BIOMECHANICAL CHARACTERISTICS OF KINEMATICS IN LONG JUMPERS

Liying Jin, Jungang Yu, Xin Jin[1] and Jinping Hu
Shandong Institute of Physical Education, Shandong, People's Republic of China
[1]Taiyuan Metallurgical Industry Institute, Shanxi, People's Republic of China

The maximum speed attained by the athlete in broad jump competition is an important objective for the approach phase of the jump. Although the technique of male broad jump athletes has been studied, very little research has focussed on the performance of female high performance broad jump athletes. The purpose of this study was to analyze the characteristics of movement kinematics in three males and three females broad jumpers. A comparison of performance between the males and females was made so as to provide the information for coaches and athletes to improve performance.

KEY WORDS: long jumper, stride, step frequency, horizontal and vertical velocity

INTRODUCTION: The subjects for this study were male and female broad jump athletes. The study examined the take-off and approach, the athlete's center of gravity, stride, step frequency, horizontal and vertical velocity. Data were obtained through biomechanical analysis of the following:
(1) Horizontal velocity of body's center gravity
(2) Vertical of velocity body's center gravity to take off
(3) Stride of last four steps to approach
(4) Steps of frequency of last four steps to approach

METHODS: Three female and three male high performance broad jump athletes were selected for the study. GV-16 high-speed cameras were used and photo frequency 100 per second NAC SPORIIAS-2000 film automatic analysis was also used. Main shaft of cameras was vertical track. The camera was placed 4m from the take-off line. In this way, the take-off and the approach of last four steps can be recorded. In addition, the horizontal and vertical velocity of body's center of gravity, stride and step frequency, were also recorded.

RESULT: Data was collected on the horizontal and vertical velocity of center of gravity in the last four steps. Approach speed determines the jump result, so for broad jumper to succeed, maximum effort is required in the approach. In addition, constant height must be maintained in order to gain the furthest distance. Therefore it requires consistent exertion by the athletes, but the amount of output was determined by the specific technique of approach and take- off. The key to the success lies in the last four steps. The analysis in Table 1 showed that in the last four steps, the average value of horizontal velocity was misleading. The faster speed in this phase produced the better result for broad jumpers. Example: Table 1 showed that female: A is the fastest. C is faster than B, but the B result is better than C. Male B is faster than A. This result is better than B. the reason is not related to approach speed and technique. The faster approach speed therefore, the greater is the technical difference. The result showed that approach speed is directly proportional to take-off strength. If the take off technique does not equal approach speed, this would affect their take off effect. Thus they cannot reach necessary height for the jump, consequently affecting their result. Broad jumpers reach certain speeds through the approach technique. When the athletes commence their jump, the end result is already determined by take off technique, corresponding with approach speed. If the jump corresponded with approach speed, this would show that broad jumpers' technique was not coordinated. Example: Female athlete C and male B have the same performance. They both have two problems. One is related to technique that does not fit approach speed and the other relates to insufficient specific energy for the approach speed. If these two questions could be solved, broad jump athletes would increase their jump distance by combining take off strength with approach speed.
Table 3 showed that maximum stride of women and men are the second last step but

minimum strides are the final step. By lowering their center of gravity sufficiently at the second last step, they can gain greater vertical velocity during taking off and also increase vertical working distance. So it is crucial to increase the stride at the second last step. Because they are preparing for take off during final approach, the running rhythm is noticeably changed. The stride or step frequency is increased at the second last step in order to maintain high speed. This is done to ensure that there is smooth transition to the approach phase from the abrupt take off, in order to complete the change in the center of gravity. The athlete's take off leg should land quickly so that the approach speed and take off speed link up. Thus the minimum step is the final step. This not only completes the transition from approach to taking off by shortening take off time but also can increase taking off height. If the final step is too long, body's center of gravity will fall. If the final step is too short, body's center gravity will also be changed so that rhythm and structure of movement are interrupted. So minimum step is the final step in order to preserve take off strength. It appears that international high performance male and female broad jump athletes adopt the technique of a second last step that is bigger than the final step. This will change in technique will benefit horizontal velocity by a change in vertical velocity. During take off in broad jump competition, athletes can maintain greater vertical velocity in order to achieve considerably better overall results.

Table 1 Horizontal Velocity of Body's Center Gravity (m/s)

Athlete		Result (m)	Average value	Max value	Min value
Women	A	6.69	8.9	9.1	8.8
	B	6.64	8.5	8.7	8.5
	C	6.35	8.7	9.0	8.6
Men	A	7.91	10.0	10.2	9.8
	B	7.86	10.3	10.5	10.0
	C	7.75	9.8	10.0	9.6

Table 2 Vertical Velocity of Body's Center Gravity (m/s)

Athlete		Result (m)	The third last step	The second last step	Final step	Take off
Women	A	6.69	0.4	0.5	0.3	3.0
	B	6.44	0.4	0.5	0.3	2.9
	C	6.35	1.0	0.6	0.1	2.7
Men	A	7.91	0.8	-0.2	0.3	3.1
	B	7.86	0.4	-0.1	0.4	3.2
	C	7.75	0.5	0.1	0.1	3.0

Table 3 Stride (m)

Athlete		Result(m)	The fourth last step	The third last step	The second last step	Final step
Women	A	6.69	1.92	1.71	1.94	1.87

	B	6.44	2.11	2.10	2.14	2.09
	C	6.35	2.15	2.16	2,24	2.14
Men	A	7.91	1.92	1.86	2.12	1.91
	B	7.86	2.06	1.94	2.21	2.04
	C	7.75	2.29	2.27	2.31	2.24

Table 4 Step Frequency (step/second)

Athlete		Result (m)	Average value	Max value	Min value
Women	A	6.69	4.93	5.54	4.21
	B	6.64	4.27	4.54	4.07
	C	6.35	4.10	4.86	3.50
Men	A	7.91	5.64	5.87	5.23
	B	7.86	5.23	5.97	4.74
	C	7.75	4.30	4.55	4.00

CONCLUSION: The analysis of last four steps, relating to maximum value of horizontal velocity were as follows; female A and C are final step, B is the last four steps. Male A, B and C are the last second step. When observations were made on twelve women broad jumpers who played in the finals in 23thOlimpic Games, relating to the maximum value of horizontal velocity, the results were similar. Six jumpers used the second last step, two jumpers used the fourth last step, three jumpers used the third last step, on jumper used the final step. Female athletes showed a tendency towards the fourth last step, while male athletes showed a tendency towards use of the second last step. This showed that there was a great difference between each of them. Vertical velocity of body's center of gravity during taking off, showed minimum value for male athlete A, B and C with the second last step. Table 2 showed that the vertical velocity results are directly proportional to their results during taking off. Two factors that restrict velocity are stride and step frequency. Table 4 showed that the step frequency of the last four steps is directly proportional to their result. Thus for maximal results in the broad jump, the fourth last step technique should be adopted in combination with the high step frequency method.

REFERENCE:

Chang, G.. *Biomechaincs of sport Beijing*. People's sports publishing house. Biomechanics analyze of excellent broad jumpers (1988). *Sport Study*. **6**.

Analyze of take off horizontal and vertical velocity about the broad jump (1987). *Sport Teaching*. **2**.