UNIVERSITY ARENA – Journal of Physical Education, Sport and Health, vol. 8, issue 5, 2025, p. 87-92
ISSN 2602-0440, ISSN-L 2602-0440
DOI: https: //doi.org/10.62229/UaViii_5_25-12

VERTICAL JUMP PERFORMANCE IN YOUTH VOLLEYBALL PLAYERS: AN OPTOJUMP-BASED ANALYSIS

Gabriela IORDACHE[1*], Marius STOICA[2], George DINA[3]
[1, 2, 3] *National University of Physical Education and Sport, 060057, Bucharest, Romania*
**Corresponding author: gabrielagheorghe37@yahoo.com*

Abstract. *Background.* Vertical jump performance is a critical component in volleyball, directly involved in technical actions such as spiking and blocking. In youth athletes, understanding the neuromuscular and anthropometric determinants of jump efficiency is essential for optimizing training.
Objectives: The objective of this study was to assess the biomechanical parameters of vertical jump performance (Tflight, Tcontact, Elevation, Power) in female volleyball players aged 12 to 14, and to examine their associations with anthropometric characteristics (body height and weight).
Purpose: The purpose of this research was to identify the dominant physical determinants of jump efficiency in junior female volleyball players, and to provide objective support for the development of age-specific physical training programs focused on enhancing explosive strength and reducing contact time.
Methods: Twenty-one athletes from the CTF Mihai I Volleyball Club participated in standardized jump testing using the OptoJump Next system. Each athlete performed three vertical jumps without arm swing. The parameters recorded were: flight time (Tflight), contact time (Tcontact), jump height (Elevation), and estimated power (Power), along with body height and weight. Spearman correlation coefficients were used to analyze the relationships between variables.
Results: Strong negative correlations were found between power and Tcontact (rs = –0.84), and moderately strong positive correlations between power and jump height (rs = 0.51). A very strong correlation was also observed between Tflight and Elevation (rs = 0.95). Anthropometric variables showed weak or moderate associations with jump performance.
Conclusions: Vertical jump performance in this age group is primarily influenced by neuromuscular efficiency, rather than anthropometric characteristics. Training programs should prioritize explosive strength development and rapid force generation in volleyball-specific contexts.

Keywords: vertical jump, volleyball, youth athletes, OptoJump, neuromuscular performance.

Introduction

Vertical jump performance is a critical physical component in volleyball, as it directly influences key actions such as spiking, blocking, and jump serving. The efficiency of these skills is largely determined by the athlete's level of lower-body explosive strength and the rapid activation capacity of the neuromuscular system. Therefore, objectively assessing this parameter offers valuable information regarding the athletes' specific physical conditioning, especially in youth players undergoing motor development.

Vertical jump performance in volleyball cannot be evaluated only by the height reached. A complete assessment requires the analysis of several biomechanical variables. Modern systems like

OptoJump Next can accurately measure these variables and are often used in standardized athlete testing. In physical training, this data helps build each player's functional profile and supports decisions related to individualized training programs.

This study is part of a larger research project focused on evaluating and improving the physical fitness of young female volleyball players (u15 and u17). The aim of this paper is to present detailed results from one of the studied groups. Although the research included two different samples, the current paper focuses only on Group 2 – athletes aged 12 to 14 – aiming to outline a biomechanical profile specific to this age group. This focused approach allows for a more accurate and practical analysis, useful for coaching and training adapted to the real developmental needs of young athletes.

Study Objectives*:*

- To evaluate the development level of biomechanical parameters of vertical jump performance (Tflight, Tcontact, Elevation, Power) in female volleyball players aged between 12 and 14;
- To describe the physical and motor profile by analyzing the relationships between jump-related biomechanical parameters and morphological variables (body weight and height);
- To provide a foundation for optimizing sport-specific physical training, based on the interpretation of these indicators.

Participants

The group analyzed in this study consisted of 21 female volleyball players registered with the CTF Mihai I sports club, aged between 12 and 14 years. All participants were actively engaged in a regular, sport-specific training program and were consistently competing in official matches within the Romanian National Volleyball Championship, organized by the Romanian Volleyball Federation. The selection of the sample was based on their training level, eligibility within the targeted age category, and availability for testing. The inclusion of this cohort aimed to establish a representative biomechanical profile for athletes at this particular stage of athletic development.

Equipment and Testing Procedure

The testing was carried out using the OptoJump Next system (Microgate), a two-dimensional optoelectronic device designed to evaluate biomechanical parameters of vertical jump performance.

The test protocol involved the execution of three consecutive vertical jumps without arm swing, in order to eliminate the influence of arm momentum on the results. Under these controlled conditions, the recorded values reflected the athletes' raw physical potential, independent of technical execution.

For each participant, the following biomechanical parameters–commonly used in vertical jump performance analysis–were recorded:

- Tflight – flight time (seconds);
- Tcontact – ground contact time (seconds);
- Elevation – jump height (centimeters);
- Power – estimated power generated during take-off (watts);

In addition, two anthropometric variables were measured: body weight (kg) and height (cm).

Statistical Analysis

Data processing was performed using a spreadsheet application (Microsoft Excel), which enabled the calculation of mean values, standard deviations, and coefficients of variation for each analyzed

parameter. Additionally, the relationships between biomechanical and morphological variables were examined using Spearman's rank correlation coefficient, in order to identify potential associations between body weight, height, and vertical jump performance indicators.

Spearman's correlation coefficient (rs) was employed to assess the strength and direction of monotonic associations between the morphological variables (body weight and height) and the biomechanical parameters (Tflight, Tcontact, Elevation, and Power). The coefficient was calculated using the standard formula:

$$rs = 1 - [6 * \Sigma d^2] / [n(n^2 - 1)]$$

where d represents the difference between the ranks of each pair of values, and n is the number of observations.

Results

Table 1. Mean values of the analyzed parameters in Group 2 (n = 21)

Parametru	**Medie**	**Deviație standard**
Timp de zbor (s)	0,454	0,03
Timp de contact (s)	0,345	0,04
Înălțimea săriturii (cm)	25,5	1,9
Putere (W)	27,5	2,7
Greutate (kg)	58,9	5,2
Înălțime (cm)	169	4,6

Analysis of the mean values reveals a biomechanical profile characterized by a reduced ground contact time and a power output exceeding the expected average for this age category. Although the jump height is moderate, it is achieved within a short time frame, indicating a good ability to rapidly generate force and a neuromuscular efficiency consistent with the technical demands of volleyball actions.

To explore the relationships between the analyzed variables, Spearman's rank correlation coefficient was calculated, revealing the following significant associations:

Table 2. Spearman Correlation Coefficients between Variables (n = 21)

Variable	*Height*	*Weight*	*Tflight*	*Tcontact*	*Elevation*	*Power*
Height	1.00	0.70	0.03	0.48	0.03	–0.36
Weight	0.70	1.00	-0.01	0.49	–0.12	–0.41
Tflight	0.03	–0.01	1.00	–0.13	0.95	0.49
Tcontact	0.48	0.49	–0.13	1.00	–0.15	–0.84
Elevation	0.03	–0.12	0.95	-0.15	1.00	0.51
Power	-0.36	–0.41	0.49	-0.84	0.51	1.00

A weak negative correlation was observed between body weight and elevation (rs = -0.12), suggesting that, within this sample, higher body mass doesn't significantly influence the ability to achieve greater jump height. This very low association may indicate that, at this age category (12–14 years), jump height is more strongly influenced by neuromuscular factors than by morphological characteristics.

A strong negative correlation was found between power and ground contact time (rs = -0.84), indicating that players with higher power levels are able to perform the take-off phase in a much shorter time. This aspect is particularly relevant in volleyball, where short ground contact times enable fast and efficient actions, such as spiking or blocking. Therefore, the ability to generate force in a brief time frame becomes a key indicator of specific physical preparedness and vertical jump efficiency.

A very strong positive correlation was recorded between jump height and flight time (rs = 0.95), showing that as jump height increases, so does the time spent in the air. This relationship highlights that both variables reflect the same type of performance–vertical impulse efficiency–and can be used jointly to estimate the development of explosive strength qualities in athletes of this age group.

A moderately strong positive correlation was observed between power and jump height (rs = 0.51), suggesting that players who generate greater power tend to achieve higher jumps. This relationship emphasizes the direct connection between force production capacity and the effectiveness of vertical take-off.

A moderate positive correlation was found between body height and ground contact time (rs = 0.49), indicating that taller players tend to spend slightly more time in the support phase. This tendency may be explained by the biomechanical characteristics of longer body segments, which can negatively affect execution speed and coordination.

Conclusions

The findings of this study clearly highlight that vertical jump performance in young female volleyball players is predominantly influenced by neuromuscular factors–particularly the ability to rapidly generate high force output and to minimize ground contact time. These aspects reflect the efficiency of muscle contraction and the explosive capacity of the neuromuscular system involved in the jumping action. Together, they contribute decisively to the effectiveness of vertical impulse, directly impacting the height achieved during the jump.

Consequently, vertical jump performance is not primarily conditioned by anthropometric characteristics such as height or body mass, but rather by the functional readiness of the neuromuscular system to respond explosively. Based on these findings, physical training programs designed for this age group should prioritize the development of explosive strength qualities required for volleyball-specific actions.

The data obtained from the assessment of biomechanical parameters related to vertical jump provide a solid foundation for outlining the motor profile of female volleyball players aged 12 to 14.

The correlation analysis between performance variables (Tflight, Tcontact, Elevation, Power) and morphological variables (body weight, height) highlights the predominant influence of specific motor qualities on the biomechanical parameters involved in generating an efficient vertical impulse–over general anthropometric characteristics.

The very strong negative correlation between power and ground contact time, along with the moderately strong positive correlation between power and jump height, support the idea that the development of explosive strength and force production speed is essential for enhancing volleyball-specific actions that rely on vertical jumping–particularly spiking and blocking.

The extremely high correlation between flight time and jump height further confirms the relevance of these indicators in monitoring athletic progress.

Morphological variables showed only weak to moderate correlations, suggesting that vertical jump performance is mainly determined by trainable motor abilities rather than body composition.

This conclusion is particularly important for the planning of physical preparation, as it indicates that performance optimization can be achieved through systematic interventions targeting specific motor capacities.

Therefore, these results will serve as the basis for designing a specific physical training program for players in this age group, focused on enhancing neuromuscular efficiency in vertical actions. The program will integrate exercises aimed at improving the ability to generate and transmit explosive force in the shortest possible time, under conditions that closely simulate the actual demands of the volleyball game.

Practical Implications and Future Research Directions

The findings of this study provide valuable insights for coaches, physical education teachers, and conditioning specialists, highlighting the importance of objectively assessing biomechanical parameters to support the individualization of training. In the context of developing athletes at formative stages, it is essential that interventions focus on enhancing the neuromuscular system's ability to respond explosively during volleyball-specific actions.

Future studies are encouraged to expand the sample size and include different age groups, as well as to conduct longitudinal monitoring of progress following the implementation of individualized training programs. Additionally, investigating the relationships between other biomechanical indicators and in-game performance could contribute to a more comprehensive understanding of the optimal physical profile in youth volleyball.

Conflict of interests

The authors declare that there is no conflict of interest regarding this paper.

Acknowledgment

We would like to thank the coaches and athletes of the CTF Mihai I Sports Club for their involvement and collaboration during the testing sessions. We also acknowledge the logistical support provided by the National University of Physical Education and Sport in Bucharest.

Authors' Contributions

All authors have equally contributed to this study.

References

Dragnea, A., & Bota, A. (2000). Teoria activităţilor motrice. Bucureşti: Editura Didactică şi Pedagogică.

Alexe, N. (1993). Antrenamentul sportiv modern. Bucureşti: Editura Editis.

Bompa, T. O., & Haff, G. (2009). Periodizarea: Teoria şi metodologia antrenamentului. Bucureşti: Editura Ex Ponto.

Stoica, M. (2018). Optimizarea pregătirii fizice în jocurile sportive. Bucureşti: Editura Universităţii Naţionale de Educaţie Fizică şi Sport.

Dina, G. (2022). Evaluarea performanţei motrice în sportul juvenil. Bucureşti: Editura Universitară.

Ionescu, A. (2020). Ghid de pregătire fizică pentru sportivi juniori. Cluj-Napoca: Presa Universitară Clujeană.

Petrescu, C. (2019). Analiza biomecanică a săriturilor verticale la sportivi de performanţă. Revista de Educaţie Fizică şi Sport, 19(2), 67–74.

Marin, D. (2021). Corelaţii între parametrii neuromusculari şi performanţa în săritură la volei. Revista Ştiinţa Sportului, 33(1), 41–50.

Tudor, V. (2005). Capacităţile motrice. Bucureşti: Editura RAI.

Barbu, D. (2023). Particularităţi ale pregătirii fizice la jucătoarele de volei U14. Revista Naţională de Kinetoterapie și Sport, 12(3), 88–95.

Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. Sports Medicine, 40(10), 859–895.

Gathercole, R. J., Sporer, B. C., & Stellingwerff, T. (2015). Countermovement jump performance with increased training loads in elite female volleyball players. International Journal of Sports Physiology and Performance, 10(7), 908–915.

Sattler, T., Hadzic, V., Dervisevic, E., & Markovic, G. (2015). Vertical jumping tests in volleyball: Reliability, validity, and playing-position specifics. Journal of Strength and Conditioning Research, 29(6), 1541–1550.

Sheppard, J. M., & Newton, R. U. (2012). Long-term training adaptations in elite male volleyball players. Journal of Strength and Conditioning Research, 26(8), 2180–2184.

Newton, R. U., Gerber, A., Nimphius, S., Shim, J. K., Doan, B. K., Robertson, M., ... & Kraemer, W. J. (2006). Determination of functional strength imbalance of the lower extremities. Journal of Strength and Conditioning Research, 20(4), 971–977.