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Correlation of High Jump Performance and Selected Linear Kinematical Variables of Different Phases of Fosbury-Flop Technique

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Abstract

The Purpose of the study was to find Correlation between Dependent Variable (High Jump Performance) and Independent Variables (Selected Linear Kinematical Variables) of Different Phases of Fosbury-Flop Technique. **Selection of Subjects:** Universe of the Study: The study was confined to India only. Sampling Frame: Subjects were selected as a sampling frame from India only and their age was ranging from 16 to 28 years. Sampling Methods: Subjects were selected on the basis of purposively random sampling method. Sampling Size: A total of 8 male professional High Jumpers (who had been participating regularly and who have attained the performance level of 1.95 meters) from India were selected for the study. **Selection of Variables: Anthropometrical Variables:** Age, Height, Weight, Hand Length, Fore Arm Length, Upper Arm Length, Fore Leg Length, Upper Leg Length and Foot Length. **Linear Kinematical Variables:** Height of centre of gravity of the body at initial take-off (touching the ground by take-off foot) of Fosbury-flop technique in high jump, Height of centre of gravity of the body during take-off (total body weight on the take-off foot) of Fosbury-flop technique in high jump, Height of centre of gravity of the body at final take-off of Fosbury-flop technique in high jump, Height of bar/Height of performance of the subject in Fosbury-flop technique, Length of last stride before take-off (toe of the rear foot to heal of the take-off foot), and Speed of the subject. **Criterion Measures:** Age of subject was measured by Chronological Age in year, Height of the subject was measured by Anthropometric Rod in meter, Weight of the subject was measured by Lever Balance/Weighing Machine in kilogram, Height of centre of gravity of different phases of take-off skill in Fosbury-flop technique was measured by Max Traq 2D / Silicon Coach Pro-7 Motion Analysis Software in meter, Speed of subject of duration take-off skill in Fosbury-flop technique was measured by Cinematography/Manually in meter/second, Height of bar/highest performance of the subject was measured by Non Stretchable Tape in meter. Max Traq 2D / Silicon coach pro-7 motion analysis software was use for Kinematical analysis of take-off in Fosbury-flop techniques. The centre of gravity of the subject at the time of different phases of take-off skill in fosbury- flop technique by segmentation method as suggested by Games G. Hay was recorded. **Statistical Technique:** To Kinematical analyze of Fosbury-flop technique in high jump and to determine the key components of Fosbury-flop technique, descriptive statistic was used. To find out correlation between dependent variable (high jump performance) and independent variables (selected linear kinematical variables) of different phases of Fosbury-flop technique in high jump, Pearson correlation was used. The level of significance was set at 0.05. **Conclusions:** Mean, standard deviation, scores of linear kinematics variables in meter during Take-off in Fosbury-flop Technique have been found as follow: Length of last stride (1.12 ±.081), Speed of the subjects (1.56 ± .240), Highest Performance (1.97 ± .022), Centre of Gravity (H1) at Initial Take-off in Fosbury-flop technique (1.23 ± .030), Centre of Gravity (H2) During Take-off in Fosbury-flop technique (1.19 ± .032) and Centre of Gravity (H3) at Final Take-off in Fosbury-flop technique (1.28 ± .013) respectively. Significant correlation was found between H3 (Height of Centre of Gravity of the Body at Final Take-off) with High Jump Performance of subjects in case of linear kinematic variables.

Key Words: **Kinematical Analysis, Fosbury-Flop Technique**

INTRODUCATION

Biomechanics studies the mechanical movement of living beings from the mechanical point, keeping in view the biological constraints under which these mechanical movements are performed. The mechanical laws are applied considering the mechanical characteristics and mechanical capacities of the locomotor apparatus of the organism, which functionally depends upon the biological conditions of the organism. Furthermore, external environment conditions are also taken into consideration. Thus, biomechanics is an applied form of mechanics applicable to the motion of the living bodies.

All movements of living beings are governed by the laws of mechanics, as every movement is mechanical in nature involving locomotion of the body mass in space and time .however, in contrast to the movements of non-living beings, which are subjected to mechanical laws, the movements of living bodies besides being governed by mechanical laws are also subjected to biological laws.

The science of biomechanics has many areas of applications. These are automobile construction, ergonomics, bionics, functional anatomy, orthopedic, space exploration, physical education and sports.

In this era ,where athletic performance are approaching the physiological limits, it has become important to evaluate how mechanical energy can be best applied to achieve the goal and therefore, it has become imperative to analyze the existing techniques and if necessary, refine them and also to develop new techniques to make the maximum use of mechanical energy.

Objectives of the Study:

1. First objective of the study was to Kinematical analyze the Fosbury-flop technique.
2. The objective of the study was to find out the correlation between dependent variable (high jump performance) and independent variables (selected linear kinematical variables) of different phases of Fosbury-flop technique.

RESEARCH METHODOLOGY

Coverage/ Selection of Subjects

1. Universe of the Study: The study was confined to India only.
2. Sampling Frame: Subjects were selected as a sampling frame from India only and their age was ranging from 16 to 28 years.
3. Sampling Methods: Subjects were selected on the basis of purposively random sampling method.
4. Sampling Size: A total of 8 male professional High Jumpers (who had been participating regularly and who have attained the performance level of 1.95 meters) from India were selected for the study.

Selection of Variables / Units of Observation

The following Anthropometrical and kinematic (Linear) variables were selected for the purpose of this study:-**Anthropometrical Variables:** Age, Height, Weight, Hand Length, Fore Arm Length, Upper Arm Length, Fore Leg Length, Upper Leg Length and Foot Length. **Linear Kinematical Variables:** Height of centre of gravity of the body at initial take-off (touching the ground by take-off foot) of Fosbury-flop technique in high jump, Height of centre of gravity of the body during take-off (total body weight on the take-off foot) of Fosbury-flop technique in high jump, Height of centre of gravity of the body at final take-off of Fosbury-flop technique in high jump, Height of bar/Height of performance of the subject in Fosbury-flop technique, Length of last stride before take-off (toe of the rear foot to heal of the take-off foot), and Speed of the subject.

Criterion Measures

Criterion Measures adopted for the study were as follows: Age of subject was measured by Chronological Age in year, Height of the subject was measured by Anthropometric Rod in meter, Weight of the subject was measured by Lever Balance/Weighing Machine in kilogram, Height of centre of gravity of different phases of take-off skill in Fosbury-flop technique was measured by Max Traq 2D / Silicon Coach Pro-7 Motion Analysis Software in meter, Speed of subject of duration take-off skill in Fosbury-flop technique was measured by Cinematography/Manually in meter/second, Height of bar/highest performance of the subject was measured by Non Stretchable Tape in meter.

Max Traq 2D / Silicon coach pro-7 motion analysis software was use for Kinematical analysis of take-off in Fosbury-flop techniques. The centre of gravity of the subject at the time of different phases of take-off skill in fosbury- flop technique by segmentation method as suggested by Games G. Hay was recorded.

Statistical Technique

The following statistical technique was employed: To Kinematical analyze of Fosbury-flop technique in high jump and to determine the key components of Fosbury-flop technique, descriptive statistic was used. To find out correlation between dependent variable (high jump performance) and independent variables (selected linear kinematical variables) of different phases of Fosbury-flop technique in high jump, Pearson correlation was used. The level of significance was set at 0.05. The data was analyzed by applying SPSS19-Version.

RESULT AND DISCUSSION

Descriptive statistics was computed to determine and analyze the linear kinematical variables at different phases of take-off of Fosbury-flop technique in high jump and result pertaining to same has been presented in table no - 1.

Table-1: Descriptive Statistics of Male High Jumpers in Relation to Linear Kinematical Variables during Take-off in Fosbury-flop Technique

Variables	Mean	Std. Deviation	Std. Error	Range	Min.	Max.	Sum
L in meter	1.12	.081	.038	.24	1.00	1.24	8.95
Speed of the Subject in meter/second	1.56	.240	.085	.85	1.18	2.03	12.46
Highest Performance in(meter)	1.97	.022	.007	.06	1.95	2.01	15.78
H1 in(meter)	1.23	.030	.010	.09	1.18	1.27	9.81
H2 in meter	1.19	.032	.011	.09	1.14	1.23	9.49
H3 in meter	1.28	.013	.004	.04	1.26	1.30	10.24

Where: - L= Length of last stride before Take-off (toe of the rear foot to heal of the Take-off foot)

H1= Height of Centre of Gravity of the Body at Initial Take-off

H2= Height of Centre of Gravity of the Body during Take-off

H3= Height of Centre of Gravity of the Body at Final Take-off

It is evident from table - 1 that mean, standard deviation, scores of linear kinematics variables in meter during Take-off in Fosbury-flop Technique have been found as follow:

Length of last stride (1.12 ±.081), Speed of the subjects (1.56 ± .240), Highest Performance (1.97 ± .022), Centre of Gravity (H1) at Initial Take-off in Fosbury-flop technique (1.23 ± .030), Centre of Gravity (H2) During Take-off in Fosbury-flop technique (1.19 ± .032) and Centre of Gravity (H3) at Final Take-off in Fosbury-flop technique (1.28 ± .013) respectively whereas standard Error and Range of scores was found as follow: Length of last stride (.038 & .24), Speed of the subjects (.085 & .85), Highest Performance (.007 & .06), Centre of Gravity (H1) at Initial Take-off in Fosbury-flop technique (.010 & .09), Centre of Gravity (H2) during Take-off in Fosbury-flop technique (.011 & .09) & Centre of Gravity (H3) at Final Take-off in Fosbury-flop technique (.004 & .04) respectively.

To determine the relationship of linear kinematical variables with the performance of high jump at different phases of take-off in Fosbury-flop technique. The data collected was analyzed by using the correlation (Pearson Correlation) and result pertaining to that has been presented in table - 2.

Table-2: Relationship of Linear Kinematical Variables with the High Jump Performance (N=8)

		Correlation Coefficient (r)
Linear Kinematical Variables	**L (meter)**	-.046
	Speed of the Subject (meter/second)	-.299
	H1 (meter)	.364
	H2 (meter)	.233
	H3 (meter)	.775*

***significant at 0.05 level**

Coefficient of correlation required to be significant at 6 degree of freedom = (.707)

Where: - L= Length of last stride before Take-off (toe of the rear foot to heal of the Take-off foot)
H1= Height of Centre of Gravity of the Body at Initial Take-off
H2= Height of Centre of Gravity of the Body during Take-off
H3= Height of Centre of Gravity of the Body at Final Take-off

Table -2 reveals that in case of H3 (Height of Centre of Gravity of the Body at Final Take-off) obtained value of (.775) is greater than tabulated value of (.707) therefore it shows significant relationship of this independent variable with High Jump Performance of subjects. Whereas, in case of L {Length of last stride before Take-off (toe of the rear foot to heal of the Take-off foot)}, Speed, H1 (Height of Centre of Gravity of the Body at Initial Take-off) and H2 (Height of Centre of Gravity of the Body during Take-off) the obtained values (-.046), (-.299), (.364) and (.233) are lower than tabulated value of (.707) therefore it shows insignificant relationship of these independent variables with High Jump Performance of subjects.

Discussion of finding

The results of the study shows that mean, standard deviation, scores of linear kinematics variables in meter during Take-off in Fosbury-flop Technique have been found as follow: Length of last stride (1.12 ±.081), Speed of the subjects (1.56 ± .240), Highest

Performance (1.97 ± .022), Centre of Gravity (H1) at Initial Take-off in Fosbury-flop technique (1.23 ± .030), Centre of Gravity (H2) During Take-off in Fosbury-flop technique (1.19 ± .032) and Centre of Gravity (H3) at Final Take-off in Fosbury-flop technique (1.28 ± .013) respectively.

The correlation (Pearson Correlation) technique was applied to determine the relationship of linear kinematical variables with the performance of high jump at different phases of take-off in Fosbury-flop technique. From the results of the study it was quite revealed that in case of H3 (Height of Centre of Gravity of the Body at Final Take-off) obtained value of (.775) is greater than tabulated value of (.707) therefore it shows significant relationship of this independent variable with High Jump Performance of subjects.

The present results supports that the vertical velocity and the height of COM at the end of take-off phase together determine the height of the flight ($r=0.75$, $p<0.01$; $r=0.1.$, n.s, respectively). Thus, the vertical velocity of the athlete at the end of the take-off phase determines how high the COM will rise after TO. The most important factor related to the vertical velocity of TO is the low COM position at TD ($r=-0.70$, $p<0.01$). These findings are well in agreement with the theoretical findings of Alexander (1990) and the earlier experimental results **(Dapena, 1980; Greig and Yeadon, 2000).**

Conclusions:

On the basis of the findings of the study, the following conclusions are drawn:

1. Mean, standard deviation, scores of linear kinematics variables in meter during Take-off in Fosbury-flop Technique have been found as follow: Length of last stride (1.12 ±.081), Speed of the subjects (1.56 ± .240), Highest Performance (1.97 ± .022), Centre of Gravity (H1) at Initial Take-off in Fosbury-flop technique (1.23 ± .030), Centre of Gravity (H2) During Take-off in Fosbury-flop technique (1.19 ± .032) and Centre of Gravity (H3) at Final Take-off in Fosbury-flop technique (1.28 ± .013) respectively.
2. Significant correlation was found between H3 (Height of Centre of Gravity of the Body at Final Take-off) with High Jump Performance of subjects in case of linear kinematic variables.

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