Kinematical Analysis of DISCUS Throwing by Jordanian Elite Athletes

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Abstract

The purpose of the present investigation was to identify some kinematical variables noticed in performance of Discus throwers in Jordan in comparison with international standards, and further to explore the association of such variables as (Discus starting velocity, altitude of starting point, starting point angle, forces acting on the instrument) and achievement. Populations consisted of 6-international level athletes during 2004-2005 season. The study has shown no association between achievement and the hypothesized variables, in addition there found to be an association between starting point angle and achievement. Results also indicated that there were large differences between Jordanian vs. international levels of achievement, favoring that of the international level, whereas significant differences were noticed in such variables as starting angle, starting velocity, and altitude of starting point, in favor of international level. The study recommended that a kinematical analysis made periodically is a necessity, and stressed on the need for developing personal physique, and to bring the significant role of biomechanics in coaching within attention of trainers.

(KeyWords: DiscusThrowing, KinematicalAnalysis, Biomechanics, Achievement , Jordan)

1- Introduction

Many research efforts interested in making kinematical analysis of variety sport games including field and track has been made. However, Discus throwing has received very lesser attention of such research efforts that could make fewer, if any, contribution to development of such sport .particularly in Jordan. Effectiveness of Discus throwing heavily relies upon the technique, and concrete performance during its technical sequences, so that unrevealing fine performances will no doubt bring to surface spot of strengths and weakness among Discus throwers, where that would yield more integrated performance model to be compared with findings of other similar studies, and exploring associations between them and achievement, for sake of fostering the status held by kinematical analysis as a significant Discipline helpful in further development of sport coaching process, particularly in high-level ones.

Statement of the problem

The present investigation is interested in updating information regarding effectiveness of Discus throwing skill performed by elite athletes of Jordan, and to provide more data supporting significance of kinematical analysis of such biomechanical skill, which is related to athlete technique. In general, athletes lack necessary data or have misperceived information as how to practice the skill was focused on more heavily than what the skill really is. In practice, description of motion including its variables could not be made unless principles of kinematical analysis of performance, as currently used by those who are interested, are clearly understood.

Objectives of the study

The purpose of the current study, therefore, is twofold.

First, to identify some kinetic performance variables of Discus throwers in Jordan comparing with international levels, and ..

second, exploring associations between such variables and achievement.

Hypothesized of the study

a) There are statistical significant differences in certain kinetic performance variables that favor the international level.

b) there are statistical non-significant associations among certain variables of performance, on one hand and with achievement on the other.

Scope of study covers the following spheres

Human: *Elite Discus throwers of Jordan*

Time: *204-2005 season*

Place: *Al Hasan Sport city.*

Literature Review:

Essential Mechanical Principles of DISCUS Throwing:

The primary goal of Discus throwing is to throw it to a farther possible.distance by making use of four factors (altitude

of tool starting point-tool velocity- starting point angle-aerodynamics forces .. i.e. forces impacting an object moving in air ..) (Paish, 1976). Altitude of starting point is governed by athlete's height, which no one coach could change, however, height of athlete is a contributing factor impacting distance to which Discus is thrown. This contributing factor is considered as of less importance comparing with other influencing factors acting along throwing distance (Husam El-Din, 1994).

Starting Angle of the Instrument:

The best possible starting angle of the instrument that reach as far as possible is °45, where starting and landing points are determined from ground surface. As a result, the most appropriate starting point of the Discus would range from (°30-°40). Then the lesser the angle than °45, the greater the distance will be gradually.(veav.1993)

Velocity of Starting for the Instrument:

Velocity with which the instrument started which is impacted by a force from the athlete affecting the distance to which the instrument would be thrown, and where force of athlete still working. This factor, of course, is viewed as one of most important factors determining length of throwing distance. In mathematical speaking, throwing distance is 55.positively proportional to squared starting velocity of the instrument. So, where starting velocity could be doubled, and then throwing distance would be increasing quadruple. The following formula shows how starting velocity would be increased:

$$\frac{\text{Force Rate} \times \text{performance Time}}{\text{Instrument Weight}}$$

Force rate generated by an athlete could be increased by weigh lifting exercises or developing way of exercising. Similarly performance time could be increased by having more developed technique and greater flexibility.

(AL-Hashemi ,1999). A diameter of throwing circle, for example, that is determined as 2.50 m could enable performing in modern style of throwing by an athlete depending upon path length of the moving Discus, which is 9 meters,while the athlete is going around a circular axe with his fullest force being when he is standing on both feet together just before the instrument is going off while still revolving inside circle (Abdel Baser, 1998) .

Methods and Procedures:

The methodology followed throughout the present study was descriptive associative. Sample (n=6) consisted of elite Discus throwers in Jordan during 204/2005 season. Mean Age of athletes was (25.93), and standard deviation (6.63), whereas mean of coaching ages (9.27), and standard deviation (5.13), mean of weighs (78.87), and standard deviation (7.17), and finally mean of achievement (46.95) and standard deviation (3.73). Characteristics of subjects are shown in Table (1).

Instruments:

1-Technical observation and experimentation
2- Literature review
3-Video camera MX3500 with 2hour speed (500per second)
4-Videotapes
5- Digital numbering for separaing video images and finding out time, shifts andspeed rates.
6- Computer for analyzing motion with Peak performance system.

Procedures:

A camera has been stationed left to athlete about 9.55m far, in that to have a perpendicular position of zoom on athlete's path with the circle. All athletes' trials were photographed in accordance with the international code for field & track sport games, particularly those related to Discus throwing. 42-Discus throwing trials were included taking into consideration a traditional movement in order to secure a synchronized movement of camera with that of athlete just 5 seconds early for purpose of having camera speed within its real range, and further to identify scope of videotaping. Final kinematical inputs were identified by employing motion analytical videotaping Peak Performance system Data gathered were tabulated in order to find out result and make comparisons with findings from previous studies.

Measurements Obtained:

- Study preparation time:
- Time measured on moment of preparing for the study post end of initial swings to a moment at which right leg is leaving ground.
- Taking off during the first round:

Time taken on moment of left leg leaving ground to moment on which right leg is touching ground (flight).

- Readiness time of throwing:

Time taken from time of preparation throwing just pre-taking off.

- Release time: (starting time)

Angle of starting, altitude of starting point, velocity of starting.

Statistical Processing:

Means (M), standard deviations (SD) and T for differences and associations were employed.

Results and Discusussion:

From the above table (2) it is noted that all association values computed (0.71; 0.65; 0.63; 0.55; 0.72 for Preparatory Rotating Time, Ground Takeoff Time, On turning time, Throwing Preparatory Time, and Release Time respectively) were all less than the tabulated associations under freedom degree of (5), and significant level of (0.95), namely (0.87),.indicating weak associations among such variables on one hand and achievement of Discus throwing that is done by subjects. This reflects inconsistent and asynchronous movements performed by subjects, however the subjects are representing an advanced level in Jordan. Obviously, lack of such association indicates differences in timing of movements for each individual of sample due to disparity in time assigned along technical continuum of Discus throwing skill. The researcher explains that by de-

gree to which technical sequences are coherent for subjects, which supposed to go so easily, without happening of any simultaneous interval halts. Preparation for rotating stage needs to be done in good timing as success of the remaining stages depends upon such initial stage of performance, which yields economies of scale force, and provide for a new path for other stages, particularly the stage of rotating in air that should be in least possible time in order to preserve the acquired kinematical energy and the resulted momentum to be employed properly in throwing the weight..

The earlier table (3) shows associations between measurements related to Discus take off (starting angle, altitude of starting point, and starting velocity) with achievement. Results clearly show that only one association (r=0.89) in existence between starting angle and achievement, which is greater that the tabulated value (r=0.87) under freedom degree=5 and significance level of (0.05). The remaining associations were (0.80) between altitude of starting point and achievement; (0.75) between starting velocity and achievement and these are less that tabulated values indicated-above.Among all measurements related to going off, starting velocity is the most important factor, and, in fact, this is a rule of thumb in all hurtling objects. There is a direct straightforward relationship between starting velocity and distance. As indicated in the table, the association between this variable and achievement for subject found insignificant, implying a noted weaknes .in one's muscular strength level, inconsistent kinematical sequence, inferior employment of previously obtained velocity and energy as properly as should be to be so workable the moment the Discus is going off.

As for the associative relationship between starting angle and distance it was found significant (r=0.89), which is larger than the tabulated value. This fact clearly indicate that although reach of such angle was good by subjects, it was rather on account of slowing starting velocity, and that stand in contradiction with integrity of Discus throwing factors, where the instrument is supposed to go off in it ideal angle with very high starting velocity. Having good go-off angle with the required level of velocity means that a thrower has exerted proportional amounts of both horizontal an vertical force composite, that yields most integrated starting angle and velocity which finally fulfill the mechanical goal of having a good throwing. There was no significant relationship between altitude of starting point, and distance, meaning that level by which instrument was thrown by subjects was not so good for Discus to a reach a reasonable distance, the reason could be that the starting point was not in focus, considering that performance is done in phases. It would be that being excessively occupied by mastering such phases would lead a thrower to disregard 150.proper hand position while Discus is going off, starting point of Discus thrown would, therefore, be inappropriate for having a good distance. However, it is clear that distance results scored by subjects were inconsistent with their respective starting velocities, and the same ap-

plies for remaining variables concerning going off. Notably, integration of such variables depends primarily upon athlete's kinematical potentiality to control highly speeded Discus, as a result increased throwing distance hinges upon increased starting velocity. The basic reason behind such problem is represented by lack of technical and physical coaching of athletes.

Results shown by the above table (4) imply that all T-values computed to check out the difference among means achievement variables, starting velocity, altitude of starting point, starting point angle on Jordanian and international levels, were all larger than the tabulated T-value under freedom degree of (10) and significant performance level of (0.01). This difference was in favor of means internationals. The implication is that inter-differences are very high between subjects vs. international levels, meaning that there was a clear and big weakness among our champions compared with internationals, the fact that imposes great efforts to be exerted to minimize such differences. Differences for the starting point, however, were not so significant. The kinematical analysis for Discus throwing is viewed as a significant contributing factor unveiling strengths and weaknesses, the researcher, so, recommends that mechanical variables should be more focused upon, which have straightforward impact upon throwing distance that could not be achieved unless physical characteristics of Discus thrower became more developed.

Conclusions and Recommendations:

No associative relationship could be found between direction and both preparatory rotating time, fight time, preparatory throwing time, and release time with regard to subject. There was a significant associative relationship between discus starting angle and achievement by study subjects. Another significant association was found between starting velocity, altitude of starting point, and achievement. Differences in discus throwing achievements were significant on Jordanian vs. international levels favoring internationals. Significant differences were observed on Jordanian vs. international levels in favor of internationals in going-off variables (starting angle-starting velocity-altitude of starting point) Considering earlier findings, the researcher.

recommends that: Periodically made kinematical analysis should be emphasized in order to find out how developed are technique and performance and thus to restore mistakes. Athlete's physical characteristics (i.e. strength, speed, and drift force) should be in focus due to its importance in having more integrated technique and achievement. Coaches need to be cautioned how important are such biomechanical variables as starting velocity and starting angle in throwing achievement. Simultaneous, streamlined, timed, and rhythmically paced performance should be focused upon in order to have most higher possible speed that can be capitalized upon in a throwing process.

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Table (1)
Characteristics of Subjects

Order	Characteristic	M	SD
1	Age	25.93	6.63±
2	Coaching Age	9.27	5.13±
3	Weight	78.87	7.71±
4	Achievement	46.95	3.73±

Table (2)
Associations between Achievements and Time Variables

Time Variable	Achievement	Tabulating	Significance
Preparatory Rotating Time	0.71	0.87	Insignificant
Ground Takeoff Time	0.65	0.87	Insignificant
On turning time	0.63	0.87	Insignificant
Throwing Preparatory Time	0.55	0.87	Insignificant
Release Time	0.72	0.87	Insignificant

Freedom degree=5, Significant level=0.95

Table (3)
Associations between Measured Starting Values with Achievement

Variables	Achievement R	Tabulated value	Result
Starting Angle	0.89	0.87	Significant
Altitude of Starting Point	0.80	0.87	Insignificant
Starting Velocity	0.74	0.87	Insignificant

Freedom degree (5), significant level (0.95)

Table (4)
Differences among variables of study

	Jordanians		Internationals		Computed	Tabulated	
Variable							Significance
	Mean	SD	Mean	SD	T-values	T-values	
Achievement	43.56	1.88	66.46	0.95	26.76	3.169	Significant
Starting Velocity	19.83	1.69	25.86	0.83	7.84	3.169	Significant
Altitude of Straining Point	1.35	0.079	1.59	0.089	4.76	3.169	Significant
Starting Angle	30.30	5.93	36.46	2.22	1.85	3.169	Insignificant

Freedom Degree =10, Significance Level=0.01