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Kinematic and dynamic analysis of long jump

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Abstract
The purpose of the present study was to investigate the Kinematic and Dynamic Analysis of Long Jump. 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 Horizontal velocity of the Ankle joint, Vertical velocity of the Ankle joint, Horizontal velocity of knee joint, Vertical velocity of the knee 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 .970, .950, .972, .813) of Long Jump athletes in all variables.

Keywords: kinematic, horizontal velocity of the ankle joint, vertical velocity of the ankle joint, horizontal velocity of knee joint, vertical velocity of the knee joint etc.

Introduction
The long jump consists of four interconnected phases: approach, take-off, flight and landing. The objectives in each phase of the jump are the same regardless of the athlete's gender or ability. To produce the greatest possible jump distance the athlete must reach the end of the run-up with a large horizontal velocity and with the take-off foot placed accurately on the take-off board. During take-off the athlete attempts to generate a large vertical velocity while minimizing any loss of horizontal velocity, and in the flight phase the athlete must control the forward rotation that is produced at take-off and place their body in a suitable position for landing. During the landing the athlete should pass forward of the mark made by their feet without sitting back or otherwise decreasing the distance of the jump. (Hay Thorson and Kippenhan, 1999) [4].

The run-up phase is crucial in long jumping; it is impossible to produce a good performance without a fast and accurate run-up. The three main tasks of the athlete during the run-up are: To accelerate to near-maximum speed, lower the body during the final few steps and brings it into the position for take-off, and place the take-off foot accurately on the take-off board.(Seyfarth, Blickhan and Van Leeuwen, 2000) [5]. In long jumping, the distance achieved is strongly determined by the athlete's horizontal velocity at the end of the run-up. To produce a fast run-up, most long jumpers use 16–24 running strides performed over a distance of about 35–55 m. By the end of the run-up the athlete reaches about 95–99 per cent of their maximum sprinting speed (Hay, 1986) [3]. Although long jump performance is determined primarily by the athlete's ability to attain a fast horizontal velocity at the end of the run-up, the athlete must also use an appropriate Take-off technique to make best use of this run-up velocity. Long jumpers place their take off foot well ahead of their COM at touchdown to produce the necessary low position at the start of the take-off. The jumper's body then pivots up and over the take-off foot, during which time the take-off leg rapidly flexes and extends. Long jumping is essentially a projectile event, and the athlete wishes to maximize the flight distance of the human projectile by launching it at the optimum take-off velocity and take-off angle. In launching the body into the air, the athlete desires a large horizontal velocity at take-off to travel forward and a large vertical velocity to give time in the air before landing back on the ground. A fast run-up produces a large horizontal take-off velocity, but it also shortens the duration of the ground contact and hence the ability of the athlete to generate a vertical impulse (force integrated over time). To increase the duration of the foot contact, the athlete plants their foot ahead of the COM at touchdown. However, the resulting increase in vertical propulsive impulse is accompanied by an undesirable increase in horizontal braking impulse. (Bridgett and Linthorne, 2006) [1].

This present study is design to analyze of the most important biomechanical factors influencing technique and performance in the long jump. The biomechanical principles behind the successful execution of the run-up, take-off, flight, and landing phases of the jump will be examined. The effects of changes in run-up velocity on the athlete's take-off technique will also examine.

Statement of the problem
The Problem entitled as "Kinematic and Dynamic Analysis of Long Jump".

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

- *(AHv)*Horizontal velocity of the Ankle joint at the time of take-off
- *(AVv)*Vertical velocity of the Ankle joint at the time of take-off
- *(KHv)*Horizontal velocity of knee joint at the time of take-off
- *(KVv)*Vertical velocity of the knee 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.

Reliability of the data

To obtain variable measurements, standard and calibrated equipments like Digital Video Camera {CASIO EX-FH 100 (50 fps)}, measurement tape and specialized motion analyzing software (Quintic coaching v-17software) approved by: HUMANKINETIC were used. All the equipments and software were supplied by standard agencies and companies and their accuracy was censured by the experts and suppliers. All the measurements pertaining to the kinematical variables were taken by the researcher under the guidance of expert. Digital video cameras {CASIO EX-FH 100 (50 fps)} were operated by expert professional videographer. So the data collected by using these instruments and software were considered reliable for the purpose of this study.

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.

Results

Table 1: Relationship between horizontal velocity of ankle joint in long jumpers with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Values
18	Horizontal velocity of Ankle joint	0.73	0.09	.813*
18	Performance	7.61	0.09	

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

*=Significant at .05 level of significance

Table & figure no. 1 illustrations that the mean value of Horizontal velocity of ankle joint of long jumpers was 0.73, whereas the standard deviation (SD) of Horizontal velocity of ankle joint of long jumpers was 0.09 respectively. At the time of calculation of relationship between Horizontal velocity of ankle joint with performance of long jumpers the r value was 0.813. The data does suggest that there is significant relationship between Horizontal velocity of ankle joint of long jumpers with performance.

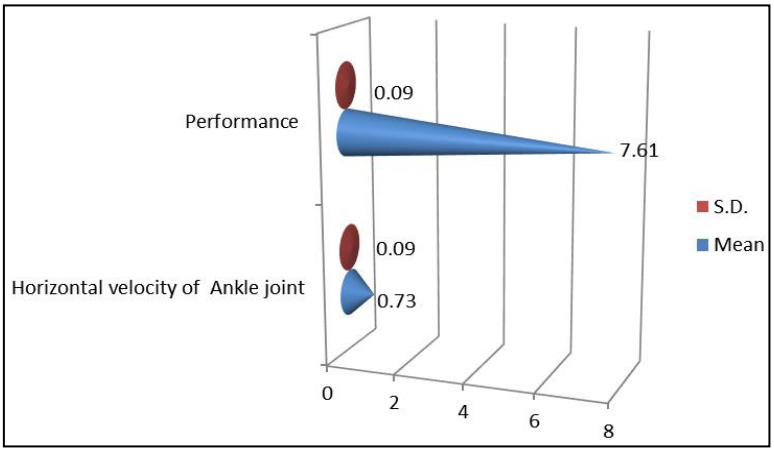

Fig 1: Shows mean and standard deviation values of Long Jumpers Horizontal velocity of ankle joint and performance

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

Trials	Variables	Mean	Standard Deviation	Correlation (r) Values
18	Vertical velocity of Ankle joint	2.06	0.10	.972*
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 Vertical velocity of Ankle joint of long jumpers was 2.06, whereas the standard deviation (SD) of angle of ankle joint of long jumpers was 0.10 respectively. At the time of calculation of relationship between Vertical velocity of Ankle joint and performance of long jumpers the r value was .972. The data does suggest that there is significant relationship between Vertical velocity of Ankle joint of long jumpers with performance.

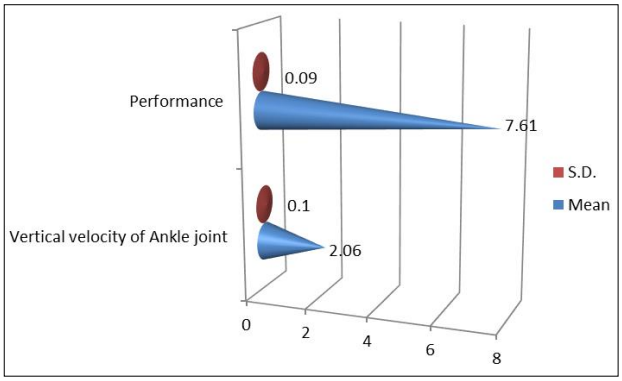

Fig 2: Shows mean and standard deviation values of long jumpers vertical velocity of ankle joint and performance

Table 3: Relationship between horizontal velocity of knee joint in long jumpers with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Values
18	Horizontal velocity of Knee joint	-6.12	0.76	.950*
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 Horizontal velocity of Knee joint of long jumpers was -6.12, whereas the standard deviation (SD) of Horizontal velocity of Knee joint of long jumpers was 0.76 respectively. At the time of calculation of relationship between Horizontal velocity of Knee joint with performance of long jumpers the r value was .950. The data does suggest that there is significant relationship between Horizontal velocity of Knee joint of long jumpers with performance.

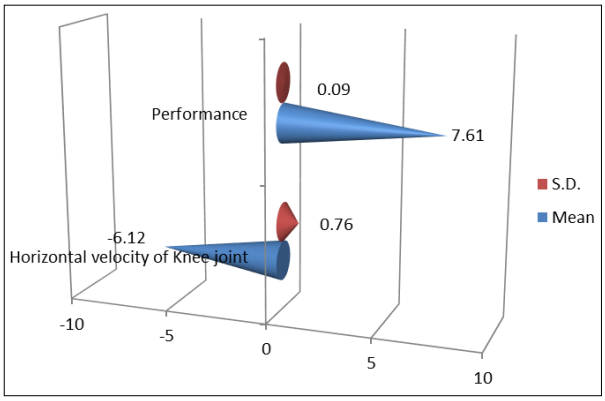

Fig 3: Shows mean and standard deviation values of long jumpers horizontal velocity of knee joint and performance

Table 4: Relationship between vertical velocity of knee joint in long jumpers with performance

Trials	Variables	Mean	Standard Deviation	Correlation (r) Values
18	Vertical velocity of Knee joint	1.79	0.71	.970*
18	Performance	7.61	0.09	

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

Table & figure no. 4 shows that the mean value of Vertical

velocity of Knee joint of long jumpers was 1.79, whereas the standard deviation (SD) of Vertical velocity of Knee joint of long jumpers was 0.71 respectively. At the time of calculation of relationship between Vertical velocity of Knee joint with performance of long jumpers the r value was .970. The data does suggest that there is significant relationship between Vertical velocity of Knee joint of long jumpers with performance.

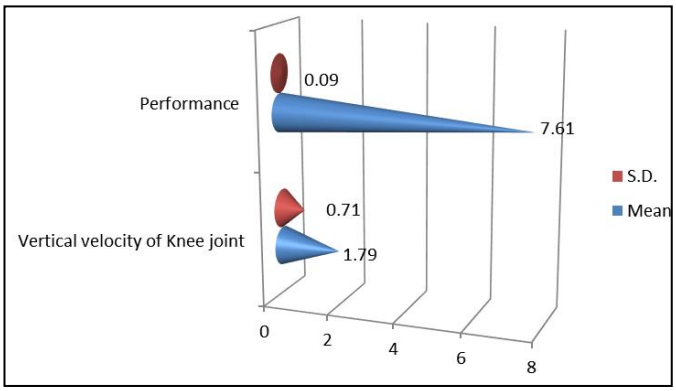

Fig 4: Shows mean and standard deviation values of long jumpers vertical velocity of knee joint and performance

Discussion of the Funding

1. The result of the study informs that there is significant relationship between Horizontal velocity 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) [2] "Biomechanical Analysis of the World Record Long Jump" supported the present study.
2. The result of the study revealed that significant relationship between Vertical velocity 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) [2] "Biomechanical Analysis of the World Record Long Jump" supported the present study.
3. The findings showed that significant relationship between Horizontal velocity of Knee joint of long jumpers with performance these findings are supported by Gideon Ariel, Andrei Vorobiev and Igor Ter-Ovanessian (1993) [2] "Biomechanical Analysis of the World Record Long Jump" supported the present study.
4. The results of the study notify that there is significant relationship between Vertical velocity of Knee joint of long jumpers with performance Gideon Ariel, Andrei Vorobiev and Igor Ter-Ovanessian (1993) [2] "Biomechanical Analysis of the World Record Long Jump" supported the present study.

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