International Journal of Movement Education and Sports Sciences (IJMESS)
Annual Refereed & Peer Reviewed Journal Vol. VIII No. 1 January-December 2020
Online ISSN 2321-7200 Print ISSN 2348-5604
A UGC Approved & Notified Journal with RJIF Impact Factor 5.24

# Correlation of Long Jump Performance and Selected Linear Kinematical Variables of Hang Style Technique in Long Jump

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(Received on 05 March 2020 – Accepted & Published on 15 March 2020)

**Abstract**

The Purpose of the study was to find Correlation of Long Jump Performance and Selected Linear Kinematical Variables of Hang Style Technique in Long Jump. **Selection of Subjects:** Ten male (national / inter university level) long jumpers of from Banaras Hindu University Varanasi and Diesel Locomotive Workshop Varanasi were selected and their age ranging between 16 to 28 year. **Selection of Variables: Anthropometrical Variables:** 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 take-off of hang style technique in long jump, Height of centre of gravity of the body during flight of hang style technique in long jump, Height of centre of gravity of the body at landing of hang style technique in long jump, Highest performance of the subject in hang style technique in long jump, Length of last stride before take-off of hang style technique in long jump, and speed of the subject (take-off to landing) of hang style technique in long jump. **Statistical Technique:** To kinematical analyze of hang style technique in long jump and to determine the key components of hang style technique in long jump, descriptive statistic was used. To find out correlation between dependent variable (long jump performance) and independent variables (selected linear kinematical variables) of different phases of hang style technique in long jump, Pearson correlation was used. The level of significance was set at 0.05. The data was analyzed by applying SPSS17-Version. **Conclusions:** Mean, standard deviation, scores of linear kinematics variables (in meter) Flight in hang style Technique have been found as follow: Length of last stride (1.65 ±.12), Speed of the subjects (1.04 ± .105), Performance of the subject (6.09 ± .13), Centre of Gravity (H1) at Take-off in hang style technique (1.77 ± .15), Centre of Gravity (H2) During Flight in Hang style technique (2.51± .36) and Centre of Gravity (H3) at landing in hang style technique (.718 ± .14) respectively whereas standard Error and Range of scores was found as follow: Length of last stride (.04 & .38), Speed of the subjects (1.03 & 7.98), Performance of the subject (.69 & 1.40), Centre of Gravity (H1) at Take-off in hang style technique (.046 & .51), Centre of Gravity (H2) during flight in hang style technique (.11 & .94) & Centre of Gravity (H3) at landing in hang style technique (.04 & .42) respectively. Significant correlation was found between speed of the subject (meter/ second) with long Jump Performance of subjects in case of linear kinematic variables. Significant correlation was also found between H3 (Height of Centre of Gravity of the Body at Landing) with long Jump Performance of subjects in case of linear kinematic variables.

Key Words: **Kinematical Analysis, Hang Style Technique**

## INTRODUCATION

The laws governing motion indicate that motion is modified by a number of external environmental forces. Whether these forces are of help or these are hindrances, depends upon the prevailing conditions and the nature of motion. The problem in sports is to learn how to take maximum advantage of these external environmental forces under prevailing condition.

Ultimately, there emerged one term that gained much wider acceptance than any other. That term was biomechanics. The term biomechanics has been variously defined as:

"The mechanical bases of biological, especially muscular activity and the study of the principles and relations involved."
"The application of mechanical laws to living structures, specifically to the locomotor system of the human body.[2]"
"The study of the structure and function of biological system by means of the methods of mechanics.[3]"
"Biomechanics is the science concerned with the internal and external forces acting on a human body and the effects produced by this forces.[4]"
A further and more restricted definition is offered here.
"Biomechanics may be defined as the science, which deals with the application of mechanical laws to living being especially to the locomotor system. The sports biomechanics may also be defined as the science, which examine the internal and external forces acting on the athlete and the athletic implements in use and the effects produced by these forces."
The long jump is the only known jumping event of Ancient Greece's original Olympics' pentathlon events. All events that occurred at the Olympic Games were initially supposed to act as a form of training for warfare. The long jump emerged probably because it mirrored the crossing of obstacles such as streams and ravines. After investigating the surviving depictions of the ancient event it is believed that unlike the modern day event, athletes were only allowed a short running start. The athletes carried a weight in each hand, which were called *halteres* (between 1 and 4.5 kg). These weights were swung forward as the athlete jumped in order to increase momentum. It is commonly believed that the jumper would throw the weights behind him in mid-air to increase his forward momentum; however, halteres were held throughout the duration of the jump. Swinging them down and back at the end of the jump would change the athlete's center of gravity and allow the athlete to stretch his legs outward, increasing his distance. The jump itself was made from the bater ("that which is trod upon"). It was most likely a simple board placed on the stadium track which was removed after the event (Miller, 66). The jumpers would land in what was called a skamma ("dug-up" area) (Miller, 66). The idea that this was a pit full of sand is wrong. Sand in the jumping pit is a modern invention (Miller, 66). The skamma was simply a temporary area dug up for that occasion and not something that remained over time. The long jump was considered one of the most difficult of the events held at the Games since a great deal of skill was required. Music was often played during the jump and Philostratus says that pipes at times would accompany the jump so as to provide a rhythm for the complex movements of the halteres by the athlete. Philostratos is quoted as saying, "The rules regard jumping as the most difficult of the competitions, and they allow the jumper to be given advantages in rhythm by the use of the flute, and in weight by the use of the halter." (Miller, 67). Most notable in the ancient sport was a man called *Chionis*, who in the 656BC Olympics staged a jump of 7.05 metres (23 feet and 1.7 inches). The long jumper is a sprinter first and foremost. You must control your speed down the runway to hit the takeoff board at the right moment to propel up and forward. The farther you jump into the pit, the better. Stepping over the front of the takeoff board will lead to a disqualification. Please do not start training for the event without the help of a coach. The statement of the problem was stated as **"Correlation of Long Jump Performance and Selected Linear Kinematical Variables of Hang Style Technique in Long Jump".**

**Objectives of the Study:**

First objective of the study was to kinematical analyzed of hang style technique in long jump. Second objective of the study was to find out the correlation between dependent variable

(long jump performance) and independent variables (selected linear & angular kinematical variables) of different phases of hang style technique.

Third objective of the study was to determine the key components of hang style technique in long jump.

**Research Questions or Hypotheses:**

(A) To test the significance of relationship between long jump performance and kinematical parameters.

(B) To test the significance of relationship among independent Variables.

(C) Whether few kinematical parameters are highly related with long jump performance.

## RESEARCH METHODOLOGY

### Selection of Subjects

Ten male (national / inter university level) long jumpers of from Banaras Hindu University Varanasi and Diesel Locomotive Workshop Varanasi were selected and their age ranging between 16 to 28 year. The purpose of the study was explained to the subjects and requested to jump in their best effort during each attempt.

### Selection of Variables

The following Anthropometrical and kinematic (Linear and Angular) variables were selected for the purpose of this study:-**Anthropometrical Variables:** 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 take-off of hang style technique in long jump, Height of centre of gravity of the body during flight of hang style technique in long jump, Height of centre of gravity of the body at landing of hang style technique in long jump, Highest performance of the subject in hang style technique in long jump, Length of last stride before take-off of hang style technique in long jump, and speed of the subject (take-off to landing) of hang style technique in long jump.

**Angular Kinematical Variables:** Ankle Joint (Angle of left & Right ankle joint), Knee joint (Angle of left & Right knee joint), Hip joint (Angle of left & Right hip joint), Shoulder joint (Angle of left & Right shoulder joint), Elbow joint (Angle of left & Right elbow joint), Wrist joint (Angle of left & Right wrist joint), Angle of trunk inclination and Angle of Head Inclination.

### Criterion Measures

Criterion Measures adopted for the study were as follows: Age of the Subject was measured in Years as Chronological Age, Height of the subject was measured by Anthropometric Rod in meter, Weight of the subject was measured by Portable Weighing Machine in kilogram, Different lengths of body parts was measured with help of Sliding Caliper/Steel Tape in Cms/Inches, Height of centre of gravity of different phases of hang style technique in long jump was measured by segmentation method as suggested by Games G. Hay in meter, Speed of subject of hang style technique in long jump was measured by Cinematography in meter/second, & Length of last Stride was measured by Cinematography in meter, highest performance of the subject was measured by Non Stretchable Tape in meter and Angle of angular kinematical variables of different phases of hang style technique in long jump was measured by Max Traq 2 D / Silicon Coach Pro-7 Motion Analysis Software in degree.

Max Traq 2 D / Silicon coach pro-7 motion analysis software was use for Kinematical analysis of hang style technique in long jump. The centre of gravity of the subject at the time of different phases of hang style technique by segmentation method as suggested by Games G. Hay was recorded.

**Statistical Technique**

The following statistical technique was employed: To kinematical analyze of hang style technique in long jump and to determine the key components of hang style technique in long jump, descriptive statistic was used. To find out correlation between dependent variable (long jump performance) and independent variables (selected linear kinematical variables) of different phases of hang style technique in long jump, Pearson correlation was used. The level of significance was set at 0.05. The data was analyzed by applying SPSS17-Version.

**RESULT AND DISCUSSION**

**SECTION-A**

Descriptive statistics was computed to determine and analyze the linear kinematical variables at different phases of hang style technique in long jump and result pertaining to same has been presented in table no - 1.

**Table-1: Descriptive Statistics of Male Long Jumpers in Relation to Linear Kinematical Variables in Hang Style Technique**

| Variables | Mean | Std. Deviation | Std. Error | Range | Min. | Max. | Sum | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|
| **L in meter** | 1.65 | .12 | .04 | .38 | 1.46 | 1.84 | 16.45 | .07 | -.71 |
| **Speed of the Subject in meter/second** | 1.04 | .105 | .033 | .30 | .90 | 1.20 | 10.39 | .281 | -1.58 |
| **Performance of the subject in ( meter)** | 6.09 | .13 | .042 | .40 | 5.90 | 6.30 | 60.91 | 2.88 | -1.29 |
| **H1 in( meter)** | 1.77 | .15 | .046 | .51 | 1.54 | 2.05 | 17.62 | .49 | .40 |
| **H2 in meter** | 2.51 | .36 | .11 | .94 | 2.04 | 2.98 | 25.11 | .26 | -1.74 |
| **H3 in meter** | .718 | .14 | .04 | .42 | .46 | .88 | 7.18 | -.79 | -.11 |

**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 Take-off
H2= Height of Centre of Gravity from ground level of the Body during flight
H3= Height of Centre of Gravity of the Body at landing

It is evident from table - 1 that mean, standard deviation, scores of linear kinematics variables (in meter) during flight in hang style technique have been found as follow: Length of last stride (1.65 ±.12), Speed of the subjects (1.04 ± .105), Performance of the subject (6.09 ± .13), Centre of Gravity (H1) at Take-off in hang style technique (1.77 ± .15), Centre of Gravity (H2) during flight in hang style technique (2.51± .36) and Centre of Gravity (H3) at landing in hang style technique (.718 ± .14) respectively whereas standard Error and Range of scores was found as follow: Length of last stride (.04 & .38), Speed of the subjects (1.03 & 7.98), Performance of the subject (.69 & 1.40), Centre of Gravity (H1) at Take-off in hang style technique (.046 & .51), Centre of Gravity (H2) during flight in hang style technique (.11 & .94) & Centre of Gravity (H3) at landing in hang style technique (.04 & .42) respectively.

To determine the relationship of linear kinematical variables with the performance of long jump at different phases of hang style technique. The collected data was analyzed by using the correlation (Pearson Correlation) and results pertaining to that have been presented in table - 2.

**Table-2: Relationship of Linear Kinematical Variables with the Long Jump Performance (N=10)**

| | | **Correlation Coefficient (r)** |
|---|---|---|
| **Linear Kinematical Variables** | **L (meter)** | -.286 |
| | **Speed of the Subject (meter/second)** | .996* |
| | **H1 (meter)** | -.113 |
| | **H2 (meter)** | .046 |
| | **H3 (meter)** | .834* |

***significant at 0.05 level**

**Coefficient of correlation required to be significant at 8 degree of freedom = (.632)**

**Where:** - L= Length of last stride before Take-off
H1= Height of Centre of Gravity of the Body at Take-off
H2= Height of Centre of Gravity of the Body during Flight
H3= Height of Centre of Gravity of the Body at Landing

Table -2 reveals that in case of Speed of the Subject (meter/second) & H3 Height of Centre of Gravity of the Body at Landing obtained value of (.996 & .834) is greater than tabulated value of (.632) therefore it shows significant relationship of this independent variables with Long 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)}, H1 (Height of Centre of Gravity of the Body at Take-off), and H2 (Height of Centre of Gravity of the Body during Flight) the obtained values (-.286), (-.113) and (.046) are lower than tabulated value of (.632) therefore it shows insignificant relationship of these independent variables with Long Jump Performance of subjects.

**Discussion of Finding**

The investigator analyzes Kinematical aspects of hang style technique in Long jump. In this regard, the results of the study shows that mean, standard deviation, scores of linear kinematics variables in meter during flight in hang style Technique have been found as follow: Length of last stride (1.65±.12), Speed of the subjects (6.44 ± 3.10), Performance of the subject (5.70 ± .40), Centre of Gravity (H1) at Take-off in hang style technique (1.77 ± .15), Centre of Gravity (H2) during flight in hang style technique (2.15 ± .36) and Centre of Gravity (H3) at landing in hang style technique (.718 ± .14) respectively.

The correlation (Pearson Correlation) technique was applied to determine the relationship of linear kinematical variables with the performance of long jump at different phases of hang style technique. From the results of the study it was quite revealed that in case of Speed of the Subject (meter/second) & H3 Height of Centre of Gravity of the Body at Landing obtained value of (.996 & .834) is greater than tabulated value of (.632) therefore it shows significant relationship of this independent variables with Long 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 of **(Dapena, 1980; Greig and Yeadon, 2000).**

**Discussion of Hypotheses**

The correlation (Pearson Correlation) technique was applied to determine the relationship of linear kinematical variables with the performance of long jump at different phases of hang style technique. From the results of the study it was quite revealed that in case of Speed of the Subject (meter/second) & H3 Height of Centre of Gravity of the Body at Landing obtained value of (.996 & .834) is greater than tabulated value of (.632) therefore it shows significant relationship of this independent variables with Long Jump Performance of subjects.

Significant relationship was found among independent Variables

Speeds of the Subject & H3 Height of Centre of Gravity of the Body at Landing are highly related with long jump performance.

**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) Flight in hang style Technique have been found as follow: Length of last stride (1.65 ±.12), Speed of the subjects (1.04 ± .105), Performance of the subject (6.09 ± .13), Centre of Gravity (H1) at Take-off in hang style technique (1.77 ± .15), Centre of Gravity (H2) During Flight in Hang style technique (2.51± .36) and Centre of Gravity (H3) at landing in hang style technique (.718 ± .14) respectively whereas standard Error and Range of scores was found as follow: Length of last stride (.04 & .38), Speed of the subjects (1.03 & 7.98), Performance of the subject (.69 & 1.40), Centre of Gravity (H1) at Take-off in hang style technique (.046 & .51), Centre of Gravity (H2) during flight in hang style technique (.11 & .94) & Centre of Gravity (H3) at landing in hang style technique (.04 & .42) respectively.

(2) Significant correlation was found between speed of the subject (meter/ second) with long Jump Performance of subjects in case of linear kinematic variables.

(3) Significant correlation was also found between H3 (Height of Centre of Gravity of the Body at Landing) with long Jump Performance of subjects in case of linear kinematic variables.

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