

Evaluation of physical qualities in volleyball players.

تقييم الصفات البدنية لدى لاعبي الكرة الطائرة

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Abstract

Player of volleyball, like other players of team and individual sports, requires a strong physical structure tailored to their specialization to elevate them to a high level of physical and technical performance. Thus, the development of physical qualities among volleyball players is crucial. In this study, we will discuss these physical qualities, define them, explore their branches, and discuss methods and techniques for their development and evaluation. Sixteen volleyball players (aged 19 ± 1 years; 187.8 ± 0.36 cm, 70.83 ± 15.05 kg) competing in the Algerian 'League 1, The study sample was divided into two equal groups; a control group and an experimental group, each consisting of 8 players. The experimental group underwent a proposed training program. Both groups underwent pre-test and post-test assessments to measure the following (including maximal oxygen consumption (VO_{2max}), maximal aerobic speed (VMA), explosive strength (jump height).

Keywords: Volley Ball; Vo_{2max} ; VMA; Explosive strength; Jump height

المخلص

لاعب الكرة الطائرة كغيره من لاعبي الرياضات الأخرى الجماعية منها والفردية يحتاج إلى بنية بدنية وجسمانية تتعلق بتخصصه لتجعله رياضي ذو مستوى بدني وفني عالي، مما يجعل تنمية الصفات البدنية لدى لاعبي الكرة الطائرة ضروري جداً، في هذه الدراسة سنتطرق إلى ذكر الصفات البدنية وتعريفها وفروعها ووسائل وطرق تنميتها، شملت الدراسة ستة عشر لاعباً في الكرة الطائرة (بعمر 19 ± 1 عاماً؛ 187.8 ± 0.36 سم، 70.83 ± 15.05 كغ) يلعبون في الدوري الجزائري الدرجة الأولى. تم تقسيم عينة الدراسة إلى مجموعتين متساويتين، مجموعة ضابطة ومجموعة تجريبية، خضعت المجموعة التجريبية لبرنامج تدريب مقترح. خضعت كلا المجموعتين لاختبارات قبل وبعد البرنامج لقياس السرعة الهوائية القصوى، الحد الأقصى لاستهلاك الأكسجين، القوة الانفجارية (الارتقاء).

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الكلمات المفتاحية: الكرة الطائرة؛ الحجم الأقصى لاستهلاك الاكسجين؛ السرعة الهوائية القصوى؛ القوة الانفجارية؛ الارتقاء.

I. Introduction

Physical fitness plays an essential role in the practice and mastery of all activities, as most sports training scientists agree. They concur that physical fitness is the fundamental element upon which the other necessary components for achieving what is known as physical fitness are built. Thus, physical fitness enables the sports individual to have the ability to perform motor skills. (Wilmore, J. H., & Costill, D. L. (2004)

In the formation of a successful volleyball team, physical fitness is the first and primary element. It allows the player to sustain their efforts during training or competition and to reach the highest level of technical and skill proficiency. The task of a successful coach is to build a team whose members possess the highest level of physical fitness. One of the major problems encountered by the coach during training preparation is the weakness of physical fitness during volleyball competitions and tournaments, which prevents players from implementing the training plan and winning the competition. (Mohammed R. Hassan, Ahmed A. El-Sayed, et al. 2021)

Physical fitness is defined as the ability to sustain physical effort over the long term. It also involves the ability to perform daily tasks with vivacity and vigilance, without fatigue or stress, and to have some energy to enjoy leisure time.

Thus, a volleyball player must possess the following characteristics in terms of physical fitness and mobility:

- Muscular strength.
- Explosive power of the arms and legs.
- Speed of movement.
- Motor coordination.
- Timing.
- Agility.
- Static and dynamic balance. (Sheppard, J. M., & Gabbett, T. J. 2008)

These physical abilities are among the most important performance requirements in modern volleyball, as they are crucial in matches. Physical abilities are the foundation of performance in volleyball appropriately and effectively. Therefore, it is impossible to achieve a good attacking shot from a player who does not have the ability to jump high, as every movement made by a player on the field requires a specific quantity and type of motor abilities that correspond to the nature of the characteristics that make up the performance. (Sheppard, J. M., & Gabbett, T. J. (2008).

Developing physical fitness in volleyball requires the integration of all physical abilities such as strength, speed, endurance, flexibility, agility, accuracy, coordination, and reaction. These abilities are numerous, varied, and necessary for improving performance. (Bompa & Haff, 2009)

On this basis, the following question can be raised:

Is it possible to develop a volleyball player with explosive qualities through training that specifically targets slow-twitch muscle fibers.?

As a result, researchers have proposed a contradictory training program that requires intense and short effort, characterized by repetition, to develop both endurance and explosiveness. This program, called alternate training or mixed training, can provide better quantitative and qualitative work than continuous training.

(Astrand and colleagues in1960) were among the first to demonstrate that intense effort can be increased in alternate training compared to continuous training, by alternating between exercise periods and rest periods.

Among the exercises that are consistent and compatible with this type of training are biomechanical exercises, which require the intervention of anaerobic lactate energy metabolism to provide the athlete with the necessary energy from a physiological perspective.

To carry out the study successfully, we will examine different variables of volleyball play to better understand the share of physical activity for a high-level player, as well as its various parameters,

- including maximal oxygen consumption (VO₂max).
- maximal aerobic speed (VMA).
- explosive strength (jump height). **(McArdle, Katch, & Katch, 2010)**

Speed is a physical quality that depends on muscular factors and can be expressed in various ways: velocity or agility. 'Speed is the capacity that allows, based on the mobility of processes within the neuromuscular system and its properties, the muscle to develop force, to perform motor actions in minimal time under given conditions' **(Frey, 1977)**.

VMA corresponds to Maximum Aerobic Speed, which is the running speed at which a person consumes the maximum amount of oxygen (VO₂ max).

In long-duration races, the greatest volume of oxygen that can be consumed per minute per kilogram of body mass (VO₂ max, in ml.kg⁻¹.min⁻¹), that is, the maximal flow or maximal power of aerobic metabolism, is positively correlated with performance **(Foster, 1983)**.

The development of maximal strength positively influences other physical qualities such as strength speed, power strength (Cometti, 2001). (Ahmed M, 2005) mentions that explosiveness, power, jump height, and agility are often important during the execution of different techniques. (Cometti,2009) also demonstrates that maximal strength plays a crucial role in the production of explosive force.

Based on this theoretical framework, the main research question of our study is as follows:

To what extent is the proposed training program effective in improving endurance and explosive power in volleyball players.?

• Hypotheses

General Hypothesis:

The proposed training program has a positive effect on the development of endurance and explosive strength in volleyball players.

Partial hypotheses:

Intermittent training using plyometric exercises enhances physical develops.

- **Maximal Oxygen Uptake (VO₂max).**
- **Maximal Aerobic Speed VMA.**
- **Vertical Jump.**

Research Objectives:

The objectives of this research are to assess the effectiveness of the proposed training program, based on intermittent training using plyometric exercises, in developing the following:

- Explosive strength in volleyball players.
- Maximal aerobic speed (vma).
- Maximal oxygen uptake (VO₂max).
- Vertical jump performance.
- Identifying key physiological indicators that assist in selecting appropriate training programs to develop the aforementioned physical attributes.
- Addressing the findings of **Walid (1982)** regarding muscle fiber transformation.
- Highlighting the importance of intermittent training in volleyball.

Reasons for Choosing the Research Topic:

Among the reasons that motivated the researcher to focus on this subject are the following:

- The scarcity of research on volleyball at the national level, especially studies related to training programs.
- Highlighting the role of intermittent training based on physiological indicators in developing the physical qualities specific to volleyball players.
- Shedding light on such studies due to their importance in identifying weaknesses and strengths in the sport of volleyball.

II. Materials and Methods

2.1 Subjects: Sixteen volleyball players (aged 19 ± 1 years; 187.8 ± 0.36 cm, 70.83 ± 15.05 kg) competing in the Algerian 'League 1' participated in this study. The morphological and physical characteristics of the subjects are presented in Table 1. Two groups were formed: a control group (N=8) (Ctrl) and an experimental group (N=8) (Exp). All players were briefed on the experiment and the purpose of the study. They were all in good health, competitive, and their last injuries dated back more than a year.

Table N°1: Morphological and Physical Characteristics of the Subjects

	N	Age years	height (cm)	wight (kg)	Vertical jump (cm)	Anaerobic power Watt
Control Group	8	19,5	187±5	70,5±6	70,6±2	94,68±8
Expérimental Group	8	19,5	187±8	70 ,5±8	70,7±5	94,68±5

The absence of statistically significant differences between the experimental and control groups is evident from Table 1, regarding age, height, and weight at the research sample level. This indicates the homogeneity of the study samples. (Significance level 0.05 and degrees of freedom (N-1) =7).

2. 2 Research Tools:

- Arabic and foreign sources and references.
- Test battery to measure vertical jump.
- Test to measure maximum oxygen consumption (VO₂max).
- Test to measure maximum airspeed (VMA).

2. 3 Research Procedures and Design:

The duration of the outlined training program is 3 months (12 weeks), distributed as follows:

- 4 weeks: Interval training (15-15) to develop aerobic capacity.
- 4 weeks: Interval training (10-10) to develop non-lactic anaerobic power, with concurrent development of aerobic capacity.
- 4 weeks: Interval training (10-20) to develop both non-lactic anaerobic capacity and aerobic capacity.

These sessions occur twice a week on average.

2. 4 Explanation of the Proposed Training Program:

- The 15/15 interval involves muscular work characterized by energy consumption within 15 seconds, where oxygen consumption is around 40% for athletes accustomed to aerobic activity and 29% to 35% for those accustomed to anaerobic activity. **(Billat, 2001)**
- The 15/15 interval training aims to develop aerobic capacity (CA) **(Billat, 2001)**
- The 10/10 interval consists of neuromuscular non-aerobic work aimed at improving non-lactic anaerobic power, while also developing aerobic capacity.
- The 10/20 interval involves neuromuscular work that helps develop both non-lactic anaerobic capacity and aerobic capacity **(Billat, 2001)**.

2. 5 Physical Tests Used:

- Maximum Airspeed Test (VMA)

The Leger test was used, where the subject runs between two points spaced 20 meters apart (out and back).

They start at one point and, upon a sound signal, run to the opposite point, then reverse direction and return to the starting point, and so on.

The subject stops running when they can no longer maintain the required pace.

Maximum airspeed (VMA) is determined starting from a speed of 8 km/h and is not levelled with warm-up **(Leger et Coll. 1985)**.

- Vertical Jump Test (Bosco, 1982)

Enhancements to the basic vertical jump tests include incorporating all relevant data and criteria controlling the jump.

- Squat Jump Test (SJ)

Measures dry vertical jump without the use of a plyometric platform, without stretching, and without preparation to develop greater force explosively in a short time.

The subject starts from a knee bend position (90° angle at the knee joint) to push upward, with hands placed on the hips to avoid involving the arms in the push.

"This test measures the ability to launch from a standstill."(Markovic et al., 2004)

- Counter Movement Jump Test (CMJ)

This test measures the ability to develop maximum force over a longer period, and the pre-compression phase allows for energy production time.

The subject has the freedom to bend their legs to push upward while placing hands on the hip area.(Markovic et al., 2004)

- Maximum Oxygen Consumption Test (VO2max):

This indicator is one of the most important in physiology and sports medicine for measuring oxygen capacity, as muscles cannot continue muscular work without oxygen.(Bassett & Howley, 2000)

Cooper Test:

One of the most common tests, used by Cooper on thousands of American soldiers to assess their fitness level.

This test aims to monitor the general endurance of the athlete or aerobic fitness, serving as an indicator of functional status and efficiency of the respiratory and circulatory systems.

This test involves running a distance for 12 minutes, with the distance measured in meters. VO2max can be calculated using the following equation:(Cooper, 1968)

$$vo2 \text{ max} = \frac{d12 - 505}{45}$$

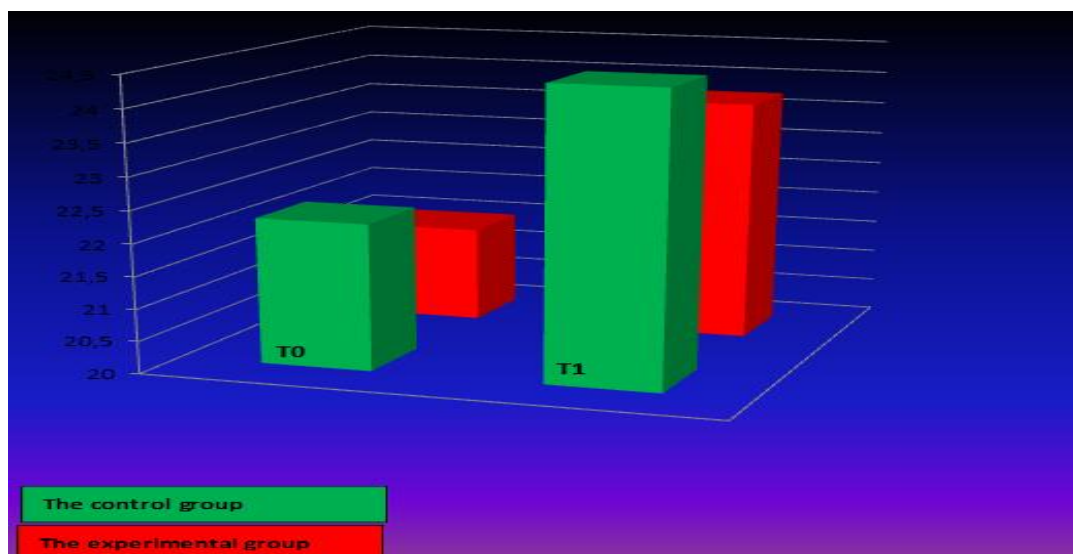
III. Résultats

3.1 Maximum Airspeed (VMA)

To determine the superiority of the proposed training program over the regular program, the researcher decided to use the T.TEST for independent samples. The results are as shown in the following table:

Table N°2: Results of (VMA) in the Post-Test.

Sample Test Results	N	Value Mean	Deviation Mean Value	T		Statistical Significance
				calculated	Tabulated	
control group	8	03,74	00,26	05,73	1,76	significant
experimental group	8	04,12	00,18	Sig:0,00		



Graph (1): Represents the statistical differences in the pre-test and post-test for selecting the maximum aerobic speed (VMA).

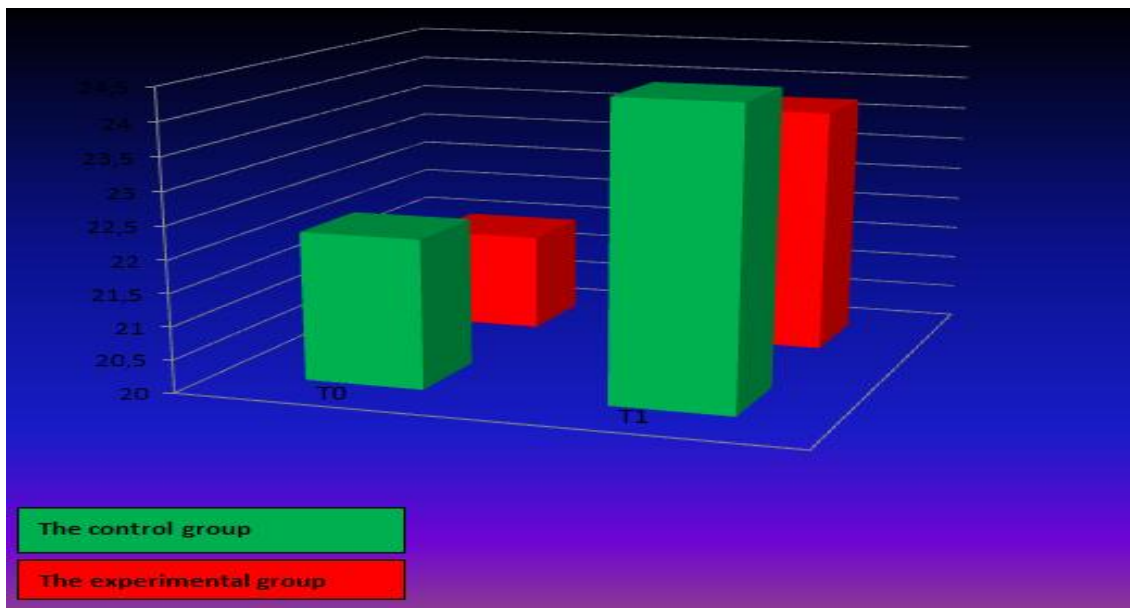
Table (2) and Figure (1) illustrate the superiority of the proposed training program, where we find that the mean for the control groups was 3.47 with a standard deviation of 0.26, compared to the experimental group whose mean was 4.18 with a standard deviation of 0.18. Additionally, the calculated t-value of 5.73 exceeds the tabulated t-value of 1.76 at 14 degrees of freedom and a significance level of 0.05.

There are statistically significant differences in favor of the proposed training program over the regular program.

3.2 The Counter Movement Jump test (C.M.J)

Table N°3: presents the results of the Counter Movement Jump (C.M.J) test in the post-test.

Sample Test Results	N	Value Mean	Deviation Mean Value	T		Statistical Significance
				calculated	Tabulated	
control group	8	21,26	00,70	07,80	1,76	significant
experimental group	8	23,74	00,55	Sig:0,00		



Graph (2): Represents the statistical differences in the pre-test and post-test for (CMJ)

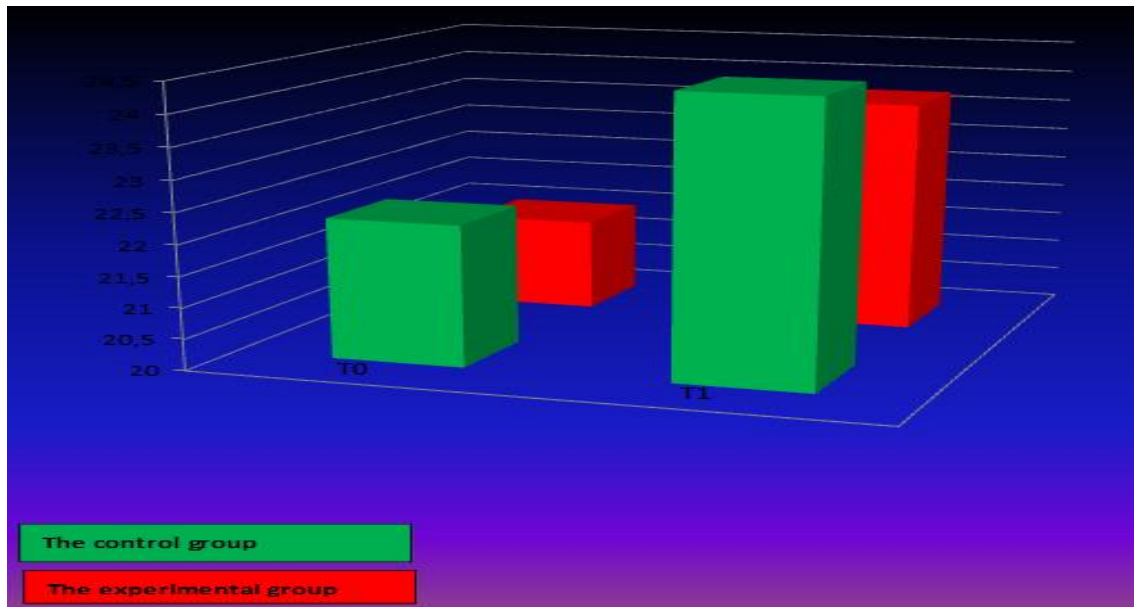
The table number (3) and graph number (2) illustrate the superiority of the proposed training program, where we find that the mean for the control group was 21.26 with a standard deviation of 0.70, compared to the experimental group whose mean was 23.74 with a standard deviation of 0.55. Additionally, the calculated t-value was 7.80, significantly higher than the tabulated t-value (1.76) at 14 degrees of freedom and a significance level of 0.05. The Sig value is indicated as 0.00, which is less than 0.05.

There are statistically significant differences in favor of the proposed training program, indicating its superiority over the regular program.

3.3 The Squat Jump Test (SJ)

Table N°4: Results of the (SJ) test in the subsequent test.

Sample Test Results	N	Value Mean	Deviation Mean Value	T		Statistical Significance
				calculated	Tabulated	
control group	8	22,22	01,49	07,80	1,76	significant
experimental group	8	24,45	00,96	Sig:0,03		



Graph (3): Represents the statistical differences in the pre-test and post-test for (SJ)

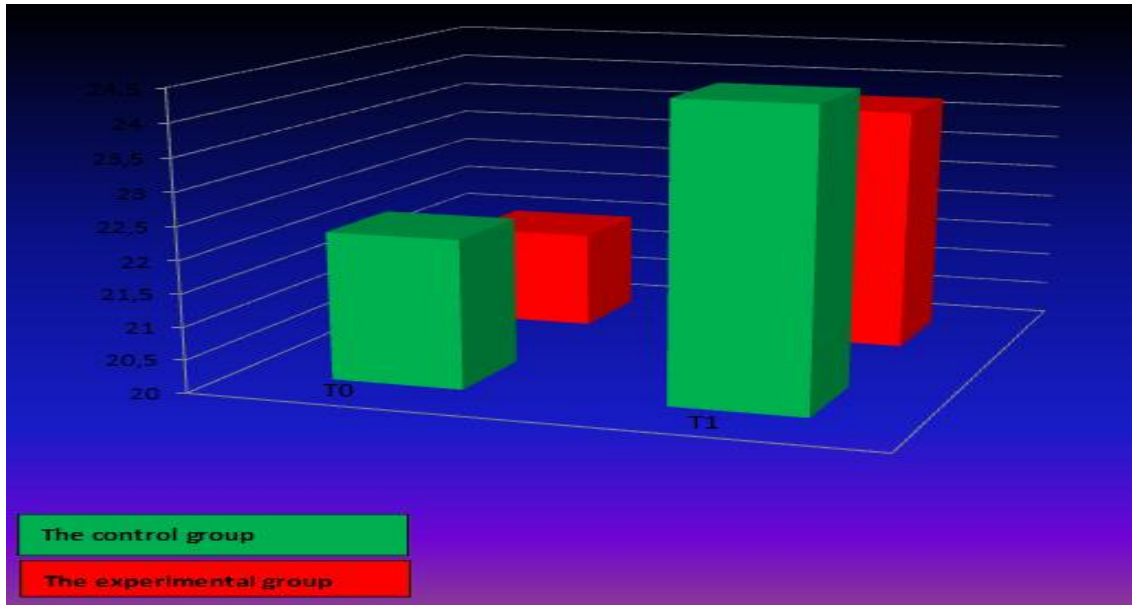
The table number (4) and the chart number (3) illustrate the superiority of the proposed training program's impact. We find that the mean for the control group was 22.22 with a standard deviation of 1.49, compared to the experimental group whose mean was 24.45 with a standard deviation of 0.96. Additionally, the calculated t-value of 3.54 is greater than the tabulated t-value of 1.76 at 14 degrees of freedom and a significance level of 0.05. Moreover, the Sig value recorded a value of 0.03, which is less than 0.05.

There are statistically significant differences in favor of the proposed training program over the regular program.

3.4 Maximum Oxygen Consumption Test (VO2max):

Table N°5: results of VO2 max in the post-test.

Sample Test Results	N	Value Mean	Deviation Mean Value	T		Statistical Significance
				calculated	Tabulated	
control group	8	41,00	01,74	08,98	1,76	significant
Experimental group	8	50,84	02,56	Sig:0,00		



Graph (4): Represents the statistical differences in the pre-test and post-test for (VO₂max)

The table number (5) and figure number (4) demonstrate the superiority of the proposed training program, where we find that the control group had an average score of 41.00 with a standard deviation of 1.74, compared to the experimental group which had an average score of 50.84 with a standard deviation of 2.56.

Furthermore, the calculated t-value of 8.98 is greater than the tabulated t-value of 1.76 at degrees of freedom 14 and significance level 0.05. Additionally, the significance value (sig) is equal to 0.00, which is less than 0.05.

There are statistically significant differences in favor of the proposed training program over the regular program.

IV. Discussion

Through the analysis of the experimental test results within the framework of intermittent training, and through the domains (15/15), (10/10), (20/10), we can identify the impact of this training on the variable components of explosiveness among volleyball players. Additionally, calculating the effects associated with explosiveness, which are particularly important for the development of high-level volleyball players, led us to the following results: (Buchheit & Laursen, 2013)

• Vo₂ Max Test:

Statistical analysis showed a significant improvement in the experimental group's level, estimated at 9.84 ml/kg/min. This indicates the effectiveness of the proposed training program in building the quantitative (aerobic) property for volleyball players. These results also interpret the constructive impact of the training program on the physiological aspects of volleyball players by developing physical quantitative characteristics clearly.

• VMA Test:

The statistical analysis of the Leger test results, which measures maximum aerobic speed, clearly demonstrates the positive impact of the proposed training program on developing maximum aerobic speed (VMA). Significant statistical differences were observed between the experimental and control groups, with an average difference of 0.38 m/s, indicating the program's effect in developing both quantitative and qualitative dual properties through the physiological adaptation induced by intermittent training on volleyball players.

• **S.J Test:**

Statistical analysis showed a significant improvement of 2.23 centimeters in the experimental group, indicating the superiority of the proposed training program in achieving greater improvement in vertical jump height from a standing position for volleyball players.

• **C.M.J Test:**

The development estimated at 2.48 centimeters through statistical analysis indicates significant improvement in leg strength endurance, which can be attributed to the explosive leg power over a long period. This property is crucial for volleyball players, highlighting the effectiveness of the proposed training program.

- **Interpretation of the results**

▪ **Interpretation of the results of the (V2O MAX) and Maximum Aerobic Speed (VMA) tests:**

The sport of volleyball requires significant aerobic endurance, as evidenced by the statistically significant improvement in the experimental group between the pre-test and post-test in the Leger and Cooper tests, indicating physiological adaptation induced by intermittent training. This led to greater development of aerobic (quantitative) physical attributes compared to conventional training methods.

▪ **Interpretation of the Vertical Jump Test (S.J_CMJ):**

The results of the vertical jump tests (S.J_CMJ) can be attributed to the plyometric training within our proposed intermittent training program. These exercises contributed to:

- Creating a physiological (neuromuscular) adaptation that facilitates energy storage, providing energy conservation for volleyball players, whether the work is quantitative or qualitative.
- Introducing performance improvement through plyometric training.
- Increasing explosive power by enhancing leg muscle strength.
- Increasing contraction speed resulting from plyometric exercises, thereby boosting leg explosive power.
- Plyometric exercises reduce speed generated by dynamic force, transitioning muscles from relaxation to high-speed contraction.
- Plyometric work facilitates faster relaxation compared to regular exercises. **(Chu, 1998)**

From a physiological perspective, short-duration intermittent training allows integration of oxidative fibers within the muscle, resulting in good recovery in both quantitative and qualitative activities.

In conclusion, through the analysis of test results, it can be concluded that fundamental physical attributes in volleyball, including both quantitative and qualitative traits under the umbrella of endurance and explosive strength, were developed through the proposed intermittent training program, this development was based on physiological principles.

(Buchheit & Laursen, 2013)

Recommendations:

Based on the theoretical study and the results obtained from the physical test battery used after implementing the proposed training program, we suggest the following recommendations:

- The training program should be explained to the athletes beforehand, prior to its implementation.
- Both the quantity and quality of performance can be improved through intermittent training.
- intermittent training using plyometric exercises promotes dual development of physical attributes — both in quantity and quality.
- intermittent training allows for an increase in training load components (intensity, volume, and physical effort density).
- Energy systems should be considered when selecting the training method.
- The athlete's physiological adaptation must be taken into account when applying the training program.
- Adequate rest periods should be respected during the implementation of the training program.
- Intermittent training can lead to balanced development of both white (fast-twitch) and red (slow-twitch) muscle fibers.
- Recovery time between two training sessions must be respected.
- Athletes should be mentally prepared before conducting physical tests.

V. Conclusion

The researcher in this study started from a theoretical background represented by the data of Hoald, which relates to the logic of muscle fibers. The researcher raised the question of the possibility of developing volleyball players with distinctive qualitative physical characteristics from training programs adopted by our clubs, which are primarily based on quantitative work. The researcher considered this impossible as it represents a physiological contradiction for the athlete's function.**(Holloszy, 1975)**

Based on this premise, the researcher proposed a training program that aligns with and develops both quantitative and qualitative physical attributes in volleyball players according to specific physiological indicators that take into account the logic of muscle fiber transformation.**(Holloszy & Booth, 1976)**

The results obtained were in line with the study's objectives, which the researcher initiated. These objectives focused on the effectiveness of the proposed training program, which involved intermittent training using plyometric exercises to develop both the basic quantitative and qualitative physical attributes of volleyball players by enhancing endurance and explosive strength.**(Chu, 1998).**

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