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THE EFFECT OF LACTIC PHYSICAL EFFORT EXERCISES ON THE DEVELOPMENT OF FAST STRENGTH AND CONCENTRATION OF BETA HORMONE AND LACTIC ACID ON THE ACCURACY OF THE FOREHAND STROKE OF TALENTED SQUASH PLAYERS

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Abstract
This study aimed to investigate the effect of anaerobic lactic physical effort training on developing speed, strength, the concentration of beta-endorphin and lactic acid, and the forehand accuracy in talented squash players. The researcher utilized this specific training method to address the research problem, focusing on how such anaerobic lactic effort training impacts speed strength and the biochemical variables of lactic acid and beta-endendorphin concentration in the context of forehand accuracy. The study involved designing a training program based on this approach. The sample consisted of 14 talented squash players, from whom 2 were excluded for a pilot study, leaving 12 players. These players were divided into two groups of 6 each: a control group and an experimental group, both drawn from talented players at the Iraqi Squash Federation Center in Baghdad. These selected players participated in pre- and post-tests for both groups to assess speed, strength, and analyses that were conducted for the biochemical variables of lactic acid and beta-endorphin concentration, as well as forehand accuracy. Statistical analysis of the collected data revealed key findings, including the development of speed, strength, and a reduction in the levels of biochemical variables like lactic acid and beta-endorphin concentration, all contributing to improved forehand accuracy in the sampled players. The researcher's recommendations emphasize the importance of incorporating specific anaerobic lactic physical effort training that maintains consistent intensity, aligns with the studied biochemical variables, and simultaneously enhances speed and strength for optimal forehand accuracy. This training approach is seen as a foundational element upon which other squash training methods can be built for future studies involving different player cohorts and similar game conditions.
Keywords: Speed Strength, Lactic Acid Concentration, Beta-Endorphin, Forehand Accuracy.

Introduction

The significant role of sport in global forums and its prominent status among nations, especially racket sports like squash, is undeniable. Squash, with its many diverse and aesthetically pleasing skills, requires speed, strength, balanced biochemical variables such as lactic acid and beta-endorphin concentrations, and precise forehand accuracy. Achieving optimal technical performance in these aspects necessitates specific anaerobic lactic physical effort training. The advancement in sports performance and significant achievements across various sports and activities stem from addressing scientific issues through modern scientific methodologies and approaches in sports training. This requires coaches and professionals in the field to deeply understand

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and apply their specialization and related sciences, leveraging this knowledge to improve athletic performance. This includes developing speed and strength, optimizing biochemical variables like lactic acid and beta-endorphin concentrations, and improving forehand accuracy through training methods that enhance physical capabilities. Athletes who regularly train experience satisfaction, despite significant variations in endorphin (beta-endorphin) secretion timing among individuals. This suggests that as an athlete's performance improves, their beta-endorphin levels tend to rise compared to other athletes, reflecting their developmental progress (Ahmed Ali,2005).

The specific anaerobic lactic physical effort imposed on athletes through training loads and competitions often disrupts their internal environment, negatively impacting their technical performance. This disruption elicits serious responses that demonstrate the capacity of the active biological systems to maintain internal environmental components and manage changes in biochemical variables. "Therefore, the approach to determining training load direction depends on understanding the primary energy supply system. Training based on energy systems is considered one of the best modern training methods for improving the performance of squash players across the studied variables" (Mohamed Khalaf, 2001). This forms the cornerstone for preventing performance decline and its adverse effects on accuracy, particularly in the forehand stroke, which is crucial for scoring and winning matches. This vital skill is influenced by the effort expended by players and affects the development of speed and strength within the game's biochemical parameters, including forehand execution.

Hence, the importance and necessity of this research arose. However, many practitioners in the coaching field are unaware of the significant impact of specific anaerobic lactic physical effort on speed and strength training, particularly when using hurdle jumps of varying heights. Furthermore, they may not fully grasp the interplay between speed, strength capabilities (especially intensity and duration), and the players' biochemical efficiency for anaerobic lactic effort, specifically regarding lactic acid and beta-endorphin concentrations. A lack of understanding in these areas can negatively impact the effective performance of forehand accuracy in talented squash players within the sample.

Research Problem

Ensuring the sustained functional capacity of players during specific anaerobic lactic physical effort, while maintaining low levels of certain variables according to the requirements for optimal performance, presents a challenge. These biochemical variables, specifically lactic acid, and beta-endorphin, are influential. Fluctuations in their levels can cause negative effects on players, leading to a loss of capabilities, whether in speed, strength, or biochemical efficiency, that impact skill performance, especially the forehand stroke. The forehand is a key means for players to achieve effective and impactful performance or to execute skills with high functional speed, strength, and efficiency. Therefore, the researcher sought to address this problem for this age group, investigating the extent to which specific anaerobic lactic physical effort impacts speed, strength, and the concentrations of lactic acid and beta-endorphin. The ability of the body's systems to cope with and overcome fatigue will influence changes in speed, strength, and the functional responses of the studied biochemical variables, which are a cause of decreased skill performance. The researcher emphasizes the role of these variables—speed, strength, lactic acid concentration, and beta-endorphin concentration—in the forehand performance of the sampled squash players. The researcher hopes that this study will open avenues for practitioners in the training field to validate the proposed efforts, as well as to enhance player efficiency by developing the requirements for speed, strength, and these crucial and effective biochemical variables, all within the framework of the training regimen for the sampled individuals.

Research Objectives

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1. To design specific anaerobic lactic physical effort training for speed, strength, and the biochemical variables of lactic acid and beta-endorphin concentration for the sampled players.
2. To identify the effect of this anaerobic lactic physical effort training on developing speed, strength, and the biochemical variables of lactic acid and beta-endorphin concentration on the forehand accuracy of the sampled players.

Research Hypotheses

1. There are statistically significant differences between pre- and post-tests in speed and strength within the studied biochemical variables for the sampled players.
2. There are statistically significant differences among speed, strength, biochemical variables, and forehand accuracy for the sampled players.

Definition of Terms

- **Biochemical Variables:** These are indicators that continuously interact within the body to maintain life and ensure the optimal functioning of internal organs, systems, and muscles. They include enzymes, hormones, and various chemical compounds that are important in sports, as their activity increases with higher performance efficiency, aiding in effort and athletic achievement (Amrullah Al-Sabati, 1998).
- **Speed Strength:** This is the nervous system's ability to produce force quickly (A, A, Abd El-Fattah; and Ahmed Kasra, 2003), or the ability to overcome resistance with high muscular tension rapidly (Mohamed Allawi; and Ahmed Kasra,2003).
- **Beta-Endorphin:** This refers to an activity that improves mood, reduces depression, anxiety, and stress, due to an increase of this hormone in the blood, which lasts up to 15 minutes after exercise (Hikmat Aziz, 2007).
- **Lactic Acid Concentration:** This is the second source of energy after the phosphagen system and functions in the presence of oxygen. It operates according to the glycogenolysis system, discovered by Emden and Meyerhof, who identified its intermediate compounds in 1930 (Abdel Badawi,2002).

Methodology

Study Design

The researcher adopted an experimental design with two groups, experimental and control, utilizing pre- and post-tests(Mohammed Hammood et al., 2025; Omar et al., 2025). This design was chosen as it aligns with the nature of the problem and the procedures of field research, given that "the nature of the problem dictates the research methodology in order to reach and uncover the truth to achieve a specific outcome" (Wajeeh Mahjoub,1993).

Participants

"The research sample represents the original population and serves as the model upon which the researcher conducts the entirety of their work" (Abdel Amir, Raed, 2006). The researcher identified the research population and sample from the talented squash players at the Iraqi National Federation Center for the game, initially numbering 14 competitors. Two players were excluded from the pilot study, reducing the number to 12 competitors, who were then divided into two groups of 6 each: a control group and an experimental group. Table (1) shows the normal distribution of the sample individuals for the variables under study.

No.	Variable	Unit of Measurement	Mean	Median	Standard Deviation	Skewness Coefficient
1	Speed Strength	m/cm	8.385	8.38	0.042	0.157

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2	Beta-Endorphin	ml	3.247	3.255	0.039	0.260
3	Lactic Acid	ml	9.22	9.21	0.071	0.079
4	Forehand Accuracy	Degree	35.33	35	0.887	0.139

Table (2) shows the results of the equivalence of the two groups (Control and Experimental) in Mean, Standard Deviations, Errors of Differences, Calculated T-values, and Significance Level.

Variable	Unit of Measurement	Control Group Mean	Control Group Std. Dev.	Experimental Group Mean	Experimental Group Std. Dev.	Calculated T-value	Error Level	Statistical Significance
Speed Strength	m/cm	8.386	0.045	8.385	0.043	0.065	0.949	Not Significant
Beta-Endorphin	ml	3.261	0.03	3.233	0.044	1.284	0.228	Not Significant
Lactic Acid	ml	9.225	0.075	9.216	0.073	0.193	0.881	Not Significant
Forehand Accuracy	Degree	35.116	0.752	35.50	1.048	0.632	0.583	Not Significant

Degrees of Freedom: 10; Significance Level: (0.05)

From the results in the table above, it is clear that the calculated T-values are lower, indicating no significant differences between the two groups (control and experimental) in both pre- and post-tests.

Data Collection Means and Equipment Used

1. Data Collection Means:
1. Arabic and foreign sources and references.
2. Tests and measurements.
3. International information network (Internet).
4. Registration forms.
2. Equipment and Tools Used:
1. Standard squash court.
2. Measuring tape.
3. 8 Cones/Markers.
4. Device for measuring height and weight.
5. 1 Stopwatch.
6. Dell Laptop.
7. Camera.
8. Special syringes for blood collection.
9. Fuji device (Japanese-made) for chemical component analysis.

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10. Lactate Pro 2 device (Japanese-made) for measuring lactate concentration.
11. Cotton and sterilization materials.
12. 10 Squash rackets.

Research-Specific Tests and Measurements

1. Physical Tests

First: Speed Strength Test (Muayyad Al-Taie, 2008)

- **Purpose:** To measure the speed and strength of the subject.
- **Description:** The subject stands and performs three alternating jumps as far as possible.
- **Measurement:** The distance is measured from the moment of the jump's start to the end of the third alternating jump, recorded in m/cm.

Second: Chemical Tests

The tests for lactic acid and beta-endorphin were determined according to modern scientific sources, aligning with the study's requirements and field procedures. Blood samples were drawn by specialized medical personnel from the forearm vein while the subjects were seated. The blood was then transferred from the syringes to numbered blood collection tubes, with each tube number corresponding to the player's name on the registration form. Ten numbered tubes with anticoagulant were used to preserve the blood for extracting beta-endorphin and measuring lactic acid concentration, with particular attention to speed in drawing plasma and placing it in the test tube for measurement.

1. Beta-endorphin.
2. Lactic acid.

Second - Measuring Blood Lactic Acid Concentration (Abu Al-Ela Ahmed,1999)

- **Objective:** To determine lactic acid concentration after effort.
- **Equipment:** Two Lactate Pro LT-1710 devices from Arakray, Japan; two lancets; two CK Strip (Calibration) strips; one Test Strip; cotton and disinfectant; two hand towels.
- **Performance Description:** Lactic acid is measured five minutes after the strength test performance to ensure its transfer from muscles to blood (Abdel Rahman Hamid,1993), as follows:
    - Prepare the Check Strip for operation, then remove it.
    - Then, remove the Calibration Strip, and finally, place and secure the Test Strip in the device.
    - Clean the area with disinfectant, then prick it with the lancet. Place a drop of blood, and the device will count down from 59 seconds to 1 second. The unit of measurement is (mmol/L).
- **Recording:** Perform the speed strength test, then measure lactic acid.

Third: Forehand Groundstroke Accuracy to a Divided Target (Osama Riyadh, 2005)

- **Purpose:** To measure the accuracy of the straight forehand stroke in squash.
- **Test Procedures:** The test is conducted on a standard squash court using squash rackets, squash balls, and a registration form. Five square targets are drawn on the right side of the front wall. The first square measures (30cm x 30cm, and the distance between each square is (20cm). Figure (3) illustrates the evaluation marks, player standing area, and test execution.
- **Performance Specifications:** The test involves the player standing behind the service line, facing the right-side wall, adopting the correct forehand stance. After explaining the test, the player is given 5 experimental attempts after a warm-up to understand the test execution. Each player is then given 10 attempts. The player starts hitting the ball continuously towards the divided target. The player must hit the ball after it bounces on the floor; otherwise, the attempt is deemed void.
- **Scoring:** Points are awarded for each correct hit as follows:

- (5) points if the ball touches a square number (5).
- (4) points if the ball touches a square number (4).
- (3) points if the ball touches a square number (3).
- (2) points if the ball touches square (2).
- (1) point if the ball touches square (1).
- (0) points if it is outside the drawn boundaries.
- **Note:** If the ball lands on one of the shared lines, the points for the larger square are counted.

Figure 1, A diagram representing the accuracy of the squash forehand skill. (Image missing, but described as a layout of a squash court with target squares)

Pilot Study

The researcher conducted a pilot study on February 25, 2025, at 3:00 PM, at the Iraqi Squash Federation Center courts, with 2 participants. This was done to gather information for the main experiment with the assistance of the research team. The pilot's study aimed to assess the method of performing the tests and the number of attempts required from each player. The specific purposes of the pilot study were(Ali et al., 2022, 2024), (Hussein Fayyad et al., 2025):

- To confirm the suitability of the tools used in the main experiment.
- To evaluate the appropriateness of the tests for the research sample.
- To ensure the readiness of the subjects for the tests.
- To assess the competence and number of the assisting research team.

Pre-Test

The pre-test was conducted on February 16, 2025, on the research sample. It included physical tests (speed and strength), biochemical tests (beta-endorphin and lactic acid concentration), and skill tests (squash forehand accuracy) at the Iraqi Squash Federation Center courts.

Training Program for Anaerobic Lactic Physical Effort Exercises

The researcher designed a specific training program based on anaerobic lactic physical effort, consisting of 16 training units. This program took into account the general capabilities and levels of the research sample on one hand, and the availability of equipment and tools on the other, relying on the results of the pilot study. The training program aimed to create an organized plan for training a group of individuals on the components of anaerobic lactic physical effort to develop speed and strength, in accordance with the requirements of beta-endorphin and lactic acid concentrations. To achieve this, the researcher defined the experimental program and allocated suitable and sufficient time for its implementation according to the requirements of anaerobic lactic physical effort in developing speed strength, along with some biochemical variables related to beta-endorphin and lactic acid concentrations, and their effect on the forehand accuracy of the sampled individuals. The training program included other components such as bodyweight jump exercises, hurdle and varying height box jumps, and various plyometric exercises, such as fast-performing lactic training, all designed to achieve the objective of these lactic exercises. Training commenced with an intensity of 85% as an initial training intensity for the research subjects, given the requirements of speed strength training and beta-endorphin and lactic acid concentration according to anaerobic lactic physical effort. This intensity also aimed to establish the technical execution of the activity, as speed strength is a fundamental factor in achieving accurate forehand performance. Training intensity for jumping exercises was based on the maximum completed time in these exercises. The number of specific speed strength training units for lactic training was two units per week, on Sundays and Wednesdays. The scheduled training program was implemented over 8 weeks, with an average of two training units per week, totaling 16 training units. These units were executed

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during the specific preparation phase. The program began on February 17, 2025, and concluded on May 20, 2025.

Post-Test

The researcher conducted the post-test on May 21-22, 2025, for speed, strength, biochemical measurements of beta-endorphin and lactic acid concentration, and squash forehand accuracy in the sampled individuals, with the assistance of the research team.

Statistical Means

The researchers used statistical analysis via the SPSS statistical package, employing(Hammood et al., 2024; Khalaf et al., 2025):

- Mean
- Standard Deviation
- T-test for paired samples

Results

Table (3) shows the Means, Standard Deviations, Differences, Calculated t-value, Error Level, and Significance for the Control Group in the Pre- and Post-Tests.

Variables	Unit of Measurement	Pre-Test Mean	Pre-Test Std. Dev.	Post-Test Mean	Post-Test Std. Dev.	Difference in Means	Difference in Std. Dev.	Calculated t-value	Error Level	Significance
Speed Strength	m/cm	8.386	0.045	8.476	0.041	0.090	0.017	12.334	0.000	Significant
Beta-Endorphin	ml	3.261	0.03	3.198	0.014	0.063	0.018	8.832	0.000	Significant
Lactic Acid	ml	9.225	0.075	7.675	0.091	1.550	0.106	35.622	0.000	Significant
Forehand Accuracy	Degree	35.116	0.752	36.33	0.816	1.166	0.408	7.000	0.001	Significant

At degrees of freedom (5) and error level (0.05).

From Table (3), it is evident that for the speed strength variable, the pre-test mean was (8.386) with a standard deviation of (0.045), while the post-test mean was (8.476) with a standard deviation of (0.041). The difference in means was (0.090), and the difference in standard deviations was (0.017). The calculated t-value was (12.334) with an error level of (0.000), indicating significance.

For the beta-endorphin variable, the pre-test mean was (3.261) with a standard deviation of (0.03), and the post-test mean was (3.198) with a standard deviation of (0.014). The difference in means was (0.063), and the difference in standard deviations was (0.018). The calculated t-value was (8.832) with an error level of (0.000), indicating significance.

For the lactic acid variable, the pre-test mean was (9.225) with a standard deviation of (0.075), and the post-test mean was (7.675) with a standard deviation of (0.091). The difference in means was (1.550), and the difference in standard deviations was (0.106). The calculated t-value was (35.622) with an error level of (0.000), indicating significance.

For the forehand accuracy variable, the pre-test mean was (35.116) with a standard deviation of (0.752), and the post-test mean was (36.335) with a standard deviation of (0.816). The difference in means was (1.166), and the difference in standard deviations was (0.408). The calculated t-value was (7.000) with an error level of (0.001), indicating significance.

Table (4) shows the Means, Standard Deviations, Differences, Calculated t-value, Error Level, and Significance for the Experimental Group in the Pre- and Post-Tests.

Variables	Unit of Measurement	Pre-Test Mean	Pre-Test Std. Dev.	Post-Test Mean	Post-Test Std. Dev.	Difference in Means	Difference in Std. Dev.	Calculated t-value	Error Level	Significance
Speed Strength	m/cm	8.385	0.043	8.595	0.032	0.210	0.017	28.755	0.000	Significant
Beta-Endorphin	ml	3.233	0.044	3.11	0.05	0.123	0.035	8.626	0.000	Significant
Lactic Acid	ml	9.216	0.044	7.293	0.185	1.923	0.209	22.514	0.000	Significant
Forehand Accuracy	Degree	35.50	1.048	38.166	0.752	2.666	0.516	12.649	0.000	Significant

At degrees of freedom (5) and error level (0.05).

From Table (4), it is evident that for the speed strength variable, the pre-test mean was (8.385) with a standard deviation of (0.043), while the post-test mean was (8.595) with a standard deviation of (0.032). The difference in means was (0.210), and the difference in standard deviations was (0.017). The calculated t-value was (28.755) with an error level of (0.000), indicating significance.

For the beta-endorphin variable, the pre-test mean was (3.233) with a standard deviation of (0.044), and the post-test mean was (3.11) with a standard deviation of (0.05). The difference in means was (0.123), and the difference in standard deviations was (0.035). The calculated t-value was (8.626) with an error level of (0.000), indicating significance.

For the lactic acid variable, the pre-test mean was (9.216) with a standard deviation of (0.075), and the post-test mean was (7.293) with a standard deviation of (0.185). The difference in means was (1.923), and the difference in standard deviations was (0.209). The calculated t-value was (22.514) with an error level of (0.000), indicating significance.

For the forehand accuracy variable, the pre-test mean was (35.50) with a standard deviation of (1.048), and the post-test mean was (38.166) with a standard deviation of (0.752). The difference in means was (2.666), and the difference in standard deviations was (0.516). The calculated t-value was (12.649) with an error level of (0.001), indicating significance.

Table (5) shows the Means, Standard Deviations, Differences, Calculated t-value, Error Level, and Significance for the Experimental and Control Groups in the Pre- and Post-Tests.

Variables	Unit of Measurement	Control Group Post-Test Mean	Control Group Post-Test Std. Dev.	Experimental Group Post-Test Mean	Experimental Group Post-Test Std. Dev.	Difference in Means	Difference in Std. Dev.	Calculated t-value	Error Level	Significance
Speed Strength	m/cm	8.476	0.041	8.595	0.032	0.210	0.017	28.755	0.000	Significant
Beta-Endorphin	ml	3.198	0.014	3.11	0.05	0.123	0.035	8.626	0.000	Significant
Lactic Acid	ml	7.675	0.091	7.293	0.185	1.923	0.209	22.514	0.000	Significant
Forehand Accuracy	Degree	36.33	0.816	38.166	0.752	2.666	0.516	12.649	0.000	Significant

At degrees of freedom (5) and error level (0.05).

Table (5) clearly indicates significant statistical differences between the post-test means of the experimental and control groups, with the experimental group showing superior performance for the sample studied.

Discussion

From Tables (3-4-5), it is evident that lactic acid and beta-endorphin concentrations are critical biochemical variables. Elevated levels of these can delay enzyme activity within muscle cells, hindering ATP production and consequently leading to severe fatigue. This system is active in high-intensity sports for approximately 30 seconds to 3 minutes (Mohamed Allawi, 2000). Additionally, beta-endorphin, often referred to as the "happiness" or "satisfaction" hormone, is crucial for sustained performance. It is particularly active during intense effort and throughout sustained performance in matches, alongside other related biochemical variables (Israa Al-Awis,1999).

Regarding beta-endorphin, its increased efficiency after intense effort in the experimental group's participants is attributed to their reliance on anaerobic lactic effort during performance. This reliance facilitated significant energy production aligned with the demands of variable forehand stroke skills, which players demonstrated through jumping, hopping, and speed and strength abilities. This also involved maximal muscular effort in speed strength training, which is crucial for energy production. "The nature of squash, with its predominantly anaerobic movements lasting 5 to 15 seconds followed by 10 to 15 seconds of rest, repeated during ball striking, involves a rapid and sudden release of anaerobic bioenergy" (Israa Al-Awis,1992). Consequently, influencing anaerobic lactic capacities enhances the muscle's ability to produce energy from glycogen when oxygen supply is insufficient.

Training squash players to increase their anaerobic lactic physical effort capacity, which accumulates in their muscles, enables them to sustain performance while maintaining speed and power for the longest possible duration. This is supported by biochemical adaptations that allow for increased anaerobic energy production, thereby developing speed, strength, lactic acid concentration, and beta-endorphin (Guyton & Hall, 1997).

Conclusions

1. The proposed anaerobic lactic physical effort training led to a greater development of speed and strength in the experimental group compared to the control group.
2. Anaerobic lactic physical effort training demonstrated an improvement in the concentration levels of beta-endorphin and lactic acid, as well as the forehand accuracy of the sampled players.
3. The predominant energy system based on anaerobic lactic physical effort in squash showed varying degrees of impact depending on the forehand performance requirements of the sampled players.

Recommendations

1. The use of anaerobic lactic physical effort training was consistent with the predominant energy system in squash. Therefore, it is recommended to develop the forehand skill in the sampled players.
2. It is essential to follow scientific principles and methods when designing training programs and to present them to experts for this type of training approach.
3. Regular medical check-ups for players are necessary to assess their health status, particularly concerning biochemical variables like beta-endorphin and lactic acid concentration, for the development of other skills.

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Appendix (1)
Sample of Exercises Used in Anaerobic Lactic Physical Effort Training for Squash Players

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Unit	Training Unit Components	Repetitions	Between Repetitions	Rest Between Repetitions	Rest Between Sets
Sunday	Hop right-left + Forehand shot towards a specific target	3-4 times	10 to 20 accurate shots towards target	2-3 min	2 min
Wednesday	Varied jumps over 50cm hurdles to develop speed strength. Forehand shot towards a specific target.	3-4 times	8-10 times	2-3 min	3 min

The anaerobic lactic physical effort training program spanned 8 weeks, with intensity ranging from 85% to 100% during the specific preparation and pre-competition phases. This was structured as follows: weeks 1 and 2 at 85% intensity, weeks 3 and 4 at 90% intensity, then weeks 5 and 6 at 95% intensity, followed by a decrease to 85% for one week, and finally an increase to 100% intensity for the final unit, based on repetitions, rest between them, and sets and rest between them, before conducting the post-test.