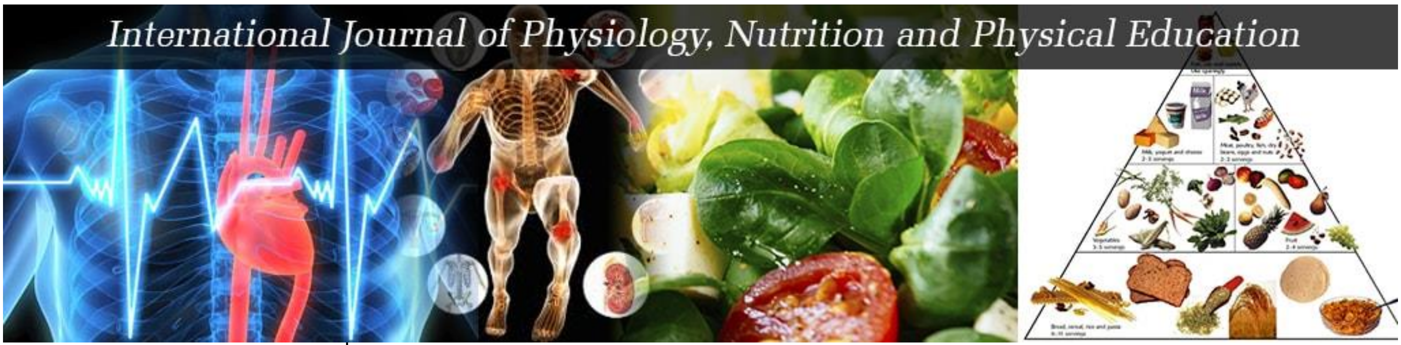

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M Pon Pandi
Guest Lecturer,
Department of Exercise Physiology & Biomechanics, Tamil Nadu Physical Education and Sports University, Chennai, Tamil Nadu, India

Corresponding Author:
M Pon Pandi
Guest Lecturer, Department of Exercise Physiology and Biomechanics, Tamil Nadu Physical Education and Sports University, Chennai, Tamil Nadu, India

Two dimensional kinematic analysis of take-off phase in long jump

M Pon Pandi

Abstract
The aim of the study was find out the relationship of take-off phase in long jump. For this study 10 long jumpers from Tamil Nadu Physical Education and Sports University, Chennai Were selected as subjects. The age of the subjects were ranged from 22 to 26 years. The study was determined to select the biomechanical variables namely take off phase, Take off time, Take off leg angle and Knee angle. The study was formulated as a random group design with 10 subjects. Each participant performed three jumping performance with maximum level that were video recorded with on camera positioned 5.63 meter away from the take-off board. Data were collected by analyzing the video recording of each jump. Data processing was performed using the KINOVEA motion analysis software. Collected data were analysed with Pearson product moment correlation technique and correlation co efficient was tested at 5% level of significance. It was concluded that there was a significant positive relationship between jumping performance and biomechanical parameter take off leg angle. And there was negative relationship between jumping performance and take off phases and take off time. It was concluded that there was no significant relationship between jumping performance and Knee angle.

Keywords: Long jump, takes off, biomechanics, take off angle, and take off time, knee angle

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 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 manoeuvres. The objectives in each phase of the jump are the same regardless of the athlete’s gender or ability. (Hay et.al., 1999) [4].
Long jump performance is primarily determined by the athlete's ability to reach a fast horizontal velocity at the end of the run-up, the athlete must also use an appropriate take-off technique to best conserve this momentum. The distance an athlete jumps is largely determined by the flight distanceand this is determined by the height, speed, and angle of projection of the centre of mass at take-off (Hay, 1993) [5]. The speed and angle of projection are determined by the combination of horizontal and vertical velocity. The horizontal velocity is developed through the run-up, where the athlete is usually close to maximum speed at the take-off board; whereas, vertical velocity is generated during contact with the board (Lees & Fowler, 1994 [7]; Linthorne, 2008) [8]. If the athlete is able to generate near maximum speed close to the board, the problem long jumpers face is how to best generate vertical velocity from the board. Adjustments can be made by the athlete when approaching the board to enable vertical velocity to be generated.
In long jumping, it is well known that take-off angles 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 *et al*., 2005) [8]. The take-off technique has been studied with the aim of finding and defining the variables that would represent the main factors of the performance (optimization) of a take-off (Coh, &Mikuz 2002; Bridgett & Linthorn, 2006) [9]. It was determined that run-up velocity (RUV) has a considerable influence on the kinematic variables of a take-off: leg angle at touchdown (LATD), total angle (TA), take-off duration (TOD), knee angle (KATD) and ankle joint angle at touchdown (AATD) (Alexander, 1990 [1]; Bridgett *et al*., 2002 [2]; Graham-Smith & Lees, 2005; Bridgett & Linthorne, 2006 [9]; Jankovic, 2009).

Methodology

The purpose of the study was to find out the relationship between the take-off phase and selected biomechanical parameters, to facilitate this study 10 long jumpers were selected from Tamil Nadu Physical Education and Sports University, Chennai who had participated in interuniversity level as subjects purposely. Their range between 22 and 26 years and their height ranged from 160 cm to 175 cm. the study was formulated as true random group design. The study was delimited take- off phase and selected biomechanical parameters such as take off stride length, take-off leg angle, and take-off time.

Camera set up procedure

To analyse the kinematic of take-off phase in long jump 2D video camera technique was used Sony Digital Camera (model: HDR-XR55OE) was used to analyse the long jump performance. The camera was mounted on the Sony tripod. The camera was placed at the height of 1.23 m from the ground level and the length between the take-off board and the camera was 5.63 m perpendiculars to the run length in the sagittal plane. Then the calibration frame for two-dimensional analysis was placed 0.80m from the take-off board and 6.43m opposite to the camera the long jumpers used 40m run up length. The athletes were asked to perform their own skill. Each jumper jumps 3 trails and the best one was selected on the final score.

Collection Data

To facilitate study the recorded videos were uploaded in to KINOVEA Motion analysis software for the collection of data. The measurement of 1 m was calibrated and the variables take off stride length was calculated from the distance between the rear leg toe to take-off leg toe and it was measured in meters. Take-off leg angle was calculated from the angle between the take-off leg and the ground take-off. Unit is degree. Knee angle was calculated from the angle between the femur and tibia in the take-off leg during take-off time, unit is Degree.

Statistical Analysis

The analyse relationship between takeoff kinematic variables and jumping performance Pearson product moment correlation was used in all cases level of significance was fixed at 0.05 significance.

Result & Discussion

The analyse relationship between takeoff kinematic variables and jumping performance

	Long jump performance	Takeoff Phase	Take off time	Take off leg angle	Knee angle
Long jump performance	*	-0.946*	-0.985*	0.933*	-0.667
Takeoff Phase		*	0.890	-0.973	0.478
Take off time			*	-0.861	0.782
Take off leg angle				*	-0.367
Knee angle					*

*Significant at 0.05 level of confidence with degrees of freedom 4. The table value is 0.900.

From the results of the study it was found that take of phase had negative relationship with long jump performance in 94.6 percentages. Hence the take-off phase time should be minimal as possible to perform better in long jump. If the athletes take more time in take-off phase means the athletes reduces their speed and their application of force in takeoff board may be in vertical hence the distance of travel may be reduced in meters. From the results of this study it was found that take off time had negative relationship with long jump performance in 98.5 percentages. Hence the take-off time duration should be as short to perform better in jumping performance. If athletes take more take-off time during the take-off time, it would be affect the resultant velocities of the long jump performance.

It also found that take off leg angle had positive relationship with long jump performance in 93.3 percentages. To increase the horizontal velocity the jumper has to increase the take-off leg angle and lean forward.

Conclusion

In this study we found that the positive relationship with takeoff leg angle and negative relationship with takeoff phase and take off time and no significant difference between Knee angle and jumping performance.

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