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CORRELATIONS BETWEEN DIFFERENT MANIFESTATION OF SPEED IN ELITE FEMALE VOLLEYBALL

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Abstract

Aim. The aim of this study was to investigate the relationships between different forms of speed—reaction speed, movement speed, and vertical jump performance—in elite junior female volleyball players.

Methods. The study employed an observational research design and included 11 Romanian female athletes, all members of the U17 national volleyball national team. Reaction speed and movement speed were assessed using the Witty system, while vertical jump performance (as an indicator of explosiveness) was evaluated using the OptoJump system. Data analysis was conducted using descriptive statistics and Spearman's rank correlation coefficient to examine the relationships between the analyzed variables.

Results. The results indicated no statistically significant correlations between reaction speed, movement speed, and vertical jump performance ($p > 0.05$), suggesting that these forms of speed function independently in elite junior female volleyball players.

Conclusions. The findings highlight that reaction speed, movement speed, and vertical jump explosiveness represent distinct motor qualities that should be developed through specific and targeted training methods. These results support the implementation of individualized physical training programs tailored to the performance demands of youth high-performance volleyball.

Keywords: speed, reaction time, movement speed, vertical jump, volleyball.

Introduction

Sports performance is the result of the interaction between physical abilities, neuromotor mechanisms, and the capacity to adapt to dynamic game situations. In team sports such as volleyball, the effectiveness of an action depends not only on the athlete's physical qualities, but also on cognitive, tactical, and situational factors that influence real-time decision-making (Zemková & Hamar, 2015).

Reaction speed and multidirectional movement speed are considered essential components in high-intensity sports, but numerous studies highlight that these abilities do not always predict performance efficiency in competitive settings (Sattler et al., 2015). Specifically, volleyball players must respond quickly to visual stimuli, anticipate opponents' actions, and coordinate their movements in relation to their teammates. These demands go beyond simple motor execution and involve a strong cognitive component.

Training agility in conditions that simulate competition has been found to improve both reaction time and the ability to adjust to sudden changes of direction more effectively than traditional drills (Kováčiková & Zemková, 2021). In volleyball, where players constantly face unexpected situations, these results highlight the importance of incorporating competitive stimuli into physical training sessions.

In youth volleyball, the development of neuromotor abilities must be aligned with their effective transfer to real game situations. Sattler et al. (2015) identified significant correlations between lower-body strength and performance in change-of-direction tests, but the impact of these factors on actual game efficiency remains debatable. This highlights the growing need to examine the relationship between standardized physical tests and specific in-game performance, in order to better understand to what extent lab-assessed speed reflects decision-making and tactical effectiveness during match play. Agility training programs, such as quick change-of-direction drills and stimulus-response exercises, lead to significant improvements in speed and motor coordination. However, Chuang et al. (2022) showed that these improvements do not automatically translate into tactical efficiency during gameplay, where rapid decision-making, anticipation, and adaptation to complex and unpredictable situations are required.

Training methods based on visual light stimuli, such as those involving Witty systems, are useful for improving visual-motor response. However, their contribution to decision-making development appears limited (Jothi et al., 2025). Although athletes may become faster at reacting to isolated stimuli, these exercises do not reflect the complex and unpredictable nature of real competition, where players must simultaneously analyze multiple elements—opponent movement, ball trajectory, and tactical intentions. Therefore, it is recommended that such drills be integrated into more complex training contexts that involve dynamic decision-making, contextual variability, and situations with a direct connection to game actions.

Therefore, the present study aims to analyze the relationships between the results obtained in Witty tests (static and dynamic) and OptoJump assessments, focusing on different forms of speed expression. The aim is to statistically verify

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whether these forms are interrelated, considering that speed is a general, genetically determined ability. Although the study was conducted on a small sample, it is important to note that the group is representative, as it includes members of the national U17 female volleyball team. Thus, the results can be considered relevant and may contribute to the reconfiguration and improvement of physical training strategies in high-performance volleyball.

Methods

Scope

The purpose of this study was to evaluate specific speed-related parameters, including visual reaction speed, execution speed, and motor adaptability, in players from the Romanian U17 national volleyball team. The assessments were carried out using computerized testing systems (Witty Green and Witty Red) and the OptoJump system, which measures lower-limb muscle contraction speed as expressed through vertical jump performance. The results obtained are intended to support the development of intervention strategies aimed at reorganizing physical training in performance volleyball, aligning it more closely with the real demands of the game.

Research questions

1. Are there statistically significant correlations between different forms of speed expression in U17 female volleyball players?
2. Do these forms of speed expression support each other within the motor profile of the tested players, or do they function as independent abilities?

In order to highlight whether different forms of speed expression support each other in high-performance sports—as suggested by the classical theories that promote the concept of "Speed as a general ability"—we focused on types of speed that are unrelated in terms of how they are physically executed. We aimed to investigate whether there are statistical correlations between these distinct expressions of speed.

- *Witty Static and Witty Dynamic* – associating visual reaction speed with movement speed.
- *Witty Static and Tcontact* – associating visual reaction speed with the contraction speed of the plantar muscles (foot) that trigger vertical jumps.
- *Witty Static and Elevation* – associating visual reaction speed with jump height, which reflects vertical impulse and explosive strength-speed.

Participants

The study included 11 U17 athletes, members of the Romanian National Cadet Volleyball Team, who were in centralized training during January 2024 in preparation for the European Championship qualification tournament. All players are registered with sports clubs affiliated with the Romanian Volleyball Federation and actively compete in the U17 National Championship.

Instruments

The use of the Witty system (Microgate) for evaluating athletes from the U17 national volleyball team is justified by its precision, versatility, and relevance to the physical and cognitive demands of volleyball. Two distinct testing protocols were employed: Witty Static (Green) and Witty Dynamic (Red), each designed for specific evaluation purposes.

The Witty Microgate system is a portable, advanced timing system composed of:

- 1 digital timer
- 2 wireless photocells
- 2 reflectors
- 4 tripods
- 1 charger with USB cable
- 1 transport backpack and analysis software

This system allows for customized test configurations and provides accurate data on reaction time, execution duration, mean values, and standard deviation. It is ideal for tracking athletes' progress and designing individualized intervention strategies.

Figure 1. Witty System Speed Test

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The device is used to assess different forms of speed expression, a key motor ability in volleyball that is, however, strongly genetically determined and therefore difficult to improve significantly. Speed becomes essential in volleyball when associated with the technical execution of various game actions, which, under these conditions, can be maximized in terms of efficiency.

This test was configured in two versions: a *static protocol*, aimed at evaluating reaction and execution speed in response to a visual stimulus; and a *dynamic protocol*, where the visual stimulus is combined with movement in multiple directions. This dynamic component highlights additional physical qualities important for volleyball performance, such as *focused attention under pressure*, *fatigue-induced performance control*, and *specific endurance* in game-like conditions.

The OPTOJUMP Microgate system assesses a series of key indicators related to vertical jump performance—an essential component for volleyball players, especially in net actions such as attacking and blocking. These actions are crucial in both offensive and defensive phases of the game and require the athlete to project upward explosively.

In this context, jump height, expressed at the moment of ball contact, is fundamentally determined by the lower-body explosive power—commonly referred to as vertical explosiveness. This quality plays a decisive role in increasing the efficiency of jumping actions in volleyball, making it a critical factor in high-level performance.

Figure 2. Optojump Test

Procedure

WITTY STATIC – Test Description:

The test involved 10 light sources placed along a 2-meter line at three different heights (50 cm, 75 cm, and 1 m) arranged symmetrically to simulate typical ball contact zones in volleyball. The athlete stood 40 cm away from the lights, in a central position, and was instructed to deactivate each randomly lit source (19 activations total) by placing the palm in front of the light, without touching it or moving the feet.

This setup was designed to assess not only visual reaction time and execution speed but also attention-related abilities such as focus, lateral coordination, and perceptual field expansion—key elements in volleyball performance.

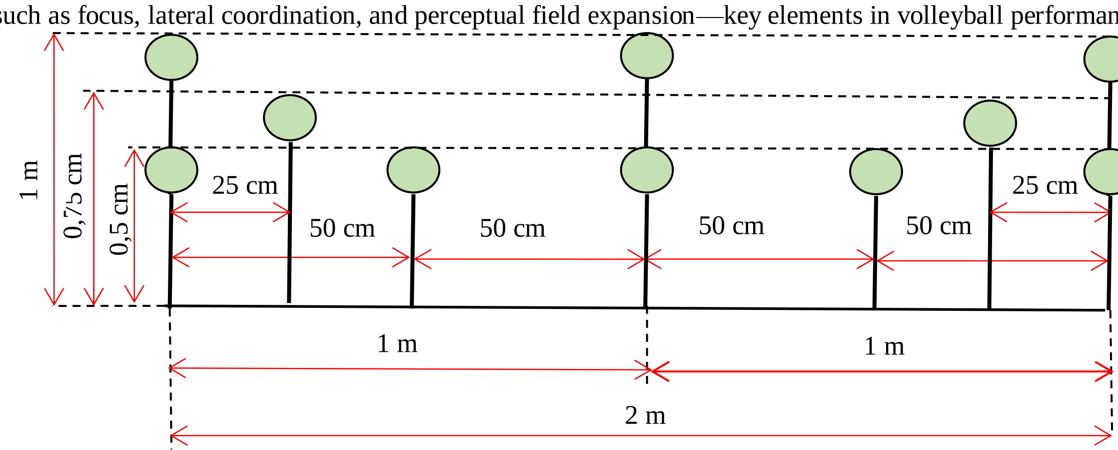

Figure 3. Witty Static Test

WITTY DYNAMIC – Test Description:

In the dynamic version of the test, 10 light signals were placed in court zones that simulate real defensive movements. The players had to run toward the lit target and return to a central baseline mark, repeating this sequence 19 times with random activation.

The test measured not only reaction time and movement speed, but also attention, coordination, and endurance. The repeated runs under pressure created a level of physical and mental fatigue similar to real match conditions, helping to assess how players perform under stress.

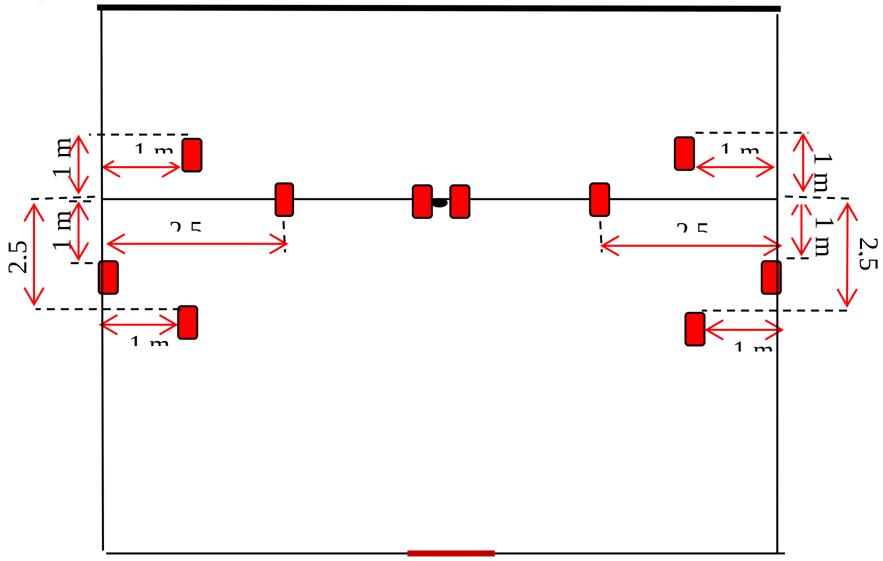

Figure 4. Witty Dinamic Test

OPTOJUMP – Test Description:

The test consisted of three consecutive vertical jumps performed without arm swing, in order to eliminate the influence of technique and isolate the athlete's raw physical potential. Under these conditions, the recorded values reflect innate motor capacity rather than technical execution.

The indicators measured by this device are: power, contact time (which reflects contraction speed), and lower-limb explosive strength, which determines jump height.


Figure 5. Optojump

Study Design

This research is a cross-sectional observational study aimed at exploring the relationships between different forms of speed expression in U17 female volleyball players using standardized tests administered through the Witty and Optojump system. The study did not include any intervention program, focusing exclusively on the evaluation of performances in these tests, as well as on the analysis of correlations between these parameters.

The main objective was to determine to what extent the indicators obtained from tests assessing visual reaction speed, movement speed (Witty Static and Dynamic), and explosive leg power through vertical jumps (OptoJump) support volleyball performance, and whether these abilities are interrelated or function independently. The research design involved the collection and interpretation of data during a single testing session, without experimental manipulation.

Statistical Analysis

To evaluate the relationships between variables, Spearman's rank correlation coefficient (ρ) was used, as it is suitable for small samples and non-parametric data. The analysis focused on identifying the associations between different forms of speed expression, such as reaction time, displacement speed, and vertical jump parameters. The significance threshold was set at $p < 0.05$.

Results

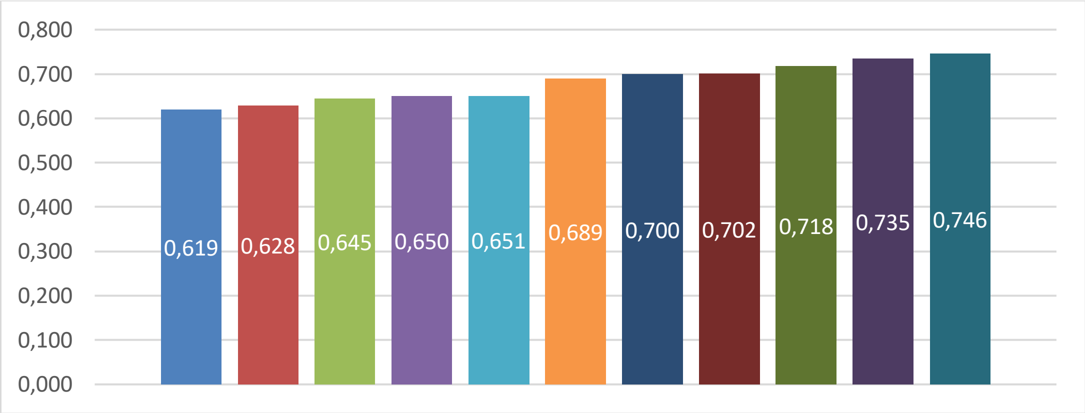

Figure 6. Average values over 19 executions (GREEN laps)

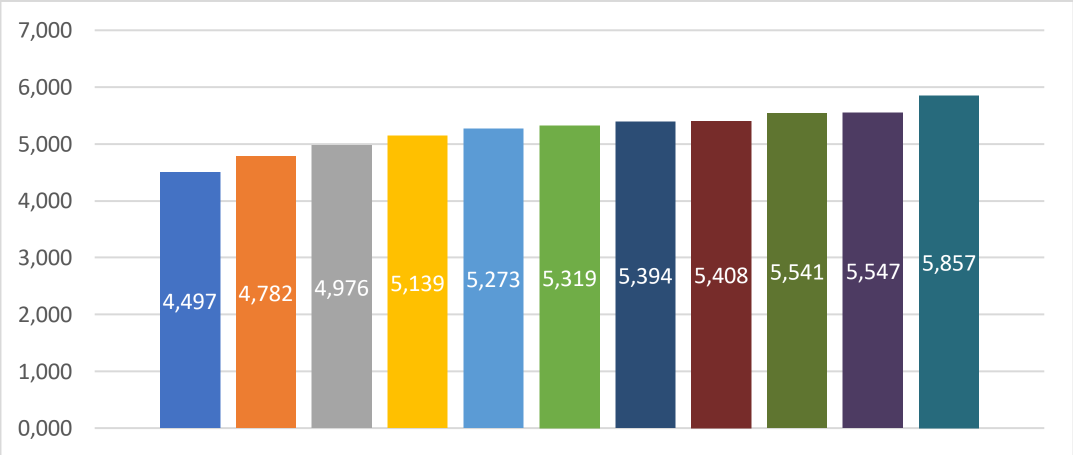

Figure 7. Average values over 19 executions (RED laps)

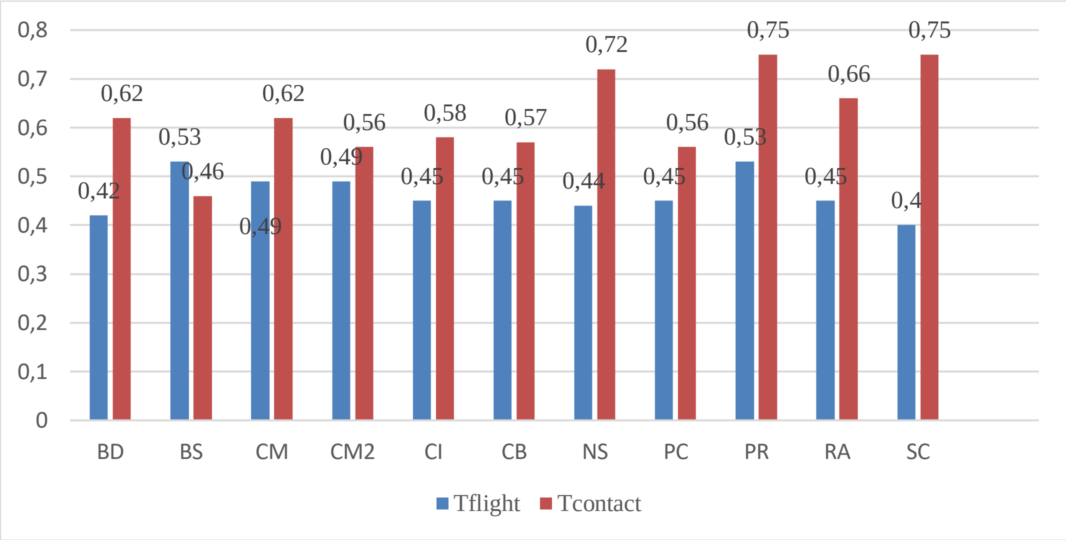

Figure 8. Individual values recorded for a) Time flight, b) Contact time

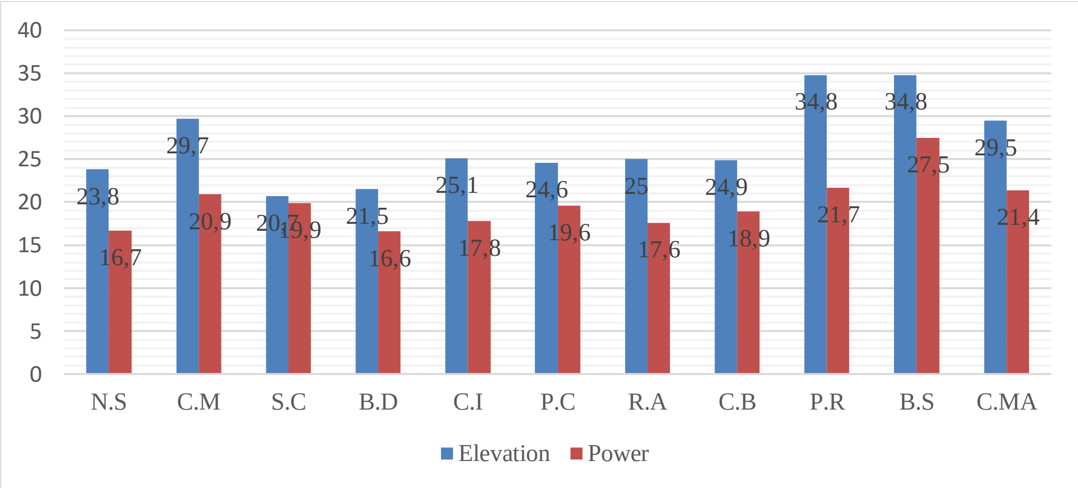

Figure 9. Individual values recorded in a) Elevation and b) Power tests.

Table 1. Witty Static and Witty Dynamic test results

Name	Witty Static	Witty Dynamic
N.Ș.	0.619	4.497
C.M.	0.628	5.273
S.C.	0.645	5.857
B.D.	0.650	5.541
C.I.	0.651	4.782
P.C.	0.689	5.394
R.A.	0.700	5.547
C.B.	0.702	5.408
P.R.	0.718	4.976
B.S.	0.735	5.319
C.M.	0.746	5.139

Table 2. Descriptive statistics – Witty Static and Witty Dynamic

Descriptive statistics	Witty Static	Witty Dynamic
Mean	0.680273	5.248455
Standard error	0.013205	0.115433
Median	0.689000	5.319000
Mode	0.619000	4.497000
Standard deviation	0.043795	0.382849
Variance	0.001918	0.146573
Kurtosis	-1.363723	-0.309893
Skewness	0.063146	-0.491261
Minimum	0.619000	4.497000
Maximum	0.746000	5.857000

The Spearman correlation between the Witty Static and Witty Dynamic test results showed a coefficient of rs = 0.009 and a significance level of p = 0.979, indicating no statistically significant relationship between the two variables.

This means that reaction speed (to visual stimuli) and movement speed do not support each other in the case of the tested players. In volleyball, reaction speed is important for actions such as receiving the serve, defending against attacks, blocking, or adjusting to the ball's trajectory, while movement speed is important for covering the court and changing positions.

The lack of correlation shows that these two types of speed do not naturally develop together during training. Because of this, physical preparation needs to be planned differently for each type of speed. In performance volleyball, where each position has specific movement demands, exercises should be adapted to the real needs of the player: fast reactions for the libero or setter, and quick acceleration and direction changes for outside hitters or middle blockers.

Therefore, a personalized and well-structured approach to physical training is essential for improving both individual performance and the team's overall success.

Table 3. Descriptive statistics – Witty Static and Tcontact

Name	Witty Static	Tcontact
Mean	0.680273	0.622727
Standard error	0.013205	0.027339
Median	0.689000	0.620000
Mode	0.619000	0.560000
Standard deviation	0.043795	0.090674
Variance	0.001918	0.008222
Kurtosis	-1.363723	-0.920852

Skewness	0.063146	-0.242086
Minimum	0.619000	0.460000
Maximum	0.746000	0.750000

The Spearman correlation calculated between Witty Static test scores and contact time recorded during vertical jumps was **rs = -0.19 (p = 0.581)**, indicating a weak and statistically non-significant association between the two variables. This result suggests that visual reaction speed and explosive motor execution capacity do not directly influence each other and cannot be developed simultaneously without a differentiated training plan.

This outcome supports the hypothesis that visual reaction speed does not directly impact the players' ability to generate a rapid and effective impulse during jump execution. The lack of association reveals that the development of reaction speed and jump execution speed does not follow a parallel trajectory, thus requiring targeted interventions during training.

In athletic training, this distinction between types of speed becomes essential for ensuring the efficiency of the preparation process. Visual reaction speed involves sensory and cognitive mechanisms and requires exercises that stimulate perception and quick decision-making in response to external stimuli. In contrast, motor execution components—such as reducing contact time or increasing push-off force—depend on neuromuscular activation and are developed through plyometric, reactive, or explosive strength training.

Therefore, optimizing performance requires a structured approach in which each type of speed is trained using dedicated methods, tailored to the actual demands of the practiced sport.

Table 4. Descriptive statistics Witty Static Elevation

Mean	**0.680273**	**26.763636**
Standard error	0.013205	1.454040
Median	0.689000	25.000000
Mode	0.619000	34.800000
Standard deviation	0.043795	4.822504
Variance	0.001918	23.255507
Kurtosis	-1.363723	0.189524
Skewness	0.063146	0.197520
Minimum	0.619000	20.700000
Maximum	0.746000	34.800000

The Spearman correlation coefficient calculated between the Witty Static scores and the vertical jump height was rs = 0.588, with a significance threshold of $p = 0.057$.

This result indicates a moderate positive correlation between visual reaction speed and the athletes' vertical impulse capacity, though it does not reach the conventional level of statistical significance ($p < 0.05$).

The data suggest a tendency for players who respond more quickly to visual stimuli to also register higher values in vertical jump tests. However, this association cannot be considered statistically relevant given the small sample size (N = 11).

The absence of a strong and statistically significant correlation between these two variables indicates that visual reaction speed and jump height are not directly interdependent within the training process. This supports the need for a differentiated approach in physical training planning.

Reaction speed, with its predominantly sensory-cognitive basis, should be developed through specific exercises focused on perception and rapid decision-making, whereas vertical jump height requires neuromuscular interventions aimed at enhancing explosive power.

Addressing these motor abilities separately within the training process allows for the adaptation of training content according to the athletes' actual needs, thereby maximizing individual performance potential.

Table 5. Witty Dynamic and Tcontact test results

Name	**Witty Dynamic**	**Tcontact**
N.Ș.	4.497	0.72
C.M.	4.782	0.56
S.C.	4.976	0.75
B.D.	5.139	0.62
C.I.	5.273	0.58
P.C.	5.319	0.56
R.A.	5.394	0.66
C.B.	5.408	0.57
P.R.	5.541	0.75
B.S.	5.547	0.46
C.MA.	5.857	0.62

Table 6. Descriptive statistics Witty Dynamic Tcontact

Mean	**5.182545**	**0.622727**
Standard error	0.129317	0.027339
Median	5.319000	0.620000
Mode	4.497000	0.560000
Standard deviation	0.429105	0.090674
Variance	0.184132	0.008222
Kurtosis	-0.168634	-0.920852
Skewness	0.063582	-0.242086
Minimum	4.497000	0.460000
Maximum	5.857000	0.750000

The Spearman correlation coefficient between Witty Dynamic test scores and Tcontact (ground contact time during vertical jumps) was rs = –0.188, with a p-value of 0.581, indicating a very weak and statistically non-significant relationship.

This lack of correlation suggests that movement speed, as measured by the Witty Dynamic test, and explosive power execution during jumping (reflected by contact time) are independent motor abilities. Athletes who move faster across short distances do not automatically generate quicker or more efficient take-offs in vertical jumps.

In volleyball, these findings highlight the need to treat different expressions of speed—displacement speed and explosive strength—as distinct components of physical preparation. The absence of a clear association confirms that they do not evolve in parallel and require specific, targeted training approaches.

For coaches and performance staff, this emphasizes the importance of designing separate development strategies: drills focused on speed and agility for enhancing court movement, and neuromuscular and plyometric training to reduce contact time and improve jump efficiency.

Discussions

The results of the present study indicate that different forms of speed, such as reaction speed and acceleration speed, function independently in elite junior female volleyball players and should therefore be trained separately. The absence of significant correlations between these components suggests that they do not mutually support each other in a consistent manner and should not be treated as a single, unified motor ability in physical preparation.

These findings are consistent with previous research showing that agility, reaction speed, and acceleration speed are distinct motor qualities influenced by both neuromotor and cognitive factors. Studies conducted by Zemková and Hamar have emphasized that performance in team sports depends on sport-specific motor control and decision-making processes rather than on isolated physical abilities. Similarly, Sattler et al. (2015) reported that change-of-direction speed and reactive agility are not always strongly associated with general speed parameters, particularly in high-intensity team sports.

Moreover, research by Kováčiková and Zemková (2021) demonstrated that agility training performed under competitive or game-like conditions leads to more effective improvements in reaction ability than traditional linear speed drills. These results support the idea that the development of speed abilities should be closely linked to the specific technical and tactical demands of the sport.

The wide inter-individual variability observed in the present sample further highlights the necessity of individualized training approaches. Each athlete presents a unique motor profile, and objective measurements of reaction speed and acceleration speed provide valuable information for tailoring training programs. Similar conclusions have been drawn in studies using electronic testing systems, which emphasize the importance of precise assessment tools for guiding evidence-based training decisions in high-performance volleyball (Zwierko, Popowczak, & Rokita, 2022; Zwierko et. al., 2024).

Taken together, the lack of positive correlations between the analyzed speed components suggests that current physical training strategies should be reconsidered. Rather than assuming transfer effects between different forms of speed, training programs should focus on the targeted development of each component in close connection with volleyball-specific technical actions, ensuring an effective integration of physical preparation into game performance.

Conclusions

The present study contributes to a better understanding of the relationships between different forms of speed in elite junior female volleyball players. The results indicate that reaction speed and acceleration speed should be regarded as distinct performance components that do not develop automatically together.

From a practical perspective, these findings underline the importance of designing well-structured and individualized physical training programs. Coaches should implement specific training methods for each type of speed, aligned with the technical and tactical requirements of volleyball, in order to optimize performance. Objective assessment and individualized planning remain key elements in supporting effective long-term athlete development in youth high-performance volleyball.

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