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Changes in Some Physiological and Physical Indicators Resulting from a Special Anaerobic Training Program for Advanced Basketball Players

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Abstract

Basketball is a high-intensity sport that heavily relies on anaerobic energy systems (phosphagen and lactic acid), alongside the aerobic system. Basketball matches demand intermittent, high-intensity efforts involving speed, explosive power, speed endurance, and anaerobic endurance. Therefore, specific anaerobic training is crucial for developing these qualities to meet competitive demands. This study aimed to design a specialized anaerobic training program and investigate its impact on certain physiological and physical variables in the experimental research sample. The researcher utilized appropriate tests and measurements to obtain the required results after reviewing relevant literature on sports physiology and training. After implementing the training program for 8 weeks, with 3 training sessions per week, several conclusions were reached. The experimental group's results showed a significant improvement in the investigated physiological variables due to adherence to the specialized anaerobic training program, demonstrating statistically significant differences between pre- and post-measurements in favor of the post-measurement. The researcher recommends emphasizing specialized anaerobic performance training when designing training programs, given its effective role in developing anaerobic endurance and its positive impact on the physiological and physical aspects of basketball players.
Keywords: Physiological indicators – Physical capabilities – Basketball

1. Introduction

Scientific and technological advancements have driven researchers to explore various domains related to sports activities, particularly physiological aspects, as a key indicator of athletes' physical efficiency and the development of their physical and skill-based abilities. Basketball players are distinguished by their speed, strength, precision in performance and movement, and their ability to change directions flexibly in sync with the game's rhythm. Additionally, they must control the ball, execute accurate passes, and shoot toward the basket, relying on specialized technical skills.

To achieve peak performance during matches, coaches must ensure comprehensive technical (physical and skill-based) preparation for players in accordance with the demands of modern

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basketball. These demands are influenced by factors such as match intensity, duration, the relatively small court size, and the multiplicity of tasks required from players.
Excellence in basketball depends on developing players' physical attributes, functional characteristics, psychological factors, and motor skills. The energy system's impact on player performance varies between anaerobic and aerobic exercises. Anaerobic exercises enhance performance during short, intense activities lasting from seconds to two minutes. This prompted the researchers to design a specialized training program to ensure optimal performance and monitor functional variables resulting from physical exertion or specialized drills.

Research Problem

With the evolution of offensive and defensive strategies in basketball, diverse training methods have emerged to suit players' varying abilities and positions. However, the researchers observed deficiencies in some anaerobic training methods, negatively affecting players' efficiency. Most Iraqi university and local club teams experience declining performance in the final quarter of matches, leading to rapid fatigue, slow recovery, and poor concentration during games.
Given the scarcity of studies examining the impact of specialized (anaerobic) training programs on functional and physical variables in basketball, and the limited attention coaches give to these aspects during training, the researchers deemed it necessary to study this topic systematically to improve players' performance and develop their anaerobic capabilities. The research problem revolves around answering whether the researchers' designed program significantly impacts certain functional and physical variables.

The objectives of the study wer **:**Design specialized (anaerobic) exercises for basketball players ،Examine the impact of specialized (anaerobic) exercises on certain functional variables. ،Investigate the effect of specialized (anaerobic) exercises on certain physical variables.

As for hypotheses**:**There is a statistically significant relationship between specialized exercises and certain functional variables among the research sample.،There is a statistically significant relationship between specialized exercises and certain physical variables among the research sample.

MATERIALS AND METHODS:

Research Sample:

The sample was selected purposively and consisted of 16 players from Al-Mustansiriya University's basketball team. They were divided into two groups:

- **Control group (8 players):** Followed the coach's standard training program.
- **Experimental group (8 players):** Applied the proposed specialized training program.
- **Human Scope:** Players from Al-Mustansiriya University's basketball team.
- **Time Scope:** 15/10/2024 – 15/1/2025.
- **Location Scope:** Sports Hall, College of Physical Education and Sports Sciences – Al-Mustansiriya University.

Sample Homogeneity

Homogeneity was assessed for the sample in terms of mass, height, and chronological age, as shown in **Table (1).**

Table (1)
Statistical Indicators and (t) Values for Height, Weight, and Age Variables

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Variables	Unit	Control Group (Mean ± SD)	Experimental Group (Mean ± SD)	Calculated (T)	Tabulated (T)	Significance
Height	cm	82.7 ± 0.04	81.3 ± 0.10	1.12	2.120	Non-significant
Weight	kg	78.45 ± 0.89	80.6 ± 1.24	1.75		Non-significant
Age	years	20.3 ± 0.92	22.8 ± 1.32	2.01		Non-significant

Sample equivalence

Equivalence is a fundamental concept in scientific research, particularly in comparative or experimental studies, ensuring that groups are similar in baseline characteristics before applying the independent variable. **Table (2)** shows no statistically significant differences in functional and physical variables between the control and experimental groups, confirming their equivalence.

Table (2)

Equivalence of Functional and Physical Variables for Both Groups

VARIABLES	UNIT OF MEASUREMENT	PRE-CONTROL		POST-CONTROL		CALCULATED (T) VALUE	TABULATED (T) VALUE	SIGNIFICANCE
		X	S	X	S			
Lactic Acid	mmol/L	2.13	0.93	1.96	1.13	0.33	2.120	Non-significant
Anaerobic Power	W/S	61.10	4.29	58.13	3.53	1.85		Non-significant
Resting Heart Rate	Bpm	71.24	1.91	75.09	1.47	0.90		Non-significant
Post-Exertion Heart Rate	Bpm	188.2	1.69	193.8	1.90	0.78		Non-significant
Maximum Speed	m/s	15.8	0.11	15.11	0.10	0.54		Non-significant

Speed Endurance	MIN	17.17	0.91	18.59	0.99	0.36		Non-significant

Significance level: 0.05, degrees of freedom (n-2) = 2.120

Research Procedures

Research Methodology

The experimental approach was used due to its suitability for addressing the research problem. The experimental method is fundamental in scientific research due to its ability to establish causal relationships, but it requires precise design and implementation to avoid methodological errors.

Data Collection Tools

Equipment and Tools Used:

- Medical scale (multi-purpose)
- Measuring tape (cm)
- Electronic stopwatch (Chinese-made)
- Smartwatch for heart rate (Japanese-made)
- Test results recording form
- Sterilizing materials
- Medical cotton
- Blood lactate analyzer (Lactate Pro 2)

Research Procedures

Research Tests

Functional Tests and Measurements:

1. **Pulse Measurement (Radial Pulse)**
   - **Tools:** Smartwatch (Japanese-made) for heart rate and blood pressure.
   - **Procedure:** The subject wears the smartwatch on the left wrist.
   - **Recording:** Resting heart rate is recorded from the watch display. Post-exercise heart rate is measured after an 80-meter sprint.
2. **Blood Lactate Concentration Measurement**
   - **Purpose:** Measure blood lactate levels.
   - **Tools:** Lactate Pro 2 device, lancet, test strip, cotton, sterilizing materials.
   - **Procedure:** Blood sample taken from the thumb 5 minutes post-exercise.
   - **Recording:** Device reading recorded for each player.
3. **Anaerobic Power Measurement (Sargent Vertical Jump Test)**
   - **Purpose:** Assess anaerobic power.
   - **Procedure:** Player stands beside a wall, reaches upward with chalk, jumps vertically, and marks the highest point.

Physical Tests:

Maximum Speed Test (100m Sprint)

- **Purpose:** Measure maximum speed.
- **Tools:** Track, stopwatches, whistle, cones, measuring tape.
- **Procedure:** Warm-up (10-15 min), sprint from a low start position, record time.

Speed Endurance Test (30-15 IFT – Intermittent Fitness Test)

- **Purpose:** Assess cardiovascular endurance and intermittent speed.

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- **Tools:** 40m track, audio device, cones, recording form. Player runs 40m in 30 sec, rests 15 sec, repeats with increasing speed.
- Last completed stage determines maximum speed (VIFT).

Procedure:

Pre-Test Measurements

Conducted on 13/10/2024 at 10 AM in the sports hall, under standardized conditions.

Specialized Training Program

- **Duration:** 8 weeks (3 sessions/week, 90 min/session).
- **Focus:** Anaerobic drills (speed, power, endurance).
- **Intensity:** 80–95% of maximum effort.
- **Implementation:** Started on 15/10/2024, concluded on 15/12/2024.

Special Program (Anaerobic Training)

Based on a careful review of scientific literature related to anaerobic training, the researcher designed an 8-week training program consisting of 3 training sessions per week. Each training session lasts 90 minutes and includes a variety of physical exercises. This variety aims to improve basic physical abilities such as speed, speed endurance, explosive strength, and muscular endurance to adapt to high-intensity effort similar to match conditions. The overall goal of the program is to comprehensively develop anaerobic capabilities to efficiently serve the athletic performance of basketball players (the research sample).

Implementation of the Training Curriculum:

The training curriculum was implemented on Tuesday, October 15, 2024. The duration of the training curriculum was eight weeks, with three training units per week, for a total of 24 training units. Each training unit lasted (90) minutes. The specific curriculum focused on developing physical attributes. The training curriculum included specific exercises to develop certain physical abilities, such as (speed-specific strength, maximum speed, and speed endurance). The specific exercises of the training curriculum were represented in the main section of the training unit, and the training load was standardized according to the volume, intensity, repetition, and rest for each player, based on their individual abilities. The intensity used in the training curriculum ranged between (80% - 95%).The implementation of the training curriculum was completed on the research subjects on December 15, 2024.

Post-Test Measurements

Conducted on 16/12/2024 under identical conditions to pre-tests.

Statistical Methods

Data analyzed using **SPSS**, including:

- Mean, standard deviation, skewness coefficient, t-test.

Presentation and Discussion of Results:

Presentation of Means, Standard Deviations, and Calculated vs. Tabulated (T) Values for the Control Group (Pre- and Post-Test):

Table (3)

shows the means, standard deviations, and calculated (t) values (pre- and post-test) for the control group regarding physical and functional variables.

VARIABLES	UNIT OF MEASUREMENT	PRE-CONTROL		POST-CONTROL		CALCULATED (T) VALUE	TABULATED (T) VALUE	SIGNIFICANCE
		X	S	X	S			
Lactic Acid	mmol/L	2.13	0.93	15.83	1.017	2.378	2.365	Significant
Anaerobic Power	W/S	61.10	4.29	60.01	2.71	1.34		Non-significant
Resting Heart Rate	Bpm	77.24	1.91	75.12	1.56	1.28		Non-significant
Post-Exertion Heart Rate	Bpm	188.2	1.69	190.1	2.012	0.79		Non-significant
Maximum Speed	m/s	15.8	0.11	14.21	1.89	1.59		Non-significant
Speed Endurance	MIN	17.17	0.91	16.95	2.22	0.36		Non-significant

At a significance level of 0.05 and degrees of freedom (n-1) = 2.365

Table (3) indicates that all differences between pre- and post-test measurements for the control group were **statistically non-significant** for all measured variables. This suggests that any minor changes in the means of these variables between pre- and post-tests can be attributed to chance and do not reflect a true or substantial effect. This confirms the control group's effectiveness in not receiving any experimental intervention, making it a reliable reference for comparing the experimental group's results (if applicable).

- **Lactic Acid (mmol/L):**
  - Pre-test: Mean = 2.13, SD = 0.93، Post-test: Mean = 15.83, SD = 1.017
  - Calculated (t) = 2.378 > Tabulated (t) = 2.365 → **Significant increase** This suggests a statistically significant rise in lactic acid levels post-test, likely due to the absence of anaerobic training in the control group.
- **Anaerobic Power (W/S):**
  - Pre-test: Mean = 61.10, SD = 4.29، Post-test: Mean = 60.01, SD = 2.71
  - Calculated (t) = 1.34 → **Non-significant** No meaningful change, indicating stable performance.
- **Resting Heart Rate (Bpm):**
  - Pre-test: Mean = 77.24, SD = 1.91 ، Post-test: Mean = 75.12, SD = 1.56
  - Calculated (t) = 1.28 → **Non-significant**
- **Post-Exercise Heart Rate (Bpm):**

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  - Pre-test: Mean = 188.2, SD = 1.69 ‹Post-test: Mean = 190.1, SD = 2.012
  - Calculated (t) = 0.79 → **Non-significant**
- **Maximum Speed (m/s):**
  - Pre-test: Mean = 15.8, SD = 0.11 ‹ Post-test: Mean = 14.21, SD = 1.89
  - Calculated (t) = 1.59 → **Non-significant**
- **Speed Endurance (MIN):**
  - Pre-test: Mean = 17.17, SD = 0.91 ‹ Post-test: Mean = 16.95, SD = 2.22
  - Calculated (t) = 0.36 → **Non-significant**

Presentation of Means, Standard Deviations, and Calculated vs. Tabulated (t) Values for the Experimental Group (Pre- and Post-Test):

Table (4)

presents the means, standard deviations, and calculated (t) values (pre- and post-test) for the experimental group regarding physical and functional variables.

VARIABLES	UNIT OF MEASUREMENT	PRE-EXPER		POST-EXPER		CALCULATED (T) VALUE	TABULATED (T) VALUE	SIGNIFICANCE
		X	S	X	S			
Lactic Acid	mmol/L	1.96	1.13	12.4	2.18	3.76	2.365	significant
Anaerobic Power	W/S	58.13	3.53	61.89	0.98	4.15		significant
Resting Heart Rate	Bpm	75.09	1.47	74	1.12	2.38		significant
Post-Exertion Heart Rate	Bpm	193.8	1.90	181.9	2.012	3.92		significant
Maximum Speed	m/s	15.11	0.10	13.89	2.92	2.621		significant
Speed Endurance	MIN	18.59	0.99	23.05	1.90	4.17		significant

At a significance level of 0.05 and degrees of freedom (n-1) = 2.365

Table (4) demonstrates that all variables showed **statistically significant differences** between pre- and post-tests for the experimental group. The absolute calculated (t) values (3.76, 4.15, 2.38, 3.92, 2.621, 4.17) exceeded the tabulated (t) value (2.365), confirming that the changes were not due to chance but reflected the true impact of the anaerobic training program.

Regarding lactic acid, the pre-mean was 1.96, while the post-mean was 12.4. The pre-standard deviation was 1.13, and the post-standard deviation was 2.18, indicating greater variability in lactic acid levels among individuals after the experiment.

For the anaerobic power test (W/S), the pre-mean was 58.13, and the post-mean reached 61.89. In contrast, the pre-standard deviation was 3.53, while the post-standard deviation was 0.98, suggesting that the results after the experiment became more homogeneous and convergent.
Concerning resting heart rate (Bpm) measurements, the pre-mean was 75.09 beats per minute, and the post-mean was 74 beats per minute. The pre-standard deviation was 1.47, and the post-standard deviation was 1.12, indicating greater homogeneity in heart rate measurements after the experiment.
For post-exertion heart rate (Bpm), the pre-mean was 193.8, and the post-mean was 181.9. The pre-standard deviation was 1.90, and the post-standard deviation was 2.012.
For the maximum speed test (m/s), the pre-mean was 15.11, and the post-mean was 13.89. The pre-standard deviation was 0.10, while the post-standard deviation was 2.92.
Regarding the speed endurance test (MIN), the pre-mean was 18.59, and the post-mean was 20.05. The pre-standard deviation was 0.99, and the post-standard deviation reached 1.90.

Based on Table (4), we observe that all variables show statistical significance, as the absolute value of the calculated "T" for each variable (3.76, 4.15, 2.38, 3.92, 2.621, 4.17) is greater than the tabled "T" value (2.365). This indicates that all changes between the pre- and post-measurements are not due to chance but reflect a real effect of the experimental program.

3-3 Display of Mean, Standard Deviation, and Calculated and Tabled "t" Values for the Experimental and Control Groups (Post-Post)

Presentation of the results for the arithmetic means, standard deviations, and calculated and tabular t-values for the experimental and control groups (post-test).

Table (5)

compares post-test means, standard deviations, and (t) values between the control and experimental groups.

VARIABLES	**UNIT OF MEASUREMENT**	**POST – CONTRO**		**POST-EXPER**		**CALCULATED (T) VALUE**	**TABULATED (T) VALUE**	**SIGNIFICANCE**
		X	**S**	**X**	**S**			
Lactic Acid	mmol/L	15.83	1.017	12.4	2.18	4.89		significant
Anaerobic Power	W/S	60.01	2.71	61.89	0.98	2.56		significant
Resting Heart Rate	Bpm	75.12	1.56	74	1.12	3.09	2.120	significant
Post-Exertion Heart Rate	Bpm	190.1	2.012	181.9	2.012	2.671		significant
Maximum Speed	m/s	14.21	1.89	13.89	2.92	2.77		significant

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Speed Endurance	MIN	16.95	2.22	23.05	1.90	3.57		significant

At a significance level of 0.05 and degrees of freedom (n-2) = 2.120

All variables exhibited **significant differences** favoring the experimental group, confirming the anaerobic program's positive impact on physiological and physical performance compared to the control group.

Lactic Acid (mmol/L)

For lactic acid (mmol/L), the post-intervention mean for the control group was 15.8 with a standard deviation of 1.017. The post-intervention mean for the experimental group was 12.4 with a standard deviation of 2.18. The calculated t-value was 4.89, which exceeded the tabulated t-value of 2.120, indicating a significant level of significance. This analysis, showing a calculated t-value (4.89) greater than the tabulated t-value (2.120), indicates a statistically significant difference in mean lactic acid levels between the control and experimental groups. Notably, the mean lactic acid in the experimental group decreased (12.4) compared to the control group (15.83). This may suggest an improvement in lactate clearance ability or an enhancement in performance that requires lower lactate levels.

Anaerobic Capacity (W/S)

Regarding anaerobic capacity (W/S), the post-intervention mean for the control group was 60.01 with a standard deviation of 2.71. The post-intervention mean for the experimental group was 61.89 with a standard deviation of 0.98. The calculated t-value was 2.56, which exceeded the tabulated t-value of 2.120, indicating a significant level of significance. This demonstrates a statistically significant difference in anaerobic capacity. The mean anaerobic capacity increased in the experimental group (61.89) compared to the control group (60.01), suggesting that the training program was effective in improving anaerobic capacity.

Resting Heart Rate (Bpm)

For resting heart rate (Bpm), the post-intervention mean for the control group was 75.12 with a standard deviation of 1.56. The post-intervention mean for the experimental group was 74 with a standard deviation of 1.12. The calculated t-value was 3.09, which exceeded the tabulated t-value of 2.120, indicating a significant level of significance. This indicates a statistically significant difference in resting heart rate.

Post-Exertion Heart Rate (Bpm)

Concerning post-exertion heart rate (Bpm), the post-intervention mean for the control group was 190.1 with a standard deviation of 2.012. The post-intervention mean for the experimental group was 181.9 with a standard deviation of 2.012. The calculated t-value was 2.671, which exceeded the tabulated t-value of 2.120, indicating a significant level of significance. This suggests an improvement in the efficiency of the cardiorespiratory system and its ability to respond to exertion more effectively.

Maximum Speed (m/s)

For maximum speed (m/s), the post-intervention mean for the control group was 14.21 with a standard deviation of 1.89. The post-intervention mean for the experimental group was 13.89

with a standard deviation of 2.92. The calculated t-value was 2.77, which exceeded the tabulated t-value of 2.120, indicating a significant level of significance. The analysis shows that the calculated t-value (2.77) is greater than the tabulated t-value (2.120). This indicates a statistically significant difference in maximum speed. It is observed here that the mean maximum speed slightly decreased in the experimental group (13.89) compared to the control group (14.21). This unexpected result, if the goal was to increase maximum speed, may require further analysis of the training context.

Speed Endurance (MIN)

Regarding speed endurance (MIN), the post-intervention mean for the control group was 16.95 with a standard deviation of 2.22. The post-intervention mean for the experimental group was 20.05 with a standard deviation of 1.90. The calculated t-value was 3.57, which exceeded the tabulated t-value of 2.120, indicating a significant level of significance. This demonstrates a statistically significant difference in speed endurance. The mean speed endurance significantly increased in the experimental group (23.05) compared to the control group (16.95), confirming the effectiveness of the training program in improving the players' ability to maintain speed for longer durations.

DISCUSSION

Table (4) reveals statistically significant differences at the 0.05 level across all functional, physical, and skilled variables. The researcher attributes these differences to the effectiveness of the specific anaerobic training program. The special anaerobic exercises contributed to an improvement in some functional variables, which in turn reflected positively on the required physical abilities.

The clear improvement in functional variables after the specific anaerobic training program, regularly applied to the experimental group, demonstrates its efficacy in this type of training. The researcher attributes this improvement to an increased efficiency of working muscles under the stress of anaerobic training in hypoxic conditions, achieved by reducing inter-set rest periods. Additionally, running and anaerobic exercises contribute to increasing stored muscle glycogen and improving the function of active enzymes that allow for anaerobic adenosine triphosphate (ATP) synthesis. This aligns with what Sulaiman Farouk (1993) stated: "Achieving a high level in athletic performance requires comprehensive technical preparation in light of the demands of the game, taking into account the nature of the performance, game duration, field area, and the multitude of duties on the player."

Numerous studies have proven the important and decisive role of anaerobic training in improving athletic performance. This was indicated by Brandon (1995) and Mark Ardel et al. (1996), who noted that "scientifically based athletic training brings about fundamental physiological changes in various body systems. These integrated and organized functional changes result from regular physical preparation." This is also supported by Issam Abdel Khalek (2005), who highlights "the impact of physical preparation on developing physical and motor abilities such as muscular strength, endurance, speed, agility, flexibility, and their compounds like power-speed and strength-endurance."

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It is evident that the chemical processes related to energy systems during athletic activity directly influence the excitation of respiratory centers, leading to an increased breathing rate and thus an increased pulmonary ventilation volume. This chemical effect directly impacts the cells of the respiratory centers. Furthermore, any change in blood acidity (pH) due to an increase in lactic acid can directly affect respiration. This condition directly affects the chemical and sensory receptors, causing neural excitation that increases the breathing rate and removes carbon dioxide from the blood through the respiratory process (Qassem Hassan Hussein, 1990, p. 124; Issam Abdel Khalek, 1995).

The researcher attributes the high rates of change in functional aspects to the flexibility and adjustability of anaerobic training according to players' needs, without being restricted by a specific form or area. Its performance relies on changes in speed during the performance time.

Based on the foregoing, the proposed training program positively impacted the improved efficiency of functional, physical, and skilled technical aspects of football, thereby validating the research hypothesis.

It is clear from the above that the chemical processes related to energy systems during athletic activity or during basketball training directly influence the stimulation of respiratory centers, leading to an increased breathing rate and consequently an increased pulmonary ventilation volume. This chemical effect directly affects the cells of the respiratory centers. In addition, any change in blood acidity (pH) due to an increase in lactic acid can directly affect the respiratory process. This condition occurs directly on the chemical and sensory receptors, leading to neural stimulation that increases the breathing rate and rids the blood of carbon dioxide through the respiratory process (Qassem Hassan Hussein, 1990, p. 124; Issam Abdel Khalek, 1995).

Table (5) shows significant differences in the post-test measurements for both the control and experimental groups, with the experimental group's post-test results showing significant improvement. In the lactic acid test, the decrease in lactic acid levels in the experimental group after implementing the special program indicates a significant improvement in the body's anaerobic capacity and its ability to clear or utilize lactic acid as fuel. Al-Anzi (2018) states that "high-intensity endurance training or intermittent training can enhance the body's ability to tolerate higher lactate levels or delay its accumulation" (Brooks, 1986). This improvement is crucial for athletes as it delays fatigue and allows for sustained high-intensity physical effort for longer periods.

Regarding anaerobic capacity, the results indicate a slight but significant increase in anaerobic capacity, suggesting that the special training program improved the muscles' ability to produce energy quickly in the absence of oxygen. This ability is essential for activities requiring short, intense bursts of effort, such as sprinting, jumping, or weightlifting (Gastin, 2001). Although the increase seems small, it can be crucial in competitive athletic performance.

The results showed a decrease in resting heart rate, which is a classic and important indicator of improved cardiovascular fitness. This means the heart has become more efficient at pumping blood, sending more blood with each beat, and therefore requiring fewer beats to meet the body's demands (Plank et al., 2000). This improvement reflects a positive physiological adaptation to the training program.

A decrease in heart rate after exertion indicates improved cardiovascular efficiency and the body's ability to recover faster from physical exertion. This means the cardiovascular system adapts better to the demands of high-intensity physical activity and can return to a resting state more quickly (Heyward, 2018). This improvement reflects better cardiovascular fitness and a greater capacity for repeated effort. The researcher attributes the high rates of change in functional aspects to the flexibility and adjustability of special anaerobic training according to the needs of basketball players.

Interestingly, maximal speed decreased in the experimental group despite improvements in other variables. This might be attributed to the nature of the specific anaerobic training program applied to the experimental group. If the program focused more on endurance or anaerobic capacity without sufficient emphasis on developing pure maximal speed (e.g., explosive strength training or maximal effort sprints), it could lead to no improvement or even a slight decrease in speed (Blazevich & Newton, 2004). This could indicate a need to modify the program to directly include training components targeting maximal speed.

The results showed a significant improvement in speed endurance, indicating that the special training program was highly effective in improving athletes' ability to maintain high speed for a longer period. This reflects an improvement in both anaerobic and aerobic capacity, as speed endurance requires the ability to manage lactate accumulation and efficiently use energy systems (Mujika & Padilla, 2001). This variable is very important in sports that require repeated high-intensity efforts or maintaining a fast pace for an extended period, thus demonstrating that the specific anaerobic training program positively impacted the improved efficiency of functional and physical aspects, thereby validating the research hypothesis.

CONCLUSION

The results of the experimental group showed a significant improvement in the functional variables studied, as a result of their commitment to the specialized (anaerobic) training program. The results indicated statistically significant differences between the pre- and post-test measurements, in favor of the post-test ،The experimental group's results recorded remarkable progress in physical variables due to the use of specialized anaerobic exercises, with statistically significant differences between the pre- and post-tests, favoring the post-test.، The specialized anaerobic training proved effective in developing speed endurance and anaerobic power, which positively impacted performance levels, particularly in the development of speeds.

The researchers made several recommendations, including. Prioritize anaerobic training specific to performance when designing training programs, given its effective role in developing anaerobic endurance and its positive impact on the physiological and physical aspects of basketball players. Conduct similar studies focusing on sport-specific aerobic training in other individual or team sports to understand their physiological and physical

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effects. Implement the proposed sport-specific anaerobic exercise program to ensure its effectiveness and observe its positive impact on basketball players during the general preparation phase.

AUTHOR CONTRIBUTIONS

Ahmed Hassan Yass conceived the study, reviewed the literature on the work, selected the tests and measurements, designed the exercises and training units, and analyzed the results.
Fatmah Abd Alredah Hatam participated in designing the experiment, supervising the implementation of the study's tests and measurements, supervising the implementation of the training curriculum (exercises), and participating in analyzing and discussing the results.

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Appendices

Training Unit Template

Training Unit 1

Unit Duration: 85-90 minutes **Training unit objectives**

Main Section: 55-60 minutes (Anaerobic Exercises) **Improve anaerobic capacity**

Intensity: (80-95%) of maximum heart rate. Enhance recovery after high-intensity effort

Develop muscular and neural adaptation for fast, repetitive movements in basketball.

Exercise Type	Exercise Time	Sets	Rest Between Sets	Exercises	Intensity
Warm-up Period	15 min	-	-	Light jogging + flexibility + (alternating knees, arm circles, side steps, stretching exercises)	Low to Medium
Sprint Races	20 seconds	6	40 seconds	Running 30 meters at maximum speed with 40 seconds rest between each set	80-85%
Jumping Exercise	30 seconds (10-12 jumps)	8	60 seconds	Jumping from a box (50 cm)	85-90%
Side Defensive Movement Exercise	30 seconds	6	60 seconds	Fast defensive movement from side to side over a distance of 5 meters	80-85%
Running with Change of Direction Exercise	45 seconds	8	45 seconds	Using cones for quick direction changes (Zig-Zag)	90-95%

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Push-ups Exercise	30 seconds	6	60 seconds	Fast push-ups – 3 sets x 30 seconds, performed at maximum possible speed with 40 seconds rest	85-90%
Abdominal Exercise	60 seconds	4	60 seconds	Abdominal exercise for 60 seconds or 15-30 repetitions	80-85%
Cool-down Section (Stretching and Relaxation Exercises)	15 min	-	-	Cool-down exercises and static stretching for major muscles	Low