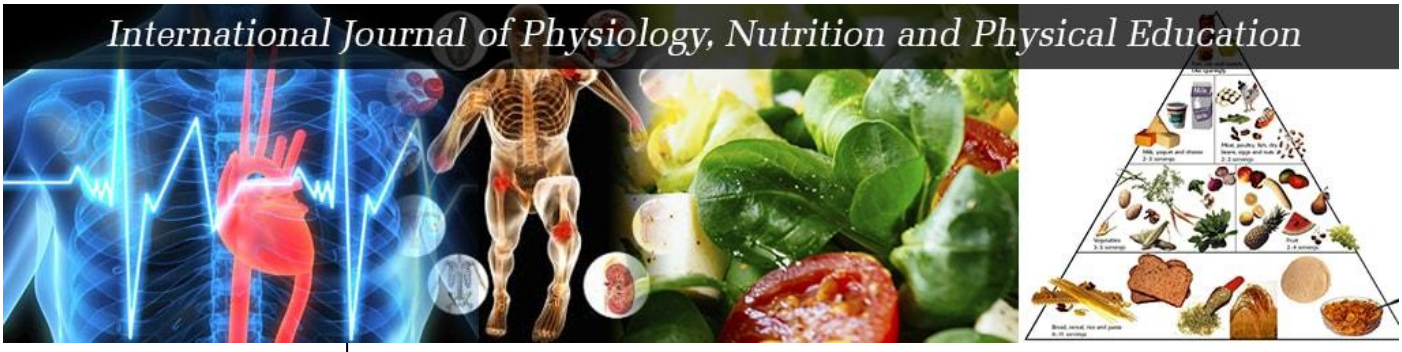

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Correlation of long jump performance and selected angular kinematical variables at landing of hang style technique in long jump

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Abstract
The Purpose of the study was to find Correlation of Long Jump Performance and Selected Linear Kinematical Variables at Landing 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.
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.
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 & angular kinematical variables) at Landing 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: Finally, mean, standard deviation, scores of angular kinematics variables in degree at landing in hang style Technique have been found as follow: Left Ankle Angle (67.40 ±15.43), Right ankle Angle (66.80 ± 7.71), Left Knee Angle (137.30 ± 21.97), Right Knee Angle (132.20 ± 22.81), Left Hip Angle (79.30 ± 20.49), Right Hip Angle (67 ± 12.67), Left Shoulder Angle (53± 31.55), Right Shoulder Angle (60.20 ± 33.28), Left Elbow Angle (156.90 ± 16.38), Right Elbow Angle (150.80 ± 29.53), Left Wrist Angle (191.8 ± 33.12), Right Wrist Angle (186.10 ± 33.52), Trunk Inclination Angle (12.6 ± 7.62), Head Inclination Angle (11.9 ± 7.03) respectively. In case of landing in hang style technique of long jump, insignificance difference was found between angular kinematical variables and with the performance of long jumpers.

Keywords: Kinematical analysis, hang style technique

Introduction
"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 at Landing 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 angular kinematical variables) at Landing of hang style technique in Long Jump.

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 & angular kinematical variables) at Landing 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

Descriptive statistics was computed to determine and analyze the angular 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 Angular Kinematical Variables at Landing in Hang Style Technique

Variables	Mean	Std. Deviation	Std. Error	Range	Min.	Max.	Sum	skewness	kurtosis
Left Ankle Angle in degree	67.40	15.43	4.88	54	43	97	674	.582	.551
Right Ankle Angle in degree	66.80	7.71	2.43	21	57	78	668	.186	-0.65
Left Knee Angle in degree	137.30	21.97	6.95	70	100	170	1373	-.214	-.826
Right Knee Angle in degree	132.20	22.81	7.21	86	84	170	1322	-.536	1.989
Left Hip Angle in degree	79.30	20.49	6.48	73	39	112	793	-.339	.791
Right Hip Angle in degree	67	12.67	4.01	43	43	86	670	-.209	.401
Left Shoulder Angle in degree	53	31.55	9.98	102	14	116	530	.964	.233
Right Shoulder Angle in degree	60.20	33.28	10.52	93	18	111	602	.019	-1.498
Left Elbow Angle in degree	156.90	16.38	5.16	48	130	178	1569	-.273	-1.099
Right Elbow Angle in degree	150.80	29.53	9.34	84	102	186	1508	-.616	-1.273
Left Wrist Angle in degree	191.8	33.12	10.47	90	149	239	1918	.009	-1.161
Right Wrist Angle in degree	186.10	33.52	10.29	91	133	224	1861	-.461	-1.309
Trunk Inclination Angle in degree	12.6	7.62	2.41	22	5	27	126	.859	-.110
Head Inclination Angle in degree	11.9	7.03	2.22	24	3	27	119	1.010	1.247

It is evident from table - 1 that mean, standard deviation, scores of angular kinematics variables in degree at Landing in hang style technique have been found as follow: Left Ankle Angle (67.40 ±15.43), Right Knee Angle (66.80 ± 7.71), Left Knee Angle (137.30 ± 21.97), Right Knee Angle (132.20 ± 22.81), Left Hip Angle (79.30 ± 20.49), Right Hip Angle (67 ± 12.67), Left Shoulder Angle (53± 31.55), Right Shoulder Angle (60.20 ± 33.28), Left Elbow Angle (156.90 ± 16.38), Right Elbow Angle (150.80 ± 29.53), Left Wrist Angle (191.08 ± 33.12), Right Wrist Angle (186.10 ± 33.52), Trunk Inclination Angle (12.6 ± 7.62), Head Inclination Angle (11.9 ± 7.03) respectively whereas standard Error and Range of scores was found as follow: Left Ankle Angle (4..88 & 54), Right Ankle Angle (2.43 & 21), Left Knee Angle (6.95 & 70), Right Knee Angle (7.21 & 86), Left Hip Angle (6.48 & 73), Right Hip Angle (4.01 & 43), Left Shoulder Angle (9.98 & 102), Right Shoulder Angle (310.52 & 93), Left Elbow Angle (5.16 & 48), Right Elbow Angle (9.34 & 84), Left Wrist Angle (10.47 & 90), Right Wrist Angle (10.29 & 91), Trunk Inclination Angle (2.41 & 22) and Head Inclination Angle (2.22 & 24) respectively.

To determine the relationship of angular kinematical variables with the performance of long jump at Landing 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.

Table 2: Relationship of Angular Kinematical Variables with the Long Jump Performance at Different Phases of Hang Style Technique

		Correlation Coefficient (r)
		At Landing
Angular Kinematical Variables	Left Ankle Angle (degree)	.271
	Right Ankle Angle (degree)	-.458
	Left Knee Angle (degree)	.488
	Right Knee Angle (degree)	-.549
	Left Hip Angle (degree)	.321
	Right Hip Angle (degree)	-.514
	Left Shoulder Angle (degree)	-.008
	Right Shoulder Angle (degree)	-.524
	Left Elbow Angle (degree)	-.458
	Right Elbow Angle (degree)	.200
	Left Wrist Angle (degree)	.603
	Right Wrist Angle (degree)	-.169
	Trunk Inclination Angle (degree)	-.044
	Head Inclination Angle (degree)	.156

*significant at 0.05 level

Coefficient of correlation required being significant at 8 degree of freedom (.632) Table-Further, Table-2 reveals that in case of Left Ankle Angle (degree), Right Ankle Angle (degree), Left Knee Angle(degree), Right Knee Angle (degree), Left Hip Angle (degree), Right Hip Angle (degree), Left Shoulder Angle (degree), Right Shoulder Angle (degree), Left Elbow Angle (degree), Right Elbow Angle (degree), Left Wrist Angle (degree), Right Wrist Angle (degree), Trunk Inclination Angle (degree)and Head Inclination Angle (degree) at landing of Hang Style technique obtained values 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 angular kinematics variables in degree at landing in hang style Technique have been found as follow: Left Ankle Angle (67.40 ±15.43), Right ankle Angle (66.80 ± 7.71), Left Knee Angle (137.30 ± 21.97), Right Knee Angle (132.20 ± 22.81), Left Hip Angle (79.30 ± 20.49), Right Hip Angle (67 ± 12.67), Left Shoulder Angle (53± 31.55), Right Shoulder Angle (60.20 ± 33.28), Left Elbow Angle (156.90 ± 16.38), Right Elbow Angle (150.80 ± 29.53), Left Wrist Angle (191.8 ± 33.12), Right Wrist Angle (186.10 ± 33.52), Trunk Inclination Angle (12.6 ± 7.62), Head Inclination Angle (11.9 ± 7.03) respectively.

The correlation (Pearson Correlation) technique was applied to determine the relationship of angular 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 landing in hang style technique of long jump, insignificance difference was found between angular kinematical variables and with the performance of long jumpers.

Conclusions

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

1. Finally, mean, standard deviation, scores of angular kinematics variables in degree at landing in hang style Technique have been found as follow: Left Ankle Angle (67.40 ±15.43), Right ankle Angle (66.80 ± 7.71), Left Knee Angle (137.30 ± 21.97), Right Knee Angle (132.20 ± 22.81), Left Hip Angle (79.30 ± 20.49), Right Hip Angle (67 ± 12.67), Left Shoulder Angle (53± 31.55), Right Shoulder Angle (60.20 ± 33.28), Left Elbow Angle (156.90 ± 16.38), Right Elbow Angle (150.80 ± 29.53), Left Wrist Angle (191.8 ± 33.12), Right Wrist Angle (186.10 ± 33.52), Trunk Inclination Angle (12.6 ± 7.62), Head Inclination Angle (11.9 ± 7.03) respectively.
2. In case of landing in hang style technique of long jump, insignificance difference was found between angular kinematical variables and with the performance of long jumpers.

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