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# A Comparison of the Effects of Three Training Methods (Plyometric, Weighted, and Barbell Training) on the Aerobic Capacity of Male Volleyball Players

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## Abstract

**Purpose:** The aim of this research is to compare the effects of three training methods — plyometric, weighted, and barbell (Turkish) training — on the anaerobic capacity of high school male volleyball players. A total of 48 subjects, aged 23 ± 5 years, were selected purposefully and randomly divided into four groups of 12 participants each. **Method:** The height and weight of the participants were recorded, and their anaerobic capacity was measured using the Lewis formula based on the vertical jump test during the pre-test. The three experimental groups performed weight training, plyometric exercises, and plyometric exercises combined with weights, respectively. The fourth group followed a standard volleyball training regimen. The training period lasted eight weeks, with three training sessions per week. After the eight weeks, a post-test was conducted to measure the effects of the different training methods on the participants' anaerobic capacity. **Results:** The results of this study showed: Eight weeks of weight training significantly improved the anaerobic capacity of the volleyball players eight weeks of plyometric training significantly improved the anaerobic capacity of the volleyball players.Eight weeks of barbell (Turkish) training significantly improved the anaerobic capacity of the volleyball players.There was no significant difference between the effects of the three training methods on anaerobic capacity. **Conclusion:** Based on the results of this research, it can be concluded that weight training, plyometric training, and barbell training are all effective in increasing the anaerobic capacity of volleyball players. Given the available time, number of athletes, and resources, any of these training methods can be selected to improve the anaerobic power of athletes. Coaches may choose the most appropriate method depending on the specific needs of their athletes and the resources available.

**Keywords:** plyometric, weighted, barbell, anaerobic power.

## Introduction

The field of sports science has expanded significantly in recent years, with numerous studies contributing to the growth of knowledge in this area. Despite this progress, there are still many unresolved issues that require further research to enhance athletic performance (Azadi, 2022). Sports science researchers and coaches continually strive to discover new methods to improve the physical preparedness and performance of sports teams and individual athletes. This is particularly important for endurance sports, where aerobic capacity (VO2 max), as well as muscle strength and explosive power in anaerobic sports, are critical factors (Edwin, 2020).

To enhance these key performance factors, a comprehensive training plan is essential. Coaches around the world often employ scientifically proven methods in their training programs. In the past, weight training was a common tool among coaches, but with the advancement of sports science and the development of various training programs, including plyometrics, new questions have arisen regarding which methods are most effective for improving sports performance (Ghane, 2014). Volleyball, in particular, is a sport that involves predominantly anaerobic exercises and activities. Therefore, speed, strength, and explosive power are vital components of a volleyball player's skill set. Special attention must be given to power development in volleyball training programs (Lesinski, 2016).

A key question for researchers is which training method is most effective for increasing the anaerobic power of athletes, particularly volleyball players. In this regard, it is important to conduct research to explore and address this question more thoroughly (Lesinski, 2016). Coaching today goes beyond just preparing athletes for competition; coaches must design comprehensive training programs that promote physical fitness. With optimal fitness, athletes are better equipped to meet the physical demands of their sport, which include speed, strength, power, aerobic and anaerobic endurance, flexibility, and agility (Najya, 2022). Without proper preparation, the risk of injury and poor performance increases significantly.

Successful coaches have learned through experience that if they want to improve the quality of an athlete’s skills, they must develop personalized training programs for each individual (Shallaby, 2010). In other words, training programs must be tailored to the specific sport and the athlete’s role within that sport. This includes focusing on key energy systems, movement patterns, and muscle groups that are essential for improving strength, endurance, and skill performance. For instance, a training program should include exercises that not only strengthen the muscle groups involved but also stimulate the movement patterns that are frequently used during the execution of specific skills (Babai Mazreno, 2013).

With the continuous advancement of sports science, which has been driven by valuable research and the experiences of researchers, there is an increasing need to re-evaluate training methods. Understanding the factors that influence elite sports performance, as well as athletes' physical abilities and the coaching methods used in different countries, is now more critical than ever (Wasim, 2020). By utilizing the findings of scientific research, it is possible to achieve significant progress and growth in both national and international sports. Moreover, conducting research plays a pivotal role in solving performance-related issues, as researchers seek to identify problems and find appropriate solutions (Rastegar, 2016).

Many coaches believe that the lack of proper strength and power training, as well as insufficient facilities, hinders the performance of their athletes (Sharifi, 2014). Therefore, conducting research that sheds light on the effects of various training methods, particularly plyometric and weight training, on the explosive power of athletes, especially volleyball players, is of great importance. Lower body strength and explosive power are essential for the execution of many volleyball movements, and recognizing the factors that contribute to success in these areas is crucial for both athletes and coaches (Najya, 2022).

Previous research has explored the effects of plyometric and weight training on the anaerobic and explosive power of athletes (Richard, 2019). However, few studies have directly compared these two training methods, particularly in the context of volleyball. By comparing these methods, it is possible to provide coaches with a more effective training regimen that can maximize results in less time and with fewer resources. Given the advancements in sports science and the growing interest in athletic performance, further research in this area is both necessary and timely.
In conclusion, there is a lack of sufficient descriptive and analytical research comparing the effects of plyometric exercises and weight training on the anaerobic and explosive power of volleyball players. The need to understand which exercise method has the greatest impact on enhancing anaerobic power makes this research essential. The purpose of this study is to evaluate the effects of three training methods — plyometric training, weight training, and aerobic training — on the aerobic capacity of volleyball players. The findings will be valuable for coaches and athletes in guiding their training choices.

## Methods

The present research examines the effect of two specific training programs (plyometrics and weight training) on the aerobic capacity of male volleyball players in Jiroft city. The study involved participants divided into experimental and control groups, with pre-tests and post-tests conducted to measure the outcomes. The research was designed as a semi-experimental study and implemented in a field setting.

## Participants and Sampling:

The statistical population consisted of 110 high school volleyball players in Jiroft city. From this group, 48 players were randomly selected and further divided into four groups of 12 participants each. The groups consisted of defenders selected randomly from the aforementioned population. The participants' height, weight, and vertical jump were measured in the pre-test phase.

**Variables:**

- **Independent Variables:**
  - Weight training
  - Plyometric exercises
  - A combination of weight training and plyometrics

- **Dependent Variable:**
  - Anaerobic capacity

**Measurement Tools:**

1. **Tape measure**: To record the height of participants.
2. **Scale**: To measure participants' weight (Soehle, made in Germany).
3. **Rubber obstacles**: For performing plyometric exercises.
4. **Scaled board**: To measure vertical jump height.
5. **Powder**: To mark the highest point reached during the jump.
6. **Jump box**: For performing plyometric exercises.
7. **Lewis diagram**: To calculate explosive power.
8. **Kasi and Japan calculator**: For data calculations.
9. **Bodybuilding equipment**: Weights and barbells for strength exercises.

**Procedure:**

To measure the dependent variable (lower body explosive power), the vertical jump test was used. This test was administered in both the pre-test and post-test stages to determine the effect of the training programs.

- **Vertical Jump Test (Sargent Method)**: The height of each participant was measured while standing, and then the participants were asked to jump as high as possible. The height difference between the standing reach and the jump height was recorded. The test was repeated three times for each participant, and the average was calculated.

- **Anaerobic Power Measurement**: Using the Lewis nomogram, anaerobic power was calculated by connecting the participant's weight in the right column to the jump height in the left column of the nomogram.

**Research Setting and Duration:**

This research was conducted in Jiroft city, with the physical tests carried out at the sports department of Islamic Azad University. The training program lasted 8 weeks, with three training sessions per week. Each session lasted 50 minutes and followed this structure:

1. **5 minutes of warm-up**
2. **10 minutes of stretching exercises**
3. **30 minutes of plyometric or weight training**
4. **5 minutes of cool down**

**Training Programs:**

**Weight Training Program:** Participants in the weight training group trained three days a week, with one rest day between sessions. The program included five selected exercises performed in three sets of 10 repetitions. During the first week, participants used 50% of their maximum load in the first set, 75% in the second set, and 100% in the third set. As participants progressed, the weight increased accordingly. The five weight training exercises were as follows:

1. Squats
2. Heel raises with weights
3. Step-ups with a barbell (onto a 40 cm box)
4. Leg press
5. Front step-ups with a barbell (onto a 40 cm box)

**Plyometric Training Program:** The plyometric group also trained three days a week with one rest day between sessions. The program started with simple plyometric exercises, and as participants progressed, the difficulty, sets, and repetitions increased. Plyometric exercises included:

1. Jump squats onto boxes
2. Depth jumps
3. Box jumps (90 seconds each)
4. Split squat jumps (one foot forward, one foot back)
5. Ring jumps

In the initial weeks, exercises were performed in two sets of eight repetitions. By the eighth week, participants completed four sets of 12 repetitions per exercise.

**Combination (Barbell/Turkish) Training Program:** This group followed a combination of weight training and plyometric exercises, alternating between the two each session. The combination program was conducted three times per week.

**Results**

The analysis of the data from this research was conducted at two levels:

**descriptive statistics** and **inferential statistics**.

At the descriptive statistics level, statistical indicators such as the mean, standard deviation, and range (minimum and maximum values) were used to present the dispersion of the results. In order to test the research hypotheses, correlation analysis was employed, along with Tukey's test for inferential statistics to compare group means and identify significant differences.
For each of the structural and physiological characteristics of the experimental and control groups, the following statistical indices were

calculated: mean, standard deviation, range of dispersion, and the maximum and minimum records.

**Table 1: Comparison of the Average Pre-Test Aerobic Power Scores in the First Experimental Group (Weight Training Exercises)**

| Variables | Average | St andard deviation | difference of means | degrees of freedom | T is calculated | Significance |
|---|---|---|---|---|---|---|
| Anaerobic capacity before the test | 11.41 | 11.46 | 10.92 | 11 | 9.82 | 0.000 |
| Anaerobic power after us | 122.33 | 12.08 | | | | |

**Table 1** provides a summary of the results from the analysis and statistical comparison of the three aerobic powers measured in the pre-test and post-test of the first experimental group. Based on the results presented in the table, it is evident that the observed t-value is greater than the critical value at the 1% error level. Therefore, the observed difference is statistically significant.

In other words, the mean score after the strength test is significantly higher than the pre-test score, indicating that weight training has a considerable positive effect on the anaerobic power of volleyball players.

**Table 2: Comparison of the Average Pre-Test Anaerobic Power Score for the First Experimental Group (Plyometric Exercises)**

| Variables | average | standard deviation | difference of means | degrees of freedom | T is calculated | Significance |
|---|---|---|---|---|---|---|
| Anaerobic capacity before the test | 109.3 | 7.40 | 11.2 | 11 | 10.12 | 0.000 |
| Anaerobic power after us | 120.50 | 5.21 | | | | |

Referring to the results listed in **Table 2**, it can be observed that the calculated value of 1 is greater than the critical value at the 5% error level. Therefore, the observed difference is statistically significant. In other words, the mean score after the strength test is higher than the pre-test score, indicating that plyometric exercises have a meaningful effect on the anaerobic strength of volleyball players.

**Table 3: Comparison of the Average Pre-Test Anaerobic Power Score for the First Experimental Group (Combined Exercises)**

| Variables | average | standard deviation | difference of means | degrees of freedom | T is calculated | Significance |
|---|---|---|---|---|---|---|
| Anaerobic capacity before the test | 109.58 | 6.37 | 12 | 11 | 16.24 | 0.000 |
| Anaerobic power after us | 121.58 | 7.47 | | | | |

Referring to the results listed in **Table 3**, it can be observed that the calculated value of 1 is greater than the critical value at the 5% error level. Therefore, the observed difference is statistically significant. In other words, the mean score after the strength test is higher than the pre-test score, indicating that the combined exercises have a significant effect on the anaerobic strength of volleyball players.

**Table 4: Comparison of the Average Anaerobic Power Score Before the Test of the First Experimental Group (Normal Exercises)**

| Variables | average | standard deviation | difference of means | degrees of freedom | T is calculated | Significance |
|---|---|---|---|---|---|---|
| Anaerobic capacity before the test | 105.0 | 4.82 | 2.75 | 11 | 5.74 | 0.000 |
| Anaerobic power after us | 107.75 | 5.41 | | | | |

Based on the results listed in **Table 4**, it can be observed that the calculated value is greater than the critical value at the 5% error level. Therefore, the observed difference is statistically significant. In other words, the average score after the power test is higher than the pre-test, indicating that regular volleyball exercises have a significant effect on the anaerobic power of volleyball players.

**Table 5: Comparison of the Three Mean Difference Scores of Post-Test and Pre-Test of High Jump in Situ (Study Groups)**

| Variables | mean | standard deviation |
|---|---|---|
| Group 1 | 10.91 | 3.84 |
| Group 2 | 11.16 | 3.78 |
| Group 3 | 12 | 2.55 |
| Group 4 | 2.57 | 1.66 |

**ANOVA Results**

<table>
<tr><th>Source of changes</th><th>sum of squares</th><th>degrees of freedom</th><th>mean square</th><th>F</th><th>Significance (p-value)</th></tr>
<tr><td>between groups</td><td>675.08</td><td>3</td><td>225.02</td><td rowspan="3">33.41</td><td rowspan="3">0.000</td></tr>
<tr><td>within the group</td><td>422.83</td><td>44</td><td>9.61</td></tr>
<tr><td>the whole</td><td>1097.91</td><td>47</td><td></td></tr>
</table>

Referring to **Table 5**, the observed F-value is greater than the critical value at the 5% error level, indicating that the observed difference between the mean anaerobic power scores of the experimental groups and the control group is statistically significant. However, the difference between the mean anaerobic power scores of the three experimental groups (1, 2, and 3) is not statistically significant. Tukey's test has shown a significant difference in anaerobic power scores between the control group and the experimental groups.

## Discussion

In this section, the results presented earlier are analyzed and compared with other relevant research findings. The discussion highlights the effects of different training methods on anaerobic power, and how they relate to the findings of other studies.

### Anaerobic Power:

- **First Experimental Group (Weight Training):**

  The mean height jump in the pre-test was 50.33 cm, which increased to 60 cm in the post-test, with a significant difference of 9.67 cm. Additionally, the average anaerobic power of this group in the pre-test was 41.11 kg-m/s, increasing to 122.33 kg-m/s in the post-test, a difference of 92.92 kg-m/s. This increase was statistically significant, indicating that weight training had a considerable impact on the anaerobic capacity of the athletes. The results of this study are consistent with the findings of Baluchi (2011), Amritsar (2015), and Guimarães (2023), as well as the research of Babaei Mazreno.

- **Second Experimental Group (Plyometric Training):**

  In this group, the mean height jump in the pre-test was 49.74 cm, increasing to 66.60 cm in the post-test, showing a significant difference of 25.11 cm. The average anaerobic capacity also increased from 33.11 kg-m/s in the pre-test to 120.50 kg-m/s in the post-test, with a significant difference of 11.17 kg-m/s. These results indicate that plyometric exercises had a significant impact on anaerobic capacity. The findings align with previous studies, confirming the positive effect of plyometric training on anaerobic performance.

- **Third Experimental Group (Combined Plyometric and Weight Training):**

  The mean height jump in the pre-test was 16.50 cm, which significantly increased to 61 cm in the post-test, a difference of 84.10 cm. Similarly, the anaerobic capacity of this group improved from 58.11 kg-m/s in the pre-test to 121.58 kg-m/s in the post-test, with a statistically significant difference. This demonstrates that a combination of plyometric and weight training had a meaningful effect on the anaerobic capacity of the athletes.

- **Control Group:**

The mean height jump in the control group increased from 48.66 cm in the pre-test to 51 cm in the post-test, with a difference of 2.44 cm. Additionally, the anaerobic power increased slightly from 105 kg-m/s in the pre-test to 107.75 kg-m/s in the post-test, but this increase was lower compared to the three experimental groups. The results of the control group are not consistent with the findings of Paryush Shekarchizadeh's research, likely due to the fact that his study was conducted on elite athletes who were already at peak physical fitness.

## Research Limitations:

1. **Indirect Measurement of Anaerobic Capacity:**
   The anaerobic capacity of the subjects was measured indirectly, which may not provide as precise results as direct measurements. This limitation could affect the accuracy of the findings.

2. **Uncontrolled Psychological and Behavioral Factors:**
   The mental states, stress levels, and behavioral patterns of the subjects were not controlled during the study, which could have influenced their performance and the outcomes of the research.

3. **Uncontrolled Diet and Daily Activity:**

The diet and daily physical activities of the subjects were not monitored or controlled throughout the study, potentially affecting the results, especially in terms of recovery and energy levels.

4. **Dependence on Additional Coaching Support:** Due to the large number of groups and the frequency of training sessions each week, an additional coach was needed to assist with the training. This may have introduced variability in the training delivery.

## Conclusion

The results of this study confirm that all three experimental groups weight training, plyometric training, and combined training experienced significant improvements in anaerobic capacity. The control group also showed an increase, but at a much lower rate. The experimental groups outperformed the control group in both height jump and anaerobic power, indicating that specific training programs have a greater effect on improving these performance metrics. By comparing the final mean differences of the experimental and control groups in the pre-test and post-test, it can be concluded that structured and targeted training programs are more effective in enhancing anaerobic capacity compared to general or unstructured training.

## Conflict of interest

The authors declare that there is no conflict of interest.

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