



Lost Moment of Momentum and Its Relationship to Javelin Throw Distance for Those with Various Record Levels

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Abstract

The research aimed at identifying the correlation between vertical and horizontal lost moment of momentum and javelin throwing distance for various record levels. The researcher used descriptive method with video capturing and skill kinetic analysis. Research sample selected intentionally, consisted of (4) elite javelin throwers in sports season (2013-2014). The most important result were that there is statistically significant correlative relationship between lost horizontal and vertical moment of momentum from the side steps phase to the preparation to throw and throwing phase and throwing distance

Keywords: Javelin throw, moment of momentum.

Introduction

Studying motor performance help in activity development and raising achievement level; the matter which leads to distinction of performance and multiplicity of variables and factors (External and internal) affecting performance. (Nest and Barlett, 1993, p.273)

The bio-kinetic analysis of motor performance converting with description movement description is the most important method of performance assessment and study. That method characterized by assessment objectivity, it depends on study of performance details through converting it to quantitative values such as: (time - force – moment of momentum). Competition demonstrated the importance of skills components studying in detailed manner to know their characteristics to raise achievement level. (Hossameddin , 2006, 31, Grehor, 1995, p232)

Track and field competitions are of basic competitions, where high record levels recorded individually, like javelin achieving furthest horizontal distance. (Saadeddin, and Abdel-Samad, 2004, p.152, Sayed. and Dukrory 2009, p9)

Through scientific reference scan in addition to experts' opinions, it was reached that javelin throw competition is of competitions that most dependent on motor transition.. (Elwa , 2005, p2, Hussein and Almhishhish, 2003, p207).

Through pilot study, researcher conducted performance kinetic analysis of the (Czech) elite athlete (an international athlete) at Athletics 14th World Championships (2013), held in Moscow. In the period from 10 – 18 August (2013), in which athlete held first rank, with javelin throw distance (87.17m). This study aimed at identify bio-kinetic variables most related to javelin throw competition. Through this quantitative analysis, it concluded that motor performance is of most important steps, which work on understanding many important points of skill performance. The researcher found that most studies considered (javelin throw) from bio-kinetic variables analysis side, without dealing with knowledge of lost moment of momentum, and its positive or negative influence on throwing distance, is there positive or negative correlation between them?

This research aimed at identifying the correlation between vertical and horizontal lost moment of momentum and javelin throwing distance for various record levels.

This research trying to answer the following queries

1. Is there a statistically significant correlation between vertical and horizontal lost moment of momentum and javelin throwing distance?
2. Are there statistically significant differences between the three record levels in each of the vertical and horizontal lost moment of momentum?

Research Terms:

Moment of Momentum "M"

It is the result of multiplying mass with velocity, and calculated as: $M = mv$ (Ivancevic, Jovanovic, Djukic, Djukic, & Markovic, 2009, p. 254)

Methods

Four elite javelin throwers in sports season (2013- 2014) with three different record levels registered in Egyptian Amateur Athletic Federation, have various record levels (elite, average, below average, and training age between 7 and 10 years. video capturing and skill kinetic analysis carried out at Faculty of Physical Education for Girls, and Alexandria stadium in 2013 – 2014.academic year. Two pilot studies carried out. In the first pilot study the quantitative and kinesthetic analysis yielded an identification of bio-kinetic variables most associated with javelin throw: (horizontal and vertical moment of momentum, and total moment of momentum of Body COG, Torso COG, Throwing arm Joints COG and pushing leg COG).

Researcher also found that available studies did not address "identifying lost moment of momentum of vertical and horizontal body axes and parts during skill under study performance. This calculated by subtracting moment

of momentum of body's center of gravity (COG) and centers of gravity of body joints for two phases: side steps phase and preparation for throw and throwing phase. There is an urgent need to conduct such a study.

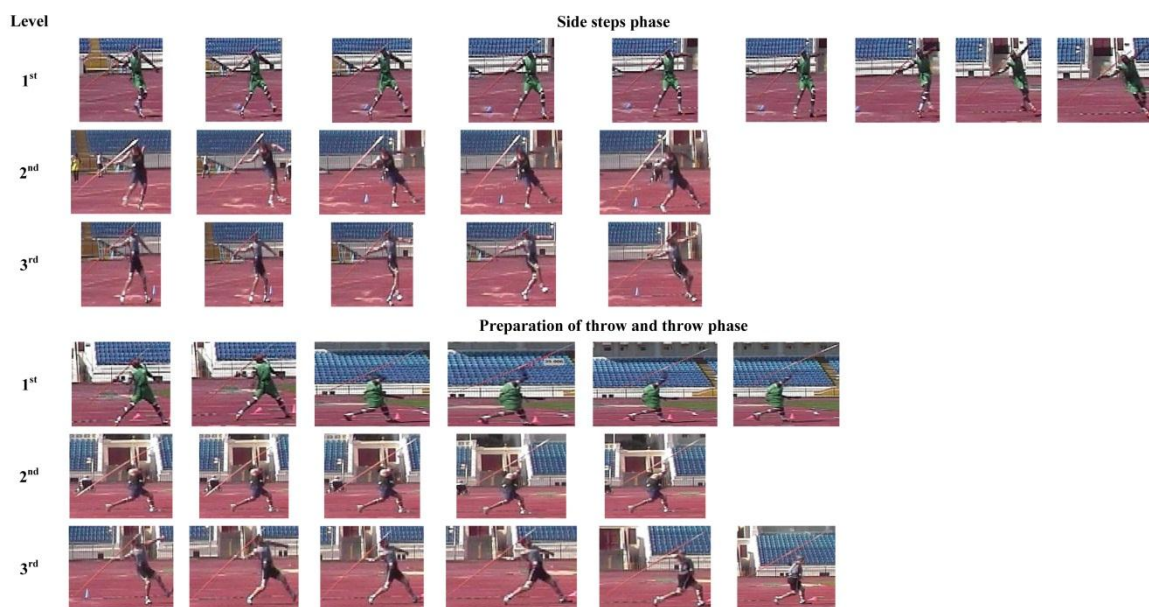
The second pilot study Conducted on Thursday 05/22/2014 in at Faculty of Physical Education for Girls, Alexandria track and field area, its results revealed unsuitability of shooting location and that shooting require camera with speed higher than (25 cadres/s) and camera should be 20 meter far from player.

The two technical performance phases of javelin throw competition determined, which are (side steps phase, and preparation to throw and throwing phase). Bio-kinetic variables resulting from motor analysis determined, which are lost moment of momentum on body horizontal and vertical axes. Video recording implemented in Alexandria sports stadium on Thursday 22/5/2014 after installation, calibration and adjustment of cameras in place fixed for that in shooting area, in such a way, camera is perpendicular to athlete and facing right side. The camera 20.60 meters far and camera lenses 1.40 meters high from ground, taking into account the aperture of the camera. Correct attempts recorded for each athlete as well as the best record level to perform analysis on them.

Determination of the two technical performance phases of the three levels in the javelin throw competition

Figure (1)

Real photos of side steps and preparing to throw and throw phases where significant changes take place in workingints during performance



Results

Presentation of pattern of output curves for a javelin throw athlete (lost moment of momentum indicator) of those with record different levels

A) First Level:

Figures (2-7)

Curves of lost moment of momentum for course of body center of gravity and centers of gravity of body joints

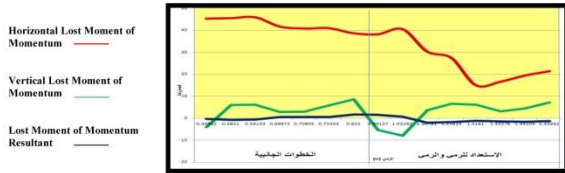


Figure (2) Curves showing lost moment of momentum indicator for course of body center of gravity



Figure (3) Curves showing lost moment of momentum indicator for course of torso center of gravity

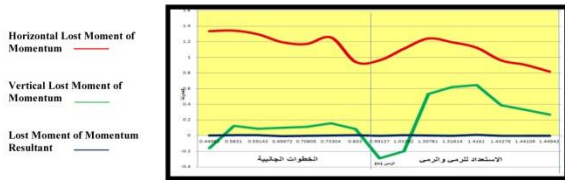


Figure (4) Curves showing lost moment of momentum indicator for course of upper arm center of gravity



Figure (5) Curves showing lost moment of momentum indicator for course of upper arm center of gravity

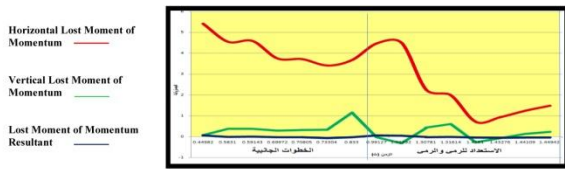


Figure (6) Curves of lost moment of momentum indicator for course of thigh center of gravity

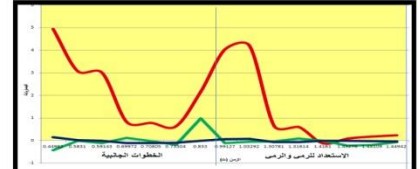


Figure (7) Curves of lost moment of momentum indicator for course of leg center of gravity

B) Second Level:

Figures (8-13)

Curves of the Lost Moment of Momentum for Course of Body Center of Gravity & Body Joints Center of Gravity

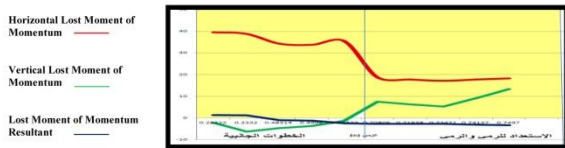


Figure (8) Curves of lost moment of momentum indicator for course of body center of gravity

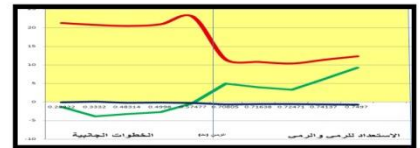


Figure (9) Curves of lost moment of momentum indicator for course of torso center of gravity

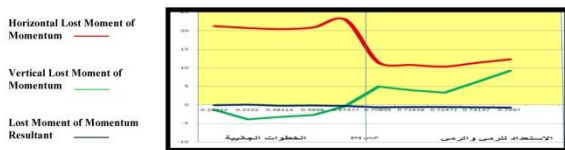


Figure (10) Curves of lost moment of momentum indicator for course of upper arm center of gravity

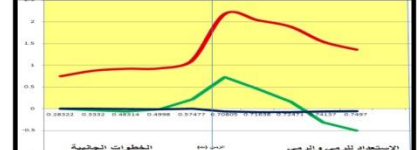


Figure (11) Curves of lost moment of momentum indicator for course of forearm center of gravity

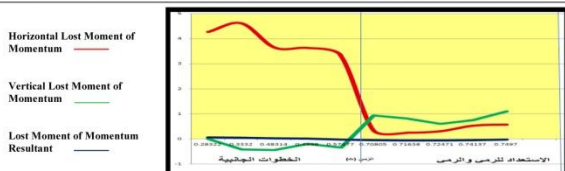


Figure (12) Curves of lost moment of momentum indicator for course of thigh center of gravity

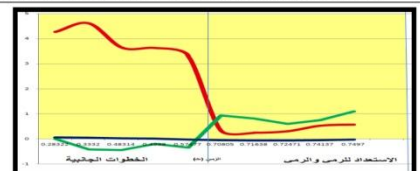


Figure (13) Curves of lost moment of momentum indicator for course of leg center of gravity

C) Third Level:

Figures (14-19)

Curves of Lost Moment of Momentum Indicator of Course of Body Center of Gravity and Body Joints Centers of Gravity

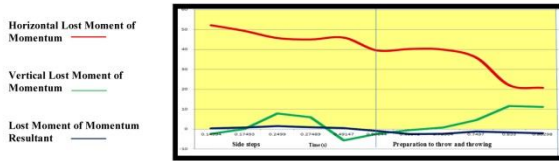


Figure (14) Curves of lost moment of momentum indicator for course of body center of gravity

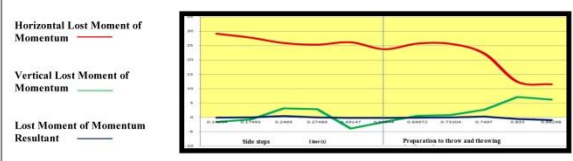


Figure (15) Curves of lost moment of momentum indicator for course of torso center of gravity

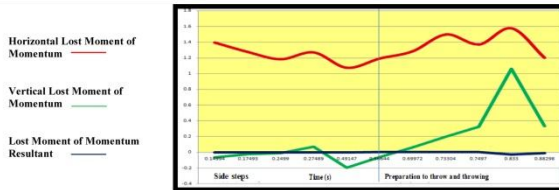


Figure (16) Curves of lost moment of momentum indicator for course of upper arm center of gravity

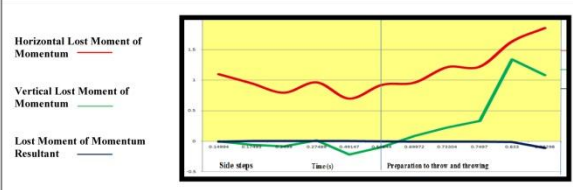


Figure (17) Curves of lost moment of momentum indicator for course of forearm center of gravity

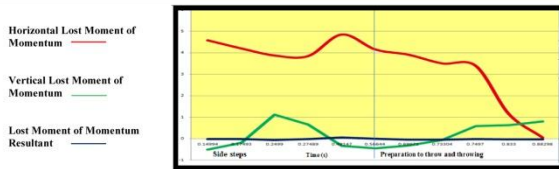


Figure (18) Curves of lost moment of momentum indicator for course of thigh center of gravity

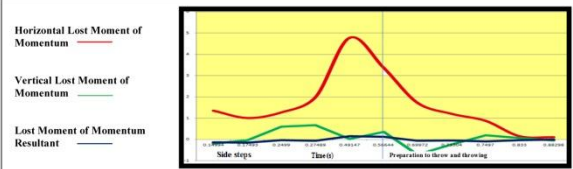


Figure (19) Curves of lost moment of momentum indicator for course of leg center of gravity

Figures (20-25)

Curves of Lost Moment of Momentum Indicator of Course of Body Center of Gravity and Body Joints Centers of Gravity for the three levels

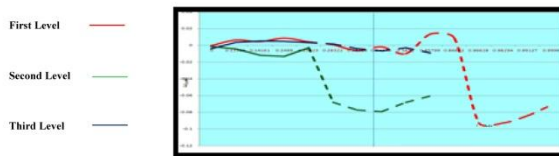


Figure (20) Curves of lost moment of momentum indicator for course of body center of gravity for 3 levels

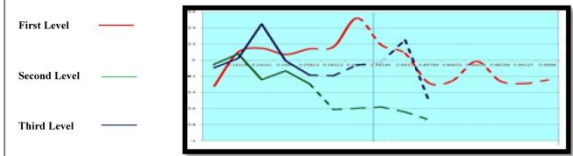


Figure (21) Curves of lost moment of momentum indicator for course of torso center of gravity for 3 levels

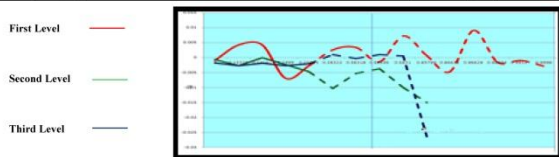


Figure (22) Curves of lost moment of momentum indicator for course of upper arm center of gravity for 3 levels

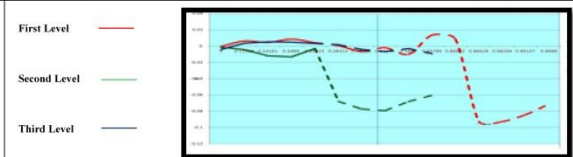


Figure (23) Curves of lost moment of momentum indicator for course of forearm center of gravity for 3 levels

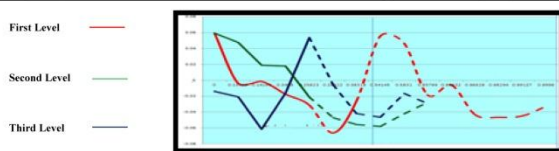


Figure (24) Curves of lost moment of momentum indicator for course of thigh center of gravity for 3 levels



Figure (25) Curves of lost moment of momentum indicator for course of leg center of gravity for 3 levels

From previous presentation of detailed lost horizontal and vertical moment of momentum's indicator path, for body and body joints center of gravity for various record levels; we find that:

The following figures deal with curves model for lost moment of momentum indicator on the "horizontal and

vertical" axes and its relationship with time taken by body and body joints centers of gravity for the three level athletes:

- Figures (2-7) for First level athlete show that amount of lost horizontal moment of momentum indicator for first level "Top" athlete's body COG shows an increase in lost

moment of momentum indicator of body center of gravity for first level athlete during side steps with larger amount than that of preparing to throw and throwing phase. It is also clear from the figures that there is an increase in torso lost moment of momentum when compared to other joints of upper and lower limbs

- Figures (13-8) for second level "average" athlete show that amount of lost moment of momentum indicator the body COG during side steps is larger than preparing throw and throwing phase.

- Figures (14-19) for third level "below average" athlete show that amount of horizontal torso COG lost moment of momentum during preparation to throw phase is less than in side steps and a decrease in body COG lost moment of momentum during preparation for throw and throwing phase, compared with side steps phase which affects throw distance.

- Figures (20-25) deal with curves model of lost moment of momentum resultant on "horizontal and vertical" axis and its relationship with time taken by body COG and body joints COG for the three levels. It is clear from the figures that amount of horizontal lost moment of

momentum for centers of gravity of first level athlete's body joints increase from one joint to the other. This indicates that there is a transition of lost moment of momentum amount from legs to torso and then to throwing arm which happens through side steps performance and then preparation for throw and throwing correctly. Moreover, there is an increase in the moment of momentum of the first level athlete's torso when compared to other joints. The amount reaches (-0.32: 0.08 kg m/s²) during the side steps phase while during the preparation for the throw and throwing phase the value ranged from (-0.27: -0.24 kg m/s²). Meanwhile, the results have led to the presence of lost moment of momentum in the lower limb of the body, which is greater than the lost moment of momentum of the upper limb during the side steps phase including the torso joint, which represents 50% of body weight. Moreover, the horizontal lost moment of momentum is transmitted from lower to upper limb with less value as a result of increasing speed of moment of momentum for upper limb, where throwing arm and its various joints in the intersection step and the preparation for the throwing movement.

Table (1)

Correlation Coefficient between the horizontal and vertical lost moment of momentum and force and throwing distance (n = 9)

Horizontal & vertical lost moment of momentum	Spearman correlation coefficient			
	With forearm and hand force		with throwing distance	
	Correlation Coefficient	Significance (p)	Correlation Coefficient	Significance (p)
Foot	-0.917 *	0.001	-0.933 *	0.000
Shank	-0.917 *	0.001	-0.933 *	0.000
Hip	-0.950 *	0.000	-0.967 *	0.000
Torso	-0.950 *	0.000	-0.967 *	0.000
Upper arm	-0.950 *	0.000	-0.967 *	0.000
Forearm & Hand	-0.950 *	0.000	-0.933 *	0.000
Body Center of Gravity (CG)	-0.983 *	0.000	-0.933 *	0.000

*p <0.05

Table (1) results reveal negative (inverse) correlation between "the horizontal and vertical lost moment of momentum" and throwing phase in the research variables.

Table (2)
Differences significance between the three record levels in "horizontal and vertical lost moment of momentum"

Variables		Kruskal Walis test				
		Average of grade			Ka 2	Significance (p)
		First level	Second level	Third level		
Horizontal & vertical lost moment of momentum	Foot	2	5	8	7.200	0.027 *
	Shank	2	5	8	7.200	0.027 *
	Hip	2	5	8	7.200	0.027 *
	Trunk	2	5	8	7.200	0.027 *
	Upper arm	2	5	8	7.200	0.027 *
	Forearm & Hand	2	5	8	7.200	0.027 *
	Body Center of Gravity (CG)	2	5	8	7.200	0.027 *
Forearm and wrist strength at moment of throwing		8	5	2	7.200	0.027 *
Throwing distance		8	5	2	7.200	0.027 *

*p <0.05

Table (2) shows that there are statistically significant differences between the three record levels in direction of the highest record level pertaining to the force and distance of the throw. There is also statistically significant differences in the direction of the lowest record level in the horizontal and vertical lost moment of momentum of body parts.

Discussion

Results provided by Table (1) related to the correlation coefficient between lost horizontal and vertical moment of momentum from the side steps phase to the preparation for throwing and throwing phase and its relationship to the throwing distance. These results indicate the amount of significance at 0.05 level and that it found that there is a significant correlation between the amount of lost horizontal and vertical moment of momentum and body parts variables (foot and leg - 0.917). In the meantime, the correlation varied in the (thigh, torso, forearm, upper arm, and hand - 0.950) variables. As for the body center of gravity, its value is (- 0.983) with the forearm and wrist force at moment of throwing.

Significant correlation found between lost horizontal and vertical moment of momentum and body parts (foot, leg, forearm and hand) variables and the body center of gravity with distance of throwing. Kibler (1998, p20) points out that in side steps phase, one of the most important variables is opposing force between pivoting leg and ground. That is to take advantage of it in consecutive activation of the transit of the horizontal move because of rotation of legs and torso in the direction of throwing.

Doede (2009, p. 90) and Milton (2010, p. 224) affirm that force is important and effective in the preparation for the throwing phase, gathering and the transit of force from larger part which is torso to the smaller part which is shoulder, then the upper arm, forearm and wrist till the throwing phase is complete. This happens because of pelvis rotation, as well as the torso rotation on horizontal level in the direction of throwing.

Hussein (1999, p140), Hassan (2004, p238) confirmed the importance of torso in moving and relatively high force transition at moment of throwing from limbs to javelin, which give throwing high force. They also in agreement that resultant of force exerted in different directions for body parts participating in throwing performance make all thrower's forces in direction which ensures achievement of maximum force of shoulder, forearm and the wrist during throwing.

The researcher believes that these variables (moment of momentum and force) are the first and basic indicators for javelin or any projectile discharge, so that it is able to reach the goal, that is, to reach the furthest distance to achieve the top level.

Table (2) dealing with differences between three record levels in research variables "lost horizontal and vertical moment of momentum" using the Kruskal Walis test, shows the following:

There are statistically significant differences level in all research variables between the three record levels in body joints lost moment of momentum, in favor of third level "less than average" which gives rise to an inverse

relationship, that is, the greater lost moment of momentum the less force and throwing distance becomes. . This fulfills the utmost benefit from Newton's third law, "For every action there is a reaction equal in magnitude and opposite in direction", during the side steps phase and on taking the last step before preparing to throw. This leads to an increase in body force through using pushing leg movement while maintaining the upper body limb in an almost vertical position thus making use of the ground reaction force and utmost benefit of the thigh movement mechanism. (Escamilla & Andrews, 1996, p.69)

Table (2) also shows that there are statistically significant differences in forearm and wrist force at moment of throwing distance in favor of first level "top record level" which gives rise to direct relationship, that is, the greater force the higher record level.

These results is consistent with Al-Ebidy, and Al-Hashmy(1991, p87) Abdel-Gawad (2005, p.82)Attallah (2009, p.64) and Abul-Ela (2013, p69) who affirm that upper limb importance appears in the appropriate inclination of torso which may help to increase the amounts of limb force which transits to throwing arm. Since the upper limb represents 50% of the body weight, this means that any force cause by upper limbs will have an impact on center of gravity and thus affects the throwing distance, which in turn access highest achievement levels.

The researcher agrees with Escamilla & Andrews (1996, p.86) in that the athlete who carries out the side steps phase in low approaching speeds is not able to produce discharging speeds that are close to his maximum limit even if the accumulated horizontal lost moment of momentum is more than enough to achieve the goal.

The researcher is of the opinion that the final throwing move is an external feature of the transit of horizontal lost moment of momentum in the form of consecutive movement system .This confirmed by results of kinetic analysis of javelin throwing.

To answer the first query, which asks, "Is there a statistically significant correlation between the vertical and horizontal lost moment of momentum and javelin throwing distance?"

The results presentation and discussion show that there is a statistically significant correlation between the horizontal and vertical lost moment of momentum and throwing distance for the three record levels. This correlation is in favor of the distinguished "first" level. This is the answer to the first query.

To answer the second query, which asks, "Are there statistically significant differences between the three record levels in each of the vertical and horizontal lost moment of momentum?"

The results show the presence of an inverse correlation between the lost horizontal and vertical moment of momentum for all the research variables and force and the throwing distance in favor of the third level, "less than average". Results also show the presence of positive correlation between lost moment of momentum of the forearm and wrist force at moment of throwing and distance of throwing, in favor of the distinguished "first" level. This answer the second query.

By analysis of the results in the same pattern, coach can discover the aspects of deficiencies and strengths in each phase of the technical performance of the skill under research and identify the effect of such deficiency on performance in general. He could, therefore be able to address the errors and improve the level of performance.

Conclusions

- 1- There is statistically significant correlative relationship between lost horizontal and vertical moment of momentum and throwing distance.
- 2- There is negative relationship between lost moment of momentum and record level.
- 3- There is positive relationship between forearm and hand force and record level.

Recommendations

- 1- Use of the guidance provided by correlations of bio-kinetic indicators "lost horizontal and vertical moment of momentum," in javelin-throwing training.
- 2- Using the bio-kinetic indicators to detect the aspects of deficiency and weakness in the athlete's performance.

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