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RESEARCH ARTICLE

The Effect of Intermittent and Continuous Instantaneous Strength Training on Biomechanical Ability, Technical Performance and Long Jump Success in Athletics

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Abstract
The use of discrete and continuous instantaneous strength training is a modern method that can develop the level of mechanical ability and achieve development in some biomechanical variables. The aim is to identify the use of continuous and discrete and continuous instantaneous strength, in developing the explosive ability, and the technical performance according to some biomechanical variables, and its direct impact on the development of the achievement of the Athletics for advanced in the long jump, the researcher hypothesized that there are significant statistical differences in the explosive ability and the technical performance According to some biomechanical variables and the achievement of the Athletics for advanced in the long jump, the researcher used the experimental method on a sample of (11) jumpers, representing the total research community. The research was applied to a sample of (8) jumpers From the National Center for Sporting Talent (Athletics for advanced) for applicants aged (17-21), for the season (2022-2023). Result: An increase in strength and speed was determined due to the use of special exercises using arm and leg weights. As a result of the measurements, Approach speed (Pre-test: 8.01±0.15; post-tes: 9.97±0.57), The Cruising Angle (Pre-test: 21.60±0.852; post-tes: 23.10±0.721) and Measurement pushing force (Pre-test: 23.10±0.721). test: 156.23±11.6; post-test: 310.12±37.7), High Jump (Pre-test: 5.75±0.21; post-test: 6.10±0.04) it was determined that there was an increase. In conludes; the researcher concluded that it is necessary to pay attention to technical performance during the performance of athletics activities.

Keywords
Technical Performance, Mechanical Ability, Biomechanics, Long Jump

INTRODUCTION

Long jump is a flexible sport that combines periodic and non-periodic. The combination of good physical fitness and professional sports skills guarantees long jumpers to achieve excellent results (Al-Zubaidi, 1999). The explosive power of the muscles plays a very important role in movement. Improving explosive power training is the top priority for our long jumpers (**Zong, 2023**). The long jump consists of 4 phases: running phase, take-off phase, flight phase and landing phase (**Kamnardsiria et al., 2015; Alwan et al., 2023**). Long jump performance depends not only on a fast horizontal speed at the end of the run, but also on take-off technique and landing on the sandy area. Successful long jump athletes pay close attention to these stages because they affect the distance of the long jump, especially the running stage, which is the first stage of the long jump (**Alyaseri et al., 2023**). Each of these stages has its own unique cinematic characteristics in terms of performance, requiring the contestant's full attention and concentration (**Vazini Taher et al., 2021**).

Strength is a very important component of overall physical fitness because it is the driving force of every physical activity (**Nurul İhsan. 2018**). **Tangkudung and Puspitorini** (**2012**)

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suggest: Strength can be divided into three forms: maximum force, elastic force and force endurance. Maximum force is the greatest force/muscle produced by contraction, without determining how fast a movement can be performed or how long it can take to perform the movement. Additionally, Syafrudin (**2012**) argues that strength is the ability of the muscles or pulling the muscles to overcome the load or resistance (resistance), both the load in the body's own sense, such as jumping due to the lifting of the body, and external loads, such as weightlifting.

Power, one of the important factors of athletic performance, has a time component and refers to the mechanical quantity defined as the temporal ratio of work done (power = work/time) and generally depends on the ability to create the maximum possible force (maximum force) (**Newton and Kraemer, 1994**). In other words, if two athletes have similar maximum forces, the person applying the force at a higher speed (or in a shorter period of time) will have a distinct advantage in the performance of anaerobic movements (**Salih, 2022; Idrees & Salih, 2022**). Performance success of many athletic actions is often a matter of how much force is applied to objects (such as the ground, ball, or sports equipment); Success during a particular athletic workout completed in a short period of time depends on the athlete's power efficiency capacity (**Stone et al., 2023**).

The rate of concentric contraction of a muscle is inversely proportional to the applied load or external force. The contraction rate of the muscle is highest when the applied force is zero. When the force increases to a level equal to the maximum force straining the muscle, the rate of contraction becomes zero. In other words, as the weight increases, the force produced by the muscle increases and the movement speed decreases (**Bartlett, 2007**). Athletic jumps are specific cyclic-acyclic movements that require a high level of motor, specific motor and functional abilities from competitors despite good performance of techniques. Additionally, all jumping disciplines contain the appropriate morphological profile (height, weight, BMI, age) of their specific athletes. It is often said that jumpers are of high growth and relatively low weight, have long legs, long and slender muscles, and their muscular structure is dominated by white muscle fibers. Long jump is an athletic discipline with a fast-strong character and belongs to a group of distance jumps, including the triple jump and horizontal jumps according to the trajectory of the body center (**Pavlović, 2016; Smajlović, 2010**). The starting speed of running is as important as the strength of the lower extremities that provide the final jump, so the result depends on speed, jumping ability and movement technique (**Jaitner, 2001**). In top-level long jump athletes, the capacity to generate and apply significant amounts of force quickly plays a fundamental role (**Slawinski, 2017**).

The application of scientific foundations and technology in the sports field is carried out through conducting more research and studies to detect the ideal methods and exercises for the development of achievement (**Flayyih & Khiari, 2023; Nikkeh et al., 2022**), The science of biomechanics detect errors by analyzing sports movements and benefiting from mechanical laws, which is one of the basic duties of coaches, To benefit from it in training, which is related to the variables of strength, speed, and the mass of the athlete to develop athletic achievement. Many of the speed and strength training exercises that jumping coaches recommend through their training programs are weight-based. Although some exercises do not match the level of skill ability, it is seen from previous research that the use of different deep jumping methods (horizontal - vertical) to improve physical capacity and biomechanical properties is effective for athletes (**Dobbs et al., 2015**).

From Athletics the long jump effectiveness is considered one of the competitions that most need analysis and scrutiny in its stages. The technical performance of this competition depends on the capabilities and biomechanical variables to achieve the best achievement. The development of the mechanical stages of technical performance contributes effectively to achieving the optimal technique. The long jump depends on the physical requirements and a high level of skill, the good linking of the mechanical and motor capabilities of the skill, during the performance to achieve the best achievement, including the approach speed, the cruising angle, and the measurement Pushing force. The researcher noticed that preparing trainings discrete and continuous instantaneous strength, taking into account the individual differences between the jumpers, that the interest in the biomechanical variables during the technical

performance because of their significant impact on the development of the mechanical ability helps in the development of achievement of the effectiveness the long jump, so a preparation was made Exercises discrete and continuous instantaneous strength, and their impact on the develop of the mechanical ability, and the technical performance according to some biomechanical variables and the achievement of the applicants in the long jump.

Research objectives to Identifying the values of the mechanical ability of the arms and legs and some biomechanical variables and achievement of the advanced in the long jump, Preparing the effect of exercises discrete and continuous instantaneous strength to develop the mechanical ability of the arms and legs and the technical performance according to some biomechanical variables and the achievement of the research sample. and to identify the effect of exercises discrete and continuous instantaneous strength to develop the mechanical ability of the arms and legs and technical performance according to some biomechanical variables.

Research hypotheses

There are differences between the tests for the development of the mechanical ability of the arms and legs and some biomechanical variables and the achievement of the applicants in the long jump.

Research limits

The In their study, researcher focused on the research sample being from the jumpers of the National Center for the Care of Athletic Talent for Athletics for advanced in the long jump the season (2022-2023)

- Researcher worked in her study for the period from (5-1-2023) until (25-3-2023).

- The program was conducted in the halls of the Iraqi Ministry of Youth and Sports - the capital Baghdad.

MATERIALS AND METHODS

The used the experimental approach with a (one group) design.

Participants

A total of 11 athletes (age: 20±1.3; height: 190 ±3.5; weight: 85 ±5.2) voluntarily participated in this study. Before initiating the study, all participants were informed in detail about the purpose of study, test procedures, potential risks and benefits of the research and then the participants signed an approval document indicating that they would participate in the study voluntarily. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures. Ethical approval of the study was obtained from Ministry of Education, Iraq Ethics Committee at the board meeting dated 20.03.2023 and numbered 17-09-2023 Ref. 216. NO. 1, 2023.

The participants identified the jumpers of National Center for the Care of Athletic Talent for the Athletics for advanced in the long jump, aged (17-21) years, their number is (11) jumpers for the sports season (2023-2022) - (the sample "it is the part that represents the community of origin on which the researcher conducts the entire focus of his work)", (**Mahjoub، 1993**). The sample was chosen by the intentional method and by (8) jumpers, with a percentage of (72.73) % of the research community, The chosen were (3) Jumpers to conduct the exploratory experiment (Table 1).

Table 1. Paerticipants physical characteristics

Variable	(n = 11) (M ± SD)
Age (years)	20±1.3
Height (cm)	190 ±3.5
Weight (kg)	85 ±5.2
BMI (kg/cm^2)	24 ± 2.9

Study Design

Measurements

Means, tools and devices used for this study are mentioned as follows:

- Arabic and foreign sources and references
- observation and experimentation
- A Lenovo laptop with the use of (Kenova) program to determine biomechanical indicators.
- One (1) camera holder
- Adhesive tape

One (1) manual electronic calculator Two (2) manual stopwatches-

A balance, a medical scale, to measure mass and length -). Flags - red and white) number (2 -A legal field for the long jump

Power platform

Field Research Procedures

Define Rsearch Parameters

The search variables were measured (approach speed, the cruising angle, and the

measurement Pushing force, by placing a camera to the left of the jumper, at a height of (1.35 m), from the center of the ascent plate, the field of photography was (8 m), the scale of the drawing was determined by the length of the leg for each jumper.

FD:Flight Distance, EP: Explosive Power, IPT: Instant Push Time

Figure 1. Long jump measurement tools

Tests used in the research

Test (medicine ball throw), weighing (2 kg), for the maximum distance (**Al-Zubaid, 1999**). From a standing position, the player throws the ball with his hands to the maximum distance while allowing one step to be taken before throwing. The player must touch the ground while throwing, and gives the tester two attempts. The best result is calculated and the distance (in meters), and its time is calculated, as the pushing time is calculated. The momentary moment of the arm is from the moment the arm moves with the ball until the moment the ball is left. The power (in watts) is calculated according to the following law:

$$\text{Explosive force (For Arms)} = \frac{(\text{Mass of the Arm} + \text{Mass of the Ball}) * \frac{\text{Flight Distance}}{\text{Flight Time}}}{\text{Instant Push Time}} \text{ (newton's)}$$

$$\text{Then apply the Power law: } \frac{\text{Explosive power X Distance}}{\text{Time}}$$

Long jump stability test

The purpose: measuring the muscular ability of the legs and torso from the long jump.

specifications (**scholich & Kreis, 1982**)

The player stands with the feet slightly apart and the arms high. He swings the arms forward down behind with the knees bent in half and the torso inclined forward. From this position, the arms swing forward strongly with the extension of the legs along the torso and push the ground with the feet, strongly in an attempt to jump forward the farthest distance Possible.

Testing instructions

The distance of the jump is measured from the starting line (the inner edge) until the last trace left by the player near the point where the heels touch the ground. The attempt is canceled in case of imbalance and must be repeated.

Recording

The tested player has two attempts to score the best of them.

Recording method

Using the analysis program (Kenova) to extract the power.

$$\text{Explosive Power (For Legs)} = \frac{\text{Body mass x 9.8 x } \frac{\textit{Flight Distance}}{\textit{It's Time}}}{\text{Instant Push Time}} \text{ (Newton's)}$$

$$\text{Explosive Ability (For Legs)} = \frac{\text{Power x Jump Distance}}{\text{Jump Time}} \text{ (Watt)}$$

Long jump achievement test

The purpose: measuring the horizontal distance of the meter and its part.

Tools used: force platform device.

Performance method: The player stands at a distance of (30-40 m) from the board and performs an approximate run, presses on the device, and rises in the air to the end of the movement.

Recording: The horizontal distance traveled by the player in the air is calculated by meters and its part. And he is given three attempts to calculate the meaning.

Exploratory experience

The first experiment was conducted on a sample of (3 jumpers) from the National Center for the Nurturing of Athletic Talent the Athletics for advanced in the long jump from outside the research sample, on Thursday (5-1-2023) at four o'clock in the afternoon, in the halls of the Ministry of Youth and Sports, the experiment was conducted To find out and find (maximum value - stresses - frequencies - times).

Experimental Procedures

Pre-tests:

The pre-examinations for the tests were conducted on Thursday (12/1/2022) at four o'clock in the afternoon, the tests were conducted and the conditions for the tests were confirmed in terms of the assistant work team, time, place and tools And devices, so that all similar conditions can be provided when conducting post-tests.

Special exercises used in the research:

The training started on Saturday (14/1/2023), and will continue until Thursday (23-3-2023).

Preparing strength training commensurate with the nature of the competition so that it is similar to the competition.

The exercises are applied in the main section of the training unit during the period of special preparation, for a period of ten weeks, at the rate of three training units per week, and the number of training units is (30) training units.

Training days: Saturday - Monday – Thursday-

Training intensity ranges from 90-100%

load waves (1:3).

Use the interval and repetitive training method

The intensity was determined according to the repetitions

Using weights in the arms and legs with a weight ranging between (3-8) kg

The exercises are given at the time of the main section and range between (50-60) minute.

Post tests:

After completing the exercises, the post-tests were conducted on Saturday (25-3-3023) , in the athletics in the Ministry of Youth and Sports. The same conditions were created in Devices and tools - Implementation method - Work team.

Electronic computing processing:

The analysis program (Kenova) was used in (AVI) format, and the biomechanical variables were extracted directly from the movie taken of the tested player during the performance of the long jump event.

Biomechanical variables:

Approach speed: It is the (time it takes) to travel a distance (the last 10 m) to the approach board

The cruising angle: It is the angle confined between the intersection of the straight line connecting the center of gravity of the body at the moment of leaving the board with the horizontal line parallel to the ground and towards the front. It is measured in degrees.

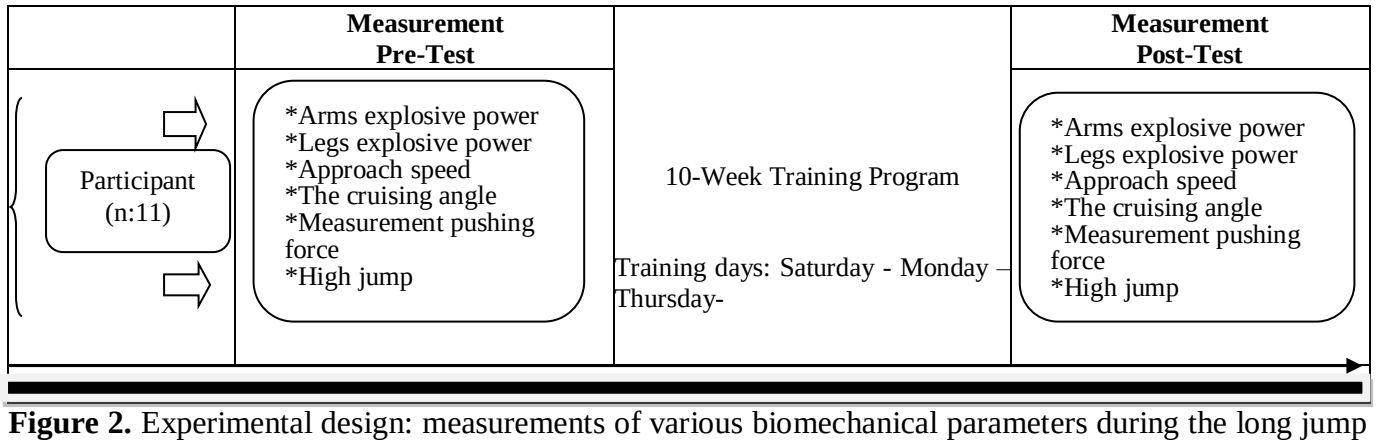

Figure 2. Experimental design: measurements of various biomechanical parameters during the long jump testing at pre and subsequent to the interventions

Table 1. 10-week training program of participants

Main section time (53 min)								
Exercise Name	Mass.Kg	İntensity	Repetitions	Rest		Repetition Time (S)	Exercise Time Minutes	Total Time İs İn Minutes
				Repetition	Exercise			
Running a distance of (30m) from the flying position	78	90%	4	3m	6m	3.64	9.24	15.24
	75					3.66	9.24	15.24
	77					3.58	9.24	15.24
						3.69	9.25	15.25
						3.74	9.25	15.25
Run a distance of (50m)	78	90%	4	3.30m	6m	6.80	10.35	16.35
						6.85	10.36	16.36
	88					6.75	10.35	16.35
						6.88	10.36	16.36
						6.94	10.36	16.36
Jumping on barrier (9) with a standard height	0	90%	4	2m	5m	12	6.8	11.8
Leaping from stability	0	90%	4	2.30m	-	5	7.63	7.63

Statistical analysis

In the descriptive analysis data is reported as means ± standard deviations and percentage of changes. Physical characteristics before the intervention were tested for difference between the groups with unpaired t-tests. Test data was examined for normality with Shapiro Wilk test and for homogeneity of test. If normality of data was presenta two way mixed analysis of variance (factors: group, time, and interaction (group vs. time)) was performed. Results were considered significant when $p<0.05$. IBM SPSS statistics version 22.0 package was used.

RESULTS

Display and discussion of the mechanical ability of the two tests, analysis and discussion:

Table 2. shows that the results appeared significant in the explosive ability, depending on both the mass and the distance, as a result of the use of special exercises through the use of weights with arms and legs and special exercises for strength and speed.

Table 2. Mean - standard deviation - difference of the means, calculated (t) value for the mechanical ability of arms and legs

Mechanical Ability	Measuring Unit	Test	M	SD	D m	SD	t value calculated	Sig.
Arms Explosive Power	Watt	Pre- Tests	2810.71	2732.15	770.33	547.99	4.76	Moral
		Post- Tests	3581.04	2419.55				
Legs Explosive Power	Watt	Pre- Test	84.65	71.34	33.89	19.14	5.01	Moral
		Post- Test	118.54	69.50				
Note / (T) calculated at (7) degree of freedom and error probability (0.01) = 3.60								

As a result of the measurements, Approach speed (Pre-test: 8.01±0.15; post-tes: 9.97±0.57), The Cruising Angle (Pre-test: 21.60±0.852; post-tes: 23.10±0.721) and Measurement pushing force (Pre-test: 23.10±0.721). test: 156.23±11.6; post-test: 310.12±37.7), it was determined that there was an increase (Table 3).

Table 3. The mean - standard deviation - standard deviation of the differences - calculated (t) value - significance level for some biomechanical variables

Variables	Measuring Unit	Test	M	SD	D M	SD	t Value Calculated	Sig.
Approach speed	m/sec	Pre- Tests	8.01	0.15	1.96	0.93	5.94	moral
		Post- Tests	9.97	0.57				
The Cruising Angle	Degree	Pre- Tests	21.60	0.852	1.5	0.93	4.55	moral
		Post- Tests	23.10	0.721				
Measurement pushing force	Kg	Pre- Tests	156.23	11.6	153.89	72.95	5.97	moral
		Post- Tests	310.12	37.7				
note / t at the degree of freedom (7) and the probability of error (0.01) = 3.60								

As a result of the measurements, it was determined that there was an increase in High Jump (Pre-test: 5.75±0.21; post-test: 6.10±0.04).

Table 4. The mean - calculated (t) value - difference of the means - standard deviation of the differences - significance level for the achievement of the long jump

Achievement	Measuring Unit	Test	M	SD	D M	SD	t Value Calculated	Sig.
High Jump	Pre- Tests	Degree	5.75	0.21	0.35	0.22	4.49	moral
	Post- Tests		6.10	0.04				
note / t at the degree of freedom (7) and the probability of error (0.01) = 3.60								

DISCUSSION

The goal of the long jump is to reach a landing spot or jumping platform as far as possible. Jump distance is measured from the push board to the closest distance to the landing position formed by the body part. A long jumper with good limb muscle strength is highly supportive of success in long jump sports. As explained, strength is the basic ability of physical conditions, especially the strength of the leg muscles (**Antoni et al., 2019**). The long jump technique is based on a natural and fairly easy movement; here the jumper strives for more speed (horizontal component horizontal throw), which transforms the reflection into a longer-distance jump (ballistic curve inclined throw). The ratio of the horizontal component (start-up speed) and the vertical component (reflection speed, flash) is related to 2:1. The effect of horizontal and vertical components directs the body and ensures that the elevation angle is between 18°-26°. This means that the decrease in angle (β) increases as a result of movements (R) that decrease the angle of elevation (α). Keeping all this in mind, a long-lapse reflection should only be performed at top speed and to the limit after the moment of verticality. Studies by some authors have confirmed the inverse relationship of horizontal and vertical body center elevation. As horizontal speed increases, vertical speed decreases and vice versa.

Table 2. shows that the results appeared significant in the explosive ability, depending on both the mass and the distance, as a result of the use of special exercises through the use of weights with arms and legs and special exercises for strength and speed, and this is confirmed by (**Adel Abdel-Basir 1999**) " The strength characterized by speed plays a role Important as one of the basic characteristics of the components of physical preparation that characterize sports activities" (**Ali, 1999**). The use of a group of vertical and wide jumping exercises with the additional weight. The jumping exercises affected the sample, and (**Mohammed Hassan Allawi and Abu Ela Ahmed 1984**) confirms that "the muscular ability to stretch contributes to increasing the speed of the motor performance of the used exercises" (**Muhammad & Abdel, 1984**).

The exercises used to develop explosive ability at the highest speed, and this stimulates the nervous system to perform quickly. The quality of the approved exercises using separate and continuous momentary strength training has an effective effect in developing research variables using resistance exercises with weights, and the exercises used are similar to the performance requirements during competition For the purpose of benefiting from the effects of these exercises to

achieve the required ability, this was confirmed by (**Abu El-Ela Ahmed 1992**)" that the ability training needs a high speed during the exercises in order to obtain a better motor performance during the competitions" (**Abdel Fattah, 1992**).

The study sample has developed in the speed of approach, as the effectiveness of the long jump requires the acquisition of the maximum horizontal transitional speed appropriate to carry out the ascent and flight to achieve the longest horizontal distance, and the horizontal speed is of great importance to achieving achievement in this activity. For the purpose of obtaining high speed in the approach run and obtaining high speed, gradient acceleration is permitted, starting from the first step and ending with the maximum speed when ascending (**Rogers, 2000**) **.** The significant results showed in the variables of the body's launch angle and the momentum. These two variables are among the important variables in the effectiveness of the long jump. From this angle, it is possible to predict the level of achievement for the jumper, as well as determine the horizontal and vertical components. It is affected by the angle of rise and the speed of the performance of the approach stage and pushes the plate strongly and the high speed to get at a flight height suitable for the center of gravity, as it helps the jumper to achieve an appropriate flight angle and achieve a good jump distance .

The researcher believes that there is a correlation between the processes of absorption and propulsion when performing the jump, and that the arms have a good effect in achieving the transfer of the resulting momentum to the trunk, and determining the appropriate angles for the rest of the body parts, which achieves the lowest values of the body's own inertia, this is confirmed by (Mohammed Hassan Allawi and Abu Al-Ala) There are some factors that work to develop and develop speed, which are the formative properties of muscle fibers, their ability to relax, and the ability of the muscle to stretch and viscosity (**Allawi & Abdel, 1984**).

Training leads to an increase in the distance and height of flight, this is due to the development of the mechanical capabilities, as the continuation of the body's flight is evidence of the amount of effective force thrust exerted by the jumper. Creating suitable conditions for performance, the researcher agrees with what was indicated by (Sarih Abdul-Karim Al-Fadhli) that the results of some research indicated that long jumpers with high levels outperform those with weaker levels in this aspect (i.e. negative momentum change) (**Al-Fadhl, 2010**).

The reason for this is as a result of the application of separate and continuous momentary strength training and in a correlated with biomechanical variables The organization of training and the application of training units in the correct manner and attention to gradation in intensity, and the beginning from the shorter distances to the longer ones that contribute to improving the research variables, this is what was confirmed by (**Qasim Hassan and Mahmoud Abdullah, 1987**) "The training unit and the upward rise of its intensity and volume, depending on the most confident level of training" (**Hussein & Abdullah, 1987**). The achievement variable is related to the parts of the body in order to take suitable positions for the motor performance of the jumper. This variable is affected in the process of linking (approaching speed, departure angle and momentum). Whenever the movement is without any stops or intersections in the body parts, an appropriate starting angle and high momentum, the achievement increases This What is confirmed by (Ammar Makki Ali, 2005) "The development that accompanied all the variables gave an indication of increasing the efficiency and consistency of work between the joints of the body and the working muscles, and thus the production of greater force which leads to an increase in the achieved achievement" (**Ali A. M., 2005**).

Conclusion

There is a development in mechanical ability. There is a development in the variables of the Approach speed - the cruising angle of the body - and Measurement pushing force. The different exercises have an effective impact in develop the mechanical ability of the arms and legs and some biomechanical variables for the technical performance of the long jump effectiveness of athletics.

Recommendations

Emphasis on the continuity of training with discrete and continuous instantaneous strength training, as it has a great role in the jumper getting a good achievement. The trainers, when carrying out the training process, should pay attention to the aspects of technical performance according to the biomechanical variables that serve the achievement. Emphasizing the use of analysis to

find out the points of error and weakness and giving appropriate training. Conducting a similar study that takes other variables and other skills from different athletics activities.

Conflict of interest

There are no conflicts of interest between fellow authors, including financial and non-financial relationships.

Ethics Committee

This study was performed by adhering to the Helsinki Declaration. Ethical approval of the study was obtained from Ministry of Education, Iraq Ethics Committee at the board meeting dated 20.03.2023 and numbered 17-09-2023 Ref. 216. NO. 1, 2023.

Author Contributions

Planned by author: Study Design, Data. Collection, Statistical Analysis, Data. Interpretation, Manuscript Preparation, Literature search. All authors have read and approved published version of the manuscript.

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