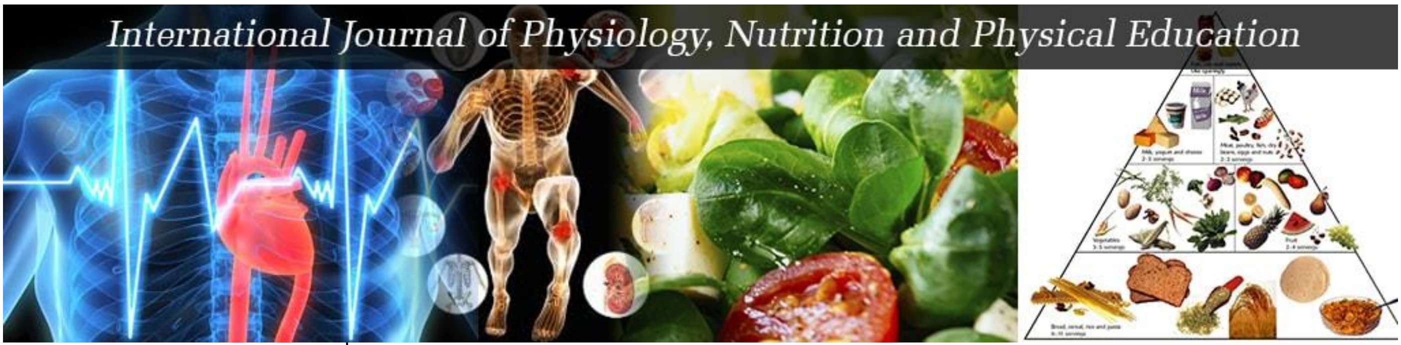

ISSN: 2456-0057
IJPNPE 2021; 6(2): 336-339
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www.journalofsports.com
Received: 13-09-2021
Accepted: 17-10-2021

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Anaerobic capacity (Phosphagen and lactate) and its relationship to the heart rate recovery curve

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Abstract
This study aims to identify the relationship between the anaerobic phosphagen capacity and heart rate recovery curve; heartbeat is recorded immediately after the physical load, after 1 minute of the physical load, and after 3 minutes of physical load. The study also aims to identify the relationship between anaerobic lactic capacity and heart rate recovery curve; the heartbeat is recorded immediately after the physical load, after 1 minute of the physical load, and after 3 minutes of physical load.
The study uses a descriptive approach to find correlational relations of the problem. This study's sample population was chosen from the Samarra University college football players. The sample consisted of (80) players, randomly selected. Statistical methods were used by the statistical software (SPSS), the percentages, arithmetical mean, standard deviation, simple correlation coefficient, and torsion modulus. The researchers concluded that a relationship between the anaerobic phosphagen capacity and heart rate recovery curve existed immediately after the physical load, after 1 minute of the physical load, and after 3 minutes of physical load. The researchers also concluded that a relationship between the anaerobic lactic capacity and heart rate recovery curve also existed immediately after the physical load, after 1 minute of the physical load, and after 3 minutes of physical load.

Keywords: Anaerobic phosphagen capacity, anaerobic lactic capacity, heart rate, recovery curve

Introduction
The use of technology in different areas of life is the most important characteristic of our modern era [1], Fields related to sports training overlap, i.e., Chemistry, Physiology…etc., especially when studying physical activity [2]. Football is the most popular game [3]. And the football needs to consider the physical side, and advantage of that in organizing effective exercises Different body organs work as one integrated unit. Sports training leads to physiological and chemical changes within the muscle cell to generate the energy that the athlete needs for performance.
Energy production is one of the scientific topics in sports training due to its connection with the activities and exercises that the athlete carries out. The athlete gets his needs of energy through carbohydrates and fatty substances to achieve organ's adaptation to carry out the performance and face the resulting fatigue according to that activity's nature and duration [4].
Besides, the work on developing the body's internal organs depends mainly on energy production systems. Therefore, modern sports training focused on developing capabilities (anaerobic or aerobic) by building codified training programs based on scientific foundations for training within the athlete's needs for energy [5].
The anaerobic capacity depends on the muscles' reactions in the absence of oxygen and is known as the glycolysis system. It is divided into two systems, the ATP - PC energy production system and the lactate glycolysis system. These activities occur during short periods ranging from 2 to 3 minutes, such as100 meters race, 400 meters race in athletics, 100 meters swimming race, and muscle strength training [6].
Recovery from training is one of the essential issues in the field of sports training. Furthermore, it has become no less important than carrying the training load and a means used by the trainer to influence the athlete's performance to raise athletic achievement, which is inferred through several indicators. One of the most important indicators is pulse.

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The pulse is an indicator of heart adequacy and the circulatory system and an indicator of the training state-level. The development of the athlete's level is related to the heart's adequacy and the circulatory system to provide the body's need with blood during the performance and its ability to return to a semi-normal state after fatigue [7].

The study's significance lies in the importance of analyzing the anaerobic capacity, both Phosphogen and lactate. The population sample was asked to perform anaerobic exercises. Then the researchers attempt to identify the relationship between the Phosphogen and lactate capacity with the heart rate during different recovery times. The study seeks to find the relationship between these variables and highlight their importance in sports training, Doing exercise leads to physiological changes to the internal organs' functional efficiency, which is the primary indicator of the performance skill level. The changes or the adaptation process that accompanies the training are important indicators of the training's success. Knowing the changes that occur in the athlete's body after performing effort and the recovery phases that he goes through is essential to the trainer. The researchers' interests in the interrelated applied functional sciences in the sports field led them to answer the following questions:

- What is the relationship between the anaerobic Phosphogen capacity and the heart rate during the recovery curve (immediately after the effort, one minute after the effort, three minutes after the effort)?
- What is the relationship between the anaerobic lactic capacity and the heart rate during the recovery curve (immediately after the effort, one minute after the effort, three minutes after the effort)?
- The study aims to achieve the following objectives:
- To identify the anaerobic-Phosphogen potential of a sample of senior players in the Samarra University college football players.
- To identify the anaerobic lactic capacity of a sample of senior players in Samarra University college football players
- To identify the relationship between the anaerobic Phosphogen capacity and the heart rate during the recovery curve immediately after the effort, after one minute of the effort, after three minutes of the effort.
- Identify the relationship between the anaerobic lactic capacity and the heart rate during the recovery curve immediately after the effort, after one minute of the effort, after three minutes of the effort.

Materials and Method

Eighty players were randomly selected from the Samarra University college football players. The tests took place in the University's Stadium from November 1st, 2019, to March 5th, 2020.

The tools used for the applied test are three stopwatches, a whistle, a ruler to measure the length, ten pillars, an electronic scale, 40 cm-high step bench.

The Applied Tests

Anaerobic-Phosphogen capacity (APC) test [8].

Ten Seconds Step Test: The participant is weighed first and then face the 40 cm-high step bench. The participant is asked to put the preferred leg on the bench while the other leg is stretched, touching the ground. The second leg is not used to push the participant up by swinging. The count starts with "one" when one leg is up on the bench and "two" when the other leg is down; this continues for ten seconds up and down. After that, the steps are counted. The anaerobic and Phosphogen capacity was calculated through the following equation. The height of the bench is converted to (0.4) meters to unify the units' measurements:

APC = 1.33 x athlete's weight (kg) x 0.4 (m) x number of steps within (10) seconds

The anaerobic lactic capacity (LAC) test

Thirty Seconds Step test: This test is similar to the previous one except that the steps are recorded within (30) seconds. The lactic capacity is calculated according to the equation below:

LAC = 1.33 x athlete's weight (kg) x 0.4 (m) x number of steps within (30) seconds

The Scientific Parameters of the test

The (steps) test used in the study has been adopted after analyzing previous studies related to the current work. The test has high scientific parameters applied to sample population in Iraq after studying these parameters in several works Zain Bayez Taher (2007) [9], Shareef Qader Hussein (2010) [10], Sadeq Yousif Mohammed (2016) [11].

The sample Homogeneity

Table 1) below shows that the torsional modulus values ranged (***±1***), indicating no significant differences and the sample population's variables are homogenous.

Table 1: Sample Homogeneity

Variables	Measurement Unit	Mean Average	Standard deviation	Torsional Modulus	Mode
Weight	Kilogram	68.95	8.15	0.75	67
Age	Month	252	10.7	0.84	251
Hight	Centemetr	178.71	6.54	0.75	177

Field Tests Procedures

Pilot test

The pilot test took place on December 25th, 2020, at noon in the stadium of the College of Physical Education and Sports Sciences at Samarra University. The sample consisted of (10) senior players. They have been excluded from the main test. The purpose of this test lies in identifying the time taken to perform it, the division of tasks, the test procedures control, the test location suitability, as well as the validity of the tools used in the test, and the time during which the test will take place in the presence of the assisting team.

The Primary Test

The anaerobic Phosphogen capacity was tested on Tuesday, January 1st, 2020, in the Faculty of Education and Sports Sciences stadium at the University of Samarra. The researchers and the assistant team tested the eight senior players of the sample population. Upon hearing the first whistle, the participant starts the steps test and stops when hearing the second whistle. One member of the assistant team is responsible for the timing, and the other is responsible for counting the steps during the performance time. The head of the assistant team measures heart rate. The heart rate was measured while the participant is seated by putting pressure on the carotid artery. The anaerobic Lactate capacity test was performed on Sunday, January 12th, 2020. The test's procedures and location are the same as the anaerobic Phosphogen capacity test.

Statistical Means

The data for this study were analyzed using a software program known as SPSS. The following statistical functions were calculated

- Percentage
- Mean average
- Standard deviation
- Torsional Modulus
- Pearson correlation coefficient (r)

Results

Analysis of the statistical parameters of the anaerobic Phosphogen capacity test and the heart rate recovery curve

Table 2) below shows that the mean average of the anaerobic Phosphogen capacity test is (66.75), while the standard deviation is (5.67). The mean average of the heart rate immediately after the effort reached (114) BPM and the standard deviation is (16.34). The mean average of the heart rate one minute after the effort is (75.33) BPM, and the standard deviation is (4.67). The mean average of the heart rate three minutes after the effort is (70.66) BPM with a standard deviation (9.68).

Table 2: Statistical parameters of the anaerobic Phosphogen test and the heart rate recovery curve

Anaerobic Phosphogen capacity (kg x m/s)		Heart Rate (BPM)					
		Immediately after the effort		One minute after the effort		Three minutes after the effort	
66.75	5.67	114	16.34	75.33	4.67	70.66	9.68

Analysis of the statistical parameters of the anaerobic lactic capacity test and the heart rate recovery curve

Table 3) below shows that the mean average of the anaerobic lactic capacity test is (76.84), while the standard deviation is (1.82). The mean average of the heart rate immediately after the effort reached (153) BPM, and the standard deviation is (6.16). The mean average of the heart rate one minute after the effort is (110.5) BPM, and the standard deviation is (12.42). The mean average of the heart rate three minutes after the effort is (91.83) BPM with a standard deviation (9.64).

Table 3: Statistical parameters of the lactic anaerobic capacity test and the heart rate recovery curve

Anaerobic Lactic capacity (kg x m/s)		Heart Rate (BPM)					
		Immediately after the effort		One minute after the effort		Three minutes after the effort	
66.75	5.67	114	16.34	75.33	4.67	70.66	9.68

Analysis of the statistical parameters of the correlation coefficient values of the anaerobic phosphogen test and the heart rate recovery curve

Table 4) below shows that the correlation coefficient value of the anaerobic Phosphogen capacity and heart rate immediately after the effort is (0.971) with a significant level of (0.001). While the correlation coefficient value of the anaerobic phosphogenesis capacity and heart rate one minute after the effort is (0.734) with a significant level of (0.04). Finally, the correlation coefficient value of the phosphogenesis anaerobic capacity and heart rate three minutes after the effort is (0.965) with a significant level of (0.001). All the significance level values were smaller than the error level (0.05), indicating a significant correlation between the variables mentioned earlier.

Table 4: Statistical parameters of the correlation coefficient values of the anaerobic phosphogenesis test and the heart rate recovery curve

Variables	Heart Rate (BPM)								
	Immediately after the effort			One minute after the effort			Three minutes after the effort		
	r	sig	result	r	sig	result	r	sig	result
Anaerobic Phosphogen capacity (kg x m / s)	0.971	0.001	Significant correlation	0.734	0.04	Significant correlation	0.965	0.001	Significant correlation

***significant correlation if sig ＜(0.05)**

Analysis of the statistical parameters of the correlation coefficient values of the anaerobic lactic test and the heart rate recovery curve: Table 5) below shows that the correlation coefficient value of the anaerobic lactic capacity and heart rate immediately after the effort is (0.889) with a significant level of (0. 01). While the correlation coefficient value of the anaerobic phosphogenesis capacity and heart rate one minute after the effort is (0.823) with a significant level of (0.02). Finally, the correlation coefficient value of the anaerobic phosphogenesis capacity and heart rate three minutes after the effort is (0.825) with a significant level of (0.017). All the significance level values were smaller than the error level (0.05), indicating a significant correlation between the variables mentioned earlier.

Table 5: Statistical parameters of the correlation coefficient values of the anaerobic lactic test and the heart rate recovery curve

Variables	Heart Rate (BPM)								
	Immediately after the effort			One minute after the effort			Three minutes after the effort		
Anaerobic lactic capacity (kg x m / s)	r	sig	result	r	sig	result	r	sig	result
	0.889	0.01	Significant correlation	0.823	0.02	Significant correlation	0.825	0. 01	Significant correlation

***significant correlation if sig ＜(0.05)**

Discussion

According to tables (4) and (5), there is a correlation coefficient between the anaerobic capacity and the heart rate recovery curve. When observing the correlation coefficient values, we find a difference in the relationship strength between the anaerobic phosphogen capacity test and the heart rate at different recovery times. The correlation coefficient's highest value was between the anaerobic capacity test results (Phosphogen and lactate) and the heart rate immediately after the effort. The researchers attribute that to the effect of anaerobic physical activity, which is included within the anaerobic energy system (Phosphogen and lactate) and its prominent role in the player's functional changes, in terms of heartbeat increase because of the effort the player was subjected to. The increase of heartbeats led to an increase in the nerve impulses response responsible for activating the heart muscle and increasing the number of beats to supply the body with the energy and oxygen needed for muscle activity and metabolic wastes excretion. The increase in the number of heartbeats came due to the circulatory system's response to the player's exerted effort. Kazem Jaber Amir (1997: 234) asserts that "the circulatory system must support the increasing needs resulting from physical activity and gas exchange processes in the working muscles. The degree of cardiac muscle response is a reliable measure for professionals in the Sports field [12]. "The researchers note that the correlation coefficient value of the anaerobic capacity (Phosphogen and lactate) and the heart rate recovery curve decreases proportionately after the player takes a rest period of (one minute) despite the relationship between the two values. This indicates the insufficient short time for recovery and the player's functional state not returning to a semi-normal state, bearing in mind that the anaerobic physical activity places an enormous burden on the various body systems, including the circulatory system. In terms of heart rate, recovery operations need more extended periods due to excessive activity to return to a normal state. We also note that the correlation relationship between the anaerobic capacity test (Phosphogen and lactate) and the heart rate increases with the resting length during the recovery curve after the third minute of effort. This indicates an increase in cardiac muscle activity reduction operations that enables the body to return to a semi-normal state to reach full recovery. To reach full recovery, the player needs to stop the activity for an extended period. The energy regenerates due to the Anaerobic Phosphogen effort and lactic acid disposal due to anaerobic lactate activity. The time needed for the lactic acid to be disposed of is long." [13]. From the above, it is clear that the heart rate decreases during the recovery curve due to ending the activity while preserving the relationship that links it with the intensity of anaerobic effort to which the research sample was subjected to.

Conclusion

In our study, it has been established that the anaerobic Phosphogen capacity and anaerobic lactic capacity variables and heart rate showed a significant relationship during the recovery curve (immediately after effort, one minute after effort, three minutes after effort).

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