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The Effectiveness of Specific Training Models on Increasing the Accuracy and Strength of the Jump Serve in Junior Volleyball Athletes

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Abstract

This study aims to determine the effectiveness of specific training models in improving the accuracy and strength of jump serves in junior volleyball athletes. The study employed a quasi-experimental design with a pretest-posttest control group approach. A total of 30 athletes, aged 14–16, were divided into two groups: an experimental group and a control group. The experimental group underwent a specific training program three times per week for six weeks, with each session lasting 60 minutes. The instruments used included expert-validated jump serve accuracy and power tests. Paired sample t-test results revealed significant improvements in accuracy ($t = 12.45$, $p < 0.001$) and strength ($t = 10.87$, $p < 0.001$) in the experimental group. In contrast, the control group showed no significant improvement in either variable. An independent-sample t-test revealed a significant difference between the two groups after the training period ($p < 0.05$), which was supported by a large effect size (Cohen's $d > 2$). These results demonstrate that targeted training effectively enhances jump serve accuracy and power. Structured, functional, movement-based training tailored to athletes' needs has been shown to positively impact junior volleyball athletes' serving performance.

Keywords: accuracy; junior athletes; jump serve; strength; specific training.

Introduction

The modern game of volleyball is characterized by increased speed and power, as well as efficient game strategy. One important element of the game is the serve, which not only starts the game but also creates pressure on the opponent. Among the various types of serves, the jump serve is one of the most dominant techniques used in professional-level volleyball due to its ability to produce unpredictable speed, ball rotation, and direction (Inkinen et al., 2013; Liu et al., 2024).

The jump serve incorporates complex biomechanical aspects, including core and lower-limb muscle strength, jump-timing coordination, body-rotation speed, and fine motor control at the moment of ball contact (Tillman et al., 2004; Häyrinen et al., 2011). In competitive matches, an effective jump serve can result in points (aces) or disrupt the opponent's receiving formation, providing a psychological and strategic advantage to the serving team.

However, although the importance of the jump serve is widely recognized in coaching literature and practice, its application to junior athletes still presents challenges. Many young athletes lack the muscle strength, motor coordination, and tactical understanding necessary to consistently and accurately execute jump serves (Ramirez-Campillo et al., 2021). Research by Bujang et al. (2024) shows that, compared to international standards, the level of accuracy and strength of the jump serve is still relatively low in the junior athlete group.

This inability stems not only from underdeveloped physical abilities, but also from training methods that do not specifically target jump serve development. Many junior-level coaches still use general training methods that do not directly address the specific demands of the jump serve, so the necessary motor and biomechanical adaptations are not achieved optimally (Thomas et al., 2023; Widianto & Susanto, 2020).

The specific training approach is a relevant solution to these challenges. This method directly replicates or simulates the conditions, movements, and intensity of the intended skill. In the context of a jump serve, for example, specific training includes functional exercises that emphasize aspects of jumping technique, arm swing coordination, core muscle strength, and decision-making in match situations (Markovic & Mikulic, 2010). Research has shown this approach to be more effective in producing neuromuscular and motor adaptations than generalized training (Fort-Vanmeerhaeghe et al., 2016).

This study's novel contribution is the development and application of a structured, measurable, and tailored specific training model for junior athletes' physiological characteristics and motor abilities. This study addresses the lack of research evaluating the effectiveness of specific training models for jump serves in young age groups. Most previous studies have focused on adult or elite athletes (Oliveira et al., 2020; Liu et al., 2024), so the implementation and validity of these models in early-age coaching contexts still need further study.

The specific drills developed in this study included explosive exercises, such as plyometric drills (Markovic & Mikulic, 2010), ball swing techniques with various speed and angle variations, and situational drills that mimic match conditions (Sheppard et al., 2009). Emphasizing the integration of technique and physical conditioning optimizes the synergy between components of jump serve performance (Ziv & Lidor, 2010). This approach is also designed with the principles of individualization and progressivity in mind (Bompa & Haff, 2009) to allow for the tailoring of training to each athlete's initial abilities. It is hoped that this model will accelerate the motor learning process (Magill & Anderson, 2017), correct incorrect techniques, and improve the consistency and effectiveness of jump serves (Forthomme et al., 2005).

This research is significant not only because it improves technical performance but also because it touches on an important aspect of sports performance coaching, especially at the junior level. Young athletes are in a critical stage of motor development; therefore, appropriate training interventions will impact the development of fundamental skills and readiness for higher levels of competition (Lloyd & Oliver, 2012). It is a sensitive period for developing optimal physical and coordinative capacity and requires a systematic, adaptive training approach (Ford et al., 2011; Myer et al., 2013). Thus, specific, evidence-based training models can lay the groundwork for a more scientific, measurable approach to modern coaching (Gilbert & Trudel, 2004; Williams & Hodges, 2005; Bishop, 2008).

In a national context, improving the serving techniques of junior athletes can be part of an effort to enhance volleyball coaching overall. Due to the importance of the jump serve in the modern game and the low level of mastery of this technique

among junior athletes, a structured intervention is necessary. This study aligns with national sports development directives that emphasize innovation in training systems and the development of young athletes.

Additionally, this study is novel in that it simultaneously measures jump serve strength and accuracy after the training intervention, producing more holistic data regarding the method's effectiveness. Previous studies have tended to measure only one parameter (Tillman et al., 2004; Bojanic et al., 2023), but this study combines both parameters in one evaluation framework.

Thus, this study is expected to serve as a practical reference for coaches, sports teachers, and academics when designing jump serve technique training programs tailored to junior athletes' characteristics. Ultimately, this model can be incorporated into the coaching curriculum of clubs, sports schools, and training centers so that it can contribute directly and effectively.

Methods

Research Design

This study employs a quantitative approach with a quasi-experimental pretest-posttest control group design. The study aimed to determine the effect of specific training models on improving the accuracy and strength of jump serves for volleyball athletes. The study included two groups: an experimental group that received specific training and a control group that underwent conventional training. The design is structured as Figure 1.

Participants

The research subjects were 30 junior volleyball athletes, aged 14-16, from two clubs in Bekasi City. Each group consisted of 15 athletes who were purposely selected based on the following criteria: actively training at least three times a week; not participating in special jump serve training; and being in good health. All participants obtained written consent from their parents or guardians.

Instrument

1. Jump Serve Accuracy Test

This test uses the "target zone" method, which is based on a modification of the NCSU Volleyball Skills Test Battery model. The opponent's field is divided into six target zones. Each participant performs ten jump serves and counts the number that land in the target zone.

2. Jump Serve Strength Test

Strength is measured based on the speed of the serve using a radar gun (in km/h). The radar gun is placed parallel to the baseline behind the server to measure the ball's speed after contact.

3. Technique Observation Sheet

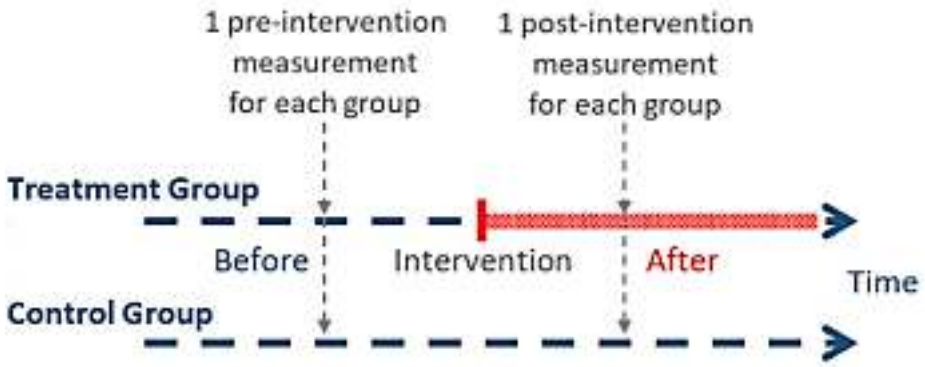
This is a checklist used to record the consistency of technical movements (toss, jump, and arm swing). It is completed by two trained observers.

Procedure

The research procedure began with a series of preparatory steps, including coordination with relevant schools, clubs, and coaches to ensure logistical and ethical compliance. Researchers conducted initial meetings with the athletes to explain the study objectives and procedures, and informed consent was obtained from all participants or their guardians. Prior to the main study, validity and reliability tests were conducted on all measurement instruments to ensure accuracy and consistency.

Following preparation, a pretest was administered to both the experimental and control groups. This involved baseline measurements of jump serve accuracy and power, conducted by certified instructors using standardized protocols. The data obtained from the pretest served as a reference point for evaluating changes after the intervention.

Figure 1
Diagram pretest-posttest control group design (Source: Reichardt et al., 2019, 2019).



The treatment phase lasted for six weeks. During this period, the experimental group participated in a specialized jump serve training program conducted three times per week, with each session lasting approximately 90 minutes. The training program focused on developing specific components of the jump serve technique, including toss and arm swing mechanics, coordination of approach steps, plyometric exercises to enhance explosive power, and targeted serving drills aimed at designated zones on the court. In contrast, the control group continued with general volleyball training sessions, which did not specifically address jump serve development.

At the conclusion of the six-week intervention, a posttest was conducted using the same procedures and measurement protocols as in the pretest. This allowed for direct comparison of the results between the two groups to determine the effectiveness of the jump serve training program.

Data Analysis

The data were analyzed using an independent-sample t-test to compare the post-test results between the experimental and control groups and a paired-sample t-test to observe changes within each group. The normality test used the Shapiro-Wilk test, and the homogeneity test used Levene's test. The analyses were conducted using SPSS version 25, and the significance level was set at $p < 0.05$.

Results

This study involved 30 junior volleyball athletes aged 14–16 years from two clubs in Bekasi City. The participants were randomly assigned to two groups: an experimental group (n = 15) and a control group (n = 15). Each athlete underwent pretest and posttest measurements following a six-week intervention period designed to improve jump serve performance.

These results shown in Table 1 demonstrate notable improvements in both performance indicators for the experimental group, while only minimal gains were observed in the control group.

The outcomes confirmed that all variables were normally distributed and demonstrated homogeneity of variance ($p > 0.05$), thus validating the use of parametric statistical procedures.

Following the six-week intervention period, the experimental group exhibited statistically significant improvements ($p < 0.05$) in both jump serve accuracy and jump serve power, accompanied by very large effect sizes (Cohen's $d > 2.0$), indicating a substantial practical impact. In contrast, the control group, which followed standard training protocols, demonstrated no statistically significant gains ($p > 0.05$), with effect sizes ranging from small to moderate.

To further examine the efficacy of the intervention, independent samples t-tests were conducted on the posttest scores to compare the performance outcomes between the two groups. Both comparisons yielded highly significant differences ($p < 0.001$), with very large effect sizes (Cohen's $d > 1.3$), confirming that the experimental group outperformed the control group by a substantial margin.

These findings provide strong empirical support that the targeted six-week training program significantly enhanced jump serve performance among junior volleyball athletes. The program, which was specifically designed to improve toss mechanics, step coordination, and upper-limb and core muscular strength, proved to be an effective intervention for optimizing critical technical and physical components of the jump serve. In contrast, the conventional training followed by the control group produced only marginal improvements, further underscoring the added value of a specialized and structured training regimen.

Table 1
Descriptive Statistics and t-Test Results for Jump Serve Accuracy and Power Pretest–Posttest Comparison and Between-Groups Posttest Differences

Variable	Group	Pretest M (SD)	Posttest M (SD)	t (14)	*p*	Cohen's *d*	t (28)	*p*	Cohen's *d*
Jump Serve Accuracy	Experimental	62.4 (5.3)	85.7 (4.8)	12.45	< .001	2.54	9.32	< .001	2.10
	Control	61.8 (6.1)	66.2 (5.9)	2.10	.052	0.42			
Jump Serve Power *(km/h)*	Experimental	72.5 (4.6)	86.3 (5.1)	10.87	< .001	2.22	8.75	< .001	1.95
	Control	71.9 (5.2)	74.2 (5.0)	1.95	.065	0.39			

t (14) = paired samples t-test within each group;
t (28) = independent samples t-test comparing experimental and control groups on posttest scores.
Cohen's *d* interpreted as: small = 0.2, medium = 0.5, large = 0.8, very large > 1.3.
All significance levels are two-tailed.

Discussion

This study demonstrated that applying specific training models positively affects volleyball athletes' jump serve accuracy and strength. Exercises designed to focus on the technical, tactical, and physical aspects of the jump serve can improve movement efficiency and the athlete's ability to control the ball's direction and power.

Specific exercises, such as drill targeting, plyometric training, and core and leg strengthening, support the development of stable, effective movement patterns. These findings align with those of Smith and Lees (2020), who stated that explosive strength and systematically trained coordinative skills strongly influence serving performance in volleyball. The ability of the muscles to generate force when jumping and hitting the ball simultaneously is crucial to achieving optimal accuracy and ball speed.

In addition to the physical aspects, specific training also plays a role in building technical consistency. Repetitive training with a structured approach improves muscle memory, making it easier for athletes to control their toss and swing. Riki Agustian (2023) emphasizes that technical skills, such as a precise toss and proper posture when making contact with the ball, significantly impact the accuracy of the serve.

This specific training model also has advantages over conventional training. Generalized and undirected training often fails to target important components of the jump serve. According to Dimyati's (2016) research, training that does not consider the specific movement needs of a particular sport tends to have a smaller impact on performance improvement.

The specific training model used in this study supports the development of better neuromuscular abilities. Plyometric exercises, which emphasize fast and explosive movements, improve motor unit recruitment efficiency and reflex speed. These are both necessary for executing jump serves (Pratama et al., 2024). In volleyball, players who have mastered the technique and have explosive muscle strength can produce serves that are more difficult for opponents to return.

These findings are important for coaches and training program developers. They can integrate specific training models into the routine training curriculum, especially during competition preparation phases, to improve serving ability, which is a strategic component of volleyball. This aligns with Kurniawan and Weda's (2022) assertion that structured and systematic training is crucial for developing sports skills.

The results are promising, but the study has limitations regarding sample size and training duration. To obtain more generalizable results, future studies should consider including more participants and extending the intervention's duration. Additionally, combining physical exercise with technology, such as video analysis or VR-based training applications, could be an interesting innovation for developing specific exercises in the digital era (Bakhri et al., 2020).

Thus, the specific training model has been proven to be an effective approach to improving the quality of jump serve technique. This effectiveness includes improvements in motion control, directional accuracy, hitting power, and energy efficiency in movement execution. This research reinforces the idea that training designed according to the specific needs of a skill is more likely to produce real, sustainable performance improvements.

Conclusions

This study shows that the specific training model significantly improves the ability of volleyball athletes to perform jump serves, in terms of both accuracy and strength. Training that focuses on technical and physical elements in accordance with the characteristics of the jump serve motion can improve movement efficiency, accuracy, and hitting power. Exercises such as drill targeting, core and leg muscle strengthening, and plyometric exercises have been shown to support the neuromuscular and mechanical adaptations required for volleyball serving.

This model can serve as a reference for developing volleyball training programs, particularly for developing individual technical skills. This research also opens opportunities for developing more innovative training programs by incorporating technological or sports psychological approaches to optimize athlete performance.

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