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The relationship of some biomechanical variables of the final steps and ascent with the achievement of the long jump

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Abstract

This study aims to identify the values of some biomechanical variables of the long jump's last steps, the values of some biomechanical variables and rise of the long jump, the values of some biokinematic variables and the achievement of the long jump, and the relationship between the values of some biomechanical variables of the last steps, The rise and the achievement of the long jump. The sample consisted of five advanced jumpers in the West Asian Athletics Championship for Long Jump, which was held on (30-5-2024) at the Palm Trunk Stadium in Basra Governorate. Video recording, modern scientific techniques(Maxtraq) and programs were used in the analysis to extract the biomechanical variables to be studied. In addition to using the drawing scale in the exploratory and final experiment. The legal attempts were given according to the international law of athletics for the long jump. The best attempt was taken and analyzed for each jumper in the longest distance. After obtaining the raw values, they were processed statistically using the statistical package (SPSSV.21), which included the arithmetic mean, standard deviation, coefficient of variation, and the test (R) for correlations. The results obtained were discussed, in addition to making some conclusions and recommendations that are consistent with the current research on the long jump for advanced jumpers at the West Asian level participating in the championship

The researcher concluded the following:

-Many significant correlations appeared within the correlation relationship between some biokinematic variables and achievement in the long jump event, including (impact angle - take-off angle - angular difference - angular velocity - peripheral velocity - last step time - last step speed).

--Many significant correlations appeared within the correlation relationship between some biokinematic variables and achievement in the long jump event, including (linear momentum - kinetic energy - power – strength)

Keywords: Biomechanics - Final steps - Ascent - Achievement - Long jump

-Identification of the research:

1.1 Introduction

Biomechanics is one of the sciences that emerged and developed as a result of the difficult human conditions that he went through throughout the ages. The human movement, ancient and modern, originally depends on purely physical rules. Biomechanics helps in investigating and studying natural and athletic human movements from all aspects. Their most important pain in sports fields is the analysis within the biomechanical concept that helps in facilitating knowledge of the athletic details movements through the video camera that compensates for the naked eye. It is unable to observe the movement in its clear, rapid form, and kinematic analysis is concerned with studying the movement from the apparent point of view by describing the parts it needs in the movement to be studied. Biomechanics is concerned with analyzing movements clarifying and improving the art of athletic performance (technique) and researching the laws and conditions of athletic movements choosing the best art of performance (technique) for the game. Accordingly, this science seeks to improve sports technique to correct and develop it according to the accuracy of

movement requirements (Alawi, 2007, 15). Athletics is one of the most important sports practiced by people of all ages and genders due to its various health, therapeutic and recreational benefits. In addition to its clear importance in Olympic tournaments because it enables athletes and thus teams to achieve the largest number of medals when compared to other individual games. The long jump event is one of the difficult track and field events to perform. It depends on multiple mechanical foundations and kinematic and kinetic variables. It consists of several technical stages with a sequential movement rhythm (approach, rise, flight, landing) (Johnson, 1982, 25). The long jump is more complex than many people think and the ideal jumping technique often requires years of practice and training (Myers, 1986, 18). The rise phase in the long jump is one of the most complex and influential stages of the event in terms of the achievement level due to the interconnectedness of its successive sections that must be performed with high strength and speed within a very short time constitutes (90%) of the achievement of the long jump. (Al-Hashemi, 1981, 35) (Al-Talib, 1988, 141). (Dostal) indicates that the mechanics of movement in the long jump are affected by the factor of the relationship between the angle and speed during the jump based on anatomical, physiological experiences, and knowledge. It is possible to determine the ideal type or model for the jump (Dostal: p40 -1980). The researcher hopes from his study to reach the nature of the mechanical performance of our jumpers and to employ biomechanical laws to raise the level of achievement of our jumpers to achieve distinguished achievements in international championships. Hence, the importance of the research lies in studying the relationship between some biomechanical variables of the final steps with the advancement and achievement of the long jump for advanced jumpers. In addition to the great importance that can be

benefited from by those working in the track field and games, especially in the effectiveness of the long jump.

1.2 Research problem:

The human body is subject in its movement to the force that works to change its kinetic state. The researchers often resort for studying the results (kinematic variables) without studying the causes (kinetic variables). These variables affect and affected by each other. Giving the body a description of any movement is not enough to study it and know its weak or strong aspects by describing its paths unless this is coupled with the reasons for these aspects and how to find the optimal solutions to raise the level of technical performance of the movement taken by the human body or one of its parts under the influence of certain forces.Since the rise stage is one of the difficult stages in the effectiveness of the long jump the most complex due to the interconnected kinetic variables in its successive sections that affect each other in the level of performance and achievement that must be performed within a very short period of time, speed, distance and height cannot be achieved without the presence of driving forces for this body.

Through the follow-up of the researcher in track and games field through the field participation of Iraqi club athletes, Arab and West Asian athletics championships. It witnessed that there are deficiencies in some of the values of biomechanical variables and achievement especially during the approximate run in the long jump and the ascent process especially the last step and ascent. It requires the athlete to control the approximate run especially the last steps and ascent step. It can affect the horizontal speed, ascent and final achievement of the long jump. In the last step, the position of the body changes completely. It may require another mechanical work to pass the

stage. Accordingly, the researcher decided to study this case as it is one of the problems that need more research and hard work to achieve the best digital achievements in this event like the rest of the developed countries. This is done by using video imaging for analysis and advanced programs to advance this event. In addition to the shortcomings in bio-kinematic research that dealt with the study of the male element especially the advanced champions which prompted the researcher to study this topic especially the correlations of the biomechanical variables.

A comprehensive study of the last steps and the advancement with the achievement long jump for the advanced at Iraq level and Arabs participating in the Arab Championship held in Basra. The goal is for the benefit of workers and trainers in track and field games (athletics) at Iraq level and Arabs in general.

1.3 Research objectives: The research aims to the following:

1.Identify the values of some biomechanical variables for the last steps of the long jump.

2.Identify the values of some biomechanical variables and the rise of the long jump.

3.Identify the values of some bio-kinematic variables and the achievement of the long jump.

4. Identify the relationship between the values of some biomechanical variables for the last steps, the rise and the achievement of the long jump.

1.4 Research hypotheses:

The research imposes the following:

1.The existence of a significant correlation between some biomechanical variables and the final steps in the long jump.

2.The existence of a significant correlation between some biomechanical variables and the rise in the long jump.

3.The existence of a significant correlation between some biomechanical variables and the achievement of the long jump.

4.The existence of a significant correlation between some biomechanical variables of the final steps and the rise with the achievement of the long jump.

1.5 Research areas:

1.4.1 Human field: Advanced jumpers participating in the West Asian Long Jump Championship.

1.4.2 Time field: For the period from 24-5-2024 to 15-8-2024.

1.4.3 Spatial field: Athletics stadium - Palm trunk in Basra Governorate.

1.6 Definition of terms:

1-6-1 Biomechanics: Biomechanics is concerned with analyzing movements, clarifying and improving the art of athletic performance (technique), and studies the laws and conditions of athletic movements and choosing the best art of performance (technique) for the game. (Alawi, 2007, 15)

3.Research procedures:

3.1 Research methodology:

The descriptive approach was used using the correlational method for its suitability of the research nature.

3.2 Research community and sample:

The research sample consists of the best advanced jumpers participating in the West Asian Championship held in Basra Governorate, numbering (5) jumpers, representing 100% of the research community. They were deliberately selected in the West Asian Athletics Championship held in Basra Governorate. The championship on Thursday, corresponding to (30/5/2024) officially registered in the final of the men's long jump competition.

Table No. (1) shows the best attempts of the jumpers in the final of the men's long jump competition, who obtained the best numbers during the championship in sequence from (1-5) according to this form with their names in Table No. (1).

(6) attempts were given to each jumper during the experiment according to international law, provided that there was a sufficient rest period given to the jumpers during the performance of the attempts to ensure that the attempts were performed at the same level. The best attempt was chosen according to the achievement. Appendix (1) shows the six attempts of the jumpers (5) five for the jumpers in the West Asian Championship held in Basra Governorate from 5-30-2024

3.3. Data collection methods:

We used Arab and foreign scientific references and sources, the Internet, scientific and technical observation, measurement, testing, analysis, and the assistant work team as methods for data collection to obtain a number of biomechanical variables under study.

3.3.1 Measurement

The height was measured in centimeters with a (restameter) device and the mass in kilograms with a medical scale to the nearest 50 grams with the clothes in which the player jumped.

3.3.2Test: The jumpers test was used according to the international law of athletics, the number of attempts is (6) attempts according to the international law of athletics and the best is analyzed in light of the best achievement of the highest jump distance. A video camera was used and placed at a distance of (8.50) meters and a height of (130) cm for all jumpers to cover the total work of the approximate run and rise.

3.3.3 Scientific and technical observation:

To achieve the scientific and technical observation, the researcher used video photography, using a CASIO Exilim HS EX-ZR400 video camera at a speed (240 fps). The first camera was placed at a distance between the focus of the camera lens and the jump performance site (5) meters away from the player and to the left of the jumpers. While the height lens focus above the ground was (1.30) meters above the ground, to identify the values of the biomechanical variables (kinematics and kinetics) specific to the last steps and the (rise) stage under study. The camera was fixed on the basis of the transverse axis of the jumper's body (perpendicular to the jump performance field). When choosing the locations of two video cameras, it was taken into account that the lens axis be in the center of the movement field that the lens axis be perpendicular to the level at which the movement takes place (Alaa El-Din, 1985, 117).

3.4 Programs used in the analysis:

3.4.1 Program (Maxtraq): - This program is considered one of the latest programs for biomechanical motion analysis. Through video is cut and stored in multiple formats, as well as mechanical variables for any sports movement and angles under study are extracted.

-AC-Dcee program, version 2020, to display the images to be analyzed for the movement of the skill under study.

-Excel program used to organize the data.

-Word program for printing.

3.5 Devices and tools used in the research:

-Video camera type (CASIO Exilim HS EX-ZR400) Japanese made, number (2), with its accessories.

-Video tape type (TDK) to film the research experiment, number (2).

-Computer (laptop) type TOSHIBA Japanese made.

-Laser printer type CANON, with laser discs.

-Manual scientific calculator type Casio.

-Electronic scale to measure mass to the nearest 50 grams.

-A metric tape measure to measure achievement.

-A drawing scale (1) meter.

-Forms to record the number of attempts.

-A wide green adhesive tape, number (1).

-A rise board, 1 meter long, 20 cm wide and 10 cm wide, made of clay.

-A white and red flag for successful and failed attempts.

3.6 Exploratory experiment:

The researcher, with the help of the work team, conducted an exploratory experiment on (2) jumpers on Sunday at seven o'clock in the evening corresponding to 26/5/2024 at (7) o'clock in the evening. The filming was done at the athletics stadium in Najaf Governorate. The aim of the exploratory experiment was as follows:

-Ensure the safety and validity of the tools used, including the cameras used in the experiment.

-Identify the problems, difficulties and obstacles that may appear when conducting the race to overcome and avoid them.

-Identify the obstacles that may appear and avoid errors and interference with work.

-Identify the distance and height of the camera from the jumpers during the experiment.

-Know the time taken for the tests and measurements from the research to take this into account in the main research tests.

-Know the efficiency of the auxiliary work team from the measurement and testing

process and the results.

-Ensure the validity, angle and final locations of the cameras. (Halimi, Issam, 1999, p. 104)

3.7 The main experiment:

The main experiment was conducted on 5/30/2024 at exactly (7) pm at the Githaa Al-nakhla Athletics Stadium in Basra Governorate on the research sample, numbering (5) jumpers, in the presence of the assistant work team and all the tournament referees. Six attempts were given to each jumper during the experiment provided that there was a sufficient rest period given to the jumpers during the performance of the attempts to ensure that the attempts were performed at the same level. The best attempt was chosen according to the achievement. The researcher used video photography to achieve the scientific and technical observation, using a CASIO Exilim HS EX-ZR400 video at a speed of (240 r/s). The camera was placed (5) meters away from the player and on the left side, the lens was at a height of (1.30) m above the ground to identify the values of the biomechanical variables specific to the last step, ascent, and achievement under study. The speed of the two video cameras was (240) frames/second, the camera was turned on before the jumper took off from the beginning and before starting the experiment. An adequate warm-up was conducted for all members of the general and private research sample. After sufficient rest, the jumpers began according to the sequence of the list of names, to jump within the time specified for each jumper, the best distance from the total of the six (6) preferred attempts for each jumper from the jumpers participating in the West Asian Championship was taken and analyzed.

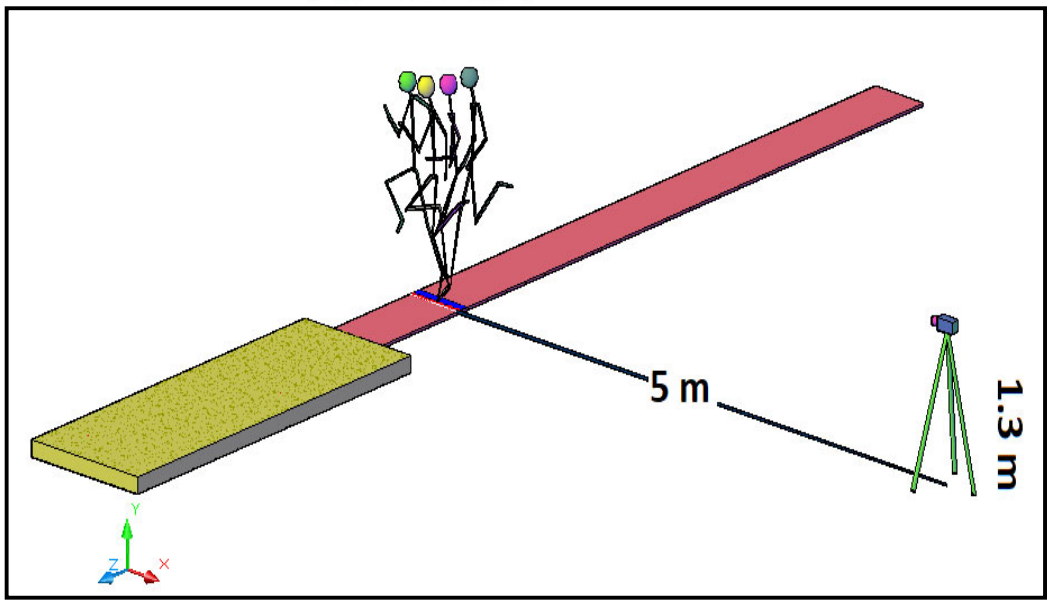


Figure (2) shows the distance and height of the camera from the experimental field (camera location)

3.8 Research variables:

To determine the biomechanical variables, the literature and scientific research in the field of biomechanics especially the long jump are referred to. Accordingly, the appropriate variables for this research are chosen. The biomechanical variables for the steps are (impact angle, ascent angle, angular difference, last step time, angular velocity, radius, circumferential velocity, penultimate step time, penultimate step length, penultimate step speed, last step length, last step speed, linear momentum, kinetic energy, power, force). Figure ( ) shows how to ascend.

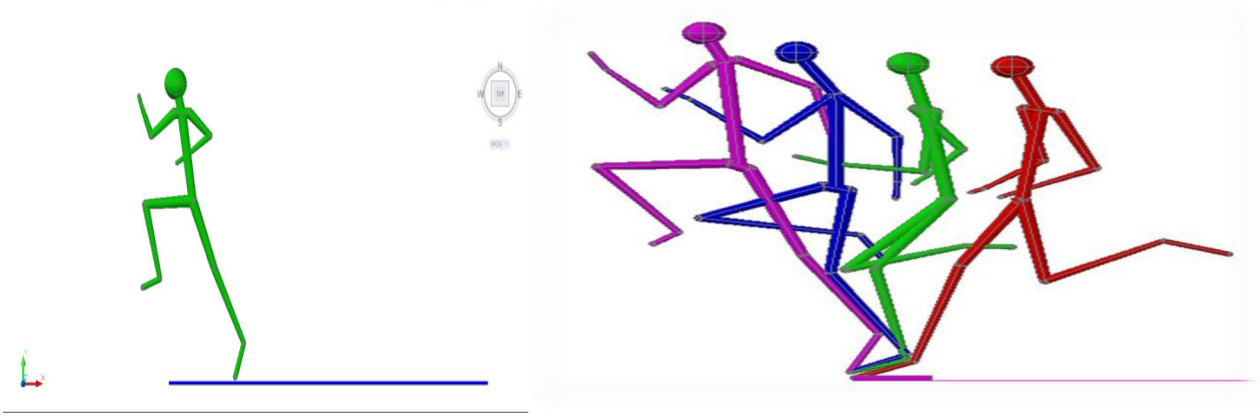


Figure (3) shows how to ascend.

Table (2)

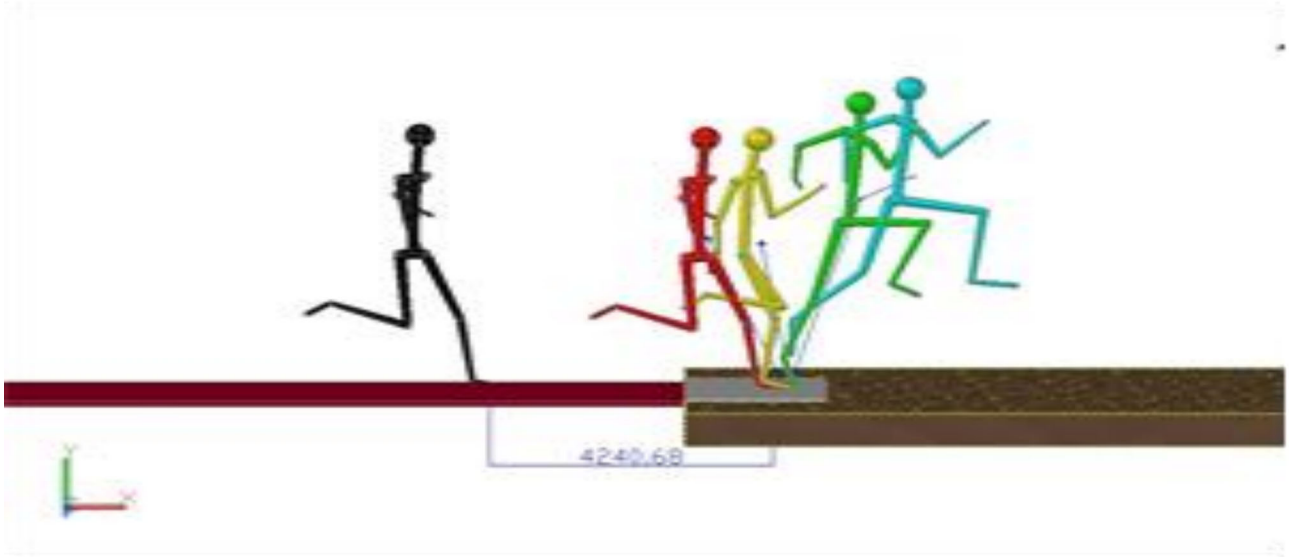
Table (1) shows some biomechanical variables and units of measurement in the long jump effectiveness

Unit of measure	Name of Biomechanical Variables	ت
Degree	Impact Angle	-1
Degree	Elevation Angle	-2
Degree	Angular Difference	-3
Degree/second	Angular Velocity	-4
Cm	Radius	-5
m/second	Circular Velocity	-6
second	Penultimate Step Time	-7
meter	Penultimate Step Length	-8
meter/second	Penultimate Step Velocity	-9
second	Last Step Time	-11
meter	Last Step Length	-12
meter/second	Last Step Velocity	-13
second	Linear Momentum	-14
joule	Kinetic Energy	-15

watt	Power	-16
newton	Force	-17

3.8.1 Measuring the biomechanical variables under study:

-**Step distance (step length)**: The step length was measured by knowing the value of the drawing scale in the picture × the value of the drawing scale in reality. Thus we obtain the real value of the step length. Whether it is the first, second or third, the procedure is the same. It is measured in (meters). Figure (4) illustrates this:



-**Impact angle**: It is the stage that starts from the moment the foot touches (the take-off board) until the force reaches its maximum level. It is measured in (degrees).

-Take-off angle – Ascent (the angle of the body's rear support at the moment of leaving the take-off board): It is the angle between the line connecting the center of gravity of the body's mass to the support base on one side and the ground level on the other side. It is measured at the moment before the jumper leaves the ground. (Degrees)

Figure (5) illustrates this:

-**Step time**: It was obtained by knowing the speed of the camera first, then using the law for step time, which is (time of one image x number of images taken for the movement - 1). It is measured in (seconds). - Angular difference of the body: It is between the moment of touching the support foot and the moment of leaving the rise phase: It is measured in (degrees) Figure 6

- Last step length:

It is the horizontal displacement between the front of the foot from the beginning of the step to the front of the other foot at the end of the step. (The displacement between the last touch of the ground before touching the rise board to its first touch on the rise board). It is measured (in meters)

-**Step speed**: It was obtained through the following law: Step length ÷ Step time, and thus we can

obtain the step speed. And measured in (meters/second) (Shalash, 1988, 119).

Angular velocity: It was obtained through the following law Angular velocity: Angular difference ÷ Time and is measured in (degrees/second) (Hall, 1999, 379)

-**Circular velocity:** It was obtained through the law: Angular velocity ÷ Section × Radius. And is measured in (m/sec).

Angular velocity × Radius

-Circular velocity = = □□ m/sec

Body angles and joints: The Kinoeva analytical program was used to extract the angles under study. (degrees)

-**Linear momentum:** After extracting the speed and knowing the mass of the jumper and using the following law: It is extracted by the law .. Horizontal momentum = mass × horizontal velocity. It is measured in kg.m/s. (Joules)

(Bush, Frederick and Gerd, David: 2001, 32)

-**Kinetic energy:** Its law .. Horizontal kinetic energy = 1/2 mass × (velocity)2 (Shalash, 1988, 171) (Al-Arabi, 2001, 287). (Al-Hashemi, 1999, 213-219)

It is measured in (joules) or (joules/second)

-**Power:** It is defined as the rate of work done and is equal to the amount of energy consumed during a unit of time. Power is measured in the international measurement system in the unit (watt) https:llar.wikipedia.org

Force: It is a vector quantity that has a magnitude and direction and is measured in the international system of units in the unit (newton) https:llar.wikipedia.org

8.3 Statistical methods:

The following treatments were used: - Percentage - Arithmetic mean - Standard deviation.

-Coefficient of variation - (R) test to study the correlation relationship with

achievement. The data were processed using the statistical package (SPSS.V.21.5).

The researcher used the following statistical methods (*):

1.Percentage:

2. Arithmetic mean

3.Standard deviation

4.Coefficient of variation

5. Simple correlation coefficient (Pearson)

4. Presentation and discussion of the research results

4.1 Presentation of the results:

Table (3) shows the arithmetic mean, standard deviation, correlation coefficient value, probability of error percentage, and correlation relationship between some bio-kinematic variables and achievement of the jumpers participating in the West Asian Long Jump Championship Table (3)

Significance	Probability	Correlation coefficient	Completion distance		Standard deviation	Arithmetic mean	- Bio kinetics Variables
			Standard deviation	Arithmetic mean			
Moral	0.039	0.869			3.49285	151.8000	Impact Angle
Moral	0.004	0.937			4.12311	50.0000	Elevation Angle
Moral	0.013	0.951			7.52994	101.8000	Angular Difference
Moral	0.028	0.918	0.252	6.844	63.42066	550.27	Angular

						Velocity
Non-moral	0.867	0.104		4.09878	95.4000	Radius
Moral	0.011	0.952		128.67447	920.97	Circumference Velocity
Non-moral	0.563	0.436		0.0602	1.850	Penultimate step length
Non-moral	0.623	0.723		0.051	0.22	Penultimate step time
Non-moral	0.542	0.589		0.601	8.40	Penultimate step speed
Non-moral	0.846	0.416		0.05657	1.65	Last step length
Moral	0.045	0.887		0.01949	0.185	Last step time
Moral	0.042	0.921		0.507	8.91	Last step speed

• Significant at P = 0.05

4.2 Discussion of the research results:

Table (3) shows the correlations between some bio-kinematic variables and the achievement of West Asian jumpers in the broad jump, as follows:

4.2.1 There is a significant correlation at the error probability ratio (0.039) between the impact angle and achievement in the long jump. The researcher attributes to the fact that preparation for the jumping process has a major role in achieving the achievement well. The preparation process requires obtaining an appropriate impact angle which prepares the jumper for a good jump process i.e. the possibility of converting the horizontal speed to a semi-vertical one by controlling the take-off angle

in the subsequent stage after the collision. The researcher indicates that the small impact angle means that the center of the body's gravity is located slightly behind the support point. It leads to preparing the body positively for the take-off process leading to a positive effect on the horizontal distance in a short time and the high horizontal speed. Then, it affects the achievement positively. (Bosco et al.) also indicates that in good performance. It begins M. Th. K. G with the rise immediately after the moment of touching the ground (Bosco et al., 1984, 46). The rise leads to a vertical displacement that negatively affects the vertical speed in the rise. Therefore, the correlation between the angle of impact and achievement appeared.

4.2.2 There is a significant correlation at the probability of error ratio 0.004 between the rise angle and achievement in the long jump. The researcher attributes to the fact that the process of rise in the long jump requires high technical performance and effective preparation. It makes the jumper exert his utmost effort in order to obtain a suitable angle of rise to reach the farthest possible distance because the jump distance depends entirely on strength and a good angle. (Mcginins & Peter: 2-) It indicates that the long jump is one of the activities that are affected by projectile factors. So, the angle was obtained larger than what does not serve the activity. Therefore, the significant relationship between the angle of rise and achievement in the long jump appeared. (McGinins & Peter: 2-1992) Therefore, the correlation between the take-off angle and achievement in the long jump appeared.

4.2.3 There is a significant correlation at a probability of error of 0.013 between the angle of the angular difference and the achievement in the long jump. The researcher attributes the value of the angular difference is the result of the equation of subtracting the value of the angle of impact from the angle of ascent, i.e. the difference between the two angles represents the true value of the true angle. The optimal angle for

ascent is determined between 45 degrees and upwards and depends on the process of converting the horizontal direction to the semi-vertical direction. The angle of ascent exceeds 45 degrees. The direction of the projectile is forward and upwards and vice versa. The researcher attributes the body is supported on one foot and moves horizontally and vertically during the rise in the rise phase. This movement increases the angular difference. Here, time is involved in the two variables, since the angular velocity = angular difference / time (Hossam El-Din, et al., 1998, 177)

4.2.4 There is a significant correlation at a probability of error of 0.028 between the angular velocity and achievement in the long jump. The researcher attributes that the angular difference between the collision angle and the rise angle was clear and that time was also clear. So, the angular velocity appeared in its full form. The main reason is the angular difference between the collision angle and the rise angle. The researcher attributes that the body is in a state of support.The transition from the highest point of M.T.K.G in the collision phase to the lowest point reached by M.T.K.G in the absorption phase in a short time increases the angular velocity of the body. This rapid transition increases the linear momentum of the body and its kinetic energy. So, it is pushed at a speed that helps the body to move horizontally. The vertical of the rise phase section, the greater the vertical displacement, and the greater the vertical velocity of the positive rise phase section. So, the greater is the angular velocity of the rise phase section, the greater the vertical velocity of the rise phase section and vice versa. The researcher attributes that the body is based on one foot and moves horizontally and vertically during the rise in the rise phase. This movement increases the angular difference. Here, time participates in the two variables, since the angular velocity = angular difference / time (Hossam El-Din, et al., 1998, 177).

Accordingly, the correlation between the angular velocity and achievement in the long jump for Arab jumpers in the long jump appeared.

4.2.5 There is a significant correlation at a probability of error of 0.011 between peripheral speed and achievement in the long jump. The researcher attributes that the law of peripheral speed is through the equation (speed × radius). Since the speed in the last step was high and the radius represented by the length of the good lower part. Then the equation of peripheral speed obtained a high value. Therefore, the correlation between peripheral speed and achievement appeared high in the long jump.

4.2.6 There is a significant correlation at a probability of error of 0.045 between the time of the last step and the achievement in the long jump. The researcher attributes that the correct technical performance is complete control over the ascent process. The correct thing is to convert the horizontal speed into a semi-vertical speed. This comes through the optimal use of time especially in the last step (the shortest step in the shortest time) and exerting maximum force in the rapid ascent process. (Al-Rabdi: $192, 2005$). It indicates that time is the denominator of the speed equation, and speed is one of the two sides of the kinetic energy equation. The shorter time, the greater kinetic energy, and the greater speed and the greater achievement. (Al-Takriti and others). It also indicates that the stages of the jump are affected by the stages that precede them. As the best achievement cannot be achieved unless the approach run stage is good, the rise is strong, and the landing is good in the negative flight stage (Al-Takriti and others, $2010, 2$). Therefore, a significant correlation appeared between the time of the last step and the achievement in the long jump.

4-2-7 There is a significant correlation at a probability of error of 0.042 between the speed of the last step and the achievement in the long jump. The researcher attributes

that the law of speed is the result of dividing the horizontal distance of the step / time. Since the time of the step was short, in addition to that, the speed in the last step was high through the shortness of the step and the shortness of its time at the same time. Since the time of the last step was short, and the force with speed is a direct relationship and time with speed is an inverse relationship. The researcher attributes that the speed of the step is the result of dividing the distance of the step by its time. When it's time is short, the result of the speed is high and the relationship between speed and time is an inverse relationship, i.e. the shorter time and the greater speed. Then the relationship between the speed of the last step and the achievement in the long jump appeared. Since the distance of the step was appropriate, the result of the equation appeared in favor of the speed of the last step. Accordingly, the shorter time of the last step, the greater speed of the step and vice versa. Therefore, the significant correlation between the speed of the last step and the achievement in the long jump appeared. To increase the angle of take-off above zero, the jumper must produce a high vertical velocity. It is why a significant correlation has been shown between final stride velocity and long jump performance. (Guthrie, Mark (2003) pp. 149-155).

4.2.8 There is no significant correlation between the variables (radius, penultimate step length, penultimate step time, penultimate step speed, and penultimate step length) (0.867-0.563-0.623-0.542-0.846) at the probability of error in the sequence) with the achievement of the West Asian Championship jumper in the long jump.

4.3 Discussion of the research results Table (4): Table (4) shows the values of the arithmetic mean, standard deviation, correlation coefficient and probability of the biomechanical variables of the research sample in the long jump for the West Asian jumpers.

Significance	Probability	Correlation coefficient	Achievement distance		Standard deviation	Arithmetic mean	Biomechanical variables
Moral	0.016	0.943*	0.252	6.84	39.870	588.00	Linear momentum
Moral	0.041	0.894*			3.226	2469.6	Kinetic energy
Moral	0.008	0.966**			4.092	5768.28	Power
Non- Moral	0.653	0.276			21.259	686.70	Force

*Significant at P < 0.05

Table (4) shows the following: Correlations between some biomechanical variables and the achievement of West Asian jumpers in the broad jump and the following:

• **4.3.1** There is a significant correlation at a probability of error of 0.016 between linear momentum and achievement of Arab jumpers in the long jump. The researcher attributes that linear momentum is greatly affected by the speed factor and speed is considered the basis for increasing and decreasing linear momentum. Since the researcher also attributes this to the fact that mass is one side of the momentum equation = mass × speed) Hill, 1995, 373. The speed of the last step was high, so a high value of linear momentum was obtained, which led to the correlation between linear momentum and achievement for Arab jumpers in the long jump.

• **4.3.2** There is a significant correlation at a probability of error of 0.041 between kinetic energy and achievement for West Asian jumpers in the long jump. The researcher attributes that kinetic energy is determined by the speed factor and half the mass. Since the mass is almost unchanged and the major variable is the speed factor and its square. Then the speed increases through its basic factors. The kinetic energy increases clearly. Both (Hill-385) and (Al-Khafaji: 85).It

indicates that kinetic energy is $1/2$ mass × (speed)2 (Hill, 1995, 385), and momentum = mass × speed (Al-Khafaji, 1984, 85) (Al-Akidi, 2007, 86). Since mass and speed are components of the two equations, the correlation appeared morally between the variable of achievement and kinetic energy.

• The researcher also indicates that speed is one side of the equation of kinetic energy = $1/2$ mass × (speed) ² (Al-Khafaji, 1984, 95), so the higher the speed, the higher kinetic energy and vice versa. Therefore, the correlation between kinetic energy and achievement in the long jump for Arab jumpers appeared in the long jump

4.3.3 There is a significant correlation at a probability of error of 0.008 between the ability and achievement of Arab jumpers in the long jump. The researcher attributes that the ability is the result of the equation of power × speed and that the speed comes through dividing the distance / time and the speed was high. So, in the final result the ability appeared clearly to have a correlation with the achievement of the long jump, so the higher speed, the higher ability, the higher correlation appeared between the ability and achievement of Arab jumpers in the long jump.

4-3-4 There is no significant correlation at a probability of error of 0.653 between the variable of power for jumpers in the long jump.

5. Conclusions and recommendations

5.1 Conclusions:

The researcher concluded the following:

5.1.1 Many significant correlations appeared within the correlation relationship between some biomechanical variables and achievement in the long jump event,

including (impact angle – take-off angle – angular difference – angular velocity – peripheral velocity – last step time – last step speed).

5.1.2 Many correlation relationships appeared between some biomechanical variables and achievement of Arab jumpers in the long jump.

5.1.3 Many correlation relationships appeared between some biomechanical variables and achievement of Arab jumpers in the long jump.

5.1.4 There is no significant correlation between the variables (radius, penultimate step length, penultimate step time, penultimate step speed, and penultimate step length)

(0.846-0.542-0.623-0.563-0.867at the probability of error in the sequence) with the achievement of the West Asian Championship jumper in the long jump.

5.1.5 Many significant correlations appeared within the correlation between some biokinematic variables and achievement in the long jump event, including (linear momentum – kinetic energy – power – force).

5.1.6 Many significant correlations appeared between some biokinematic variables and achievement of Arab jumpers in the long jump, but they did not rise to the level of significance due to the values obtained through the digital achievement of the long jump.

5.1.7 There is no significant correlation at the error probability ratio (0.653) for the power variable for long jumpers

5.1.8 Some of the physical fitness elements that appeared in the research results, such as speed and time for the jump step, had a clear correlation.

5.1.9 The achievement of the Iraqi jumpers appeared clearly better than the rest of the participating West Asian jumpers, and this indicated the development of the achievement of the long jump event in Iraq other than the participating Arab countries.

5.1.10 The role of competition with the West Asian jumpers played a major role in supporting the results of the competition at the level of Iraqis and Arabs.

5.2 Recommendations

Through the conclusions obtained by the researcher, the researcher reached the following recommendations:

5.2.1 Continuous training and focus on developing technical performance due to its great importance on digital achievement.

5.2.2 The possibility of involving the female element at the level of Iraq, the Arabs and West Asia and benefiting as much as possible from the values of this study in the long jump competition in upcoming championships.

5.2.3 Focus on maximum strength due to its importance in developing achievement.

5.2.4 During the training units, make an exceptional effort in using biomechanical variables as a basis for digital achievement in the long jump event.

5.2.5 The possibility of conducting a similar study using the ground reaction force platform to measure some biokinetic variables, especially during the ascent phase in the last step, ascent and landing.

Arabic and foreign References:

-Arabic References:

-Al-Rabdi, Kamel Jamil (2005); New in Athletics, Al-Raji Press, Beirut - Lebanon, p. 192.

-Qais Naji and Shamel Kamel; (1988): Principles of Statistics in Physical Education, Baghdad, Higher Education Press, p. 86

-Hussam Al-Din, Talha and others (1998): "Applied Kinesiology", Book Center for Publishing, Cairo, 1st ed.,

-Wadih Yassin Al-Takriti and Hassan Muhammad Al-Ubaidi, (1999); Statistical Applications Using Computers: Mosul, Dar Al-Kutub for Printing and Publishing, pp. 154 - 160

-Mahmoud Abdul Aal Amin Al-Naimi and Hussein Mardan Omar Al-Bayati (2006); Advanced Statistics in Educational Sciences and Physical Education (SPSS): Jordan, Al-Warraq Publishing and Printing Foundation, p. 133

-Bush, Frederick and Gerd, David, (2001): Fundamentals of Physics, translated by Saeed Al-Jazri and others, International House for Cultural Investments LLC, Cairo.

-Bosco, et al.: "Kinematics and Kinetics of Ascent in Long Jump", translated by (Adel Abdel Basir), Fawzy Printing House, Egypt, 1983-1984.

-Halimi, Essam: Practical Studies in Biomechanics, 1st ed., Dar Al-Maaref (1999).

-Al-Hashemi, Samir Muslat (1981): "The Origins of Jumping and Jumping in Track and Field Games", Al-Hawadeth Press, Baghdad.

-Al-Takriti, Wadih Yassin and others (2010): "The Relationship of Some Biomechanical Variables of the Ascent Phase to Achievement in Long Jump".

-Al-Talib, Diaa Majeed: (1988): Introduction to the decathlon for men and the heptathlon for women, Dar Al-Kutub for Printing and Publishing, Mosul.

-Alawi, Omar Farouk (2007): "A comparative study of some biomechanical variables of serving with the facing and parallel foot positions in tennis", unpublished

master's thesis, Council of the College of Physical Education, University of Mosul.

-Alaa El-Din, Jamal Muhammad (1985): "A laboratory study in the biomechanics of sports movements, Dar Al-Maaref, Cairo, Egypt.

-Shalash, Najah Mahdi (1988): "Principles of Biomechanics in the Analysis of Sports Movements", Dar Al-Kutub, University of Mosul.

-Al-Akeedi, Mohammed Khalil Mohammed (2007): "The Relationship of Momentum, Kinetic Energy and Potential to the Angular and Circumferential Velocity of the Throwing Arm When Shooting from a High Jump with Handball", Al-Rafidain Journal of Sports Sciences, Volume 13, Issue 44, College of Physical Education, University of Mosul.

-Al-Khafaji, Talib Nahi (1984): "Physics of Physical Sports", Dar Al-Hurriyah for Printing, Baghdad.

Forign References

-Hell .J. Susan (1999) ; Basic **Biomechanics** , 3ed :(Boston , Mc Graw – Hill International editions.

-Johnson , Earl (1982): "**Success in Athletic**" , Printed Wing Co.ltd, Hong Kong .

. Myers,Larry(1986): "**Dedicated to the promotion of the worlds oldest sport**", vol, 86. no. 4,Track and Field Quarterly Review,.(19-22).

- Dostal, 40, didaktikasska, , 1980

"**Biomechanics Of sport and exercise**", **Human Kinetics**,. aiatletiky, praha, p40.11

- Guthrie, Mark (2003). **Coach Track & Field Successfully**. **Champaign, Illinois: Human Kinetics**. pp. 149–155. ISBN 0-7360-4274-1