

## **The effect of proposed training sessions using the high-intensity interval training method on some physiological components of elite volleyball players**

**Dr. Aidi Mourad<sup>1</sup>, Dr. Guettab Mohamed<sup>2</sup>, Dr. Fedel Kais<sup>3</sup>**

<sup>1</sup>Professor Lecturer A, University Kasdi Merbah Ouargla (Algeria).

<sup>2</sup>Professor Lecturer A, University Kasdi Merbah Ouargla (Algeria).

<sup>3</sup>Professor Lecturer A, University Kasdi Merbah Ouargla (Algeria).

**The Author's E-mail: [aidi.mourad@univ-ouargla.dz](mailto:aidi.mourad@univ-ouargla.dz)<sup>1</sup>,  
[Guettab.mohamed@univ-ouargla.dz](mailto:Guettab.mohamed@univ-ouargla.dz)<sup>2</sup>, [fedel.kais@univ-ouargla.dz](mailto:fedel.kais@univ-ouargla.dz)<sup>3</sup>**

**Received: 03/2024**

**Published: 08/2024**

### **Abstract:**

This study aims to determine the effect of the high-intensity interval training programme, represented by the proposed training units, on some physiological components of elite volleyball players. The researchers used the experimental method, which is appropriate to the nature of this study. The study was carried out on a purposive sample of 20 elite volleyball players. Functional and physical tests were used and the study sample was divided into an experimental group and a control group. Pre-tests and post-tests were used, taking into account the same conditions of use. The researchers used appropriate statistical methods to process the data through the statistical package, which allowed for the verification of the validity of the hypotheses proposed in the study and the consequent conclusions and recommendations.

**Keywords:** Training programme, high-intensity interval training, physiological components, elite volleyball players ll players.

### **Introduction and problem statement:**

In numerous studies, experts have observed that modern sports training has an impact on the functional and physical aspects, which in turn influence the technical, tactical and movement performance of athletes. This highlights the importance of physical and functional components for elite volleyball players. The development of physical and functional components can only be achieved by understanding the interrelationships between physical and functional qualities and the effects of physical exertion.

Modern volleyball is a sport that relies heavily on explosive power, which requires coaches and sports training experts to intensify the training load and increase the volume of training sessions based on precise scientific principles. This should be accompanied by a focus on all technical and skill-related aspects, as they have a significant influence on the interdependent physical and functional components, the technical and movement performance elements, as well as the morphological and physiological aspects. All of the body's systems are affected by each other and by any physical effort involved in sport.

This physical effort is only possible through the availability of the necessary energy, which can be produced through anaerobic phosphate, anaerobic lactic or aerobic pathways, depending on the nature of the physical effort. The availability of oxygen as a crucial element in the production of this energy is of paramount importance.

The rapid development of the science of exercise physiology through all types of sports skills performance, and through the description and explanation of the physiological changes and adaptations that it provides, has contributed to the development of sports science and the attempt to approach the practical reality of the sports field. On the other hand, the development in the field of sports training works to discuss the external manifestations of sports skills performance, touching the physiological aspect, especially the energy systems in the athlete's body, without delving deeply into the internal physiological processes that are the fundamental source shaping the essence of this sports skills performance.

The purpose of applying the specificity of modern sports training here means the working energy system from the perspective of physiology. Volleyball, for example, does not rely on a single energy system for energy production, since muscular effort requires the intervention of three energy systems: the anaerobic phosphate, anaerobic lactic and aerobic systems, with a difference in the contribution of each system to the physical components specific to volleyball, which are classified according to their importance. (Jurgon weineck 2004;p55)

According to Matveev (1982), the training methodology aimed at directly influencing the work of the muscle leads to the identification of the energy source used to perform the activity or event, and then the application of the principle of increasing the training load to develop the working energy sources to ensure the continuity of the muscle's performance of its function.

The development of aerobic and anaerobic fitness depends on certain principles that help to focus modern sports training programmes. These principles are the fundamental basis that works to improve the sports training process in volleyball, as good sports and skill performance in various aspects of sports training depends on energy fitness. In the past, the prevailing belief was that the training process developed by increasing the volume and intensity, without

taking into account the method and style of training, which is an important factor in the development of the player's physical and functional abilities.

On this basis, we can ask the following main question:

- Does the high-intensity interval training programme improve some physiological components in elite volleyball players?

The general question allows us to ask the following sub-questions

- Are there statistically significant differences between the pre-test and post-test measurements of the experimental group in favour of the post-test measurement to improve anaerobic phosphagenic fitness specific to explosive power quality in elite volleyball players?

- Are there statistically significant differences between the pre-test and post-test measurements of the experimental group in favour of the post-test measurement to improve anaerobic phosphagenic fitness specific to speed-power quality in elite volleyball players?

## **2- Hypotheses of the study:**

### **2-1- General hypothesis:**

The high intensity interval training programme will lead to the improvement of some physiological components in elite volleyball players.

### **2-2- Sub-hypotheses:**

- There are statistically significant differences between the pre-test and post-test measurements of the experimental group in favour of the post-test measurement to improve anaerobic phosphagenic fitness specific to explosive strength quality in elite volleyball players.

- There are statistically significant differences between the pre-test and post-test measurements of the experimental group in favour of the post-test measurement to improve anaerobic phosphagenic fitness specific to speed-power quality in elite volleyball players.

### **3- The general aim of the study:**

- Through this study we are trying to achieve the objectives that can be summarised as trying to find the appropriate means to maintain the endurance of the volleyball player during the competition and delay his fatigue. This necessarily helps the player to achieve a high level of functional and physical efficiency, enabling him to play the match under high load with complete efficiency and ability, which is reflected in the level of skill performance.

- To focus on the importance of proper programming for interval training, in order to look forward to a future plan in the preparation of training programmes based on scientific foundations.

- To highlight the importance of the role of the coach in the selection of physical fitness elements used to improve the specific physical abilities of volleyball in Algeria.

Within the framework of the research problem and its importance, the researchers set several objectives to be achieved:

- Develop a proposed training programme to improve the anaerobic fitness of volleyball players.
- To determine the contribution of high-intensity interval training to the development of anaerobic fitness in volleyball players.
- To identify the specific physical elements that should be improved in volleyball players.
- To improve and increase the level of physical and skill performance of the experimental group in the pre-test and post-test.
- To determine the effect and effectiveness of the proposed high intensity training programme in improving anaerobic fitness between the pre-test and post-test of the experimental group of volleyball players.

#### **4- Operational Concepts and Terminology in the Study:**

- Training Programme: It is one of the elements of the plan, and without it the plan would be incomplete. The programme is the detailed implementation steps in the form of detailed activities to be carried out to achieve the goal.

(Al-Bik & Abbas, 2003, p. 102)

- High Intensity Interval Training (HIIT): This is an interval training method characterised by an increase in the intensity of the training load and a relatively low volume. The coach aims to develop the player's specific endurance, represented by strength endurance, speed endurance and speed-strength endurance. This pattern is also characterised by working under conditions of oxygen debt due to the use of high intensity, which can reach up to 90% of the player's maximum capacity.

(Al-Rabdi, 2004, p. 217)

- Phosphagenic Anaerobic Fitness: It is the ability to produce energy for a short period of time without the need to use oxygen and extends up to 30 seconds, and it also means working to achieve the maximum muscle contraction in the shortest possible time, estimated from 5 to 10 seconds.

(Sayed, 2003, p. 22)

- Volleyball: It is a team sport in which two teams, each consisting of six players, compete on a relatively small court divided in half by a net.

(FIVB, 2020)

#### **5-Methodological procedures followed in the study:**

##### **5-1- Method and tools:**

##### **Approach to the study:**

The experimental method involves the study of causal relationships between the variables responsible for shaping the phenomenon, event, or influencing it directly or indirectly, in order to identify the effect of each of these variables in this area (Hassan Hisham, 2007, p. 83). Since the subject of our research is related to high-intensity interval training, based on plyometric and circuit training, and its effects on improving anaerobic fitness in volleyball players, the researcher believes that this study is suitable to follow the experimental approach due to its compatibility with the nature of the treated research.

**Experimental design:**

The researchers relied on the experimental method with a dual design using the pre- and post-test for two equivalent groups, one control and the other experimental (Muhammad Hassan Allawi, 1987, p. 43).

**The pilot study:**

The aim is to measure the level of reliability and validity of the tool used in the experimental study, as it also helps the researchers to know the different conditions surrounding the experimental application process. It is a stage of testing the components of the tools after their preparation and formulation in order to ensure their suitability and appropriateness. It also provides the researchers with the opportunity to learn about the various difficulties they may encounter in reality when dealing with the phenomenon, by ensuring the validity of the physical and functional test experiments and their research means, to know their validity and authenticity, to ensure the accuracy and objectivity of the final results.

This pilot study precedes the experimental work and aims to measure the level of reliability and validity of the tool used in the field study, as it also helps the researchers to know the different conditions surrounding the application process.

The researchers started this work by approaching the study population represented by the senior category of the Ettadhamen Sports Club in Djelfa for volleyball, in the second national division, Djelfa, Algeria.

The researchers formed two groups, one experimental and the other control, according to several criteria agreed upon by the researchers in relation to the sample.

**The study population:**

The study of the entire original population requires a long time, considerable effort, and high financial cost. It is sufficient for the researchers to select a representative sample of the original population for the study, in such a way as to achieve the objectives of the study and help them fulfil their task.

The population of our study revolves around the volleyball clubs of the second national division, among the senior volleyball players in the province of Djelfa, Algeria.

### The study sample:

The good selection of the sample makes the results generalisable to the original population from which it was drawn, and to the extent that the sample represents the population, its results will be valid (Khalas Mohamed Abdelhafeez and Mostafa Hussein Bahi, 2000, p.131). For example, if you want to determine the effect of high-intensity interval training on improving anaerobic fitness, you will not be able to study all the players in the second national league volleyball clubs in Djelfa. It is therefore necessary to limit the study to the selection of a sample of players.

### How to select the study sample:

The sample is a group from the study population that must be representative of the population so that the results can be generalised. This method is used when the individuals in the original population are known, and on this basis a purposive sample is selected.

We relied on the purposive sample and the study tool was applied to two groups from the total sample studied (players of the Trojans Volleyball Club, Second National Division, Seniors, in Djelfa), estimated at 20 players, divided into two groups: an experimental group and a control group. The size of the experimental sample is 10 players and the size of the control sample is 10 players. Pre-tests and post-tests were administered to members of the control and experimental groups.

### Homogeneity of the study sample:

The researchers found the equivalence between the experimental group and the control group in some extraneous variables that affect the experimental variable and were revealed by the results of the current study and previous studies. The researchers identified the extraneous variables that may affect the experimental study, so that the differences between the experimental and control groups are not attributed to these extraneous variables, which are as follows:

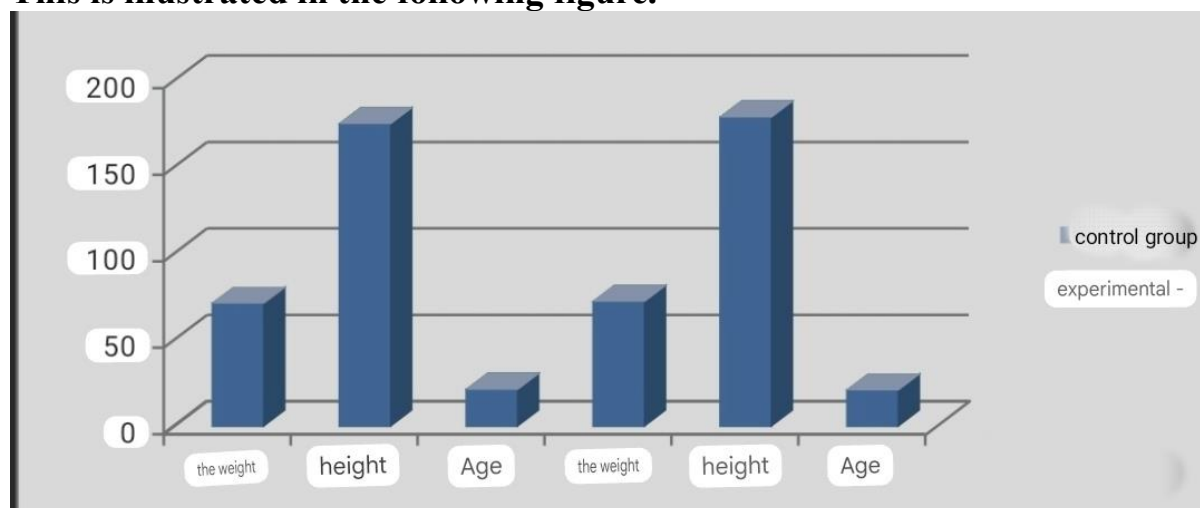
- Chronological age
- Body weight
- Total height

**Table 1 shows the homogeneity of the sample between the experimental and control groups in terms of variables (age, weight, height).**

Variables	experimental group		Control group		Coefficient of variation	Calculate d "T" value	Statistical significance	level of significance
	arithmetic mean	Standard Deviation	arithmetic mean	Standard Deviation				
Weight	70.91	3.01	72	4.05	0.03	1.55	Not statistically significant	0.01
Height	174.7	1.16	178.5	3.92				
Age	21.16	1.26	20.75	1.28				

From Table 1, we can see that the calculated t-Student value is (1.55) and that all the skewness coefficient values are (0.03) at the significance level of (0.01). As the skewness value is greater than (0.01), this indicates that there is no statistical significance for all the study variables of height, weight and age, confirming that the experimental and control groups are equivalent.

**This is illustrated in the following figure.**



**Figure 1 shows the homogeneity of the sample between the experimental and control groups for the arithmetic means of the variables (age, weight, height).**

The graph shows that the arithmetic means of the variables (age, height, weight) for the experimental group are close to the arithmetic means of the variables (age, height, weight) for the control group, confirming that the experimental and control groups are homogeneous.

#### **Areas of study:**

The researchers conducted the field study in the Wifaq Union Volleyball Club, Second National Division, Seniors, located in the November 1 Hall in the 5th of July neighbourhood in the city of Djelfa.

We conducted the field study from the beginning of December 2022.

The experimental study was conducted on a sample of players from the Ettaradjia Sports Club, Second National Division Volleyball, seniors, in the province of Djelfa for the 2022/2023 season.

#### **Data collection tools:**

The main axis on which the researchers base their choice of data collection tools depends on several criteria. The nature of the problem and the hypotheses control the process of selecting the tools. In order to collect the data from the field on the subject of the study, the researchers have to select the appropriate tools.

**- Equipment and tools used in the research:**

- A fully equipped standard volleyball court (net, posts, ribbons, antenna).
- A camera to record the tests and the training programme - A smooth wall - A stopwatch
- Plastic cones - a whistle - a medical scale - data recording paper - chalk - a tape measure - a scientific calculator.

**Data Collection Forms:**

The researchers have prepared the following forms:

- Questionnaire form to collect the referees' opinions on identifying the physical characteristics related to anaerobic and functional fitness in volleyball.
- Questionnaire form to collect the referees' opinions on the identification of physical fitness tests related to anaerobic and functional fitness in volleyball.
- Form to record growth rates, physical and functional tests related to the homogeneity of the research sample.
- Form to record the results of the pre- and post-physical and functional tests for the experimental and pilot groups.
- Form for the proposed exercises to improve the physical characteristics related to anaerobic and functional fitness.
- Form to record the personal data of each player, including (player's name, height, weight, chronological age and training age).

**Scientific procedures for the tests:**

Although the tests were standardised, the researchers attempted to rely on scientific principles in the application of the tests to determine the practicality of the selected physical and functional tests.

**Reliability of the tests:**

A reliable test is one that gives the same or close results when applied more than once to the same individuals and under the same conditions. (Abu Al-Ula, 2001, p. 455).

The researchers calculated the reliability coefficient using the test-retest method with a seven-day interval between the two applications on the same sample, and the correlation coefficient between the first and second applications was calculated using the Pearson correlation coefficient. Table (02) shows the reliability coefficients for the physical and functional tests studied.

**Table (02) shows the test-retest reliability coefficients for the functional and physical tests:**

Study variable	coefficient of stability	level of significance
----------------	--------------------------	-----------------------

<b>Explosive strength</b>	<b>0.78</b>	<b>Significant at 0.01</b>
<b>Speed-Strength (Leg Power)</b>	<b>0.83</b>	
<b>Speed-Strength (Arm Power)</b>	<b>0.86</b>	
<b>Speed</b>	<b>0.96</b>	
<b>Power Endurance</b>	<b>0.92</b>	
<b>Speed Endurance</b>	<b>0.74</b>	
<b>Lactic Acid Strength Endurance</b>	<b>0.95</b>	
<b>Lactic Acid Speed Endurance</b>	<b>0.94</b>	

Table (02) shows that the correlation coefficients between the scores of the first and second applications of the physical and functional tests are between (0.74, 0.96), and these are high values that indicate that the measure has a good degree of reliability.

#### **Validity of the study instrument:**

##### **Construct validity:**

Table (03) shows the construct validity coefficients for the functional and physical tests:

<b>Study variable</b>	<b>Self-Validity Coefficient</b>	<b>level of significance</b>
<b>Explosive strength</b>	<b>0.88</b>	<b>Significant at 0.01</b>
<b>Speed-Strength (Leg Power)</b>	<b>0.91</b>	
<b>Speed-Strength (Arm Power)</b>	<b>0.92</b>	
<b>Speed</b>	<b>0.97</b>	
<b>Power Endurance</b>	<b>0.95</b>	
<b>Speed Endurance</b>	<b>0.86</b>	
<b>Lactic Acid Strength Endurance</b>	<b>0.97</b>	
<b>Lactic Acid Speed Endurance</b>	<b>0.96</b>	

Table (03) shows that the validity coefficients for the physical and functional tests were between (0.86, 0.97), and these are high values, indicating that the measure has a good level of construct validity.

#### **The main study:**

##### **Pre-test measurements:**

The pre-test measurements were carried out and included measurements of the variables under study (physical and functional) for the two study groups

(experimental and control) in the multipurpose sports hall on the first of November in the 5th of July neighbourhood where the Volley Club of the Algerian second national division is located in the city of Djelfa, Algeria.

### **Launch of the programme:**

The implementation of the training programme began on the experimental sample for a duration of eight weeks, with three training sessions per week and a training session duration of 60 minutes. The training included physical exercises using the plyometric training method and circuit training to improve the anaerobic phosphatic fitness components and the most important functional abilities specific to volleyball for seniors in the city of Djelfa, Algeria.

### **Post-measurement:**

The researchers carried out post-measurements for the two study groups (experimental and control), which included measurements of the (functional and physical) variables under study. This was done on 1 November in the multi-sports hall in the 05th of July neighbourhood where the **الترجي** Volleyball Club, National Division 2, Seniors, Djelfa, Algeria is located.

### **Test procedure:**

The tests were applied to the experimental and control study samples in the multi-sports hall in the 5th of July neighbourhood at specified times with the support team.

The tests were administered to both the experimental and control samples under the same conditions and at the same time, with the same requirements for all sample members. These tests were conducted with an explanation and presentation of all test items by the researchers and the assistance team prior to completion by the sample, which included the following steps

- Allowing the players sufficient time to complete a full warm-up.
- Allowing the players full rest periods between one test and another.
- The researchers prepared forms to record the raw scores for each group.
- Recording the results according to the specified conditions and specifications for each test.

### **Statistical methods:**

#### **The statistical methods used:**

In this study, we used a range of statistical methods appropriate to the nature of the study design. After the application phase, the data were processed in the SPSS statistical software package in order to analyse and process them and to discuss the hypotheses in the light of the study objectives. The following statistical methods were used

### **Descriptive statistics:**

**Arithmetic mean:**

The arithmetic mean is generally considered to be the simplest type of measure of central tendency because it is easy to calculate and understand. The formula may be used as follows:

$$\bar{X} = \frac{\sum F_i X_i}{N}$$

**Standard deviation:**

It is the square root of the average of the squared deviations of the values from their arithmetic mean, and the standard deviation is considered one of the most important and widely used measures of dispersion in statistics. The formula can be expressed as

$$S = \sqrt{\frac{\sum (x_i - \bar{X})^2}{n}}$$

**Percentages:**

These were used in this study to estimate the individuals in the pilot study and to estimate the individuals in the main study population according to the study variables.

**Inferential statistics:**

**Student's t-test:**

This method is used to calculate the significance of the differences between the means of the two samples and can be used according to the following equation:

$$T = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1 - 1)S^2_1 + (n_2 - 1)S^2_2}{n_1 + n_2 - 2} \times \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

**Reliability Coefficient (Cronbach's  $\alpha$ ):**

The correlation coefficient was used to measure the reliability of the different dimensions in the two scales (even and odd items), and the formula can be expressed as:

$$\alpha = \frac{2R}{R + 1}$$

**2-5- Presentation, analysis and discussion of the study results:**

The study results were presented by analysing and discussing the functional and physical test results of the experimental and control groups in both pre-test and post-test, and placing them in tables to facilitate the observation of differences and comparison between them, and then discussing them to achieve the study objectives and verify the study hypothesis.

**Table No. (04): It shows the normality of the sample in both growth rate variables and physical and functional variables for the experimental group.**

Study Variables		Arithmetic Mean	Standard deviation	Coefficient of skewness	
<b>Parametric Variables</b>					
1	Age	16.71	0.23	-0.97	
2	Training age	6.5	0.29	-0.13	
3	Height	182.4	2.20	-1.50	
4	Weight	71.14	3.52	-0.07	
<b>Physical variables</b>					
1	explosive strength	Vertical jump from a standing position (Sargent test)	53.28	1.77	1.04
2	Speed-Strength (leg strength)	Single leg jump (30 metres)	505	0.01	-1.82
3	Speed-Strength (Arm strength)	Arm flexion and extension from prone position (10 seconds)	10.85	0.44	-2.41
4	Speed	Running (20 metres from high start)	2.29	0.03	-0.72
5	Power Endurance	Sit-up from supine position with knees bent	31.78	0.20	0.94
6	Speed Endurance	Shuttle run from high start (25m x 8)	45.47	1.82	1.23
<b>Functional variables</b>					
1	Lactic Acid Strength	lactate measuring device	26.77	0.37	-0.86

	<b>Endurance</b>				
<b>2</b>	<b>Lactic Acid Speed Endurance</b>	<b>lactate meter</b>	<b>27.31</b>	<b>0.43</b>	<b>-0.63</b>

The results presented in the above table No. (04) show the statistical description and the skewness coefficient for the study sample in the studied variables. The results of the study indicate that the values of the skewness coefficient are confined between (-3, +3), which indicates the normality of the distribution of the sample in these variables for the experimental group.

The skewness coefficient values for the anthropometric measurements of the experimental group indicate that they are normally distributed in the experimental group. The skewness coefficient values for the physical measurements of the experimental group also show that they are normally distributed within the experimental group. Furthermore, the skewness coefficient values for the functional measurements of the experimental group show that they are normally distributed among the experimental group.

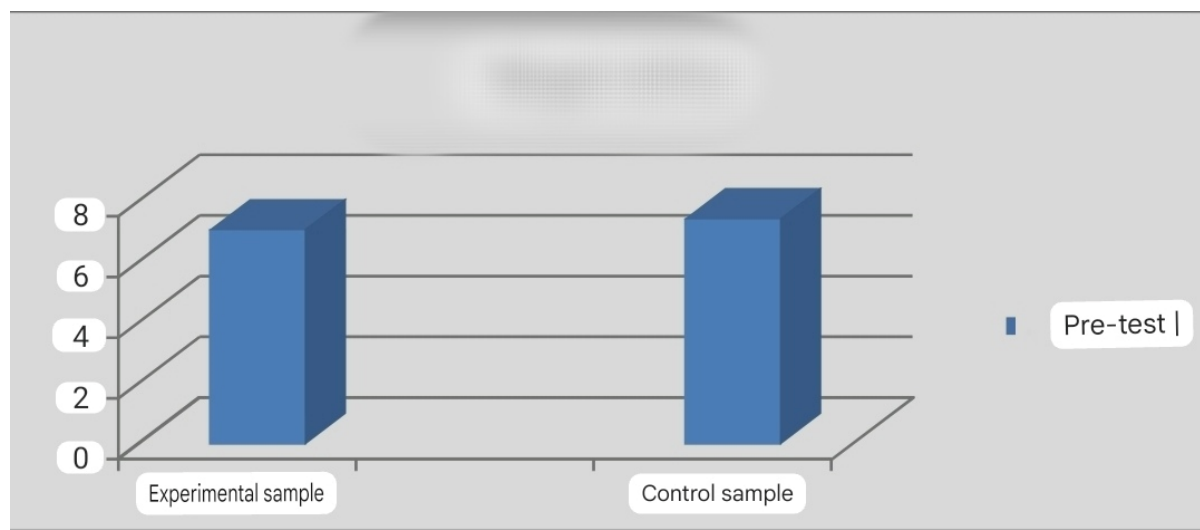
**Table No. (05): It shows the level of significance of the statistical differences in phosphagenic anaerobic fitness in terms of speed-strength quality between the experimental and control groups for the pre-test.**

Sample	preliminary test		Student's calculated T value	Coefficient of Variation	Degrees of freedom	Level of significance	statistically significant
	Arithmetic mean	Standard deviation					
Experimental Sample	7.05	0.14	1.4	0.02	18	0.01	Not statistically significant
Control Sample	7.4	0.25					

Table No. (05) shows the statistical description of the pre-test for the 30m single leg jump test. It shows that the experimental group obtained a mean of (7.05) and a standard deviation of (0.14) in this test, and the calculated T-value was (1.4) with a degree of freedom of (18) at a significance level of 0.01. As for the control group, they achieved a mean of (7.4) and a standard deviation of (0.25) in this test, with a calculated T-value of (1.4) with a degree of freedom of (18), and the skewness coefficient value was 0.02, which is greater than the 0.01 level of significance.

Based on this, it is clear that there are no statistically significant differences at the 0.01 significance level between the experimental and control groups in the 30m one-legged jump pre-test.

The following graph illustrates this:



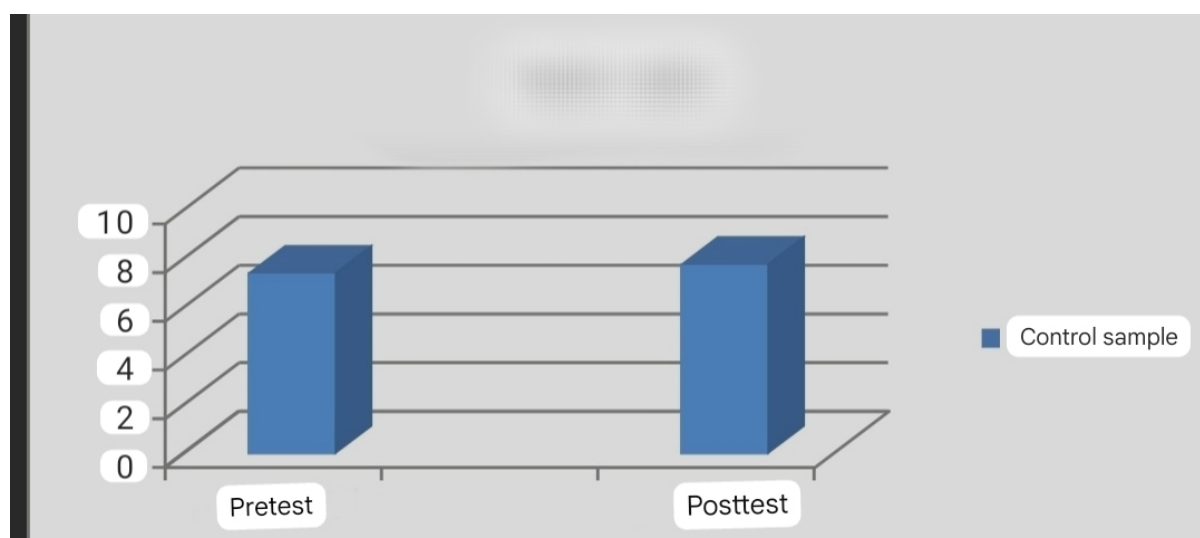
**Figure No. (02):** It shows the differences in the means of the phosphagenic anaerobic fitness related to the speed-strength quality of the legs between the experimental and control groups for the pre-test.

**Table No. (06):** It shows the level of significance of the statistical differences in phosphagenic anaerobic fitness related to the speed-strength quality of the legs for the control group between the pre-test and the post-test.

Sample	Pre test		Post-test		Student's calculate d T value	Coefficien t of Variation	Degrees of freedo m	Statistical significanc e
	Arithmeti c mean	Standar d deviatio n	Arithmeti c mean	Standar d deviatio n				
Contro l sample	18	0.02	2.9	0.21	2.9	0.02	18	Not Statisticall y Significant

Table No. (06) shows the statistical results for the control group in the pre-test of the 30m one-legged jump. The mean was (7.4) with a standard deviation of (0.25) and the calculated T-value was (2.9) with a degree of freedom of (18) at a significance level of 0.01. For the post-test, the mean was (7.76) with a standard deviation of (0.21) and the calculated T-value was (2.9) with a degree of freedom of (12). The skewness coefficient value was (0.02), which was greater than the 0.01 significance level, indicating that there were no statistical differences, but there were significant differences for the control group between the results of the pre-test and the post-test of the 30m one-legged jump.

The following graph illustrates this:



**Figure No. (03):** It shows the differences in the means of the phosphagenic anaerobic fitness related to the speed-strength quality of the legs between the pre-test and the post-test for the control group.

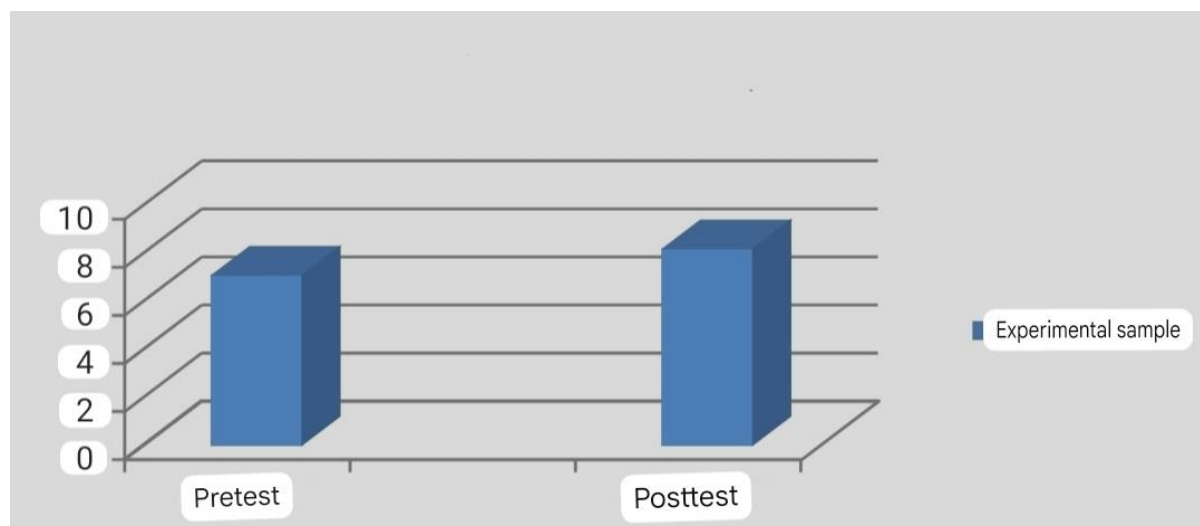
**Table no. (07):** It shows the level of significance of statistical differences in phosphagenic anaerobic fitness related to speed-strength quality of legs for the experimental group between pre-test and post-test.

Sample	Pre_ test		Post-test		Student's calculated T value	Coefficient of Variation	Degrees of freedom	Statistical significance
	Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation				
10 Experimental sample	7.05	0.14	8.15	0.12	3.05	0.000	18	Statistically significant

**Table No. (07)** presents the statistical results for the experimental group in the pre-test of the 30m single leg jump. The mean was (7.05) with a standard deviation of (0.14), and the calculated T-value was (3.05) with a degree of freedom of (18) and a significance level of 0.01.

For the post-test, the mean was (8.15) with a standard deviation of (0.12) and the calculated T-value was (3.05) with a degree of freedom of (18). The value of the coefficient of skewness was (0.000), which was less than the 0.01 level of significance, indicating that there were statistically significant differences in favour of the experimental group between the results of the pre-test and the post-test of the 30m one-legged jump.

**The following graph illustrates this:**



**Figure No. (04):** It shows the differences in the means of the phosphagenic anaerobic fitness related to the speed-strength quality of the legs between the pre-test and the post-test for the experimental group.

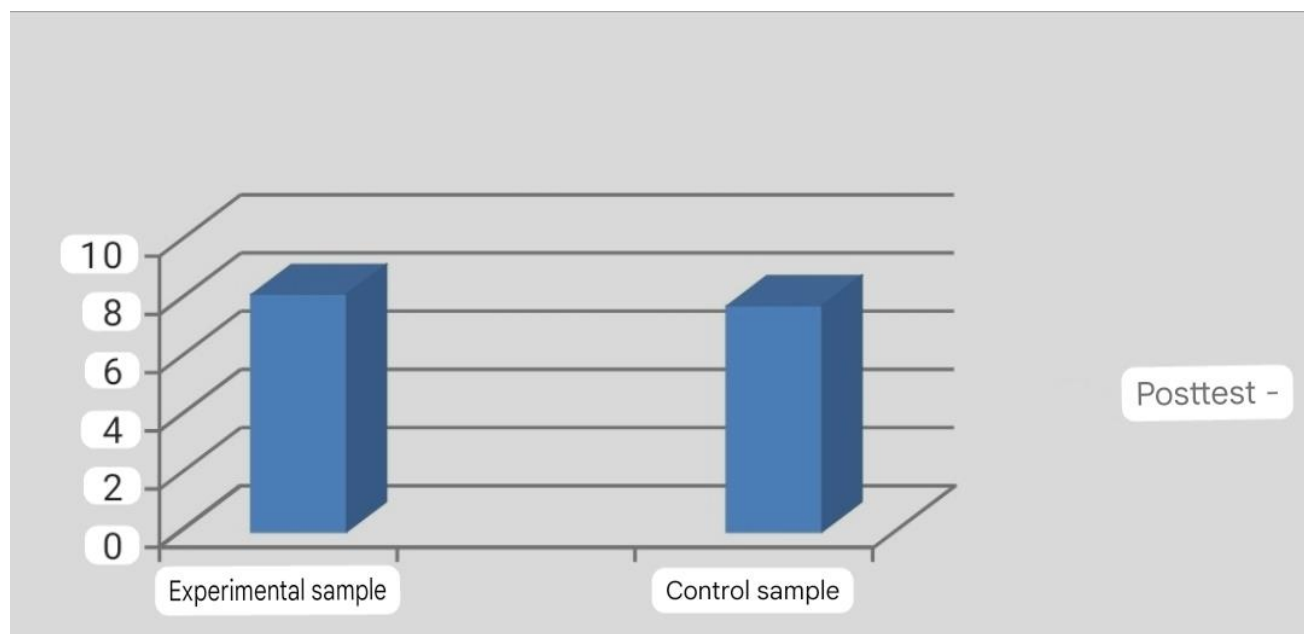
**Table No. (08):** It shows the level of significance of the statistical differences in phosphagenic anaerobic fitness related to speed-strength quality between the experimental and control groups in the post-test.

Sample	Post test		Student's calculated T value	Coefficient of Variation	Degrees of freedom	Statistical significance
	Arithmetic mean	Standard deviation				
Experimental sample	8.15	0.12	3.05	0.000	18	Statistically significant
Control sample	7.76	0.21				

Table No. (08) shows the statistical description of the post-test for the 30m single leg jump test. It shows that the experimental group achieved a mean of (8.15) with a standard deviation of (0.12), and the calculated T-value was (3.05) with a degree of freedom of (18) at a significance level of 0.01. For the control group, the mean was (7.76) with a standard deviation of (0.21) and the calculated T-value was (3.05) with a degree of freedom of (18). The coefficient of kurtosis was (0.000), which is less than the 0.01 level of significance.

This means that there were statistically significant differences at the 0.01 significance level between the experimental group and the control group in the 30m single leg jump post-test, in favour of the experimental group.

**The following graph illustrates this:**



**Figure No. (05):** It shows the differences in the means of phosphagenic anaerobic fitness in terms of speed-strength quality between the experimental and control groups in the post-test.

#### **Interpretation and discussion of the study results:**

From Table (08), which represents the post-test of the experimental and control groups of adult volleyball players for phosphagenic anaerobic capacity, we can see that there are statistically significant differences between the experimental group and the control group in favour of the experimental group.

The results of Table (26), which refers to the experimental and control groups for the pre-test, show that there are no statistically significant differences between the experimental and control groups for the adult volleyball players in the experimental group.

The study demonstrated the superiority of the proposed high-intensity interval training programme that the researchers added for the experimental group players to improve phosphagenic anaerobic capacity. The researchers attribute this to the application of the proposed training programme and its reliance on the plyometric training method in modern sports training, as well as the inclusion of the training programme with a set of anaerobic exercises based on new scientific physiological bases.

This study is consistent with the study by Ibrahim (2010), which indicated that working with high-intensity training, such as high-intensity interval training, leads to the development of specific anaerobic abilities, which in turn leads to the improvement of the ATP-PC energy system.

The researchers attribute the development of the anaerobic phosphate capacity in favour of the experimental group to the proposed training programme, which

was used to develop the anaerobic phosphate (ATP-PC) fitness capacity in terms of intensity, volume and density, with a time range not exceeding 25 seconds, as it represents the main energy system in the sport of volleyball. The demands of this sport are mostly explosive and short-term in nature. For this reason, the researchers opted for high-intensity interval training, focusing on the plyometric training method, which has been designed according to the athlete's ability to develop anaerobic phosphate capacity, based on sound scientific principles. It is worth noting that high-intensity interval training can be used in anaerobic training methods and approaches to improve anaerobic capacity and focus on increasing the efficiency of anaerobic energy systems and the fast energy system (ATP-PC).

This study is also consistent with many previous and similar studies and references, as Ali Fahmy 2008 sees that achieving high athletic form in volleyball can only be achieved through the use of intermittent training, where the heart rate ranges from (160-190 bpm), interspersed with rest periods that allow the heart rate to decrease to (110-130 bpm).

These physiological indicators related to heart rate, the duration of the short exercises performed and the high intensity of the exercise all point to the physiological components of anaerobic phosphate capacity. The researchers explain this as the ability to directly influence the physical components of power and explosive strength. This is also confirmed by Saleh Bashir (2010), who states that the athlete's ability to provide the anaerobic energy required for high-intensity efforts is considered to be the determining physiological basis for the level of short-term performance in terms of explosive power, speed power and also anaerobic phosphate capacity, which he considers to be a basic requirement for the performance of high-intensity physical efforts.

By analysing the results of the previous tables, we can conclude that high-intensity interval training, with a focus on plyometric training, led to an improvement in anaerobic phosphate capacity, in accordance with the sixth hypothesis, which reads

There are statistically significant differences in the mean values of the players' anaerobic phosphate capacity between the experimental and control groups in the post-test, in favour of the experimental group, due to the proposed training programme focused on the plyometric training method.

Therefore, the hypothesis of the study is met.

### **Conclusions and Recommendations:**

The physiological components related to high level volleyball, in addition to motor skills, are considered as transient variables to express performance over different periods that require an appropriate amount of explosive power and speed power. A volleyball player must also perform many rapid movements from time to time throughout the competition.

From the above, it is clear that the nature of performance in volleyball determines the different functional and physical demands, depending on the different speed of play, size, intensity and rest intervals through the rhythm of play during competition. This, in turn, places a significant burden on the functional and vital systems, emphasising the importance of physiological preparation of volleyball players, which is considered one of the most critical types of preparation that should be included in modern scientific sports training programmes.

Among the recommendations proposed by the researchers in this study are:

1. Interest in the development of the physical and functional components in general, as they are important for improving skill and motor performance, as well as sport recovery and rehabilitation processes.
2. Speed and explosive strength training should be based on high-intensity interval training using plyometric and circuit training methods, with attention to rest periods.
3. The development of the physiological components of elite volleyball players can only be achieved by developing physical qualities through the use of high-intensity anaerobic phosphate exercises specific to the senior volleyball category.
4. The interest in acquiring motor skills for high level volleyball players should be through the development of physical qualities in accordance with their physiological abilities and the characteristics of their age group.

### **References and Resources**

- Qasim Hassan Hussein: Sports Training Science, Dar Al-Fikr for Printing, Publishing and Distribution, 1st edition, Amman, Jordan, 1998.
- Wagdi Mostafa Al-Fateh, Mohammad Lotfi Al-Sayed: The Scientific Foundations of Sports Training, the Player and the Coach, Dar Al-Huda, Minya, 2002.
- Moufdi Ibrahim: Coordination of Foot Movements and Skills in Football, Dar Al-Kitab Al-Arabi, Egypt, 1st edition, 2014.
- Mohammad Reda Al-Waqad: Modern Planning in Football, Dar Al-Saada for Printing, Egypt, 1st edition, 2003.
- Mufti Ibrahim Hammad: Planned Training Programmes for Football Teams, Book Centre for Publishing, Cairo, 1st edition, Egypt, 1997.
- Mohammad Al-Hamamsi and Amin Al-Khouli: Foundations of Building Sports Education Programmes, Dar Al-Fikr Al-Arabi, Egypt, 1st edition, 1990.
- Mahmoud Hanafi Mukhtar: Foundations of Planning a Physical Education Programme, Dar Al-Zahran, Egypt, 1st edition, 1988.

- Mftti Ibrahim Hammad: Planned Training Programmes for Football Teams, Book Centre for Publishing, Egypt, 1st edition, 1997.
- Ahmad Nasruddin Sayed: Sports Physiology, Theories and Applications, Dar Al-Fikr Al-Arabi, Egypt, 1st edition, 2008.
- Al-Sayed Abd Al-Maqsoud: Theories of Sports Training, Book Centre for Publishing, Egypt, 1st edition, 1998.
- Abu Al-Ala Ahmed Abdel Fattah and Ahmed Nasruddin Sayed: Physiology of Physical Fitness, Dar Al-Fikr Al-Arabi, Egypt, 1st edition, 1993.
- Mufti Ibrahim Hammad: Modern Sports Training, Planning, Application and Leadership, Dar Al-Fikr Al-Arabi, Egypt, 1st edition, 2001.
- Wagdi Mustafa Al-Fateh and Muhammad Lutfi Al-Sayed: The Foundational Process for Sports Training and the Coach, Dar Al-Huda for Publishing and Distribution, Egypt, no edition, 2002.
- Volleyball External Publications, The Official Volleyball Rules Approved by the FIVB, published at the 27th FIVB World Congress in Seville, Spain.
- Ren Taelman: New Techniques for Training Football, OPCIT, 2006.
- Weineck: Sports Biology, 2nd edition, 2005.
- Jurgen Weineck: Training Manual, 4th edition, 2004.