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The explosive power of the upper and lower extremities and its relationship to the accuracy of the spike serve in volleyball

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Abstract
The present study aimed to examine the relationship between the explosive power of both the upper and lower extremities and the accuracy of performing the spike serve in volleyball. A descriptive research design was adopted as the most appropriate method for addressing the research problem. The study sample consisted of ten players from hit sports club specializing in volleyball. To achieve the objectives of the study, the researcher selected a set of standardized physical and technical tests aligned with the research aims. After analyzing and discussing the results, the findings revealed a statistically significant correlation between the explosive strength of the upper and lower limbs and the accuracy of executing the spike serve skill. Based on these findings, the study concluded that explosive muscular power plays a decisive role in the quality of technical performance in volleyball. Accordingly, the researcher recommended giving priority to developing explosive strength in training programs, as it has a direct and measurable effect on the accuracy and effectiveness of the spike serve.

Keywords: Explosive power, upper extremities, lower extremities, spike serve, accuracy, volleyball

Introduction
Physical fitness is universally acknowledged as a fundamental determinant of athletic achievement, regardless of the type of sport or competitive event. Enhancing and maintaining high levels of physical fitness is essential for athletes, and the relevance of specific fitness components varies depending on the demands of the sport. While some disciplines place a premium on endurance, others emphasize speed, agility, or muscular strength.

Among these components, muscular strength occupies a central role due to its direct impact on movement efficiency and athletic performance. No sporting activity is devoid of strength-related demands, making it a cornerstone of success in both individual and team sports. Consequently, modern training strategies in sports science have increasingly emphasized strength development as a foundation for athletic excellence.

Volleyball, in particular, is a sport that relies heavily on muscular power, especially in skills that require explosive execution. One of the most decisive techniques in volleyball is the spike serve, which demands both general muscular strength and explosive power. This specific type of strength enables the player to generate maximal force in minimal time, directly influencing the ball's velocity, trajectory, and placement. The spike serve is therefore regarded as a performance-differentiating skill that can significantly contribute to team success at competitive levels.

The significance of the present research lies in clarifying the nature and extent of the relationship between explosive power of the upper and lower extremities and the technical accuracy of the spike serve. By identifying this relationship, the study provides evidence-based recommendations for training practices aimed at optimizing volleyball performance.

Research Problem
The consolidation and mastery of skill performance in volleyball players is closely linked to the quality of physical preparation and the integration of key components of physical fitness during training and competition. However, through the researcher's observation of several matches played by the Hit Sports Club volleyball team, it was noted that the training emphasis was directed more toward technical skills, while certain essential aspects of physical

conditioning were overlooked. Among these neglected elements was explosive power, whose decline was evident in the players' performance.

Given the vital role of explosive strength in volleyball, particularly in executing high-intensity skills such as the spike serve, the researcher identified the need to investigate the relationship between the explosive power of the upper and lower extremities and the accuracy of this skill. This problem was therefore considered a suitable subject for systematic scientific inquiry.

Research Objective

- To identify the relationship between the explosive power of the upper and lower extremities and the performance accuracy of the spike serve skill in volleyball.

Research Hypothesis

- There is a statistically significant correlation between the explosive power of the upper and lower extremities and the performance accuracy of the spike serve skill in volleyball.

Research Scope

- Human Domain: The study sample consisted of players from Hit Sports Club specializing in volleyball.
- Time Domain: The research was conducted over a defined period extending from April 5, 2025, to July 1, 2025.
- Spatial Domain: The study was carried out at the volleyball training and competition field of Hit Sports Club.

Research Methodology

The researcher employed the descriptive approach, as it represents the most appropriate methodology for addressing the nature of the research problem and achieving its objectives.

Research Sample

The research population consisted of 21 volleyball players representing the *Hit Sports Club*. From this population, a random sample of 10 players was selected using a lottery method, which represents 61.47% of the original community. Players chosen for the pilot experiment were excluded from the main sample to ensure the validity of the results.

Research tools and means of data collection

To achieve the research objectives, the following tools and means were employed

- Arabic sources and references.
- Standardized physical and skill tests relevant to the research.
- Statistical methods for data analysis.
- Measuring tape.
- A legal volleyball court.
- Official volleyballs.
- Medicine balls.
- Assistance team for test management.
- Colored ribbons for court marking.

Research Tests

In order to gather reliable data, the researcher applied the following tests:

First Test (1:110)

Medicine Ball Push Test (3 kg)

- **Objective:** To measure the explosive strength of the arms.
- **Tools Required:** Flat space, small rope, medicine balls (2.70-3 kg), chair, flags or banners, measuring tape.

Performance Description

- The subject sits on a chair, holding a medicine ball with both hands in front of the chest and just below chin level.
- A rope is tied around the subject's chest and held firmly from behind to prevent forward movement while pushing the ball.
- The ball is propelled using only the hands, without trunk movement.

Instructions

- Each subject performs three consecutive attempts, after one practice attempt.
- If the subject moves or shakes on the chair during performance, the attempt is repeated.

Test Administration

- A recorder documents the results.
- A judge supervises rope handling and movement control.
- An observer identifies the ball's landing point and measures the distance.

Scoring

- The score equals the distance (in cm) from the front edge of the chair to the closest point where the ball lands, rounded to the nearest 15 cm.
- The best score from the three trials is recorded.

Second Test (1:84)

Sargent Vertical Jump Test

- **Objective:** To measure the explosive power of the legs in a vertical jump.
- **Tools Required:** Blackboard or wooden panel (0.5 × 1.5 m) marked every 2 cm, wall ≥ 3.60 m high, chalk, lime powder, and cloth for cleaning marks.

Performance Description

- The subject stands facing the board, marks the maximum standing reach with chalk, and then performs a vertical jump using a preparatory arm swing and knee flexion at a 90° angle.
- The maximum reach point during the jump is marked on the board.

Instructions

- The subject performs 3-5 attempts, with the best score recorded.
- Both feet must remain together during the jump, and chalk must not extend beyond the fingers.
- Measurements are recorded to the nearest 1 cm.

Test Administration

- A recorder logs results.
- A supervisor observes performance and calculates scores.

Scoring

- The score equals the difference (in cm) between the standing reach and the highest jump mark.

Third Test (2:240)

Volleyball spike serve accuracy test

- **Objective:** To assess the accuracy of the volleyball spike serve.
- **Tools Required:** Regulation volleyball court, five official volleyballs, and colored ribbons to divide the target areas of the court (as shown in Figure 1).

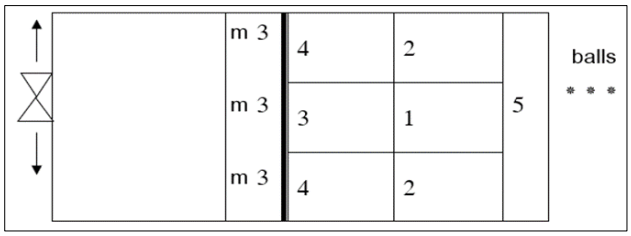

Fig 1: Volleyball smash serve accuracy test

Fourth Test (2:240) volleyball spike serve accuracy test

Performance Specifications

The tested player stands at the center of the baseline of the court, specifically at a distance of 9 meters from the net, facing the designated half of the court. From this position, the player performs the spike serve in an attempt to send the ball over the net into one of the predetermined target zones.

Performance Conditions

- If the ball touches the net and still crosses it successfully, the attempt is counted as valid.
- If the ball lands outside the court boundaries, the attempt is recorded but considered unsuccessful.
- Each player is given five attempts.

Scoring System

- The score corresponds to the zone (1-5) in which the ball lands.
- Each correct attempt is awarded the value of the corresponding zone.
- The maximum achievable score is 25 points (five successful serves landing in the highest-value zone).
- If the ball lands on a boundary line between two zones, the score of the higher zone is awarded.

Exploratory (Pilot) Experiment

The pilot study was conducted as a preliminary trial to ensure the suitability of the selected tests and procedures. The researcher, along with the assistant team, carried out the pilot experiment at the volleyball hall of *Hit Sports Club* at 5:00 p.m. on Saturday, April 5, 2025.

A group of players outside the main sample was chosen to participate. The objectives of the pilot experiment were to:

- Verify the appropriateness of the tests relative to the participants' skill levels.
- Determine the approximate time required to implement the tests.
- Assess the efficiency, coordination, and adequacy of the assistant team.

Main Experiment

After confirming through the pilot study that the tests were suitable and the assistant team was efficient, the main experiment was conducted with the research sample. This took place at the same venue, under identical spatial and temporal conditions as the pilot study, at 5:00 p.m. on Wednesday, April 9, 2025.

During this stage, all selected tests were administered to the sample, and results were carefully documented for subsequent statistical analysis to address the research objective.

Statistical Methods

The following statistical methods were employed to process and analyze the collected data:-

- Percentage (%).
- Mean (M).
- Standard Deviation (SD).
- Pearson's Correlation Coefficient (r).

Results and Discussions

Presentation, Analysis, and Discussion of the Results

Presentation and Analysis of the Results

The statistical analysis of the data collected from the research sample was conducted to verify the research hypothesis and determine the nature of the relationship between the explosive power of the upper and lower extremities and the accuracy of the spike serve skill in volleyball. The arithmetic means and the values of the Pearson correlation coefficient (r) were calculated for the variables under study.

Table 1: Show mean values and Pearson's correlation coefficients for the research variables

Variables	Mean	Calculated Value of (r)	Indication
Pushing a medicine ball weighing (3 kg) with the hands and upper limbs	317.23	0.768	Significant
Volleyball spike serve accuracy	12.80		
Vertical jump from standing position (lower limb explosive power)	32.43	0.734	Significant
Volleyball spike serve accuracy	12.80		

Statistical Analysis

The tabular value of Pearson's correlation coefficient (r) at a significance level of 0.05 and a degree of freedom (DF=8) was found to be 0.632.

From Table 1, the correlation coefficient between the *medicine ball push test (upper limb explosive power)* and *spike serve accuracy* was 0.768, which is greater than the tabular value (0.632). This indicates that the relationship is statistically significant.

Similarly, the correlation between the *vertical jump test (Lower Limb Explosive Power)* and *spike serve accuracy* was 0.734, which also exceeds the tabular value (0.632). Thus, the relationship is also statistically significant.

Discussion of the Results

The results clearly demonstrate that the calculated values of (r) exceeded the tabular value, which confirms a significant correlation between explosive power of the upper and lower extremities and the accuracy of the spike serve skill in

volleyball. This implies that greater explosive power contributes to higher accuracy and mastery in performing the spike serve.

Biomechanically, this finding is consistent with the principle of kinetic chain transfer: The explosive force generated in the lower limbs is transferred through the trunk and finally expressed through the arms. When this sequence is optimized, the resulting serve becomes more powerful, precise, and difficult to defend against. Conversely, any weakness in explosive muscular capacity disrupts this chain and reduces the effectiveness of the skill.

Supporting this perspective, Aqeel Al-Kateb notes:

"Volleyball requires the player to demonstrate the explosive power that is achieved when hitting the ball in a spike serve" (4:54).

The researcher adds that the effectiveness of this muscular ability is not limited to the legs but also extends to the arms. Developing explosive power holistically enables the player to perform the spike serve with instantaneous speed, higher vertical reach, and improved accuracy, which ultimately contributes to scoring critical points that may shift the outcome of a match.

Conclusions

- There is a statistically significant correlation between the explosive power of the upper and lower extremities and the accuracy of the spike serve skill in volleyball.
- Any development in explosive muscular power of both arms and legs leads directly to improvement in the technical performance of the spike serve.

Recommendations

- Emphasize the importance of physical fitness development in volleyball training, particularly strength-related components.
- Incorporate diverse training methods, especially plyometric exercises, to enhance explosive strength in both upper and lower limbs.
- Innovate and adopt new training strategies aimed at improving volleyball skill performance, especially the spike serve.
- Apply the conclusions of this research to the training programs of the Hit Sports Club volleyball players to maximize their competitive performance.

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