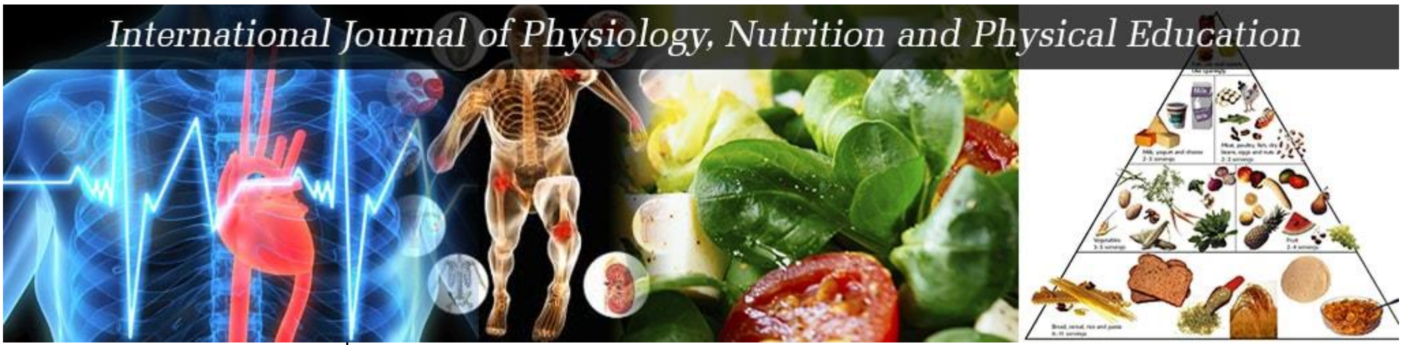

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Impact of linear kinematic parameters on long jump performance: A three dimensional study

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Abstract
The present study intended to find out the relationship among the Linear Kinematic variables of take-off in long jump and also find out which linear kinematic variable was most contributing factor in the enhancement of the long jump performance. The sample consisted of 5 (Five) Long Jumpers in the age group of 17-25 years' with mean 21.47, The test item (parameters) selected for examined Linear kinematic was Center of Mass, horizontal velocity and vertical velocity the statistical technique regression analysis was used for the present study. The present finding towards, Linear Kinematic parameters are quite thought provoking and noteworthy. Linear kinematic (vertical velocity) only showed a statistically significant difference revealed that significant relationship of vertical velocity with the performance in Long Jump also provides further insight into Long Jump, although not all variables associated with real jumping performance. To conclude, it might be interpreted that the above regression equation was reliable as the value of R^2 is .60.0. In other words, the one variable selected in this regression equation explains 60.0% of the total variability in the vertical velocity which was good. Since F- value for this regression model was significant & reliable. They found that jump performance was enhanced by a high approach speed, a high knee angle at touch-down and high (concentric and eccentric) muscle strength. Factors which did not have a great influence on jump distance were tendon compliance, muscle fibre contraction speed and some aspects of muscle architecture. We concluded that in the long jump, variables that are important to performance are interdependent and can only be identified by using appropriate statistical techniques. This has implications for a better understanding of the long jump event and it is likely that this finding can be generalized to other technical sports skills.

Keywords: athletics, linear kinematics, take off, long jump, three – dimensional analysis

Introduction
Athletics is a collection of sporting events that involve competitive running, jumping, throwing, and walking. The most common types of athletics competitions are track and field, road running, cross country running, and race walking. distance is measured from the nearest point of sand disturbed by the athlete's body. The event was created and included in the Olympics because it was deemed important for warriors to be agile and able to avoid obstacles such as leaping across ditches or streams. 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. He analyzed data reported calculations included the relation between the release height and release angle, as well as between the release speed and release angle. The calculated optimum release angles for the athletes were in good agreement with their usual competition release angles (31–35°). Each athlete had his own specific optimum release angle because of individual differences in the rate of decrease in releasing speed with increasing released angle. The method was evaluated using measurements of three experienced male long jumpers who performed maximum-effort with jumps over a wide range of take-off angles. (Langhorne, 1979) [5].

Methodology
Five male Long jumpers of Inter-varsity level from Lakshmibai National Institute of Physical

Education, Gwalior, age ranging 18- 25, were filmed at the moment of takeoff. Participants in the men's Long jump trials were filmed by Max pro software version 1.5.1.0 (3D Analyzer) and were assessed by using 3D photogrammetric techniques with three synchronized high-speed video cameras at 100 F/s and focal length 8mm. The cameras were placed perpendicular to the runway, about 5 m away in line with the takeoff board, so that sufficient number of frames would be available after TO so as to calculate the takeoff parameters. Judges were asked to place themselves in order to have clear view of all sequential movements and also they were not in the view field of the camera to obstruct analysis. The film was analyzed by using a segment Biochemical model which is defined by 14 points using calibrated through the software. Data was first calculated by direct differentiation and basis of the whole body model can be defined by using equations given by Lees *et al*. (1992).

Administration of Tests

For analysis purposes, the camera used for capturing the sequential movements was Canon- 70D and at the time of moment take off in Long jump expected Different Velocities i.e. horizontal Velocity, vertical velocity, linear velocities "*OY",* and angular velocities "OX" were developed by using Max pro software (3D Analyzer). After taking the video, the photos were taken by Pausing the video at the desired moment with the help of Kinovea Software Version-08.25. For referencing purpose, the takeoff board to Long Jump distance was taken to find out the actual height of center of Mass of each subject at selected moment. The width of take-off board & plasticine indicator board was 30 cm, vertical height of the camera was 1.25 meter and horizontal distance of the camera was 5.00 meter from the take-off board. The subjects were filmed at Lakshmibai National Institute of Physical Education, Gwalior. The Vediography sequence was taken under controlled condition. The subjects performed the technique six times all the trials were considered.

Fig 1: Position Markers on the body

Fig 2: Position Markers on the leg

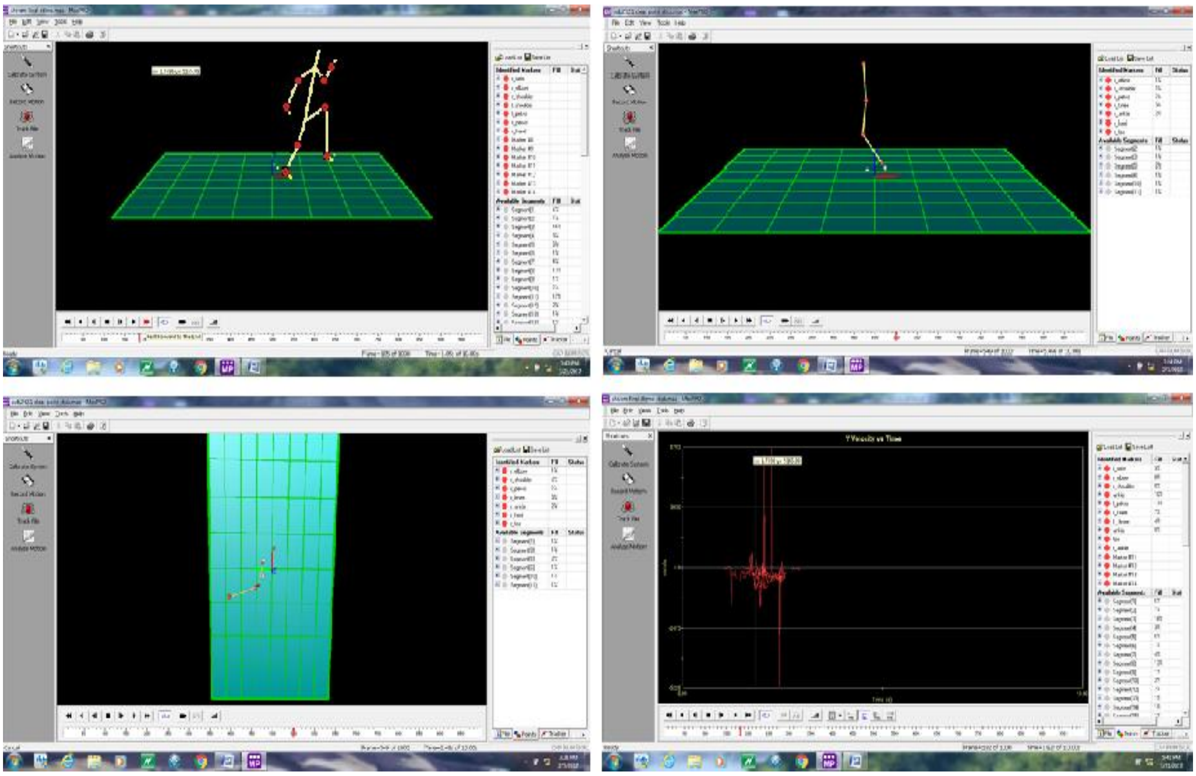

Fig 3: Developed Stick figure & three Dimensional Images at the moment of take-off in Long Jump

Results and Discussion

Statistical Technique

To find out the Relationship between Linear Kinematic variables of Long Jump, Regression Analysis was used. For testing the hypothesis the level of significance was set at 0.05. Descriptive analysis of the data was done by computing the statistics like mean and standard deviation:

Table 1: Mean and Standard Deviation Value of Linear Kinematic Analysis of Long Jump

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
Performance	5.64	.1247	30
Horizontal Velocity	6.83	1.332	30
Vertical Velocity	23.31	1.219	30
Centre of Gravity	124.80	14.83	30

The values of mean and standard deviation for the all variables are shown in table-1. These values might be used for further analysis in the study.

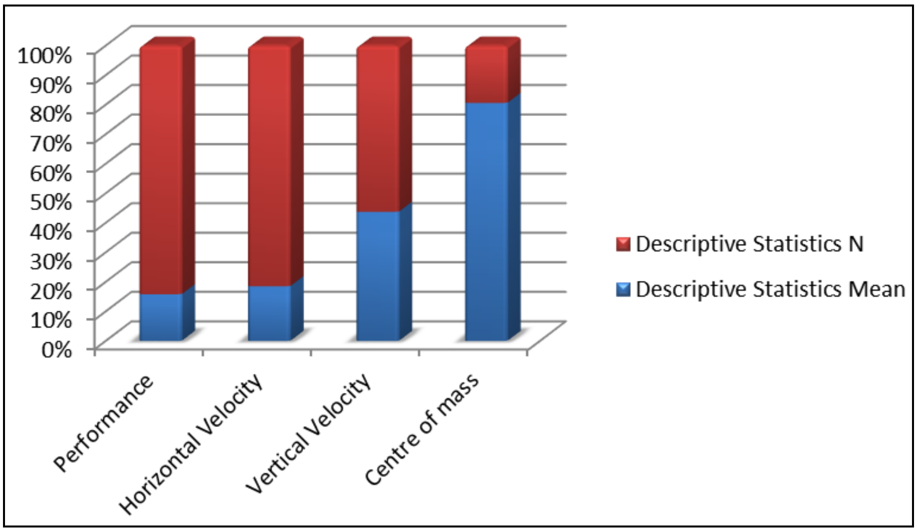

Fig 4: Graphical Presentation Shows the Mean of Linear Kinematic Variables of Long Jump

Table 2: Model Summary Along With the values of R and R^2

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.775[a]	.600	.586	.08030	.600	42.012	1	28	.000
a. Predictors: (Constant), Vertical Velocity									

The regression Model generated by the SPSS had been presented in table 2 in the model, the values of R^2 is .600, which is maximum and, therefore, the model was used to develop the regression equation. It could be seen from the table 2 that model, one independent variables, Vertical Velocity had identified and, therefore, Regression equation shall be developed using one variable only. The R^2 value for this model is 0.600, and, therefore, these one independence variables explain 60.0% variation in Vertical velocity for takeoff of long jump performance. Thus, this Model could be considered appropriate to develop the regression equation.

Table 3: Anova table showing f-value for the selected model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.271	1	.271	42.012	.000[b]
	Residual	.181	28	.006		
	Total	.451	29			
a. Dependent Variable: Performance						
b. Predictors: (Constant), Vertical Velocity						

In table 3, F-value for the entire Model had been shown. Since F- value for the model was significant, it might be concluded that the model selected was efficient also. Thus, it might be concluded that the above regression equation was reliable as the value of R^2 is .600. In other words, the one variable selected in this regression equation explains 60.0% of the total variability in vertical velocity which was good. Since the F- value for this regression model was significant, the model was reliable. At the same time, the regression coefficient in this model was significant, and, therefore, it might be interpreted that one variable selected in the model, namely Vertical Velocity had significant predictability in estimating value of Long Jump Performance.

Table 4: Regression coefficient of selected variable in model along with its t - value

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	3.800	.286		13.305	.000			
	Vertical Velocity	.079	.012	.775	6.482	.000	.775	.775	.775
a. Dependent Variable: Performance									

The table 4 shows the unstandardized and standardized coefficient in all Model. unstandardized coefficient was also known as "B" coefficients and were used to develop the regression equation whereas standardized regression were denoted by "β" and was used to explain the relative importance of independence variables in terms of their contribution towards the dependence variable in the model. In third model, t- value for the regression coefficient was significant as their significance values (p-values) were less than 0.05. Thus, it might concluded that the variables Vertical Velocity significantly explain the variation in Long Jump performance.

Regression Equation: Using regression coefficient (B) of the model shown in table 4 the regression equation could be developed which was as follow:

Performance of Long Jump = 3.800 -.079X (Vertical Velocity)

Conclusion

To conclude, it might be interpreted that the above regression equation was reliable as the value of R^2 is .60.0. In other words, the one variable selected in this regression equation explains 60.0% of the total variability in the vertical which was good. Since F- value for this regression model was significant & reliable. At the same time regression coefficient in this model was significant and therefore it might be interpreted that the one variable selected in the model performance of Long Jump valid in estimating the Vertical velocity of the Long jumper. The aims of this study were to conduct a three-dimensional analysis of take-off phase in the long jump and to explore the interrelationships between key variables, 5 (Five) male long jumpers were filmed using three-dimensional methods various key variables for the long jump were used in a series of correlational and regression analysis. The relationships between key variables when correlated directly one-to-one were generally poor. However, when analyzed using a regression approach, a series of variables was identified which supported the general principles outlined in the one model. These variables could be interpreted in terms of speed, technique and strength. We concluded that in the long jump, variables that are important to performance are interdependent and can only be identified by using appropriate statistical techniques. This has implications for a better understanding of the long jump event and it is likely that this finding can be generalized to other technical sports skills.

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