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A COMPARATIVE BIOMECHANICAL ANALYSIS OF THE (TAKE-OFF) PHASE ACCORDING TO THE MOST IMPORTANT DYNAMIC INDICATORS (KINEMATICS) IN COMPLETING THE BROAD JUMP AND ITS RELATIONSHIP TO THE EFFECTIVENESS OF THE TRIPLE JUMP FROM MOVEMENT

[1] Dr. SABAH MAHDI SALIH
[2] Dr. HASANAIN FALAH HASAN
[1,2] Al-Qadisiyah University - College of Physical Education and Sports Sciences
[1,2] Iraq
[1] sabah.salih@qu.edu.iq
[2] sporteacher15@qu.edu.iq

Abstract.
The researcher reviewed previous studies on athletics, particularly the broad and triple jump events, noting that most studies focused on specific aspects, such as the physical characteristics affecting performance. Few studies have considered the shared physical, skill, kinematic, and kinetic variables between these two events. After consulting with experts, the researcher found it feasible to explore the relationship between these variables in the "rise" stage of both events, given their similarities in approach, jump, and performance methods.

This study aims to examine the relationship between the basic kinematic and kinetic variables affecting the performance of the broad and triple jump events. The researcher used a descriptive approach, employing correlation and comparison methods. The sample consisted of six male national team players, three specializing in the broad jump and three in the triple jump, each performing seven attempts, totaling 42 attempts. The main experiment was conducted at Al-Qadisiyah University.

The study concluded significant differences in the left foot's dynamic variables, favoring the triple jump event. The researcher recommends using advanced devices that align with developments in athletics, particularly in jumping events, to enhance training processes and technical stages.

Keywords : (Bio kinetic analysis, take-off phase, dynamic indicators, triple jump effectiveness)

1. Chapter One

1.1. Introduction and the importance of the research:

Biomechanics is considered one of the important sciences in the faculties of physical education, which enables us to analyze the various human movements through many mechanical laws in order to reach the correct technique, and the presence of the devices used such as scientific devices and means and diagnostic means

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has led to the ease of explaining the athlete's movement, and it is known that the naked eye of a person is not sufficient to obtain accurate scientific information and facts for many sports movements, and the judgment is on the correctness of the movement by general evaluation, which is considered an inaccurate case with scientific research to absorb the movement's kinetic details and determine the nature of its errors, and because the effectiveness of the long and triple jump.

Biomechanics (is the science that is concerned with studying movements as a function and the anatomical position as a structure and mechanics of performance, and it can be defined as the science that is concerned with studying movement under the anatomical and mechanical conditions of the musculoskeletal system[1]. A distinction must be made between jumping and vaulting events, as the compound games contain jumping events, which are the long jump and the high jump, and one jumping event, which is the pole vaulting event. If the jumper performs the event without assistance or a tool, it is called the vaulting event. Since the jumper uses the pole in the pole vaulting event, it is an auxiliary tool, so it is called the vaulting event.[2] The broad jump and triple jump events are individual events that have been clearly positively affected by the development of various sciences and the use of training methods and techniques for the number of jumpers, which has contributed to raising their physical and skill level. Their motor requirements from the kinematics point of view are summarized in reaching high rates of speed at the beginning of the step as a result of the speed resulting from the approach, as well as the resulting force resulting from the ascent, the broad jump, also known as the vault The broad jump is one of the basic events in the sport of power sports, as the broad jump requires a combination of strength, speed, and technique to achieve the longest jump possible. The athlete runs a short distance to gain sufficient speed, then jumps from a specific line, trying to land as far as possible on a designated sand. These two events require great strength in the lower body muscles, in addition to good balance and the ability to control air movement. The importance of the research is to study the most important dynamic indicators (kinetics) in the jump phase and their relationship to achievement between the broad jump and triple jump events by performing both events simultaneously using the same dynamic variables or those that are close to them.

1.2. Research problem:

By observing and reviewing the researcher on many previous scientific studies and research that were studied, especially those studies and research that dealt with track and field athletics, which included the jump events (broad - triple), where he found that most of these studies dealt with a specific aspect of the event such as studying the general physical characteristics that affect the performance of the technical stages of the two events that affect their performance and that many of them overlooked that there is more than one event that shares what it requires of physical and skill characteristics as well as kinematic and kinetic variables with another event, and after the researcher asked and surveyed the opinions of some experts and specialists in this field about the extent to which it is possible to benefit from the variables of the broad jump event and include them in the performance of the triple jump event, as they share With it in the physical biokinematic variables, it was found that it is possible to conduct a scientific practical study on the nature of the relationship between these variables between the activities of the broad jump and the triple jump for the (rise) phase of the movement on a sample of jumpers, and the reason for this is the great similarity between the two activities in

[1] Hussein Mardan Omar: Biomechanics and Sports, 1st ed., Deposit No. in the National Library and Archives in Baghdad, 2023 AD, p. 67.
[2] Akram Hussein Al-Janabi: Technical and biomechanical analysis of the decathlon for men and the heptathlon for women and their training methods, second edition, Iraqi Library and Archives, 2019, p. 85

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terms of the approach phase and the jump and the method of performing them skillfully, as well as benefiting from their variables to be entered into the triple jump activity, so the researcher decided to study these two activities to identify the type of relationship between the basic kinematic and kinetic variables that affect the achievement of the broad jump activity and the achievement of the triple jump activity from the movement, as well as identifying the similarities and differences of the variables that will be studied and the possibility of achieving and benefiting from them in both activities by analyzing and extracting the values that were analyzed for the most important dynamic variables affecting the achievement of both activities, and identifying the type of relationship between those variables and the achievement and then finding the differences between them, and thus it is possible to prepare a player who is integrated in terms of the physical and skill aspects so that he can perform both activities at the same time using the same dynamic variables or those that are close From them, and through this we can reach a real process in investing a lot of effort and time during the training process.

1.3. Research objectives:

1- Identify the values of the most important dynamic indicators (kinetics - kinetics) for the (rise) stage in achieving the broad and triple jump activities of the movement.

2- Identify the relationship between the most important dynamic indicators (kinetics - kinetics) for the (rise) stage in achieving the broad and triple jump activities of the movement.

3- Identify the differences between the values of the most important dynamic indicators (kinetics - kinetics) for the (rise) stage between the broad and triple jump activities of the movement.

1.4. Research hypotheses:

1- There is a significant relationship between the values of the most important dynamic indicators (kinetics - kinetics) for the (rise) stage and achieving the broad and triple jump activities of the movement.

2- There are significant differences between the values of the most important dynamic indicators (kinematics - kinetics) for the (rise) stage between the long and triple jump activities of the movement.

1.5. Research areas:

1.5.1. Human field: Advanced long and triple jump players.

1.5.2. Spatial field: College of Physical Education and Sports Sciences Stadium - Al-Qadisiyah University.

1.5.3. Time field: (12/28/2023) to (4/22/2024)

2. Chapter Two

2.1. Research Methodology and Procedures:

2.2. Research Methodology:

The researcher used the descriptive method using the correlation and comparative method to suit the nature of the study problem.

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2.3. Research community and sample:

(The objectives that the researcher sets for his research and the procedures he uses are what determine the nature of the community or sample that he chooses)[3], the researcher determined his research sample in the intentional way, which is a sample of the national team players who advanced in the (broad jump - triple jump) men's event, and their number is (6) players representing the elite in these events, where the sample was divided into two groups so that there are (3) players in the broad jump event and (3) players in the triple jump event, so that each player will perform (7) attempts. The total becomes (42) attempts in both events. The body measurements of the players that represent the specifications of the sample were determined in order to ensure their homogeneity. Table No. (1) shows this:

Table (1) shows the body measurements of the players

Training age	**weight**	**age**	**trunk length**	**man height**	**Total length**	Anthropometric Measurements
5.625	71.5	23.75	61.75	87.75	183.75	Mean
0.96	2.96	1.48	2.38	5.72	3.96	Standard Deviation
7	75	26	65	95	189	Highest Value
4.5	67	22	59	80	178	Lowest Value
17.07	4.14	6.23	3.86	6.52	2.16	Coefficient of Variation
0.28	-0.43	0.43	0.19	-0.09	-0.18	Skew

2.4. Methods, tools and devices used in the research:

- Arab and foreign sources.
- Observation and analysis.
- Observation and analysis.
- Personal interviews and expert opinions.
- Motion analysis programs.
- Internet.
- Long jump and triple jump field.
- Registration form.
- Adhesive tapes.
- Office supplies.
- Video cameras (1) type (iPhone 14 pro Max) 240/minute image.
- Modern (hp) computer.
- Drawing scale and metric tape measure.
- Tripod for camera (1).
- Adhesive tapes to determine the places for measurements.
- Kenova program for motion analysis (2023 edition).
- Data entry form.
- French-made (Dynafoot 3) system.

[3] Risan Majeed Khuraibet: Research Methods in Physical Education, Mosul University Press, 1988, p. 41.

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• Drawing scale.

2.5. Research procedures:

2.5.1. Exploratory experiment:

The researcher conducted an experiment on Tuesday 1/16/2024 at eleven o'clock in the morning on the broad and triple jump field in the stadium of the College of Physical Education - Al-Qadisiyah University in order to identify the negatives that the sample may encounter during the main experiment in order to avoid them. (Wagih Mahjoub) stressed that "conducting the exploratory experiment leads to avoiding shortcomings with determining the location, time and duration of the experiment [4] where the researcher conducted the experiment on players in each of the (broad jump, triple jump) events in athletics and its purpose was:

1- In order to identify all the obstacles that the researcher and the sample may face during the main experiment.

2- Identify the sufficient time to conduct the test.

3- In order to train the auxiliary work team on how to use tools and devices.

4- Identify the operation of the camera's validity and the distances for placing it next to the throwing field.

5- Identify the jump field.

6- Identify the appropriate number of auxiliary work staff.

3-4-2- Biomechanical variables under study and the method of extracting them:

The kinematic variables for the (broad jump - triple jump) events were measured using the Kinova 2023 kinetic analysis program by installing it on the laptop. After that, the video is extracted By the two activities and conducting analytical operations on them and extracting data for each of the following variables: 1- The angle of approach at the moment of jump: It is the angle between the line connecting the center of gravity of the body and the foot at the moment of touching the ground with the horizontal line passing from the foot parallel to the surface of the ground [5], as shown in Figure (1).

Figure (1) Approach angle

2- The push angle at the moment of jumping: It is the angle between the line connecting the center of gravity of the body and the foot at the moment of leaving the ground with the horizontal line of the ground passing through the foot leaving the ground, as shown in Figure (2).

[4] Wajih Mahjoub: Physical and Cardiac Kinematic Analysis of Sports Movements, Baghdad, Higher Education, 1991, p. 239.
[5] Sareeh Abdul Karim, Talib Faisal: Track and Field Games, Baghdad, University House for Printing, 2010, p. 164.

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Figure (2) Push-off angle

3- The push-off knee angle at the moment of support at the moment of jump: It is the angle between the line connecting the hip joint and the knee with the line connecting the knee to the foot touching the ground, as shown in Figure (3):

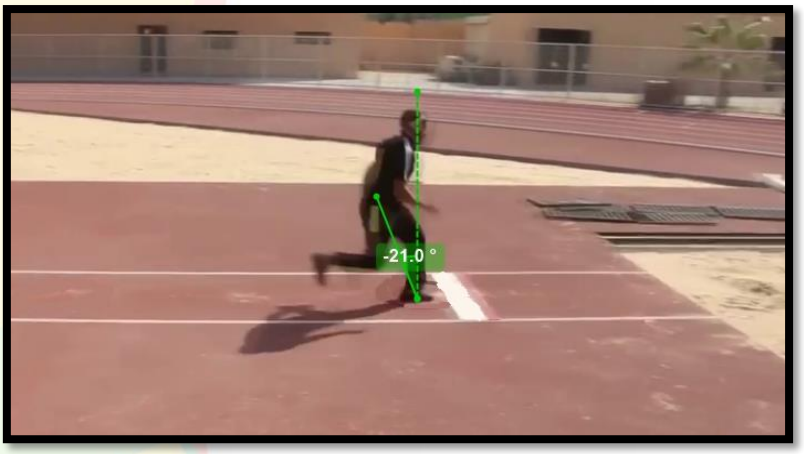

Figure (3) The angle of the knee of the pushing leg at the moment of support

4- The angle of the knee of the pushing leg at the moment of jumping: It is the angle between the line connecting the hip joint and the knee with the line connecting the knee to the foot at the moment of the end of the push and the pushing leg leaving the ground, as shown in Figure (4).

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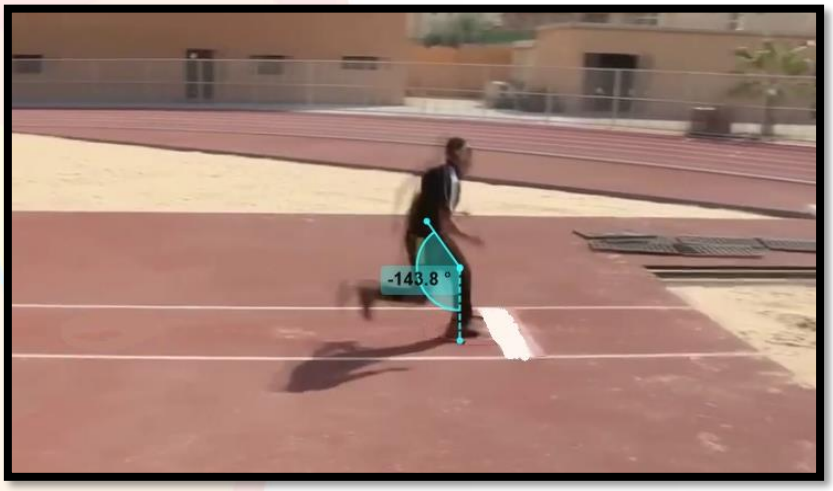

Figure (4) The angle of the knee of the pushing leg at the moment of push

5- The body's inclination at the moment of leaning on the pushing leg at the moment of jumping: It is the angle between the vertical line descending to the ground and passing through the fulcrum and the pushing foot and the line passing through the center of gravity of the body (hip joint) and the fulcrum foot at the moment the foot touches the ground. As shown in the figure

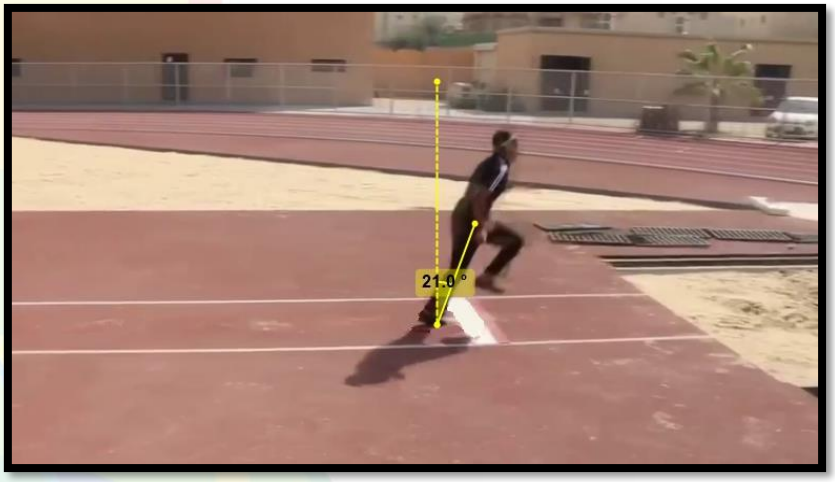

Figure (5) The angle of the body's inclination at the moment of support with the pushing leg

6- The body's inclination at the moment of support with the pushing leg The moment of jumping: It is the angle between the vertical line descending to the ground and passing through the fulcrum (the pushing leg) and the line passing through the hip joint and the fulcrum foot before the moment the foot leaves the ground, as shown in the figure:

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Figure (6) The angle of the body's inclination at the moment of pushing with the pushing leg

7- Achievement: The distance between the front of the jumper's leg and the closest point to the jumper's body after the end of the attempt in both activities.

3-4-3- Extracting the kinematic determinants using the Dynafoot3 system: [6]This system is one of the modern and advanced devices, as it gives us the amount of balance for the feet and the difference between them, as well as the footprint of the feet and the pressures exerted by the parts of the feet, whether the heel or the metatarsals or the right or left side. This system is one of the modern and advanced devices that are placed under the foot, as it gives us the amount of mechanical distribution of pressure and force, in addition to other kinematic and kinetic information related to the balance of the feet and the difference between them, as well as the footprint of the feet and the pressures exerted by the parts of the feet, whether the heel or the metatarsals or the right or left side. According to the study needs and the sports movement analysis system (Dynafoot3) relies on Bluetooth wireless frequency to exchange information between a program on the computer and the sensors placed under the foot. The system covers an area estimated at (20 meters) outdoors and doubles in indoor sports halls, meaning it can cover a basketball, handball, volleyball, tennis, badminton, table tennis court, and most indoor events, weightlifting, boxing, wrestling, gymnastics, etc. This device is the first in scientific progress technology to evaluate biomechanics. It contains a speed integration system and allows for the detection of biomechanical variables of body parts. It displays and calculates kinetic and dynamic data in real time with body movement and provides selected planning models. In addition, the (Dynafoot3) system is done through a pump placed inside the shoe and can be connected directly to Bluetooth or by storing data in the electronic piece connected to it. It is specialized in knowing the foot balance of athletes or ordinary people. This system includes Figure (1) as follows:

1- Four pairs of tanks with sizes (36-37), (38-39), (40-41), (42-43).

2- And with sizes starting from (28, 29), (30-31), (32-33), (34-35), (44-45), to (46-47).

3- Acquisition and transmission modules

[6] TECHNO CONCEPT, a French company, is a global manufacturer of mechanical devices that simulate athletic performance, 2017 edition.

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4- Connection wires extensions

Acquisition and analysis 5- DYNAFOOT© software CD

Charger6- Charger

7- Bluetooth Dongle 2.4GHz

8- Carrying case

9- User guide

System specifications:

Sensor technology:

Its sensors are pressure resistant, with high resolution. The number of sensors is 58 sensors for each sole from sizes (36 to 47), 28 sensors (28 to 35).

- Sensor size 9 mm

- Appears on the surface 0.81 cm^2

- Measurement range 2000 g for each sensor

- Allowable temperature (0°C to +60°C)

- Measurement range +/- 6 g

Data transfer: There are two modes or methods for data transfer:

1. Instant mode: via Bluetooth for a distance of (20) m.

2. Recording mode The distance is unlimited, via a recording memory (RAM) with a capacity of 240 seconds of recording.

Battery life / 3.5 hours of continuous operation.

Charging time / 2 hours on electricity (220 volts).

This system can also be used to know:

- Step time and foot support time on the ground for the right or left side.

- Analysis of the gait of the feet and the difference between them.

It can be used in sports injuries and to know the injured runner and the extent of recovery of the injured foot compared to the healthy foot.

It is used in tests to measure flat feet and determine the level of pressure on the feet. The Dynafoot is a pump placed inside the shoe and can be connected directly to Bluetooth or by storing data in the electronic piece attached to it. It is specialized for the case after injury or after surgical intervention to determine the balance of the foot in athletes or ordinary people.

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This system is important in measuring blood pressure, determining the load points and weight of each phase during walking, in addition to measuring the step length. It is used in physical therapy units and operates with a Bluetooth signal for a distance of (20) meters.

To extract the mechanical determinants of the research, the ground force measurement system (Dynafoot3) was used. This system consists of four parts:

1. The foot pedal, which is placed inside the shoe in the form of a pin containing electronic sensors with high-precision specifications distributed over its area.

2- The force calculator, which calculates the amount of force applied to the ground.

3. A wire connected to the tester's leg, which connects the pin to the force calculator.

4- A signal receiver device connected to the laptop, receives the signal from a distance of (20) meters.

To ensure the broadcast distance, the system was placed in the middle of the approach phase during the application of the test so that the system signal covers it.

In addition, the data of each player must be entered into the system before working with it. This data includes the player's age, weight, height, and gender.

This system gives the results in the form of a report consisting of images for each runner:

Forces distribution shows the distribution of force on each toe (right, left) as well as the distribution of force on the heel from the medial and lateral sides and the distribution of forces on the midfoot from the medial and lateral sides, as shown in the following figures ( ) below:

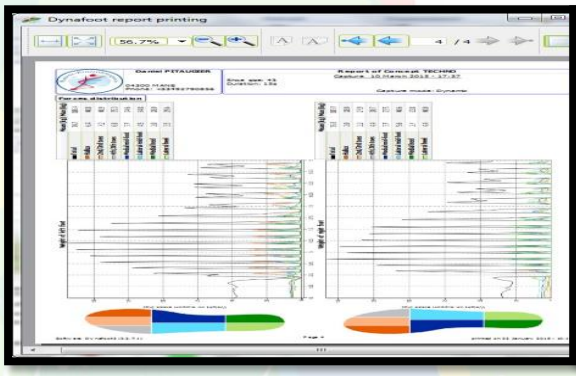

Figure (6) shows the distribution of forces.

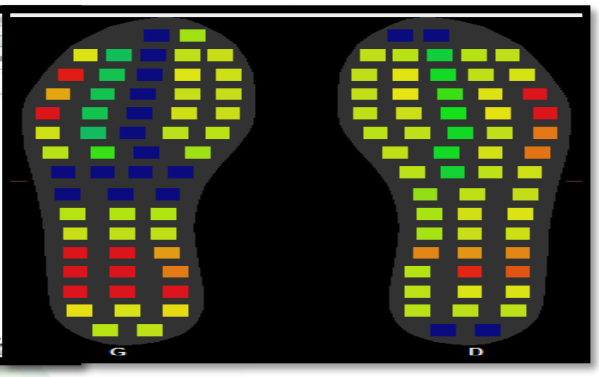

Figure (5) shows the two feet and the distribution of sensors on them

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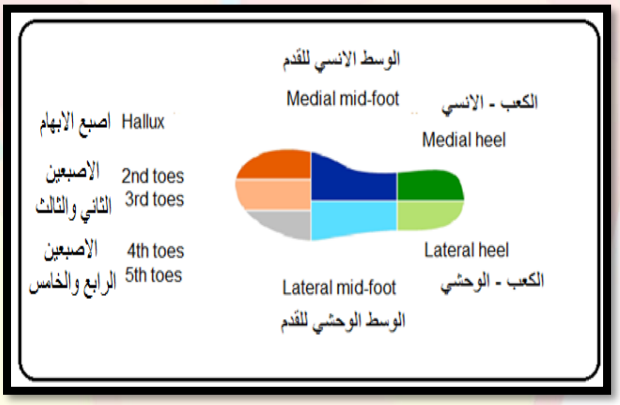

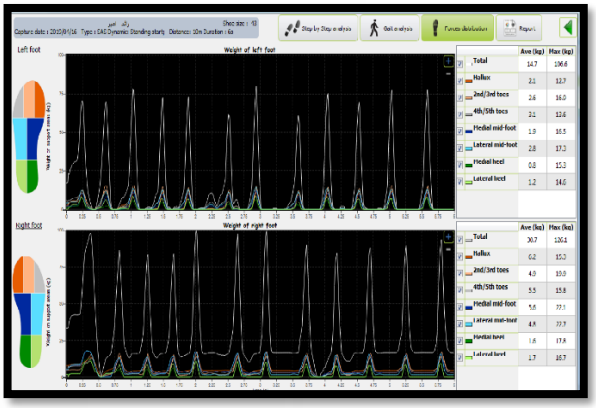

Figure (8) shows the seven areas of the foot. Figure (7) shows the kinematic variables extracted from the system for the right and left feet.

Figure (9)

Exhibits the parts of the Dynafoot3 system

3-5- The main experiment:

The researcher conducted the main experiment on Tuesday (23/1/(224) at the College of Physical Education stadium - Al-Qadisiyah University at nine o'clock in the morning on a sample of advanced national team players, where the players performed a general and special warm-up and prepared to conduct the test for the two activities (broad jump, triple jump) in order to identify the kinematic variables affecting the achievement. The jumpers were photographed with a (1) iPhone 14 pro Max 240/accurate image camera. The camera was

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placed on the left side next to the field at a distance of (10.40 meters) and a height of (120 cm) to cover the (rise) stage for both activities, i.e. the photography is done from the stage of the players rising from the board to the end of the landing area. Before the players performed the test, the (Dynafoot 3) system was prepared, connected, and placed under the player's foot and connected via Bluetooth to the laptop Wirelessly covering a distance of (20 meters) and during the performance of the test, the camera and the (Dynafoot 3) system were turned on together and the start signal was given to the assistant staff to start the test. Each player was given (7) attempts, out of a total of (6) players, so that the total number of attempts became (42) correct attempts, i.e. (3) players for the broad jump event and (3) players for the triple jump event. The achievement distance was measured in the successful attempts from the front of the foot to the last trace left by the jumper after the attempt. After that, the researcher will transfer the imaging to the computer and the films will be processed and cut and analyzed using the kinetic analysis program (kinova). After that, the information was collected and stored in the (Excel) program and then processed statistically using the statistical package (SPSS). 3-6- Statistical methods:

The researcher used the statistical package (SPSS):

3. Chapter Four

4-1- Presenting the results of the differences for the comparative biomechanical analysis of the (rise) stage according to the most important dynamic indicators (kinetics - kinetics) in completing the broad jump and its relationship to the effectiveness of the triple jump from the movement and analyzing and discussing it:

Table (2)

shows the arithmetic means and standard deviations and the calculated (t) value and the level of significance for the most important kinematic variables in the (rise) stage between the effectiveness of the broad jump and the triple jump from the movement

Significance	**Significance level**	**(t)**	**(F)**	**Triple jump**		**Broad jump Triple jump**		Kinematic indicators
				الانحراف المعياري	الوسط الحسابي	الانحراف المعياري	الوسط الحسابي	
Moral	0.000	3.813	0.299	3.434	79.71	3.885	83.44	Approach angle
Random	0.113	1.612	0.008	3.851	90.95	4.011	92.65	Push angle at the moment of jump
Moral	0.003	3.148	0.424	7.590	163.23	6.628	169.22	Pushing leg knee angle at the moment of support
Moral	0.001	3.499	0.226	4.165	173.24	4.781	177.44	Pushing leg knee angle at the moment of jump

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Moral	0.000	5.031	1.391	1.199	16.92	1.111	18.47	Body tilt at the moment of support with the pushing leg
Random	0.126	1.553	0.417	0.768	16.72	0.655	17.02	Body tilt at the moment of push with the pushing leg
Moral	0.000	110.55	33.31	0.376	16.07	0.084	8.001	Achievement
(0.05) is (2.02)>table value at (40) degree of freedom and significance level								

The table above shows for the purpose of identifying the significance of the differences, where the value (t) was used for independent samples and the value (F) and the significance level between the effectiveness of (broad jump - triple jump) in terms of the kinematic variables respectively, the tabular value was (2.02) at a significance level of (0.05) in front of a degree of freedom (40) and since the calculated values were greater than the tabular, which indicates the presence of significant statistical differences, as for the variable, the angle of approach, its value appeared significant and in favor of the largest arithmetic mean (83.44), the variable, the angle of the knee of the pushing leg at the moment of leaning, was also significant for the largest arithmetic mean (169.22), the angle of the knee of the pushing leg at the moment of jump, the value of the largest arithmetic mean (177.44), the body tilt at the moment of leaning on the pushing leg, the arithmetic mean was (18.47), all of these variables appeared significant in favor of the effectiveness of the broad jump, for the last variable, the achievement, the largest arithmetic mean value was (16.07) and in favor of the effectiveness of the jump The triple. As for the rest of the variables, they appeared with a random value that the researcher did not mention. Interpretation of the variables that appeared with a significant value, the first variable is the approach angle, which is the reason for the appearance of the significant significance, as there is a relationship between the produced force and the time of the push. The shorter the push time (time of foot contact), as well as extending the angle behind the knee, the greater the force produced for the take-off. Therefore, the jumpers must push the ground with high force and speed to increase the force of the take-off. This is what the push-off law confirmed.[7] Also, the jumper must reach his high speed in the last steps before the take-off board, with the steps adjusted to suit the conversion of the running speed to the length of the jump in the best possible way. The last step before the last must also be longer than the previous step (i.e. the second step before the last).[8], the second variable, the angle of the knee of the pushing leg at the moment of support, is also significant, because the goal of performing the hop is to achieve the best horizontal distance, which must be proportional to the angle of the push. As for the angle of the knee of the pushing leg at the moment of the jump, this increase in the angular velocity affected the increase in the linear velocity of the center of gravity of the body, considering that the angular velocity is related to the linear (circumferential) velocity if this velocity is associated with a circular body [9], with regard to the variable of the body's inclination at the moment of support with the pushing leg, since a decrease in this angle at the moment of support will inevitably lead to a decrease

[7] Akram Hussein Al-Janabi: The previously mentioned source, 2019, p. 92.
[8] Sareeh Abdul Karim Al-Fadhli, Khawla Ibrahim: Theoretical and practical foundations of athletics for colleges of physical education, 1st ed., Al-Ghadeer for Modern Technical Printing, 2012, p. 157.
[9] Talha Hussein Hussam Al-Din (and others): The previously mentioned source, 1998, p. 181.

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in the velocity at the moment of support, which must be at its highest value. [10], and the muscle gives high energy by increasing the distance that the muscle works on and its strength, which results in great muscle work and an increase in the muscle's energy reserve (considering that muscle work = kinetic energy) [11], as for the last variable, the achievement, the researcher attributes this to the fact that the jumpers reached greater horizontal distances during the jump, which led to the appearance of high and significant values in favor of the effectiveness of the triple jump, as well as the lack of significance in favor of the effectiveness of the broad jump due to the hip landing near the point of landing of the feet and not behind the area of the feet, which causes a reduction in the achievement distance ( ). The researcher believes that the goal of both activities that they share is to reach the farthest possible distance to achieve the achievement.

Table (3)

shows the arithmetic means, standard deviations, calculated (t) value, and significance level for the areas of maximum pressure of the foot (left) in the (rise) stage between the activities of the broad jump and the triple jump of the movement

Significance level	**t**	**f**	**Triple jump (left foot)**		**Broad jump (left foot)**		**Maximum pressure variables for foot areas (left)**	
			Standard deviation	**Arithmetic mean**	**Standard deviation**	**Arithmetic mean**	**Parts of the foot**	**Foreign name**
0.001	-3.372	3.318	2.217	12.98	1.257	11.36	Thumb	Hallux
0.003	-3.149	0.098	2.856	15.91	2.658	13.59	Second and third toes	2nd/ 3rd toes
0.001	-3.432	0.105	2.304	13.38	2.170	11.33	Fourth and fifth toes	4th/ 5th toes
0.000	-4.624	0.127	4.560	16.07	4.230	10.64	Mediated midfoot	Medial mid-foot
0.001	-3.502	0.075	4.635	15.86	4.058	11.78	Lateral midfoot	Lateral mid-foot
0.000	-4.123	1.868	3.107	12.33	3.798	8.51	Mediated malleolus	Medial heel
0.008	-2.753	9.524	1.819	10.61	3.157	8.71	Lateral malleolus	Lateral heel
0.000	-5.125	1.866	17.556	97.18	13.128	75.95	Total	Total
(0.05) is (2.02)>table value at (40) degree of freedom and significance level								

In light of the extracted data for the variables of the left foot print areas for the above jump stage for both activities (broad jump - triple jump), where the table shows that the level of significance was significant for

[10] Alaa Fouad Saleh: The effect of a curriculum with different resistances on some physical abilities and motor manifestations according to kinematic indicators and the level of triple jump performance, unpublished doctoral dissertation, 2012, p. 45
[11] Sareeh Abdul Karim Al-Fadhli: Applications of biomechanics in sports training and motor performance, 1st ed., Amman, Jordan, Dar Dijlah, 2010, p. 79.

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all variables of the left foot areas, it is noted that the significance was in the area (thumb toe, second and third toes, fourth and fifth toes, medial midfoot, lateral midfoot, medial heel, lateral heel, total) and in favor of the total arithmetic mean of the strength areas for the triple jump activity, and through the total for the foot areas above, it is clear that the value of the arithmetic mean for the triple jump activity is greater than the value of the arithmetic mean of the strength total for the broad jump activity, and the researcher believes that these significant differences are a result of the difference in the technique of the two activities as well as their specificity and other reasons. While the jumper stands on the starting line, he is based on most areas of the foot so that the foot is fully supported on the starting line while standing, and this indicates the difference in the position of the pivot foot and the method of support that the jumper controls in the stage The jump for this activity.

Table (4)

shows the arithmetic means, standard deviations, calculated (t) value and significance level for the areas of maximum foot pressure (right) in the (take-off) phase between the broad jump and triple jump activities of the movement

Significance level	t	f	Triple jump (left foot)		Broad jump (left foot)		Maximum pressure variables for foot areas (left)	
			Standard deviation	Arithmetic mean	Standard deviation	Arithmetic mean	Parts of the foot	Foreign name
0.001	3.486	0.012	1.70	11.50	1.35	12.93	Thumb	Hallux
0.042	-2.084	4.000	2.73	14.50	3.63	12.71	Second and third toes	2nd/ 3rd toes
0.023	2.345	15.477	1.47	12.34	3.78	14.14	Fourth and fifth toes	4th/ 5th toes
0.007	-2.817	0.625	4.42	14.99	4.19	11.75	Mediated midfoot	Medial mid-foot
0.006	-2.862	1.717	3.72	15.75	4.48	12.60	Lateral midfoot	Lateral mid-foot
0.020	-2.402	0.644	3.07	11.92	3.46	9.82	Mediated malleolus	Medial heel
0.007	-2.787	1.668	2.49	11.48	1.88	9.84	Lateral malleolus	Lateral heel
0.048	-2.020	0.870	14.49	92.47	17.57	83.78	Total	Total
(0.05) is (2.02)>table value at (40) degree of freedom and significance level								

From the table above, which shows the variables of maximum pressure for the right foot areas for both activities (broad jump - triple jump), it is clear that the significance was for all areas of the foot and for both activities, and as shown above, for the broad jump activity, the significance value was in two areas of the foot (the big toe, the fourth and fifth toes) and the reason for that is that the player in these steps is at the beginning

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of acceleration so that the body is leaning forward to obtain a push (acceleration), so the pressure is great on this area to give the body the power to meet forward, and also that the player in this step is in a state of launch from the beginning of the jump step and in a state of pushing with the entire leg and the foot is placed on the take-off board completely to obtain the highest flight and thus obtain the farthest possible distance, for the areas of the foot in the triple jump activity, the significance was in the areas (the second and third toes, the medial middle of the foot, the lateral middle of the foot, the medial heel, the lateral heel) and what supports that is the total sum of the areas, which was in favor of the triple jump activity, the reason for that is because The jumper at this stage has left the take-off board and is trying to push with the greatest possible force and speed and in the shortest possible time, so the focus is on these areas more than the rest, as for the area of the second and third toes, the reason is that the player at this stage is in a state of acceleration of the body and is trying to increase the force of pushing the body forward and upward and increase the speed and reduce the time, so the focus is on the two areas, as for the area of the lateral midfoot, the reason for the large value of the arithmetic mean is that the player's steps were ideally taken to approach the beginning of the event, and when he reached the take-off board, he bent the knee joint slightly because extending the leg completely leads to straightening the trunk and thus increasing the time that leads to the consequences of reducing the speed and force of the flight time and thus the distance. The area of the medial midfoot is that the jumper bends the knee joint because extending the leg completely leads to straightening the trunk and thus causes slowing down the speed and delaying the landing on the ground. 4-2- Presenting the results of the correlations of the matrix (calculated values) for the comparative biomechanical analysis of the (rise) stage according to the most important dynamic indicators (kinetics - kinetics) in achieving the broad jump and their relationship to the effectiveness of the triple jump from the movement and analyzing and discussing them:

Table (5)

shows the correlation matrix for the values of the most important kinematic indicators of the (rise) stage in achieving the broad jump between them and the achievement

Achievement	**Maximum right foot pressure**	**Maximum left foot pressure**	**Body tilt (push-off)**	**Body tilt (support)**	**Knee angle (push-off)**	**Knee angle (support)**	**Push-off angle**	**Approach angle**	**Kinematic variables**
								1	Approach Angle
							1	-0.149	Push Angle
						1	-0.054	.793**	Knee Angle (Back)

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					1	0.098	-0.041	0.031	Knee Angle (Push)
				1	0.156	-.447-*	-0.012	-0.300	Body Tilt (Back)
			1	-0.178	0.355	.542**	-0.120	0.265	Body Tilt (Push)
		1	-0.035	-0.053	-0.149	0.079	0.183	0.343	Maximum Left Foot Pressure
	1	-0.080	0.193	0.190	0.215	0.103	0.030	0.234	Maximum Right Foot Pressure
1	-.378-*	-0.101	0.018	-.439-*	-.409-*	.424*	-.414-*	.377*	Achievement
The tabular value at a significance level of 20 and a significance level of 0.05 is 0.42.									

The table above shows the correlation matrix of the most important dynamic indicators (kinetics) for the (rise) phase of the broad jump effectiveness at a significance level of (0.01), a significance level of (0.05), a degree of freedom of (20), and a tabular value of (0.42) between them and the dependent variable.

As for the variables that have a significant correlation between them and the dependent variable, they are (the angle of approach, the angle of push, the angle of the knee (support), the angle of the knee during (pushing with the leg), the tilt of the body (supporting with the leg), the maximum pressure of the right foot) at the moment of the jump, where it was significant at a significance level of (0.05).

The emergence of a significant correlation between the variables, which are (the angle of approach with the angle of push, the angle of knee (support) with the angle of approach, the angle of knee (support) with the tilt of the body (support) and the tilt of the body (push) at the moment of jump. Interpretation of the variables that appeared to be significantly correlated with the achievement, the reason for the variable of the angle of approach appearing significantly is that the kinetic path of the player's body when jumping with the pushing

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leg is a large angle, which reduces the momentum of the body and thus obtains the highest horizontal jump, the variable of the push angle appeared to be significantly correlated, which is a decrease in the value of the angle when performing this stage, which in turn leads to an increase in the push of the leg upward and forward when performing the movement with the push, and this is what is required, i.e. the goal of the angle was achieved when performing it at this stage, i.e. achieving the push when performing fast movements, whether jumping, running or jumping, the emergence of the variables of the angle of knee (support) and the variable of the angle of knee (push) at the moment of jump significantly, it was found that the level of the foot of the jumper when pushing is faster at this stage, which is represented by an increase in the angular range of the knee at the moment of pushing at this stage, which has a direct relationship with this The effectiveness, as the rotational movements that arise from the movements of the legs and the movements of the arms in the jump had a positive effect on the development of this angle, which has a positive effect on taking the correct position and angle at this stage. As for the variables of the body's inclination angle when leaning and the body's inclination angle when pushing at the moment of jumping, a significant correlation appeared between them and the achievement. The reason is that the decrease in the value of the angle at the moment of leaning for the (jump) stage, which indicates that the kinetic path of the player's body's center of gravity was at a good level and consistent with the goal of achieving the horizontal speed required for the kinetic performance, i.e. an appropriate inclination angle at the moment of pushing with the jumping foot and is consistent with the angle of leaning and pushing at this stage. As for the last variable, the maximum pressure of the right foot, a significant correlation appeared with the dependent variable. The reason is that the jumper, when performing the approach run and reaching the board, presses the entire foot by the body, which in turn leads to the production of large pressures distributed on the sole of the right foot, and thus these pressures move to an opposite reaction from the ground in the upward direction, which turns into a positive horizontal speed, which is the desired goal. The variables that showed a significant correlation between them are the approach angle with the variable of the knee angle (support) at the moment of pushing with the jumping leg, while the variable of the knee angle (support) showed a significant correlation with each of the variables (body tilt (support), body tilt (push) at the moment of pushing with the jumping leg. At a degree of freedom (20) and a significance level of (0.01) and a level of (0.05). It is that these variables are related to each other when performing the movement sequence of the activity, meaning that there is a possibility of an increase in a certain variable leading to a decrease in another variable, either positively or negatively, and they are harmonious. Among them and perform the work required of them and it is considered one of the important variables in this activity in particular and jumping and running activities in general, and this is what Bastawisi Ahmed confirmed (and he also adds that it is not possible to reach a good ascent unless it is linked to a harmonious rhythm in the approach phase.[12]

Table (6)

shows the correlation matrix for the values of the most important kinematic indicators for the (ascent) phase in completing the triple jump between it and the achievement

[12] Bastawisi Ahmed: Track and Field Competitions, Education, Technique, Training, 1st ed., Cairo, Dar Al Fikr Al Arabi, 1997, pp. 238-242. 1- Talha Hussam Al Din: Source previously mentioned, p. 64.

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Achievement	Maximum left foot pressure	Body tilt (push-off)	Body tilt (support)	Knee angle (push-off)	Knee angle (support)	Push-off angle	Approach angle	Kinematic variables
							1	Approach Angle
						1	.491**	Push Angle
					1	0.112	-.453-*	Knee Angle (Back)
				1	.474*	.528**	0.072	Knee Angle (Push)
			1	.718**	.683**	0.133	-.609-**	Body Tilt (Back)
		1	.493**	.503**	.572**	-0.003	-0.143	Body Tilt (Push)
	1	0.045	.508**	0.182	.461*	-0.104	-.572-**	Maximum Left Foot Pressure
1	.460*	.386*	.816**	.758**	.714**	.468*	-0.328	Achievement

It is noted from the table that there is a significant correlation between the most important dynamic variables (kinematics) and the dependent variable in the (jump) phase of the triple jump effectiveness at a degree of freedom (20) and a significance level of (0.01) and (0.05) and a tabular value of (0.42).

The variables that showed a significant correlation between them and the dependent variable are (push angle, knee angle (support), knee angle (push), body tilt (support), body tilt (push), maximum pressure of the left foot, maximum pressure of the right foot) at the moment of the jump phase.

Interpretation of the correlations that appeared between the variables and the dependent variable, for the push angle at the moment of jump, the research attributes this to the fact that the rise in this stage is linked to the approach angle and the push angle, the performance of which is linked to the player's speed during the approach phase, which is reflected in the improvement of the subsequent stages, and thus these angles are in accordance with the motor and skill performance without affecting the player's rise, the knee angle (support) at the moment of jump also has a significant correlation with the achievement that increasing the push with the foot leads to the angular range of the leg (Atho) indicated that training by moving a certain weight at high speeds may help in increasing the motor speed of the working joints by improving their ranges and the time

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of this range as a result of the high load on the muscles ( ), as for the variable of the knee angle (push), there is a significant correlation with the achievement, as this angle, the smaller it is, leads to the jumper getting a proper fall in the triple jump pit, thus achieving the entire body's forward thrust and avoiding the body falling and touching any part of it, thus getting rid of the problem of losing part of the jump distance, which can make him lose advanced positions during The championship, for the variables of body inclination (support) and body inclination (push) at the moment of jump, the angles of body inclination at the moment of support and push are considered at this stage, which constitute an important and fundamental factor in the fluidity and correct organization of the body, as well as maintaining speed through its movement, as reducing the angle of body inclination at the moment of support and increasing it at the moment of push helps reduce the gravitational torque that resists movement during support and vice versa when increasing it at the moment of push, leads to an increase in the angular velocity of the leg in order to gain the required kinetic balance. As for the variable of maximum pressure of the left foot at the moment of the jump stage, the reason for the emergence of a moral link with the achievement is that the jumper during the performance of the activity and the difference in the contact of the feet with the ground when running quickly leads to the distribution of pressures on parts of the areas of the left foot in different proportions according to the player's technique, and these differences are the result of the player's movement and the extent of the stages he has reached. It is known that this activity consists of several stages that differ slightly from the stages of the wide jump activity, which requires the player to change his steps continuously until he reaches the jump stage, which is the real location of the player and through which these forces can be converted The pressures resulting from its collision with the ground, which results in an opposing force that leads to obtaining a horizontal speed useful for the player and reaching the farthest possible distance by taking advantage of the effectiveness of the broad jump and using it in performing the effectiveness of the triple jump. As for the variables that showed a significant correlation between them, they are the angle of approach with each of (the knee angle (support) at the moment of push, the body tilt (support), the maximum pressure of the left foot). As well as the variable of the push angle with the knee angle (push). The knee angle (support) with each of (knee angle (push), body tilt (support), body tilt (push). There is a significant correlation between the variable knee angle (push) with each of (body tilt (support), body tilt (push). Also the variable body tilt (support) with each of (body tilt (push), maximum pressure of the left foot) at the moment of jump. The interpretation of the relationships that appeared as correlations between them is that these variables are interconnected in terms of motor performance, and this correlation leads to one affecting the other, in other words, whenever there is a variable with a large value, it may be met by a variable with a small value. This is not a condition, but rather according to the motor positions of the jumper and the stage in which he is, according to the mechanical foundations, it is possible to determine the horizontal or vertical speed, and they are important in the (jump) stage. This is what (Raisan Khreibet Majeed and Najah Mahdi Shalash, 1992) confirmed after the jumper reaches the take-off board, his speed is high and the period of contact of the foot with this The board helps to achieve a suitable vertical acceleration that serves the goal of launching the center of gravity of the athlete’s body to the furthest horizontal distance, as the horizontal and vertical components of the movement of the emerging body are determined by the approach and force of contact (hitting) the take-off board, forming the resultant flight of the athlete’s body [13].

Chapter Five

4. 5- Conclusions and Recommendations:

[13] Risan Khuraibet Majeed and Najah Mahdi Shalash: Kinetic Analysis, Dar Al-Hikma Press, Basra, 1992, p. 277.

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4.1. Conclusions:

1- Each of (the angle of approach, the angle of the knee of the pushing leg at the moment of support, the angle of the knee of the pushing leg at the moment of jump) affects the achievement and in favor of the effectiveness of the broad jump.

2- The highest kinematic variables affecting the achievement is the variable (the body tilt at the moment of support with the pushing leg) in the effectiveness of the broad jump.

3- The significant differences were shown for all variables of the left foot regions in the region (the thumb, the second and third toes, the fourth and fifth toes, the medial midfoot, the lateral midfoot, the medial heel, the lateral heel, the total) and in favor of the effectiveness of the triple jump.

4- The best force exerted on the right foot appeared in two regions, which are (the thumb, the fourth and fifth toes) for the effectiveness of the broad jump.

5- The best force exerted on the right foot in the triple jump event was in the areas (the second and third toes, the medial midfoot, the lateral midfoot, the medial heel, the lateral heel).

6- There is a significant correlation between them and the dependent variable which is (the angle of approach, the angle of push, the angle of the knee (support), the angle of the knee during (the push with the leg), the inclination of the body (support with the leg), the maximum pressure of the right foot) at the moment of rise in the broad jump event.

7- The emergence of a significant correlation between the variables among themselves which is the angle of approach with each of the angle of the push, the angle of the knee (support) with the angle of approach, the angle of the knee (support) with the inclination of the body (support) and the inclination of the body (propulsion) at the moment of rise for the broad jump event.

8- The variables with the highest correlation with the achievement are the variable in sequence (the inclination of the body (support), the angle of the knee (support), the angle of the knee (support), the angle of the push, the angle of the approach, the maximum pressure of the right foot) at the moment of rise in the broad jump event.

9- The emergence of a significant correlation between them and the dependent variable, which is (the push angle, the knee angle (support), the knee angle (propulsion), the body tilt (support), the body tilt (propulsion), the maximum pressure of the left foot, the maximum pressure of the right foot) at the moment of the jump phase in the triple jump event. 10- The emergence of a significant correlation between them, which is the approach angle with each of (the knee angle (support) at the moment of push, the body tilt (support), the maximum pressure of the left foot). And the push angle variable with the knee angle (propulsion). The knee angle (support) with each of (knee angle (push), body tilt (support), body tilt (push). And the variable of the knee angle (push) with each of (body tilt (support), body tilt (push). Also the variable of body tilt (support) with each of (body tilt (push), maximum pressure of the left foot) at the moment of jumping in the triple jump event.

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11- The results showed that the areas of strength during the push for the jump phase focused on the strong push in the forefoot.

4.2. Recommendations:

1- Emphasizing in the training process the development of the kinematic variables that achieved the highest values in achievement.

2- Investing in the kinematic variables with a great impact and harnessing them in developing achievement in the two events.

3- Urging trainers to conduct similar studies in order to evaluate performance periodically from the dynamic aspects (kinematics - kinetics).

4- Emphasizing during training the push with the strong leg during the jump phase to address the weakness that occurs in this phase.

5- Emphasizing the use of kinetic analysis Talking to keep pace with the development in mechanical sciences to work on enhancing strengths and overcoming weaknesses in technical performance, which are identified through accurate kinetic analysis.

6- Emphasizing the mechanism and fluidity of motor performance and transferring power during the jump from the take-off foot to the knee joint and then to the thigh and trunk, i.e. in a motor sequence.

7- Adopting the precise approach to improving the motor fluidity of the body angles, which depends on dynamic indicators (kinetics) and achieving a better level of performance for the two activities.

8- Through the (Dynafoot 3) system, it is possible to determine the areas of maximum pressure force for the feet in the jump phase and thus treat the weakness and benefit from it in the process of training and qualifying players.

9- Paying attention to the kinematic variables in the jump phase so that the players' available capabilities can be utilized to the greatest extent in achieving the digital achievement.

Focusing on pushing the take-off foot primarily in the jump phase in order to achieve the achievement.

10- Coaches should train players not to perform on the back of the foot (heel) but rather to run on the front of the foot (thumb, front metatarsals, medial and lateral midfoot).

11- The necessity of searching for other modern, advanced devices that keep pace with the development taking place in sports events, especially jumping events (long jump - triple jump) to benefit from them in the training process to develop the technical stages.

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