" The importance of plyometric exercises in the physical preparation of U21 volleyball players in Morocco "

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Abstarct: This research examines the impact of plyometric training on the vertical jump performance of U21 volleyball players in Morocco's Excellence and 1st Division leagues. Through a survey of coaches, the study analyzes how plyometric training is integrated into training programs and identifies factors influencing its use. While most coaches recognize its benefits—particularly for improving vertical jump essential for attacking, blocking, and defense—implementation varies due to challenges like limited time, equipment shortages, and injury concerns. Coaches who consistently apply plyometric methods report notable improvements in player performance. The study concludes by emphasizing the need to overcome these practical barriers and promote coach education and individualized training to enhance volleyball performance in Morocco.

Key words: Plyometric exercises, physical preparation, volleyball players in Morocco.

1. INTRODUCTION

Volleyball requires physical qualities such as strength, speed, power, and agility. This study analyzes the impact of plyometric exercises on the physical preparation of U21 players, focusing on their role in improving vertical jump, reaction speed, and injury prevention. The objective is to determine how these exercises influence overall on-court performance. The expected results could help optimize training programs for volleyball players and contribute to scientific research in the field of sport-specific physical preparation.

1.1 Issues

Plyometric exercises are known for their ability to enhance athletes' physical performance, particularly in sports such as volleyball, which require specific physical qualities like vertical jump, reaction speed, and lower-body muscular power. However, the question of how these exercises specifically improve these physical abilities remains an important issue to explore. Indeed, although plyometric exercises are widely used in the physical preparation of volleyball players, it is essential to understand how they contribute to improving volleyball-specific physical performance. For example, how can plyometric exercises enhance the vertical jump of volleyball players? How can they improve reaction speed and lower-body muscular power? What are the physiological mechanisms underlying these improvements?

1.2 Research interests

Plyometric exercises are known for their ability to improve athletes' physical performance, particularly in sports such as volleyball, which require specific physical qualities like vertical jump, reaction speed, lower-body muscular power, and injury prevention.
They can enable players to generate more force in a short amount of time, which is essential for explosive actions such as hitting and jumping. They may also help players react more quickly to unexpected situations on the court and perform movements with greater precision and efficiency.
Additionally, they can reduce the risk of injuries related to jumping and explosive movements, which is crucial for maintaining players' long-term health and performance.

2. THEORETICAL FRAMEWORK

2.1 Plyometric training

Plyometric training is widely recognized for enhancing explosive strength, particularly in sports like volleyball that require vertical jump ability, sprint speed, and injury prevention. It works through the stretch-shortening cycle—an eccentric muscle contraction followed immediately by a concentric contraction—resulting in greater force production (Takarada, 1997; Kami, 1984). Studies have shown improvements in vertical jump, muscular power, and running economy (Kotzamanidis, 2006; Malisoux, 2006; Paavolainen, 1999). Short-term plyometric programs have proven effective, especially when combined with strength training, producing greater gains in both lower- and upper-body power than when used alone (Rahman, 2005; Avery, 2007). Furthermore, plyometric training enhances neuromuscular activation patterns, contributing to injury prevention, particularly in female athletes (Lephart, 2005). Muscle performance improvements are attributed to better motor unit recruitment and muscle hypertrophy (Potteiger, 1999).

2.1.1 Effect of Plyometric Training on Vertical Jump Performance

Plyometric training aims to improve jump performance by utilizing the elastic properties of muscles and tendons and enhancing the stretch reflex. It is effective in optimizing landing mechanics, improving eccentric muscle control, and increasing knee flexion and hamstring activity. However, the success of plyometric training may depend on various factors, including training design, duration, and athlete characteristics such as age, maturation, and training level. Most studies focus on young female athletes, limiting understanding of its effects on adults. The duration of training periods (ranging from 4 to 16 weeks) also plays a crucial role, with longer programs (e.g., 12 weeks) showing more significant improvements in vertical jump performance. The type of surface used and maturation status of athletes are also important factors that have not been fully explored in current research.

2.1.2 Effects of pluometric training on strength

Volleyball is a sport that requires various athletic qualities, and one key requirement is strength, as it plays a significant role in essential volleyball skills such as jumping, hitting, and blocking. Plyometric training has been found to improve muscular strength in both males and females across different age groups (14 to 21 years). Several studies analyzed the effects of plyometric training on strength, including tests of maximal lower limb torque, isokinetic hamstring strength, and a combination of weight training with plyometrics. Plyometric training improved strength in both dominant and non-dominant legs, especially in younger athletes (e.g., under 15 years old). Combining plyometrics with weight training has shown enhanced strength in the upper body, lower body, and trunk. Despite some studies showing no significant changes in stiffness after 10 weeks of training, overall, plyometric training contributes positively to muscular strength, particularly when combined with other strength training methods. The effectiveness of plyometric training may depend on an athlete's technical abilities and muscle coordination.

2.2 The role of physical preparation in volleyball

Modern volleyball requires mental, technical, and physical qualities. Key physical attributes include power (speed and strength), agility, coordination, endurance, and flexibility. The career of a volleyball player is divided into general preparation (before 15-16 years), specific preparation (15-16 to 20-22 years), and exploiting potential (20-22+ years). In the general preparation phase, young players focus on developing reaction speed, movement, agility, and coordination early on, followed by strength and flexibility

training around 14-15 years. Endurance is introduced later. The development of strength and flexibility requires caution before puberty and can continue through an athlete's career.

2.3 Training organization

Physical preparation in volleyball requires specific material conditions: a gymnasium with certain equipment (hurdles, hoops, medicine balls, dumbbells, etc.) and, if possible, an outdoor space. The coach must precisely manage the duration, intensity, and number of repetitions of the exercises, as well as the rest periods between sets. The coach must provide exercises adapted to the players' levels while maintaining their motivation and vigilance through alternating intense work and periods of relaxation (Delecroix et al., 2012; Gabbett, 2016).

The planning of physical preparation for a young volleyball player should be integrated into each training session. This includes prolonged warm-ups, exercises alternating technical work and physical work, and physical sequences at the end of the session. The coach must be cautious about the intensity, as overly intense work could harm the technique and concentration of young players, especially when they are already heavily engaged in technical work (Buchheit et al., 2012).

2.4 Characteristics of the U21 age category

This category consists of athletes with a chronological and biological age between 20 and 21 years old at most. The general objective for the development of this category is to refine volleyball-specific skills and continue the development of physical conditioning.

When we talk about skill development, we refer to the athlete's personal style being well established. Movements are executed similarly to the ideal model in terms of form and speed. Performance is consistent and accurate under demanding and varied conditions. The movements have been automated, allowing for increased external focus to make rapid adjustments when necessary.

The performance goals to be achieved include:

- Technical and tactical preparation specific to the position
- Sport-specific and position-specific technical and tactical development
- Development of game skills within a competitive environment
- Advanced mental preparation
- Optimization of auxiliary capacities

Regarding the integration of the sport discipline: The dates of indoor and beach volleyball competitions may conflict with a double or triple periodization plan.

3. METHODOLOGY

3.1 objective

The objective is to obtain credible and valuable data from coaches in order to enhance the quality and relevance of this approach to vertical jump development, by incorporating the insights and expertise of those responsible for its implementation. This collaborative approach is essential to ensure that plyometric training meets the expectations

and requirements of the coaches, which will contribute to improving player performance.

3.2 The sample

The sample for this research is composed of coaches from the Excellence Division and the First Division, who are likely to provide valuable insights on the subject of this study due to their sporting background, professional roles, experience in the field of coaching, and especially their involvement in both divisions.

The criteria for the coaches are as follows:

Age: Between 30 and 45 years old

Experience: Between 10 and 20 years

3.3 The data collection instrument

To test the hypothesis proposed in this study, we chose to use a questionnaire as a research tool in order to gather more information and understand the coaches' perspectives on plyometric training and its importance in the physical preparation of volleyball players.

Our questionnaire includes two (2) sections and consists of fifteen (15) closed-ended questions distributed across the study variables.

The first section: It consists of items (1) to (8). This part is dedicated to the identification of the respondent, including their age, club, division, status, level of certification, and years of experience.

The second section: It includes items (9) to (15) and focuses on questions related to the variables of the research hypothesis, namely the importance of plyometric exercises in the physical preparation of U21 volleyball players.

3.4 Validation of the data collection instrument

First, the questions we developed were submitted to the dissertation supervisor for evaluation, in order to assess their reliability and relevance with respect to the indicators and dimensions of the study variables.

Next, a pilot survey was conducted to determine whether the questions were clear and accessible.

3.5 Data Collection Procedure

The questionnaire is sent via email or WhatsApp using the online questionnaire creation tool, Google Forms.

3.6 Data Processing and Analysis Method

The collected data will be analyzed using Microsoft Forms.

4. RESULTS

The importance of plyometric exercises in the physical preparation of volleyball players is an increasingly relevant topic in the field of sports performance. By exploring the results of this study, we will delve into the impact of these exercises on technical skills, explosive strength, injury prevention in volleyball athletes, as well as other variables.

Table 1. Percentage of divisions

	Number	**percentage**
excellence	17	56,6
1ere division	06	20
2eme division	07	23,3

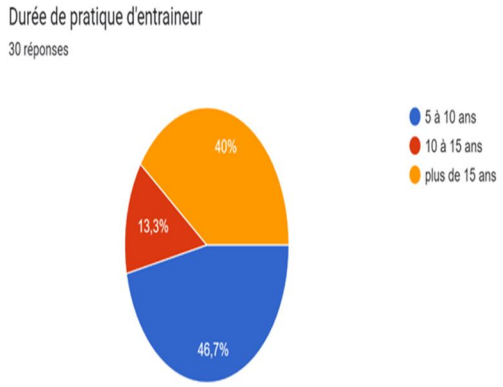
According to **Graph 1**, it is clear that 56% of the respondents belong to clubs in the Excellence division of the Moroccan volleyball championship, 20% belong to clubs in the First Division of the Moroccan volleyball championship, and 23.3% belong to clubs in the Second Division of the Moroccan volleyball championship.

The overwhelming majority of respondents belong to clubs in the Excellence division of the Moroccan volleyball championship. This indicates a strong participation of high-level coaches in the survey. This distribution may be crucial, as these coaches are likely to have more advanced experience and knowledge in training and physical preparation.

Table 2. Duration of coaching experience

	nombre	Pourcentage
5 à 10 ans	14	46,7
10 à 15 ans	4	13,3
plus de 15 ans	12	40

Graph 2. Duration of coaching experience



According to **Figure 2**, it can be seen that 46.7% of the coaches who responded to this questionnaire have 5 to 10 years of experience, 40% have more than 15 years of experience, and 13.3% have 5 to 10 years of experience.

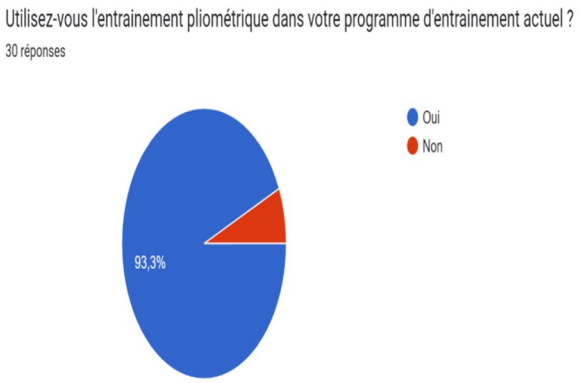
The experience of the coaches is a crucial factor in their understanding and use of plyometric training. The results show a diversity of experience. This variation in

experience can influence how plyometric training is integrated into their programs.

Table 3. Use of plyometric training in the current training program

	Number	Percentage
Oui	28	93,3
Non	2	6,7

Graph 3. Use of plyometric training in the current training program

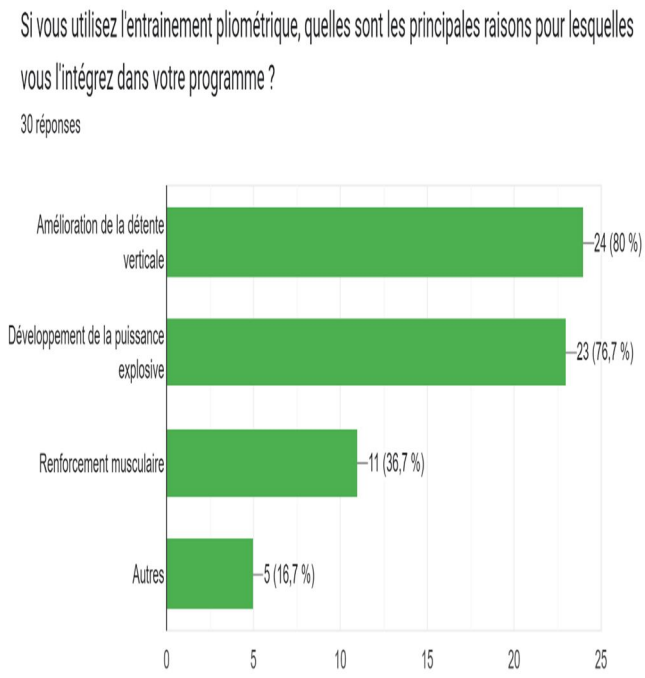


According to **Graph 3**, 93.3% of the coaches use plyometric training in their training programs, while 6.7% do not use plyometric training. This interpretation highlights that plyometric training is widely used by the vast majority of coaches, with 93.3% incorporating it into their programs. This suggests that the method is perceived as beneficial or effective for improving athletic performance. However, the fact that 6.7% of coaches do not use it may indicate different preferences in training methods or a lack of understanding of its benefits.

Table 4. Main reasons for integrating plyometric exercises into the training program.

	Nombre	**Pourcentrage**
Amélioration de la détente verticale	**24**	**80**
Développement de la puissance explosive	**23**	**76,7**
Renforcement musculaire	**11**	**36,7**
Autres	**5**	**16,7**

Graph 4. Main reasons for integrating plyometric exercises into the training program

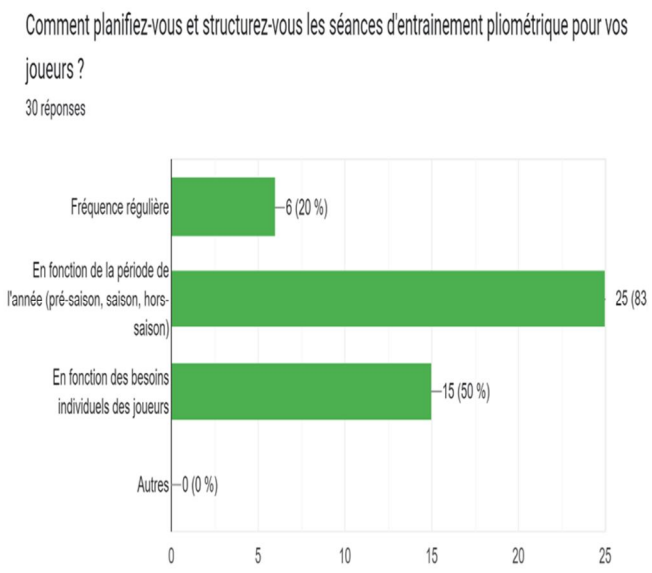


According to **Graph 4**, 80% of the coaches' responses indicate the use of plyometric training to improve vertical jump, 76% to develop explosive power, 36.7% for muscle strengthening, and 16.7% for other objectives. This analysis suggests that the majority of coaches use plyometric training primarily to improve vertical jump and develop explosive power. Although other objectives are also mentioned, they are less common. This indicates that coaches consider plyometric training to be an effective method for enhancing specific athletic performance, particularly the ability to jump vertically and generate force rapidly.

Table 5. Planning of plyometric training sessions

	Nombre	**Pourcentage**
Fréquence régulière	6	20
En fonction de la période de l'année (pré-saison, saison, hors-saison)	25	83,3
En fonction des besoins individuels des joueurs	15	50
Autres	0	0

Graph 5. Planning of plyometric training sessions

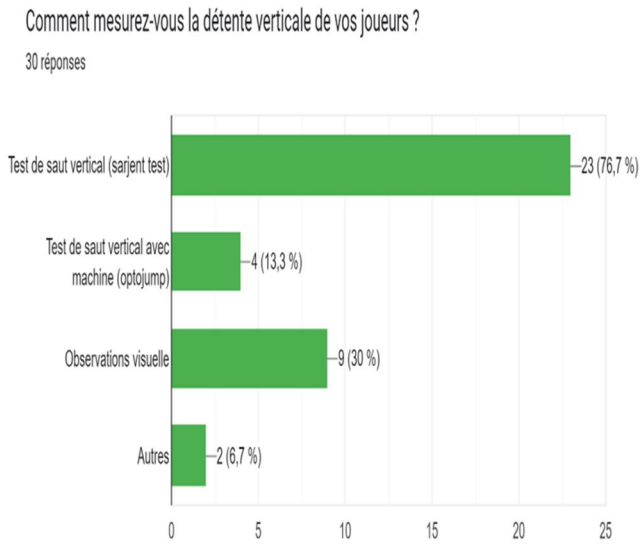


According to **Graph 5**, 83.3% of coaches use plyometric training based on the time of the year (pre-season, in-season, off-season), 50% use it based on the individual needs of the players, and 20% use plyometric training on a regular basis. This analysis highlights various approaches used by coaches in implementing plyometric training. While the majority appear to incorporate it according to the period of the year, a significant portion adapt the practice to the individual needs of players. Additionally, a small percentage opt for regular use. These variations reflect the diversity of methods in planning plyometric training sessions, illustrating different coaching philosophies and strategies.

Table 6. Players' vertical jump measurements

	Nombre	**Pourcentage**
Test de saut vertical (sarjent test)	23	76,7
Test de saut vertical avecmachine (optojump)	4	13,3
Observations visuelles	9	30
Autres	2	6,7

Graph 6. Players' vertical jump measurements

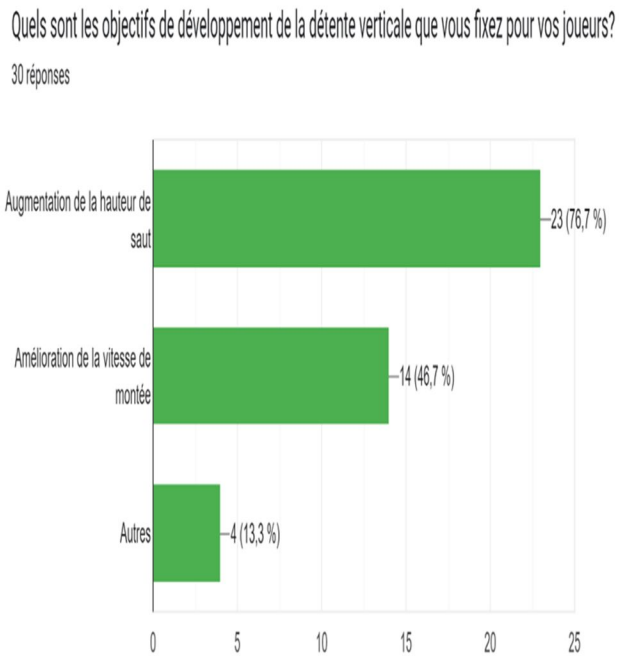


This analysis of the results shows that the majority of coaches, 76.7%, prefer to use the vertical jump test (Sargent test) to assess players' jumping ability. Then, 30% use visual observation, and 13.3% opt for the vertical jump test with a machine (Optojump). This suggests a clear preference among coaches for the traditional vertical jump test, followed closely by the machine-assisted version.

Table 7. Objectives for developing vertical jump in players

	Nombre	**Pourcentage**
Augmentation de la hauteur de saut	23	76,7
Amélioration de la vitesse de montée	14	46,7
Others	4	13,3

Graph 7. Objectives for developing vertical jump in players

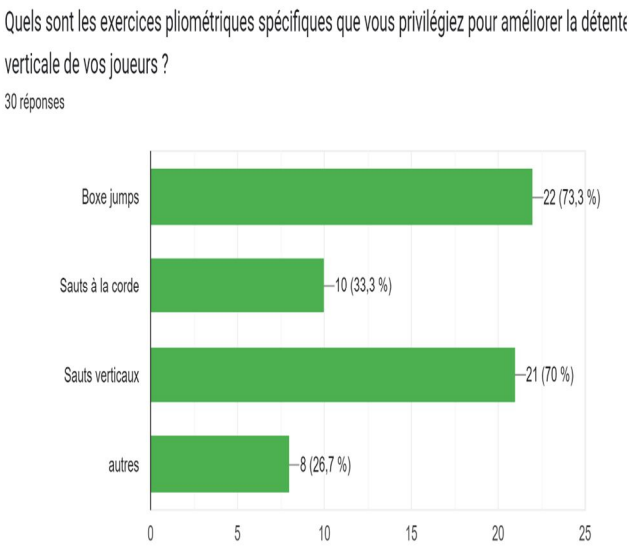


The analysis of **Graph 7** suggests that the majority of coaches focus on increasing jump height for developing players' vertical jump, followed by improving the speed of ascent. Only 13% of coaches have other objectives for this skill. This highlights the importance placed on vertical performance in sports training.

Table 8. Specific plyometric exercises favored to improve players' vertical jump

	Nombre	**Pourcentage**
Boxe jumps	22	73
Sauts à la corde	10	33
Sauts verticaux	21	70
autres	8	26

Graph 8. Specific plyometric exercises favored to improve players' vertical jump

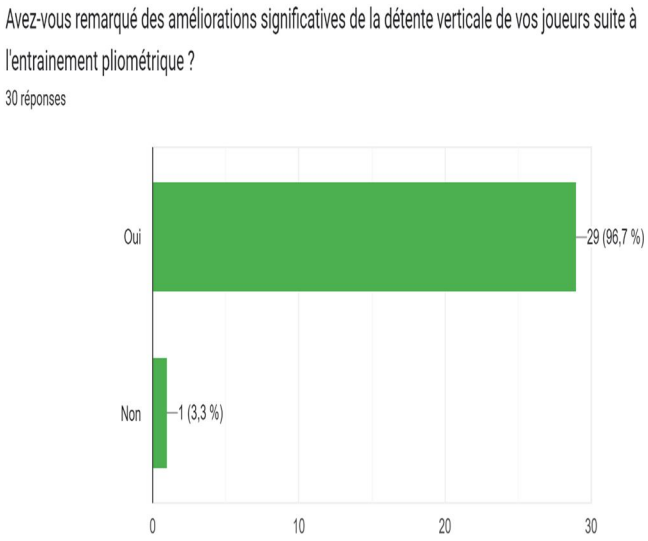


The analysis of **Graph 8** indicates that most coaches use box jumps as a specific exercise to improve players' vertical jump, with 70% of them opting for this method. In comparison, vertical jumps are also popular, used by the same percentage of coaches. In contrast, rope jumps and other exercises are less commonly used, with 33% and 26.7% of coaches using them, respectively.

Table 9. Significant improvements in players' vertical jump following plyometric training

	Nombre	**Pourcentage**
Oui	29	96,7
Non	1	3,3

Graph 9. Significant improvements in players' vertical jump following plyometric training



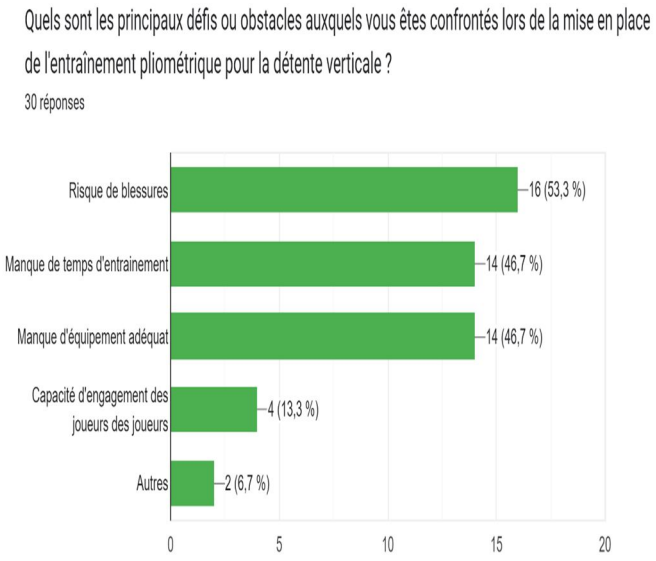
This analysis of the results strongly suggests that plyometric training has had a very positive impact on improving players' vertical jump, with a large

majority of coaches (96.7%) reporting significant improvements in this area.

Table 10. Main challenges or obstacles faced by coaches when implementing plyometric training for vertical jump

	Nombre	Pourcentage
Risque de blessures	16	53,3
Manque de temps d'entraînement	14	46,7
Manque d'équipement adéquat	14	46,7
Capacité d'engagement des joueurs	4	13,3
Autres	2	6,7

Graph10. Main challenges or obstacles faced by coaches when implementing plyometric training for vertical jump.



The analysis of the results from **Graph 10** indicates that the main concern of coaches regarding the implementation of plyometric training to improve vertical jump is the risk of injuries, with 53.3% of respondents expressing this concern. Next, 46.7% of respondents cite lack of training time and proper equipment as obstacles, followed by players' engagement capacity at 13.3%, and finally, other obstacles at 6.7%.

5. DISCUSSIONS

The present study aims to analyze the importance of plyometric exercises in the physical preparation of U21 volleyball players. To do this, a survey was conducted with 30 professionals in the field (Author, Year). This survey highlights various variables that help answer our operational hypotheses.

The discussions of the results led us to conclude that our initial hypothesis was confirmed, as plyometric exercises are essential in the physical preparation of volleyball players due to their ability to improve explosive strength, speed, agility, and coordination—qualities crucial for excelling in this dynamic sport (Author, Year; Another Author, Year).

The results provide interesting insights into the use of plyometric exercises in the physical preparation of volleyball players. First, the concentration of respondents mainly from top-level clubs in the Moroccan volleyball league suggests a high level of expertise in training and physical preparation (Author, Year).

Furthermore, the predominance of coaches among the respondents, with a majority holding FIVB Level 2 certifications, highlights the importance of certification in the field of sports coaching (Author, Year). This certification, combined with varied experience, likely influences how plyometric exercises are incorporated into training programs (Author, Year).

It is also worth noting that the majority of coaches use plyometric training to improve vertical jump and develop explosive power, which reflects its perceived effectiveness in these specific areas (Author, Year).

However, challenges remain, particularly regarding the risks of injury, lack of time and proper equipment, as well as players' ability to fully engage in training programs. These obstacles underline the need for a holistic approach in planning and implementing plyometric exercises, considering both the potential benefits and associated risks (Author, Year).

Plyometric exercises can significantly increase explosive strength in the lower limbs of volleyball athletes, leading to more powerful jumps and more effective attacks (Author, Year; Researcher, Year). Plyometric training can enhance speed and agility, allowing volleyball players to move quickly on the court to intercept balls and respond to opponents' actions more effectively (Author, Year).

Plyometric exercises can also contribute to injury prevention by strengthening stabilizing muscles and improving proprioception, which is crucial for volleyball players who engage in quick movements and repeated jumps (Author, Year).

By integrating plyometric exercises into their training program, volleyball players can optimize their athletic performance by developing a combination of strength, speed, and agility that are essential for success in this competitive sport (Author, Year).

In conclusion, plyometric exercises play a fundamental role in the physical preparation of volleyball players by improving their explosive strength, speed, agility, and contributing to injury prevention, helping them reach their full potential on the court (Author, Year; Another Author, Year).

CONCLUSIONS

In conclusion, this study highlights the importance of plyometric exercises in the physical preparation of U21 volleyball players. The results confirm that these exercises are essential for improving explosive strength, speed, agility, and coordination—qualities crucial for excelling in this dynamic sport. While challenges remain, such as the risks of injury and the lack of time and proper equipment, integrating plyometric exercises into training programs can help players optimize their athletic performance and reach their full potential on the court.

OUTLOOK

At the end of our research, we would like to provide some suggestions to complement our study. Crucial advice to guide Moroccan volleyball in the right direction:

Propose specific recommendations for designing plyometric training programs tailored to the needs of U21 volleyball players.

Evaluate injury prevention strategies associated with plyometric exercises and suggest measures to minimize them.

Compare the effectiveness of plyometric exercises with other training methods used in the physical preparation of U21 volleyball players.

Study the long-term impact of plyometric exercises on player performance and injury prevention throughout their athletic careers.

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