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The Effect of Exercises with Different Resistances to Develop Some Biomechanical Variables to Achieve the Effectiveness of the Triple Leap for Female Students

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Abstract

Each sport has a set of characteristics that distinguish it from others. The Triple Leap is considered one of the sports that needs special characteristics and abilities. This sport, by its nature, requires a high tactical physical level. Supporting training with scientific theories relied upon to build learning and mechanical foundations can achieve the goals that this type of sports aspires to. The research aimed to prepare resistance training exercises to develop some biomechanical variables and raise the level of performance of triple leap athletes. The experimental method was chosen to achieve the research goal by designing two equal experimental and control groups with a pre- and post-test and applying it to the sample. the research sample consisted of 18 students from the second stage, Department of Physical Education and Sports Sciences - Al-Mustaqbal University for the academic year (2023-2024) in Iraq. The findings revealed that incorporating diverse resistances into the training program significantly influenced the improvement of biomechanical variables and performance in the studied triple jump event. Specifically, the experimental group displayed a notable advantage in developing both biomechanical variables and overall performance compared to the control group. This highlights the crucial role for coaches to utilize a varied selection of resistance shapes and weights to optimize the enhancement of the triple jump event.

Keywords: biomechanical variables, triple leap, motor performance.

Introduction

At the present stage, the world is witnessing a broad scientific renaissance in all fields, including the sports field (Azzawi, Alshukri, Jawoosh, & Kadhum, 2022). This development is due to the benefiting from various research and studies presented, especially in the field of biomechanics and sports training science, which is concerned

with developing the athlete's physical, motor, and skill proficiency so that he can fulfill the requirements of athletic achievement (Barbosa et al., 2023).

Athletics is considered one of the sports that relies on the advanced scientific method to improve the level of achievement, such as sports training, biomechanics, physiology, anatomy, and others. the Scientific ideas came about designing various training curricula that include improving biomechanical variables and according to the intensity applied in training and in a manner commensurate with the needs of these sports (Herman, Pritchard, Cosby, & Selkow, 2022; Jawoosh et al., 2022).

There are many important biomechanical variables to identify the level of motor performance and control these variables by using motor analysis in the triple leap sport. measuring biomechanical variables can draw a clear image about how to achieve high accuracy and fluidity in the interconnection of the performing stages (Pleša, Kozinc, & Šarabon, 2022). This has a significant impact on developing and integrating performance among athletes and demonstrating the importance of using motion analysis programs when performing the triple leap step and measuring the speed of the final step, angle of flight, vertical speed, and other biomechanical variables. motion analysis programs are an accurate measure for measuring mechanical variables, as they are considered important for achieving the best results during the technical stages of the triple leap (Zaras, Stasinaki, & Terzis, 2021).

The poor achievement suffered by female triple leap Iraqi athletes returned to weakness in some physical, skill traits, abilities, and biomechanical variables. This study aims to increase interest in biomechanical variables because they play a major role in improving ideal technique and thus improving achievement level among female athletes. at the same times, applying resistance training in accordance with the foundations of sports training and the correct mechanical foundations that ensure the development of female athletes in a manner commensurate with the method of technical performance of this sport and with a high economy.

Methodology

Incorporating the typical research problem, the most suitable scientific research method for addressing the current study's issue is experimental application. This approach is selected for both teams, involving experimental and control groups, along with a pre- and post-test for equivalence.

Sample of the study

The research population was defined as female students in the second stage of the Department of Physical Education and Sports Sciences at Al-Mustaqbal University for the academic year (2023 - 2024), totaling 18 students, as detailed in Table (1). From this population, 16 female students were randomly selected to form the research sample. Using a lottery method, these students were assigned to two groups: control and

experimental, each comprising 8 female students, resulting in a selection percentage of 88%. The selection process involved the simple random method (lottery method), wherein student names were placed in a box, names were drawn, and sample members were chosen for each group.

Table (1) shows the distribution of members of the research sample.

The population	The sample	Pilot study	Percentage
18	16	2	88%

Homogeneity of the Sample:

The homogenization process was conducted for the research sample members with respect to the variables (height, leg length, mass). This step was taken due to the influence of these variables on the dependent variables. The statistical procedures applied included the coefficient of variation and the skewness coefficient, as presented in Table (2)."

Table (2) Homogeneity of the research sample

No	Variable	Measurement	Mean	SD	Median	Skewness	CV
1	height	Miter	1.639	0.061	1.59	0.044	3.412
2	leg length	Centimeter	0.91	0.026	0.89	0.517	2.324
3	mass	Kilogram	59.55	2.86	59.50	0.660	4.315

Table (2) indicates that the skewness coefficients for the variables fall within the range of ±3. This suggests homogeneity among individuals in the research sample with regard to the variables (height, leg length, mass).

Method, Devices and Tools used in research.

1- Research methods.
   - The interview.
   - Note.
   - Tests and measurement.
2- Devices and tools.
   - Two Casio video cameras, made in Korea.
   - laptop type Dell.
   - Electronic scale.
   - Two manual timing watches, type (KISLO 610), Chinese.
   - Kinetic analysis program (Kenova).
   - The drawing scale is one meter long.
   - Two camera holders.
   - Rubber ropes of multiple lengths.

- Resistors of different weights.
- Training barriers (of different heights).
- Boxes (different heights).
- Measuring tape.

The measurement

Biomechanical Variables:

To identify the variables for use in this research, an exhaustive survey of the most pertinent sources and references related to the research was conducted (Jasminan & Chandana, 2021; Makaruk, Porter, & Starzak, 2018). The findings were subsequently presented to specialists for consultation, and based on their input, specific biomechanical variables crucial to the research were identified. These variables include:

1- The speed of the last step before the hopscotch.
2- Flight angle.
3- Execution of the triple jump.

Triple Jump Test:

The triple jump test serves as a means to assess both the achievement in the triple jump and various biomechanical variables. Initiated with a brisk run covering the full approach distance, the athlete transitions through distinct phases. Beginning with the approach phase, the athlete executes the hopscotch phase employing the same leg positioned on the rising board. Subsequently, a jump is executed with the leg opposite to the one used in the hopscotch phase. The athlete then rises with the stepping leg, ultimately landing with both legs in the designated landing area. Each player is afforded three attempts in the triple jump test (Nonnato, Hulton, Brownlee, & Beato, 2022).

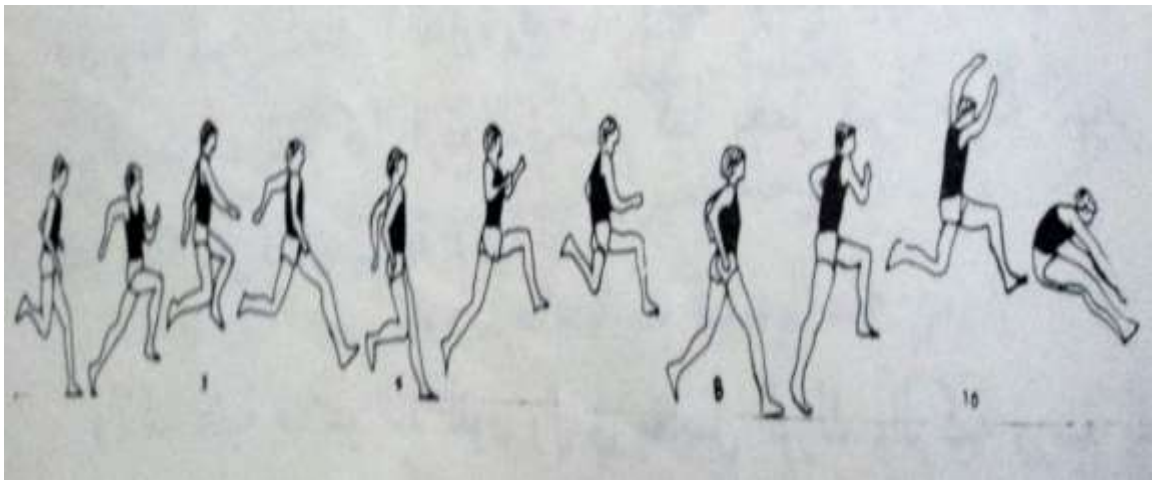

Figure (1) shows the triple jump completion test.

Points are scored based on the distance measured from the ascending board to the nearest trace left by the body in the landing zone near the ascending board. Each player is granted three attempts, and the best attempt is considered for scoring.

Additionally, the biomechanical variables (speed of the last step before the hop, angle of flight, completion of the triple jump) are assessed by capturing the technical performance of the research sample in the triple jump test, both pre- and post-achievement, as illustrated in Figure (2).

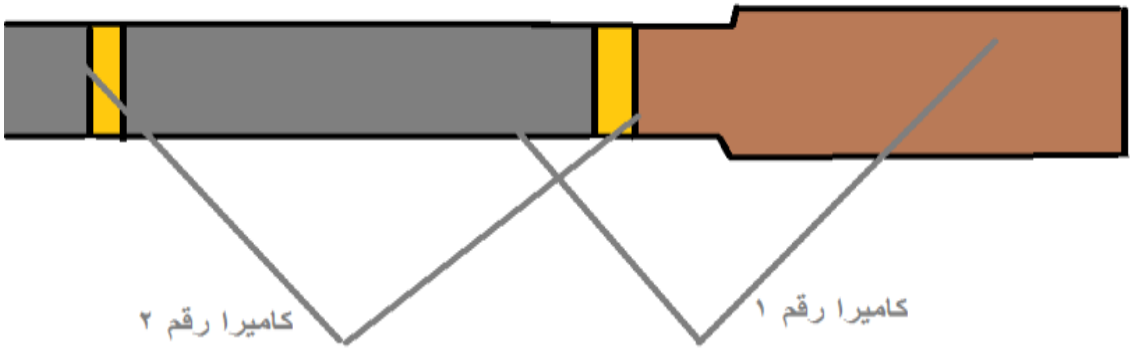

Figure (2) shows a depiction of the triple test and measurement of biomechanical variables.

In this study, two photographic devices were employed. Positioned at a distance of 7 meters from the approximate running field and at a height of 1.6 meters, the machines were spaced 5.90 meters apart. Measurements were conducted using a drawing scale of 1 meter, and the following biomechanical variables were assessed:

1- The speed of the last step before the hopscotch:

The speed of the last step before the hopscotch is defined as the step just before the jumper's foot makes contact with the stepping board. This measurement is crucial for gauging the jumper's speed before executing the triple jump, calculated according to the following formula: Speed = meters/time (meters/second) (Hussain & Almujamay, 2022).

2- Flight angle.

The angle of flight for each stage is defined as the angle between the line connecting the body's center of gravity before leaving the board (located in the second to fourth frame of its flight) and the horizontal line parallel to the ground, oriented towards the front. This angle is measured in degrees (Thotawaththa & Chandana, 2021).

The pilot study:

A pilot study stands as a crucial preparatory step in research across diverse disciplines. It involves a preliminary investigation by the researcher on a limited sample before commencing the actual study. The exploratory experiment was executed on

November 16, 2023, involving a sample of four female students from within the research cohort. The objectives of the exploratory experiment were:

- Determine the time required for test administration.
- Train the assisting staff team.
- Inspect and ensure the safety of the utilized tools.

Pre-tests

On November 13, 2023, pre-tests were administered at the stadium of the Department of Physical Education and Sports Sciences at Al-Mustaqbal University College. These pre-tests encompassed biomechanical variables and the execution of the triple jump event.

Equivalence of Samples:

To ensure the precision of research results and attribute differences solely to the independent variable, equivalence was established between the control and experimental groups. This study employed the T-test for two independent samples, as illustrated in Table (3). The purpose of this process was to control variables that could potentially impact the accuracy of the study's outcomes.

Table (3) shows the equivalence of samples.

Variables	Measuring	Control Group		Experimental Group		*T-test*	*p*
		Mean	SD	Mean	SD		
The speed of the last step before the hopscotch	Meters/ Second	6.5	0.351	6.46	0.128	0.105	0.922
Flight angle	Degrees	17.700	0.447	17.733	1.032	0.349	0.744
Achievement	Meters	9.690	0.305	9.076	0.543	0.247	0.820

The level of significance is set to $p < 0.05$.

Main Search Experience (Exercise Application):

Following the conclusion of pre-tests, this study administered exercises with varying resistances to the experimental group, ensuring a high standard of exercise quality. The implementation of exercises outlined in the training program commenced on November 20, 2023, and spanned a duration of 4 weeks, constituting 3 training units per week. In total, the intervention comprised 12 training units. The exercise intensity ranged between 85% and 100%, employing the high-interval training method.

Two types of counterweights, distinguished by weight and material (rubber), were utilized. The researcher incorporated additional weights equivalent to 10-15% of each body part's weight. Specifically, torso weights ranged from 1-2 kg, while leg weights ranged from 0.25-1 kg. Circular rubber ropes, placed between the legs, and ropes with

lengths of 2-25 meters were also employed. It is noteworthy that these exercises were exclusively applied to the experimental group. The entire exercise regimen concluded on December 27, 2023.

Post-tests:

In this study, the post-tests were executed on December 31, 2023, at the Department of Physical Education and Sports Sciences field at Al-Mustaqbal University, adhering to the same conditions as those applied during the pre-tests.

Data Analysis:

In the field of the study mentioned above, various software programs are applicable; however, researchers must select the most suitable software for their needs. The Statistical Package for Social Sciences (SPSS) software is extensively utilized for statistical analysis, particularly in the domains of education and research. This research employed SPSS version 22 for data analysis. Descriptive analysis of the data included means, standard deviations, and T-tests for variables such as the speed of the last step before the hopscotch, flight angle, and the achievement of female players. The significance level was set at $p < 0.05$.

Result:

The descriptive analysis for biomechanical variables is shown in Table (4), encompassing the speed of the last step before the hopscotch, flight angle, and achievement.

Table (4) shows the arithmetic mean, the SD, and the T-test of the post-test for the control and experimental groups.

Variables	Measuring	Control Group		Experimental Group		*T-test*	*p*
		Mean	SD	Mean	SD		
The speed of the last step before the hopscotch	Meters/ Second	6.048	0.211	6.350	0.114	3.662	0.012
Flight angle	Degrees	17.353	0.716	18.862	0.416	3.183	0.007
Achievement	Meters	9.575	0.519	10.116	0.406	2.353	0.039

The level of significance is set to $p < 0.05$.

The results of the descriptive statistical analysis for biomechanical variables indicate that the speed of the last step before the hopscotch for Iraqi female triple jumpers was (*T-teat* = 3.662, *p* = 0.012), the flight angle was (*T-test* = 0.514, *p* = 0.007), and the achievement score was (*T-test* = 2.353, *p* = 0.039).

Discussion:

Upon reviewing the findings in Table (4), this study observed significant differences in the post-test outcomes between the experimental and control groups. This suggests a notable impact of the speed of the last step before the hopscotch. Each student demonstrated a distinct style of approximate running to attain a suitable speed aligned with her individual physical capabilities and technical skills. It is crucial to note that there are no universal ideal speeds for a specific event due to variations in players' physical specifications. Instead, ideal speeds are unique to each player and can be identified through continuous training and experience. Furthermore, during the allocated training period, diverse resistances were introduced for the experimental group members, contributing positively to this variable.

These observed differences stem from the exercises designed with a foundation in scientific principles and a strategic approach to enhance the effectiveness of the triple jump. By forsaking traditional means and incorporating resistance, the propulsion process experiences an acceleration in speed. This acceleration is attributed to the exploitation of kinetic energy acquired by players, particularly during the last step, to fortify strength in the ascending phase. This strategic utilization ensures minimal loss of kinetic energy, thereby positively impacting muscular capabilities and significantly influencing the ultimate achievement.

Accurate technical execution by the player during the approach phase, coupled with adopting an appropriate posture in the rising phase, guarantees the generation of substantial momentum. This momentum can then be efficiently utilized as a reaction force during the pushing phase, contributing to increased distance. Furthermore, it facilitates achieving a brief reaction time, crucial for attaining optimal performance and success in the overall achievement.

Upon presenting the results from the flight angle test as depicted in Table (4), a significant effect on the flight angle was evident, favoring the experimental group. The flight angle variable is intricately linked to both the speed and strength of the body, along with the body's position at the moment of propulsion. The observed enhancements among the experimental group members are attributed to the efficacy of the exercises meticulously designed by the researcher. These exercises involved constructing motor programs for the rising stage, fostering the students' sensory-motor perception as they executed the movements. This process facilitated the preservation of the movement in memory, enhancing their ability to retrieve it.

Control over performance stems from sensory perception of the movement's impact and what is stored in motor memory, representing the memorized movement program utilized by the learner. This program serves as the reference for initiating the

movement, portraying the envisioned motor action. This mental image of motor work acts as a guide for learners, providing a comprehensive understanding of the final performance.

Consequently, the exercises devised in this study to enhance the triple jump event, incorporating varying resistances and emphasizing repetition for motor performance, led to a notable advancement in the flight angle variable.

Upon presenting and scrutinizing the results in Table (4), evident and significant differences between the control and experimental groups became apparent, favoring the experimental group. This outcome is attributable to the utilization of exercises in this research involving various resistances, such as rubber ropes and weightlifting. Consequently, these interventions contributed to a notable enhancement in the achievement of the female students, successfully achieving the second objective of the study.

The first hypothesis of the research, positing that these resistances would lead to achievement development, finds support in the diverse nature of the resistances employed. The variations in resistance types, the specific areas targeted by them, and the differing weights of the weights collectively demonstrated that the set of exercises implemented by this research for the experimental group fulfilled specific motor functions. These exercises systematically engaged crucial muscle groups involved in the triple jump.

Achievement, defined as the athlete's best horizontal distance in the triple jump event, saw improvement through the researcher's meticulously designed exercises, integral to the training program. This improvement signifies enhanced work efficiency among the muscles and joints of the body, resulting in increased force production. Consequently, it positively influenced the overall achievement attained by the participants.

Conclusion:

In conclusion, the training regimen incorporating various resistances demonstrated a discernible impact on the advancement of biomechanical variables and performance within the studied triple jump event. Notably, the experimental group exhibited a pronounced advantage in the development of both biomechanical variables and overall performance compared to the control group. This underscores the importance for coaches to employ a diverse array of resistance shapes and weights when aiming to enhance the triple jump event.

The imperative of integrating training with different resistances for the development of biomechanical variables and performance extends beyond the triple jump

event. Coaches are encouraged to incorporate such training methodologies across various events. Furthermore, these exercises should not be limited to specific athlete categories, as their positive impact on speed development suggests their potential efficacy for athletes across diverse categories, including triple jumpers.

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