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IDENTIFICATION OF TRAINING MODELS TO IMPROVE LOWER LIMB MUSCLE STRENGTH DURING VOLLEYBALL SPIKE MOVEMENTS

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Abstract

Volleyball has been known in Indonesia since 1928, introduced by Dutch teachers in secondary schools. It later developed nationally with the establishment of the Indonesian Volleyball Association (PBVSI) on January 22, 1955, in Jakarta. The objective of this study is to identify effective types of training models to strengthen lower limb muscles in order to support optimal performance during spike movements, through an in-depth analysis of relevant and evidence-based literature. This research employs a Systematic Literature Review (SLR) approach. Data were collected from several databases such as Google Scholar, JPJO, Taylor and Francis, and DOAJ, with publication years ranging from 2015 to 2024. After applying inclusion and exclusion criteria, a total of 10 relevant articles were selected and analyzed thoroughly. The results show that **plyometric training models** are highly effective in increasing explosive power and vertical jump height—both of which are key factors in successful spike execution. Exercises such as depth jumps, tuck jumps, and bounding stimulate the neuromuscular system to produce rapid force output.

Keywords: spike training types, lower limb muscle strength, strength training models

In the game of volleyball, there are several basic techniques that must be mastered by every player, including *serves, passing, smash, and block*. These four basic techniques are capital that must be learned before playing volleyball if you want to excel, many athletes ignore these basic techniques even though the techniques in volleyball are interrelated with each other. So that an athlete will not be optimal when doing basic volleyball techniques while playing or competing, this will hinder the athlete's achievement to develop (Sports et al., 2024)**.** Especially in the spike technique, which is one of the important elements in the game of volleyball, the lack of mastery of basic techniques can greatly affect the performance and outcome of the match. Spike is one of the skills to attack the opponent's defense in volleyball to get points(Affan Yaumulhak, Jajat Darajat, Agus Gumilar, 2024). There needs to be special exercises to increase the strength of the leg muscles. Physical, technical, and tactical and mental coaching cannot be separated from the training itself. The ability to power the leg muscles is one of the most important factors to support the achievement of a volleyball athlete(Adhi et al., 2017). The explosive ability of the muscles or often called *Power* is one of the physical elements that has an important role in sports activities, both as a supporting element in a certain movement and the main element in achieving movement techniques(Ismoko & Sukoco, 2013). The sequence of exercises to increase power is given after the sportsman is trained on the elements of strength and speed. *Power* It is strongly influenced by two other physical component elements, namely muscle strength and speed. These two physical components are inseparable, since in principle they work together to produce the explosive power of the muscles (*Power*)(Ismoko & Sukoco, 2013). Leg muscles are a group of muscles located in

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the lower extremities of the human body, namely the thighs, calves, and legs. These muscles function to support activities such as walking, running, jumping, standing, and balancing the body. The leg muscles consist of large muscles that are strong to support the weight of the body as well as small muscles that support smooth movement and coordination(Takeshi Asai, Shinichiro Ito, Kazuya Seo, 2014). Practice is a process that is systematically arranged and designed through several stages, and is carried out continuously. In general, training aims to improve and develop the abilities and skills of athletes. The main goal of this training is to bring positive changes, not only to support fitness, but also to improve the techniques possessed and improve the physical condition of athletes, so that they are able to perform optimally in every sports activity, including when competing(Sulistyo, 2016).

METHODS

The method used is *Syistematic Literature Review* (SLR), with a prism approach, the data sources used come from google scholar, taylor and francis, and DOAJ. With criteria; Articles published between the last 10 years, articles in Indonesian or English, studies involving leg muscle strength training interventions, studies involving athletes or subjects who practice spikes. Data collection technique by opening the journal page then entering keywords such as: Types of Spike AND *Spike* Volleyball exercises, Leg muscle strength, Leg muscle training model, *plyometric training, Resistance training*. The journals that have been collected amounted to 70 and filtered into 30 and the final results amounted to 10 journals.

Table 1. Journal Screening

Identification	Data collection and information are sourced from google scholar, taylor and francis, and DOAJ. 70 articles
Screening	Selection of articles that are in accordance with the research. 30 Journal
Eligibility	Review of Journals that are chosen to be significant to the problem 10 Journal

RESULTS AND DISCUSSION

Table 2. Journal review results

Yes	Title	Author/ Year	Research Results
1.	The Effect of Jump to Box, Depth Jump and Single Leg Depth Jump Exercises on Increasing Leg Muscle	Devi Lestya pembayun, Oce Wiriawan, Hari Setijono 2018	These three exercises have a significant effect on increasing the strength and power of leg muscles.

	Strength and Leg Muscle Power		
2.	Plyometric Double Leg Tuck Jump: Its Effect On Volleyball Athletes' Leg Muscle Power	Sutimin 2021	Exercises in the sand are superior to those on the ground in increasing the strength of the participants' leg muscles.
3.	The Effect of Rope Jump Training with the Interval Training Method on Leg Muscle Strength	Gift Dwi Aisyah 2015	There is a significant increase in leg muscle strength after rope jump training
4.	The Effect of High Intensity Interval Training (HIIT) Training Method in Increasing Leg Muscle Power and Agility in Volleyball Games	Linda Susila 2021	HIIT deserves to be used to improve technical aspects such as smash and agility of volleyball athletes.
5.	The Effect of Split Squat Jump Exercises on Increased Leg Muscle Power and Smash Accuracy in Volleyball Games	Rusdiana Joseph 2018	Split squat jumps effectively increase leg power and smash accuracy, supporting the concept that leg strength plays a role in the stability and effectiveness of shots in volleyball.
6.	Effect of Plyometric Front Cone Hops and Plyometric Lateral Cone Hops Exercises on Increased Leg Muscle Explosiveness and Agility	Yully Wahyu Sulistyo 2016	Both methods are effective, with front cone hops being the most superior.
7.	The Effect of Plyometric Hurdle Hopping Exercises on the Explosive Power of the Leg Muscles	Nurdiansyah and morality 2018	The Effect of Plyometric Hurdle Hopping Exercises on the Explosive Power of the Leg Muscles
8.	The Effect of 75lbs and 45lbs Resistance Band Training on Leg Muscle Power of SMAN 1 Taman Sidoarjo	M. Viton Lis& I Dewa Made Aryananda Wijaya Kusuma 2018	The two band loads do not provide a significantly different effect
9.	Comparison of Plyometric Exercises Depth Jump and Jump To Box Against Leg Muscle Power in Smash Volleyball Game	Deswita Suprianti & Zenda Plenna 2020	Jump to box excels with a significant difference in power.
10.	The Effectiveness of Plyometric Exercises in Increasing the Power of the Arm Muscles and Leg Muscles of Volleyball Athletes: Literature Review	Ridlo Dwi Priyoko & Oni Bagus Januarto 2022	Plyometrics has been shown to be generally effective on muscle power, but its success is highly dependent on program personalization and facility availability.

From several journals that have been read and reviewed about what exercises are effective in increasing leg muscle strength, almost all experiments are (*Jump to box, depth jump, split squat jump, tuck jump, cone hops, hurdle hopping)* states that the exercise *plyometric* increase the strength of the leg muscles, it can be concluded that exercise *plyometric* that has consistently been proven effective in increasing the power of leg muscles(Devi Lestya Pembayun, 2018). This is in line with exercise theory *plyometric* which states that exercises with an explosive character are able to optimize muscle work in the elongating and shortening phases of the muscles when contracting rapidly, resulting in higher explosive power. Exercises such as *Jump to box, depth jump, split squat jump, cone hops, to double leg tuck jump,* proven to be able to stimulate

adaptation *neuromuscular* which is important in the development of muscle power. This is in accordance with the principles of sports physiology which states that high-intensity exercise and rapid movement can improve the activation of motor units and the efficiency of muscle contraction(Yusuf, 2018)(Aisyah, 2015)(Nurdiansyah & Susilawati, 2018)

Some of the results also suggest that training media, such as sand surfaces, can provide additional stimuli that have an impact on performance improvement, as they involve greater muscle work in maintaining stability and thrust strength. In addition to *plyometric*, other training methods such as *High Intensity Interval Training* (HIIT) and *Rope jump* It also contributes to the increase in leg muscle power, although with slightly different effectiveness. This remains relevant to the theory of interval training, which is able to develop anaerobic capacity and muscle strength through the repetition of high loads with short rest periods(Susila, 2021).

Interestingly, exercise media also plays an important role in the effectiveness of exercise programs. One study showed that doing exercises on sand surfaces resulted in a more significant increase in leg muscle power than on hard surfaces. This happens because sand demands more work than the stabilizer muscles and core muscles, which ultimately increases thrust strength and body balance two crucial aspects when performing spikes. In addition to plyometric exercises, the *High Intensity Interval Training* (HIIT) and rope jumping also show positive results, although the increase is not as great as plyometric. HIIT works through high-load repetition with short rest periods, which strengthens muscle endurance and the system *anaerobic. Rope jump*, meanwhile, trains the rhythm and speed of the leg muscles, although the effect is more pronounced on increased endurance and muscle strength in general, rather than specifically on explosive power (the ability to generate maximum force)(Susila, 2021).

However, not all exercise methods provide optimal results. Exercise with "*Resistance Band*"In some studies it has shown inconsistent results on increased leg muscle power. This may be due to the limitations of the resistance band in allowing explosive movements at maximum speed. In training, power development relies heavily on the speed of muscle contraction under load, and resistance bands generally provide gradually increased resistance, rather than producing maximum force directly(Liskhardinanda & Kusuma, 2021).

Taking into account the results of these studies, it can be affirmed that explosive exercises, in particular *plyometric*, is the most effective method in increasing the strength and power of the leg muscles, which is very crucial in spike movements compared to exercises *resistance* or durability. The success of the exercise program also depends heavily on the suitability of the type of exercise to the character of each different individual, the variety of training media used, and a structured and progressive approach. Therefore, in designing a training program for volleyball athletes, coaches are advised to combine exercises *plyometric* with *Resistance Training* and other methods in a balanced manner to obtain optimal performance improvements. With good and consistent training on *plyometric* and additional *resistance* will help increase the strength of the leg muscles to the satisfactory results of spike movements(Ender et al., 2018)

CONCLUSION

Based on the results of research conducted through the "*Systematic Literature Review*" (SLR) method on various studies that discuss exercise models to increase leg muscle strength in performing volleyball spike movements, it can be concluded that. Resistance training training models are generally effective for increasing leg muscle strength through structured weight exercises, such as *squats, lunges, and leg presses. Resistance training* provides a foundation of

muscle strength that is essential for stability and control when performing *spike* jumps. The plyometric training model is highly effective in increasing muscle explosiveness and vertical jump height, which is a key factor in the success of *spike* movements. Exercises such as *depth jumps, tuck jumps,* and bounding stimulate the *neuromuscular* system to generate strength quickly.

The combination of *resistance* and *plyometric training* provides the most optimal results in increasing leg muscle strength and *spike performance*, as these two training models complement each other. The effectiveness of each training model is influenced by the frequency, intensity, and physical condition of the athlete, so the selection and application of exercises needs to be done in a programmatic manner and adjusted to the needs of athletes. Therefore, in designing training programs for volleyball athletes, coaches are advised to combine *plyometric* training with *resistance training* and other methods in a balanced manner to obtain optimal performance improvement.

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