RUN-UP SPEED PARAMETERS FOR ELEMENTARY SCHOOL LONG JUMPERS

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The purposes of this study were to investigate the run-up speed parameters of the elementary long jumpers and to obtain coaching suggestions on the run-up techniques for the coaches. Subjects were nineteen male and female elementary school long jumpers who participated in an athletics competition held in Japan. The run-up speed was collected by using a laser speed apparatus. There was a significant positive relationship between the official jumping distance and the maximum speed. This study revealed that reaching the maximum run-up speed as close to the take-off line as possible would help to maintain the run-up speed and to obtain large the take-off speed and the jumping distance.

KEY WORDS: running jump, run-up speed, laser speed apparatus.

INTRODUCTION: Koyama et al. (2011) collected and analysed the run-up speed data for 965 elite male and female long jumpers and Japanese skilled high school male and female long jumpers, whose performance ranged from 5.30 to 8.57 m by using a laser-based speed apparatus (LDM301S, 4-assist Co., Japan) in official competitions. They revealed that the maximum run-up speed for the elite long jumpers was significantly related to their official jumping distance, and developed a method to estimate the maximum run-up speed in training session.

The long jump is one of important materials in physical education in Japanese elementary school. Ueya and Nakamura (1984) developed a deterministic model of the jumping distance for elementary school students. They found that there was a significant positive relationship between the take-off speed and the jumping distance in elementary school students (r = 0.694). However, there was no description and suggestion for elementary school students to obtain large run-up speed during the run-up and preparatory phases prior to take-off.

Very little information of the run-up speed and its change during approach of elementary school long jumpers causes. Most of coaches and teachers no appropriate advices to the jumpers.

Therefore, the purpose of this study was to investigate change in the run-up speed of the elementary school long jumpers for appropriate suggestions on the run-up techniques.

METHODS: The subjects were nine male and ten female elementary school long jumpers, aged of 11 to 12 years, who participated in an athletic competition held in 2016. The changes in run-up speed for thirty-eight long jump trials, two trials from each jumper, were collected with the laser based speed apparatus set at the front side of the jumpers, and the data were sampled at 100 Hz (Figure 1). The subject's motion was videotaped using a digital movie camera (Exilim EX-F1, Casio Co., Japan) operating at 60Hz. The run-up speed data and the video image data were synchronized.

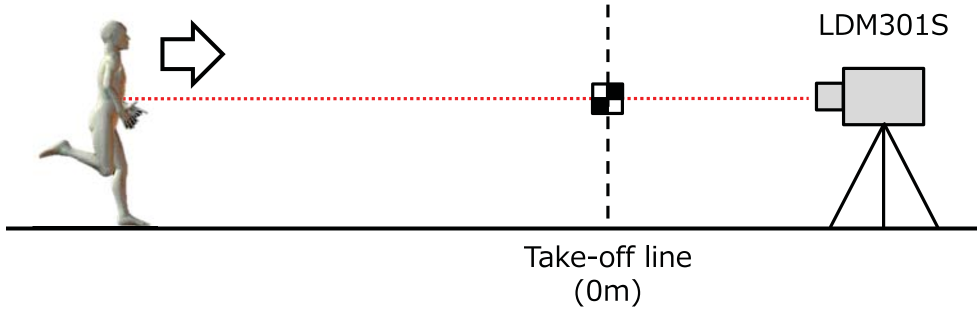

Figure 1: Experimental setup with a laser based speed apparatus.

The run-up speed was obtained by differentiating the displacement of the jumper's body by time and was smoothed with a Butterworth low-pass digital filter at a cut-off frequency of 0.5 Hz (Koyama et al., 2011). Kintaka et al. (2013) reported that a cut-off frequency of 0.5 - 1.0 Hz was optimum for the run-up speed by comparing them with data collected from video motion analysis.

Figure 2 shows an example of change in the run-up speed and parameters investigated: (**a**) maximum run-up speed (maximum speed), (**b**) the distance from the take-off line at which the maximum run-up speed appeared (appearance distance), (**c**) the run-up speed at the take-off (take-off speed), (**d**) decrease in the run-up speed from the maximum to the take-off speed (decreased speed), and (**e**) the distance from the take-off time at which a long jumper started the approach (start point). Additional two parameters were (**f**) the time from the start to the take-off (run-up time) and (**g**) the official jumping distance.

The circles shown in the curve in Figure 2 indicate the distance of foot contact that collected from the video data.

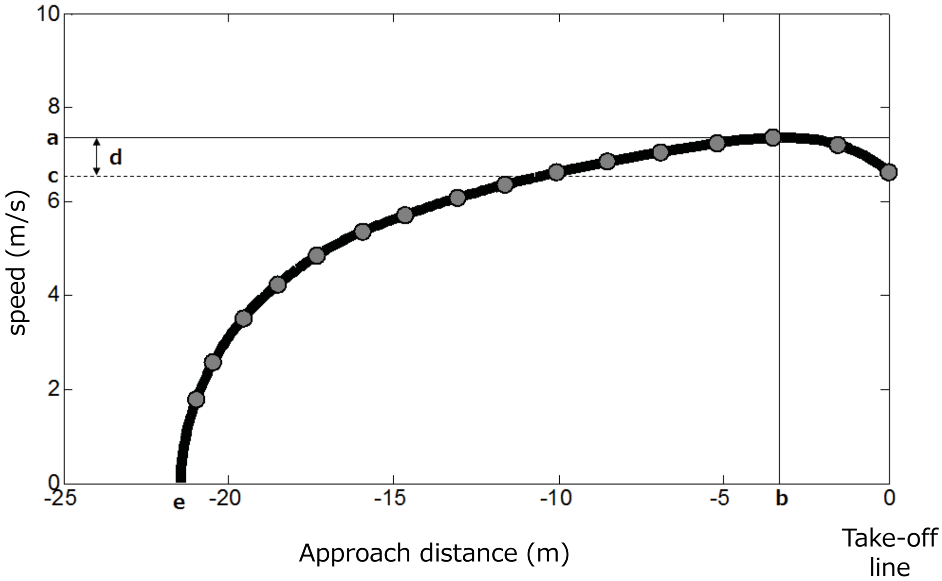

Figure 2: An example of change in the run-up speed and parameters investigated.

Pearson's product moment correlation coefficient (*r*) and standardised partial regression coefficient (β) were calculated to see correlations between the run-up parameters. The level of significance was set at $p < 0.05$.

RESULTS: Table 1 shows the run-up parameters of the elementary school long jumpers. The maximum speed appeared around 3 m from the take-off line (Table1, b), which corresponded to the second steps before take-off (Figure 2)

Table 1
The run-up parameters of elementary school long jumpers (n = 38).

		mean	sd	max	min
a	maximum speed (m/s)	7.18	0.31	7.87	6.62
b	appearance distance (m)	-3.33	0.47	-2.26	-4.40
c	take-off speed (m/s)	6.08	0.49	6.90	4.70
d	decreased speed (m/s)	-1.10	0.44	-0.43	-2.06
e	start point (m)	-22.33	1.77	-19.19	-28.39
f	run-up time (sec)	4.68	0.33	5.51	4.13
g	jumping distance (m)	3.92	0.22	4.36	3.49

Table 2 shows the Pearson's product moment correlation coefficients (*r*) between the run-up parameters.

There is a significant positive relationship between the official distance and the maximum speed (**a-g**: r = 0.44, p < 0.01). The significant relationships were also found between the maximum speed and the appearance point (**a-b**: r = –0.32, p < 0.05), the take-off speed (**a-c**: r = 0.48, p < 0.01) and the start distance (**a-e**: r = –0.67, p < 0.01), the appearance point and the decreased speed (**b-d**: r = 0.69, p < 0.01), and the take-off speed and the decreased speed (**c-d**: r = 0.78, p < 0.01).

Table 2
The Pearson's product moment correlation coefficient (*r*) between the run-up parameters (n = 38).

	a : maximum speed	b : appearance distance	c : take-off speed	d : decreased speed	e : start distance	f : run-up time	g : jumping distance
a : maximum speed							
b : appearance distance	-0.32 *						
c : take-off speed	**0.48 ****	0.41 *					
d : decreased speed	-0.17	**0.69 ****	**0.78 ****				
e : start distance	**-0.67 ****	0.36 *	-0.23	0.22			
f : run-up time	0.15	0.13	0.02	-0.08	**-0.66 ****		
g : jumping distance	**0.44 ****	-0.05	0.15	-0.14	-0.17	-0.08	

n.s. * p < 0.05 **** p < 0.01**

The multiple regression analysis was used to investigate the contribution of the run-up parameters to the official jumping distance. In this study, the official jumping distance was used as the dependent parameter and the others as the independent parameters. The maximum speed was removed from the independent parameters because of the collinearity to the official jumping distance. A significant multiple correlation coefficient was obtained (R^2 = 0.27, F = 0.009). The regression equations standardizing (1) was:

$$g = -0.31 * b + 0.93 * c - 0.91 * d - 0.11 * e - 0.20 * f - 0.07 \quad (1)$$

where each coefficient of the equation (2) shows the standardised partial regression coefficient (β). The take-off speed (β = 0.93, p < 0.01) and the decreased speed (β = 0.91, p < 0.01) were significantly correlated to the official jumping distance.

DISCUSSION: Several investigations reported a significant relationship between the maximum run-up speed and the jumping distance for elite male long jumpers (Hay, 1986), elite female long jumpers (Lees et al., 1993) and Japanese high school male and female long jumpers (Koyama et al., 2011). Similar result was obtained in the present study for elementary school jumpers (r = 0.44, p < 0.01). Therefore, elementary school long jumpers can be advised to improve sprint ability. From the results of the run-up time (Table1, f) , the workouts of sprint training for elementary school long jumpers should continue 4 to 5 seconds and 20 to 30 m from the start.

Koyama et al. (2011) analysed the run-up speed for 965 elite male and female long jumpers and Japanese skilled high school male and female long jumpers (5.30 to 8.57 m) by using the laser speed apparatus in official athletic competitions. The maximum run-up speed of adult long jumpers appeared around 5 to 7 m before the take-off line, which corresponded to the second to third steps before the take-off. Comparing with Koyama's results elementary school long jumpers reached the maximum run-up speed closer to the take-off line, because of their shorter stride length.

Long jumpers must obtain a large vertical velocity of the body during the take-off phase while maintaining the horizontal velocity acquired in the approach (Hay and Miller, 1985). Significant partial regression coefficients of the take-off speed (β = 0.93) and the decreased speed (β = 0.91) indicate that reaching the maximum run-up speed as close to the take-off line as possible would help to obtain large jumping distance. Shimizu et al., (2015) noted that exaggerated backward lean of the trunk and lower body prior to take-off foot touchdown cause greater loss of the horizontal CG velocity during the take-off phase. Therefore, elementary school long jumpers should concentrate on the take-off motion rather than the take-off preparatory motion. For example, putting a marker at 3 m before the take-off line may be appropriate for elementary school long jumpers to attain large maximum run-up speed.

CONCLUSIONS: The significant positive relationship was found between the official jumping distance and the maximum speed in elementary school long jumpers. This study revealed that reaching the maximum run-up speed as close to the take-off line as possible seemed to help to attain large take-off speed and the jumping distance. Elementary school long jumpers should concentrate on the run-up and take-off motion rather than the take-off preparatory motion.

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