KINEMATICS OF TAKEOFF MOTION OF THE WORLD ELITE LONG JUMPERS

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INTRODUCTION: In 1991, Mike Powel (USA) marked the world record of men's long jump of 8.95 m at the 3rd World Championships in Athletics (WC) in Tokyo. The world record has not been renewed for 17 years. The purpose of this study was to investigate kinematics of the takeoff motion of the world elite male long jumpers who participated in the final of the 11th WC in Osaka.

METHODS: The men's long jump finalists were videotaped with two high-speed video cameras (250 Hz) placed on the stadium. These cameras covered the 2nd last, last stride and takeoff phases. A calibration pole was set at the fourteen locations in the videotaping area to reconstruct real coordinates of the jumpers' segment endpoints. Twenty-three segment endpoints were digitized, and three-dimensional coordinates were obtained by using a three-dimensional direct linear transformation method. These coordinate data were smoothed with a Butterworth low-pass digital filter at optimal cut-off frequencies determined by residual analysis, 4.8 to 8.4 Hz.

RESULTS AND DISCUSSION: Table 1 shows velocity of center of gravity of the jumper at touchdown (TD) and toe-off (TO) of the takeoff and correlation coefficients of these variables to the jumping distance. The jumping distance was sum of the official distance and the loss of takeoff, the horizontal distance between the toe of the takeoff foot and the front edge of the takeoff board.

Table 1 C.G. velocities during the takeoff and coefficient between jump distance and velocity parameters

		Jump distance (m)	HV @ TD (m/s)	HV @ TO (m/s)	VV @ TO (m/s)	⊿HV (m/s)	Takeoff angle (deg)	Takeoff time (s)
1st	Saladino	8.58	10.52	8.90	3.75	-1.63	22.9	0.124
2nd	HOWE	8.50	10.87	9.26	3.46	-1.61	20.5	0.132
3rd	Phillips	8.31	10.38	8.96	3.67	-1.41	22.3	0.136
4th	Lukashevych	8.25	9.97	8.27	3.78	-1.70	24.6	0.112
5th	Mokoena	8.28	10.12	8.33	3.71	-1.79	24.0	0.136
6th	Beckford	8.20	10.63	9.05	3.25	-1.58	19.8	0.128
7th	Badji	8.09	10.16	8.83	3.17	-1.33	19.8	0.144
8th	Marzouq	8.04	10.22	9.03	3.01	-1.19	18.4	0.132
correlation coefficient		-	0.574	0.150	0.683	-0.589	0.460	-0.288

The horizontal velocity (HV) at TD ranged from 9.97 to 10.87 m/s, and there was no significant relationship between the jumping distance and HV at TD. Fukashiro *et al*. (1994) reported that the approach velocity was 10.20 - 10.58 m/s for the finalists, with M. Powel (11.00 m/s) and C. Lewis (11.06 m/s). It is noteworthy that although there was no significant relationship between the HV at TO and jumping distance ($r=0.150$), the positive tendency was observed between the VV at TO and jumping distance ($r=0.683$, $p<0.1$) in the finalists of WC 2007, indicating that the current world top male long jumpers may emphasize increasing the vertical velocity of the C.G. to obtain a good result. Viewed from the C.G. velocity at TO, the finalists could be divided into three groups: the first group tended to obtain large horizontal and vertical velocity (1st Saladino, 2nd Howe, 3rd Phillips), the second one indicated small horizontal and large vertical velocity (4th Lukashevych, 5th Mokoena), and the third one characterized by large horizontal but small vertical velocity (6th Beckford, 7th Badji, 8th Marzouq).

REFERENCES:

Fukashiro, S *et al*., (1994). Biomechanical analysis of the long jump (in Japanese). In Japan Association of Athletics Federations (ed.), The Techniques of the World Top Athletes (Research Report of the 3rd World Championships, Tokyo) (pp. 135-151). Tokyo: Baseball Magazine Co.