J. Phys. Ther. Sci. 29: 1352–1356, 2017

The Journal of Physical Therapy Science

Original Article

Comparison of physical activities of female football players in junior high school and high school

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Abstract. [Purpose] This study aimed to compare physical activities between junior high school and high school female football players in order to explain the factors that predispose to a higher incidence of sports injuries in high school female football players. [Subjects and Methods] Twenty-nine female football players participated. Finger floor distance, the center of pressure during single limb stance with eyes open and closed, the 40-m linear sprint time, hip abduction and extension muscle strength and isokinetic knee flexion and extension peak torque were measured. The modified Star Excursion Balance Test, the three-steps bounding test and three-steps hopping tests, agility test 1 (Step 50), agility test 2 (Forward run), curl-up test for 30 seconds and the Yo-Yo intermittent recovery test were performed. [Results] The high school group was only significantly faster than the junior high school group in the 40-m linear sprint time and in the agility tests. The distance of the bounding test in the high school group was longer than that in the junior high school group. [Conclusion] Agility and speed increase with growth; however, muscle strength and balance do not develop alongside. This unbalanced development may cause a higher incidence of sports injuries in high school football players.

Key words: Adolescent female, Football player, Physical activity

(This article was submitted Apr. 19, 2017, and was accepted May 9, 2017)

INTRODUCTION

Adolescent female athletes have a high incidence of injury with a high number of severe cases[1)]. Because of the increasing number of female football players in Japan[2)], the increasing incidence of serious sports injuries is a source of concern. The prevention of these sports injuries is required and the role of physical therapists is important.

According to our previous study[3)] that investigated past sports injuries in the university male and female football players, the incidence of sports injuries in high school tended to be higher in female players. For male players, muscle strength develops with adolescent growth, but this does not improve in female players and it is a reason why the incidence of sports injuries is higher in high school female players[4)]. However, there are few studies investigating the physical factors during development that influence the incidence of sports injuries.

The purpose of this study was to compare physical activities between junior high and high school female football players in order to explain the factors that predispose to a higher incidence of sports injuries in high school female football players.

SUBJECTS AND METHODS

Twenty-nine female football players belonging to a regional club team (18 junior high school and 11 high school students) participated in this study. The basic participant characteristics are shown in Table 1. For the assessment of flexibility, Finger

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Table 1. The basic characteristics of the participants

	Junior high school group (n=18)	High school group (n=11)	
Age (years)	13.4 ± 0.8	16.3 ± 1.1	**
Height (cm)	155.3 ± 5.4	160.1 ± 5.9	*
Body weight (kg)	47.0 ± 7.7	54.3 ± 5.2	*
BMI (kg/m^2)	19.4 ± 2.4	21.3 ± 2.5	*

Mean values ± standard deviation for variables.
BMI: body mass index
*p<0.05, **p<0.01

Floor Distance (FFD) was measured. A participant stood on the edge of a platform flexed the trunk, and slowly dropped both arms to the floor putting the hands together and without the knee flexing. The distance from the tip of their finger to the platform surface level was measured. When the participant's hands crossed the stand surface level, positivity (+) was assumed and when the surface was not reached, negativity (−) was assumed. We measured twice and the maximum value was recorded.

For the assessment of postural sway, the center of pressure (COP) during single limb stance with eyes open and closed was measured by using a pressure platform (Twin-gravicorder G-620, Anima Co., Ltd., Japan). The participant kept the hands on the hip at double stance on the force platform, and lifted one limb and maintained a single limb stance in accordance with the examiner's instructions. During the measurement, the participant stared at an object placed at the eye level 2 m away with eyes open, and continued with eyes closed. The height of the lifting side of the limb was not particularly standardized, while the participant was instructed not to touch the stance limb, nor to move the stance limb and touch the floor. The total COP path length and COP sway area during the 20 seconds with eyes open and closed were recorded after the posture was stabilized. The measurements were conducted after 2 practice trials each. The evaluations were on both sides and the order of measumemnt side was randomized[5)].

For modified Star Excursion Balance Test (mSEBT), the initial posture was defined as the single limb stance with the center of the supporting sole on the point where the 3 sticks crossed. Further, the participant reached with the non-stance limb as far as possible without lifting the heel of the stance limb and without shifting weight to the toe of the reaching side. We defined the maximal reach distance as the distance at which the participant can return to the initial standing position with double limb stance. The sequence of the reach direction was anterior, post-lateral and post-medial from the reach side. Three trials were repeated and their average value was recorded. The results were normalized by the spina malleolar distance. The participant practiced for 6 trials and after the rest period that lasted few minutes, we confirmed participants were not fatigued and the measurements were conducted[6)].

The 40-m linear sprint time was measured once.

In the bounding test, the maximum distance covered when the participants started the jump with both legs, followed by two single leg jumps (right leg→left leg or left leg→right leg), and subsequently landed on both legs was measured.

In hopping tests maximum distance covered by three steps with a single leg was measured. The same was repeated for the other leg. The bounding test and hopping tests were measured once each after several times of practice. The results were normalized by the height.

An examiner conducted two agility tests recommended by the Japan Football Association for the physical assessment of football players. Agility test 1 (Step 50) (Fig. 1) to assess agility for defense. The participant always looked ahead (looked at the cone of the goal), and ran from step 1–9 as fast as possible. In steps 1–7, the participant went round the cone. Agility test 2 (Forward run) (Fig. 2) to assess agility for offence. The participant repeated a sprint, half-turn, and slalom as fast as possible from a start point to a finish point. The examiner measured the time required to run from the start to the finish[7)].

A hand held dynamometer (HHD: μ-Tas F-1, Anima Co., Ltd., Japan) was used for the measurements of hip abduction and extension maximal voluntary isometric strength. For the measurement of hip abduction[8)] and extension strength[9)], a participant was in a supine position and a prone position, respectively. The strength was measured by placing the sensor of the HHD on the distal part of the thigh and the examiner stabilized the pad to prevent its movement during the measurement. A belt was used to stabilize the HHD. After a practice trial, a maximal hip abduction or extension contraction about 5 seconds was repeated for 2 trials, and its maximum value was recorded. The isokinetic knee flexion and extension peak torque were measured by 60°/second of angular velocity through a range of 5–95° of knee flexion and extension by using an isokinetic dynamometer (Cybex Humatic Norm, Medica Co., Ltd., USA). After 3 practice trials, 3 measurements were performed, and their maximum values were recorded[10)]. All the muscle strength measures were conducted on the left side, which was the non-dominant limb, and the results were normalized by body weight.

The repetitive curl-up test was measured for 30 seconds according to Sports Test of Japan Sports Association guidelines[11)]. A participant was in the supine position with the knees in 90° flexion, the knees and the feet apart to the width of the shoulders. The subjects placed their hands on the back of the head and their feet were held by an examiner. The participant sat up

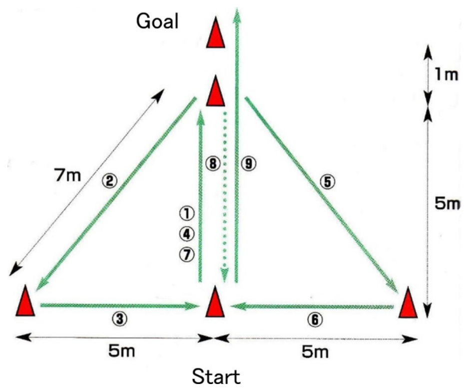

Fig. 1. Agility test 1 (Step 50)[7]
The participant always looked at the cone of the goal, and ran from step 1–9 as fast as possible. In steps 1–7, the participant went round the cone.

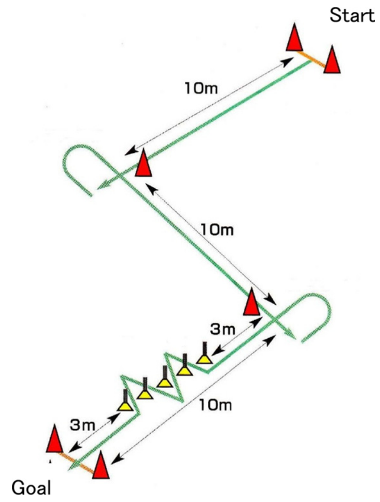

Fig. 2. Agility test 2 (Forward run)[7]
The participant repeated a sprint, half-turn, and slalom as fast as possible from a start point to a finish point.

until both elbows touched the knees and lay down until the inferior angles touched the floor. The repetitive curl-up test was performed as fast as possible for 30 seconds and the number of times it was completed was recorded. The Yo-Yo intermittent recovery test was performed according to the method by Bangsbo[12].

Based on the test of normality of the distribution of each variable, a two-sample t-test was conducted to compare each of the variables between the junior high school players and the high school players. SPSS PASW21 (Microsoft Inc., Chicago, IL, USA) was used for statistical analyses and the statistical significance level was set at $p<0.05$. We explained the purpose and methods of this study to the participants and their guardians, assured them about the protection of personal information and obtained consent in writing. This study was approved by the Ethical Committee Board of Kobe International University, Japan (Approval No. 2011-10).

RESULTS

The high school group was significantly faster than the junior high school group in the 40-m linear sprint time ($p<0.05$) and in the two agility tests ($p<0.01$). The distance of the bounding test in the high school group was longer than that in the junior high school group ($p<0.05$). There was no significant difference between the two groups in FFD, lower limb muscle strength, repetitive curl-up test,, hopping test, COP during single limb stance with eyes open and closed, mSEBT, and Yo-Yo intermittent recovery test (Table 2).

DISCUSSION

In this study, the physical activities of junior high and the high school females were compared with each other and we attempted to identify factors affecting the incidence of sports injuries. Balance, jumping, and endurance were not significantly different between the two groups The high school group had a significantly higher linear sprint time and better agility tests than the junior high school group.

Although several reports[13] have compared the development of the physical activity with growth between males and females, few studies have considered in-depth the effect of age and development on physical activity, such as agility or speed in female athletes. Commonly, with age, muscle strength and endurance rapidly develop and the junior high and high school age groups are the most suitable age for training according to the Miyashita model[14] in Japan. Although the suitable ages for training regarding muscular strength, endurance, and motor skill have been reported, the suitable ages for speed and agility training are unclarified in the Miyashita model[14]. Furthermore, development in females is faster than in males, but the age of development in the Miyashita model[14] is not differentiated between males and females. The Miyashita model[14] was proposed 30 years ago, however, today, the degree of maturity in children varies. Therefore, this model should be revised.

Ohsawa[15] reported that agility develops rapidly from 10.6 years old in girls based on the results of the new physical fitness test of the Japanese Ministry of Education and Science over the last ten years. It is considered that the Side Stepping Test, which Ohsawa[15] defined as an agility test, includes elements not only related to speed but also to power. Our using agility tests are recommended by the Japan Football Association and mainly include agility specific for the playing of football. They

Table 2. Junior high school group vs. High school group

		Junior high school group (n=18)	High school group (n=11)	
FFD (cm)		9.30 ± 3.94	11.73 ± 5.97	
Postural away (cm^2)				
Sway area left limb stance with eyes open		3.76 ± 1.43	4.03 ± 1.91	
Sway area left limb stance with eyes closed		8.74 ± 3.51	9.04 ± 3.21	
modified Star Excursion Balance Test (%)*a				
Right limb stance	Anterior	101.13 ± 7.01	101.00 ± 6.93	
	Post-medial	103.60 ± 8.87	103.03 ± 7.80	
	Post-lateral	103.56 ± 7.53	100.86 ± 6.52	
Left limb stance	Anterior	102.14 ± 8.46	100.63 ± 6.24	
	Post-medial	103.47 ± 7.62	104.13 ± 6.10	
	Post-lateral	102.09 ± 7.21	101.76 ± 4.71	
40 m linear sprint time (seconds)		6.70 ± 0.32	6.47 ± 0.24	*
Bounding test (fold)*b		4.41 ± 0.41	4.87 ± 0.42	*
Hopping test (fold)*b	Right limb	3.42 ± 0.02	3.42 ± 0.16	
	Left limb	2.77 ± 0.26	2.94 ± 0.26	
Agirity test 1 (seconds)		11.56 ± 0.63	10.40 ± 0.57	**
Agirity test 2 (seconds)		5.94 ± 0.3	5.57 ± 0.27	**
Muscle strength on left limb (Nm/kg)				
Hip abductor		4.45 ± 1.1	5.17 ± 1.13	
Hip extensor		4.50 ± 1.43	4.83 ± 1.80	
Knee extensor		5.92 ± 1.64	6.24 ± 1.18	
Knee flexor		3.73 ± 0.93	3.62 ± 0.78	
Repetitive curl-up test (times/30 seconds)		25.44 ± 3.68	24.18 ± 3.09	
Yo-Yo intermittent recovery test (m)		1,024.44 ± 297.17	974.55 ± 197.81	

Mean values ± standard deviation for variables. *$p<0.05$, **$p<0.01$
*aEach result was normalized by the spina malleolar distance.
*bEach result was normalized by the height.

strongly include elements speed such as quick turns. However, Ohsawa[15] reported that agility rapidly develops in fifth and sixth-grade elementary school students. In this study, the agility in the high school students (average age; 16.27 ± 1.10) was significantly greater than that in the junior high school players (average age; 13.39 ± 0.78). Different factors might influence different kinds of agility tests. In addition, motor learning may also have influenced the study's outcomes because high school players have been involved in sports for a longer time than junior high school players.

Female basketball players from high school and university underwent a sports injury prevention program for an average 203.7 days (range 112–287 days) in the study by Miki et al[16]. Comparing the conditions before and after the intervention, agility test markedly improved only in the high school players. This suggests that the most crucial developmental stage to train for agility is during high school. Accurate postural control and balance are required when stopping and quickly turning in agility tests. In the agility test, several physical activities are integrated, such as muscle strength, general balance, and speed.

Previous studies have reported that agility in females is related to jumping distance[17] and linear sprint time[18]. In addition, it is also reported that the agility test was correlated with muscle strength of the hip and knee[19]. It seems that greater agility involves greater muscle strength and power. However, there were no differences in muscle strength and balance between the junior high school and high school players. However, muscle strength and balance do not develop alongside, agility and speed increase with growth. Moreover, faster movement speed causes increased external contact force between players, with an increased risk of injury. If the ability to achieve control at high speeds is not sufficiently developed, the incidence of contact sports injuries might increase. This unbalanced development may cause a higher incidence of sports injuries in high school football players.

This study has four limitations: (1) the sample size was small; (2) the participants were from a single team and as such our findings may be peculiar to this team; and (3) development in female adolescents may differ considerably between individuals. Moreover, development may lead to a decline in physical activity. We classified the participants into junior high school and high school players, thus, individual differences were not considered. (4) We measured only the limited lower limb muscle strength. However, according to Hara et al.[20], the hip and knee flexor muscle strength correlates with agility. Therefore, further studies are necessary in this regard.

Further research is needed to clarify the correlation between agility related to development and injury risk during play in adolescent female football players.

ACKNOWLEDGEMENT

This study was supported by the Kobe International University Rehabilitation Department Institute (project 10).

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