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Relationship of kinematic analysis and performance of long jump athletes

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Abstract
The purpose of the present study was to investigate the relationships between the kinematic analysis and performance of long jump athletes. Total Three long jumpers will select as a sample: Indian elite male long jumpers who had represented at international level will be selected as a sample on the basis of performance in preceding competition. The age of all the subjects will be ranged above 18 years. The kinematic variables were Projection angle, Angle of ankle joint (take-off leg), Angle of knee joint (take-off leg) & Angle of Hip joint at the time of take-off and performance of long jump athletes. The Kinematic Analysis of long jump athletes mean, standard deviation and Karl Pearson's product moment coefficient correlation were employed with the help of statistical package of SPSS. The level of significance was set at 0.05. The outcome of the study shows that significant relationship with performance (.977, .989, .815, .937) of Long Jump athletes in all variables.

Keywords: kinematic, projection angle, angle of ankle joint, angle of hip joint etc.

Introduction

The long jump is a formerly commonly called the "broad jump". It is a track and field event in which athletes combine speed and strength in an attempt to leap as far as possible from a take off point. The long jump is the only known jumping event of Ancient Greece's original Olympics' pentathlon events. The long jump has been part of modern Olympic competition since the inception of the games in 1896. The basic technique used in long jumping has remained unchanged since the beginning of modern athletics in the mid-nineteenth century. The athlete sprints down a runway, jumps up from a wooden take off board, and flies through the air before landing in a pit of sand. A successful long jumper must, therefore, be a fast sprinter, have strong legs for jumping, and be sufficiently coordinated to perform the moderately complex take-off, flight, and landing maneuvers. The objectives in each phase of the jump are the same regardless of the athlete's gender or ability. Hay Thorson and Kippenhan, 1999) [2].

Just before touchdown the athlete pre-tenses the muscles of the take-off leg. The subsequent bending of the leg during the take-off is due to the force of landing, and is not a deliberate yielding of the ankle, knee, and hip joints. Flexion of the take-off leg is unavoidable and is limited by the eccentric strength of the athlete's leg muscles. Maximally activating the muscles of the take-off leg keeps the leg as straight as possible during the take-off. This enable athlete's COM to pivot up over the foot, generating vertical velocity via a purely mechanical mechanism. Over 60 per cent of the athlete's final vertical velocity is achieved by the instant of maximum knee flexion, which indicates that the pivot mechanism is the single most important mechanism acting to create vertical velocity during the take-off. The knee extension phase makes only a minor contribution to the generation of vertical velocity, and the rapid plantar flexion of the ankle joint towards the end of the take-off contributes very little to upward velocity. Long jumpers spend a lot of time on exercises to strengthen the muscles of their take-off leg. Greater eccentric muscular leg strength gives the athlete a greater ability to resist flexion of the take-off leg, which enhances the mechanical pivot mechanism during the take-off and hence produces a greater take-off velocity. The stretch-shorten cycle, where the concentric phase of a muscle contraction is facilitated by a rapid eccentric phase, does not play a significant role in the long jump take-off. Rather, fast eccentric actions early in the take-off enable the muscles to exert large forces and thus generate large gains in vertical velocity. In the long jump take-off the instant of maximum knee flexion is a poor indicator of when the extensor muscles of the take-off leg change from eccentric activity to concentric activity. In long jumping, the gluteus maximusis active isometrically at first and then concentrically; the hamstrings are active concentrically throughout the take-off; rectus femoris acts either isometrically at first then eccentrically or eccentrically throughout the take-off; and the vasti, soleus, and gastrocnemius act eccentrically at first and then concentrically. The explosive extension of the hip, knee, and ankle joints during the last half of the take off is accompanied by a vigorous swinging of the arms and free leg. These actions place the athlete's COM higher and farther ahead of the take-off line at the instant of take-off, and are also believed to enhance the athlete's take-off velocity. Some athletes use a double-arm swing to increase the take-off velocity, but it is difficult to switch smoothly without loss of running velocity from a normal asynchronous sprint arm action during the run-up to a double-arm swing at take-off. (Lees, Fowler and Derby 1993) [5].

It is well known that take-off angles in the long jump are substantially less than the 45˚ angle that is usually proposed as the optimum for a projectile in free flight. Video measurements of world-class long jumpers consistently give take-off angles of around 21˚. The notion that the optimum take-off angle is 45˚ is based on the assumption that the take-off velocity is constant for all choices of take-off angle. However, in the long jump, as in most other sports projectile events, this assumption is not valid. The take-off velocity that a long jumper is able to generate is substantially greater at low take-off angles than at high take-off angles and so the optimum take off angle is shifted to below 45˚.(Linthorne, Guzman and Bridgett 2005) [6].

Statement of the problem

The Problem entitled as "Relationship of Kinematic Analysis and performance of Long Jump athletes".

Method and Procedure

Selection of subjects

Total Three long jumpers will select as a sample: Indian elite male long jumpers who had represented at international level will be selected as a sample on the basis of performance in preceding competition. The age of all the subjects will be ranged above 18 years.

Selection of variables

- *(Φ)*Projection angle at the time of take-off
- *(AΦ)*Angle of ankle joint (take-off leg) at the time of take-off
- *(KΦ)*Angle of knee joint (take-off leg) at the time of take-off
- *(HΦ)*Angle of Hip joint at the time of take-off

Criterion Measure

- The criterion measure for this study was the performance of the jumper. Total of six attempts were given to each subject. The performance of each jump was judged accurately and performance was recorded.
- The selected biomechanical variables such as Projection angle at the time of take-off, Angle of ankle joint (take-off leg) at the time of take-off, Angle of knee joint (take-off leg) at the time of take-off, Angle of Hip joint at the time of take-off, Horizontal velocity of the Ankle joint at the time of take-off, Vertical velocity of the Ankle joint at the time of take-off, Horizontal velocity of knee joint at the time of take-off, Vertical velocity of the knee joint at the time of take-off, Horizontal velocity of the hip joint at the time of take-off, Vertical velocity of the hip joint at the time of take-off.

Filming Protocol

Motion capture technique was used in this study. To recorded the video of the long jumpers, while they performing the jump digital video camera (50 fps) was used by a professional photographer. After obtaining the recorded video, the video was analyzed through quintic coaching v-17 software approved by Human kinetics. First video was digitized through quintic coaching v-17 software. After the procedure of digitizing, the video was calibrated. The calibrated video gives us the results through makers, stroboscopic effect technique, stick figures, stopwatch programming, angle manual (horizontal, vertical, draw angles), linear and angular analysis manual etc. with the help of "quintic coaching v-17 software."

Motion capture technique/Digital videography was used to analysis the kinematic variables of male long jumper. Digital video camera CASIO EX-FH 100(50 fps) was used for videography of long jump performance. The performance of the subject was recorded with stroboscopic effect from approach to landing. Digital Video camera was placed 6meter away at the side of take-off leg (lateral axis) of the long jumper.

Administration of the test

Three Indian elite male long jumpers who had represented at international level will be selected as a sample. All the selected subjects were asked to perform the long jump with their full potential and accurate technique. The jumpers were well directed, informed and prepared for the study. Six chances were given to every jumper. They were asked to perform the long jump in the natural way as they actually perform. It was ascertained that subjects possess reasonable level of technique. Players were video graphed with systematic filming method as required. Motion capture technique was used in this study. To recorded the video of the long jumpers, while they performing the jump, digital video camera (50 fps) was used by a professional photographer. The performance of the subject was recorded with stroboscopic effect from approach to landing. Digital Video camera was placed 6 meter away at the perpendicular to the plane of motion.

Statistical Procedure

With regard to purpose of the study Karl Pearson's product moment coefficient correlation statistical technique was calculated between selected kinematical variables with performance of male long jumpers. In order to check the significance, level of significance was set at 0.05.

Table 1: Relationship between Projection Angle in long jumpers with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Values
18	Projection Angle	16.98	0.64	.977*
18	Performance	7.61	0.09	

'r'$_{0.05}$(16)= 0.497

*=Significant at .05 level of significance

Table & figure no. 1 represents that the mean value of Projection angle of long jumpers was 16.98, whereas the standard deviation (SD) of Projection angle of long jumpers was 0.64 respectively. At the time of calculation of relationship between Projection angle with performance of long jumpers the r value was .977. The data does suggest that there is significant relationship between Projection angle of long jumpers with performance.

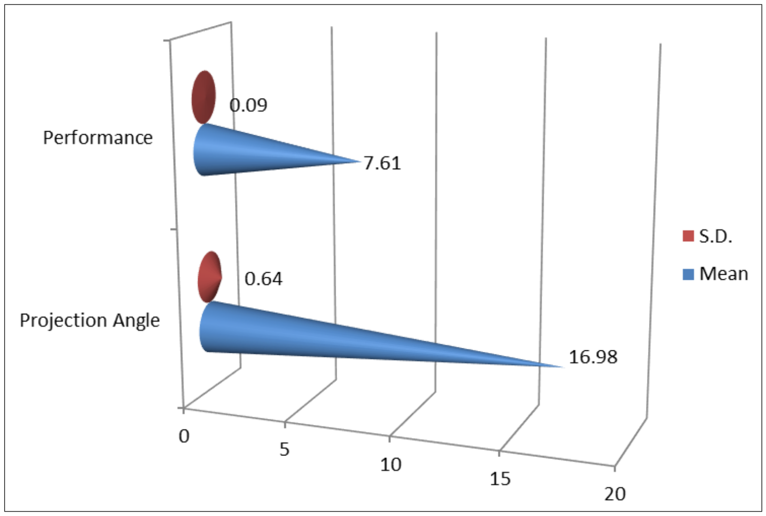

Fig 1: Shows mean and standard deviation values of long jumpers Projection angle and performance

Table 2: Relationship between Angle of ankle joint in long jumpers with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Values
18	Angle of ankle joint	144.31	1.70	.989*
18	Performance	7.61	0.09	

‘r’$_{0.05}$(16)= 0.497*=Significant at .05 level of significance

Table & figure no. 2 shows that the mean value of angle of ankle joint of long jumpers was 144.31, whereas the standard deviation (SD) of angle of ankle joint of long jumpers was 1.70 respectively. At the time of calculation of relationship between Angle of ankle joint with performance of long jumpers the r value was .989. The data does suggest that there is significant relationship between angle of ankle joint of long jumpers with performance.

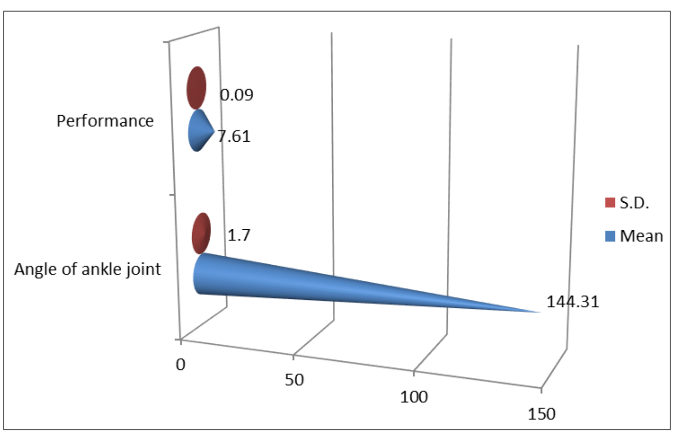

Fig 2: Shows mean and standard deviation values of long jumpers angle of ankle joint and performance

Table 3: Relationship between Angle of Knee joint in long jumpers with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Values
18	Angle of Knee joint	175.27	0.71	.815*
18	Performance	7.61	0.09	

‘r’$_{0.05}$(16)=0.497
*=Significant at .05 level of significance

Table & figure no. 3 shows that the mean value of angle of knee joint of long jumpers was 175.27, whereas the standard deviation (SD) of angle of knee joint of long jumpers was 0.71 respectively. At the time of calculation of relationship between Angle of knee joint with performance of long jumpers the r value was .815. The data does suggest that there is significant relationship between angle of knee joint of long jumpers with performance.

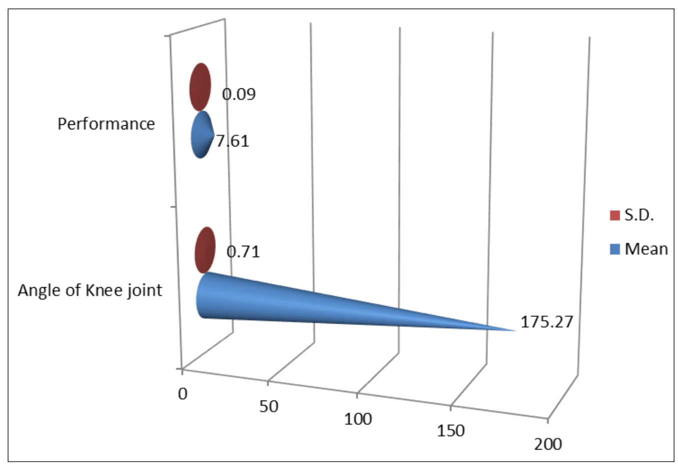

Fig 3: Shows mean and standard deviation values of long jumpers angle of knee joint and performance

Table 4: Relationship between Angle of Hip joint in long jumpers with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Values
18	Angle of Hip joint	160.82	1.81	.937*
18	Performance	7.61	0.09	

‘r’$_{0.05}$(16)=0.497
*=Significant at .05 level of significance

Table & figure no. 4.3 shows that the mean value of angle of hip joint of long jumpers was 160.82, whereas the standard deviation (SD) of angle of hip joint of long jumpers was 1.81 respectively. At the time of calculation of relationship between Angle of hip joint with performance of long jumpers the r value was -.937. The data does suggest that there is significant relationship between angle of hip joint of long jumpers with performance.

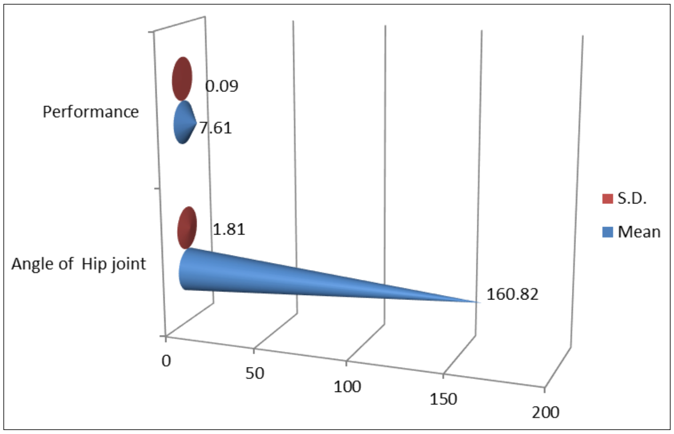

Fig 4: Shows mean and standard deviation values of long jumpers angle of hip joint and performance

Discussion of the findings

1. The results of the study notify that there is significant relationship between Projection angle of long jumpers with performance. Gideon Ariel, Andrei Vorobiev and Igor Ter-Ovanessian (1993) Biomechanical Analysis of the World Record Long Jump supported the present study.
2. The result of the study informs that there is significant relationship between Angle of ankle joint of long jumpers with performance. On the basis of analysis of the data, investigator found that the earlier study of Gideon Ariel, Andrei Vorobiev and Igor Ter-Ovanessian (1993) "Biomechanical Analysis of the World Record Long Jump" supported the present study.
3. The results of the study explain that there is significant relationship between angle of knee joint of long jumpers with performance. These findings are supported by Gideon Ariel, Andrei Vorobiev and Igor Ter-Ovanessian (1993) "Biomechanical Analysis of the World Record Long Jump" supported the present study.
4. The result of the study revealed there is significant relationship between angle of hip joint of long jumpers with performance Gideon Ariel, Andrei Vorobiev and Igor Ter-Ovanessian (1993) "Biomechanical Analysis of the World Record Long Jump" supported the present study.

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