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The Effect Of Hypoxic Training On Some Blood Components And Some Biochemical Variables In Basketball Players

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Abstract

The aim of the research is to identify the extent of the effect of hypoxic training on some biochemical variables in the research sample, and to identify the effect of hypoxic training on some blood components in the research sample. The researcher used the experimental method to suit the nature of this research, using a one-group experimental design with a pre- and post-test. The research population and sample were chosen intentionally and were represented by the students of the Specialized Basketball School. The size of the population reached (14) players, and (8) players were chosen to represent the research sample. Thus, the percentage of the research population reached (57%). After conducting the experiment and processing the results statistically, analyzing and discussing them, the researcher concluded that hypoxic exercises have a major role in developing and increasing the proportion and number of red blood cells in the blood, and that hypoxic exercises have a clear effect in increasing the proportion of hemoglobin in the blood, and the proportion of red blood cells in the blood as a whole developed as a result of applying hypoxic exercises, which are characterized by a lack of oxygen. Hypoxic exercises have a major role in increasing the volume of red blood cells and increasing the percentage of oxygen in the blood as a result of the hypoxic exercises used in the research. In light of the previous conclusions, the researcher recommends informing the trainers of the importance of hypoxia and using their own training units, and adopting the exercises prepared by the researcher in the training and use Hypoxic to bring about skill, physical and biochemical development. The researcher recommends to conduct similar studies on different samples and different sporting events, and to conduct comparative studies between boys and girls to find out effects on any gender, to apply hypoxic training and find out its effect physically and skillfully in other research.

Keywords: Hypoxic Exercises, Blood Components, Biochemical Variables, Basketball.

Introduction

The development achieved in all fields, including the sports field, has brought about a qualitative leap in various types of sports. Studies and research in the field of physical education, sports training, and sports physiology have achieved important accomplishments, leading to raising the athletic, physical, and functional level of athletes. Basketball is one of the complex team sports that depends on the element of practice and requires long periods of strenuous and continuous training in order to learn and master the required motor skills. This requires the availability of specific physical elements for this game in the basketball player. Among the most important of these elements are speed and rapid strength to ensure the player's ability to reach from the backcourt to the opponent's court and thus score points.

Likewise, “physical performance depends on the blood’s ability to carry oxygen, the ratio of hemoglobin concentration, the number of red blood cells in the bloodstream, and their ability

to perform their functions" (szyguia:1990: 184). Recently, interest has emerged in the method of training with controlled breathing, as many researchers and specialists have studied this method for the purpose of developing various physiological qualities in players, considering that this method leads to an increase in oxygen debt by reducing the number of breaths during performance, which leads to an increase in the body's ability to adapt to oxygen debt. Thus, the importance of the research is evident in knowing the effect of hypoxic training on some biochemical variables and some blood components in the research sample.

Through the researcher's monitoring of the basketball field match and through the use of the opinions of the supervisor and coaches and conducting interviews with the basketball instructors at the College of Physical Education, it became clear that there is a weakness in the players' ability to endure fast play for long periods. This is due to the use of traditional exercises by the trainees, which do not give the trainee a great role in improving his performance and raising his level. This prompted the researcher to use more modern exercises, represented by the use of hypoxic exercises, which help to adapt some functions of the circulatory system to the high loads of the trainees and raise the level of functional efficiency.

Research Objectives:

1- To identify the effect of hypoxic training on certain biochemical variables in the research sample.
2- To identify the effect of hypoxic training on certain blood components in the research sample.

1. Research Methodology and Field Procedures:

2.1 Research Methodology

The researcher used the experimental method, as it is suitable for the nature of this research, employing a single-group pre-test/post-test experimental design.

2.2 Research Population and Sample

The research population and sample were selected purposively and consisted of students from the specialized basketball school. The population size was (14) players, and (8) players were selected to represent the research sample, thus representing (57%) of the research population.

2.3 Research Tools

2.3.1 Data Collection Methods

- Arabic and Foreign Sources and References
- Testing and Measurement
- Self-Observation
- Player Data Registration Form
- Supporting Staff
- Statistical Methods

2.3.2 Equipment and Tools Used

- Plus Oximeter
- 5 ml Single-Use Plastic Syringes
- Medical Cotton
- Alcohol-Based Antiseptic
- Heparin-Containing EDTA Tubes

- Ice Box for Keeping Containers Safe Until Arrival at the Laboratory
- Complete Blood Count (CBC) Meter
- CBC Results Recording Form

2.4 Research Variables:

- RBC (Red Blood Cells)
- HGB (Hemoglobin)
- HCT (Percentage of red blood cells in total blood volume)
- MCV (Mean Corpuscular Volume)
- Saturated Blood Oxygen

2.5 Pre-Test Study

The researcher, in agreement with the director of the specialized basketball school and the school's coaches and players, conducted a pre-test study on (4) players from outside the research population on Friday, November 9, 2025. The pilot study aimed to:

- Verify the suitability of the equipment and tools used
- Practice conducting the tests and the time required for each test
- Clarify the role of the assistants in conducting the research and define the specialization of each of them
- Identify any difficulties that may arise during the pilot study and work to eliminate them before conducting the main study

2.6 Research Procedures

2.6.1 Pre-test of the Research Sample

Blood oxygen saturation was measured and recorded on the player data registration form. Blood samples were taken immediately after the training session. Each player was assigned a number, and this number was placed on their blood sample (numbers 1-8). A 2 ml blood sample was drawn by a specialist and taken to the Baquba General Hospital laboratory for analysis on November 17, 2025.

2-6-2 Implemented Curriculum

After reviewing sources and consulting experts, the researcher prepared a training program for the research sample during the preparation period. Implementation of the program began on November 23, 2025, and concluded on January 20, 2026.

- The exercise layer was part of the main section of the training session and lasted (45-50) minutes.
- The program was implemented with (3) training sessions per week for (8) weeks, totaling (24) sessions.
- The training load was gradually increased every two weeks.
- The program was implemented using a high-interval and low-repetition training method.
- Individual differences among players were taken into account, and for the safety of the players, hypoxic training was stopped if headaches or facial redness occurred during training.
- The training load was distributed across the training weeks of the program.
- The curriculum was implemented using low and high interval and repetition training methods.
- Individual differences among players were taken into account, and for the safety of the players, hypoxic training was stopped if headaches or facial redness occurred.
- Load grades were distributed across the training weeks during the program

Table (1) shows the formation of weekly training loads

Weeks	**Intensity of Training**
Weeks 1 and 2	Intensity on the first and second days: 70%, and on the third day: 75%
Weeks 3 and 4	Intensity on the first and second days: 75%, and on the third day: 80%
Weeks 5 and 6	Intensity on the first and second days: 80%, and on the third day: 85%
Weeks 7 and 8	Intensity on the first and second days: 85%, and on the third day: 90%

2.6.3 Post-Test (for the research sample)

The researcher conducted the post-test according to the pre-test variables, keeping the same conditions and variables in terms of time, place, and climate. The test was administered on January 21, 2026.

2.7 Statistical Methods

The researcher used the SPSS statistical package to extract the research results.

2. Presenting, analyzing, and discussing the results.

3.1 Presenting the results of the pre- and post-tests for the research variables:

Table (2) shows the arithmetic means and standard deviations of the research variables

Variables	Pre-test		Posttest	
	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation
RBC	5.211	0.52949	5.745	0.347
HGB	14.575	0.8212	15.625	0.848
HCT	44.550	2.51744	47.963	1.965
MCV	86.0	6.91014	88.375	4.368
Blood Oxygen level	97%	2%	99%	1.6%

Table (2) shows that the arithmetic mean for RBC in the pretest was (5.211) and the standard deviation was 0.52949. The arithmetic mean in the posttest was (5.745) and the standard deviation was (0.347). As for HGB, the arithmetic mean in the pretest was (14.575) and the standard deviation was (0.8212), and in the posttest it was (15.625) and SD was 0.848 respectively. The arithmetic mean in the HCT pretest was (44.550) and the standard deviation was (2.51744), while in the posttest it was (47.963) and the standard deviation was (1.965). The arithmetic mean in the MCV pretest was (86.0) and the standard deviation was (6.91014), and in the posttest it was (88.375) and the standard deviation was (4.386). The arithmetic mean for the ratio Blood oxygen in the pre-test was (97%) and the standard deviation was (2%), while in the post-test the arithmetic mean was (99%) and the standard deviation was (1.6%).

Table (3)

Shows the arithmetic means and standard deviations of the pre- and post-tests, the error rate, the calculated and tabulated T, and the significance level for red blood cells (BRC).

Variables	Test	Pre-test	Test	Post Test	Standard	T	T	Significance
	Standard Deviation	Mean	Standard Deviation	Mean	Error	Calculated Value	Tabulated value	

RBC	5.211	0.52949	5.745	0.347	0.01	0.043	3.50	Significant

Table (4)
Shows the arithmetic means and standard deviations of the pre- and post-tests, the error rate, the calculated and tabulated T, and the significance level for hemoglobin (HGB).

Variables	Test	Pre-test	Test	Post Test	Standard	T	T	Significance
	Standard Deviation	Mean	Standard Deviation	Mean	Error	Calculated Value	Tabulated value	
HGB	14.575	0.8212	15.625	0.848	0.01	0.034	3.50	Significant

Table (5) shows the arithmetic means and standard deviations of the pre- and post-tests, the error rate, the calculated t-value, the tabulated t-value, and the significance level for the percentage of red blood cells relative to the total blood volume

Variables	Test	Pre-test	Test	Post Test	Standard	T	T	Significance
	Standard Deviation	Mean	Standard Deviation	Mean	Error	Calculated Value	Tabulated value	
HCT	44.550	2.51744	47.963	1.965	0.01	0.013	3.50	Significant

Table (6) shows the arithmetic means and standard deviations of the pre- and post-tests, the error rate, the calculated t-value, the tabulated t-value, and the significance level for the mean corpuscular volume (MCV)

Variables	Test	Pre-test	Test	Post Test	Standard	T	T	Significance
	Standard Deviation	Mean	Standard Deviation	Mean	Error	Calculated Value	Tabulated value	
MCV	86.0	6.91014	88.375	4.368	0.01	0.455	3.50	Significant

Table (7) shows the arithmetic means and standard deviations of the pre- and post-tests, the error rate, the calculated and tabulated t-values, and the significance level for blood oxygen saturation

Variables	Test	Pre-test	Test	Post Test	Standard	T	T	Significance
	Standard Deviation	Mean	Standard Deviation	Mean	Error	Calculated Value	Tabulated value	Significant
Blood Oxygen Level	97%	2%	99%	1.6%	0.01	0.051	3.50	

2.2 Discussions

Based on the results of the statistical analysis of the study data, and guided by scientific references and previous studies, the results were discussed. Table (3) shows that the number of red blood cells increased in the post-test more than in the pre-test. This increase is attributed to the use of hypoxic exercises, as exercise under low oxygen leads to adaptations in the blood. The lack of oxygen stimulated an increase in the number of red blood cells to compensate for the oxygen deficiency, and an increase in red blood cells increases the efficiency of oxygen transport. Neubur: (2001) also indicates that the use of hypoxic exercises led to an increase in the number of red blood cells. Rodrigues et al. (2000) add that repeated exposure to hypoxic training is sufficient to increase red blood cell (RBC) count. (Rodrigues: 2000: 312).

Table (4) shows the results of blood hemoglobin tests. The table shows an increase in the hemoglobin level in the post-test compared to the pre-test. The researcher attributes this increase to the use of hypoxic training. Exercise in hypoxic conditions causes adaptations within red blood cells, increasing the hemoglobin level and thus enhancing the cell's ability to transport oxygen to compensate for the oxygen deficiency resulting from these exercises. This is confirmed by Radziyevsky et al. (1993), who found that using breathing control training for athletes led to a noticeable increase in respiratory volume per minute, arterial blood oxygen saturation, increased blood hemoglobin, and decreased blood lactic acid levels, as well as improved performance. (Radziyevsky: 1993: 285)

Casas et al. (2000) state that regular, short-term exposure to hypoxia leads to physiological responses that enhance physical performance. It also leads to an increase in red blood cells and hemoglobin. Furthermore, hypoxic training improves both aerobic and anaerobic endurance in athletes (Casas M., 2000:125). Table (5) shows the results of the red blood cell-to-total blood ratio. The post-test showed a greater increase in the red blood cell ratio than the pre-test. This is attributed to the use of hypoxic training, which induces physiological responses. Hypoxic training stimulates the blood to transport a greater quantity of oxygen, and providing this oxygen requires a larger quantity of red blood cells.

Mr. Abdel-Maqsoud (1992) states that physical training leads to an increase in blood volume of one to two liters, and the blood volume of highly trained men can reach (7-8) liters. Consequently, there is an increase in the amount of hemoglobin corresponding to this increase in blood volume of (200-300 g), which leads to an increase in the amount of oxygen that the blood can carry. (Abdel-Maqsoud: 1992: 136). Hossam El-Din Farouk (2002) agrees that there are responses to red blood cells and hemoglobin when using physical loads, where an increase in the number of red blood cells occurs with a change in the percentage of hemoglobin in the blood when using muscular activities. These responses require several hours to return to the normal level that it was at before carrying out the physical load. We observe these responses after high-intensity physical performance for a short period of time (Farouk: 2002: 28).
Table (6) shows the average size of the red blood cell. The results in the table show an increase in the size of the cell in the post-test compared to the pre-test. The reason for this increase is the use of hypoxic exercises, which caused changes in the size of the cell to compensate for the oxygen deficiency. The increase in size is due to the increase in the percentage of hemoglobin in the blood, enabling the cell to carry a larger amount of hemoglobin and thus increase the percentage of oxygen transported to the body.

Table (7) It shows the percentage of oxygen in the blood, and through the results we conclude that there is an increase in the percentage of oxygen in the blood in the post-test compared to what it was in the pre-test. This increase is due to the use of hypoxic exercises, as exercising with a lack of oxygen leads to an increase in the number of red blood cells, an increase in blood hemoglobin, and an increase in the size of the blood cell. All these factors help to increase the percentage of oxygen in the blood.

Mohammed Alawi and Abu Al-Ala Abdel Fattah (2000) consider hypoxic training to be a modern method for improving athletic performance. They argue that hypoxic training increases oxygen debt by reducing the number of breaths during exercise, thus increasing the body's ability to adapt to oxygen deprivation (Alawi, 2000: 310). Ashraf Suleiman (1995) confirms that hypoxic training results in the body's cells and tissues being able to extract more oxygen and increases lung volume (Suleiman, 1995: 88).

3. Conclusion:

After conducting the experiment, statistically processing, analyzing, and discussing the results, the researcher concluded that hypoxic training plays a significant role in developing and increasing the percentage and number of red blood cells in the blood. Hypoxic training also has a clear effect on increasing hemoglobin levels in the blood. The percentage of red blood cells in the blood as a whole improved as a result of applying hypoxic training, which is characterized by oxygen deficiency. Furthermore, hypoxic training plays a significant role in increasing red blood cell volume and increasing blood oxygen levels due to the oxygen-deficient training used in the research, In light of the previous conclusions, the researcher recommends that coaches be made aware of the importance of oxygen deficiency and the use of their own training units, and that the exercises prepared by the researcher be adopted in hypoxic training to bring about skill, physical and biochemical development, and that similar studies be conducted on different samples and different sporting activities, and that comparative studies be conducted between boys and girls to determine the greater effect in which gender, and that oxygen deficiency training be applied and its physical and skill-related effects be determined in other research.

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Appendix (1) Exercises Used

1. 40m run, holding your breath for 20m. Repeat 4 times.
2. 60m run, holding your breath for 40m. Repeat 2 times.
3. Run 30m, then receive a ball and shoot 4 times on your breath and once holding your breath. Repeat 4 times.

4. Perform 4 sit-ups, then stand up, receive a ball, and shoot 4 times on your breath and once holding your breath.
5. Perform 3 sit-ups, then stand up and perform a dribbling drill, quickly passing the ball to a teammate. Do 2 repetitions with your breath, then once while holding your breath.
6. Place four lines on the court, 1.5 meters apart. The player runs to the fourth line, then back to the first, then back to the third, and finally back to the second line, once with your breath and once while holding your breath.
7. Distribute 6 balls around the arc. Place a target 2 meters from each ball and halfway between the two balls. The player shoots at the basket, then circles the target and returns to shoot the other ball.
8. Perform 4 squats, then jump over two hurdles, then run towards the basket to receive a pass from the coach. Do 2 repetitions with your breath and once while holding your breath.
9. The player dribbles from one end of the court to the other, then passes the ball to a teammate and returns to a defensive position.
10. Support your arms against the wall, keeping your body leaning against it, and perform a sprint for 30 seconds on breath and 15 seconds holding your breath.
11. Jump upwards, then spread your legs and land. Perform 15 squats on breath and 10 holding their breath.