RELATIONSHIP BETWEEN STOPPAGE TIME, RALLY LENGTH, AND SELECTED PERFORMANCE VARIABLES IN ELITE MEN'S VOLLEYBALL COMPETITIONS

Mehmet Görkem İŞGÜZAR[1], Ifet MAHMUTOVIĆ[2], Serdar USLU[3], Rıza BARAK[3,4]

1 Ziraat Bankasi Sports Club, Ankara, Turkey
2 University of Sarajevo, Faculty of Sport and Physical Education, Bosnia and Herzegovina
3 Gazi University, Faculty of Sport Sciences, Physical Education and Sport Teaching, Ankara, Turkey
4 Spor Toto SC Ankara, Turkey

Corresponding author:
Ifet MAHMUTOVIĆ
University of Sarajevo, Faculty of Sport and Physical Education, Patriotske lige 41, 71000 Sarajevo, Bosnia and Herzegovina
Phone: +387 61 484 350
Email: ifet.mahmutovic@fasto.unsa.ba

ABSTRACT

Purpose: *This study aimed to examine the relationships between stoppage time (ST), rally time (RT), and selected performance variables in elite men's volleyball competitions across three leagues with and without ST restrictions.*

Methods: *A total of 1616 rallies were analysed, including 450 from the 2022 Men's Volleyball Nations League (VNL), 500 from the 2022 Turkish Efeler League (TL) playoff finals, and 666 from the 2022 Italian Serie A League (IL) playoff finals series. Match videos were analysed using Data Volley software, and technical performance variables, RT, and ST were recorded. Spearman correlation and Kruskal–Wallis H tests were applied to examine relationships and differences among leagues (p < .05). Ethical approval was not required because only publicly available match data were analysed.*

Results: *Significant positive correlations were found between ST and RT in all leagues (ρ = .28–.33, p < .001). Weak to moderate negative correlations were observed between ST and reception percentage in the IL and VNL (ρ = −.08 to −.13, p < .05), while a weak positive correlation was found in the TL (ρ = .10, p = .029). Across*

all leagues, ST was negatively correlated with first-attack success ($\rho = -.15$ to $-.21$, $p < 001$).

Conclusion: ST was significantly shorter in the VNL compared with the TL and IL. Differences were also observed in reception and attack performance variables across leagues. These findings indicate that temporal characteristics of the game are associated with technical performance in elite men's volleyball.

Keywords: volleyball, RT, ST, performance, competition structure

ODNOS MED ČASOM PREKINITVE, DOLŽINO IZMENJAVE ŽOG IN IZBRANIMI VARIABILNIMI DEJAVNIKI V ELITNIH MOŠKIH ODBOJKARSKIH TEKMOVANJIH

IZVLEČEK

Namen: Namen te je bil proučiti ter primerjati razmerja med časom prekinitve (ST) in spremenljivkami, povezanimi z uspešnostjo, ter časom izmenjave žog (RT) v elitnih moških odbojkarskih tekmovanjih v treh ligah, in sicer z omejitvami časa prekinitve in brez njih.

Metode: Analizirali smo skupno 1616 izmenjav, vključno s 450 izmenjavami iz moške lige VNL (Volleyball National League) 2022, 500 izmenjavami iz finala turške lige Efeler (TL) 2022 in 666 izmenjavami iz finala italijanske lige Serie A (IL) 2022. Tekmovalni videoposnetki, ki jih je med tekmami posnel isti trener, so bili analizirani z uporabo programa Data Volley 4.03.09, iz njih pa so bili izpisani tehnični podatki, dolžine izmenjav in trenutki premora med igro.

Rezultati: Analiza je pokazala pomembno pozitivno korelacijo med ST in trajanjem izmenjav v vseh ligah. Pomembna negativna korelacija je bila opazna med ST ter učinkovitostjo sprejema v ligah IL in VNL, medtem ko je bila v ligi TL ugotovljena pozitivna korelacija. Poleg tega je bila v vseh ligah opazna pomembna negativna korelacija med prvim napadom izmenjave in ST. V vseh ligah je bila ugotovljena tudi pomembna pozitivna korelacija med odstotkom žog v igri in časom prekinitve.

Zaključek: Primerjava ugotovitev iz treh lig je pokazala, da je bil ST v ligi VNL znatno krajši kot v ligah TL in IL. Prepoznane so bile razlike med ligami pri spremenljivkah, povezanih s sprejemi in napadi. Rezultati kažejo, da so časovne značilnosti igre povezane s tehničnimi dosežki v elitnih moških odbojkarskih tekmovanjih.

Ključne besede: odbojka, izmenjava žog, počitek, obremenitev, zmogljivost

INTRODUCTION

Rule changes or different practices in sports are associated with variations in game duration and rest intervals, which may be related to physical and technical performance characteristics. Some sports specify the exact length of rest periods between rallies and play (Sánchez-Moreno, Afonso, Mesquita, & Ureña, 2016). In volleyball, there are no official limits for RT and ST during competitions (Stanković, Perić, Ruiz-Llamas, & Quiroga-Escudero, 2017), although certain pauses, such as time-outs or set breaks, are regulated by the rules (Türkiye Voleybol Federasyonu, TVF, 2023).

As scores become more evenly matched, games tend to be more competitive, with more points played, which may be accompanied by increased fatigue levels (Sánchez et al., 2016). In such situations, players may engage in behaviours such as requesting position checks, medical assistance, floor cleaning, or delaying their transition to the service zone in order to recover before the next rally. Consequently, RT and ST in volleyball may vary considerably during a match (Mroczek, Januszkiewicz, KawczyŃski, Borysiuk, & Chmura, 2014).

Since its establishment, the International Volleyball Federation (FIVB) has introduced several rule changes aimed at balancing attack and defence, extending rally length, and enhancing spectator experience (Hileno, Gonzàlez-Franqué, Iricibar, Laporta, & García-de-Alcaraz, 2023).

In 2022, a 15-second timer was implemented in VNL matches to regulate ST between rallies, starting immediately after a rally ends and controlled by the table referee (Federation Internationale de Volleyball, 2022).

According to official volleyball rules, a player must serve within 8 seconds of the referee's whistle (TVF, 2023); however, no regulation exists regarding the transition time from the end of a rally to the service position. Under the new rule, players are required to both assume their service position and execute the serve within 15 seconds after the timer starts.

These rule innovations are expected to be related to ST and RT. Understanding how restrictions on stoppage time are associated with technical performance is important for training planning and competition preparation. Previous research across various sports has examined the relationships between temporal characteristics of competition and performance outcomes (Torres-Luque, Sánchez-Pay, Fernández-García, & Palao, 2014; Granatelli et al., 2014; Ferreira, Volossovitch, & Sampaio, 2014); however, no studies have directly investigated how changes in temporal characteristics in volleyball relate to technical performance during matches.

Due to the specific structure of volleyball, it is hypothesized that changes in game rules are associated with variations in ST and RT, and that these temporal variables are related to technical performance indicators such as serve reception and attack success.

Therefore, the purpose of this study was to examine the relationships among ST, RT, and selected performance variables (serve reception and attack performance) in the 2022 men's VNL, TL, and IL, comparing competitions with and without ST restrictions.

METHODS

Study Sample

A total of 1,671 rallies were included in the study, consisting of 450 rallies from the 2022 Men's VNL, 550 rallies from the TL playoff matches, and 666 rallies from the IL playoff matches. The competitions analysed included the quarterfinals, semifinals, and finals from each league.

Technical Analysis

All matches were analysed using Data Volley 4 software by the same experienced performance analyst. The first serve reception, first attack, and first block actions of both teams in each rally were evaluated according to the technical scoring system presented in Table 1. Reception percentage and first-attack success percentage were calculated based on these evaluations.

To assess the reliability of the technical analysis, 10% of the rallies were randomly selected and reanalysed two weeks later by the same observer. Intra-observer reliability was evaluated using intraclass correlation coefficients (ICC), which showed acceptable agreement (ICC > 0.85 for all variables).

Table 1. Technical Scoring

1ST RECEPTION		1ST ATTACK	
Technical Value	Points	Technical Value	Points
Perfect	6	Perfect	6
Positive	5	Positive	5
3-4m close	4	Cover	4
Negative	3	Negative	3
On the net	2	Block	2
Error	1	Error	1
None	0	None	0

Reception Evaluation
Perfect: A reception that arrives exactly to the setter's hands in front of the net.
Positive: Similar to perfect reception but 1 or 2 metres open from the net
Exclamation: A reception 3–4 metres from the net
Negative: A reception more than 4 metres from the net
Over the net: Direct reception in the opponent's side of the court.
Error: A reception that wins points for opposing team
None: No reception (Oppsing team serve error)

Attack Evaluation
Perfect: An attack that wins the point
Positive: An effective attack that continues the game in the own court (non-score)
Cover: An attack that touches and turns from the opponent's block
Negative: An ineffective attack that continues the game in the opponent's side of the court (non-score)
Block: An attack blocked by the opposing team
Error: An attack that loses the point

Analysis of RT and ST

Total match time was recorded in seconds from the first serve to the final ball contact. RT was defined as the interval between the serve and the moment the ball contacted the floor to end the rally. The sum of all rally durations represented the total ball-in-play time. ST was defined as the interval between the end of one rally and the subsequent serve. External factors such as time-outs, video challenges, referee interventions, substitutions, floor cleaning, and protests were included in ST. All temporal variables were recorded in seconds and entered into an Excel spreadsheet corresponding to the technical performance data for each rally.

Statistical Analysis

The data were analysed using SPSS version 25.0. The Shapiro–Wilk test was applied to assess the normality of data distribution. As the data were not normally distributed, non-parametric statistical methods were used. Spearman's rank correlation coefficient (ρ) was calculated to examine the relationships between ST, RT, reception percentage, and attack percentage within each league.

Differences between leagues were evaluated using the Kruskal–Wallis H test. When a significant main effect was detected, post-hoc pairwise comparisons were performed to identify differences between leagues. Superscript letters (a, b) in the tables indicate statistically significant differences between leagues, where median values sharing the same letter are not significantly different ($p < .05$).

Interquartile ranges (IQR) were reported as measures of variability. The level of statistical significance was set at $p < .05$. Bonferroni correction was not applied because each league was analysed independently and the study was exploratory in nature.

All competition videos were obtained from publicly available sources, and no personal or identifiable data were collected. Therefore, ethical approval and informed consent were not required for this study.

RESULTS

According to Table 2, in the Italian league, a low positive correlation was observed between ST and RT ($\rho = .282$, $p < .001$), along with weak negative correlations with reception percentage ($\rho = -.078$, $p = .043$) and attack percentage ($\rho = -.153$, $p < .001$).

In the VNL, a moderate positive correlation was found between ST and RT ($\rho = .328$, $p < .001$), whereas weak negative correlations were observed with reception percentage ($\rho = -.128$, $p = .007$) and attack percentage ($\rho = -.214$, $p < .001$).

In the TL, a weak positive correlation was identified between ST and RT ($\rho = .296$, $p < .001$), a weak positive correlation with reception percentage ($\rho = .098$, $p = .029$), and a weak negative correlation with attack percentage ($\rho = -.154$, $p = .001$).

Table 2. Results of the Spearman correlation test between ST, RT, reception percentage, and attack percentage across leagues.

League			RT	1st Reception	1st Attack
IL	ST	ρ	.282*	-.078*	-.153*
		p	.000	.043	.000
		N	666	666	666
VNL	ST	ρ	.328*	-.128*	-.214*
		p	.000	.007	.000
		N	450	450	450
TL	ST	ρ	.296*	.098*	-.154*
		p	.000	.029	.001
		N	500	500	500
ρ – correlation value (Spearmon rho) p – level of statistical significance					

According to Table 3, a significant difference was found among the VNL, TL, and IL in ST (H(2) = 155.1, p < .001). ST in the VNL (median = 22, IQR = 14) was lower than in the TL (median = 27, IQR = 10) and the IL (median = 29, IQR = 10).

No significant differences were observed among the leagues in RT (H(2) = 1.41, p = .500). The IL (median = 4, IQR = 4), VNL (median = 4, IQR = 2), and TL (median = 4, IQR = 0) leagues showed similar rally durations.

According to Table 4, no significant differences were found among the leagues in reception percentage (H(2) = 6.8, p = .330) or attack percentage (H(2) = 7.2, p = .270). Median reception percentage values were 19.8 (IL), 20.7 (VNL), and 25.2 (TL), while median attack percentage values were 31.7 (IL), 31.6 (VNL), and 27.6 (TL).

Table 3. Results of the Kruskal-Wallis H Test comparing temporal variables across leagues.

	LEAGUE	N	X	MAX	MIN	MEDIAN	H	p
ST (sec)	**IL**	666	34	163	16	29[b]	155.1*	<.001
	VNL	450	29	105	15	22[a]		
	TL	500	35	194	19	27[b]		
RT (Sec)	**IL**	666	4.8	30	2	4	1.41	0.5
	VNL	450	4.8	29	2	4		
	TL	500	4.76	22	1	4		

*Values data are presented as median and interquartile range (IQR).
Superscript letters (a, b) next to median values indicate the results of post-hoc pairwise comparisons. Groups sharing the same letter do not differ significantly, whereas groups with different letters do ($p < .05$).

Table 4. Kruskal-Wallis H test results comparing technical variables across leagues.

	League	N	Median	H	p
1st Reception %	**IL**	666	19.8	6.8	0.33
	VNL	450	20.7		
	TL	500	25.2		
1st Attack %	**IL**	666	31.7	7.2	0.27
	VNL	450	31.6		
	TL	500	27.6		

Values are presented as median (interquartile range, IQR). Differences among leagues were not statistically significant ($p > .05$).

DISCUSSION

Volleyball is a demanding anaerobic sport that combines explosive movements—both vertical and horizontal—with short recovery periods (Silva et al., 2019). A volleyball player performs various motor actions on the court, including movements with and without the ball (locomotion), aimed at achieving specific goals and heavily engaging the nervous and muscular systems (Mroczek et al., 2014).

However, contact with the ball is brief, lasting only seconds, such as during passing, serving, or spiking. Most volleyball movements are performed without the ball (Mroczek et al., 2014). When measuring total match time, the portion spent actively with the ball—the working time—is much smaller than the rest periods, which consist of several components (Stanković et al., 2017). Rest and work times vary with the game's characteristics and fluctuate unpredictably across phases of play, reflecting effort intensity (Sánchez-Moreno et al., 2016).

The longest rest periods usually occur between rallies (Stanković et al., 2017). A rally is defined as a sequence of game actions starting with the server's serve and ending when the ball is out of play (TVF, 2023). During a rally, two phases occur: Complex I (side-out), which includes serve, reception, pass, and attack, and Complex II (transition), which involves block, defence, pass, and attack (de Angelis, Bento, Silva, Oliveira, & Franco, 2020). Rally length is regarded as a key performance indicator associated with match success (Hughes & Bartlett, 2002).

The VNL examined in this study is a major international volleyball league in which the winning team qualifies directly for the Olympic Games, the world's premier sporting event (Federation Internationale de Volleyball, 2022). Italy is a leading volleyball nation, ranked first in Europe and third worldwide in men's volleyball, while Turkey is ranked ninth in Europe and fourteenth globally, behind Italy in the international standings (FIVB, 2023; CEV, 2024). When considering club leagues, the most recent FIVB Club World Champion was a team competing in the IL (Volleyball Club World Championship, 2023), reflecting the high competitive standard of the IL at the club level.

Despite differences in league rankings and competition intensity, no significant differences were observed in average rally lengths across the leagues. This challenges the assumption that rally length alone is a reliable performance indicator. Sánchez-Moreno et al. (2016) reported an average rally duration of 4.99 seconds with rest times of 29.02 seconds in elite men's volleyball, while Mroczek et al. (2014) found rally durations ranging from 6 to 12 seconds. In the present study, the average RT was 4.8 seconds in IL, 4.8 seconds in the VNL,

and 4.78 seconds in TL. These findings are consistent with Sánchez-Moreno et al. (2016) but differ from those of Mroczek et al. (2014). The average ST was 34 seconds in IL, 29 seconds in the VNL, and 35 seconds in TL (Table 4). Statistically, no difference was observed between IL and TL, whereas ST in the VNL were significantly shorter (Table 4).

This difference can be attributed to the rule limiting rest time between rallies in VNL competitions. Interestingly, Sánchez-Moreno et al. (2016) analysed tournaments without such restrictions, yet their results were similar to those observed in the VNL with time limits. Therefore, ST in the TL and IL tend to be relatively long. Moreover, Sánchez-Moreno et al. (2016) reported that longer RT are associated with longer ST, and the present findings are consistent with this observation, as a significant positive correlation between RT and ST was identified across all three leagues (Table 3).

This suggests that longer ST are associated with longer subsequent rallies and may contribute to improved preparation for the following rally. Longer ST may enhance the quality of subsequent technical actions and overall player performance. In volleyball, one of the most important skills following the serve is serve reception, which is a key determinant of success. However, the determinants of effective serve reception have received limited attention (Paulo, Zaal, Seifert, Fonseca, & Araújo, 2018). In this study, a negative correlation was found between successful serve reception and ST in the IL and the VNL (Table 3).

This may indicate a decrease in reception success as service intensity increases, despite longer ST allowing additional recovery. Conversely, in the TL, a positive correlation was observed between ST and success in receiving (Table 3). This suggests that the relationship between ST and reception performance may vary with the technical and competitive levels of the league.

Additionally, the lowest median value for good serve reception was observed in the Italian league, whereas the highest was in TL; however, this difference was not statistically significant (Table 4). This pattern may indicate that, despite longer stoppage times in TL, service intensity tends to be lower; however, this interpretation should be interpreted with caution due to the lack of statistical significance. It may also suggest that overall game intensity in the TL differs from that in the VNL and IL.

Several studies in elite men's volleyball indicate that a key predictor of success during the side-out phase is the effectiveness of the first attack within a rally (Peña, Rodríguez-Guerra, Buscà, & Serra, 2013; Zetou, Tsigilis, Moustakidis, & Komninakidou, 2006). In the present study, the median success

rate of the first attack was lower in the TL than in the VNL and IL; however, these differences were not statistically significant (Table 4).

Volleyball involves short bursts of high-intensity actions interspersed with longer low-intensity periods (Angelis et al., 2020). It is characterized by short-duration, high-intensity efforts that primarily rely on the alactic energy system, unlike sports such as soccer, basketball, and swimming, which rely more on aerobic sources (Bara-Filho, Andrade, Nogueira, & Nakamura, 2013). Therefore, effective recovery during matches remains an important factor influencing physical performance.

Despite significant differences in stoppage times among leagues, a significant negative correlation was observed between the success rate of the first attack and ST across all leagues. This indicates that longer rest periods were associated with lower success in the first attack, despite the potential benefit of increased recovery time. When interpreting these findings, it is important to consider that both attackers and defenders typically perform their initial actions under similar resting conditions, which may partially explain this relationship.

A limitation of this study is that technical performance was evaluated by a single trained observer. Although standardized Data Volley procedures were applied consistently across all matches, future studies should include inter- and intra-rater reliability analyses to strengthen the robustness of technical performance assessment.

CONCLUSION

Because stoppage times vary by league and organization, training models should be tailored to the level and rules of the organization in which the competition occurs. In volleyball, increasing the pause between rallies facilitates more effective recovery. However, it does not directly improve the success rate of the first attack, as it also provides the opponent a chance to recover. Therefore, coaches are encouraged to use training methods that enable their athletes to recover more quickly than their opponents. Longer ST result in longer rallies. It becomes possible to finish rallies more quickly with improved recovery.

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