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Exploring the benefits and types of plyometric training in volleyball: A systematic review

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ABSTRACT

Over the past decade, research to explore the benefits and types of plyometric exercises in volleyball has grown rapidly. However, the literature review on this topic is still very limited. The aim of this study was to conduct a systematic and in-depth review of the benefits and types of plyometric exercises in volleyball. Two databases (Scopus and Web of Science) were used to select articles containing information on this topic. The search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. After exclusion criteria, only 25 articles were categorized. Demonstrated the positive impact of various plyometric exercises on volleyball play. The results showed that the benefits and types of plyometric exercises can increase strength, agility/speed in volleyball games. In-depth analysis of the technical and tactical aspects of volleyball games shows that jumping exercises on water, jumping exercises on sand, squat jumping exercises, and vertical jumping exercises can increase leg muscle strength so that it can increase the jump height of the players to improve the stroke, especially in the smash technique (attack) in volleyball games.

Keywords: Benefits; Exercise Types; Plyometric; Volleyball

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INTRODUCTION

Volleyball is an intense anaerobic sport that combines explosive movements (i.e., in both vertical and horizontal directions) with short recovery periods (Silva et al., 2019). Therefore, explosive power, which is defined as the ability of a person's muscular-nervous system to realize tension in the shortest possible time (Ramirez-Campillo et al., 2020), considered a fundamental aspect of successful athletic performance (Çımenlı et al., 2016). In fact, when speed and agility are combined with maximum strength, the result is power (Jastrzebski et al., 2014). Muscular strength allows certain muscles to produce the same amount of work in less time, or a greater amount of work in the same amount of time, which is important for running, jumping and leaping (Young et al., 2016), and rapid change of direction (Jastrzebski et al., 2014). Indeed, studies have shown a strong relationship between strength measures and vertical jump performance (Trajkovi et al., 2016),

The vertical jump is a complex movement that requires the coordination of multiple muscles in the body, arms, and legs (Campillo et al., 2021). Knowing that

each player performs more than 250 jumps in a volleyball match consisting of five sets (Martinez, 2017), Jumping ability has been identified as one of the key determinants of high performance in volleyball (Aghajani et al., 2014). In fact, several studies have shown that vertical jump test results are indicative of an athlete's performance level (Trajkovi et al., 2016). For example, Palao, Manzanares, and Valadés (2014) Found that vertical jump performance during spiking and blocking was greater in Canadian national volleyball players compared to Canadian university volleyball players. In a review of vertical jumps in female and male volleyball players, noted that better-performing teams consisted of players with high vertical jumps (Tsoukos et al., 2018).

Jump training is commonly associated with plyometric training and, in particular, with exercises that emphasize the musculotendinous unit (Gjinovci et al., 2017). The facts, Stojanović et al., (2017) Found that a combination of bodyweight pliometrics, including countermovement jumps, depth jumps and squat jumps, resulted in an increase in vertical jump height of 4.7% to 15%. Nevertheless, this type of training improves neuromuscular coordination through nervous system training (Davies et al., 2015), thus allowing for a shortening-strain cycle (SSC)-which is an elongating motion (i.e. eccentric) quickly followed by a shortening motion i.e. concentric (Davies et al., 2015) to react faster (Behm et al., 2017). In addition, since this training includes muscle lengthening, it can also improve flexibility, increasing the amount of elastic energy stored in the muscles (Kristicevic et al., 2016), stimulates more muscle units (Carrillo et al., 2023), produces a higher (neural) firing frequency (Nicholson et al., 2021). And improve joint proprioception (Kristicevic et al., 2016).

According to the concept of training specificity, effective transfer of training adaptations occurs when exercises match the task, e.g., testing, competition (Behm et al., 2017). In the game of volleyball, pliometric exercises involve jumping, leaping and running and throwing exercises that are done quickly and explosively. (Davies et al., 2015). These movements are also related to the development of agility (Keoliya et al., 2024). This ability is considered a reinforcement of motor programming through neuromuscular conditioning and adaptation of muscle spindle nerves, Golgi tendon organs, and joint proprioceptors (Campillo et al., 2021). In addition, the age and gender of the athlete should be considered when planning a strength training program. For example, in adolescence, the changes that occur in the muscular, nervous and hormonal systems due to the development associated with puberty (i.e. growth spurt) affect the ability of adolescents to perform movements (Palao, José et al., 2014). In addition, the growth spurt in females occurs approximately two years earlier than the growth spurt in males and peaks at 15-16 years of age, while males continue their growth spurt until 19-20 years of age (Jastrzebski et al., 2014). Due to these changes in adolescence, it was found that female athletes have weaker quadriceps and hamstring muscles (even when normalized by body weight) in the adult stage when compared to male athletes (Keoliya et al., 2024). These differences reflect differences in the ability to generate strength, affect jumping performance and are reflected in the different motor patterns exhibited by the two sexes (Carrillo et al., 2023).

Over the past decade, plyometric training in volleyball has undergone rapid development. These studies usually take an empirical approach, such as investigating

the effects of plyometric training over an eight-week period on the jumping performance of volleyball players, performed on wooden and synthetic surfaces (Çımenlı et al., 2016), evaluating the impact of plyometric training and volleyball skill-based training on female volleyball players (Gjinovci et al., 2017), and assess the effect of plyometric and resistance training on explosive power and strength in young male volleyball players (Aghajani et al., 2014). However, the literature review on this topic is very limited, with only two studies identified (Ramirez-Campillo et al., 2020; Silva et al., 2019). Both studies are limited to data up to 2020, recommending further exploration of the benefits of such training modalities for volleyball player performance.

This knowledge gap underscores the critical need for this literature review. The purpose of this systematic review was twofold: (i) to assess the benefits of plyometric training for volleyball players, and (ii) to describe the different types of plyometric training in the sport of volleyball. Addressing these gaps is critical, given the increasing interest in optimizing training methodologies to improve athletic performance in volleyball. This review aims to bridge the existing knowledge gap by providing insights into the efficacy and types of plyometric training in volleyball, which will ultimately guide future research and training practices in the field. The research questions underlying this review are: (i) What are the benefits of plyometric exercises on volleyball players? (ii) What types of plyometric exercises are most effective for improving volleyball players' performance in various aspects of the game?

METHOD

Search Strategy

The search was initiated using the Scopus and Web of Science (WoS) databases, both considered the leading indexing systems for citation (Farid et al., 2020), and frequently visited by previous researchers worldwide (Perdima, Feby et al., 2022; Sweileh, 2020; Yang et al., 2021). The search strategy included a combination of keyword variations ("strength training" OR "power training" OR "plyometric training" OR "resistance training" OR "weight training" OR "complex training" OR "weight-bearing exercise" OR "eccentric training") AND ("volleyball" OR "volleyball players"). Commencing on March 5, 2024, the search aimed to identify articles within the last 5 years (2019–2023) that met the inclusion criteria. The search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Shaffril et al., 2019). Additionally, PRISMA emphasises review reports that evaluate randomised trials, which can serve as a basis for reporting systematic reviews across various types of research (Onofre et al., 2021)

Exclusion Criteria

The exclusion criteria used were as follows: (1) articles that were duplicated; (2) articles that were not published in journals indexed in Journal Citation Report (JCR) or Scimago Journal Rank (SJR); (3) articles in languages other than English; (4) journal articles with selected empirical data, meaning review articles, book series, books, and chapters in books were all excluded; and (5) articles that did not explicitly mention technology in martial arts.

Procedure

From the search results, 166 publications were obtained from two databases: WoS (66 articles) and Scopus (100 articles). After following the exclusion criteria, only 25 articles remained. The majority of the articles were rejected due to their lack of a specialised focus on plyometric training in volleyball. All articles were extracted from the database and analysed through Mendeley software to remove duplicate articles.

this section. It is also necessary to write down the techniques for obtaining the subject (qualitative research) and / or the sampling technique (quantitative research).

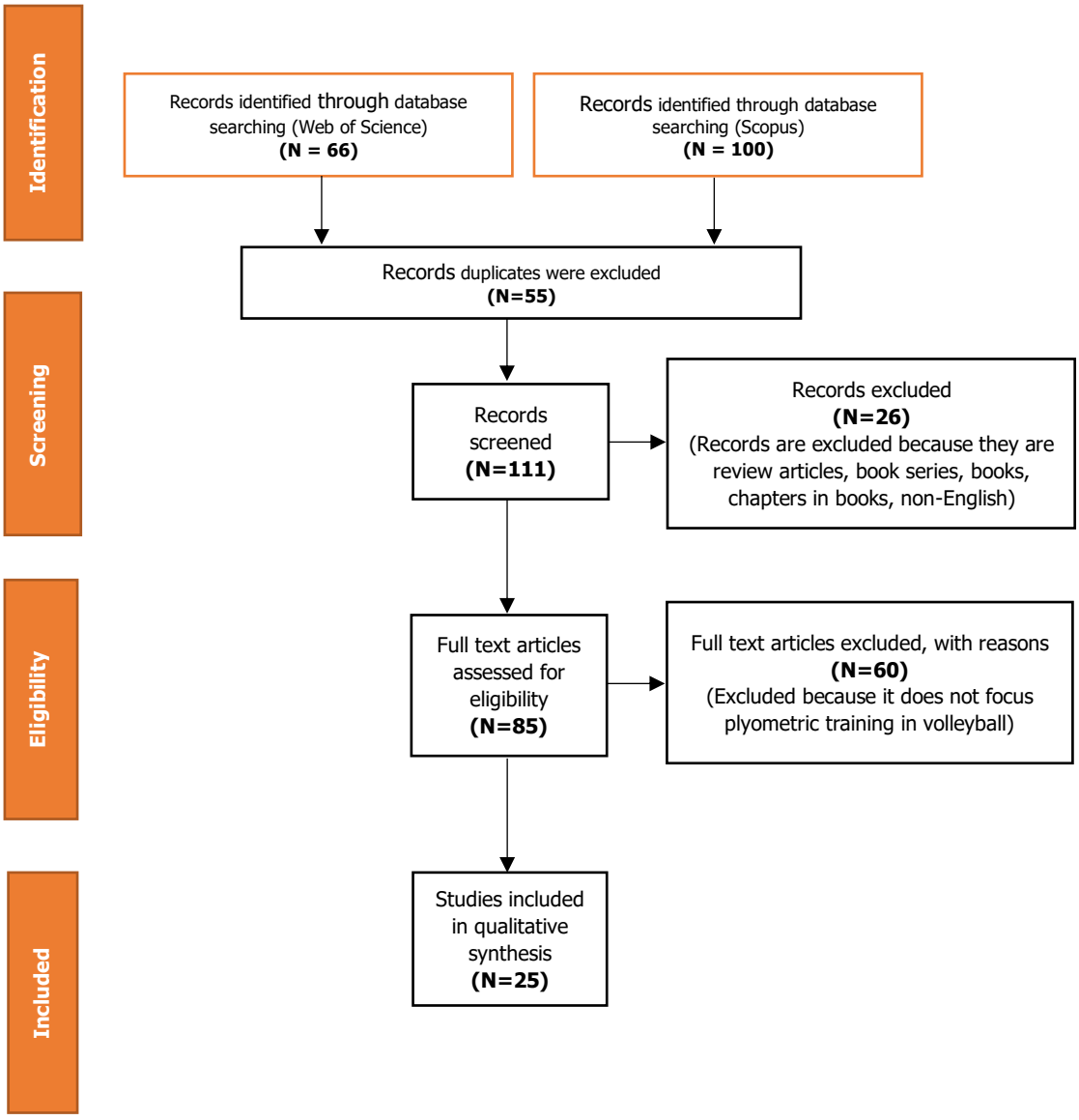

Figure 1. The Flow Diagram of the Study
(Adapted from Shaffril et al., 2019).

RESULTS AND DISCUSSION

The seven categories listed in Table 1 (except author and year) are described and discussed in the 25 articles.

Table 1. Article Summary on plyometric training in volleyball

Author and Year	Country	Methods	Purpose	Types of Exercise	Benefits	Sources
(Ahmadi et al., 2021)	Switzerland	Experimental Research	To determine the effect of 8 weeks of pliometric jump training performed on sand on biomechanical variables related to jumping and physical fitness of female indoor volleyball players.	Jumping exercises are performed on sand.	Improve strength, agility/speed, and vertical jump performance of volleyball players.	International Journal of Environmental Research and Public Health
(Berriel et al., 2022)	Brazil	Experimental Research	To compare the effects of the 4-week jump versus complex training method on lower extremity muscle strength and maximal isokinetic torque of knee extensors and flexors in elite men's volleyball players.	Squat jump exercise	Improved performance and jump power, knee extensor/flexor ratio, and total muscle work increased after 4 weeks of squat jump training.	International Journal of Sports Physiology and Performance
(Cai & Wang, 2022)	China	Experimental Research	To determine water resistance training on dynamic stability in volleyball athletes.	Jumping exercise in water	Exercise in water can significantly improve the dynamic stability of the lower extremities, and the effect can be maintained for up to 6 weeks after completion.	Sociedabe Brasileira
(Chaturvedi et al., 2023)	India	Experimental Research	To see the effect of short duration pliometric training on vertical jump speed in volleyball players.	Vertical jump exercise	Short-duration pliometric training is effective for improving vertical jump. jump height and running speed in volleyball players. The specificity of pliometric training is important for optimal sports performance enhancement.	Journals Bahiana
(Dell'Antonio et al., 2023)	Brazil	Experimental Research	To analyze the feasibility of a six-week land- and water-based plyometric training intervention and measures on spike and block range in young volleyball athletes.	Jumping exercise in the water.	Beneficial for spike and block performance in young volleyball athletes.	Sports Science
(Dell'antonio et al., 2022)	Brazil	Experimental Research	To analyze the effect of aquatic pliometric training on the jumping performance of volleyball players.	Jumping exercise in the water	To improve technical skills and overall physical condition (muscular endurance and strength, aerobic exercise	Journal of Human Kinetics

Author and Year	Country	Methods	Purpose	Types of Exercise	Benefits	Sources
					and coordination).	
(Fathi et al., 2019)	Tunisia	Experimental Research	To determine the effects of 16 weeks of combined strength and pliometric training or plyometric training alone and how a detraining program can modify adaptations in response to a training stimulus.	Vertical jump exercise	Combined strength and pliometric training provides better improvement than pliometric training alone.	Journal of Strength and Conditioning Research
(Giatsis et al., 2022)	Switzerland	Experimental Research	To compare the biomechanical parameters of drop jumps executed on rigid and sand surfaces	Practice jumping on sand.	Pliometric training on sand is recommended to produce advanced performance in vertical jumping. However, there is limited information on the biomechanics of drop jumps on sand.	Journal of Functional Morphology and Kinesiology
(Guimarães et al., 2023)	Brazil	Experimental Research	To evaluate the effect of 4 weeks of plyometric training (PT), conducted in the pre-competitive period, on the vertical jump performance of professional volleyball athletes..	Squat jump exercise	Improved performance and jump power, knee extensor/flexor ratio, and total muscle work increased after 4 weeks of squat jump training.	Biology of Sport
(Hale et al., 2019)	Amerika Serikat	Experimental Research	To determine if an 8-week combined strength and plyometric/aility off-season conditioning program improves performance on three vertical jump protocols and agility times in adolescent female volleyball athletes.	Vertical jump exercise	Combined strength and plyometric/aility for 8 weeks improves performance on three vertical jump protocols and agility time in adolescent female volleyball athletes.	Journal of Physical Education and Sport
(Hammami, Ben, Ayed, et al., 2022)	Brazil	Experimental Research	To determine the acute effects of maximal and submaximal hurdle jump training protocols implemented during a single training session on balance, vertical jump, reactive strength, and leg stiffness in young volleyball players.	Vertical jump exercise	Indicating that young volleyball players should implement a dynamic plyometric protocol involving maximal hurdle jump training and subsequent balance and muscle strength.	Frontiers in Physiology
(Hammami, Morales-Gene, et al., 2022)	Brazil	Experimental Research	To evaluate the changes in dynamic, reactive, and strength power, as well as balance (as volleyball performance related parameters) in pubertal volleyball players when part of their normal	Squat jump exercise	Improves dynamic, reactive, and strength performance, and balance (as parameters related to	Biology of Sport

Author and Year	Country	Methods	Purpose	Types of Exercise	Benefits	Sources
			season training regimen was replaced by elastic band training.		volleyball performance)	
(Harput et al., 2023)	Turkey	Experimental Research	To determine the effect of pliometric training on vastus lateralis (VL) and patellar tendon size, quadriceps isokinetic strength, and vertical jump height in adolescent female volleyball players.	Vertical jump exercise	Pliometric training for 6 weeks improves quadriceps isokinetic strength in both limbs and vertical jump height of adolescent female volleyball players.	International Journal of Athletic Therapy and Training
(Balasas et al., 2022)	Ukraina	Experimental Research	To improve vertical jump height, and to monitor the effect of a 15-week off-season plyometric and resistance training program on vertical jump height in adolescent female volleyball players.	Vertical jump exercise	The 15-week workout was shown to increase jump height and leg power.	Journal of Science in Sport and Exercise
(Kalinowski et al., 2022)	Amerika Serikat	Experimental Research	To compare the effect of bilateral and unilateral conditioning activities of isometric and pliometric combinations.	Squat jump exercise.	Indicating that a combination of exercises can effectively produce a post-activation performance enhancement effect but should replicate the explosive task as much as possible.	Frontiers in Physiology
(Kroll et al., 2020)	Amerika Serikat	Experimental Research	To evaluate the effect of stroboscopic vision on depth jump performance.	Jumping exercise in water	Significantly improved the dynamic stability of the lower extremities, and the effect could be maintained...	Sports Biomechanics
(Krzysztofik et al., 2021)	Switzerland	Experimental Research	To examine the effect of lower body (CA) plyometric conditioning activities with self-selected intra-complex rest intervals on upper and lower body volleyball specific performance.	Squat jump exercise.	Improves jumping performance and power, knee extensor/flexor ratio, and total muscle work	Applied Sciences-Basel
(Maćkała et al., 2020)	Polandia	Experimental Research	To determine the effect of the application of modified pliometric training character (circuit implementation method) for four weeks on explosive power.	Vertical jump exercise	Improved that plyometric training positively impacted horizontal jump performance, albeit with a greater improvement compared to vertical jumps.	Acta Kinesiologica

Author and Year	Country	Methods	Purpose	Types of Exercise	Benefits	Sources
(Martinez, Jordan et al., 2023)	Tunisia	Experimental Research	To analyze the effect of pliometric training (PT) at different frequencies on jumping performance, sprinting speed, and service speed in adolescent male volleyball players.	Squat jump exercise	Improve the performance of jumping, sprinting speed, and serving speed in adolescent male volleyball players.	Frontiers in Physiology
(Mrocze et al., 2019)	Polandia	Experimental Research	To improve vertical jumping ability as an indirect evaluation of the lower extremity explosive power of male volleyball players.	Squat jump exercise.	To improve vertical jumping ability as an indirect evaluation of the lower extremity explosive power of male volleyball players.	Journal of Strength and Conditioning Research
(Oliveira, Maríam et al., 2023)	Spanyol	Experimental Research	To synthesize the results of different systematic reviews investigating the effect of plyometric training on jumping performance of volleyball players.	Vertical jump exercise	Increase a player's height, resulting in more effective attacks, solid blocks, and strong defense.	Retos
(Tammam & Hashem, 2020)	Saudi Arabia	Experimental Research	To compare the individual and combined effects of 6 weeks of PNF stretching and plyometric training in muscle strength and flexibility for young volleyball players.	Vertical jump exercise	Boosting from PNF and PLYOT has surpassed their individual effects on muscle strength but not on flexibility variables.	Amazonia Investiga
(Thattarauthodiyil & Shenoy, 2021)	India	Experimental Research	To determine the effect of lower body plyometrics training and lower body plyometrics training combined with.	Vertical jump exercise	Both lower body pliometric training and lower body pliometric training combined with a dynamic stretching program twice a week for eight weeks showed significant improvements in vertical jump performance.	International Journal of Applied Exercise Physiology
(J. Wang et al., 2022)	China	Experimental Research	To examine the effect of blood flow restriction resistance training at different external loads on muscle strength and vertical jump performance of volleyball players.	Squat jump exercise.	Increases muscle strength but also greater vertical jump performance as well as improving jumping performance.	Journal Dose Response

Author and Year	Country	Methods	Purpose	Types of Exercise	Benefits	Sources
(M. H. Wang et al., 2020)	Taiwan	Analisis Kovariat	To determine the effect of pliometric training on changes in electrical signals in the lower extremity muscles of volleyball players.	Vertical jump exercise	Neuromuscular improvement of volleyball players during continuous block jumps.	Applied Sciences

Based on Table 1, the findings from this literature review categorise two research questions, namely:

A. What are the benefits of plyometric training on volleyball players?

The benefits of pliometric training can improve the strength, agility/speed, and vertical jump performance of volleyball players (Ahmadi et al., 2021). Increasing such exercise does not warrant greater exercise intensity and different combinations of fall heights may be required to obtain adaptation (Andrade et al., 2020). And can improve jumping performance and power, knee extensor/flexor ratio, and muscle work. (Berriel et al., 2022). Furthermore, it can also significantly improve lower extremity dynamic stability (Cai & Wang, 2022). And can improve sprint speed (Chaturvedi et al., 2023). Among these benefits are spike and block performance in volleyball athletes (Dell'Antonio et al., 2023). Six weeks of training in a youth volleyball player's training routine improves performance for the athlete (Dell'antonio et al., 2022). A combination of strength and pliometric training provided better improvements (Fathi et al., 2019). Produce advanced performance in the vertical jump (Giatsis et al., 2022). And performance in power jumps (Guimaraes et al., 2023). Thus improving performance on the three vertical jump protocols and agility time in female volleyball athletes (Hale et al., 2019). balance and muscle strength (Hammami, Ben, Ayed, et al., 2022). dynamic strength, and reactive strength (Hammami, Morales-Gene, et al., 2022). After that, it can increase the isokinetic strength of the quadriceps in both limbs and the vertical jump height of adolescent female volleyball players. (Harput et al., 2023). Jump height and leg power (Kalinowski et al., 2022). As well as improving body balance and toning muscles (Kroll et al., 2020). Improves significant dynamic stability, and the effect can be maintained (Krzysztofik et al., 2021). That way it can improve performance and power in jumps (Maćkała et al., 2020). Improves horizontal jump performance, albeit with a greater improvement compared to vertical jumps (Martinez, Jordan et al., 2023). Vertical jumping ability as an indirect evaluation of lower extremity explosive power of volleyball players (Mrocze et al., 2019). However, it can improve the performance of jumping, sprinting speed, and serving speed in volleyball players (Oliveira et al., 2023). And it can also increase a player's height, resulting in more effective attacks, solid blocks, and strong defence (Tammam & Hashem, 2020). As well as its individual effect on muscle strength but not on flexibility variables (Thattarauthodiyil & Shenoy, 2021). Lower body pliometric exercises combined with an eight-week dynamic stretching programme showed significant improvement in vertical jump performance, which was greater than LL-BFR-RT and HL-RT (J. Wang et

al., 2022). As well as improving the neuromuscular of volleyball players during continuous block jumps (Wang et al., 2020).

B. What type of plyometric exercise is most effective for improving the performance of volleyball players?

Practice Jumping on Sand

As for doing jumping training on sand, of course, it can increase strength, agility / speed, so that it can increase the jump height of the players to increase the stroke, especially in the smash technique (attack) in volleyball games (Ahmadi et al., 2021). The jump training involves a more in-depth analysis of the aspects of jump training on sand in volleyball games. For example, in sand jumping exercises can contribute to improving the strategy and execution of certain movements.

Jumping exercises on sand are quite an effective form of training to be given to athletes useful for improving performance, because this exercise is quite fun and is able to have a good effect on players. This exercise on the role of helping athletes and players identify weaknesses and strengthen strengths in competition can provide a more in-depth view of the competition (Giatsis et al., 2022). This analysis can detail how the application of a specific sand jumping exercise is performed

Jumping Exercise in the Water

Jumping training on water can significantly improve the dynamic stability of the lower extremities, and the effect can be maintained in the context of the role of training in volleyball sports (Cai & Wang, 2022). This type of exercise is very beneficial for players in spiking and blocking in volleyball players, block or dam is a defensive effort by stemming or holding the ball from the opponent's attack. The dam movement is carried out above the net with the aim of holding the opponent's smash (Dell'Antonio et al., 2023).

The jumping drills involve a more in-depth analysis of the aspects of jumping drills in water in the game of volleyball. For example, the exercise can improve technical skills and overall physical condition muscular endurance and strength, and coordination (Dell'antonio et al., 2022). In jumping training on water can also increase leg muscle strength so that it can improve the jumping performance of the players to be more optimal in the Volleyball game (Kroll et al., 2020). The role of this exercise in helping athletes and players identify weaknesses and strengthen strengths in competition can provide a more in-depth view of the exercise.

Squat Jump Exercise

Thus the squat jump training method is a squat jump in place that begins with a squat. The form of leg muscle training is squat jumping training, namely the movement of jumping up so that both legs are straight and when going down both knees are slightly bent with the position of the hips only slightly lowered. Squat jumping exercise is a form of exercise to train and increase endurance, leg muscle power, and strength (Berriel et al., 2022; Guimaraes et al., 2023; Krzysztofik et al., 2021).

Squat jump training when applied regularly, and continuously, programmed, and high discipline greatly affects the results of its jumping ability. And can also improve the performance of dynamic, reactive strength and balance when doing jump service (Hammami, Morales-Gene, et al., 2022). To be able to do jump service can be trained by using squat jump training. Squat jump training is by squatting one foot in front, jumping up until the legs are straight and returning to the original attitude by exchanging the front leg for the back (J. Wang et al., 2022).

In doing jump service, a maximum jump is needed which is useful for shooting the ball at the opponent with speed and strong strength, so that the ball in the service can shoot sharply and produce points (numbers) (Mrocze et al., 2019). So that this squat jumping exercise can be applied by coaches to increase leg muscle explosive power (Martinez, Jordan et al., 2023). And also can show that the combination of exercises can be done effectively and produce the effect of post-activity performance improvement but must be as much as possible to apply to the volleyball game (Kalinowski et al., 2022).

Vertical Jump Training

Vertical jump is the ability to jump as far as possible from a standing position with straight legs (Chaturvedi et al., 2023). This ability is usually required in various types of sports such as basketball, volleyball, or athletics. To be able to improve vertical jump ability, consistent and effective training is required (Fathi et al., 2019). Vertical jump is the ability to jump as far as possible from a standing position with straight legs. This ability is often required in various sports such as basketball, volleyball, or athletics (Hale et al., 2019). Vertical jump is calculated based on the distance traveled from the standing position to the highest point of the jump. The longer the distance traveled, the higher one's vertical jump ability (Hammami, Ben, Ayed, et al., 2022). Vertical jump requires strength and speed from the muscles of the lower body, especially the thigh and calf muscles. Therefore, exercises aimed at improving vertical jump ability often involve training the muscles of the lower body (Thattarauthodiyil & Shenoy, 2021). Good vertical jump ability can improve performance in sports and also improve body balance and overall muscle strength (M. H. Wang et al., 2020). Vertical jump, also known as countermovement jump, is a plyometric exercise that uses your body weight to activate muscle groups throughout the body (Harput et al., 2023). Perform a vertical jump by bending your hips, knees and ankles until you drop into a quarter-squat position. Once you've practiced the standard vertical jump, consider trying other jump variations (Balasas et al., 2022).

The basic block technique is one of the main keys to getting points from your opponent (Maćkała et al., 2020). Dam or block serves to block the opponent's attack from near the net as well as a counterattack to the opposing side (Oliveira et al., 2023). The effect of vertical jump training on block techniques in volleyball games that vertical jump has a significant effect on the basic technique of blocking volleyball (Tammam & Hashem, 2020). Hal ini terbukti pada penelitian yang telah dilakukan oleh beberapa peneliti sebelumnya, dapat disimpulkan bahwa terdapat pengaruh yang signifikan dari latihan vertical jump terhadap kemampuan blocking bola voli, hasil yang diperoleh dari

penelitian yang telah dilakukan bahwa vertical jump memberikan pengaruh yang positif terhadap teknik blocking bola voli.

DISCUSSION

The main objective of this paper is to conduct an in-depth systematic literature review on the role of pliometric training in volleyball. The findings from this literature review illustrate the role of pliometric exercises in volleyball in two main aspects namely physical education learning and sports science. In addition, the review showed that the role of pliometric exercises can be extended to involve technical and tactical aspects in volleyball games. From several types and benefits of plyometric jump training that have been reviewed, there are 4 types of exercises that can be applied, namely:

First, the benefits of jumping training on sand, in doing jumping training on sand of course can increase strength, agility / speed, so that it can increase the jump height of the players to increase the stroke, especially in the smash technique (attack) in volleyball games (Ahmadi et al., 2021). Jumping training on sand is a form of training that is quite effective to be given to athletes useful for improving performance, because this exercise is quite fun and able to have a good effect on players (Giatsis et al., 2022).

Second, namely jumping training in the water, this type of exercise is very beneficial for players in spike and block on volleyball players, block or dam is a defense effort by stemming or holding the ball from the opponent's attack. The dam movement is carried out above the net with the aim of holding the opponent's smash (Cai & Wang, 2022). In jumping training on water can also increase leg muscle strength so that it can improve the jumping performance of the players to be more optimal in volleyball games. The role of this exercise can help athletes and players identify weaknesses and strengthen strengths in competition can provide a more in-depth view of the exercise (Dell'antonio et al., 2022).

Third, squat jump training, squat jump training is a form of exercise to train and increase endurance, leg muscle power, squat jump training when applied regularly, and continuously, programmed, and high discipline greatly affects the results of its jumping ability. And can also improve the performance of dynamic, reactive and balance strength when doing jump service (Wang et al., 2022). In doing jump service, a maximum jump is needed which is useful for shooting the ball at the opponent with speed and strong strength, so that the ball in the service can shoot sharply and produce points (numbers). So that this squat jump training can be applied by coaches to increase the explosive power of leg muscles (Kalinowski et al., 2022).

Fourth, Vertical jump training is the ability to jump as far as possible from a standing position with straight legs. This ability is usually required in various types of sports such as basketball, volleyball, or athletics. To be able to improve vertical jump ability, consistent and effective training is needed. Vertical jump is the ability to jump as far as possible from a standing position with straight legs. This ability is often required in various sports such as basketball, volleyball, or athletics (Wang et al., 2020). Vertical jump is calculated based on the distance traveled from the standing position to the highest point of the jump. The longer the distance traveled, the higher a person's vertical jump ability. Vertical jump requires strength and speed from the muscles of the lower body, especially the thigh and calf muscles. Therefore, exercises aimed at improving vertical jump ability often involve muscle training. A good vertical

jump can improve sports performance as well as improve body balance and overall muscle strength. Vertical jump, also known as countermovement jump, is a plyometric exercise that uses your body weight to activate muscle groups throughout the body. Perform a vertical jump by bending your hips, knees and ankles until you drop into a quarter-squat position. Once you've practiced the standard vertical jump, consider trying other jump variations (Aghajani et al., 2014).

Plyometric training is one method to develop explosive power, which is an important component in the achievement of most athletes. The principle of the pliometric training method is that the muscles always contract both at the time of lengthening (eccentric) and shortening (concentric). pliometric training is useful for improving muscle nerve reactions, explosiveness, speed and the ability to generate force (power) in a certain direction (Campillo et al., 2021). Plyometric exercises show the full force characteristics of muscle contractions with a very fast response, dynamic loading (dynamic loading) or very complicated muscle stretching. Pliometrics has the advantage of utilizing the force and speed achieved by accelerating body weight against gravity, this causes the speed force in plyometric exercises to stimulate various sports activities such as jumping, running and throwing more often than weight training or can be said to be more dynamic or explosive (Tsoukos et al., 2018).

Based on the various opinions above, it can be concluded that pliometric exercise is a form of explosive power training with the characteristics of using very strong and fast muscle contractions, namely the muscles always contract both when extending (eccentric) and when shortening (concentric) in a fast time, so that during the work of the muscles there is no relaxation time. Pliometric exercises will get good results if done perfectly and with high intensity. Intensive training, namely the training process must be increasingly heavy by increasing the workload, the number of repetitions of movement and the intensity of movement.

CONCLUSION

From the review studies that have been conducted, it can be concluded that pliometric training has a significant role in volleyball jumping. An in-depth analysis of the technical and tactical aspects of volleyball games shows that jumping exercises on water, jumping exercises on sand, squat jumping exercises, and vertical jumping exercises can increase leg muscle strength so that it can increase the jumping height of the players to increase the stroke, especially in the smash technique (attack) in volleyball games. Several limitations inherent in this review need to be noted. Firstly, although a thorough literature search was conducted, some published studies may have been missed due to the possibility that the keywords used were different from the current keywords used. Secondly, the databases used in the article search were limited to only two databases namely Scopus and WoS. Overall, this study shows that pliometric training has become an indispensable partner in volleyball development, and makes a valuable contribution to education and sports science. However, to optimize the benefits of this technology, further studies are needed regarding efficient and effective implementation, meeting accessibility aspects, and overcoming challenges that arise. Future researchers can also add other databases, such as ScienceDirect, ERIC, IEEE, SPORTDiscus, and others, to the article search. It is also necessary to apply pliometric exercises in improving jumps in volleyball.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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