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## The most important biomechanical variables and their relationship to the performance of advanced discus throwers

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### Abstract

The discus throwing event is one of the difficult arena and field activities in terms of technical performance, which depends on a lot of biomechanical variables that we have to research continuously to diagnose and develop through field training, and by using a multi-media computer that relies on video imaging to analyze mechanical variables and the use of a device A platform for measuring strength connected to a computer, Warka type, to extract the kinematic variables (force-time) curve to designate the researcher, coach and player to detect aspects of weakness and strength and then improve these variables. The applicants and their achievement, the percentage of the contribution of these variables to achievement, and thus it is assumed that there is a correlation between the characteristics of the curve (strength - time) with the most important biomechanical variables and the achievement of the discus throw players applicants. The researcher used the descriptive analytical approach for its suitability and the nature of the research, as the research sample included two players with the effectiveness of throwing the disc, who were chosen randomly, including (6) kinetic variables, and (14) mechanical variables were identified, and (6) variables of which represent the characteristics of the (strength) curve. Time) and (8) variables representing the most important biomechanical variables, researched based on the opinions of some experts through a questionnaire prepared for this purpose, and after presenting, analyzing and discussing the results, the researcher reached the following conclusions: A strong direct correlation appeared between (the least force recorded and each of the linear velocity of the shoulder, the linear velocity of the hip, and the linear velocity of the knee).

**Keywords:** Biomechanical variables, performance, advanced discus

### Introduction

As a result of the relentless scientific efforts of scientists and technicians in all fields to address weaknesses, identify facts, invest them and use them to develop achievement, and to reach accurate measurements, devices that are characterized by few errors were designed to obtain accurate results, and the attitude of scientists to the sports field had an effective contribution, especially in athletics and discus throwing effectiveness. Specifically, as the current achievements were distinguished by comparing them with previous achievements at high levels, many field and laboratory studies and researches dealt with most of the physical characteristics of the advanced discus players in Iraq, which directly affect the development of the physical side to improve the skill side, but it did not address the Studying the amount of force exerted by the discus thrower during a certain period of time to identify the true values of the force exerted during the motor performance in order to reach the high achievement and linking that with the important biomechanical variables that have a direct impact on the achievement, so the study of the effectiveness of discus throwing using biomechanics to achieve advanced results Through the study of the forces affecting it or the use of methods and tools wa Various technical devices enable students to identify precise mechanical details It gives us indicators (weak technical performance of the event) that were not known in the past in this way it has reached today. The rotation stage in discus throwing is in the preliminary stage, through which it is necessary to obtain the appropriate position to prepare for the main stage of discus throwing by performing the rotation properly, then reaching the confrontation stage, and then doing the main section in the performance, which is throwing the disc for the

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farthest possible distance, as each stage depends on From the previous and subsequent stages to the high achievement by acquiring the appropriate kinetic energy and transferring it to the disk to achieve the achievement.

Hence the study and research of the characteristics of the curve (force - time) to identify (the maximum and minimum force recorded on the curve, the maximum and minimum time for this force, the rate of force, the area under the curve) for the final stage of the discus players in addition to determining some kinematic variables (the starting angle, Shooting speed) which has a direct effect on the achievement of the discus throw.

### Research problem

The progress of achievement in discus throwing activity depends on discovering theories and following modern scientific methods when applied in the various aspects surrounding the sports training process, by analyzing the performance of the players according to the biomechanical variables in order to reach the scientific facts that serve the achievement of this event. During her follow-up to the results of advanced discus throwers in Iraq, the Iraqi number in this activity did not develop for a long time, so the researcher found it necessary to study this subject to stand on the practical obstacles, especially that studying the issue of force through the force measurement platform can contribute to the development of many solutions to the problems that Weightlifters suffer from it, as well as providing us with numerical values as an indicator of strength and its impact time. Therefore, this issue must be studied from a biomechanical point of view and the amount of force exerted by the player being the main cause that brings the player to high achievement by using the force measuring platform device to find out And determine the characteristics of strength - time related to the achievement of advanced shooters This device gives a true and objective indicator of the amount of force exerted during the motor performance of throwing the disc through Recording the changes in the force exerted in each unit of time in the final stage of pushing the weight, and thus the curves resulting from that can be studied to determine the amount of this force during the unit of time that has an effect on achievement, in the absence of studying the results of the force action of the discus players because the force is The real reason for the integration of propulsion and obtaining the appropriate acceleration during the performance and its relationship to some biomechanical variables related to achievement, as the study of the research problem came to put some scientific solutions through studying the characteristics of the curve (force - time) and its relationship to the most important biomechanical variables and advanced discus players, which May contribute to the development of achievement.

### Research aims

1. To identify the relationship between achievement and kinetic variables for advanced discus players.
2. The relationship between achievement and the most important kinematic variables for advanced discus players.

### Research Hypotheses

1. The existence of a relationship between achievement and kinetic variables for advanced discus players.
2. Existence of a relationship between achievement and the most important kinematic variables for advanced discus

players.

### Research areas

1. The human field: discus players in the southern region.
2. Time range: From 5/1/2019 to 14/3/2019.
3. The spatial field: Al-Jumhuriya Stadium in Basra Governorate.

### Research Methodology

The researcher used the descriptive approach in the manner of studying the correlational relations, as it is the most suitable approach to solve the scientific research problem. The descriptive approach explains "the reality of incidents and the report of their present facts through analysis and evaluation in order to draw important conclusions to correct or update this reality or develop new knowledge" (Ahmed, 1989) <sup>[3]</sup>.

### Research community and sample

The research community was determined by the advanced weightlifting players in Iraq, who are (2) players.

The research sample was selected from advanced players (for the southern region) who represent the best level in discus throwing and who belong to the clubs registered in the Iraqi Central Association for Athletics. (7) A player in the generality of Iraq, and the researcher chose this sample because it is suitable for representing the research community, and this is what some researchers indicated, in that the researcher "may study the study community as a whole if the size of this community falls within the limits of the researcher's capabilities and capabilities and can actually cover it Through study and research" (Abdullah, 1999) <sup>[15]</sup> and in order to identify the characteristics of the sample, the researcher extracted the arithmetic mean and standard deviation for some of the sample specifications, so that the main field experiment and its results would be highly accurate, in the variables (height, age, training age, mass and achievement).

### The means, tools and devices used

#### Data collection methods (Thouqan, 1992) <sup>[17]</sup>

- Arabic and foreign references and sources and the international information network.
- Tests and measurements.
- Technical observation and experimentation.
- A questionnaire to determine the research variables.
- Personal interviews \*.

### Tools and devices used

Tools and devices that contribute to collecting the required data through scientific and practical observation, as indicated successively:

- A video camera type (PANASONIG 3500-M) with a frequency of (24) images / second - a videotape with a time of (2) hours.
- Linen tape measure (50 m) long, (1) to measure the completion distance.
- Reflective guide signs to designate the anatomical points of the subject of the study.
- Legal weight for men weighing (7.257) kg. Number 2).
- Warka type computer
- Force measuring platform with a concrete platform for placing the force measuring platform.
- White gypsum to plan the throwing field.
- A drawing scale with a length of 1 meter (it was shown in the picture 1.53 cm).

- Motion analysis software.
- Two (2) laser discs.
- Electronic calculator Type (Pentium 4).
- A medical device for measuring weight and height.

### Force Measuring Platform

The researcher used a Force Plate Form (5 x 100 x 120 cm), the platform was connected to an electronic computer (NECOPC-60001-MKII) and a display screen (MONITER) type (NEC-JC-1460 DE). As well as a video disc recorder (DISC DRIVE) type (NEC-PC-60m 31B) and a printer (PRINTER - PLOTTER) type NEC-PC-6023BE) and a Japanese-made digital avometer (AVOMETER - PM - 2522 - VA) and a power supply linked to a measuring platform Power is made by Mahli (DC-POWER-SUPPLY) and a German-made STORAGE OSILLOSCOPE (PM-3234-10-MHZ) and electrical circuits connected to the computer. ADC-PORTS) to deal with the automatic computer and convert the movement and feed it to the computer. These circuits are divided into:

- Electronic control circuits.
- Programming control circuits Soft Ware Controlling.
- The following figure shows how to connect the force measuring platform device and its accessories to the computer:

### Research Variables

For the purpose of identifying the most important biomechanical variables (kinetic and kinematics), the researcher put these variables in a questionnaire form \*\* and this form was distributed to a group of experts and specialists \*\*\* in the subject (biomechanics and the arena and field) to select the most important of these variables as well as "important flexibility" in achieving The best achievement of this activity, and after sorting the data of these forms, the variables that got the percentage that achieved more than 80% were selected according to the relative importance, as the researcher has the right to choose the percentage that he deems appropriate to choose a certain number of variables.

### Exploratory experience

In order to obtain the correct information and guaranteed results to benefit from when conducting the main experiment, the researcher conducted the exploratory experiment on 12/20/2018 on Maysan discus players, and this experiment took place on the scout camp stadiums.

The main objective of the exploratory experiment was to identify all the difficulties that the researcher might face in the main experiment.

### The main experience

The main experiment was conducted on Saturday 10/1/2019. After completing the reconnaissance experiment and ensuring the validity of the devices and tools, this experiment was conducted at the Republic Stadium, and the camera was set to the left of the player when he performed the initial stance, at a distance of 8.90 meters and the height of the lens (the middle of the lens) off the ground was (1.06 meters) so that the imaginary line of the middle of the lens (focal length) was perpendicular to the trajectory of the final throwing movement to ensure the follow-up of the movement. Each player was given (6) attempts according to the international effectiveness law, which gives six attempts if the number of players is (8) or less, with a time interval between attempts (3-4) minutes.

### Videography

In order to stand on the kinematic variables that affect the achievement of the discus throw, and in order to obtain a scientific formula to study these variables, the researcher used video imaging, as video imaging is (one of the important means in discovering mistakes and adjusting the closeness or divergence of the players' technical performance levels) (Fouad, 1982) <sup>[16]</sup> and he can The researcher, by drawing the paths of the points of the body, described the movement and analyzed it to see how close the levels of a certain group of players are. It is also possible to determine the geometric path of the body by using the drawing scale. And also set the timeline by changing the number of images per second.

On this basis, the research sample was filmed with a video camera (PANASQNNC-3500TM) with a frequency of (24 images / sec) and using a video cassette (VHC-RD). The video camera was installed on a large tripod, and the height of the center of the lens was (1.06). m from the ground and at a distance of (8.90) m from the trajectory of the final throwing movement to follow up the movement as in Figure (13), and the researcher used a drawing scale, as each (1) m by nature is equal to (1.53). Label the image, and these measurements were used to extract velocities, angles, and distances later. The imaging process took place as the researcher placed phosphorous markers on the anatomical joints of the body for each of (ankle, knee, hip, elbow, shoulder, and palm joints) on one side. The body of the player in order to identify these anatomical points when transferring the image and analyzing it after connecting the lines between the marks.

### Statistical methods used

- Arithmetic mean.
- Standard deviation.
- Simple link.
- Standard error.
- simple regression coefficient:

### Displaying the results of the curve properties (force-time) and the results of the most important biomechanical variables, analysis and discussion.

The results and the shapes of the curves (force - time) showed that there is a difference in the values of these variables during the attempts carried out by the members of the research sample, which are supposed to be relatively similar in their values, given that the members of the research sample represent the highest numerical level in this activity in Iraq and it is supposed to be They have a mechanism in motor performance due to the training age in which they practiced this activity and the level they reached at the country level. As shown in Table (2).

**Table 1:** Shows the arithmetic mean and standard deviations for all research variables for the sample

T	Variable	Arithmetic mean	Standard deviation
1	less powerful	204.75	59.30
2	less powerful time	0.180	0.033
3	maximum strength	1218.16	20.08
4	time of maximum power	0.258	0.036
5	launch speed	12.64	2.20
6	departure angle	38	2.6
7	The total linear speed of the driving hand	11.56	0.23
8	The total linear velocity of the right shoulder	6.23	0.44
9	achievement	45.64	0.28

Presentation of the results of the matrix of correlations of the kinetic variables with each other, achievement, analysis and

discussion.

**Table 2:** It shows the results of the matrix of correlations of the kinetic variables with each other and the achievement in discus throwing effectiveness

Variables /achievement	Less powerful	Its time	Maximum strength	Its time	Achievement
Less powerful	-	0.49	- 0.3 4	0.08 0	0.33
Less powerful time		-	- 0.66	- 0.3 9	0.015
Maximum strength			-	0.6 3 _	0.69 *
Time of maximum power				-	0.78 *
Achievement					-

D at level (0.05) and degree of freedom (10) - tabular value (0.57)

We note that the values of the correlation coefficient between a less powerful variable were not Function with its time as well as with maximum force and its time and completion, and this indicates that variable - q l Strength was not at the required level among the research sample individuals (applicants), as it is assumed that the relationship shows a function with the results of The rest of the variables, especially with time, due to the correlation of the force achieved with the time to achieve the required explosive force even when using the least force, whether when preparing to perform the throw or when preparing to perform the final throw, the value of the correlation with time appeared much less than the tabular value of the correlation, which indicated that there is no significant relationship Statistical (significant) and illustrated For the researcher, there is a lack of emphasis on the correlation of explosive and rapid strength training for the two men when training discus players. Likewise, there was no correlation between the least strength and each of the maximum strength, its time, and achievement, as the calculated correlation values appeared and all these values are less than the tabular value of (0.57), and the researcher believes that although the strength in the muscles of the two legs contributes to achieving transitional speed and However, he notices the weakness of the relationship between the kinematic indicators of the force-time curve, which expresses when the force changes in the driving muscles of the leg at every moment of time, as it is assumed that the relationships are interconnected with each other in these indicators to ensure the integration of the technique and achieve The high fluidity in the technical performance, which serves the interdependence of the performance stages of this event and the achievement of good achievement and response The fact that these variables are related to the work of the muscles of the legs, And that there must be a role for the muscles of the arms in achieving good results in these variables, so The role of the movements of the arms It lies in the integration of the harmonic motions during glide and transition as well as in the final push position. In this sense, And it turns out That there is a lack of integration in the physical attributes that pertain to explosive and rapid force among the members of the research sample as a result of the lack of correlation in the characteristics of the curve that expresses the amounts of these forces exerted upon performance, and that the integration of this physical aspect must be emphasized when they are Because it is one of the necessary and necessary aspects for the integration of the physical performance of weightlifters, and perhaps this is one of the reasons for looking for solutions to raise the level of performance and

achievement of Iraqi discus players, as the achievement in this event suffers from a clear weakness at the Arab, Asian and international levels.

As for the results of the correlations between the time of least power and the rest of the variables, all of the relationships appeared to be statistically insignificant, as is the case in the variable that preceded it, as the correlation values between this variable and the variables of maximum power, time, and achievement, which are correlation values that are not statistically significant because they are less than the tabular value (0.57) under the degree of freedom (10) and the level of significance (0.05), and this is logical because the time of the least force is related to the value of this accomplished force that was discussed previously, which was not at the level of ambition that qualifies discus players to achieve integration in this push. And the higher and smooth the thrust of the force, the better the kinetic appearance, as (Muhammad Yusuf Al-Sheikh) indicates that "the more streamlined the path of the forces, the more the movement is streamlined, and this is what is called dynamic formation, meaning the path of force in relation to time for this movement" (Muhammad 1996) And a significant (significant) correlation appeared between the results of the maximum power variable Each of its time is average and completion, with a correlation value, All of which affect the body's acquisition of the movement and speed required to give the tool the required linear momentum and to achieve the best horizontal distance, and as a result, the relationship appeared significant with achievement as well. And the reason for that The movement of confrontation and the final throw is one of the basic movements practiced by the discus player during the various stages of training. The players of the national team, has led to the development of these movements as a result of repeated training on them, which gave integration in the application of the required force within the performance time, and this affected the characteristics of the value of the maximum force recorded on the curve and its time, which made the fluidity of the movement of the sample individuals positively affect the fluidity of (force - Al-Zaman), as Wajih Mahjoub mentions in "Flow means integration in motor performance and the highest level the athlete reaches" (Wajih, 1987). As a result, the strong relationship between the maximum strength recorded and achievement was statistically significant.

**Presenting, analyzing and discussing the results of the matrix of correlations between the kinematic variables with each other and achievement**

**Table 3:** The results of the associations between the variables Kinematics with each other and achievement in discus throwing effectiveness

Kinematic variables	Cruising speed	Departure angle	Linear speed of the hand	Shoulder linear velocity	Achievement
Cruising speed	-	- 0.72	0.4 9	0.8 8	0.6 9
Departure angle		-	0.5 8	0.3 8	0.6 4
Linear speed of the hand			-	0.8 1	0.4 7
Shoulder linear velocity				-	0.9 8
Achievement	-				-

\* D at level (0.05) and degree of freedom (10) - Tabular value (0.57)

It is noted from the aforementioned results presented in the above table that the calculated correlation values between the kinematic variables with each other were as follows:

- The cruising speed recorded a high correlation (statistically significant) with each of the cruising angle and The linear speed of the shoulder, which is higher than the tabular value (0.57) under the degree of freedom (10) and the level of significance (0.05), and this indicates the existence of a correlation between these variables mentioned in the previous table. The researcher believes that the starting speed is an expression of the final result of the sum of the speed of the parts of the body that he acquires during the stages of performance. These factors are among the most important factors affecting the length of the throwing distance, which is directly proportional to the square of the speed, as we mentioned earlier. While we note that the values of the correlation between the starting speed and each of the linear speed of the right driving hand were not statistically significant, and the researcher believes that there are two basic principles that must be applied by the discus player to be able to obtain maximum strength and speed, and these two principles are that the use of all joints that can be used, and that the use of each joint is in its order and timing, and this means that the forces in these joints must be combined to obtain a horizontal speed and thus a high starting speed,
- The angle of departure achieved a statistically significant correlation with the angle of inclination of the body at the moment of support, and the researcher believes that the position of the body at the moment of support represents a short position commensurate with the positions taken by the body and its parts (such as the position of the arms, the position of the torso and the two legs), which helps in the transmission of the thrust force between the different parts of the body. And from one side of the body to the other, and this thing is used by the weight player when the discus thrower with the right hand (as is the case among the research sample individuals) stabilizes the left side at the moment before the momentum transfer directly to the right side to increase the power of throwing, which gives Possibility to control the appropriate angle of departure, and this case was positive for the members of the research sample, but that was not effective in achieving the rest of the relationships Correlation between the angle of departure with the rest of the kinematic variables, where the correlation values appeared between this angle with the linear speed of the right hand, and the linear speed For the right shoulder, this means the smoothness of the movement of the joints, the shoulder and the wrist of the hand in producing the largest possible force for the push and the failure to achieve the angle required for the launch, and this also affected the production of the movement with the correct timing of the performance. The relationships between the linear speed of the hand and the linear speed of the shoulder appeared with a statistically significant

correlation value, to fit these two speeds in completing the movement of the joints with each other, that is, the correlation between these two speeds was appropriate in achieving the final speed for performance.

- The researcher believes that this relationship indicates that the movement of the discus thrower during the performance must be linked to its preparatory, main and closing sections, and this must be confirmed by the coaches and players in order for the main goal of the performance to be to obtain the highest linear speed for the decisiveness and its parts during Stages of performance This speed can be transmitted as a quantity to different parts of the body.
- It is noted from the same table (3) that the achievement (as a variable directly related to the studied kinematic variables) had statistically significant relationships with the launch speed as well as with the launch angle, as the achievement achieved in pushing the weight is subject to the factors that affect the weight as a projectile, and the most important of these factors They are the speed and angle of launch, where the proportionality is directly in the horizontal distance achieved and between the speed and angle of launch of the disc, and since both the speed of launch and the angle of launch are the main variables in achieving the goal of throwing the disc, which is the achievement of the largest horizontal distance, so it becomes clear the importance of changing the starting angle in Light the distance to be achieved (Talha, 1997).
- a function between the linear speed of the right shoulder with the achievement, and this indicates that the speed gained for the shoulder girdle was the result of a certain amount of force at the time of the impact of this force, and this means the necessity of the participation of large muscle groups as much as possible (in the torso) to work in a specific path and for the longest time To produce the highest force, which necessarily gives the largest possible shoulder speed.
- As for the linear speed of the right hand, the correlation appeared to be statistically insignificant, and the researcher believes that each stage of the performance of the discus thrower is directly related to the stage that precedes it. Shoulder speed, which is considered a previous stage, but the results show the opposite. Therefore, this is one of the indicators of weakness in the technical (technical) aspect of the research sample, which caused the achievement to be disproportionate to the angle of departure that was previously mentioned.

**Conclusions and recommendations**

**Conclusions**

1. A non-significant correlation appeared between achievement, the lowest recorded power, and the least power time of the research sample.
2. No there is a significant difference between the other variables (the least recorded power, the time of the least power) and the achievement of the research sample

members.

3. There is a significant difference between each of (the angle of departure, the speed of departure, the total speed of the shoulder), and the achievement of the research sample members.
4. P - D - C - D - meaning - difference between K - L - M - N of the following kinematic variables (total speed of the hand) and the achievement of the advanced discus players.

### Recommendations

1. Emphasis on paying attention to (the total linear speed of the hand, the total linear speed of the shoulder, and the angle of departure) because of their great influence on the final launch speed of the tool.
2. And kinetic variables alike to work on enhancing the correct ones, and correcting the defect in some of them through the development of alternative aspects responsible for the development of these mechanical variables and their integration among the members of the research sample.
3. Paying attention to biomechanical factors (kinetic and kinematics) by developing information about these factors among coaches and players, as well as using teaching aids and kinetic analysis films for discus players to introduce the importance of mechanical aspects.

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