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Assessment of Physiological Indicators and Their Association with Basketball Performance Skills

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Absract :

The present research aimed to examine the relationship between selected physiological indicators and the level of skill performance in basketball players. More specifically, the study sought to identify the differences among physiological variables and performance effectiveness within the research sample, as well as to determine the relationship between these physiological indicators and players' performance efficiency. The study involved 25 players competing in first-division basketball clubs. The findings revealed a significant correlation between long-term anaerobic capacity, heart rate, and the performance effectiveness of the teams included in the study. In contrast, no significant relationship was observed between short-term anaerobic capacity, aerobic capacity, and performance effectiveness.

Based on these findings, the researchers emphasized the importance of developing physical fitness components within training programs due to their close association with blood pressure regulation, heart rate responses, and recovery processes. Furthermore, the study recommended the organization of specialized development and training courses for basketball coaches, with the contribution of international experts from advanced basketball nations, particularly in the field of exercise physiology, in order to enhance coaches' understanding of the importance of physiological indicators during training sessions and competitive performance.

Keywords: physiological indicators; skill performance level; basketball; anaerobic capacity; aerobic capacity; heart rate; physical fitness; performance effectiveness; recovery process; sports physiology.

The introduction:

In the modern era, exercise physiology has become a fundamental pillar of sports training processes. Its importance is reflected in the continuous

development observed in physical, technical, and tactical performance levels, resulting from the physiological adaptations induced by training loads on the various systems of the human body. Through these adaptations, athletes acquire the ability to cope with fatigue and the physical demands imposed by training sessions and competitive performance.

Athletic progress is essentially the result of functional and biological adaptations occurring within the body's internal systems. Consequently, the athlete's functional capacities improve according to the nature of the sporting activity, the duration of practice, and the style of performance (Abu El-Ela Abdel Fattah, 2008, p. 22).

Accordingly, advancement in basketball requires continuous scientific experimentation related to physical, technical, tactical, functional, psychological, and educational aspects in order to apply them effectively within the framework of the game's rules and demands. Scientific training methods contribute significantly to increasing blood circulation efficiency within muscular and nervous tissues, as well as enhancing oxygen transport processes.

Basketball is considered one of the sports activities that require extensive scientific research to identify the most effective methods and approaches capable of improving players' performance during matches. Evaluating players' performance in competition is regarded as an essential process because it reflects the effectiveness of the training methods employed and the physiological adaptations resulting from them (Muhammad Abdel Rahim, 2003, p. 125).

Furthermore, analyzing and evaluating players' technical and movement performance during matches helps identify performance errors and reinforce successful technical actions. One of the essential requirements of the training process is therefore the continuous analysis and evaluation of performance in order to diagnose and correct errors arising from different playing situations and competitive pressures.

Although several methods exist for measuring technical, physical, tactical, and psychological abilities outside competition settings, such assessments do not always provide a complete picture of the player's actual level during match performance. This is mainly due to the influence of numerous situational and competitive factors that directly affect performance effectiveness during games (Bob Cousy, 1997, p. 98).

1- Research problem :

In recent years, developed countries in the field of sports have increasingly integrated medical examinations, physiological testing, and functional assessments into sports training programs in order to enhance the efficiency of athletes' vital systems, particularly in basketball. These evaluations help determine the level of physiological adaptation achieved by players and clarify the relationship between the body's functional condition and physical performance capacities, which directly influence players' effectiveness during competition.

Through the researcher's continuous observation of the Algerian Premier Basketball League, combined with his previous experience as a player and

consultations with experts and specialists, it was noted that players' performance effectiveness tends to decline during the third and fourth quarters of matches. This gradual decrease appears to be mainly associated with a reduction in the players' physical capacities, which negatively affects technical and tactical performance and consequently influences match outcomes.

Based on these observations, the researcher identified the core problem of the study as the insufficient adaptation of the functional systems in a manner consistent with the specific physiological demands of basketball. This decline is reflected through several physiological indicators, including heart rate, blood pressure, pulse pressure, aerobic capacity, and anaerobic capacity. These indicators play a crucial role in evaluating players' movements, technical skills, and tactical actions performed throughout the match.

2- research aims :

1. To identify the differences between groups in terms of physiological indicators and performance effectiveness among the research sample.
2. To determine the relationship between selected physiological indicators and the performance effectiveness of the research sample.

Research Hypotheses

1. There are significant differences between groups regarding physiological indicators and performance effectiveness within the research sample.
2. There is a statistically significant relationship between certain physiological indicators and the performance effectiveness of the research sample.

3- Research Importance

The importance of this research lies in examining the relationship between physiological indicators and the performance effectiveness of basketball players. The study particularly focuses on anaerobic and aerobic capacities, in addition to several physiological variables measured during rest and physical effort. These indicators include heart rate, arterial blood pressure, pulse pressure, and mean arterial pressure, which are considered essential variables for evaluating the functional status of athletes.

Furthermore, the findings of this research may contribute to the development and planning of training programs based on scientific principles. Such an approach can help coaches and specialists optimize player preparation processes and improve performance effectiveness in basketball according to modern training methodologies

4. Research Methodology and Field Procedures

4.1 Research Methodology

The researcher adopted the descriptive approach using the survey method, as it was considered the most appropriate methodology for achieving the objectives of the present study. This method is based on investigating phenomena as they exist in reality and aims to describe them accurately through both qualitative and quantitative analysis.

4.2 Research Sample

The research sample was intentionally selected from players representing some clubs competing in the Algerian First Division Basketball

Championship. Out of the 16 clubs participating in the league, five clubs were selected, representing approximately 31% of the total population. From each club, five main players participating in the 2022–2023 season were chosen.

Accordingly, the total research sample consisted of 25 players out of an overall population of 200 players, representing 12% of the original study population. The selected players belonged to the clubs of Blida, Boufarik, Biskra, Ain Témouchent, and Algiers. In addition, homogeneity procedures were conducted for the research sample, as presented in Table (1).

Table (1) It shows the homogeneity of the research sample

T	Measurements	X	S	Torsion coefficient	The result
1	height	185	8	0.535	homogeneous
2	the weight	83	14	0.882	homogeneous
3	the age	29	6	0.098	homogeneous
4	Training age	12	2	1.590	homogeneous

4.3 Data Collection Methods

Tools Used in the Research

The researcher employed several tools and instruments to obtain the data necessary to address the research problem and achieve the study objectives. Research tools are considered essential means through which researchers collect data, measurements, and information related to the phenomenon under investigation.

For this purpose, the following instruments were used:

- A 50-meter measuring tape.
- A medical scale equipped with a height measurement ruler to determine body height and weight.
- A blood pressure and heart rate monitoring device.

4.4 Steps for Designing the Performance Effectiveness Form

The performance effectiveness of basketball players was determined through several stages, including:

A. Reviewing References and Previous Studies

The researcher consulted numerous scientific references and studies related to basketball performance effectiveness. Based on this review, a performance evaluation form consisting of 14 items was developed.

B. Performance Analysis through Objective Observation

The effectiveness of players' performance was analyzed using objective observation during match situations.

C. Consultation with Experts and Specialists

The proposed evaluation form was presented to experts and specialists in the field of basketball to determine the relevance and importance of the positive and negative performance indicators included in the study.

D. Identification of Main Axes and Performance Indicators

The researcher identified the principal dimensions and indicators of performance effectiveness. This approach was adopted because analyzing the phenomenon through its basic components facilitates a more comprehensive understanding of overall performance.

4.5 Method of Analyzing the Performance Form

After determining the dimensions to be measured, the researcher established a scoring system based on positive and negative performance during matches.

- Each successful positive performance was awarded one positive point.
- Successful scoring actions were awarded two points.
- Each negative performance was assigned one negative point.

The results were calculated according to the following equation:

Player performance level = (Positive performance - negative performance)/
The time the player participates in the match.

Definitions

- **Positive performance:** all successful movements, tactical situations, and technical skills executed by the player.
- **Negative performance:** all unsuccessful movements, tactical situations, and technical skills performed by the player.
- **Actual playing time:** the effective duration during which the player participated in the match.

The observation form consisted of two main axes used to evaluate players' performance during one of the four quarters of the match.

First Axis: Positive Performance

- Successful scoring.
- Successful ball interception during defense or attack.
- Successful defensive rebound.
- Successful offensive rebound.
- Successful fast break attack.
- Successful assist leading to a two-point score.
- Correct positioning followed by successful scoring.

Second Axis: Negative Performance

- Failed scoring attempts.
- Failed blocking or defensive interventions.
- Failed defensive rebound.
- Failed offensive rebound.
- Failed fast break attack.
- Rule violations and fouls.
- Traveling or illegal stopping during play

5. Measurements and Tests Used

Identification of the Physiological Indicators under Study

After reviewing numerous scientific references and consulting specialists in the field of physiological testing, the researcher selected a set of tests suitable for measuring the physiological indicators targeted in the study, as follows:

1. **Short anaerobic capacity test:** 50-yard sprint test.
2. **Aerobic capacity test:** Harvard Step Test (5 minutes).

5.1 Measurements Used

Measurement of Heart Rate and Blood Pressure

Heart rate and blood pressure were measured using an electronic blood pressure monitoring device attached to the palm of the hand. The device provided immediate measurements of pulse rate and blood pressure directly after the completion of physical effort. To ensure accurate readings, measurements were taken as quickly as possible after exercise while the participant was in a seated position.

5.2 Tests Used

1. 50-Yard Sprint Test for Short Anaerobic Capacity

Objective of the Test

To measure short anaerobic capacity

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Test Description:

The test was performed using a moving start from a distance of 13.5 meters before the starting line. The participant accelerated progressively toward the starting line at maximum speed. Timing began once the athlete crossed the starting line and stopped when the athlete reached the finish line located 50 yards away. The performance time was recorded in seconds.

Calculation Formula:

$$\text{Short anaerobic capacity} = \frac{\text{Distance travel time in seconds}}{\text{Distance travel time in seconds}}$$

2. Harvard Step Test (5 Minutes)

Objective of the Test

To measure aerobic capacity.

Test Description

The participant stood facing a box or bench with a height of 51 cm. Upon the start signal, the participant stepped up and down following four sequential movements:

1. Placing one foot on the box.
2. Placing both feet on the box.
3. Returning the first foot to the ground.
4. Returning both feet to the ground.

Participants were instructed to maintain an upright body posture throughout the test. The stepping movement was performed at a rate of 30 repetitions per minute for five continuous minutes (300 seconds). If the participant stopped because of fatigue or inability to continue, the time completed before stopping was recorded.

Calculation Formula :

$$Aerobic\ capacity = \frac{Number\ of\ seconds\ the\ tester\ takes\ to\ perform\ x\ 100}{2x\ the\ number\ of\ times\ the\ pulse\ returns\ to\ normal}$$

5.3 Scientific Foundations of the Tests Used:

Validity of the Tests

The selected tests and the performance effectiveness evaluation form were presented to experts and specialists in the field. All experts approved the suitability of the tests, resulting in a 100% agreement rate.

Reliability of the Tests

To determine test reliability, the researcher conducted a pilot study on a sample of five players from the original research population on 12/04/2023. The tests were repeated after an interval of seven days. The simple Pearson correlation coefficient was then calculated to determine the reliability coefficients of the tests.

Objectivity of the Tests

Objectivity refers to the absence of personal bias or subjective influence during the evaluation process. The more independent the test results are from subjective judgment, the greater the objectivity of the test.

To verify objectivity, the researcher calculated the simple correlation coefficient between the scores assigned by the evaluators. The results confirmed a high degree of objectivity for the tests used in the study, as presented in Table (2).

Table (2) shows the scientific foundations of the tests

the test	objectivity of tests	stability of tests,
Short anaerobic power (50 yards(	0.96	0.98
Harvard Aerobic Capacity (5 minutes(	0.96	0.95

6. Main Experiment

The main experiment was conducted on the research sample. Throughout this period, physical and physiological tests were administered to the players of each team under identical conditions. In addition, the players' performance effectiveness was assessed through scientific observation of matches from the first stage of the Algerian First Division Basketball Championship.

During match analysis, both positive and negative performances of the competing teams were recorded. One match from the first stage of the championship was randomly selected and analyzed using a specially designed observation form approved by experts and specialists in basketball. Through this procedure, the researcher obtained the performance effectiveness scores for each player included in the study sample.

Tests Conducted on the Players

First Day

A. Short Anaerobic Capacity Test (Phosphagen System) – 50 Yards

The following procedures were applied:

1. Measurement of heart rate and blood pressure variables before administering the physical tests.
2. Administration of physical tests based on the anaerobic energy system.
3. Measurement of heart rate and blood pressure immediately after completion of the tests.

B. Long Anaerobic Capacity Test (Lactic System) – 60 Seconds

The following procedures were applied:

1. Administration of physical tests according to the lactic anaerobic system.
2. Measurement of heart rate and blood pressure immediately after completing the tests.

Second Day

Aerobic Capacity Test (Harvard Test – 5 Minutes)

The following procedures were applied:

1. Administration of physical tests according to the aerobic energy system.
2. Measurement of heart rate and blood pressure immediately after completion of the tests.

9. Statistical Methods Used

The researcher used the following statistical methods for data analysis:

1. Arithmetic Mean.
2. Standard Deviation.
3. Percentage.

4. Analysis of Variance (ANOVA – F Test).
5. Pearson Simple Correlation Coefficient.

7. Presentation of Results

7.1 Presentation of the Results of Physiological Indicators Before and After Effort and the Performance Level of the Research Sample

The results section presents the values of the physiological indicators measured before and after physical effort, in addition to the performance effectiveness levels obtained by the research sample players.

Table No. (3) shows the arithmetic means and standard deviations for the functional indicators and performance level for the research sample.

S	X	Variables		
2.9750	61.9300	Heart rate	Before the effort	Physiological indicators
2.5658	132.000	Systolic blood pressure		
3.0173	84.87700	Diastolic blood pressure		
1.8820	12.6815	Short anaerobic capacity (50 yards)	After the effort	
2.9029	171.5200	Heart rate		
4.4583	178.7200	Systolic blood pressure		
2.5331	86.4000	Diastolic blood pressure		
2.5688	66.4332	Aerobic capacity (5 minutes)		
4.3558	159.1600	Heart rate		
3.8306	172.4400	Systolic blood pressure		
2.4953	66.3200	Diastolic blood pressure		
0.2891	0.1699		**Performance level**	

Table (3) presents the descriptive statistics of the physiological indicators measured before and after physical exertion, in addition to the performance effectiveness values of the research sample.

The results showed that the arithmetic mean of heart rate before exertion was 61.920 beats/min with a standard deviation of 2.985. The arithmetic mean of systolic blood pressure before exertion reached 131 mmHg with a standard deviation of 2.565, whereas the arithmetic mean of diastolic blood pressure before exertion was 83.880 mmHg with a standard deviation of 3.018.

Regarding short-term anaerobic capacity, the arithmetic mean was 12.681 kg/s with a standard deviation of 1.872. After exertion, the arithmetic mean of heart rate increased to 171.520 beats/min with a standard deviation of 2.902. Similarly, the arithmetic mean of systolic blood pressure after exertion reached 178.720 mmHg with a standard deviation of 4.458, while the arithmetic mean of diastolic blood pressure after exertion was 86.400 mmHg with a standard deviation of 2.533.

The table further illustrates the results related to aerobic capacity measured using the 5-minute Harvard Test. The arithmetic mean of heart rate after exertion was 159.600 beats/min with a standard deviation of 2.568. In addition, the arithmetic mean of systolic blood pressure reached 172.440 mmHg with a standard deviation of 3.830, whereas the arithmetic mean of diastolic blood pressure was 66.320 mmHg with a standard deviation of 2.495.

Finally, the table showed that the arithmetic mean of performance effectiveness for the research sample was 0.169 with a standard deviation of 0.289.

7.2 Presentation of the Calculated and Tabulated F-Values for the Physiological Indicators Under Study

This section presents the calculated and tabulated F-values obtained from the analysis of variance (ANOVA) conducted to determine the significance of differences among the physiological indicators investigated in the study.

Table (4) shows the calculated and tabulated (F) value for the functional indicators for the research sample

indication	Calculated F value	Mean squares	Degrees of freedom	Sets of squares	Source of variance	Functional indicators	
aleatory	1.181	4.017	4	16.067	Between groups	Short anaerobic capacity (50 yards)	After the effort
		3.412	20	68.038	Within groups		
aleatory	1.515	11.760	4	47.040	Between groups	Heart rate	
		7.760	20	155.200	Within groups		
aleatory	2.245	36.960	4	147.480	Between groups	Systolic blood pressure	
		16.46	20	329.200	Within groups		
aleatory	2.731	13.600	4	54.400	Between groups	Diastolic blood pressure	
		4.980	20	99.600	Within groups		

		4.220	20	84.400	Between groups		
significant	11.769	27.786	4	111.146	Within groups	Aerobic capacity (5 minutes)	
		2.361	20	47.219	Between groups		
significant	10.098	76.140	4	304.560	Within groups	Heart rate	
		7.540	20	150.800	Between groups		
aleatory	0.838	12.640	4	50.560	Within groups	Systolic blood pressure	
		15.080	20	301.600	Between groups		
significant	4.068	16.760	4	67.040	Within groups	Diastolic blood pressure	
		4.120	20	82.400	Between groups		

Table (4) presents the calculated and tabulated F-values for the physiological indicators examined in the study at a significance level of 0.05 and degrees of freedom (20,4).

The results indicated that the calculated F-value for short anaerobic capacity was 1.181, which was lower than the tabulated value of 2.87. Therefore, no statistically significant differences were observed among the groups regarding short anaerobic capacity.

Similarly, the calculated F-value for heart rate after exertion reached 1.515, which was also lower than the tabulated value of 2.87, indicating the absence of statistically significant differences.

Regarding systolic blood pressure after exertion, the calculated F-value was 2.245, which remained below the tabulated value of 2.87. Consequently, no significant differences were identified between the groups. The same trend was observed for diastolic blood pressure after exertion, where the calculated F-value reached 2.731, remaining lower than the tabulated value, which confirms the absence of significant differences.

In contrast, the calculated F-value for aerobic capacity reached 11.769, which exceeded the tabulated value of 2.87. This result indicates the presence of statistically significant differences among the groups in aerobic capacity.

Likewise, the calculated F-value for heart rate after exertion associated with the aerobic capacity test was 10.098, which was greater than the tabulated value of 2.87, demonstrating

statistically significant differences between the groups.

For systolic blood pressure after exertion in the aerobic test, the calculated F-value was 0.838, which was lower than the tabulated value, indicating no significant differences. However, the calculated F-value for diastolic blood pressure after exertion reached 4.068, exceeding the tabulated value of 2.87, thereby indicating statistically significant differences among the groups.

7.3. *Displaying the calculated and tabulated results of the performance level:*

Table (5) shows the calculated and tabulated (F) value for performance effectiveness for the research sample

Source of variance	Sum of squares,	degrees of freedom	mean of squares	calculated (P) value	significance
Between groups	0.987	4	0.247	4.843	Significant
Within groups	1.019	20	0.0593		

Table (5) shows the calculated (F) value for performance effectiveness, which amounted to (4.843) and the tabulated value (2.87) at a significance level (0.05) and with a degree of freedom (20.4). Since the calculated value is greater than the tabulated value, therefore, there are significant differences.

7.4. Presenting the results of the correlation between functional indicators and the performance level of the research sample:

Table (6) shows the correlation between functional indicators and performance effectiveness

Functional indicators		***Calculated correlation value***
after the effort	***Short anaerobic power (50 yards)***	**0.314**
	Heart rate	**0.015**
	Systolic blood pressure	**0.130 -**
	Diastolic blood pressure	**0.093**
	Aerobic capacity (5 minutes)	**0.074**
	Heart rate	**0.164 -**
	Systolic blood pressure	**0.189**
	Diastolic blood pressure	**0.031 -**

Table (6) shows the correlation between the pulse rate before the effort, the performance level, as it reached (0.038), between the systolic blood

pressure before the effort and the performance level, as it reached (-0.013), and the diastolic blood pressure before the effort, the performance level, as it reached (0.120).

The table shows the correlation between short-term anaerobic capacity and its indicator, the 50-yard test, and the level of performance, as it reached (0.314), and between the heart rate after the effort and the effectiveness of the performance, which amounted to (0.015), and between the systolic blood pressure after the effort and the level of performance, as it amounted to (-0.130), and between Diastolic blood pressure after exertion and performance level reached (0.093)

The table shows the correlation between aerobic capacity and its index, the 5-minute step test, with performance effectiveness, which reached (0.074), and between heart rate after exertion and the performance level, which reached (-0.164), and between systolic blood pressure after exertion and performance level, which reached (0.189), and blood pressure. Diastolic blood after exertion and performance level reached (-0.031)

8. Discussing the results:

- Discussion of the Results Concerning the Relationship Between Physiological Indicators and Performance Effectiveness of the Research Sample Teams

Table (6) illustrates the relationship between physiological indicators and performance effectiveness among the research sample players. The findings revealed a statistically significant correlation between prolonged anaerobic (lactic) capacity and performance effectiveness, as the calculated correlation coefficient (R) reached 0.403, which exceeded the tabulated value of 0.396 at a significance level of 0.05 and a degree of freedom of 23.

The results also demonstrated significant correlations between heart rate, pulse pressure related to prolonged anaerobic capacity, and performance effectiveness. The calculated correlation coefficients were 0.460 and 0.407, respectively, both exceeding the tabulated value, which confirms the existence of statistically significant relationships.

The researcher explains these findings by emphasizing that the lactic anaerobic energy system represents the predominant energy source in basketball, contributing approximately 90% of the energy demands during play. Basketball performance is characterized by rapid and repeated movements that require players to transition quickly between defense and attack, in addition to jumping, shooting, passing, and ball handling. Most of these actions occur within periods ranging from 15 to 60 seconds, which corresponds mainly to the lactic anaerobic energy system, considered the primary physiological system involved in basketball activity.

These findings are consistent with the study conducted by Latif Muhammad Kamal (1992, p. 230), which indicated that the physiological changes

accompanying performance lead to functional adaptations that enable players to maintain performance levels without significant decline. This observation was evident among some of the clubs included in the study, where improvements in aerobic and anaerobic capacities appeared through several physiological indicators. Such developments may be attributed to the effects of the training loads applied to the players, which contributed to enhancing their physical condition.

Similarly, Hamdi Ahmed and Ghazi Al-Sayed highlighted that physical training loads imposed during sports practice produce functional adaptations within the body's vital systems. These adaptations increase physiological efficiency and improve the ability of the body systems to tolerate and adapt to physical demands, although the degree of adaptation varies according to the intensity and volume of the imposed loads.

Despite the absence of significant correlations between some of the remaining physiological indicators and performance effectiveness, the researcher attributes this result to the decline in performance effectiveness observed among certain members of the research sample. In several cases, negative performance indicators outweighed positive ones, which adversely affected overall performance effectiveness despite the players possessing acceptable levels of physical fitness.

This can be explained by the fact that performance effectiveness in basketball is influenced not only by physical fitness, but also by technical, tactical, functional, and psychological factors. In this regard, Issam Abdel Khaliq (p. 13) emphasized that analyzing players' performance during matches and evaluating their effectiveness provides important information for guiding training processes aimed at achieving functional development and physiological adaptation through systematic training programs specifically designed to meet the demands of sports performance.

9. Conclusions:

- ✓ The results revealed a statistically significant correlation between prolonged anaerobic capacity and heart rate with the performance effectiveness of the teams included in the research sample.
- ✓ No statistically significant correlation was found between short anaerobic capacity (phosphagen system), aerobic capacity, and the performance effectiveness of the research sample teams.

10. Recommendations:

- Greater emphasis should be placed on developing physical fitness components, particularly speed, speed endurance, and general endurance, within training programs due to their close relationship with blood pressure regulation, heart rate responses, and recovery processes. Regularity and continuity in training should also be maintained.
- Coaches are encouraged to use the performance effectiveness evaluation form developed and modified by the researcher to analyze players' performance, identify weaknesses, and reinforce positive aspects. Performance effectiveness should also be considered a primary criterion for player selection

during matches, especially at the national team level.

- Coaches should regularly apply the physiological tests examined in this study and periodically monitor blood pressure and heart rate in order to evaluate training programs and determine the physiological condition of players.
- It is recommended to organize specialized development and training courses for basketball coaches with the participation of experts from advanced basketball countries, particularly in the field of exercise physiology, to enhance understanding of the importance of physiological indicators during training sessions and competitive performance.

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