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THE EFFECTIVENESS OF FASCIA TRAINING IN IMPROVING SERVE ACCURACY AND SPIKE VELOCITY AMONG FEMALE VOLLEYBALL PLAYERS AT PALESTINE TECHNICAL UNIVERSITY – KADOORIE

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Abstract
This study investigated whether an eight-week fascia-based training program improves serve accuracy and spike velocity in female volleyball players at Palestine Technical University – Kadoorie. Twenty-eight athletes were randomly assigned to an experimental group (n=14) that performed fascia training three times per week (45 minutes per session) or to a control group (n=14) that continued routine practice. A quasi-experimental pretest–posttest control-group design was used. Outcomes were serve accuracy to five court zones and spike velocity in three conditions (Standing A, Above Net, General Position C). Groups were equivalent at baseline. Within the experimental group, paired samples t-tests showed significant pre–post gains ($\alpha \leq 0.05$) in all skill variables, with particularly large improvements in serve accuracy (Zone 1: 324.05%, Zone 2: 134.27%, Zone 3: 100.58%, Zone 4: 163.16%, Zone 5: 68.82%) and smaller but reliable increases in spike velocity (Standing A: 0.96%, Above Net: 1.28%, General Position C: 1.67%). Between groups, ANCOVA controlling for pretest scores indicated that the experimental group outperformed the control in every serve-accuracy zone (F values significant at $\alpha \leq 0.05$; $\eta^2=0.25–0.48$) and in all spike-velocity tests (F significant; $\eta^2 \approx 0.20–0.21$). These effects reflect moderate-to-large practical magnitudes. The findings suggest that fascia-oriented conditioning—which emphasizes elastic loading, recoil, and kinetic-chain coordination—can enhance the precision and speed components underpinning volleyball's decisive technical actions. Implementing such training alongside technical practice may offer coaches a feasible, evidence-supported strategy to improve performance quality among university-level female players.
Keywords: Fascia training; Volleyball performance; Serve accuracy; Spike velocity

INTRODUCTION

Volleyball is a game that incorporates power, accuracy, and timing, and the players have to integrate strength, flexibility, and regulation in each movement (Keoliya et al., 2024). The serve and the spike belong to the various technical skills, two of the most critical actions, which define how the play moves and succeeds (Karisman, 2023). In the case of female university players, such skills are not only about the power but also about the expression of effective, well-focused force by being in balance and rhythm (Wang et al., 2025). Recently, sports performance studies have started to uncover the use of the more conventional methods of muscle training by taking a closer look at the extensions of the body, where the fascial system is seen to be more effective in determining the movement efficiency of the body (Schleip et al., 2021).

Fascia Training is a new model of athletic conditioning that focuses on the exercises that stimulate and develop the connective tissue structure of the body. This system is vital in stability, elasticity and energy transmission between the muscles and joints (Alabau-Dasi et al., 2022). The fascia training improves coordination and fluid movement along the kinetic chain through controlled stretching, dynamic loading, and the rebound movement (Allois et al., 2021). As opposed to traditional strength programs which aim to train single muscle groups, fascia-based work is based on general movement patterns - assisting athletes to perform quicker, more precise, and more powerful motions (Souzana et al., 2022). In volleyball, where lower- and upper-body power is crucial, this kind of training can have a direct impact on the accuracy of the serve and the speed of the spike (Soylu and Altundag, 2024).

In Palestine Technical University - Kadoorie the volleyball among women is gradually evolving, and a great deal of its participants continue to use the traditional training methods that do not take into account the modern biomechanical concepts wholly. The introduction of fascia-based training may be a scientific and practical solution to the improvement of technical performance by more effective body mechanics. Knowledge of whether such a direction can result in quantifiable changes in serving and spiking can assist coaches in creating more intelligent and evidence-based training programs appropriate to the requirements of the female athletes at the university level..

Problem Statement

Despite advances in sports science, training programs for female volleyball players at Palestinian universities continue to emphasize muscular strength and endurance, often neglecting the fascial and myofascial systems' roles in dynamic movement. This oversight constrains the athletes' capacity to produce fast, coordinated, and energy-efficient actions—qualities essential for effective serving and spiking. For example, interventions targeting myofascial structures, such as dry needling of latent trigger points, have been shown to improve explosive performance in female volleyball players (Ladriñán-Maestro et al., 2024). Moreover, narrative reviews of the myofascial system emphasize its importance in coordinated force transmission and energy conservation, identifying it as a crucial yet underutilized domain in high-speed athletic actions (Colonna & Casacci, 2024). In contrast, studies from the Palestinian volleyball context indicate that local research continues to focus primarily on conventional physical and harmonic capacities rather than fascial or connective-tissue aspects, underscoring a persistent gap in training design (Nassar et al., 2024). The absence of fascia-specific exercises in most conditioning programs means that players may develop strength without achieving the optimal transfer of power through their kinetic chains, leading to inconsistent accuracy and reduced striking velocity (Schleip et al., 2021). There is also a lack of empirical research within the Palestinian context examining the application of fascia training in volleyball performance. Most existing studies focus on Western populations and professional athletes, leaving a void in localized evidence for university-level female players.

Therefore, this study proposes to experimentally assess whether a structured fascia training intervention can produce measurable improvements in serve accuracy and spike velocity among female volleyball players. By employing a quasi-experimental design with pre-test and post-test assessments and a control group, the research aims to isolate the contribution of fascial conditioning to performance enhancement. The outcomes are expected to inform both the theoretical understanding of movement integration and the practical design of advanced volleyball training programs grounded in connective tissue and neuromuscular principles.

Research Questions

1. Does the use of a Fascia Training program enhance accuracy in female volleyball players in Palestine Technical University - Kadoorie?
2. Does Fascia Training program improve the spike velocity and skill performance overall at the end of the training?
3. Do the post-test Fascia Training and conventional training method result in statistically significant differences in the skill variables in the experimental and the control group?

Research Objectives

1. To investigate the influence of the Fascia Training program on acquiring the essential technical skills, especially serve accuracy and spike velocity, in the female volleyball players.
2. To determine the level of change in skill performance of pre- and post-tests due to the training program applied.
3. To compare the post-test outcomes of the experimental and control group to establish the Fascia Training effectiveness in improving the volleyball-specific skills performance.

Research Hypotheses

H1: There are no statistically significant differences at the level ($\alpha \leq 0.05$) between the pre-test and post-test measurements of the skill variables among female volleyball players in the experimental group.

H2: There are no statistically significant differences at the level ($\alpha \leq 0.05$) in the post-test results of the skill variables between female volleyball players in the experimental group and those in the control group.

Significance of the Study

The present research is important because it proposes a new evidence-based approach to volleyball performance in the form of Fascia Training that will increase energy transfer and neuromuscular coordination. It offers scientific ideas new to the field of research on how to increase the accuracy of serves and the velocity of the spike by highlighting the importance of the fascial system, which has always been in the shadow of the traditional strength exercise. In the Palestinian university sports setting, the results provide a practical benefit since they provide a contemporary and accessible strategy of enhancing the technical and functional skills of female athletes. In addition, the study is valuable to the field of sports science throughout the world as it applies the concept of fascia-based training to collegiate female volleyball athletes to favor more comprehensive, effective, and injury-preventive performance models.

Operational Definitions

Fascia Training: "This is a type of training based on the idea of bringing elasticity, tension management, and functional incorporation of the body fascial network. It has dynamic stretching, rebound loading, multi-planar movement patterns, and myofascial release exercises targeting coordination, force transmission, and the overall efficiency of the movement" (Schleip et al., 2021).

Serve Accuracy: "The skill of the volleyball player to serve the ball to a specific area of the court of the opponent with accuracy, control, and consistency" (Costa et al., 2024). The accuracy of the serves in this research was assessed by the performance tests where the successful serves were made to the specific areas (zone 1-5) under standardized circumstances.

Spike Velocity: "The fastest instant of the volleyball contact when spiking is performed, and the player can both produce and transmit the kinetic energy effectively through the body through the kinetic chain" (Baena-Raya et al., 2021). The spike velocity was measured in this study with the help of performance-based measurements in three conditions of standing, elevation above the net, and general attack position.

THEORETICAL FRAMEWORK

The musculoskeletal, nervous, and fascial systems work synergistically and define the capability of an athlete to produce and transmit force effectively to improve athletic performance in volleyball (Martin et al., 2024). Recent changes in the paradigms of training have moved beyond a muscle-based perspective on training to a systems-based view of the human body as an interactive myofascial web (Ruggia, 2025). Fascia Training Fascia Training is a practice that focuses on elasticity, continuity, and adaptability of fascial tissues and has become a scientifically-based approach in increasing the efficiency of movements and neuromuscular coordination (Allois et al., 2021). This framework provides theoretical background to the investigation into the usefulness of fascia-based conditioning to enhance the accuracy of serve and spike velocity of female volleyball players (Caldeira, 2021).

The volleyball play is characterized by fast stretch-shortening cycles, the optimal coordination of the kinetic chain, and the accurate motor control (Baena-Raya et al., 2021). Although effective in enhancing isolated muscle force, traditional strength and power training usually does not consider the elastic, proprioceptive, and coordinative properties of fascial tissues (Rios, 2025). The current paradigm incorporates the concepts of biomechanics, physiology, and learning in order to understand the potential of fascia-based training to help achieve the best results in such a skill-based volleyball action.

Biomechanical Foundations of Fascia and Movement Efficiency

Fascia refers to a three compartment connective tissue, which encloses and connects all organs including muscles and bones. It does not have the functions of a structural support by itself but has functions of a force transmission organ and a sensory regulation organ. Based on the Fascial Continuity Model (Schleip and Muller, 2013), tension in a particular area of a muscle transmits along the fascial lines in a remote area, and constitutes a common chain of mechanical interdependence. The force exerted by the prime movers (such as pectoralis major or quadriceps) in this network is shared through the fascial chains and enhances coordination and reduces energy waste (Bordoni and Myers, 2020). The Biomechanics of a volleyball Spike or serve is determined by the series of energy transfer through lower extremities via the trunk to upper extremities a process known as the kinetic chain.

Neurophysiological Principles and Motor Control Adaptations

The fascial system is densely innervated with mechanoreceptors including Ruffini endings, Pacinian corpuscles as well as interstitial receptors being able to provide the body with ongoing sensory responses to tension, pressure and movement. The idea of Tensegrity Model of human movement has evolved fascia as an active sense organ that may be engaged in the postural regulation and proprioception processes. In this aspect, fascial training does not simply alter tissue mechanics but it re-calibrates neural control loops that order patterns of musculoskeletal activity (Oleari et al., 2023). The fine motor sequencing and timing is correlated with the maximum performance of a volleyball player whenever he or she serves or spikes.

It has a theory founded on the Central Pattern Generator (CPG) theory (Feldman et al., 2021) and the Dynamic Systems Theory (Kelso, 1995), according to which movement is an effect of the interaction of the neural control with the muscular properties and a combination of environmental conditions. The proprioceptive pathways become more sensitive and intermuscular coordination becomes more effective (Fascia Training), which makes the changes between the eccentric loading and concentric releasing stages easier (Schleip & Muller, 2013). The neurophysiological alterations can be among the causes of experimented variations in both precision and speed, and the nervous system is more precise to utilize the elastic recoil with less energy loss (Schleip et al., 2021).

The Myofascial System and Elastic Energy Transfer

Fascia Training is primarily based on Elastic Energy Storage and Recoil Theory, which states that elastic tissues could be biological springs that could temporarily store mechanical energy during eccentric loading and discharged during concentric movement (Schleip and Bartsch, 2021). Volleyball volleys consist of the high-speed stretchshortening cycles (SSC) during which the myofascial system is pre-loaded and then released violently (Rebelo et al., 2022).

Conventional muscle training enhances the contractile power whereas fascia-based training enhances the ability of tendons and aponeuroses to store and release elastic energy (Chaitow, 2018). Schleip et al. (2021) showed that the targeted fascial stimulation can improve the alignment and hydration of the connective tissue, making it stiffer and more resilient.

This enhances viscoelastic balance to provide quick transitions between loading and propulsion with less delay between relaying the ground-reaction force. The example of a spike is that, when a spike is performed the player has increased fascial recoil which increases the speed of arm swing and keeps the transfer of kinetic energy between the trunk and the hitting arm steady. And in the same fashion, in serving, fascial elasticity also helps in the whip-like action in projecting the ball with high speed, and the neuromuscular fatigue is also reduced.

Integration of Fascia Training within Volleyball Performance

Volleyball activity is typified by repetitive explosive movements which involve coordinated interactions of a number of muscle groups along planes of movements. Although different, the spike and serve have biomechanical principles, which include proximal-to-distal sequencing, stretch-shortening, and rapid stabilization when landing. Traditional conditioning tends to isolate muscle groups whereas Fascia Training is more of a global movement approach- increasing connectivity among lower- and upper-body parts of the body (Al-talahmeh et al., 2025). Fascia-oriented exercises can facilitate the ability to establish more efficient kinetic connection of the legs, the trunk, and the arms by targeting spiral and longitudinal chains of fascia (e.g., the superficial back line or the lateral line as defined by Myers, 2020).

Such integration directly converts into volleyball-specific movements, an elastic posterior chain raises the height and speed of the arm in a jump, and better fascial movement in the upper quadrant increases rapid and precise rotary movement of the shoulder. Moreover, the greater fascial hydration and sliding range, the lower the internal friction, which enables a more comfortable deceleration on ball contact, which is a necessary element to preserve precision when using high force (Myers, 2020). The effects of this integration are not limited to physical efficiency to movement precision. The superior sensory information of fascial mechanoreceptors allows the athlete to have a better time and place perception of the limbs, which leads to better consistency of the serve direction and spike placement (Hodgson, 2025). By so doing, conditioning using fascia closes the mechanical-mechanical and the perceptual-perceptual division of volleyball performance.

Skill Acquisition and Motor Learning in Serve Accuracy and Spike Velocity

Motor skills that are complex in both the biomechanical strength and mental control are serve accuracy and spike velocity. Regarding motor learning, the abilities are mastered through feedback, variability and contextual interference- that can be better developed through fascia-oriented practice. The Ecological Dynamics Approach (Davids et al., 2015) believes that the learning process is a consequence of perceiving and acting within the confines of the tasks. Fascia Training allows the athlete to select smaller signals of the environment and can adjust the motor output as it increases the proprioceptors and movement sensitivity.

Furthermore, the Schema Theory of Motor Learning (Schmidt, 1975) also emphasizes that variability of practice boosts the generalized motor program, which forms the basis of performance of a motor skill. The changing nature of fascia exercises both directionally and rhythmically, predetermines the athletes to a range of loading vectors and time varying states, which is an automatic stimulator of a flexible motor pattern, which is readily applied to volleyball action. This also leads to reduced error in movement and more consistent ball contact with time, and with consistency, increased accuracy.

Spike velocity, in its turn, is directly related to rate of force development (RFD) and intermuscular coordination (Blazevich et al., 2020). The eccentric-concentric transition of the neuromuscular latency, in its turn, promotes the faster contraction rate and reduces the electromechanical delay (Marathamuthu, 2020). These conforming adaptations that produce the performance enhancements that can only be immediately identified in the explosive technical act of volleyball are created as the result of these performances.

Conceptual Model of Fascia-Based Performance Enhancement

The combination of the latter principles into a theoretical framework are the notion of fascia as a mechanical and neural intermediary of performance enhancement. The model is a combination of three interacting sub systems:

1. **Mechanical subsystem:** Enhancement of tissue stiffness, recoil capacity, and energy efficiency through targeted fascial loading.
2. **Neural subsystem:** Enhanced proprioceptive feed-back, intermuscular timing and central coordination which is a resultant increase in the activity of mechanoreceptors.
3. **Skill subsystem:** Precision of technical performance by refinement of motor learning, minimisation of energy dissipation, and increased accuracy of movements.

In this model, Fascia Training is a unifying stimulus that has an effect on the hardware (biological structure) and software (motor control) of athletic movement. In volleyball, the two-fold effect is an increase in accuracy of serves because of a better proprioceptive calibration, and increased spike velocity because of an increase in kinetic chain efficiency. The interaction of the mechanical elasticity with the neural sensitivity represents the principle of biotensegrity where stability and movement are attained by stable tension and not by structure.

Empirical and Theoretical Support

Empirical evidence in recent years supports the explanatory nature of the theoretical foundations of including fascia-based training in performance training. To illustrate, Baena-Raya et al. (2021) showed that athletes whose force-velocity profiles were more optimized and whose neuromuscular coordination was higher showed better change-of-direction performance a finding that is consistent with the conception that connective tissue mechanics and evanescent force travel can play an important role in the execution of athletic skill. These results support the theoretical assumption that the fascia system is not a passive system, but rather an involved party in the process of modulating forces, proprioceptive responses, and energy recycling (Schleip, and Bartsch, 2021).

Biomechanically and physiologically, specific fascial stimulation has been found to add stiffness to tissues, improve the collagen fiber orientation, and augment viscoelasticity of connective tissues (Schleip et al., 2021). These modifications minimise the losses of energy in quick changes of movement and enhance the performance of rebound in stretch-shortening cycles. This mechanism is a plausible way of how the fascia training can result in improved output and more precise control through the high-speed serves and spikes in explosive sports like volleyball that need to be effectively transferred across the joints.

Emerging evidence on the neural side supports the high mechanosensitivity of the fascial network. The high concentration of mechanoreceptors like Ruffini and interstitial receptors gives fascia a role in sensory control and motor control (Oleari et al., 2023). Fascia training could therefore reset sensorimotor loops, improving intermuscular timing and reducing electromechanical delay. The nervous system can better utilise stored elastic energy with optimised feedback and coordination so that the refined movements required to serve direction and spike velocity can be accomplished.

Combined, these empirical and theoretical sources of evidence point to one conceptual framework: fascia is a mechanical mediator and neural integrator of athletic movement. In volleyball, this refers to the fact that properly designed fascia training can be used upstream of strength benefits - better movement economy and coordination and hence produce quantifiable benefits in serve accuracy and spike velocity performance.

Theoretical Proposition

Resting on the combined theoretical argument, the current research is premised on the following hypothesis:

Fascia-based training improves the performance of volleyball skills as it maximizes the mechanical, neural, and perceptual efficiency of the kinetic chain resulting in quantifiable elevations in the accuracy of the serves and the velocity of the spikes.

It is this recommendation that bridges the gap between micro-levels of the adaptations of connective tissue and the macro-levels of sport performance. The model assumes that repeated elastic loading improves fascial resilience, neuromuscular control and proprioceptive feedback mechanisms get fined to give more efficient and better-release movement performance. Those are not the only anticipated outcomes that can be attained but are accuracy, timing, and intersegmental harmony-some of the components of the high-level volleyball performance.

This theory contributes to the relevance of Fascia Training as an intervention to the performance and scientifically indubitable intervention, basing on the biomechanics, physiology, and motor learning. Good theoretical grounds as to why the fascial system should be incorporated in volleyball conditioning programs would be the ability of the fascial system in storage of elastic energy, neuromuscular communication and integration of body parts. The regularity of use will probably simplify the efficacy of release of force, enhance precision of the movement, and generate the neuromechanical foundation of explosive-like movements such as serving and spiking by Fascia Training.

In conclusion, the interplay of myofascial elasticity, neural coordination, and skill adaptation provides a complete developed theoretical framework, through which the processes of intervention based on fascia can be converted into the actual volleyball performance increase. Such synthesized knowledge does not only provide the hypothesis of the present research with the justification but also contributes to an overall theoretical advancement of the science of athletic training as fascia is recognized to be among the major predictors of the quality of movement and the performance optimization.

Methodology

The current study adopted a quasi-experimental approach to explore the effectiveness of a fascia-based training program on improving serve accuracy and spike velocity among female volleyball players at *Palestine Technical University – Kadoorie*. This design incorporated both an experimental and a control group, allowing for comparisons between pre- and post-test performances to determine the influence of the intervention. The experimental design followed the structure (O_1–T–O_2) for the experimental group and (O_3—O_4) for the control group, where *T* represents the application of the Fascia Training program and *O* indicates the pre- and post-tests conducted on both groups.

Participants and Grouping

The study sample consisted of 28 female volleyball players aged between 18 and 21 years, enrolled in the volleyball program at *Palestine Technical University – Kadoorie, Ramallah Branch*. The participants were purposefully selected and randomly divided into two equal groups:

- An **experimental group (n = 14)** that underwent the Fascia Training program.

- A **control group (n = 14)** that continued with its standard volleyball training regimen.

To ensure equivalence, both groups were compared on baseline characteristics including age, body mass, height, and selected physical fitness variables. The results confirmed that no statistically significant differences existed between the two groups at the pre-test level ($p \leq 0.05$), as shown in Table (1) and Table (2).

Table1*Descriptive characteristics of the study sample (n = 28)*

Variables	Mean ± SD	Skewness	Kurtosis
Age (years)	19.75 ± 0.97	-0.51	-0.52
Body Mass (kg)	59.64 ± 8.52	0.76	0.27
Height (m)	1.64 ± 0.06	0.17	-0.02

To ensure group equivalence before the intervention, *t*-tests were conducted on demographic and baseline physical-fitness variables as shown in table (2):

Table2 *Comparison of pre-test characteristics between the experimental and control groups*

Variables	Experimental Group (n = 14) Mean ± SD	Control Group (n = 14) Mean ± SD	*t*-value	*p*-value
Age (years)	19.86 ± 0.94	19.64 ± 1.01	1.74	Ns
Body Mass (kg)	62.35 ± 7.88	56.93 ± 8.53	0.56	Ns
Height (m)	1.64 ± 0.06	1.63 ± 0.05	0.23	Ns
Medicine Ball Throw (m)	3.24 ± 0.45	3.08 ± 0.20	1.22	Ns
Bench Press (kg)	28.71 ± 2.64	26.93 ± 4.29	1.33	Ns
Deadlift (kg)	44.71 ± 5.82	47.93 ± 5.48	-1.50	Ns
Squat (kg)	46.79 ± 5.86	45.43 ± 4.82	0.67	Ns
Speed 4.5 m (s)	1.55 ± 0.32	1.37 ± 0.16	1.83	Ns
Speed 9 m (s)	2.33 ± 0.22	2.22 ± 0.49	0.77	Ns
Agility (T-Test, s)	8.04 ± 0.64	7.93 ± 0.47	0.89	Ns
Flexibility (Sit and Reach, cm)	23.86 ± 7.35	21.79 ± 7.12	1.53	Ns

SD = Standard Deviation; Ns = no significant difference at $p \leq 0.05$.

The results presented in Table (2) demonstrate that both groups were statistically comparable in all measured variables prior to the implementation of the training program. This equivalence strengthened the internal validity of the experimental design and ensured that any subsequent differences could be attributed to the fascia training intervention rather than to pre-existing disparities.

Description of the Training Program

The Fascia Training program was the independent variable of this study which was constructed to improve myofascia elasticity, kinetic efficiency and neuromuscular coordination. The implementation of the program took place during eight weeks and had three sessions a week, with each last session about 45 minutes. The experimental group was exposed to the sessions comprising of a mixture of dynamic stretching exercises, elastic rebound exercises, and multi-directional exercises, which are consistent with physiological principles of fascia elasticity.

The program was categorized into progressive stages which became more complex and more intense as time went by to enable adaptive tissue response to enhance muscle-fascia interaction. The control group did the same thing they always did, that is, undergo normal volleyball training sessions that included regular warm-ups, practice of the technical skills and team playing without any fascia-specific elements. Both groups trained in the same environment, facilities were the same and so was the time schedule.

Skill-Related Performance Tests

Two performance variables that were dependent variables based on their skills were selected:

1. **Serve Accuracy Test:** every player was asked to make a sequence of serves sent to five areas (1-5) on the opponent side to the court. Landings of serves in the target zones were also noted successfully and the total score of accuracy was taken as the average number of successful serves per trial.
2. **Spike Velocity Test:** Spike performance was measured using radar apparatus to measure its velocity. All the participants performed three types of spikes, standing spike, above-net spike, and general attack spike and the average velocity of these attempts was used to represent the level of spikes of the player.

All the skill tests were done twice, once prior to the training period, and right after the training period. The testing activities were standardized and the warm-up activities across the two sessions were the same to ensure that there was reliability.

Data Analysis Procedures
Data were processed using the Statistical Package for the Social Sciences (SPSS, Version 28). Descriptive statistics, including means, standard deviations, and skewness values, were computed to describe the sample characteristics.
Inferential statistics included:

- Paired Samples t-test to identify significant differences between pre- and post-tests within the experimental group.
- Analysis of Covariance (ANCOVA) to compare post-test results between the experimental and control groups while controlling for pre-test scores.
- Eta Squared (η^2) to determine the effect size of the intervention.
- Percentage Change calculations to measure improvement rates in each variable.

The significance level was established at $\alpha \leq 0.05$ for all statistical tests.
This methodological framework was constructed to ensure objectivity, internal validity, and reproducibility. Through the combination of a controlled experimental design, a well-structured fascia-based training program, and standardized skill performance assessments, the study sought to determine the practical effectiveness of Fascia Training in enhancing key volleyball performance skills—specifically serve accuracy and spike velocity—among female athletes at *Palestine Technical University – Kadoorie*.

RESULTS

First Hypothesis
There are no statistically significant differences at the level ($\alpha \leq 0.05$) between the pre-test and post-test measurements of skill-related variables among female volleyball players in the experimental group.
To test this hypothesis, the researcher used the Paired Samples t-test to identify significant differences between the pre- and post-test means of the skill variables under investigation among the experimental group participants. The results are presented in Table (3).

Table3*Results of the Paired Samples t-test for the differences between pre- and post-test measurements of skill variables among the experimental group (n = 14)*

Skill Variables	Pre-Test Mean	SD	Post-Test Mean	SD	*t*-value	Sig. Level	Improvement %
Serve Accuracy Speed / Zone 1	0.79	1.12	3.35	0.93	7.49	0.00*	324.05%
Serve Accuracy Speed / Zone 2	1.43	1.16	3.35	1.01	5.43	0.00*	134.27%
Serve Accuracy Speed / Zone 3	1.71	1.14	3.43	0.65	5.06	0.00*	100.58%
Serve Accuracy Speed / Zone 4	1.14	0.53	3.00	0.68	9.02	0.00*	163.16%
Serve Accuracy Speed / Zone 5	1.86	0.86	3.14	0.66	4.84	0.00*	68.82%
Spike Velocity (Standing A)	2.08	0.07	2.10	0.08	2.52	0.03*	0.96%
Spike Velocity (Above Net)	2.35	0.10	2.38	0.10	2.84	0.01*	1.28%
Spike Velocity (General Position C)	2.40	0.10	2.44	0.10	3.10	0.02*	1.67%

**Significant at $\alpha \leq 0.05$; tabulated t-value ($t(0.05, df=13)$) = 2.16*

The results in Table (3) reveal statistically significant differences at the ($\alpha \leq 0.05$) level between the pre-test and post-test in favor of the post-test for the key skill variables—serve accuracy and spike velocity—among the experimental group participants. The percentage of improvement was notably high across all serve accuracy zones, reaching (324.05%) in Zone 1, (134.27%) in Zone 2, (100.58%) in Zone 3, (163.16%) in Zone 4, and (68.82%) in Zone 5. Similarly, improvements were observed in spike velocity, with gains of (0.96%) from a standing position (A), (1.28%) above the net, and (1.67%) in the general attack position (C). These results demonstrate marked progress in post-test performance, particularly in serve accuracy, highlighting the effectiveness of the fascia training program in improving motor coordination, elastic control, and neuromuscular efficiency among the players.
Figure (1) illustrates the degree of improvement in the measured skill variables between the pre-test and post-test for the experimental group.

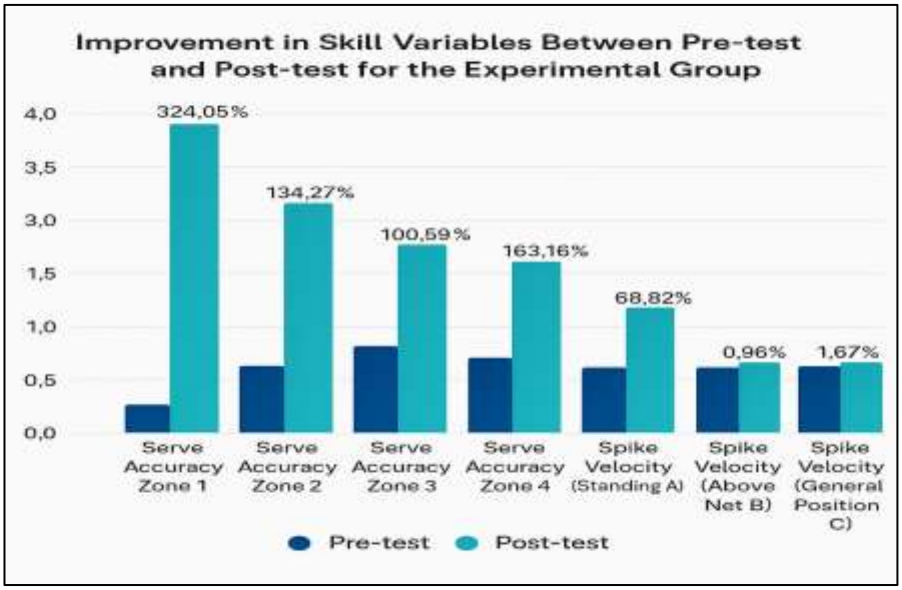

Figure1 *Improvement in Skill Variables Between Pre-test and Post-test for the Experimental Group*

Second Hypothesis

There are no statistically significant differences at the level (α ≤ 0.05) in the post-test measurements of skill-related variables between female volleyball players in the experimental group and those in the control group.

To test this hypothesis, Analysis of Covariance (ANCOVA) was employed to control the effect of pre-test scores and compare post-test means of the skill variables between the experimental and control groups. The Effect Size (η^2) was calculated using Eta Squared to determine the magnitude of the training program's impact. The results are shown in Tables (4) and (5).

Serve Accuracy Speed

Table4 *Results of ANCOVA for the comparison of post-test means between the experimental and control groups in serve accuracy speed (Zones 1–5)*

Dependent Skill Variable	Group	Adjusted Mean (SE)	F-value	Sig. Level	η^2	Interpretation
Serve Accuracy / Zone 1	Experimental	3.36 (0.25)	22.833	0.000*	0.48	Large
	Control	2.07 (0.29)				
Serve Accuracy / Zone 2	Experimental	3.36 (0.27)	11.125	0.003*	0.31	Large
	Control	2.43 (0.27)				
Serve Accuracy / Zone 3	Experimental	3.43 (0.17)	10.243	0.004*	0.29	Medium
	Control	2.71 (0.22)				
Serve Accuracy / Zone 4	Experimental	3.00 (0.18)	10.629	0.003*	0.30	Medium
	Control	2.07 (0.25)				
Serve Accuracy / Zone 5	Experimental	3.14 (0.18)	8.340	0.008*	0.25	Large
	Control	2.07 (0.27)				

**Significant at α ≤ 0.05.*

The F-values for all serve zones were statistically significant at (α ≤ 0.05), indicating that the experimental group significantly outperformed the control group in all serve accuracy variables after training. The effect size values (η^2) ranged between 0.25 and 0.48, representing moderate to large effects according to Cohen's criteria.

This improvement can be attributed to the targeted fascia training, which emphasized repetitive practice in varied game-like conditions, enhancing neuromuscular coordination and movement responsiveness. Training across multiple serve zones likely elevated both physical and technical adaptability, resulting in more accurate and forceful serves. Since the serve is a decisive offensive skill that initiates the point and sets tactical tone, the observed enhancement demonstrates meaningful gains in performance quality.

Figure (2) illustrate the weighted post-test means for serve accuracy speed across zones (1–5) for both the experimental and control groups.

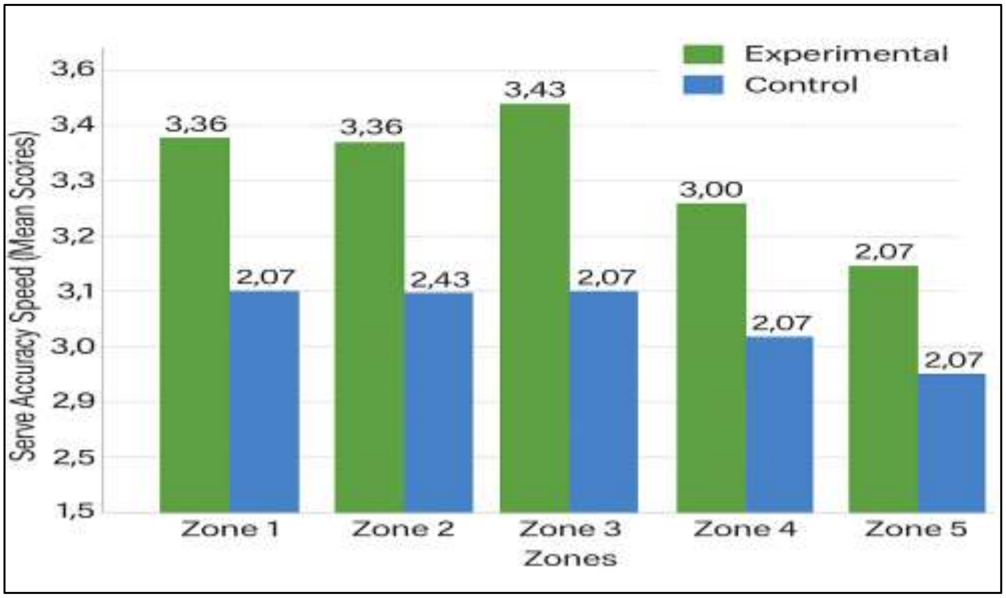

Figure2 *Comparison of Post-Test Means in Serve Accuracy Speed (Zones 1–5) Between Experimental and Control Groups*

Spike Velocity

Table5 *Results of ANCOVA for the comparison of post-test means between the experimental and control groups in spike velocity (Standing A, Above Net, and General Position C)*

Dependent Skill Variable	Group	Adjusted Mean (SE)	F-value	Sig. Level	η²	Interpretation
Spike Velocity (Standing A)	Experimental	2.10 (0.021)	6.572	0.017*	0.21	Large
	Control	2.00 (0.040)				
Spike Velocity (Above Net)	Experimental	2.38 (0.027)	6.637	0.016*	0.21	Large
	Control	2.27 (0.043)				
Spike Velocity (General Position C)	Experimental	2.44 (0.027)	6.226	0.020*	0.20	Medium
	Control	2.34 (0.035)				

**Significant at $\alpha \leq 0.05$.*

The results revealed statistically significant differences in all three spike velocity conditions (Standing A, Above Net, and General Position C) at ($\alpha \leq 0.05$) in favor of the experimental group. The effect size (η^2) ranged between 0.20 and 0.21, representing moderate effects according to Cohen's scale.

These findings indicate that the fascia-based training program contributed substantially to improving explosive power and movement speed associated with the spike action. The improvement is likely due to the inclusion of specific exercises aimed at developing elastic strength, neuromuscular coordination, and dynamic balance. The spike is a complex, multi-joint skill requiring synchronization between approach velocity, take-off height, and arm swing acceleration.

The fascia-oriented exercises enhanced the athletes' ability to generate and transfer force efficiently through the kinetic chain, improving approach rhythm, vertical impulse, and arm power. The results confirm that the program not only developed physical strength but also elevated the technical quality of spiking performance, a key determinant of offensive efficiency in competitive volleyball.

Figure (3) illustrate the weighted post-test means of spike velocity under the three testing conditions for both the experimental and control groups.

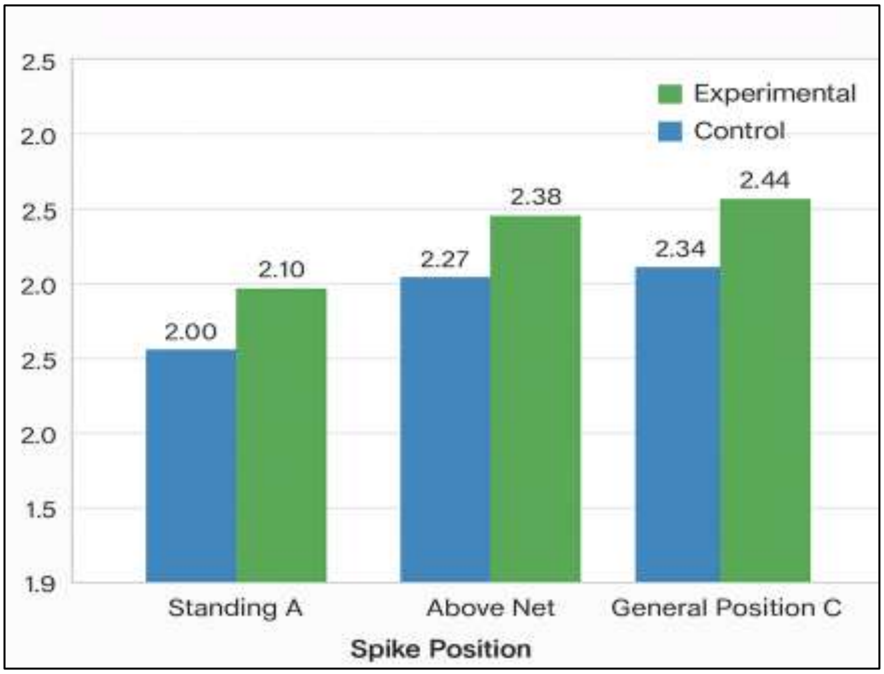

Figure3 *Comparison of Post-Test Means in Spike Velocity Between Experimental and Control Groups*

RESULTS DISCUSSION

The present findings show clear, statistically significant pre–post improvements in all skill variables for the experimental group, with especially large gains in serve-accuracy across Zones 1–5 and smaller but reliable increases in spike velocity across all three testing conditions. ANCOVA further confirmed that, after controlling for baseline, the experimental group outperformed the control group in every serve-accuracy zone ($\eta^2 = 0.25–0.48$) and in all spike-velocity tests ($\eta^2 \approx 0.20–0.21$). Interpreted through contemporary fascia and performance science, these outcomes are coherent with mechanisms that link connective-tissue elasticity, neuromechanical coordination, and kinetic-chain efficiency to volleyball skill execution.

First, the magnitude and consistency of the serve-accuracy gains align with the role of the myofascial network in distributing tension and improving intersegmental coordination during rapid, multi-planar actions. Recent syntheses highlight fascia as an active contributor to elastic storage–recoil and to proprioceptive regulation that sharpens timing and directional control (Schleip & Bartsch, 2021; Schleip, Wilke, & Baker, 2021). By emphasizing dynamic loading, rhythmic rebound, and multi-directional sequences, the fascia program likely enhanced elastic energy return and reduced "energy leakage" along the kinetic chain, enabling more precise ball placement under speed. Because serve accuracy depends on both ball speed and spatial precision, the use of a validated accuracy protocol strengthens confidence that the improvements observed reflect real changes in skill (Costa et al., 2024).

Second, the moderate effects on spike velocity are compatible with a dual pathway: improved elastic recoil and refined intermuscular timing. Evidence across strength and conditioning shows that spike and serve speeds covary with athletes' force–velocity profiles (Baena-Raya et al., 2021), and that training that elevates the rate of force development (RFD) and movement specificity tends to yield the largest ballistic gains (Blazevich et al., 2020; Rebelo et al., 2022). Fascia-oriented loading complements these adaptations by improving collagen alignment and tissue viscoelastic behavior (Schleip et al., 2021), thereby shortening the eccentric–concentric transition and assisting a "whip-like" proximal-to-distal sequence crucial to the spike. The small-to-moderate absolute increases observed here are therefore consistent with a mechanism in which connective-tissue tuning enhances the effectiveness of the neural drive already present from regular volleyball practice.

Third, the pattern of results is convergent with emerging interventions that couple connective-tissue and neuromotor emphases. For example, neuro-athletic conditioning has improved upper-limb performance and serve speed in elite volleyball players (Soylu & Altundağ, 2024), while adjunct techniques targeting myofascial trigger points can acutely raise explosive outputs such as jump performance (Ladriñán-Maestro et al., 2024). Although the present program did not include those specific modalities, the shared logic—optimizing sensorimotor integration and connective-tissue behavior—helps explain why skill metrics improved beyond what was achieved by the control group's traditional regimen. At a tissue level, pilot evidence that training can measurably alter fascial properties (e.g., plantar-fascia thickness) also supports the plausibility of structural adaptation within the eight-week window used here (Alabau-Dasi et al., 2022).

Finally, the context matters. Reports from the region show that many programs remain muscle-centric (e.g., elastic-band interventions and conventional physical capacities) with limited explicit focus on the fascial subsystem (Nassar et al., 2024). Against this backdrop, the current results provide localized evidence that a fascia-based block can translate into volleyball-specific skill gains in female university athletes. Taken together with broader reviews of volleyball training that emphasize specificity, kinetic-chain integration, and explosive coordination (Rebelo et al., 2022; Keoliya et al., 2024; Wang et al., 2025), the present data argue for embedding fascia principles alongside strength and power work rather than treating them as optional extras.

CONCLUSION

An eight-week fascia-training block (3×45-min/week) produced statistically and practically meaningful improvements in serve accuracy and detectable, consistent gains in spike velocity among female volleyball players, with the experimental group surpassing a matched control on all post-test skill measures. These outcomes are theoretically supported by contemporary evidence that myofascial tissues contribute to elastic energy management, proprioceptive acuity, and intersegmental force transmission (Schleip & Bartsch, 2021; Schleip et al., 2021). They are also performance-relevant in volleyball, where ball speed and directional precision depend on efficient kinetic-chain sequencing (Baena-Raya et al., 2021; Rebelo et al., 2022). In a setting where training often emphasizes isolated muscular strength, the present work demonstrates that fascia-oriented conditioning can add value by improving the neuromechanical foundations that underpin skill execution in serving and spiking.

Recommendations

Based on the statistical findings and observed improvements in serve accuracy and spike velocity, the fascia training program demonstrated measurable effectiveness in enhancing key technical skills among female volleyball players. The following recommendations are proposed to help coaches and practitioners apply these results in real training environments:

1. Integrate fascia training into the regular conditioning schedule to improve serve accuracy across all target zones, emphasizing precision, rhythm, and controlled elastic movement.
2. Design progressive fascia-based drills that replicate match situations to enhance spike velocity and promote coordinated energy transfer throughout the kinetic chain.
3. Combine fascia exercises with technical volleyball practice to reinforce neuromuscular timing and movement control, ensuring direct skill transfer to game performance.
4. Continue fascia training during competitive seasons to maintain tissue elasticity, reduce fatigue, and sustain performance gains achieved during the intervention.
5. Encourage coaching staff at Palestine Technical University – Kadoorie and similar programs to adopt fascia-oriented approaches as a standardized component of volleyball skill development and injury prevention.

REFERENCES

1. Al-talahmeh, M., Touhami, I., Abdellaoui, S., & Abderrahman, A. b. (2025). Superior multi-domain performance enhancement through myofascial training versus conventional methods in adolescent volleyball athletes: a randomized controlled trial. *TPM–Testing, Psychometrics, Methodology in Applied Psychology*, *32*(S5 (2025): Posted 03 August), 424-434.
2. Alabau-Dasi, R., Nieto-Gil, P., Ortega-Avila, A. B., & Gijon-Nogueron, G. (2022). Variations in the thickness of the plantar fascia after training based in training race. A pilot study. *The Journal of Foot and Ankle Surgery*, *61*(6), 1230-1234.
3. Allois, R., Niglia, A., Pernice, A., & Cuesta-Barriuso, R. (2021). Fascial therapy, strength exercises and taping in soccer players with recurrent ankle sprains: A randomized controlled trial. *Journal of bodywork and movement therapies*, *27*, 256-264.
4. Baena-Raya, A., Soriano-Maldonado, A., Rodríguez-Pérez, M. A., García-de-Alcaraz, A., Ortega-Becerra, M., Jiménez-Reyes, P., & García-Ramos, A. (2021). The force-velocity profile as determinant of spike and serve ball speed in top-level male volleyball players. *Plos one*, *16*(4), e0249612.
5. Blazevich, A. J., Wilson, C. J., Alcaraz, P. E., & Rubio-Arias, J. A. (2020). Effects of resistance training movement pattern and velocity on isometric muscular rate of force development: a systematic review with meta-analysis and meta-regression. *Sports Medicine*, *50*(5), 943-963.
6. Bordoni, B., & Myers, T. (2020). A review of the theoretical fascial models: biotensegrity, fascintegrity, and myofascial chains. *Cureus*, *12*(2).
7. Caldeira, P. J. P. (2021). *Constraints-led approach and synergetic behaviour in volleyball performance* Universidade de Lisboa (Portugal)].
8. Chaitow, L. (2018). *Fascial dysfunction: manual therapy approaches*. Jessica Kingsley Publishers.

9. Colonna, S., & Casacci, F. (2024). Myofascial system and physical exercise: a narrative review on stretching (Part I). *Cureus*, *16*(12).
10. Costa, C. L. A., Valentini, N. C., Nascimento, E. M. d., & Ugrinowitsch, H. (2024). Validity and reliability of the volleyball serve accuracy-test. *Journal of human sport and exercise. Alicante. Vol. 19, n. 2,(2024), p. 570-578.*
11. Davids, K., Araújo, D., Seifert, L., & Orth, D. (2015). Expert performance in sport: An ecological dynamics perspective. In *Routledge handbook of sport expertise* (pp. 130-144). Routledge.
12. Feldman, A. G., Levin, M. F., Garofolini, A., Piscitelli, D., & Zhang, L. (2021). Central pattern generator and human locomotion in the context of referent control of motor actions. *Clinical Neurophysiology*, *132*(11), 2870-2889.
13. Hodgson, D. (2025). Spinal Reflex Modulation in Real and Virtual Environments: Investigating the Muscle Spindle's Role in Sensorimotor Adaptation to Altered Visual Feedback, Sympathetic Arousal, and Postural Tasks.
14. Karisman, V. A. (2023). Hybrid sports education and step game approach: Improving volleyball skills. *Jurnal Sportif: Jurnal Penelitian Pembelajaran*, *9*(1), 110-124.
15. Kelso, J. S. (1995). *Dynamic patterns: The self-organization of brain and behavior*. MIT press.
16. Keoliya, A. A., Ramteke, S. U., Boob, M. A., Somaiya, K. J., & Keoliya, A. (2024). Enhancing volleyball athlete performance: A comprehensive review of training interventions and their impact on agility, explosive power, and strength. *Cureus*, *16*(1).
17. Ladriñán-Maestro, A., Sánchez-Infante, J., Martín-Vera, D., Del-Blanco-Múñiz, J. A., Domínguez-Balmaseda, D., Guzmán-Pavón, M. J., & Sánchez-Sierra, A. (2024). Effects of dry needling on vertical jump performance in female volleyball players. A randomized controlled trial. *Frontiers in Sports and Active Living*, *6*, 1470057.
18. Marathamuthu, S. (2020). *Contralateral Effects of Eccentric Exercise and Delayed Onset Muscle Soreness (DOMS) of the Plantar Flexors: Evidence of Central Mechanism Involved* University of Malaya (Malaysia)].
19. Martin, Ș. A., Gavra, M. G., & Martin-Hadmaș, R. M. (2024). Analyzing Targeted Muscle Strength: Impact on Speed, Endurance, and Performance in Female Volleyball. *Applied Sciences*, *14*(23), 10951.
20. Myers, T. W. (2020). Visual Assessment of Postural Antecedents to Nonspecific Low Back Pain. In *Fascia, Function, and Medical Applications* (pp. 149-173). CRC Press.
21. Nassar, A. F. A., Altloul, B. M. O., Zakarneh, I., Jarrad, M. R., İssa, A., & Daraghma, A. (2024). The Impact of Training Program Utilizing Elastic Bands on Selected Physical and Skill Variables among Volleyball Players. *International Journal of Disabilities Sports and Health Sciences*, *7*(2), 296-306.
22. Oleari, C., Castro-Arenas, C., & Miralles, M. (2023). Biomechanics, tensegrity and biotensegrity in joint modeling. Congreso Argentino de Bioingeniería,
23. Rebelo, A., Valente-dos-Santos, J., Pires, I. G., Arrais, I., Pereira, J. R., & Turner, A. N. (2022). Strength and Conditioning for Volleyball: A Review. *Strength & Conditioning Journal*, 10.1519.
24. Rios, I. J. C. (2025). Introduction to Muscle Strength and Force in Sports Science. In *Functional Electromechanical Dynamometry* (pp. 3-22). Routledge.
25. Ruggia, T. (2025). Rethinking Aging: A Systems-Based Model of Neuromuscular Decline.
26. Schleip, R., & Bartsch, K. (2021). Elastic storage and recoil dynamics. *Fascia in Sport and Movement*, 97.
27. Schleip, R., & Müller, D. G. (2013). Training principles for fascial connective tissues: scientific foundation and suggested practical applications. *Journal of bodywork and movement therapies*, *17*(1), 103-115.
28. Schleip, R., Wilke, J., & Baker, A. (2021). *Fascia in sport and movement*. Jessica Kingsley Publishers.
29. Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological review*, *82*(4), 225.
30. Souzana, K., Anastasia, B., Paraskevi, M., Asimenia, G., Eleutherios, K., Sotiris, A., Dimitrios, A., & Athanasios, E. (2022). Pilates or a fascia programme training to improve the size of muscles and physical abilities in healthy adults? *European Psychomotricity Journal*, *14*, 26-40.
31. Soylu, C., & Altundag, E. (2024). Rewiring for victory: neuro-athletic training enhances flexibility, serve speed, and upper limb performance in elite volleyball players—a randomized controlled trial. *Applied Sciences*, *14*(23), 11102.
32. Wang, J., Qin, Z., Zhang, Q., & Wang, J. (2025). Lower limb dynamic balance, strength, explosive power, agility, and injuries in volleyball players. *Journal of Orthopaedic Surgery and Research*, *20*(1), 211.