The Effect of Hypoxic and Hyperoxic Training on Certain Blood Cells, Blood Gases, and Time Trial Performance of Cyclists

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The study is aimed to prepare Preparing hypoxic exercises (oxygen deficiency) for the first experimental group competitors and hypoxic exercises (oxygen increase) for the second experimental group competitors, and identifying the superiority of the differences between the measurements and post-tests of the first experimental group (oxygen deficiency) and the second experimental group (oxygen increase) in the values of some blood cells (EPO, FERs, Hb, (Hct, and gas exchange (po2, spo2) and the achievement of the individual race against the clock for the Dhi Qar Cycling Federation racers among the research sample members. The experimental method with two groups was used for its suitability and the nature of the phenomenon to be studied. The research community represents the Dhi Qar Cycling Federation, youth category (17-18 years old). The study came out with the following most important conclusions: The results of blood cell variables measurements showed that they fall within the normal limits and did not record a critical measurement among the research sample members. The results of the study recorded a noticeable effect in raising and improving the level of measuring some blood variables (EPO, FERs, Hb, Hct) as a result of training using the (oxygen deficiency) method and effectively among the members of the first experimental group. The results of gas exchange variables measurements also appeared to fall within the normal limits and did not record a critical measurement among the research sample members. The results of the study recorded a noticeable effect in raising and improving the level of measuring gas exchange (po2, spo2) as a result of training using the (oxygen increase) method and effectively among the members of the second experimental group. The most important recommendations are to adopt the (oxygen deficiency) method as a means of assistance in improving the level of blood variables and developing the physical and motor aspects, adopting the (oxygen increase) method as a means of assistance in improving the level of gas exchange, adopting blood variable measurements as an indication of the adaptation of the players' functional organs and systems, adopting the results of the study in blood cell variables and physical abilities that were reached as a criterion for evaluating the level of functional and training status among the research sample members.

1- Research definition.

1-1 Introduction to the research and its importance:

Given the importance of diversity in the means and methods of modern training science and the combination between them, and accompanying that with effective and influential training of a quality that is consistent with the nature of the muscular work implemented in the field with the training

method prepared to achieve the desired goals for which it was set, to improve the physical efficiency of the working muscle groups and corresponding to the performance of the duty of motor action, in light of saving time and effort in the training process to prepare and prepare athletes for competitions, it has become necessary for those concerned with cycling to delve into the fields of modernity from the scientific means that facilitate the application of specialized methods, and perhaps the method of hypoxic training (Hypoxic, which means training under conditions of low oxygen, and hyperoxic, which is based on training under conditions of increased inhaled oxygen, are two methods whose primary goal is to increase the aerobic capacity of endurance athletes in general according to two different physiological mechanisms.

The importance of this study is focused on knowing which method is the best and most efficient in developing some blood cells for the research community and knowing which is better in developing mechanisms for the transfer of gases in the blood in a better way that serves to supply the working muscle tissue and thus achieve better time achievement.

1-2 Research Problem

The research problem was represented by the hesitation of most of the competitors in maintaining the same performance in the race, in addition to the weakness in showing the required level at the appropriate time, especially when reaching the finish line due to fatigue. There are reasons that lead to fatigue, including physical, psychological, functional or physiological, the most important of which is the depletion of oxygen in the body so that its consumption becomes more than its availability as a result of the increased energy expenditure as requirements for performing the race, and finding different ways or means to provide an amount of oxygen in the body to benefit from it in providing energy that the competitors benefit from during the race is very important.

1-3 Research objectives:

1- Number of hypoxic exercises (oxygen deficiency) for the members of the first experimental group.

2- Number of exercises using the hyperoxic method (increasing oxygen) for the members of the second experimental group.

3 - Identifying the significance of the differences between the values of the pre- and post-tests and measurements in some blood cells and gases and the achievement of the first group (hypoxic).

4- Identifying the significance of the differences between the values of the pre- and post-tests and measurements in some blood cells and gases and the achievement of the second group (hyperglycemia).

5- Identifying the significance of the differences between the two experimental groups in the tests and dimensional measurements in the values of some blood cells, gases, and achievement.

1-4 Research hypotheses:

1- Hypoxic exercises (oxygen deficiency) had a positive effect on the values of some cells and blood gases in the individuals of the first experimental group.

2- Hyperoxic exercises (increasing oxygen) have a positive effect on the values of (Po2, Spo2) in the individuals of the second experimental group.

3 - The first group (oxygen deficiency) was superior in blood cell values and achievement in post-tests and measurements.

4 - The second group (increased oxygen) was superior in gas values in dimensional measurements.

1-5 Research areas:

1-5-1 Human domain: Dhi Qar Cycling Federation players (youth) for the (2025) season.

1-5-2 Time domain: For the period from (10/23/2024) to (12/9/2024).

1-5-3 Spatial domain:

1-5-3-1 Union Headquarters.

1-5-3-2 Specialized Heart Hospital.

1-5-3-3 New Nasiriyah highway Road.

2- Research methodology and field procedures:

2-1 Research Methodology:

There are many methods used in scientific research, and the choice of any method depends on the nature of the study used (and because experimental research is characterized by precision and control over the variables studied and it is considered the only research method that accurately explains the relationship between effect and cause).[1]

Therefore, the researcher resorted to using the experimental method with two experimental groups because it is suitable for the nature of the research problem in order to reach the truth and reveal it,

[1](1) Muhammad Hassan Alawi and Osama Kamel: Scientific Research, Education and Psychology, Cairo, Dar Al Fikr Al Arabi, 1999, p. 104.

through a comprehensive investigation of the phenomena and evidence related to the problem, as it is considered "the precise and controlled scientific activity, and it is a procedure for controlling the influential factors surrounding the experiment except for one factor, which is the independent variable, for the purpose of measuring its effect on the dependent variable."[2)]

Table No. (1)

The approved experimental design presented in the research.

Post-tests	Experimental handling	Pre-tests	The group
blood cells arterial blood gases Race completion (20) kilometers	Hypoxic Training + General Syllabus	blood cells arterial blood gases Race completion (20) kilometers	First trial
	Oxygen Booster Training + General Syllabus		Second Experiment

2-2 Research community and sample:

The researcher has defined the research community as "all individuals, persons or things who are the subject of the research problem."[(3)]They are the Dhi Qar Cycling Federation competitors participating in the Iraqi Cycling League for the season (2025) in the youth category over the age of (17/18) years, numbering (15) players registered in the records of the Dhi Qar Governorate Sub-Federation of Cycling. Their percentage represented (100%) of the research community, as they were divided into two groups (first experimental and second experimental) by lottery with (6) players for each group, (3) for the exploratory experiment, as the first group (first experimental) was subjected to exercises using the oxygen deficiency method, while the second group (second experimental) was subjected to exercises using the oxygen increase method. They were homogenized and equalized as in Table (1(,(2).

[2(2)] Dhafer Hashim Al-Kazemi: Scientific Applications for Writing Educational and Psychological Letters and Theses - Planning and Design, Baghdad, Dar Al-Kutub and Documents, 2012, p. 137.
[3]() Dhoqan Obaidat (and others): Scientific Research: Its Concept, Basics, and Tools, Amman, Dar Al Fikr Al Arabi, 2000, p. 105.

Table No. (2)

It shows the homogeneity between the first experimental research group (oxygen deficiency) and the second experimental group (oxygen increase) for the variables (height, weight, chronological age, training age).

Coefficient of skewness	Standard deviation	The mediator	Arithmetic mean	The group	Unit of measure	Statistical Processing Variables
0.73_	6.50	178	176.40	First trial	poison	height
0.67_	6.22	180	178.60	Second Experiment		
0.82	2.9	61	61.8	First trial	kg	Mass
0.57	2,1	60	60.4	Second Experiment		
0.96	2.5	17	17.8	First trial	year	Chronological age
0.72	2.5	17	17.6	Second Experiment		
0.85	0.70	2	2.20	First trial	year	Training age

Table No. (3)

Shows the values of the arithmetic means, standard deviations and (T) The first experimental group (oxygen deficiency) and the second experimental group (oxygen increase) to investigate changes in some blood cell variables, gas exchange, individual race achievement against the clock, and strength endurance test.

Significance of differences	Significance level	value(T) Calculated	Second Experiment Increase oxygen		First Experiment Lack of oxygen		Unit of measure	Processors / Variables
			±A	S	±A	S		
Blood cell measurements								
Non-moral	0.122	1,12	0.28	6.85	0.28	6.71	mu/mL	EPO

2-3

Non-moral	0.261	0.31-	0.91	65.49	1.31	65,65	Ng/mL	FER
Non-moral	0.112	1.56	0.48	13.92	0.44	13.60	g/dl	Hb
Non-moral	0.176	0.23	0.85	41.76	0.88	41.67	%	HCT
Gas exchange measurements								
Non-moral	0.093	1.63	1.95	91.44	1.65	90,12	mm/Hg	Po2
Non-moral	0.101	1.77	0.21	98,16	0.23	98	%	Spo2
Physical variables								
Non-moral	0.281	0.04	18.32	2130, 2	18:30	2129. 8	m	bear strengt h
Non-moral	0.312	-0.85	0.92	41.76	0.97	42.11	min	Achiev ement 20 km

Means of collecting information, tools and devices used in the research:

2-3-1 Information collection methods:

- Note.
- Personal interviews.
- Arabic and foreign sources and references.
- International Information Network (Internet)

2-3-2 Tools used:

- Bicycles for each rider, conforming to the legal specifications for the youth category, number (12)
- (12) Movable Training Roller
- Bike repair kit.

- (6) Australian made oxygen deficiency training masks.
- Oxygen cylinders with oxygen masks according to medical standards, number (6).
- Whistle number (2).
- Traffic sign number (4).
- Compression bandage.
- Medical injection capacity (5.CC).
- Medical cotton.
- Blood storage tubes Plastic.

2 - 3 - 3 Devices used:

- Computer type (FUJITSU).
- Camera type (SONE).
- Medical scale number.
- Device ROLL MIXER.
- Printer type EPSON.
- Device (sysmex)
- device (Mimi IDAS)
- device (AIA900,TOSOH)
- device(ABL800, (FLEX
- counter POIAR FIOW)) Electronic bike mounted.
- Device PUSH pulse oximeter (3).
- Stopwatch.

2-4 Field research procedures

2-4-1 Determine the research variables

2-4-1-1 Determine functional indicators

In order to determine the functional indicators of the research sample individuals, the researcher sought to: review Scientific sources and references and consultation with the supervisor, the following functional indicators were identified:

2-4-1-1-1 Determination of blood cell variables:

1- Erythropoietin (EPO).

2- Hemoglobin(Hb).

3- Ferritin (FER).

4- Hematocrit (HCT).

3-4-1-1-2 Determine gas exchange variables:

1- The partial pressure of oxygen (Po2).

2- Oxygen saturation levelSpo2)).

2-4-2 Description of the measurements used in the research

3-4-2-1 Measurement of some blood cells:

- In order to measure the blood cell variables of the study, (4 ml) of venous blood was withdrawn using a tourniquet by a specialized medical staff at the Heart Hospital for the research sample members during rest time using (5 ml) disposable medical syringes. Then the blood was emptied into special tubes prepared for the purpose of preserving it and preventing its clotting into three sections (1 ml), (1 ml) and (2 ml) after numbering them according to the sequence of the research sample. They were placed in a device ((ROLL MLXER For the purpose of preventing blood clots, (2 ml) of blood was taken to measure the level of blood cells (hemoglobin (Hb), hematocrit (HCT) using the (sysmex) device, then (1 ml) of blood was taken to determine the level of the erythropoietin hormone (EPO) using the (AIA900, TOSOH) device, then (1 ml) of blood was taken to determine the level of (ferritin hormone (FER)) using the (ABL827, (FLEX) device.

Figure (1) shows the method of drawing venous blood to measure blood cells.

3-4-3-2 Description of gas exchange variable measurements:

In order to measure the gas exchange variables of the study, (1 ml) of arterial blood was withdrawn using a tourniquet by a specialized medical staff at the Heart Hospital for the research sample individuals at rest using (5 ml) disposable medical syringes. It is placed directly in the ABL800, FLEX device to know the level of oxygen partial pressure (Po2), oxygen saturation level (Spo2).

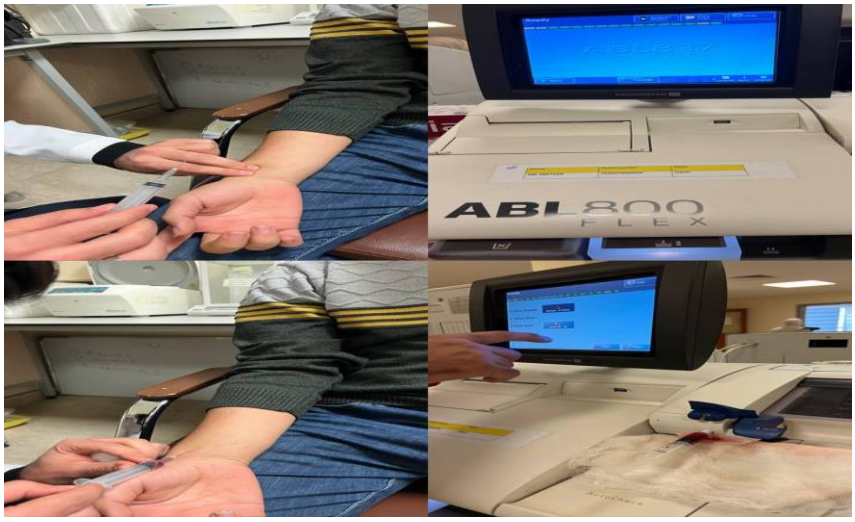

Figure (2) shows the method of drawing arterial blood to measure blood gases.

2-5 Main experiment

2-5-1 Pre-tests

Pre-measurements were performed at the Specialized Heart Hospital on Wednesday, 10/23/2024. The aforementioned functional variables were measured, as well as age, weight, and height. The conditions related to the measurements and tests were taken into consideration in terms of time, place, tools used, method of implementation, and two assistant work teams in order to work on providing them in the dimensional measurements and tests.

2-5-2 Strength endurance exercise:

The researcher prepared a training curriculum, as shown in Appendix No. (15), with the aim of improving the aerobic endurance exercises of cyclists. The training curriculum included the following:

Aerobic endurance exercises using hypoxic (lack of oxygen) and hyperoxic (increased oxygen) methods were carried out in the preparation phase to accompany the general program. They were applied for a period of (6) weeks and (18) training units (*). This is consistent with the opinion of everyone who (klinzing)[(4)], and(Sharky) [(5)]"The number of units per week was between (2-3) units, and the number of weeks was not less than (6) weeks so that development could appear." The first training unit was implemented on Saturday 10/26/2024, and the last training unit was on Thursday 12/5/2024, at a rate of (3) training units per week on (Saturday, Tuesday, and Thursday) with the help of the trainer (*).

The researcher took into account the age group and physical ability of the individuals in the experimental research sample, and relied on exploratory experiments and sources related to sports training science and the rules of training for the hypoxic (lack of oxygen) and hypoxic (increased oxygen) methods, in addition to the opinions of experts and specialists in sports training and bicycles to benefit from their guidance in developing the program in its final form before implementing it.

- The duration of the strength endurance training using the hypoxic and hyperoxic methods is between (25-30) minutes.
- Taking into account the appropriate formation of the training load in terms of intensity and volume.
- Use low-intensity interval training to develop strength endurance.
- Use of training during the special preparation period.
- Controlling the pulse rate (140-165%) using a pulse oximeter.
- Wave between training units using a load formation (2:1).
- Use intensity during the training unit, ranging from (50-75%).

[()]Klinzing, Basketball For Strength And Stars, Champion Ship Books, USA, 1996, P78.[4]
[()]Sharky, Fitness And Health, Human Kinetics, USA 1997, P115.[5]

Table No. (4)

Shows the number of units and their total time for the hypoxic and hyproxic methods in the main experiment.

6 weeks	**Training program time**
18 units	**Number of units**
Main section only	**Hypoxic and hypoxic training for the two experimental groups**
(3) Units	**Number of units per week**
From (25-30) minutes	**Daily training time**
From (75-90) minutes	**Weekly training time**
From (450-540) minutes	**Total unit training time**

3-5-3 Measurements and post-tests:

Dimensional measurements were conducted after the completion of the main experiment, which lasted (6) weeks, on Sunday 12/8/2024. The aforementioned functional variables were measured.

The conditions related to the measurements and tests were taken into consideration in terms of time, place, tools used, method of implementation, and two assistant work teams in order to provide the same conditions in the preliminary measurements and tests.

3- Presentation, analysis and discussion of results.:-

This chapter deals with presenting, analyzing and discussing the research results, after the researcher has completed collecting the data resulting from the measurements used, which were placed in tables, because they represent ease in extracting scientific evidence; and because they are an appropriate explanatory tool for the research that enables the research hypotheses and objectives to be achieved in light of the field procedures carried out by the researcher.

3-1- Displaying, analyzing and discussing the results of functional variables:

3-1-1- Presentation, analysis and discussion of the results of the functional variables for the first experimental group (oxygen deficiency):-

Table (5)

Shows the arithmetic means, standard deviations and the value of (T) Calculated and significance level in functional variables (EPO, FER, HCT, Po2) for the first experimental group (oxygen deficiency) in pre- and post-measurements

Significance of differences	Sig	value ((T calculated	Dimensional measurement		Pre-measurement		Statistical Processing Variables
			± A	S	± A	S	
moral	0.00	25.80	0.48	12,13	0.28	6.71	EPO
moral	0.00	11.31	3.34	83.75	1.31	65,65	FER
moral	0.00	4.04	0.62	43.61	0.88	41.67	HCT
moral	0.00	2,54	1.24	92.46	1.65	90,12	Po2

In light of the extracted data for the research sample individuals, Table () shows the differences in functional values (EPO, FER, HCT, PO2) in the pre- and post-measurements. As shown in the table above, the nature of the sample individuals for the first experimental group showed differences between the pre- and post-measurements.

In the variable (erythropoietin hormone EPO) and using the (T) test for correlated samples to extract the differences, as its calculated values reached (25.80) at a significance level of (0.00) between the pre- and post-measurements of the first experimental group and in favor of the post-measurements.

As for the variable (ferritin protein FER) and using the (T) test for correlated samples to extract the differences, as its calculated values reached (11.31) at a significance level of (0.00) between the pre- and post-measurements of the first experimental group and in favor of the post-measurements.

As for the variable (hematocrit HCT) and using the (T) test for correlated samples to extract the differences, as its calculated values reached (4.04) at a significance level of (0.00) between the pre- and post-measurements of the first experimental group and in favor of the post-measurements.

But in a variable Partial pressure of oxygen (PO2) and using the (T) test for correlated samples to extract the differences, as its calculated values reached (2.54) at a significance level of (0.00) between the pre- and post-measurements of the first experimental group and in favor of the post-measurements.

3-1-2- Presentation, analysis and discussion of the results of the functional variables for the second experimental group (increased oxygen):-

Table (6)

Shows the arithmetic means, standard deviations and the value of (T) Calculated and significance level in functional variables (EPO, FER, HCT, Po2) for the second experimental group (increased oxygen) in pre- and post-measurements

Significance of differences	Sig	value ((T calculated	Dimensional measurement		Pre-measurement		Statistical Processing Variables
			± A	S	± A	S	
Non-moral	0.73	0.36	0.40	6.93	0.28	6.85	EPO
Non-moral	0.88	0.98	1.23	66,16	0.91	65.49	FER
Non-moral	0.21	0.88	1,13	42.32	0.85	41.76	HCT
moral	0.00	4.77	0.74	95.88	1.95	90.44	Po2

In light of the extracted data for the research sample individuals, Table () shows the differences in functional values (EPO, FER, HCT, PO2) in the pre- and post-measurements. As shown in the table above, the nature of the sample individuals for the second experimental group showed differences between the pre- and post-measurements.

In the variable (erythropoietin hormone EPO) and using the (T) test for correlated samples to extract the differences, as its calculated values reached (0.36) at a significance level of (0.73) between the pre- and post-measurements of the second experimental group and in favor of the post-measurements.

As for the variable (ferritin protein FER) and using the (T) test for correlated samples to extract the differences, as its calculated values reached (0.98) at a significance level of (0.88) between the pre- and post-measurements of the second experimental group and in favor of the post-measurements.

As for the variable (hematocrit HCT) and using the (T) test for correlated samples to extract the differences, as its calculated values reached (0.88) at a significance level of (0.21) between the pre- and post-measurements of the second experimental group and in favor of the post-measurements.

But in a variable Partial pressure of oxygen (PO2) and using the (T) test for correlated samples to extract the differences, as its calculated values reached (4.77) at a significance level of (0.00) between the pre- and post-measurements of the second experimental group and in favor of the post-measurements.

1-3-3Show results Functional variables And its analysis and discussion for the two experimental groups:-

Table (7)

Shows the arithmetic means, standard deviations and the value of (T) Calculated and significance level in the Variables Functional(EPO, FER, HCT, Po2) between the Experimental group the first (oxygen deficiency) and the experimental group the second(more Oxygen) in dimensional measurements

Significance of differences	sig	value ((T calculated	Dimensional measurement of experimental The first		Dimensional measurement For Experimental Second		Unit of measure	Statistical Processing Variables
			± A	S	± A	S		
moral	0.00	16.66	0.48	12,13	0.40	6,93	mu/mL	EPO
moral	0.00	15.70	3.34	83.75	1.23	66,16	Ng/mL	FER
moral	0.00	3.22	0.62	43.61	1,13	42.32	%	HCT
moral	0.00	7.5	0.74	95.88	1.24	92.46	mm/Hg	Po2

In light of the data extracted for the research sample individuals, Table ( ) shows the differences in Functional values (EPO,FER,HCT,PO2) in Measurement The dimension And as shown in the table above, the nature of the sample individuals for the two experimental groups showed differences In measurements Dimensionality.

In a variable(erythropoietin hormone EPO)Using the (T) test for independent samples to extract the differences, the calculated values reached (16.66) at significance level (0.00) in measurement the dimension of the two groups first and experimental Second In favor of the experimental in the first group.

As for the variable (ferritin protein FER) Using the (T) test for independent samples to extract the differences, the calculated values reached (15.70) At a significance level of (0.00) in a to measure dimension of the two groups First Experiment and experimental Second In favor of the experimental group First.

In the variable (hematocrit HCT) Using the (T) test for independent samples to extract the differences, the calculated values reached (3.22) at a significance level of (0.00) in Measurement Dimension of the two groups First and second trial In favor of the experimental group First.

As for the variable Partial pressure of oxygen (PO2) and using the (T) test for independent samples to extract the differences, as its calculated values reached (7.5) at a significance level of (0.00) in Measurement the dimension of the two groups For the first and second trial For the control and experimental group and in favor of the experimental group Second.

4- Conclusions and recommendations

4-1 Conclusions

1The results of the study recorded a noticeable effect in raising the level of blood variables measurement (EPO, FERs, Hb, (Hct The hypoxic training method improved effectively in the members of the first experimental group (hypoxia).

2The results of the study recorded a noticeable effect in raising the level of blood gas measurements (PO2, (SPO2) and improved as a result of training using the (hyperoxic) method and effectively in the members of the second experimental group (increased oxygen).

4-2 Recommendations

1- Adopting hypoxic training (oxygen deficiency) as a means of helping to improve blood variables (EPO, FERs, Hb, (Hct And the development of physical aspects (strength endurance - achievement)20 km).

2- Adopting hyperoxic training (increasing oxygen) as a means of helping to improve gas exchange.po2, (spo2

3- Adopting measurements of some blood cells and gas exchange as an indication of the adaptation of the body's functional organs and systems of the competitors.

4- Adopting the results of the study in some blood variables, gas exchange, and physical abilities that were reached as a criterion for evaluating the level of functional and training status among the research sample members.

Sources

- Muhammad Hassan Alawi and Osama Kamel: Scientific Research, Education and Psychology, Cairo, Dar Al Fikr Al Arabi, 1999, p. 104.
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