 30m, with 49% being shorter than 10m (Stolen, et al., 2005), which suggests measuring speed should be shorter than 30m. It has been reported that speed is not an indicator of competitive level in either male or female players (Mujika, et al., 2009). However, 20m sprint speed in collegiate women's football players (mean: 3.76±0.17 sec) is 0.24 seconds slower than that of the U-19 Japan women's team (mean: 3.52±0.15 sec). Converting these results into distance per 0.1 second, the distance for the subject team in this study was approximately 53cm and the U-19 Japan team was approximately 57cm. The difference in speed (0.24 seconds) translates into an approximately 130cm difference. Because football players are required to employ their skills in a fluid environment, small differences can cause a pinch or chance. Increased individual speed in women's football players is considered an important physical characteristic in improving team performance. In other words, speed of women's football players is closely related to competitive level, and differences are thought to be revealed in game performance between U-19 Japan and collegiate women's football players.

Agility is defined as the ability to change direction quickly, and it is influenced by explosive strength, balance, muscle coordination, and flexibility (Mujika, et al., 2009). Illinois Agility Test, Pro-agility Test, 15m Agility Run, 505 Agility Test, 10m×5 Shuttle Running, and Zig-zag Test are employed to measure agility in women's football players (Hoare & Warr, 2000; Kubo, 2010; Mujika, et al., 2009; Vescovi & McGuigan, 2008). This study adopted Step 50 test. Because no other studies employ this method, however, we cannot compare our findings with other data. Although agility is reported to be influenced by competitive level (Kubo, 2010; Mujika, et al., 2009), there is a need to examine whether Step 50 test has an influence on competitive level in women's football players.

There was no significant difference in repeated high-intensity running performance by position in collegiate women's football. Mean value of the Yo-Yo IR1 test of collegiate women's football players in this study was 889.5±321.7m. The values for U-19 Japan and Nadeshiko Japan players were 1142.0±308m and 1192.0±304m, respectively (Hirose, 2008). Mujika et al. reported a correlation between Yo-Yo IR1 test and competitive level in women's football players (2009). The result in collegiate women's football players was approximately 22% lower than U-19 Japan team players and 25% lower than Nadeshiko Japan players, which indicates a correlation between competitive level and Yo-Yo IR1 test results.

Football involves repeated sprinting and jogging, which are high-intensity running. Krustrup et al. (2005) reported a correlation between competitive level and high-intensity running distance (15km/h or more). Mohr et al. (2008) examined moving speed and frequency in elite women's football players at different competitive level during games, and clarified that top-level players in the US had longer high-intensity running distance compared with the players on the Denmark and Sweden teams. Difference in competitive level was observed in high-intensity running distance during the last 15 minutes of games. This suggests that the ability to continue high-intensity running in the last half of a game has a significant influence on outcome.

Furthermore, body composition was negatively correlated with repeated high-intensity running performance, and FFM was significantly correlated with running distance in Yo-Yo IR1 test, which suggested the importance of body composition as an index of talent selection and development in football (Mujika, et al., 2009). Longitudinal comparison among Nadeshiko Japan players (Hirose, 2009) showed body fat and FFM between 16.6 and 18.0%, and between 45.4 and 46.5kg, respectively. These results suggested that improvement of the competitive level of collegiate women's football players requires improvement of body composition from 24.7±3.1% (body fat) and 41.1±3.1kg (FFM), the implementation of resistance training, and an increase in repeated high-intensity running performance through systematic intermittent endurance training.

5. Conclusion

We examined the physical characteristics of collegiate women's football players by positions. Results revealed no significant difference among positions. It was clarified that competitive level was correlated with Yo-Yo IR1 test and jump performance results. This suggested that improvement of performance in collegiate women's football players requires improvement in physical characteristics. It is especially necessary to design systematic training to improve repeated high-intensity running performance.

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