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The effect of suggested exercises according to the ballistic training method on insulin-like growth factor-1 hormone, speed-specific strength of leg muscles, and achievement of the triple jump in advanced athletes

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Abstract

Speed-specific leg muscle strength is the primary physical skill required by the athletes of the triple jump, this skill will be developed through suggested exercises based on ballistic training. In addition, the study will follow how these suggested exercises affect insulin-like Growth Factor-1 hormone (IGF-1) and how much impact they have on the ability of athletes to perform this sport. However, the research challenge crystallized by choosing the training approach based on ballistic resistance exercises, which involve a combination of quick strength training with weights, measuring their impact on the biochemical and physiological variables under study to enhance the performance of the research sample. According to the researcher's assumption, there is a positive impact of adopting ballistic training on the development of speed-specific strength, insulin-like Growth Factor-1 hormone (IGF-1), and the achievement of the research sample. The triple jump team of the Anbar Governorate, consisting of (5) players, served as the researcher's purposive training method. The researcher concluded that the training methodology used has caused variations in the level of the variables under study, because these are crucial for finishing the triple jump activity, thus, he advised the importance of monitoring the athlete's speed-specific strength, and hormone levels of (IGF-1).

Keywords: Leg muscles, ballistic training, advanced athletes, exercises, growth factor-1 hormone, (IGF-1)

Introduction

Athletic training aims to achieve the necessary level by developing the required physical qualities and abilities, elevating the skills level, as well as improving the harmony of performance. The improvement of the physical skill, especially speed-specific strength that is completely compatible with the continuous performance required by the triple jump skill, which is performed by the player making three constant jumps at the same level without a break, at this point the triple jump must be effective, hence, these ongoing performances required muscles that are distinguished by strength associated with speed, in addition to its importance to the approach run before performing the jumps. For this reason, we need modern training methods, such as the ballistic training method, that develop the muscles of the athlete's body, particularly the leg muscles of the triple jumper, because it aims to regulate the muscles used to perform the skill and implement it precisely without deceleration or a stop. The Significance of the research lies in presenting the ballistic training method the researcher has adopted to improve the speed-specific leg muscle strength and understand its effect on the hormone (IGF-1) and, consequently, identify their role in achieving the triple jump in the research sample.

Research Problem

For a triple jumper, speed-specific leg muscle strength are crucial criteria because this sport demands the player to do three constant jumps that must be performed with strength and speed, each at the same level, in addition to understanding the effect of the external training load on the player's body's internal load, which is represented by physiological changes and adaptations.

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This includes awareness of the amounts of hormones, enzymes, and other substances that are essential to the stability of the player's body's functional systems, thus, they perform their activities in a way that is consistent with the size, intensity, and volume of training the player practices and permits him to keep the achievement appropriately and precisely. The experience of the researcher as a former athlete and current athletics coach enabled him to observe that most coaches and athletes disregard physiological measurements and do not employ modern training methods to build speed-specific strength. Therefore, to deduct their impact on the variables under study to assist the athlete in reaching their utmost prospect, the researcher defined the problem of his study as providing physical exercises per the ballistic training method, which depends on improving rapid strength using weights with amounts that fit the physical ability of the research sample.

Research Aims

- Developing exercises according to the ballistic training method for the research sample.
- Identifying the effect of the ballistic training method in developing the speed-specific strength and insulin-like hormone (IGF-1) and achieving the triple jump in the research sample.

Research hypothesis

- There are statistically significant differences between the pre- and post-tests in the speed-specific strength, insulin-like hormone (IGF-1), and the achievement of the triple jump of the research sample.

Research Fields

Human Field: A sample of the triple jump players of the Anbar Governorate team.

Time Domain: Period from 06/03/2023 to 08/26/2023.

Spatial Domain: Ramadi Sports Club Stadium.

Theoretical Reviews

Ballistic Training Method

The indication behind ballistic training is that its exercises contain quick and forceful movements against resistance abilities ideal for specific figures such as weight wraps, jackets and lifting weights ranging from (30% - 50%) of the athlete's maximal capacity. Athletes who have reached their maximum strength benefit from these exercises that help them develop speed strength, because this type of training requires high-intensity exercises, however, they are performed with small weights and resistances yet through many repetitions. Thus, they increase the efficiency of the working, opponent, and fixator muscles as well as the ligaments and tendons supporting these muscles to withstand the stress placed on them when performing exercises or competing. "The main goal of lightweight training is to increase the rate of explosive force production, while traditional training using heavy weights increases the players' maximum strength. Also, high-speed training leads to a much faster athletic performance than traditional training using heavy weights" ^[1]. Ballistic training is used to overcome the decrease in speed when its training is associated with weights. The performance of exercises of this type of training goes through three stages. The movement begins when the muscle contracts by shortening (Concentric), then comes the landing stage, which depends

on the amount of movement generated from the first stage, then the third stage, which includes the decrease in speed (Deceleration) accompanied by the muscle contraction by lengthening (Eccentric). Ballistic training exercises affect muscle cells, which leads to an increase in muscle size and the preservation of embodied energy within it to benefit from it when the conversion between the two phases of contraction by lengthening and shortening is carried out with maximum force and speed" ^[2]. This is what the triple jumper needs when performing the jumping skill in an integrated manner. In light of the stages of ballistic movement, the goal of ballistic performance lies in reaching the maximum acceleration at the moment of the body's launch to the maximum height and horizontal distance. In order to give the body, the greatest possible speed, the maximum capacity that the player can achieve must be applied. Ballistic training also aims to stimulate the working, opposing and stabilizing muscles without any decrease or reduction in speed, so it maintains precise coordination for most sports activities, especially for triple jumpers, as "slowing down when performing the skill negatively stimulates the opposing muscles and affects muscle capacity, so this training method avoids this problem since there is no slowing down when performing the exercises or skill, so the athlete has the freedom to jump to the maximum range without restricting the movement" ^[3]. The movements performed at maximum speed and Acceleration are ballistic movements characterized by high launch rates, short contraction times, and high rates of force stimulation. This emphasizes the distinctive feature of the three stages of muscle contraction when performing the extreme effort that occurs during ballistic movement, while the amount and intensity of the Coactivation of the opposing muscle is variable. In cases of a low progression of tonic muscle activation (Coactivation), there is a decrease in the electrical activity of the working muscle, or what we call the resting period before the ballistic contraction (Ballistic-contraction). This period serves to maximize the amount of force and speed for the next contraction and the selective activation of the fast motor fibers in the muscle (Fast witch). Therefore, high-speed ballistic training causes certain adaptations in the neuromuscular system that occur as a function of the basic physiological muscle mechatronics and facilitates the performance of ballistic movement that leads to muscle activation and improved neuromuscular adaptation, because "ballistic exercises impose an eccentric force on the joints, ligaments and tendons when they are performed, as in landing after jumping from a squat. Therefore, the athlete must gradually move from no load to load and must not reach a state of fatigue and stress before performing ballistic training for muscle capacity and stop training when the player feels weak physical performance or difficulty in executing the jumping skill in the required manner" ^[4]. It is preferable to use ballistic training at the end of special training because it requires high muscle adaptation to be able to bear light weights or resistances that work to build and develop the working muscle and strengthen the ligaments and tendons connected to it.

Insulin-like Growth Factor (IGF-1)

IGF-1 hormone is one of the growth factors and is a hormone consisting of a single chain of amino acids amounting to (70) single-chain amino acids with three disulfide bridges within the molecule, and its molecule is

similar in its chemical composition to the pre-insulin molecule, and the IGF-1 hormone helps in the growth of muscles, bones and cartilage through its important role in activating somatotropin [5]. IGF-1 is produced in many tissues of the body, but the liver is the main source of production of this very important hormone in the building process and has a major effect in stimulating growth carried out by growth hormone. The hormone is transported by the binding protein (IGFBP-3), which also controls its duration and vital activities. The lifespan of IGF-1 in its free form is between (10-30 m), while the lifespan of the binding protein is (90 m). When the hormone is bound to the specific binding protein, the lifespan reaches (12 h) hours. The direct effects of growth hormone are associated with IGF-1 because it is the main factor in the protein production process. It also regulates growth hormones because it represents a direct stimulus for growth. It also reduces the effect of insulin on adipose tissue and activates (glucose oxidation) and the production of lipids and glycogen [6]. On this basis, the IGF-1 is linked to the liver in terms of secretion, while it is linked to the muscles in terms of construction and growth. The direct effects of growth hormone are related to IGF-1 because it is the main component of the protein production process. Growth hormone does not have a direct biological effect on the blood, but rather activates the formation of IGF-1 in the liver to perform the known biological functions of growth hormone. The secretion of IGF-1 is affected by protein deficiency and a decrease in the cortisol hormone, as this deficiency leads to a decrease in the activity of IGF-1, while excessive doses of estrogen inhibit its production in the normal form [7, 8]. Growth hormone stimulates cells such as the liver to secrete IGF-1, which stimulates the production, spread and reproduction of cartilage cells. IGF-1 also plays a role in stimulating cell growth to form new tissues, growth of existing tissues and inhibition of cell death. Therefore, its role is of great importance in increasing cell size (hypertrophy) and increasing their number (hyperplasia). The IGF-1 is an effective product for tissue connection and it contributes to cartilage repair and is vital for bones and increasing their density and durability. It is very useful in treating any injury that the player may suffer, in addition to its role in reducing the rehabilitation period and increasing the strength of the injured area that was treated [9, 10].

Speed-Specific Strength

It is a combined ability of strength and speed and is considered one of the basic abilities in determining the level of performance in many sports competitions, especially for triple jump players who rely on it directly when performing the jumping skill. The speed-specific strength is linked to sports activities that require strong and fast movements simultaneously, and this physical ability depends on producing muscle contractions that are used to perform motor skills. This strength is not of value to the triple jump player unless it is accompanied by speed in performance that is consistent with the nature of the skill, therefore, it is necessary to develop strength and link it in special exercises with speed to get the player to the best achievement because the muscular system, especially the leg muscles of triple jump players, bears the responsibility of overcoming the resistance of the body weight and gravity when his body rises upwards, which requires the player to have strong muscles and rapid contractions during the approach run and

when performing the difficult skill that requires motor balance and precise coordination to perform the three jumps appropriately. These requirements require adaptation and compatibility between the nervous and muscular systems, especially if the skill performance falls within the anaerobic energy production system, which requires the transmission of rapid and continuous signals to perform the high-intensity exercises required by the skill. "The speed of muscle contraction requires certain physiological characteristics, some of which are available in the central nervous system, which performs its function through rapid and repeated exchanges of Stimulation and Inhibition processes of nerve cells and the continuous and precise organization of the work of motor units, as the muscle produces the energy required to cause rapid muscle contractions" [11]. Consequently, the importance of the speed-specific strength for triple jump players lies in the integration of the muscle's ability to produce maximum force to perform the precise motor path of the skill, especially if the motor speed is high when using this force, and this is what the player needs to perform the physical and skill requirements of this sporting activity to obtain the best achievement.

Triple Jump

This sporting activity is one of the complex competitions that requires the player to perform three consecutive and continuous jumps to perform its skill. Therefore, it requires a player who has high coordination and motor balance and integrated physical abilities, especially the ability of speed-specific strength of the legs, so that he can perform the skill of the triple jump in an integrated manner, this skill is performed in three stages, starting with the hop stage, which is done by hitting the take-off board with the pushing foot, rising off the ground, then landing on the take-off foot itself. Then begins the second stage, called the step stage, in which the body is pushed up and forward with the foot that performed the hop itself, but landing on the opposite foot, so the third stage begins, which is the jump stage, in which the player rises with the opposite foot and ends with landing with both feet in the sand pit. It is preferable that the angle of elevation of the player's body from the ground when performing the triple jump skill ranges between (18° - 22°) depending on the individual differences between the players to achieve the best horizontal distance, because the small angle of elevation leads to fluidity in transferring the body to the furthest possible distance, in addition, this angle maintains the horizontal speed and does not decrease it in all jumps. However, if the speed is converted to vertical speed, it will negatively affect the player's ability to distribute the jump distance between the three jumps equally, because the jump distance for the step phase will be less than the hop distance, because the player here has lost the necessary horizontal speed that works to divide the completion distance between the three jumps equally.

Research Methodology and Field Procedures

Research Methodology

The researcher used the experimental method by designing one group with two tests, pre and post-tests, for its suitability to the nature of the research problem.

Research Sample

The research sample was tested in a purposive method and consisted of (5) Players representing Anbar Governorate

team in the advanced triple jump sport. Table (1) shows the homogeneity of age and variables under study for the

research sample:

Table 1: The Homogeneity of The research sample

Variables	Measuring Unit	Mean	Standard deviation	Median	Kurtosis*
Age	Year	24.4	1.816	24	0.660
Training age	Year	5.3	2.018	5	0.445
Hormone (IGF-1)	ng / ml	207.2	20.533	203	0.613
Speed-specific strength	Meter	9.55	0.228	9.50	0.657
Triple jump achievement	Meter	15.19	0.198	15.12	1.060

*The distribution is moderated if the values of kurtosis are less than (± 3)

Pre-Tests

The level of IGF-1 was measured at Al-Shifa Medical Analysis Laboratory at ten in the morning, while the speed-specific strength tests for the leg muscles and the completion of the triple jump were conducted at the Ramadi Sports Club stadium on (6/4/2023) at four in the afternoon, as follows:

Measurement of Insulin-like Growth Factor (IGF-1) [12]

Measurement objective: To know the concentration of the Insulin-like Growth Factor (IGF-1) in the blood.

Measurement Methods: The IGF-1 hormone is measured by taking a blood sample of (5ml) milliliters from a vein, then isolating the serum using a centrifuge. A (German-made Siemens IMMULITE 2000 xpi Autoanalyzer) is used. Further, to find the percentage of the hormone in the blood, we add (50 μ L) microliters of blood serum to each hole of the device's ELISA plate, and immediately after that we add (50 μ L) of the secondary antibody (HRP) to each hole and incubate for (60 m) minutes. Furthermore, below a temperature of (37 °C), then the plate is washed 5 times, then (90 μ L) of the reagent substrate is added to each hole, which works to give a specific color to the product of the reaction between the serum and the HRP and incubated for (15m) at room temperature, then the stopping agent is added at a concentration of (50 μ L) to stop the reaction and prevent the continuation of color change or light production to reach the required point of the reaction. Then the product is taken and placed in the Spectrophotometer. After waiting for (10m), the result of the device is then read at a wavelength of (450 nm) nanometers.

Recording

The device is read and the reading result is subjected to statistical processing according to the following equation:

IGF-1 Cons = Absorbance - Intercept / Slope (ng/ml)

The final output of this equation is recorded in the measurements form, and this output is used as a basis for the concentration of the IGF-1, and is measured in units (ng/ml).

Speed-Specific Strength Test for Leg Muscles [13]

Measurement name: Five-point stability test.

Measurement objective: Measure the speed-specific strength of the leg muscles.

Tools used: Measuring tape - Suitable place for jumping - Take-off line

Performance description: The player stands behind the starting line with one foot forward and the other behind, then begins to jump forward, pushing on the support leg and landing on the leg swinging forward, i.e. from the right leg to the left leg and alternating with repeating the jumps until he lands with the fifth jump on both feet together.

Recording: The distance is measured from the inner edge of the take-off line to the last trace left by the tester.

Triple Jump Achievement Test

Measurement objective: To measure the achievement of the triple jump.

Tools used: A place that includes a running field and a landing pit, a measuring tape.

Performance description: The test begins with a quick approximate run, performing the entire jumping skill that begins with the hop stage, then the step, then the jump stage and landing with both feet in the sand pit.

Recording

Each player is given three attempts and a five-minute rest between one attempt and another, and each attempt is measured in meters and parts of them for each attempt from the take-off board to the closest trace left by the player towards the take-off board.

The Main Experience

The duration of implementing the research sample for the proposed exercises according to the ballistic training method took (8) weeks, at a rate of (3) training units per week, thus the total number reached (24) training units that lasted for the period from (6/5/2023) to (8/24/2023), in which the researcher prepared physical exercises to develop the characteristics of strength and speed and combine these two characteristics to develop the speed-specific strength for the leg muscles, and these exercises were applied in the special preparation stage of the training stages, so they included high-intensity exercises interspersed with relatively few rest periods between repetitions, and exercises that combine strength with speed using body weight such as (jumping from a squat position over hurdles without stopping, running by jumping for a distance of (40 m) meters, running three hops for each leg for a distance of (30 m) without stopping, climbing stairs quickly and descending slowly with repeating the exercise for five repetitions that increase with the increase in the training duration, running at high intensity for distances ranging between (20m - 50m) with repetitions interspersed with appropriate rest periods. It also included exercises using resistance such as lifting weights or

wearing a weight vest or a weight kettlebell with an intensity ranging between (30% - 50%) of the player's maximum capacity. The most important exercises were placing weights on the shoulders (jumping up from a half-squat position, bending and extending the knees fully from the bear position, jumping on a bench with the legs alternating right and left, raising the bar above the head while performing the movement of the legs forward and backward alternately). Among the exercises that relied on wearing a weight vest were (jumping forward and backward, running with a jump right and left on hoops, jumping over hurdles with both feet), while the exercises in which a weight kettlebell was used included (jumping with both legs on a box with a height of (20cm), running forward and backward, opening and closing the legs, jumping on the spot). The purpose of these ballistic exercises was to stimulate the functional systems and arouse the working body tissues, especially the muscular, nervous and glandular systems, in a positive way to achieve the goal of training in acquiring the leg muscles the appropriate muscular structure, great strength, high speed and appropriate adaptation that the player needs to perform the triple jump

skill at the best level. The researcher took into account the physical and physiological level of the research sample's capabilities, so the exercises were limited to high intensity that reached (100%) when the sample performed a section of the free exercises without weights, while the intensity of training using resistance ranged between low and medium so that the players would not reach the stage of abnormal fatigue that leads to their functional systems not adapting to the required level.

Post-Test

The post-tests were carried out in the same way as the Pre-tests, as the researcher took the required measurements on 8/26/2023.

Statistical Means ^[14]

Arithmetic means, median, standard deviation, torsion modulus, t-test for symmetric samples.

Presentation, Analysis and Discussion of the Results Presentation and Analysis of the Results

Table 2: Statistical treatments of pre-test and post-test of research variables

Variables	Pre-test		Post-test		X Variance	S Variance	T-test Cal.	Results
	X	S	X	S				
Hormone (IGF-1)	207.2	20.535	223.2	25.05	16	2.302	6.950	Significant
Speed-specific strength	9.55	0.228	10.21	0.414	0.656	0.085	7.717	Significant
Triple jump achievement	15.19	0.198	15.66	0.310	0.464	0.053	8.754	Significant

The final results of Table 2 for the pre- and post-tests and measurements of the research variables IGF-1, speed-characterized strength of the leg muscles, triple jump achievement show that there were different differences between the pre- and post-tests amounting to (16, 0.656, 0.464) respectively, and the deviations of those differences were (2.302, 0.085, 0.053) respectively, and the calculated (T-test) value for the research variables amounted to (6.950, 7.717, 8.754) respectively, and when compared with the tabular degree of (3.747) at the significance level (0.01) and degree of freedom (5-1=4) to identify the significance of the differences between the pre-test and post-test, whose numbers proved that the differences were significant in favor of the post-test because the calculated (T) values are greater than their tabular values in all study variables.

Discussion of the Results

The researcher attributes the significant differences obtained by the research sample between the pre-test and post-test in favor of the post-test for all research variables to the proposed exercises according to the ballistic training method, which contained speed and strength exercises with high intensity that are consistent with the requirements of this training method, which is often used to develop physical abilities that link two or more physical fitness qualities. Therefore, most of the exercises included the research sample performing speed exercises with resistance to increase the speed-specific strength of the leg muscles, which is one of the most important physical abilities needed by a triple jumper, these exercises led to an increase in the effectiveness and activity of the IGF-1, which helps build muscles to overcome the frequent muscle contractions when performing physical exercises characterized by fast and strong repetitions that require the availability of this

hormone immediately and continuously in order for the player to perform his various physical exercises in the best possible way. This increase came naturally due to "the important role played by IGF-1 in building muscles and cartilage and increasing bone density" ^[15]. The IGF-1 also has a role in regulating the physiological processes that occur in the functional systems in the athlete's body during the chemical reactions that the body needs to produce energy and restore the recovery of the muscles and working systems, especially in exercises that rely on the ballistic training method, "IGF-1 can be used as a muscle growth factor and predictor of recovery speed" ^[16]. Performing exercises and physical efforts increases the hormonal response, especially exercises that require manipulation of the intensity of their performance, which varies between high intensity such as maximum speed training or medium intensity in the case of using resistance with speed training, as "these hormonal responses lead to increased adaptation of the tissues working to withstand high-intensity training or resistance training" ^[17]. This is what the test results proved in that increasing the activity of the IGF-1 led to the development of the speed-specific strength of the leg muscles in the research sample. Stress hormones, the most important of which is the IGF-1, help when applying physical exercises according to the ballistic training method to increase the metabolism of nutrients, as "the growth hormone and the IGF-1 work to bring about fundamental changes in the production of energy necessary for metabolic processes to maintain muscle contractions when performing physical activity, as they continuously mobilize energy during physical effort" ^[18].

The researcher attributes the development in the speed-specific strength of the leg muscles to the type of physical exercises proposed according to the ballistic training

method, which included high-intensity exercises to develop speed and strength separately, and others to develop physical abilities, especially the speed-specific strength of the leg muscles, which is the main physical ability that a triple jumper needs when performing the jumping skill, "Ballistic exercises are characterized by incomplete contractions that lead to increased pressure on the muscle to bear the burdens of high-intensity exercises" [19]. Speed exercises with resistance using weights, weight jackets, or weight kettle bells led to muscle adaptation and increased ability to bear the burdens of strong exercises and their ability to perform the rapid contractions required by these exercises, especially resistance exercises that were performed by the research sample in different forms and positions, which had a positive impact on developing the speed-specific strength of the leg muscles, as well as their role in stimulating and adapting the largest number of muscle fibers to perform speed repetitions using resistance, "Ballistic exercises play a role in activating a large number of muscle fibers and in rapid contraction at the same time in the fastest time, as the more muscle fibers participate, the more force the muscle can produce" [20]. Therefore, these exercises helped stimulate the required number of muscle fibers and also increased neuromuscular coordination in transmitting the appropriate nerve signals to perform exercises that combine strength and speed. The nervous system works to stimulate the nerve cells responsible for the motor units to stimulate the working muscle fibers to increase the strength and speed of their contraction, as "when training physical abilities, neurological changes occur in shortening the time needed to recruit motor units and increasing the tolerance of motor neurons to high nerve impulses" [21]. This is what the researcher sought to do in developing exercises that combine strength and speed to increase the muscle's ability to perform appropriate rapid contractions and raise the muscle's ability to perform the triple jump skill with coordination and precise coordination through which the player can perform the jumping skill accurately. Therefore, the proposed ballistic exercises led to the development of the speed-specific strength of the leg muscles and improved the coordination between the leg strength and the speed of pushing them to the ground by stimulating the nervous system with more motor units participating in the skill performance. The exercises aimed to develop the muscle groups working in performing the triple jump skill, which requires this necessary physical ability for the leg muscles in jumpers because it requires fast and strong maximum muscle contractions that express the extent of the leg muscles' ability to push the body up and forward so that the player can obtain the best motor performance when performing the skill during competitions, this is what happened in the research sample in terms of development in contraction strength over a longer period of time when they performed ballistic training, which gave the player a highly efficient achievement and the ability to contract and expand the fast muscle fibers that are compatible with this training method, which included speed and strength exercises with body weight resistance, such as fast running, hopscotch, jumping on the spot or over hurdles, and climbing the stands, as well as speed exercises combined with external resistance, such as weight training, running, jumping, and hopscotch exercises by wearing a jacket and weights. These exercises led to the development of speed-specific strength and improved neuromuscular

coordination as a result of the research sample performing these exercises, most of which are characterized by running and jumping, which is done by extending and shortening the muscle, which helped stimulate the fast working muscle fibers, as "various jumping exercises work to develop the efficiency of the nervous and muscular systems to perform fast and strong jumps in opposite directions, while reducing the performance time for these opposite variables to give them an advantage in jumping" [22].

The researcher attributes the improvement in the triple jump to the proposed ballistic exercises prepared by the researcher according to the level of the research sample, which led to an increase in muscle strength and contraction speed, which increased the strength of the leg muscles to push the body up and forward, in addition to increasing the activity of the IGF-1, which enhanced the muscle tolerance to heavy training loads and performance of the achievement at the best level. The ballistic exercises were characterized by high intensity in strength or speed training with a relatively long rest, whether between repetitions or between the groups that make up the training unit, while the level of intensity decreased in exercises that link speed to resistance, such as jumping, vaulting and hopscotch exercises, by wearing weight wraps, jackets, and lifting weights to perform repetitions at appropriate and constant speeds, in addition to maintaining the ability of the muscles to continue to contract rapidly, which is compatible with this type of dual exercise between strength and speed, which leads to the adaptation of the muscles to bear additional weights and increases their ability to produce a distinctive speed-specific strength that is compatible with performing the triple jump skill at the best level, because "increasing the speed of performance occurs when producing the greatest muscular action by using jumping and hop exercises, in addition to containing harmonious exercises that contribute to coordinating and organizing strength, which is reflected in improving the level and speed of performance, because the time for storing energy within the muscle and ligaments must be short and occurs as a result of eccentric contraction and reflexive reaction" [23]. The researcher took into account the precise proportion between effort and rest in order to avoid the players reaching abnormal fatigue that leads to the player's weak ability to perform physical and skill exercises properly, especially since ballistic exercises are linked to the nervous system that stimulates nerve cells to stimulate the motor units working in performing the appropriate muscle contractions to perform physical and skill exercises. Therefore, the nervous system should not be overworked because it will negatively affect neuromuscular coordination and thus the skill will not be mastered accurately. The nature of ballistic training works to develop physical abilities that require producing rapid force more than once, such as the speed-specific strength that matches the triple jumper who uses it during the approach run and when performing the jumping skill, because the exercises of this training method led to the adaptation of the working muscle groups when performing this skill in all its stages. Therefore, the proposed exercises had a major and primary impact in developing the speed-specific strength of the leg muscles and increasing the glands' secretion of growth hormone, which increased the activity of the IGF-1, which led to an increase in the muscle building of the working muscles, which made them gain a greater ability to bear the burdens of ballistic exercises and thus improved the

achievement to the best level. Therefore, ballistic training created a state of equivalence between the training load and the speed-specific strength of the leg muscles based on the biochemical changes represented by the increased activity of the IGF-1. In addition, repeating the exercises developed the physical ability of the leg muscles in the sample by recruiting the motor units of the working muscles in the physical and skill performance of this sporting activity, which led to the development of the skill of jumping up and forward and obtaining Precise and appropriate muscle contractions to convert vertical jump speed into horizontal jump speed at an appropriate angle, and this is what happened to the sample whose research results demonstrated a tangible improvement in their level of achievement.

Conclusions and Recommendations

Conclusions

1. Ballistic training exercises led to an increase in the percentage of insulin-like growth factor (IGF-1) in the blood of the research sample.
2. Ballistic training exercises led to an improvement in the level of achievement of the triple jump in the research sample.

Recommendations

1. Use the ballistic training method to develop the speed-specific strength and achieve the triple jump effectiveness because it is one of the most appropriate training methods in developing the speed-specific strength of the leg muscles and achieving this sporting activity.
2. The necessity of linking speed exercises with the use of resistance when developing the physical capabilities of sports activities whose skills depend on jumping and vaulting because of their importance in developing the speed-specific strength of the muscles working in physical performance.
3. Trainers should monitor the activity of the IGF-1 because of its importance in building muscle and cartilage and increasing bone hardness and durability.
4. Conduct research to study the effect of the ballistic training method on hormones or other physiological variables.
5. Conduct research to determine the effect of the variables under study on athletes practicing other sporting activities.

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