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Plyometric training: A Systematic review on volume and intensity in high-level volleyball

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ABSTRACT

Background: Plyometric training was originally practiced in European athletics from 1919 to 1930. Plyometric training involves the athlete practicing several jumps. In 1964, plyometric training began to be practiced in other sports. In 1976 and 1977, plyometrics was used during the Italian championship. **Aims:** This systematic review was to determine the volume and intensity of the plyometric training for high-level volleyball. **Methods:** This study followed the PRISMA methodology. The articles were selected from January to July 2024, totaling 24 articles to ensure research quality. The printed articles and books were e-mailed to the author by his Italian colleague
G. B. After collecting the scientific books and articles, the author wrote the results. **Result:** The systematic review identified an optimal training frequency of 2 to 3 weeks for male and female athletes. The recommended plyometric training for males consisted of 2–8 sets of 4–20 jumps, with rest intervals ranging from 15 seconds to 5 minutes and jump heights between 20–110 cm. For females, the suggested regimen included 2–7 sets of 5–15 jumps, with similar rest intervals and jump heights between 20–80 cm. In addition to plyometric training, both groups were advised to engage in bodybuilding exercises focused on developing maximum and explosive strength. The article also provided detailed recommendations on exercise types (e.g., horizontal jumps, tuck jumps, drop jumps, hurdle jumps) and appropriate training volume and intensity for plyometric workouts. **Conclusion:** Plyometric training is a very important strength training for the volleyball player because it improves several motor capacities.

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INTRODUCTION

Sportive training literature determined that strength is important for sports performance (Badillo et al., 2017; Costa, 2022; Turner, 2018). Then, the strength in Brazilian sportive training literature is a physical quality essential for the athlete. Russian sportive training literature informed that strength is a physical capacity that the athlete trains regularly during the season (Zakharov, 2012). East German sportive training literature classified strength as a conditioning motor capacity, but this motor capacity acts in the quality of the sports task. Therefore, the strength in sportive training literature is perhaps the most important motor capacity for sports performance (Joanella & Rother, 2022; Tavakkoli et al., 2022). The terms physical quality, physical capacity, and motor capacity are synonymous.

Strength training is much studied in athletics literature, where a type of strength training is plyometric (Lagos et al., 2024; Moura et al., 2021; Moura 2023). In plyometric training, the athlete practices several jumps to improve the lower limbs' explosive strength and reactive strength (Yu et

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al., 2025). Therefore, plyometric training is very important to strength training for athletes (Raiola et al., 2025; Yuan et al., 2025). Plyometric training began in European athletics from 1919 to 1930 (Marques Junior, 2025). During the 1950s and 1960s, researchers in the Soviet Union conducted numerous studies on plyometric training, with Dr. Yuri Verkhoshansky recognized as the principal pioneer in this field (Marques Junior, 2019). In 1964, plyometric training began to be practiced in other sports (Nett, 2014). This type of training was commonly used in sports, with most methods originally developed within athletics. Over time, other sports disciplines adopted and incorporated this innovative training approach (Tubino & Moreira, 2003).

The moment that plyometric training began to be practiced in volleyball is not known (Esposito et al., 2024; Marques Junior, 2025). However, in 1964 (Nett, 2014), plyometric training was indicated for the strength training of volleyball players. In 1976 and 1977, the Italian Volleyball Championship prescribed plyometric training for a volleyball team. The development of plyometric training involved collaboration between notable figures, including the Soviet physical trainer and the Italian scientist Carmelo Bosco, who was conducting his studies in Finland then. In 1977, plyometric training was implemented as part of circuit training for volleyball players in East Germany. However, despite its application, plyometric training in high-level volleyball remains limited. The existing volleyball literature does not provide comprehensive details regarding training volume (sets, repetitions, duration in weeks, and weekly frequency) or intensity (drop height, external load, and rest intervals) (Marques Junior, 2020). Therefore, the objective of the present systematic review was to determine the appropriate volume and intensity parameters for plyometric training in elite-level volleyball.

METHOD

This study followed the PRISMA methodology (Moher et al., 2009). Articles were selected from January to July 2024 using multiple academic databases, including Google Scholar, PubMed, ResearchGate, Scielo, Redalyc, Scopus, DOAJ, ScienceDirect, Semantic Scholar, and Latindex. The search was conducted using the following keywords: "plyometric training in volleyball", "plyometric training in high-level volleyball", and "jump training in volleyball". In addition to digital sources, the author utilized printed articles and books available in his library and printed materials sent via email by an Italian colleague, G. B.

The author conducted a systematic review to examine the volume and intensity of plyometric training in high-level volleyball, following the methodological guidelines of Thomas and Nelson (2002). The inclusion criteria for article selection were: (1) the study focused on plyometric training in high-level volleyball; (2) the training involved jump-related tasks, with or without weights (e.g., ballistic jump squats, counter-movement jumps); and (3) the article provided data on the structure of the plyometric training. Articles that failed to meet these criteria were excluded.

From July to December 2024, the author reviewed 1,000 articles on plyometric training in high-level volleyball. After screening, 976 articles were excluded due to insufficient relevance or incomplete data. In December 2024, 24 articles were evaluated using the quality assessment scale by Galna et al. (2009), which consists of 13 items, each scored 0, 0.5, or 1 point. The selected studies were determined to be of medium to high quality (see Table 1).

Subsequently, in January and February 2025, the author analyzed and summarized each of the 24 selected studies, compiling the information into Table 2. In February and March 2025, the article's discussion section was written based on the findings and synthesis of the reviewed studies.

RESULTS AND DISCUSSION

Results

The quality of each study was evaluated with the Galna et al. (2009) scale, presented in Table 1. The white lines are the men's volleyball studies (n = 13), the gray lines are the women's volleyball studies (n = 8), and the second white lines are the studies that female and male volleyball players practiced the same plyometric training (n = 3). The articles in Table 1 are in alphabetical order.

Table 1. Quality of Each Study

Study	1	2	3	4	5	6	7	8	9	10	11	12	13	Average and Quality of each Study
1) Alp et al. (2021)	1	1	1	1	0	1	0	1	0	0	1	1	1	0.76 (medium)
2) Çimenli et al. (2016)	1	1	0.5	1	0	1	1	1	0	0	1	1	1	0.73 (medium)
3) Jastrzeleski et al. (2014)	1	1	0.5	1	0	1	1	1	0	1	1	1	1	0.88 (high)
4) Maffiuletti et al. (2002)	1	1	1	1	1	1	1	1	0	1	1	1	1	0.92 (high)
5) Mroczek et al. (2017)	1	1	1	1	1	1	1	1	0	0	1	1	1	0.84 (high)
6) Muriyedath et al. (2025)	1	1	0.5	1	1	1	1	1	0	1	1	1	1	0.88 (high)
8) Öz et al. (2019)	1	1	1	1	1	1	1	0	1	1	1	1	1	0.92 (high)
9) Pastore et al. (2016)	1	1	0.5	1	1	1	1	1	0	0	1	1	1	0.73 (medium)
11) Soundara et al. (2010)	1	0.5	0.5	1	1	1	1	1	0	0	1	1	1	0.76 (medium)
12) Suresh et al. (2017)	1	1	0.5	1	1	1	1	1	0	0	1	1	1	0.73 (medium)
13) Yu et al. (2025)	1	1	1	1	1	1	1	1	0	1	1	1	1	0.92 (high)
Study	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**Average and Quality of each Study**
1) Ahmadi et al. (2021)	1	1	1	1	1	1	1	1	0	1	1	1	1	0.92 (high)
2) Baharuddin et al. (2020)	1	1	0.5	1	1	1	1	1	0	1	1	1	1	0.88 (high)
3) Foqhaa et al. (2021)	1	1	1	1	1	1	1	1	1	1	1	1	1	1 (high)
4) Gjinovci et al. (2017)	1	1	0.5	1	1	1	1	1	1	1	1	1	1	0.96 (high)
5) Guimarães et al. (2023)	1	1	0.5	1	1	1	1	1	1	1	1	1	1	0.96 (high)
6) Kitamura et al. (2020)	1	1	0.5	1	1	1	1	1	0	0	1	1	1	0.80 (medium)
7) Mackala et al. (2021)	1	1	0.5	1	1	1	1	1	0	1	1	1	1	0.88 (high)
8) Newton et al. (2006)	1	1	1	1	1	1	1	1	0	0	1	1	1	0.84 (high)
Study	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**Average and Quality of each Study**
1) Chaturvedi et al. (2023)	1	1	1	1	1	1	1	1	0	1	1	1	1	0.92 (high)
2) Ramlan et al. (2018)	1	1	0.5	1	1	1	1	1	0	1	1	1	1	0.88 (high)
3) Usman et al. (2015)	1	1	1	1	1	1	1	1	0	1	1	1	1	0.92 (high)

The quality assessment of the selected studies was based on the 13-item scale developed by Galna et al. (2009). Each item addresses a specific aspect of research quality. The items are as follows: (1) research aims or questions clearly stated (scored as 1 = yes; 0.5 = yes, lacking detail or clarity; 0 = no); (2) participant details provided, including number, age, sex, height, and weight (scored from 0 to 1); (3) recruitment and sampling methods described (1 = yes; 0.5 = yes, lacking detail or clarity; 0 = no); (4) inclusion and exclusion criteria clearly outlined (1 = yes; 0.5 = yes, lacking detail or clarity; 0 = no); (5) control of covariates such as walking speed, age, and gender (scored from 0 to 1); (6) clear description of key outcome variables (1 = yes; 0.5 = yes, lacking detail or clarity; 0 = no); (7) methodology described in sufficient detail to allow replication, including participant sampling,

equipment, procedures, data processing, and statistical analysis (scored from 0 to 1); (8) methodology appropriately designed to answer the research question (1 = yes; 0 = no); (9) reliability of the methodology reported (1 = yes; 0 = no); (10) internal validity of the methodology stated (1 = yes; 0 = no); (11) research questions adequately addressed in the discussion (1 = yes; 0 = no); (12) key findings supported by the results (1 = yes; 0 = no); and (13) logical interpretation of key findings supported by references (1 = yes; 0 = no). Based on the total score, studies were categorized as low quality (0 to 0.59), medium quality (0.60 to 0.80), or high quality (0.81 to 1.0).

Table 2 presents a summary of each study included in the systematic review. In the table, rows with white shading represent studies conducted with male volleyball players; gray rows indicate studies with female players; alternating white rows signify studies in which both male and female players participated in the same plyometric training program. The articles are organized in alphabetical order by the first author's surname.

Table 2. Summary of Each Study

Study	Volleyball Team	Weeks of Training	Strength Training in Lower Limbs	Frequency per Week	Effect (Pre-test and Post-test)
Alp et al. (2021)	Turkish male players (n = 10) of 21.10±2.11 years old.	6	Plyometrics (zigzag jumps, tuck jumps, and drop jumps).	3	Agility of 4.57 m: 6.32±0.34 seconds (s) (pre) and 6.24±0.34 s (post).
Çimenli et al. (2016)	Male players aged 18 to 24 competed in the Turkish championship. The players were divided into a wooden surface group (n = 12) and a synthetic surface group (n = 12).	8	Plyometrics with CMJ, tuck jumps, 30 to 70 cm drop jumps, and other exercises (1 or 2 sets x 10 jumps x 2 minutes of rest - min).	3	Spike jump: wooden with 59.2±5.8 cm (pre) and 65.9±7.1 cm (post); synthetic with 56.7±3.7 cm (pre) and 60.9±4.7 (post).
Jastrzeleski et al. (2014)	Males of the Polish volleyball were divided into two plyometric groups of 10 athletes: High intensity of 21.2±1.36 years old and low intensity of 20.7±1.52 years old.	6	Plyometrics of high intensity (hurdle jumps, drop jumps, and drop jumps with barbell) with 2 to 7 sets x 6 to 12 jumps x 20 to 81 cm. Plyometrics of low intensity (CMJ, hurdle jumps, and drop jumps) with 2 to 5 sets x 4 to 12 jumps x 20 and 30 cm.	3	Spike jump: high intensity with 57.7±6.36 cm (pre) and 60.9±7.16 cm (post); low intensity with 59±4.84 cm (pre) and 62.3±5.92 cm (post).
3) Maffiuletti et al. (2002)	Male players (n = 10) of 21.8±2.8 years old competed in the Italian championship.	4	Plyometrics (CMJ, hurdle jumps of 40 cm, and drop jumps of 40 cm) with 5 sets x 10 jumps x 3 min of rest.	3	Spike jump: 53±4.8 cm (pre) and 54.40±4.8 cm (post).
Mroczek et al. (2017)	A male team (n = 16) of 21.12±1.67 years old competed in the 2nd division of the Polish championship.	6	Plyometrics (horizontal jump and after spike jump, squat jump - SJ, CMJ, hurdle jumps, and horizontal jumps with 2 to 5 sets x 5 to 20 jumps) and bodybuilding (leg press, power snatch, power clean, and squat) with 2 to 3 sets x 6 and 10 repetitions x load of 60 to 85% of 1RM.	2	Stiffness of right leg muscles: 545.92±75.977 DV (pre) and 601 DV (post)
Muriyedath et al. (2025)	Indian male players (n = 15) of 18 to 24 years old.	12	Plyometrics (horizontal jumps, drop jumps, tuck jumps, and others) with 3 sets x 6 to 10 jumps x 2 min of rest.	3	CMJ: 42.53±1.64 cm (pre) and 46.53±1.40 cm (post).

Study	Volleyball Team	Weeks of Training	Strength Training in Lower Limbs	Frequency per Week	Effect (Pre-test and Post-test)
Öz et al. (2019)	A male team (n = 14) of 29.1±4.3 years old competed in the Turkish championship.	8	Plyometrics (CMJ, lateral jumps, and drop jumps of 40 or 85 cm) with 2 to 8 sets x 8 to 16 jumps	2	T-drill agility test: 9.9±0.4 s (pre) and 8.59±0.4 s (post).
Pastore et al. (2016)	Male beach volleyball player (n = 1) of 19 years old.	6	Bodybuilding on Monday and Thursday (leg press, squat with free bar, and leg curl) with 4 sets x 5 repetitions x 2 min of rest x load of 85% of 1RM during the 1st to 4th weeks, and a load of 90% of 1RM during the 5th and 6th weeks. Plyometrics on Tuesday and Friday (drop jumps of 35 to 60 cm) with 4 sets x 8 jumps x 2 min of rest and 3 sets x 6 jumps x 2 min of rest.	2	CMJ: 29±0.03 cm (pre) and 43±0.01 cm (post)
Suresh et al. (2017)	Male players aged 18 to 25 were divided into two plyometric groups of 15 athletes each: ground and sand.	2	Plyometrics (CMJ, horizontal jumps, diagonal jumps, jumps over the cones) with 2 to 3 sets x 10 jumps x 2 to 3 min of rest.	-	Block jump: ground with 70.13±4.88 cm (pre) and 71.13±4.86 (post).; sand with 65.40±6.19 cm (pre) and 67.65±5.85 cm (post).
Yu et al. (2025)	Male players were divided into three plyometric groups of 10 athletes each (aquatic jumps of 23.4±2.2 years old, sand jumps of 23.7±2.4 years old, and land jumps of 24.1±1.5 years old)	6	Plyometrics (drop jumps of 40 cm, SJ, and tuck jumps) with 4 sets x 10 to 20 jumps x 1 min and 30 s of rest.	2	CMJ: aquatic with 46.5±3.6 cm (pre) and 52±4.1 cm (post); sand with 46.4±3.5 cm (pre) and 51.9±3.2 cm (post); land with 45.8±2.8 cm (pre) and 48.6±2.8 cm (post)
Ahmadi et al. (2021)	Female players were divided into two plyometric groups (sand jumps of 23.5±2.8 years old with n = 8 and rigid jumps of 22.7±2.6 years old with n = 9).	8	Plyometrics (CMJ, horizontal jumps, single leg jumps, lateral jumps, tuck jumps, single leg to lateral jumps, hurdle jumps, and drop jumps of 40 cm) with 6 to 10 jumps on each surface (sand and rigid).	2	Velocity of 20 m: sand with 4.05±0.38 s (pre) and 3.96±0.33 s (post); rigid with 4.19±0.27 s (pre) and 4.12±0.12 s (post).
Baharuddin et al. (2020)	Female players (n = 10) of 19 to 25 years old with anterior cruciate ligament injury.	6	Plyometrics (SJ, CMJ, tuck jumps, single leg squat jumps) with 2 to 5 sets, 10 and 15 jumps x 30 s and 2 min of rest.	2	Horizontal jump: 171.89±16.94 cm (pre) and 181.89±10.18 cm (post).
Foqhaa et al. (2021)	Female players (n = 10) of 20.70±1.06 years old.	8	Plyometrics (SJ, drop jump, ballistic jump squats with sand weight in the leg, tuck jumps with sand weight in the leg, and kick with sand weight in the leg) with 5 and	3	Spike jump: 37.3±6.52 (pre) and 42.36±5.63 (post).

Study	Volleyball Team	Weeks of Training	Strength Training in Lower Limbs	Frequency per Week	Effect (Pre-test and Post-test)
			7 sets x 10 and 12 jumps x 3 min of rest.		
Gjinovci et al. (2017)	A female team (n = 21) of 21.8±2.1 years old competed in the 1st division of the Kosovo championship.	12	Plyometrics (CMJ, lateral jumps, diagonal jumps, hurdle jumps, and drop jumps) with 12 to 21 sets x 40 to 58 jumps x 2 to 4 min of rest.	2	CMJ: 38±6.5 cm (pre) and 48.5±5.2 cm (post).
Guimarães et al. (2023)	A female team (n = 9) of 19.5±3.73 years old competed in the 2nd division of the Brazilian championship.	4	Plyometrics with rest of 1 min and 30 s to 2 min (CMJ with 4 sets x 10 jumps, ballistic jump squats with 4 sets x 10 jumps x load of 20% of 1RM, CMJ with 4 sets of 15 s).	2 to 3	CMJ: 28.93±3.24 cm (pre) and 31.67±3.39 cm (post).
Kitamura et al. (2020)	Female players (n = 14) of 18.6±3.5 years old.	8	Plyometrics with rest of 1 min (30 to 40 cm) and ballistic jump squats with rest of 3 min (4 to 6 sets x 6 to 8 jumps x load of 4-12% 1RM).	2	CMJ: 28.27±4.33 cm (pre) and 28.47±3.04 cm (post).
Mackala et al. (2021)	Female players (n = 14) of 22.66±2.96 years old competed in the 3rd division of the Polish championship.	5	Plyometrics during a circuit training (lateral jumps, hurdle jumps of 35 cm, drop jumps of 45 cm, block jumps, and tuck jumps) with 2 and 3 sets x 60 or 90 s in each exercise x 3 min of rest.	2	Drop jumps test from 60 cm with a vertical jump: 35.26±5.68 cm (pre) and 35.01±4.06 cm (post).
Newton et al. (2006)	A female team (n = 14) of 20±1.2 years old competed in the 1st division of the American championship.	4	Seven weeks were spent on heavy resistance training (front and back squats, leg presses, and deadlifts). Eight to 11 weeks (4 weeks) were spent on ballistic jump squats on the Smith machine. There was a volume of 8 and 10 weeks (3 sets x 6 jumps) and 9 and 11 weeks (3 sets x 3 jumps). All sets were performed with a minimum of 2 minutes of rest.	-	Spike reach: 294.9±10.4 cm (pre) and 294.6±10.9 cm (post).
Chaturvedi et al. (2023)	Male and female players of 18 to 21 years old (n = 15).	4	Plyometrics (CMJ, horizontal jumps, and drop jumps) with 3 to 25 sets x 5 to 15 jumps x 15 to 30 s of rest.	3	Velocity of 20 m: 3.39±0.29 s (pre) and 3.55±0.33 s (post).
Ramlan et al. (2018)	Six male (n = 6) and six female (n = 6) players aged 18 to 24 were divided into two plyometric groups (grass surface and concrete surface).	4	Plyometrics (hurdle jumps of 71 cm and drop jumps of 20 cm) with 3 to 7 sets x 7 and 12 jumps x 2 min of rest.	2	CMJ: grass with 38.83±6.94 cm (pre) and 40.17±5.98 cm (post); concrete with 35.33±6.97 cm (pre) and 39±6.89 cm (post).
Usman et al. (2015)	Male (n = 30) and female (n = 30) players of 18 to 22 years old.	8	Plyometrics (SJ, tuck jumps, lateral hurdle jumps, zigzag jumps, single leg jumps, and	2	Pulmonary Function Test (lung function in liters, l): forced

Study	Volleyball Team	Weeks of Training	Strength Training in Lower Limbs	Frequency per Week	Effect (Pre-test and Post-test)
			drop jumps with 30 and 80 cm) with 3 sets x 6 to 10 jumps x 1 to 5 min of rest.		vital capacity of the male (pre: 4.18±0.02 l, post: 4.46±0.05 l) and female (pre: 4.13±0.01 l, post: 4.25±0.02 l); forced expiratory volume in 1 s of the male (pre: 3.50±0.02 l, post: 3.80±0.06 l) and female (pre: 3.38±0.02 l, post: 3.49±0.03 l).

Data on plyometric training were extracted from Table 2, and the author developed Table 3 to provide practical guidance for physical trainers. This table outlines the recommended volume and intensity parameters for plyometric exercises intended to support volleyball players' physical preparation.

Table 3. Content Prescribes Plyometric Training for the High-level Volleyball

Gender	Age of the Studies	Weeks of Training	Exercises and Motor Capacity	Sets x Jumps x Rest (s, min)	Drop Height (cm)	Load of 1RM	Frequency per Week
Male (n = 16 studies)	18 to 29.1±4.3 years old	2 to 12	Plyometrics: SJ, CMJ, horizontal jumps, tuck jumps, zigzag jumps, lateral jumps, diagonal jumps, jumps over the cones, horizontal jumps and after-spike jumps, and single-leg jumps.	2-8 sets x 4-20 jumps x 15 s-5 min of rest	-	-	2 to 3
			Plyometrics: hurdle jumps, lateral hurdle jumps, drop jumps, and drop jumps with barbells.	2-8 sets x 4-20 jumps x 15 s-5 min	20-110	-	2 to 3
			Bodybuilding: maximum strength, max (leg press, squat with free bar, and leg curl), and explosive strength (leg press, power snatch, power clean, squat, ballistic jump squats). Rep is the abbreviation of repetition.	Max: 4 sets x 5 rep x 2 min of rest. Expl: 2-6 sets x 6-10 rep x 2 min of rest	-	Max: 85-95%. Expl: 60-85%.	2 to 3
Female (n = 11 studies)	18 to 25 years old	4 to 12	Plyometrics: SJ, CMJ, horizontal jumps, tuck jumps, zigzag jumps, lateral jumps, diagonal jumps, block jumps, single-leg jumps, and single-leg squat jumps.	2-7 sets x 5-15 jumps x 15 s-5 min of rest	-	-	2 to 3
			Plyometrics: hurdle jumps and	2-7 sets x	20-	-	2 to 3

Gender	Age of the Studies	Weeks of Training	Exercises and Motor Capacity	Sets x Jumps x Rest (s, min)	Drop Height (cm)	Load of 1RM	Frequency per Week
			drop jumps.	5-15 jumps x 15 s-5 min of rest	80		
			Bodybuilding: maximum strength, max (front squat, back squat, leg press, and deadlift), and explosive strength (ballistic jump squats and tuck jump).	Max: no data. Expl: 3-8 sets x 3-12 jumps x 3 min of rest	-	Max: no data. Expl: 2-20% of 1RM or sand weight in leg (3-10 kg)	2 to 3

Discussion

Implication

This systematic review identified that plyometric training in high-level volleyball significantly improves multiple motor capacities, including velocity, agility, horizontal jump, and explosive strength during vertical jumps such as the countermovement jump (CMJ), spike jump, and block jump. These results align with expectations, as previous studies have consistently shown that plyometrics enhance key conditioning components (Bompa, 2004; Marques Junior, 2025; Raiola et al., 2025). Interestingly, recent findings by Ngangomcha and Singh (2024) further expand the scope of plyometrics, demonstrating improvements in technical skills such as dribbling, passing, and shooting in female soccer players.

The systematic review revealed that the volume of plyometric training for male volleyball players typically ranged from 2 to 8 sets of 4 to 20 jumps, while for female players, the volume ranged from 2 to 7 sets of 5 to 15 jumps. These volumes differ from general sports training literature, which often recommends around 4 sets of 10 jumps, noting that significant fatigue occurs after 15 to 20 jumps. It is important to note that Verkhoshanski's foundational studies on plyometric volume were primarily conducted with athletes from explosive track and field disciplines such as sprinting, hurdling, jumping, and throwing. In contrast, historical data on Soviet volleyball training reported by Fomin (1979) indicated plyometric volumes of 7 to 9 sets and 8 to 10 jumps, which closely align with the findings of this review.

The intensity of plyometric training also varies considerably across sports. For example, Ruth Beitia, a Spanish high jumper, performed repeated CMJs and horizontal jumps on sand over 100 meters as part of her plyometric regimen (Lanza, 2004). This training, combined with bodybuilding, enabled her to set the Spanish high jump record in 2003 with a height of 2.00 meters. Similarly, 21-year-old basketball players improved CMJ after four weeks of drop jump training from 30, 50, and 60 cm heights (Pechlivanos et al., 2024). In West Germany, triple jumpers regularly included bodybuilding, drop jumps from varying heights, horizontal jumps, and ballistic jump squats in their training. The literature suggests that plyometric intensity should be tailored based on an athlete's age, sport type, training phase, and experience level (Egger, 2019; Borzov, 2019).

In a notable example, American high jumper Patrick Matzdorf practiced drop jumps from 122 cm, later achieving a world record high jump of 2.29 meters in 1971 (Hay, 2022). However, such extreme drop heights are rarely used due to injury risk. More commonly, athletes perform drop or hurdle jumps from heights ranging between 50 and 75 cm (Zakharov, 2012). Thierfelder reported increased injury risk at heights exceeding 75 to 110 cm. For this reason, Verkhoshanski (2011) recommended a progressive increase in drop height, up to 75 cm or more, based on the athlete's readiness. Marques Junior (2017), through a systematic review and meta-analysis, found that drop

heights between 50 and 75 cm produced the greatest improvements in CMJ performance, classifying them as high-intensity.

This review found that plyometric intensity during drop and hurdle jumps ranged from low to high for male players (20 to 110 cm) and female players (20 to 80 cm). Historical Soviet volleyball data supported this range, with recommended drop heights of 60 to 70 cm for men and 45 to 55 cm for women. The Soviet system strongly emphasized plyometrics, requiring male athletes to jump at least 90 cm to qualify for the national team (Marques Junior, 2019). Verkhoshanski (2018) also recommended drop heights between 60 and 110 cm for volleyball players, which aligns with the findings of this review. Similarly, Campillo (2020) identified a suitable drop height range of 30 to 80 cm for volleyball training. The literature strongly supports complex training—which combines plyometrics and bodybuilding—to improve vertical jump performance in volleyball athletes (Rodriguez et al., 2017; Verkhoshanski, 2018).

Ballistic jump squats are one of the most prominent strength training exercises to complement plyometric training (Bompa, 2004; Marques Junior, 2020). However, the current review found limited volleyball-specific studies on ballistic jump squats, challenging direct comparisons of volume and intensity data (Marques Junior, 2001). Nevertheless, the literature indicates the importance of training for maximal and explosive strength in volleyball (Pastore et al., 2016). Additionally, this review highlighted underutilized exercises such as tuck jumps and ballistic jump squats performed with ankle weights or sand resistance (Foqhaa et al., 2021).

Regarding training frequency, the systematic review found that plyometric training was most commonly performed two to three times per week among volleyball players, consistent with existing recommendations in plyometric training literature (Marques Junior, 2025). Thus, the findings of this systematic review provide valuable guidance on the appropriate volume and intensity of plyometric training for high-level volleyball. Physical trainers can apply these insights to design effective training programs. Despite its contributions, the review had a notable limitation: the sample of included studies was relatively small, with only 16 studies focusing on male players and 11 on female players. Nevertheless, several findings were consistent with Verkhoshanski's original research, widely regarded as the "father" of plyometric training.

Research Contribution

This systematic review provides an in-depth synthesis of 24 studies focusing on the application of plyometric training in high-level volleyball, addressing a significant gap in the existing literature. Unlike general plyometric studies that focus on athletes in track and field or other explosive sports, this review centers specifically on volleyball—a sport with unique demands on lower-limb power, agility, and jump performance. The study presents comprehensive data on training parameters, including sets, repetitions, rest intervals, drop heights, and frequency, distinguishing between male and female athletes. It also integrates findings related to the concurrent use of strength training, such as bodybuilding and ballistic jump squats, offering practical implications for designing hybrid training regimens. Furthermore, the review highlights the evolution of plyometric training within the volleyball context, linking its historical development to contemporary applications. By mapping out optimal ranges for training intensity and volume, this review serves as a practical reference for coaches, physical trainers, and sports scientists aiming to enhance athlete performance while managing fatigue and reducing injury risk. The inclusion of historical Soviet and Italian influences adds a unique perspective, bridging classical strength theories with modern empirical findings, thus enriching the scientific discourse on sport-specific conditioning in volleyball.

Limitation

The main limitation of this study lies in the relatively limited number of available high-quality research articles specifically addressing plyometric training in volleyball. Although the review includes 24 selected studies, only a few offered comprehensive data on both training volume and intensity, especially with controlled experimental designs. Additionally, many studies varied in their methodologies, sample sizes, and athlete experience levels, making cross-comparison challenging. Furthermore, there was a lack of longitudinal studies examining long-term adaptations. These

limitations restrict the generalizability of the results and underscore the need for more standardized and sport-specific research in this field.

Suggestion

Future research should aim to develop standardized, volleyball-specific plyometric training protocols that account for individual differences in athlete profiles, such as age, sex, and performance level. Studies should utilize controlled, longitudinal designs to investigate how various combinations of volume and intensity impact different performance outcomes, including agility, vertical jump, and injury prevention. Additionally, future research can explore the integration of wearable technology and biomechanical analysis to monitor and adjust training loads in real-time. More evidence is also needed on how plyometric training influences technical and tactical volleyball performance to better inform holistic player development.

CONCLUSION

Plyometric training is a form of strength training widely applied across various sports disciplines. Originally developed for use in athletics, coaches later adopted it in other sports, including volleyball. However, according to Verkhoshanski (2021), the term "plyometric training" may not be entirely accurate; the more appropriate term is "reactive strength training." For further elaboration, readers may refer to Marques Junior (2025). This systematic review examined the volume and intensity of plyometric training in high-level male and female volleyball players, revealing results that closely align with Verkhoshanski's foundational studies. Despite this alignment, the review faced certain limitations. The included studies did not determine the optimal volume and intensity of plyometric training tailored to volleyball players' development. Addressing this gap presents a valuable opportunity for future research. In conclusion, plyometric training is very important strength training for volleyball players because it improves vertical jump, velocity, agility, and other motor capacities.

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AUTHOR CONTRIBUTION STATEMENT

NKMJ was solely responsible for the conception, design, data collection, analysis. IRP manuscript writing, and final approval of this work.

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