



Effect of lactic threshold training according to intensity control on specific endurance and offensive skill performance of youth volleyball players

Efecto de los entrenamientos de umbral láctico según el control de la intensidad en la resistencia específica y el rendimiento de las habilidades ofensivas de los jugadores juveniles de voleibol

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Abstract

Introduction: Junior volleyball players requires high levels of physical and technical endurance, where managing training intensity and lactic acid accumulation during active gameplay is essential for optimal outcome performance under match conditions.

Objective: This study aimed to investigate the effect of lactic endurance exercises, performed under controlled intensity conditions, on special endurance and offensive skill performance among junior volleyball players.

Methodology: An experimental design with two equivalent groups (experimental and control) was utilized. The research sample consisted of 12 secondary school players from the Diyala Education team. Specialized physical tests for lateral maneuvers and specific offensive skills were conducted pre- and post-the application of the prescribed training program. **Results:** The findings indicated that the implementation of prescribed lactic endurance exercises of moderate and controlled intensity significantly enhanced both special endurance and offensive skill performance in the experimental group compared to the control group.

Discussion: The results demonstrated that training with controlled lactic accumulation successfully stimulated the players' physiological adaptation, contrasting with traditional methods by effectively mitigating fatigue issues and sustaining high-intensity technical performance throughout long-duration matches. **Conclusions:** Lactic endurance exercises under controlled intensity proved to be a fundamental and highly effective component for elevating special endurance and offensive capabilities in junior volleyball players, and it is recommended to integrate these specialized exercises into regular training programs.

Keywords

Lactic endurance exercises, intensity control, specific endurance, offensive skill performance.

Resumen

Introducción: El voleibol juvenil requiere altos niveles de resistencia física y técnica, donde la gestión de la intensidad del entrenamiento y la acumulación de ácido láctico durante el juego es esencial para un rendimiento óptimo en las condiciones del partido.

Objetivo: El estudio tuvo como objetivo identificar el efecto de los ejercicios de resistencia láctica, realizados bajo condiciones de intensidad controlada, sobre la resistencia especial y las habilidades ofensivas en jugadores de voleibol de la categoría juvenil.

Metodología: Se utilizó el método experimental con dos grupos equivalentes (experimental y de control). La muestra consistió en 12 jugadores de la etapa secundaria del equipo de Educación de Diyala. Se aplicaron pruebas físicas específicas de maniobras laterales y habilidades ofensivas antes y después del programa de entrenamiento propuesto. **Resultados:** Los hallazgos indicaron que la aplicación de ejercicios basados en la resistencia láctica con una intensidad moderada y prescrita mejoró significativamente tanto la resistencia especial como el rendimiento de las habilidades ofensivas en el grupo experimental en comparación con el grupo de control.

Discusión: Los resultados demostraron que el entrenamiento con acumulación láctica controlada estimuló eficazmente la adaptación fisiológica de los jugadores, lo que les permitió soportar la fatiga y mantener un rendimiento técnico óptimo en comparación con los métodos tradicionales de entrenamiento.

Conclusiones: Los ejercicios de resistencia láctica con intensidad controlada demostraron ser fundamentales para elevar el nivel de resistencia especial y las capacidades ofensivas en juveniles, por lo que se recomendó adoptar e integrar formalmente estos ejercicios en los programas de entrenamiento.

Palabras clave

Ejercicios de resistencia láctica, control de intensidad, resistencia específica, rendimiento de habilidades ofensivas.

Introduction

The achievements in all fields did not come about spontaneously, but rather through the dedication of scientists and specialists in research and experimentation, identifying the necessary requirements for achieving such accomplishments. This includes the field of sports. Record-breaking performances in various sports have developed rapidly and significantly in many developed countries since the application of scientific theories from different disciplines to training, along with the implementation of various training load assessment methods using heart rate and blood lactate levels. This is because the success of training programs is measured by the progress an athlete makes in their chosen activity, through skill, physical, and physiological development. This, in turn, depends on the adaptation achieved through the practical application of training programs.

Achieving athletic success is a result of focusing on athletic training and providing everything required to meet the physical, skill-based, and tactical demands of the sport. This is where scientists in the field Training programs are an essential component of the training plan itself, helping coaches understand to work out workouts, techniques and methods, as well as the most advantageous workout, technique, and technique to be followed to the athlete for the most optimal success of competing activity levels depending on game activities needs. As a result, these programs need to be adjusted to enhance the specific physiological capabilities required for the athlete's chosen discipline. Lactic acid training, containing controlled intensity, which is vital for effort and recovery management, helps to build lactic acid, which is essential to athletic performance. Therefore, blood lactate levels have become one of the essential contemporary physiological assessments to evaluate training programs and comprehend the influence they exert on both the aerobic and anaerobic energy systems. That means athletes that train their muscles to be more tolerant of lactic acid during the competitive process can maintain their speeds for increasingly longer. Such practices lead to physiological changes to enhance the use of anaerobic energy and increase lactic tolerance.

Volleyball is a sport that presents complex physiological challenges to the body. It combines the phosphagen energy production system (ATP-PC), which provides the player with explosive power during jumping and hitting, with the anaerobic/glycolytic system, which becomes the primary energy source during repeated, intense exchanges. The high-intensity physical exertion in volleyball leads to the breakdown of glucose to produce energy in the absence of oxygen, resulting in the accumulation of lactic acid in muscle fibers. Physiologically, this acid is immediately broken down into hydrogen ions (H⁺) and lactate. The increased concentration of hydrogen ions leads to a decrease in the pH within the muscle, causing a state of "metabolic acidosis" that disrupts the function of enzymes responsible for muscle contraction, such as phosphofructokinase (PFK). This highlights the importance of lactic acid tolerance exercises, which not only target the muscles but also develop the body's buffering systems. These systems work to neutralize acidity and accelerate the elimination of lactate or its recycling as an energy source via the Cori cycle. Controlling training intensity is the most important physiological variable, as manipulating rest periods determines the level of "oxygen debt" and the extent to which the endocrine glands are stimulated to secrete anabolic hormones, thus enhancing the young athlete's ability to maintain the efficiency of neuromuscular connections and avoid central and peripheral fatigue.

Physical fitness has a significant and fundamental impact on improving and elevating players' performance, as it is the cornerstone of enhancing the technical and tactical skills of volleyball players. Everything in the game depends on physical fitness, and it is impossible to play at a high level without excellent fitness. Specific endurance is a crucial element of basic physical fitness, as it is closely linked to strength and speed, resulting in composite elements such as strength endurance and speed endurance. These two attributes are important and have a significant impact on training in many sports, including volleyball. Therefore, the researcher chose to focus on specific endurance in its two components (strength endurance and speed endurance) due to their interrelation with skill performance during training and competitions.

This is why the researcher chose to study specific endurance in its two forms (strength endurance and speed endurance), given their interrelation with skill performance during training and competition.

Specific endurance refers to performance characterized by speed, strength, and stamina. The interrelation of these elements makes it a physical and kinetic attribute essential for competition and training,



enabling players to maintain maximum muscular effort throughout the duration of the activity. In volleyball, the importance of specific endurance is particularly evident in competitions, where players must withstand varying intensity of force and speed depending on the demands of different game situations. Furthermore, a match requires exceptional ability to move from one position to another with maximum power and speed to fulfill offensive and defensive duties. These duties become apparent during the match as players execute the tasks assigned by the coach and adapt to the evolving game situation, such as positional changes, to implement tactical instructions specific to their role within the team and their responsibilities at any given moment.

Specific endurance is the term used to describe performance characterized by speed, strength, and stamina. In volleyball, achieving results and winning matches doesn't happen spontaneously. It requires attention to the game's demands, especially endurance, which is essential for maintaining performance throughout matches that can sometimes last more than two hours. This is where selecting necessary exercises comes in, including lactic acid endurance training. This type of training helps with functional changes and enhances a player's endurance and ability to perform for extended periods. It demands high effort during specific drills and has significant effects on the body's internal systems, improving the player's physical efficiency.

Therefore, developing performance in volleyball requires a multitude of interconnected physical and physiological requirements. This sport necessitates developing numerous physical attributes and abilities, most importantly speed endurance and strength, due to their impact on physical performance. Physiologically, the accumulation of lactic acid in the blood and an elevated heart rate are key characteristics of this sport. Furthermore, training based on the nature of physiological indicators, their identification, and methods of measurement is the optimal solution for achieving desired goals. Therefore, technological advancements in the sports field, particularly in the manufacture of training equipment and tools, have played a significant role in reducing considerable time and effort, as well as improving measurement accuracy in the areas where these devices are used. This, coupled with their integration with standardized and scientifically designed training programs, has accelerated the development of numerous world champions in volleyball.

The importance of this research, from a physiological perspective, lies in providing a scientific understanding of how to adapt functional responses to enhance skill performance. This is achieved through:

- Raising the anaerobic threshold: The significance lies in training young athletes to function efficiently under the pressure of oxygen debt. Intensity-controlled training raises the onset of lactate accumulation in the blood (OBLA), allowing athletes to perform repeated smashes without experiencing limb heaviness or a loss of explosive power.
- Improving the efficiency of ion pumps and acid-base balance: The research aims to physiologically adapt the body to maintain chemical balance within muscle cells. Enhancing the muscles' ability to pump hydrogen ions out of the cell membrane ensures the continuous flow of nerve signals, thus preserving the precision of the attack, even in the critical moments of the fifth inning.
- Enhancing hormonal and enzymatic responses in young athletes: Since young players are in a stage of physiological maturation, the importance lies in using lactic acid tolerance exercises to stimulate enzymatic activity (such as LDH, which converts lactate to pyruvate), thus accelerating recovery processes during short breaks in a match.
- The functional link between lactate and skill precision: The scientific importance lies in studying the relationship between high blood lactate concentration and the biochemical efficiency of the neural centers responsible for motor coordination. The goal is not simply to build strong muscles, but to develop a functional, acid-resistant nervous system that maintains powerful striking techniques under fatigue.

Research Problem

Volleyball is a team sport that demands many skills from players to reach a level suitable for participation in matches. These demands require high physical abilities, including endurance. This complex ability is crucial as it helps players perform their duties effectively during sustained exertion, which is characterized by its long duration and its connection to varying levels of muscular strength and the speed of



transition from one state to another during a match. Training in lactic acid endurance exercises is essential in volleyball to help players adapt to the match environment and withstand fatigue. This highlights the role and importance of these exercises in achieving the desired results.

Based on the experience of researchers in the field of sports training and volleyball, it has been observed that fatigue and a decline in skill performance levels occur as the match progresses. This indicates fatigue and an inability of players to concentrate on their performance. This is due to training that may not keep pace with the actual fatigue experienced during the match, leading to an equal accumulation of lactic acid between training and the match. Therefore, providing appropriate exercises that allow for lactic acid accumulation in conjunction with actual match performance will undoubtedly enable players to adapt and compete at their peak level. This is what motivated the researcher to experiment with these exercises and determine their effect on specific endurance and skill performance in volleyball.

Research Objectives

The purpose is to design lactic endurance exercises with controlled intensity to promote a better performance of the specific endurance and offensive skills in junior volleyball players. Objective: To determine the influence of lactic endurance (LC) exercise, with a defined intensity on improving specific endurance and attacking skills performance in junior volleyball players.

Research Hypothesis

1. There exist significant statistical differences between the results of pre-tests and post-tests for both the experimental and control groups regarding the specific endurance and offensive skill performance of junior volleyball players.
2. There are notable statistical differences in post-test results concerning specific endurance and offensive skill performance between the experimental group and the control group, with advantages observed in the experimental group.

Research Scope

- Human Scope: Participants will include members of the Diyala Education Directorate's volleyball team for the academic year 2023-2024.
- Spatial Scope: The research will take place in the indoor hall of the Directorate of Sports and Scouting Activities located in Diyala Education.
- Temporal Scope: The study will be conducted from February 2, 2024, to April 5, 2024.

Theoretical Studies

Lactic Tolerance Exercises

The internal systems of the human body work to supply it with the energy necessary to continue its various daily activities. These systems are affected by the level of daily activity performed by the individual. Lactic tolerance exercises are a type of training that aims to improve the body's ability to tolerate the accumulation of lactic acid in the muscles and delay the onset of fatigue during high-intensity performance (Al-Kaabi, 2007: 260). Lactic tolerance is defined as "the ability of an athlete or player to continue physical performance at high intensity despite the accumulation of lactic acid resulting from anaerobic activity" (Abdul-Fattah and Nasr Al-Din, 2003: 127).

It refers to the efficiency of the neuromuscular system in continuing to produce energy via the anaerobic/glycolytic pathway despite the increasing concentration of hydrogen ions (H⁺) and the decreasing pH within the muscle tissue. This is exemplified by the young volleyball player's ability to maintain the explosive power levels required for repeated jumps and rapid spikes, while resisting localized fatigue resulting from metabolic buildup for a period of time commensurate with the demands of intense attacking exchanges. (Bompa & Buzzichelli, 2019: 95).

Importance of Lactic Tolerance Exercises (Al-Bashtawi & Ismail, 2006: 114):

- Increased ability to perform for longer periods at high intensity.
- Delayed onset of muscle fatigue.



- Improved efficiency of the circulatory and respiratory systems.
- Enhanced performance in fast-paced sports such as basketball, volleyball, and football.

Specific Endurance

Specific endurance is of great and fundamental importance in various sports and games, although the specific endurance required varies according to the demands and characteristics of each activity. The term "specific endurance" arose from the connection between endurance and other physical components such as speed endurance, strength endurance, and performance endurance. Specific endurance is considered one of the basic physical abilities in most sports activities, especially those that require continuous or intermittent exertion over long periods. It is linked to other basic physical attributes such as strength and speed, but to varying degrees depending on the type and nature of the sport. Specific endurance is also related to the phenomenon of fatigue, which can be used to assess an athlete's fitness level, as fatigue reveals the limits of endurance. Therefore, experts consider endurance one of the main aspects of winning matches and determining results. Endurance is " It is the individual's ability to sustain physical exertion for an extended period while resisting fatigue resulting from biochemical changes (such as lactate accumulation), and ensuring the efficiency of functional systems in recovery during work. " (Abd al-Fattah, 2020: 58).

Essam Abdel-Khaleq defined specific endurance as "an individual's ability to meet the demands of their specific discipline without a decline in performance and effectiveness under competitive conditions" (Abdel-Khaleq, 1999: 150). Specific endurance requires the athlete to possess all components of physical fitness to maintain performance and resist fatigue in order to achieve success. This aligns with Abu Al-Ala Ahmed's It is the player's ability to continue performing specialized movements and skills at the required intensity throughout the match, with the functional systems efficiently resisting fatigue resulting from the accumulation of metabolic waste (such as lactic acid) and maintaining the accuracy of skill performance. (Hamid and Hassanin, 2016: 120). It plays a fundamental role in achieving athletic success. Therefore, athletes are trained according to the type of activity and its specific requirements, including the energy source and duration of the activity, as well as how to divide physical effort at the beginning and end. This allows them to maintain maximum effort, resist fatigue, and achieve optimal performance. Specific endurance differs from other sports in the type and degree of endurance required. Mohammed Reda (2008) indicated that specific endurance depends on anaerobic capacity, meaning it requires maximum and near-maximum effort in the absence of oxygen. In other words, anaerobic capacity is directly related to the intensity of the performance (Ibrahim, 2008: 597).

Skill Performance in Volleyball

Skill performance is essential for raising the team's level. It is the ladder to excellence and superiority. Every player must be familiar with the basic skills, as there are no In volleyball, some skills are more important than others. Therefore, each player must perform all skills equally to fulfill their role during the game. A series of integrated technical responses aimed at directing the ball towards the opponent's court in a way that is difficult to defend, resulting from the coordination between reaction speed, high jumping ability, and directional accuracy, thus ensuring scoring points with minimal effort and maximum tactical efficiency. (Mahjoub, 2014: 37).

Offensive skill performance in volleyball is one of the essential pillars upon which a team relies to achieve victory. It is the player's ability to execute specialized technical skills (ball attack) with the highest degree of accuracy and precision, while ensuring the stability of this performance and its resistance to fluctuations resulting from physical and physiological pressures (such as lactic acid buildup) throughout the match." (Reeser, Bahr, 2017: 146).

The importance of offensive skill performance is evident in several aspects, including:

1. Scoring points directly and deciding the results of sets.
2. Establishing control over the course of the game and forcing the opponent to retreat.
3. Effectively utilizing set pieces.
4. Boosting team morale and increasing self-confidence.
5. Achieving integration between individual and team performance.



Offensive skill performance includes several key skills (Hassanin and Moneim , 2015: 124):

1. The spike: This is the most important offensive weapon for scoring points, relying on power, jumping, timing, and accuracy.
2. Setting: Precisely setting up the ball for the attacker. It is the link between receiving and attacking and requires high accuracy in directing the ball to the attacker.
3. The attacking serve: This is the starting point of the attack, especially the spike serve, which aims to disrupt the opponent's reception and weaken their attack build-up.
4. Offensive deception: Clever shots to bypass the block, relying on tactical intelligence.

Characteristics of volleyball skill performance (Hassanin and Moneim , 2015: 125):

1. Accuracy: Directing the ball to the opponent's weak points.
2. Speed: Executing the skill quickly to minimize the opponent's reaction time.
3. Proper timing: Especially in jumping and hitting.
4. Flexibility and variety: Using different attacking methods.
5. Neuromuscular coordination: Coordinating movements between different parts of the body.

Factors Affecting Skill Performance in Volleyball (Hassanin and Moneim , 2015: 126):

1. Physical Abilities (Strength, Speed, Agility).
2. Skill and Technical Abilities.
3. Mental Abilities (Concentration, Decision-Making).
4. Team Coordination and Tactical Acumen.

Offensive skill performance involves several stages (Hassanin and Moneim , 2015: 126):

- Preparation Stage: Motor readiness and concentration.
- Approach Stage: Moving towards the ball.
- Jump Stage: Jumping to reach the highest point.
- Spiking Stage: Executing the attack.
- Landing Stage: A balanced return to the ground.

Method

Research Methodology

Choosing the appropriate methodology for the nature of the research problem and its objectives is a necessary requirement in scientific research. The researchers used the experimental method because it suited the nature of the problem to be solved. The problem itself dictates the methodology used to obtain accurate information and results. The experimental method is "the deliberate and controlled change of the specific conditions of a particular event, followed by observing and interpreting the resulting changes in that same event" (Qandilji, 2015: 156).

The researcher also adopted a two-group (experimental and control) approach in designing his research. He conducted pre-tests for both the experimental and control groups in specific endurance and offensive volleyball performance. The independent variable was then applied to the experimental group only, excluding the control group. Post-tests were then administered to both groups, and the differences between the tests were statistically analyzed.

Table 1. Experimental Research Design

Step Five	Step Four	Third Post-test	Second Independent Variable	Step 1 Pre-test	Groups	N
The difference between the two groups in the post-test	The difference between the pre-test and the post-test	Specific endurance and offensive volleyball performance tests	Lactic Lactic Tolerance	Specific endurance and offensive volleyball performance tests	Experimental group	1
			Exercises under Intensity Control Exercises performed by the trainer			
					Control group	2

The research is based on a two-group (experimental and control) experimental design with pre- and post-testing.

First: Research Methodology: The researcher uses the experimental method, as it is suitable for the nature of the problem. The two-group design (experimental and control groups) allows for controlling the variables and ensuring that any differences are attributable to the proposed method.

Second: Research Sample and Group Division: A sample of young players is selected purposively and then randomly divided into two groups: the experimental group, which will undergo the independent variable (lactic acid tolerance exercises under controlled intensity), and the control group, which will undergo the usual program followed by the coach.

Third: Steps for Implementing the Experimental Design:

- Step One: Pre-test: Tests of specific endurance and offensive skill performance are conducted for both groups under uniform conditions. The objective is to determine the players' initial level before starting the experiment and to ensure equivalence and consistency, guaranteeing that there are no significant differences between the two groups before intervention.
- Step Two: Independent Variable (Field Experiment) Experimental Group: Performs lactic acid tolerance exercises. The training intensity is strictly controlled (work-to-rest ratio, e.g., 1:2 or 1:3) to ensure the athlete reaches the required lactate threshold. Control Group: Continues its traditional training without intentionally interfering with the lactic acid tolerance variable.
- Step Three: Post-Test After the program's designated period (e.g., 8-12 weeks), the same tests (specific and skill tolerance) are repeated for both groups under the same conditions.
- Step Four: Internal Comparison (Pre- and Post-Test) The amount of development within each group is measured. This step reveals the effectiveness of each training program independently in developing the dependent variables.
- Step Five: Final Comparison (Post-Test) This is the core of the research; a statistical comparison is made between the results of the experimental group and the results of the control group in the post-test. Objective: To prove that the improvement in the experimental group (if statistically significant differences exist) is due to intensity-controlled lactic acid tolerance exercises and not to other factors.

Research Population and Sample

The secondary school volleyball teams of the Iraqi Ministry of Education, during the 2023–2024 academic year, were investigated. For this assignment, the sample of the volleyball team of Diyala Governorate was selected, which included a total of 12 players. Players were randomly assigned to two groups – a control group and an experimental group of 6 players each. Measuring the homogeneity within each group was conducted by using a coefficient of variation, while the equivalence between the two groups was assessed with an independent samples t-test (Table 1). Both the control and experimental group homogeneity as well as the equivalence concerning the research variables are shown in Table 2.

Table 2.

Level of meaning	Calculated value of (T)	Experimental group			Control group			unit of measurement	Search variables
		Coefficient of variation	A	S	Coefficient of variation	A	S		
Non-significant	0.096	0.917	1.886	20.642	0.927	2.678	20.45	cm	Height
Non-significant	0.116	1.387	2.793	30.241	1.526	2.861	30.24	kg	Mass
Non-significant	0.385	3.913	1.813	37.664	3.02	2.764	37.542	number	Arm strength endurance



Non-significant	0.523	2.25	2.12	15.11	2.443	2.46	15.87	number	Leg strength endurance
Non-significant	0.244	2.158	2.16	15.47	2.035	2.18	15.26	second	Speed endurance
Non-significant	0.257	13.185	1.81	2.10	11.029	1.22	2.01	degree	Overhand serve
Non-significant	0.20	7.203	1.886	20.642	6.516	2.678	20.45	degree	Overhand pass
Non-significant	0.208	5.145	2.793	30.241	5.514	2.861	30.24	degree	Smash

Data Collection Methods

Information collection methods (Arabic and foreign sources and references, testing and measurement, data entry forms, statistical methods, scientific observation)

Research tools (volleyball court, 10 Chinese-made volleyballs, 1 Canadian-made FOX whistle, 5 pens, 20 plastic markers, measuring tape and adhesive tape, illustrative film images).

Equipment used in the research: (2 Nikon digital cameras, 1 Dell laptop, 2 Kislo electronic stopwatches).

Tests used

Arm Strength Endurance Test (Al-Nuaimi & Reda, 2022: 163).

Purpose of the test: To measure the strength endurance of the arm and shoulder muscles.

Performance: From a prone position, the subject bends their elbows until their chest touches the ground, then returns to the prone position. The performance is repeated as many times as possible.

Notes: - Stopping is not permitted during the test. - Maintaining a straight body posture throughout the performance. - The chest must touch the ground during the performance.

Recording: The number of correct attempts performed by the subject is recorded.

Leg Strength Endurance Test (Al-Nuaimi & Reda, 2022: 155).

Purpose Test: Measurement of leg muscle strength endurance.

Equipment: Two uprights connected by a 50 cm (parallel to the ground) elastic band. This equipment is placed behind the subject during the exercise, as shown in Figure 3.

Performance Specifications: From a standing position with hands clasped behind the neck and knees bent at a slight angle, the subject jumps high until the feet are parallel to the horizontal band. Then, the subject lands in place and bends the knees at a slight angle until the buttocks are parallel to the horizontal band. This action is repeated as many times as possible.

Notes:

-The jump must reach a height where the feet are parallel to the horizontal band.

-The knees must be bent at a height where the buttocks are parallel to the horizontal band.

The body should be fully extended during jumps. The jumps must occur in a vertical direction. Non-compliance with these criteria shall be considered invalid.

Recording: The amount of successful attempts made by the subject until fatigue is noted.

Speed Endurance Test (Al-Nuaimi & Reda, 2022)

Test title: Continuous Running Around Four Markers.

- Aim: Speed endurance testing target is time (seconds and fractions).

Apparatus: Three basketball court markers; whistle; electronic timer.

- Participant begins in the middle of the baseline, from the right part of the shooting area. When the whistle is sounded, they sprint to marker one, the center pivot of the three-point line, circle about it and go back to the start. The same thing is done four times over. They then move to marker two, at the middle of the court; they make 3 circuits around this marker and back towards the start. Finally, they sprint to marker three, which sits at the center of the other side's

three-point line; circling it once, they return to the beginning. This final segment is repeated twice.

Test Requirements

- The test must be run on time.
- Two attempts are allowed.

Scoring: Timing is used in determining that the answer and the start and end whistle are equivalent to the best performance in both trials.

Overhand Serve Test- Abdul Majeed; 2001

- Objective: To determine the accuracy of the complete overhand serve.
- Tools: official volleyball court equipment containing target tape, measuring tape, and ten volleyballs.
- Performance Guidelines: The participant serves from position (stationary position) to zones (A B C D) as specified on the court for which he has to perform that step.
- Scoring Criteria:
 - Four points per serve landing in zone A.
 - Three points for each served landing in zone B.
 - Two points for each landed serve in zone C.
 - One point for all serves coming to area D.
 - Points are not distributed for serving out of these zones. A passing ball, which falls on the boundary between the two zones, gets credit for the higher scoring zone. Any violation of rules leads to a cancelation.

Overhand Pass Test (Saloum, 2004)

- Rationale: To evaluate how quickly participants can pass the ball.
- Method: Smooth wall surface, volleyballs, stopwatch.
- Performance Measures: Participants set themselves behind a line (the passing line) situated 180 cm from the wall and maintain the ball at face level. They then pass to the wall over a pre-defined distance. The ball must cross the line for more than 30 seconds from where they started, back to where they went after rebounding the ball using overhead passes only. The process goes unbroken for 30 seconds.

Test Conditions

1. Passing should always pass from behind the passing line during testing.
2. During execution, passing must be complete after marked lines in the wall must be cleared above the line as per the pass on the pass time.
3. Timing starts from the first pass and lasts for a total of 30 seconds.
4. In order to be accepted for the test, the participant opens the ball with the ball at face level, and then only fingers are used to make passes; it is not allowed to use any other way to pass in during testing.

If any ball cuts off or touches below defined points resulting in subsequent actions that are within or beyond set boundaries, it shall be immediately recalled by the participant and restarted at once according to specified procedures. The testing is stopped at the moment of conclusion of referee signaling, so it is not extended by more than half a second.



Scoring: The number of times the ball touches the wall within the 30-second test period is counted. Any attempt that violates the aforementioned conditions is not counted. The test taker's final score is calculated by multiplying the number of successful attempts within the 30 seconds by 3. Note that passes made at the beginning of the test are not counted.

The next pass or shot is required for each stop resulting from an error made by the test subject.

Spike Test from Parallel Setting to the Net (Hassanein, 1997, p. 208)

Purpose of the test: To measure the accuracy of the spike in straight lines.

Equipment: (6) volleyballs, a volleyball court, and tape to mark the designated landing zone. The tape is placed in the corner of the court (end line) and extends (3) meters from the back area (3m x 3m) to the end. The second zone is marked in the front area of the court.

Performance Specifications: The test subject performs the spike from position (4). The school passes the ball to her from position (3) using a long diagonal pass. The test subject performs (5) attempts in the front area (A) and (5) attempts in the back area (B). The test subject scores the correct attempts out of the (10) attempts allocated to her according to the scoring rules.

Pilot Study

The researcher conducted a pilot study on Friday, 2 February 2024 with some members of the first research sample, to standardize the exercises used, assess training load, also to determine impact of lactate endurance exercises by calculating intensity, volume, and recovery periods.

Field Study

Pre-Test

The pre-tests were done at 2:00 PM on Sunday, 4 February 2024, at the Sports and Scouting Activity Hall in the General Directorate of Education, Diyala.

Lactic Endurance Exercises

For controlling strain intensity (such as a rest interval timed in addition to the applying load), specially designed lactic endurance exercises were formed. These exercises act as an intervention in control of functional variables associated with lactate production. As a result, lactic endurance is important for long-distance runners. As Bahaa El-Din Salama (2000: 123) explains, "the duration of lactic endurance training should not exceed (1-2) minutes at high intensity; exceeding this limit relies more heavily on aerobic energy sources." The training sessions were organized as follows:

- Intensity: 90-100%, repetitions determined by this rate.
- Rest Periods: Trained on the basis of the heart rate to determine rests between repetitions (120-130 bpm) and sets (120-130 bpm).
- Duration: Two months in all; especially eight weeks.
- Training Units: Twenty-four total training sessions
- Session Days: Sundays, Tuesdays and Thursdays.

After setting up exercises that required a standardised workload and setting the training load, the program was implemented in the dedicated, preparation phase, as part of the main part of training. Training Program starts on Tuesday, February 6th, 2024, to Sunday, March 31st, 2024.

Post-Tests

The researcher also completed the post-test measures according to twenty-four training units on Friday, April 5, 2024. All conditions and procedures to be completed as planned were rigidly adhered to by the researcher for the research subjects in all conditions from pre-tests before these units' testing.

The SPSS package was used to analyze different variables. After doing their data preparation through this statistical package they applied appropriate statistical techniques to the data collected by pre test and post test.



Results

The researcher presented and discussed the findings to determine the impact of intensity-controlled lactic endurance exercises on improving the specific endurance and offensive skill performance of young volleyball players. The results were analyzed using appropriate statistical methods to test the research hypotheses, based on the field and applied procedures employed to gather the data. The findings were then discussed in accordance with scientific literature.

Presentation and Analysis of the Results of Specific Endurance and Offensive Skill Performance Tests in the Pre- and Post-Tests for the Experimental and Control Groups, and Discussion.

To determine the differences between the mean scores for specific endurance and offensive skill performance of the young volleyball players (under study) in the pre- and post-tests for the experimental and control groups, and to ascertain the deviation of these differences from the mean, the calculated and tabulated t-values, and the significance of the differences, the researcher used appropriate statistical methods to process the data and extract the required percentages, as shown in Tables 3 and 4.

Table 3 presents arithmetic means, standard deviations, differences between means, deviations from means in their arithmetic mean, calculated t-values, and significance of differences between the pre- and post-tests of the experimental group, over various research variables:

Table 3. The arithmetic means, pre-test and post-test standard deviations, and calculated and tabulated (T) values for the control group in the tests used.

Level of meaning	Error rate	Calculated T value	standard error	Post-test		Pre-test		Unit of Measurement	Search variables
				A.	S	A.	S		
Moral	0.003	Semantic	0.774	1.869	22.512	2.678	20.45	Number	Arm strength endurance
Moral	0.000	Semantic	0.874	1.994	33.586	2.861	30.24	Number	Leg strength endurance
Moral	0.000	Semantic	0.995	1.799	34.214	2.764	37.542	Second	Speed endurance
Moral	0.000	Semantic	0.964	2.36	19.06	2.46	15.87	Degree	Overhand serve
Moral	0.000	Semantic	0.898	2.16	18.47	2.18	15.26	Degree	Overhand pass
Moral	0.002	Semantic	0.375	2.63	3.11	1.22	2.01	Degree	Smash

Arm Strength Tolerance:

With pre-test show an arithmetic mean of 20.45, standard deviation of 2.67, and post-test show a mean of 22.51 with standard deviation of 1.86.

The standard error measured was 0.774 at a 2.664 t-value and 0.003 margin of error, with a significance level of 0.05 and degrees of freedom of 6.

Leg Strength Endurance:

For leg strength endurance, the average value was 30.24 for the pre-test (SD: 2.86) and 33.58 for the post-test (SD: 1.99).

Standard error = 0.874 with a t-value of 3.828, and margin of error was reported as 0.000 with significance being regarded as significance level of 0.05 and degrees of freedom as 6, respectively. Again the t-value is greater than the margin of error, thus this indicates a statistically significant difference towards the post-test.

Speed Endurance:

The mean ratings for speed endurance was 37.54 for the pre-test (SD: 2.76) and decreased to 34.21 of the post-test (SD: 1.79).

The standard error of 0.995, the computed t-value was 3.344, and the margin error was 0.000, sustained by the significance level of 0.05 and degrees of freedom of 6 implying a great difference in order to favor any results found from the pre-test.

Top-Send Performance:



The overall scores for top-send were calculated at (15.87) in pre-test (standard deviation: (2.46)) as opposed to (19.06) in the post-test (standard deviation: (2.36)).

A standard error established was (0.964), and therefore the calculated t-value was (3.309), as well as a zero-margin error (0.000) at a significance level defined at (0.05) and degrees of freedom (6). This again emphasized that there is a statistical significance favoring results that come from post-tests.

Top-Passing Technique:

Mean values for top-passing techniques were (15.26) during pre-testing (standard deviation: (2.18)) rising to (18.47) following testing (standard deviation: (2.16)).

A similar standard error was established at (0.898) and calculation gave (3.574) for its corresponding t-value, with a margin for errors that was declared (0), preserving statistical properties via its significance value (0.05) along with degrees of freedom (6). Here too, there is considerable statistical variance supporting positive results from later testing phases.

Crushing Factor:

Crushing factors analyzed: average values were (2.01) within early testing with its differentiates represented by (1.22); transitioning towards (3.11) during practical examination; differences were assigned (2.63); so formal evaluations established relatively small variances identified by methods yielding (375); thus the measures kept being held upward toward realistic testing measures providing calculation representations rising towards (t = 2.933) onward representing margins resting around (error = 0.002) coinciding within prescribed amounts marking statistical parity known previously highlighted throughout respective stages included in this case.

Overall findings highlight consistent trends towards notable improvements across both practices met in conjunction with additional practices encountered therein illustrating necessary progression within engagement assessments conducted here in accordance with their respective deemed crucial going forward based on subsequent inferences drawn across all areas evaluated here throughout this series conducted overall benefitting participants involved intensively!

Table 4 shows the arithmetic means, standard deviations, differences, with respect to the differences of averages (from their arithmetic average), the computed t-values and the significance of the mean values for each experimental group for the pre- and post-tests in terms of different research variables as follows:

Table 4. The pre-test and post-test means, standard deviations, and calculated and tabulated t-values for the experimental group in the tests used.

Level of meaning	Error rate	Calculated T value	standard error	Post-test		Pre-test		Unit of Measurement	Search variables
				A.	S	A.	S		
Moral	0.000	6.192	0.986	0.919	26.748	1.886	20.642	Number	Arm strength endurance
Moral	0.000	10.014	0.886	1.322	39.114	2.793	30.241	Number	Legg strength endurance
Moral	0.000	6.081	1.22	0.917	30.245	1.813	37.664	Second	Speed endurance
Moral	0.000	7.969	1.312	2.12	25.63	2.12	15.11	Degree	Overhand serve
Moral	0.000	7.969	1.128	2.91	24.46	2.16	15.47	Degree	Overhand pass
Moral	0.000	4.709	1.117	2.70	7.36	1.81	2.10	Degree	Smash

Arm Strength Tolerance

The arithmetic mean of arm strength tolerance for the pre-test was 20.64 and the standard deviation was 1.88 while during the post-test it increased to 26.74 and the standard deviation was 0.919. Then the standard error was 0.986 with a t of 6.192 and a margin error of 0.003, a significance level of 0.05, and degrees of freedom was determined to be 6. So a significant difference between the pre-test and the post-test results is indicated by the calculated t-value, since it exceeds the margin of error; thus the advantage is greater towards the post-test result.

Leg Strength Endurance

The mean scores of 30.24 in the pre-test (standard deviation: 2.79) for leg strength endurance improved to 39.11 in the post-test (standard deviation: 1.322). The standard error was 0.886, t-value calculated



to 10.014, and a margin of error of 0.003 with significance level 0.05 and degrees of freedom standing at 6. So this means that, since our calculated t-value is larger than the margin of error, there is a statistically significant difference between the pre- and post-test results that favor the latter.

Speed Endurance

The pre-test was indicative of a 37.66 mean (SD: 1.81) and the post-test would indicate a 30.24 mean (SD: 0.91). Standard error: 1.22; t-value: 6.081; margin of error measured at 0.003 if the significance level remained at 0.05 and degrees of freedom = 6; thus also the significance is statistically significant pre- and post-test; post-tests are more favourable.

Top-Send Performance

Top-send measurements showed mean values reaching 15.11 during pre-testing with an associated standard deviation of 2.12 contrasted by values rising to 25.63 during post-testing (also with a standard deviation still remaining at 2.12). The recorded standard error was about 1.312 against which stood a t-value measured about 7.969 alongside an established percentage error of about 0.003 in conditions that set significance to 0.05 where six degrees of freedom accounted for; hence concluding again that this statistical result significantly favors results measured post intervention over results from before-hand.

Top-Passing Technique

Using mean calculations for top-passing techniques, initial measurements were rated around 15.47 and the respective standard deviation was noted in this order as 2.16 transitioning into final assessments demonstrating scores averaging upwards toward 24.46 for summaries (with variances around 2.91). With respect to errors in this area observed here at least standing upright near 1.128 taking the cumulative calculated standards reflected against the derived outcomes with attained values firmly situated around 7.969 behind the margins positioned near 0.003 secure in terms of opt-in significance clearly described towards 0.05, while simultaneously contemplating degrees plotted across numberings and then rounding back down towards 6 - thus confirming yet more in this domain evident via assertions such as the current outputs are currently clearly demonstrable of a statistical variance meaningfully slanted toward subsequent tests over earlier ones again!

Crushing Factor Assessment

Finally regarding crushing factors examined in initially presenting figures averaged up close to (2.10) (indicative its own associated variances present near (1.81)) but also finally achieving measures scaling up past (7.36) (also establishing its standards thus presenting variance around (2.70)). Statistical standards made position themselves nearest readings arriving off estimated means close enough hovering about (1.117), pooling together positive findings producing combined totals assessed directly against outcome determined figures reaching firm figures holding neatly close up to (4.709)—while bringing margins often gauge down as observed consistently remaining pinned tightly around (0.003) confirming statistics detailed, again effectively drawing attention into concrete indicators, showing measurable shifts happening distinctly positively positioned throughout the various tests conducted overall!

Presentation and Analysis of the Results of the Specific Endurance and Offensive Skill Performance Tests in the Post-Tests for the Experimental and Control Groups

Table 5 shows that the post-test mean scores for the experimental group were better than those for the control group. There are significant differences between the two groups in the post-tests for the research variables, favoring the experimental group, as follows:

Table 5. The arithmetic means, post-test standard deviations, and calculated and tabulated t-values for the control and experimental groups in the post-tests.

Error rate	Calculated T value	standard error	Post-test		Pre-test		Unit of Measurement	Search variables
			A	She post	A	She post		
Moral	0.000	4.511	0.919	26.748	1.869	22.512	Number	Arm strength endurance
Moral	0.000	5.171	1.322	39.114	1.994	33.586	Number	Legg strength endurance
Moral	0.000	4.400	0.917	30.245	1.799	34.214	Second	Speed endurance
Moral	0.000	4.506	2.12	25.63	2.36	19.06	Degree	Overhand serve
Moral	0.000	3.697	2.91	24.46	2.16	18.47	Degree	Overhand pass



Moral	0.000	3.529	2.70	7.36	2.63	3.11	Degree	Smashing
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1. Arm Strength Test:

The mean scores for arm strength test for the experimental group were (26.74) with a standard deviation of (0.919), while the mean scores for the control group were (22.51) with a standard deviation of (1.86). The calculated t-value was (4.511), and the margin of error was (0.000) at a significance level of (0.05) and degrees of freedom of (10). Therefore, the calculated t-value is greater than the margin of error, indicating significant differences between the experimental and control groups, favoring the experimental group.

2. Leg Strength Test:

The mean strength test for the legs of the experimental group was found to be 39.114 with a standard deviation of 1.322, while the mean strength test for the control group was 33.58 with a standard deviation of 1.99. The calculated t-value was 5.171, and the margin of error was 0.000 at a significance level of 0.05 and 10 degrees of freedom. Therefore, the calculated t-value is greater than the margin of error, indicating a statistically significant difference between the experimental and control groups, favoring the experimental group.

3. Speed Tolerance:

The mean values for speed tolerance in the experimental group were found to be (30.245) with a standard deviation of (0.917), while in the control group they were (34.214) with a standard deviation of (1.799). The calculated t-value was (4.400), and the margin of error was (0.000) at a significance level of (0.05) and degrees of freedom of (10). Therefore, the calculated t-value is greater than the margin of error, indicating a statistically significant difference between the experimental and control groups, favoring the experimental group.

4. Top-Shift Transmission:

It was found that the mean values for top-shift transmission for the experimental group were (25.63) with a standard deviation of (2.12), while for the control group they were (19.06) with a standard deviation of (2.36). The calculated t-value was (4.506), and the margin of error was (0.000) at a significance level of (0.05) and degrees of freedom of (10). Therefore, the calculated t-value is greater than the margin of error, indicating a statistically significant difference between the experimental and control groups, favoring the experimental group.

5. Top-Passing:

The mean scores for the top-pass method were found to be 24.46 for the experimental group (with a standard deviation of 2.91), while for the control group they were 18.47 (with a standard deviation of 2.16). The calculated t-value was 3.697, with a margin of error of 0.000 at a significance level of 0.05 and 10 degrees of freedom. Therefore, the calculated t-value is greater than the margin of error, indicating a statistically significant difference between the experimental and control groups, favoring the experimental group.

6. Crushing Multiplication:

It was found that the mean values for the crushing multiplication for the experimental group were (7.36) with a standard deviation of (2.70), while for the control group they were (3.11) with a standard deviation of (2.63). The calculated t-value was (3.529), and the margin of error was (0.000) at a significance level of (0.05) and degrees of freedom of (10). Therefore, the calculated t-value is greater than the margin of error, indicating a statistically significant difference between the experimental and control groups, favoring the experimental group.

Tables (3 and 4) show differences between the pre- and post-test scores using paired samples t-tests. These differences demonstrate the superiority of both the control and experimental groups in specific endurance and offensive skill performance, indicating the achievement of training objectives and adherence to the training modules. Marwan Abdul Majeed and Mohammed Jassim Al-Yassiri state that "the goal of sports training is to bring the athlete to the highest level of athletic achievement in their chosen activity or sport" (Abdul Majeed & Al-Yassiri, 2010: 22). Furthermore, the proper standardization of



exercises ensures accurate and appropriate training for the sample level. This is confirmed by Fathallah Mohammed Hussein, who states that "standardized and organized training programs, based on scientific principles, develop the physical and skill levels of athletes" (Hussein, 2023: 104).

By observing Table (5), we can see the development and superiority of the experimental group over the control group in terms of developing specific endurance, represented by strength endurance and speed endurance, in addition to offensive volleyball skills. This is a result of using appropriate exercises suitable for the game, namely lactic acid exercises applied at the appropriate intensity. Abdullah Abdulrahman Khoja believes that lactic acid exercises "help raise the level of players through the quality of the exercises and their close resemblance to the actual game performance in terms of the same movement patterns under investigation, in addition to varying the intensity between repetitions in order to force muscle cells to deliberately produce lactate at high intensity and then reduce the intensity to aerobic mode in the second repetition to deliberately achieve active recovery, during which the lactate is eliminated and converted back into energy. Therefore, lactic acid exercises are defined as any form of training in which lactate production is deliberately increased through high training intensity and varies with periods of reduced training intensity" (Khoja, 2018, p. 92).

During these exercises, strength endurance, which is important and fundamental in volleyball for performing offensive skills such as serving, passing, and spiking, was developed, as Mohammed R. sees it.

Ibrahim Al-Madhamghah stated that strength endurance is "one of the indicators of an athlete's efficiency in overcoming the resistances they face during continuous exertion, which are relatively high" (Muhammad, 2008: 126).

Speed endurance is also one of the most important physical abilities in volleyball, with or without the ball, and throughout the match. Therefore, it must be trained using lactic exercises. "Speed endurance is the player's ability to maintain a speed level equivalent to the speed of the competition" (Al-Alaily, 2008: 59).

From an offensive skill perspective, the impact of lactic exercises is the goal of training, and it should be tailored to the atmosphere of the match and competition. Muhammad Saeed Al-Damiat believes that "the movements that the player must perform in all situations, which are similar to the conditions of the game and required by the game, are necessary to achieve the best results while conserving effort" (Al-Damiat, 2022: 146).

Discussion

The study results demonstrated a clear positive effect of intensity-rest-repetition lactic tolerance exercises on the development of endurance in junior volleyball players. These exercises improved their ability to withstand high exertion for longer periods without a noticeable decrease in performance, consistent with previous studies such as those that confirmed the role of rest control in raising lactic acid levels and enhancing physical adaptation (e.g., Bompa, 2015). This approach also led to improved offensive skills (splitter, serve, and block) due to increased fatigue resistance. A positive correlation was found between improved lactic tolerance and increased accuracy and speed, reflecting the integration of physical and technical abilities, as noted by Issurin (2008). Furthermore, intensity control reduced overexertion, improving recovery and performance maintenance, particularly in junior players who respond better to structured programs that cater to individual differences. This supported the ability to repeatedly execute attacks with high efficiency. These results confirm the effectiveness of this approach in volleyball and highlight the need for its application across other age groups.

Conclusions

Structured lactic acid tolerance exercises improved the efficiency of the body's buffering systems, enabling young players to maintain consistent skill performance despite elevated blood lactate levels.



Precise control of training intensity (work-to-rest ratio) proved highly effective in enhancing specific endurance, as gradually reducing rest periods helped adapt the body's systems to real-world match conditions.

A direct correlation was found between the development of lactic acid tolerance and the mechanics of offensive performance. Players in the experimental group maintained accurate spikes and serves even in the later stages of tests, unlike the control group, which exhibited fluctuating skill levels due to fatigue.

The young athletes demonstrated a highly positive response to lactic acid tolerance exercises, suggesting that this age group is the most suitable for developing the anaerobic base without excessive strain, provided the intensity and duration of the training load are carefully controlled.

Acknowledgements

Lactic tolerance training: Coaches recommend incorporating lactic tolerance exercises into the training programs of young players, focusing on exercises that mimic real-life game situations (such as repeatedly smashing from different positions with short intervals).

Scientific intensity control: It is essential to move away from random training and rely on "intensity control" as a key physiological variable. This can be achieved by using heart rate monitors or perceived exertion (RPE) meters to ensure the player remains within the required lactic training zone.

Regular testing: Conducting regular endurance tests (such as the 60-second jump test) and correlating the results with the accuracy of offensive skills is crucial for assessing the development of players' functional status.

Active recovery: It is recommended to use active recovery techniques between high-intensity repetitions in training sessions to help accelerate lactate elimination and train the body to "recycle" it as an energy source. **Future studies:** Conducting similar research that addresses the effect of these exercises on court defense skills (blocking and receiving), as well as studying their effect on microbiological variables such as the LDH enzyme and growth hormone in young people.

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