

Influence of rotation and reception zone on reception performance in elite women's volleyball

EDUARDO LÓPEZ MARTÍNEZ¹, CARLOS LÓPEZ-SERRANO², CÉSAR HERNÁNDEZ GONZALEZ³,
JUAN JOSÉ MOLINA MARTÍN⁴

¹Department of Sports Sciences, Faculty of Medicine, Health and Sports, Universidad Europea de Madrid, Madrid, SPAIN;

^{2,4}Department of Sports, Faculty of Sciences of Physical Activity and Sport (INEF), Technical University of Madrid, Madrid, SPAIN;

³ Fédération Française de Volley, FRANCE

Published online: July 31, 2026

Accepted for publication: July 15, 2026

DOI:10.7752/jpes.2026.07135

Abstract

Reception is a key determinant of performance in high-level teams, and it is influenced by contextual factors that affect both its execution and the outcome of the rally. This study examined the combined effect of team rotation and reception zone on reception performance in high level women's volleyball. We analysed 17,836 receptions from the Olympic Games and the 2024 Volleyball Nations League using descriptive statistics and logistic regression models (multinomial and ordinal). Teams tended to serve often to Zone 5, regardless of rotation, likely trying to avoid the libero and make it harder for the outside hitter to build the attack when positioned in the front row. Reception in these front-row areas was more inconsistent, with more errors and poorer contacts than in other zones, especially in receiving Team Rotations 3 and 6. In addition, the libero's position was shown to play a relevant role in reception performance, with better outcomes in RZ6 (in Team Rotations 1, 3 and 6); and in RZ1 (In Team rotation 2). Additionally, the position of the outside player near the setter appears to influence reception performance, with lower performance observed when it coincides with its usual reception zone in several rotations: Team Rotation 2*RZ5, Team Rotation 3*RZ5, and Team Rotation 6*RZ1. These findings reinforce the relationship between rotation and reception zone, and they can help to guide both training towards weaker areas and serving strategies to gain advantage in high level women's volleyball. They also provide a useful reference for analysing the evolution of the game and the potential impact of future rule changes.

Keywords: Volleyball, performance, reception, reception zone, rotation.

Introduction

Performance analysis of game actions in volleyball is a key tool for both researchers and coaches, as it helps to identify the parameters that make the difference in competitive performance (López-Serrano et al., 2022). The importance of analysing individual and isolated actions in volleyball lies in the very logic of the game, which is characterised by a sequential and cyclical structure in which each action directly influences the next (João & Pires, 2015; Stutzig et al., 2015). In this context, performance in the initial actions of a rally conditions the development and effectiveness of subsequent actions (Silva et al., 2016). However, this mechanistic perspective relies on simple and stable models that hardly capture the open, dynamic and constantly changing nature of the game (Ureña & Moreno, 2024). Therefore, greater attention has been given to studies that analyse actions within their dynamic interactions (Lames & McGarry, 2007) and adopt systemic approaches to achieve a deeper understanding of the game (Hurst et al., 2016; Mesquita et al., 2013).

Reception constitutes the initial action executed by the team opposing the serve and aims to control the opponent's serve with maximal precision. Several studies have associated reception performance with setting quality, setting speed, the available attacking-system options, organisation of the block, and attack performance (Costa et al., 2017, 2024; Martins et al., 2021; Marzano-Felisatti et al., 2022; Polychronopoulos et al., 2025; Rocha et al., 2023; Wang & Wang, 2025). This relationship becomes particularly relevant because the attack following reception, in the so-called side-out or K1 phase (Salas & Molina, 2009; Ureña & Moreno, 2024), is one of the main ways of scoring among high-level players (Drikos et al., 2020; Giatsis et al., 2022), and is a predictor of victory (Kaya et al., 2024; Paulo et al., 2016; Zetou et al., 2007).

Previous research has established relationships between behavioural and contextual variables with reception performance in sub elite and high level volleyball, identifying relationships with serving technique (Bari et al., 2023; López et al., 2021; Sotiropoulos et al., 2021; Stamm et al., 2016), height (Pawlik & Mroczek, 2023) and serve speed (Petrů & Vencúrik, 2024); as well as the receiver's role (Rocha et al., 2023), the reception zone, serve trajectory, reception technique, or combinations thereof (López et al., 2025; Rocha et al., 2021; Sotiropoulos et al., 2021).

However, considering each of the six rotations as distinct initial contextual situations that affect the setter's initial position and the team's offensive structure and organisation in K1 (do Nascimento et al., 2025; López et al., 2023; Rocha et al., 2023); we consider incorporation the receiving team's rotation as a variable influencing performance to be highly relevant (Zadraznik et al., 2009).

Although numerous investigations have included the reception zone as a variable in their analysis, we argue that insufficient attention has been paid to the influence exerted by the receiving team's rotation on the reception zone and performance when both variables interact. Indeed, we identified only the study by López et al. (2022), conducted with high-level male players, as a reference. They found that the reception performance differed depending on the team rotation, the reception area, and the interaction between both variables. This difference may also affect the selection of the serve destination zone.

Given the established differences between high-level men's and women's volleyball that influence reception performance (Barzouka et al., 2021; Drikos et al., 2024), alongside the need for further evidence in elite women's volleyball due to its comparatively limited representation in research (Drikos et al., 2018; Vieira et al., 2024); this study examined how the interaction between team rotation and reception zone influences reception performance in elite women's volleyball. It was hypothesised that there is an association between the reception zone and the reception performance, and that this association is mediated by team rotation.

Material & methods

Sample

The study used an observational design and included the two most relevant international competitions in the year 2024: Volleyball Nations League (VNL 2024) and Olympic Games (O.G. 2024), which yield a total of 18183 receptions. Only 17,836 receptions performed by main receivers (outside hitters and liberos) were analysed, excluding those performed by players not specialising in this role (middle blockers, opposites and setters). The final sample included 413 sets, involving 145 players in total. Among them, 46 were liberos and 99 were outside hitters.

The matches were recorded in Full HD from a slightly elevated central back position, providing an uninterrupted full-court view, in accordance with FIVB protocols. The study was approved by the Ethics Committee of the authors' institution.

Variables

The variables included in this study were:

Receiving team rotation (RT) - Six categories were established according to the setter's position in the moment of serve: R1, R2, R3, R4, R5 and R6 (López et al., 2022).

Reception zone (RZ) - Zone where the receiver intercepts the serve. According to López et al. (2025): RZ3 (front row), RZ5, RZ6 and RZ1 (corresponding to back row FIVB zones 5, 6 and 1).

Reception performance (RP) - Based on López et al. (2022) the following categories were established into five values: Reception Error (RER), the serve achieves an ace or a reception error; Reception Bad (RBA), the reception quality does not allow elaboration of a sequence with setting and spike, returning a free ball; Reception Moderate (RMO), does not allow setting firsts times; Reception Good (RGO), allows setting first times with risk; Reception Excellent (REX), allows any type of setting in optimal conditions.

Data analysis

Initially, receptions were analysed by rotation and reception zone using descriptive statistics, and chi-square tests to examine their association. To grasp the relationship, Haberman's corrected residues were used. These residues were considered significant when they exceeded the level of ± 1.96 as an absolute value (Haberman, 1978).

Multinomial logistic regression was used to determine the effect of rotation and reception zone on reception performance,. Subsequently, ordinal logistic regression was used to analyse the combined influence of rotation, and reception zone on the reception quality. Effect size was reported as odds ratios (OR) with 95% confidence intervals (95% CI). Significance was defined as $p < 0.05$. All abbreviations are defined before first use: χ^2 (Chi-square), p (significance level), V_c (Cramér's V effect size), OR (odds ratio), and CI (confidence interval). Cramér's V was interpreted according to conventional thresholds (≈ 0.06 small, ≈ 0.17 moderate, ≈ 0.29 large) (Cohen, 1988). To evaluate the variance explained by the models, the Nagelkerke pseudo r^2 was calculated. All data were analysed using SPSS v.26.

Reliability

Matches were recorded with Data Volley Pro4. Actions were reviewed by a single observer with 10 years' experience scouting at top international levels. The inter-intra observer reliability for performance (PER) and reception zone (RZ) was evaluated using Cohen's Kappa test (Cohen, 1992), based on 10% of the sample (42 randomly chosen sets; Tabachnick & Fidell, 1983). Excellent inter- and intra-observer agreement was found for PER ($\kappa = 0.846$ and $\kappa = 0.928$; $p < 0.001$), involving a second observer with over eight years of international experience. RZ also showed excellent agreement ($\kappa = 0.876$ and $\kappa = 0.935$). Interpretation follows (Landis & Koch, 1977). Analyses were performed in SPSS software (v.26, IBM, USA).

Results

Comparison of reception zone according to rotation

The most frequent reception area was RZ5 (43.2%), followed by RZ6 (37.5%) and RZ1 (18.7%). Only .5% was registered in the front area (RZ3)

A significant relation was found between the team rotation and the reception zone ($X^2_{15} = 3051.981$; $p < .001$; $V = 0.160$), with a weak level of association between variables (Table 1). In R1 an increase of reception was observed in RZ1 and was lower in RZ3. In R2, R4 and R5, an increase of reception was observed in RZ5 and RZ6 and reception declined in RZ1. In R3 and R6, the frequency was higher in RZ1 and RZ3 and lower in RZ5 and RZ6.

Table 1. Distribution of the reception zone according to the team rotation.

		RECEPTION ZONE				
RT		RZ1	RZ3	RZ5	RZ6	TOTAL
R1	Frecuency	713	8	1545	1291	3557
	% in RT	20.0%	.2%	43.4%	36.3%	100.0%
	% in RZ	21.3%	8.6%	20.0%	19.3%	19.9%
	Residue	2.2	-2.7	.3	-1.7	
R2	Frecuency	153	12	1170	1066	2401
	% in RT	6.4%	.5%	48.7%	44.4%	100.0%
	% in RZ	4.6%	12.9%	15.2%	15.9%	13.5%
	Residue	-16.7	-.2	5.9	7.5	
R3	Frecuency	834	22	831	726	2413
	% in RT	34.6%	.9%	34.4%	30.1%	100.0%
	% in RZ	24.9%	23.7%	10.8%	10.8%	13.5%
	Residue	21.4	2.9	-9.4	-8.1	
R4	Frecuency	185	11	1299	1010	2505
	% in RT	7.4%	.4%	51.9%	40.3%	100.0%
	% in RZ	5.5%	11.8%	16.9%	15.1%	14.0%
	Residue	-15.7	-.6	9.4	3.1	
R5	Frecuency	270	6	1571	1502	3349
	% in RT	8.1%	.2%	46.9%	44.8%	100.0%
	% in RZ	8.1%	6.5%	20.4%	22.4%	18.8%
	Residue	-17.6	-3.1	4.8	9.7	
R6	Frecuency	1188	34	1292	1097	3611
	% in RT	32.9%	.9%	35.8%	30.4%	100.0%
	% in RZ	35.5%	36.6%	16.8%	16.4%	20.2%
	Residue	24.4	3.9	-10.1	-9.9	
Total		3343	93	7708	6692	17836
% in RT		18.7%	.5%	43.2%	37.5%	100.0%

Note. R1= Rotation 1; R2= Rotation 2; R3= Rotation 3; R4= Rotation 4; R5= Rotation 5; R6= Rotation 6; RZ1 = Reception zone 1; RZ5 = Reception zone 5; RZ6 = Reception zone 6; RZ3 -Front row zone. Significance $p < 0.05$.

Comparison of reception performance according to rotation and reception zone

A significant relationship was observed between reception performance and team rotation ($X^2_{20}=35.870$; $p < .016$; $V_c = .022$), and reception zone ($X^2_{12}=303.098$; $p < .001$; $V_c = .075$). However, the effect size shows a very weak level of association between variables. Table 2 presents the distribution of frequencies and percentages for reception performance by rotation and reception zone.

Table 2. Performance statistics distributed by team rotation and reception zone.

		Reception Performance					
		Error	Bad	Moderate	Good	Excellent	Total
Team Rotation	R1	205 (5.8%)	165 (4.6%)	1382 (38.9%)	959 (27.0%)	846 (23.8%)	3557
	R2	144 (6.0%)	119 (5.0%)	850 (35.4%)	691 (28.8%)	597 (24.9%)	2401
	R3	153 (6.3%)	114 (4.7%)	808 (33.5%)	711 (29.5%)	627 (26.0%)	2413
	R4	152 (6.1%)	136 (5.4%)	858 (34.3%)	722 (28.8%)	637 (25.4%)	2505
	R5	207 (6.2%)	175 (5.2%)	1251 (37.4%)	927 (27.7%)	789 (23.6%)	3349
	R6	227 (6.3%)	165 (4.6%)	1366 (37.8%)	952 (26.4%)	901 (25.0%)	3611
Reception Zone	Total	1088 (6.1%)	874 (4.9%)	6515 (36.5%)	4962 (27.8%)	4397 (24.7%)	17836
	RZ1	206 (6.2%)	172 (5.1%)	1214 (36.3%)	984 (29.4%)	767 (22.9%)	3343
	RZ3	40(43.0%)	8 (8.6%)	12 (12.9%)	19 (20.4%)	14 (15.1%)	93
	RZ5	487 (6.3%)	408 (5.3%)	2975 (38.6%)	2064 (26.8%)	1774 (23.0%)	7708
	RZ6	355 (5.3%)	286 (4.3%)	2314 (34.6%)	1895 (28.3%)	1842 (27.5%)	6692
	Total	1088 (6.1%)	874 (4.9%)	6515 (36.5%)	4962 (27.8%)	4397 (24.7%)	17836

Multinomial analysis of reception performance

According to the multinomial regression in Table 3, team rotation and reception zone affected reception effectiveness. The model revealed a differential effect of rotation depending on reception quality ($X^2_{20}= 41.101$; $p = .004$; $R^2= .014$). The model showed significantly fewer bad receptions in R6 than R4. R6 showed fewer good receptions than R3, R4 and R5, and fewer excellent receptions than R3.

The reception zone analysis ($X^2_{12}= 193.042$; $p < .001$; $R^2= .014$) showed that RZ3 had significantly more error and bad receptions than the rest of the zones. In contrast, RZ3 had more good receptions than RZ5. RZ6 had more good receptions than RZ5 and more excellent receptions than both RZ1 and RZ5.

Table 3. Multinomial regression analysis of reception performance in relation to team rotation and reception zone.

Reception Perform.	Predictor		n	B	p	OR	95% CI	
							Lower	Upper
Error	Team Rotation	R1	1088 (6.1%)					
		R2	205 (5.8%)	-.056	.595	.946	.770	1.162
		R3	144 (6.0%)	.070	.554	1.073	.850	1.353
		R4	153 (6.3%)	.133	.248	1.142	.912	1.430
		R5	152 (6.1%)	.116	.319	1.123	.894	1.412
		R6	207 (6.2%)	.068	.524	1.071	.868	1.320
	Reception zone	RZ1	227 (6.3%)	Ref.	-	-	-	-
		RZ3	206 (6.2%)	.113	.252	1.119	.923	1.357
		RZ5	40(43.0%)	3.074	.000	21.620	11.211	41.692
		RZ6	487 (6.3%)	.065	.386	1.067	.921	1.237
Bad	Team Rotation	R1	355 (5.3%)	Ref.	-	-	-	-
		R2	1957 (4.9%)					
		R3	165 (4.6%)	.017	.888	1.017	.808	1.280
		R4	119 (5.0%)	.193	.141	1.213	.938	1.567
		R5	114 (4.7%)	.154	.235	1.167	.905	1.504
		R6	136 (5.4%)	.313	.013	1.367	1.067	1.752
	Reception zone	RZ1	175 (5.2%)	.196	.098	1.216	.965	1.533
		RZ3	165 (4.6%)	Ref.	-	-	-	-
		RZ5	172 (5.1%)	.196	.068	1.216	.986	1.500
		RZ6	8 (8.6%)	1.716	.000	5.565	2.251	13.754
Good	Team Rotation	R1	408 (5.3%)	.104	.206	1.109	.945	1.303
		R2	286 (4.3%)	Ref.	-	-	-	-
		R3	4962 (27.8%)					
		R4	959 (27.0%)	.012	.836	1.013	.900	1.139
		R5	691 (28.8%)	.181	.008	1.198	1.049	1.369
		R6	711 (29.5%)	.231	.001	1.260	1.106	1.436
	Reception zone	RZ1	722 (28.8%)	.221	.001	1.247	1.093	1.423
		RZ3	927 (27.7%)	.086	.166	1.090	.965	1.230
		RZ5	952 (26.4%)	Ref.	-	-	-	-
		RZ6	984 (29.4%)	.011	.844	1.011	.907	1.126
Excellent	Team Rotation	R1	19 (20.4%)	.658	.076	1.931	.934	3.992
		R2	2064 (26.8%)	-.167	.000	.846	.779	.919
		R3	1895 (28.3%)	Ref.	-	-	-	-
		R4	4397 (24.7%)					
		R5	846 (23.8%)	-.084	.173	.919	.815	1.038
		R6	597 (24.9%)	.035	.616	1.036	.903	1.188
	Reception zone	RZ1	627 (26.0%)	.163	.017	1.177	1.029	1.346
		RZ3	637 (25.4%)	.102	.138	1.108	.968	1.268
		RZ5	789 (23.6%)	-.074	.248	.929	.819	1.053
		RZ6	901 (25.0%)	Ref.	-	-	-	-
Moderate	Team Rotation	R1	767 (22.9%)	-.249	.000	.780	.696	.873
		R2	14 (15.1%)	.346	.381	1.413	.652	3.065
		R3	1774 (23.0%)	-.291	.000	.747	.686	.813
		R4	1842 (27.5%)	Ref.	-	-	-	-
		R5	6515 (36.5%)	Ref.	-	-	-	-
		R6						
	Reception zone	RZ1						
		RZ3						
		RZ5						
		RZ6						

Note: OR, Odds Ratio; CI, Confidence Interval; p, p-value; RT: rotation team; RZ: reception zone. Significance $p < 0.05$. Reference value for performance: moderate receptions.

Relationship between team rotation, reception zone and reception performance

The relationship between team rotation, reception zone and reception performance was analysed using ordinal regression, which grouped rotation and reception zones and examined their interaction (RT*RZ). The model in Table 4 shows significant differences in reception performance ($X^2_{60}=203.329$; $p < .001$; $R^2= .009$), which makes it possible to see that there is an interaction between the RT and the RZ.

It could be observed in team rotations, that during R1 the reception performance was higher in RZ6 than in RZ5 and RZ3. In R2, the reception performance was lower in RZ5 than in RZ6 and RZ1. In R3 performance was higher in RZ6 than in the rest of the zones (RZ1, RZ3 and RZ5) and lower in RZ3 than in RZ1 and RZ5. In R4 the performance was lower in RZ3 than in RZ1, RZ5 and RZ6. Finally, in R6 performance was higher in RZ6 than in RZ1 and RZ5.

Comparing interactions dependent on different team rotations, R6*RZ6 showed significantly higher performance than many of the other interactions (R1*RZ1, R1*RZ3, R1*RZ5, R2*RZ5, R3*RZ1, R3*RZ3, R4*RZ3, R4*RZ5, R5*RZ5, R5*RZ6, R6*RZ1, and R6*RZ5). At the opposite extreme, R3*RZ3 and R4*RZ3 showed lower performance than receptions executed in any rotation from zones RZ1, RZ5, and RZ6.

Table 4. Ordinal regression analysis to predict volleyball reception performance based in interaction of team rotation and reception zone.

Predict.	OR	p.	95% CI		Predict.	OR	p.	95% CI	
			Lower	Upper				Lower	Upper
R1*RZ1	0.823	.001	0.737	0.919	R4*RZ1	1.111	.283	0.918	1.344
R1*RZ3	0.361	.008	0.170	0.767	R4*RZ3	0.186	<.001	0.094	0.367
R1*RZ5	0.802	<.001	0.732	0.878	R4*RZ5	0.879	.008	0.799	0.967
R1*RZ6	0.969	.509	0.879	1.066	R4*RZ6	0.937	.208	0.846	1.037
R2*RZ1	1.115	.302	0.907	1.373	R5*RZ1	0.914	.261	0.781	1.069
R2*RZ3	0.866	.670	0.447	1.679	R5*RZ3	0.674	.387	0.275	1.649
R2*RZ5	0.807	<.001	0.732	0.889	R5*RZ5	0.811	<.001	0.740	0.888
R2*RZ6	0.984	.750	0.890	1.089	R5*RZ6	0.902	.030	0.823	0.990
R3*RZ1	0.808	<.001	0.728	0.899	R6*RZ1	0.836	<.001	0.759	0.921
R3*RZ3	0.403	<.001	0.255	0.636	R6*RZ3	0.553	.002	0.380	0.803
R3*RZ5	0.934	.214	0.840	1.040	R6*RZ5	0.848	.001	0.771	0.932
R3*RZ6	1.121	.050	1.008	1.257	R6*RZ6	Ref.	-	-	-

Note: OR, Odds Ratio; CI, Confidence Interval; p, p-value; RT: rotation team; RZ: reception zone

Discussion

This study examined how the team rotation and reception zone influenced reception performance in elite women's volleyball. The results showed a higher percentage of serves received in RZ5, with lower reception performance in RZ5 compared to RZ6 in R1, R2, R3, and R6.

When analysing the reception zone separately, RZ6 showed more good receptions than RZ5, and more excellent receptions than RZ5 and RZ1. Despite this, 37.5% of serves were directed at RZ6, second only in frequency to RZ5 (43.2%). This suggests that players are not always looking for the most aggressive option, but sometimes for something a bit more balanced. In this case, serving to RZ6 might feel like a safer choice when hitting hard, while still making reception uncomfortable. Something similar has been seen in men's volleyball, where this area is often used to create doubt in the receiving team without taking too many risks (Afonso et al., 2012; Rentero et al., 2015; Valhondo et al., 2018). In the same direction, our results also seem to match what Wang and Wang (2025) pointed out regarding, a more aggressive serving style in women's volleyball at the 2024 Olympic Games compared to Tokyo 2020. However, the number of serves directed at RZ6 was only significantly higher when the libero did not receive in RZ6. Furthermore, RZ3 showed significantly more errors and poor receptions than the other zones, but more good receptions than RZ5. The wider limits of the confidence intervals also indicate considerable variability in performance. The good receptions could be explained by the tactical use of a float serve in the front row zone, the aim of which is to hinder the opponent's offensive system without involving a high risk in its execution (López et al., 2023; Maia & Mesquita, 2006). Meanwhile, balls received in the front row due to the serve making contact with the top of the net and subsequently changing trajectory could lead to more reception errors (Ciuffarella et al., 2013; López et al., 2021). The tactical relevance of serving to the front-row zone justifies its inclusion in the study. However, the findings should be treated with caution due to the low representation of this zone in the total number of plays.

The frequency analysis showed that reception zone was associated with rotation. In R1, an increase in reception was observed in RZ1 and a decrease in RZ3. In R2, R4 and R5, an increase in reception was observed in RZ5 and RZ6 and a decrease in RZ1. In R3 and R6, the frequency was higher in RZ1 and RZ3 and lower in RZ5 and RZ6. The existence of a relationship between the reception zone and the rotation in which it took place makes it possible to establish a tactical causality, understanding the six rotations as distinct contextual game situations. As in the study by López et al. (2022), which involved a high-level male sample, the results obtained here appear to indicate a strategy of avoiding the area of the court where the libero is receiving with the usual three-receiver structure (Ciuffarella et al., 2013; Paulo et al., 2016). Preventing the libero from receiving the ball could be a logical tactical strategy, given the libero's role as a specialist in dig and reception, with a high reception success rate (Callejón & Hernández, 2009). Serving to RZ5 in rotations R2, R4 and R5 – where the libero is positioned at RZ1 – allows the serve to be directed away from the libero's area of influence. Furthermore, RZ5 is the usual reception zone for outside hitters acting as front hitters. By forcing these players

into the reception-attack transition with the serve, it becomes more difficult for them to integrate into the attack system (Marcelino et al., 2014; Molina-Martín et al., 2022; Rocha et al., 2023; Sotiropoulos et al., 2021), potentially reducing their spiking performance (López et al., 2023) and facilitating the serving team's defence (Palao et al., 2004; Ureña et al., 2000). In line with the above, a higher frequency of serves to RZ5 has been reported in women's top-level volleyball (Barzouka et al., 2021; López et al., 2025).

In R3 and R6, there was a tendency to serve into the front-row zone. López et al. (2022) found that in the men's category, the frequency of receiving in the front zones also increased in R3 and R6, noting that serving into the zone where the middle hitter was running increased. It therefore, it appears that serving to the front zone in these rotations may hinder the middle hitter's run, thereby impeding playability in attacking systems (Rocha et al., 2021). This situation may be particularly relevant in R6, where the setter, opposite and middle hitter occupy the same space; notably lower attack performance has been reported in K1 when the serve is directed at that convergence point in men's volleyball (López et al., 2023). However, it is possible that the new rules established by the FIVB (2025) – which allow players to move without committing a positional fault from the moment the ball is served, rather than from the moment of contact as was the case under previous rules – may reduce the effectiveness of serves directed at the movement zones of setters or attackers who are not involved in the reception set-up.

When analysing the interactions between rotation, reception zone and performance, it was found that serves received in RZ6 when the libero is usually in that zone (R1*RZ6, R3*RZ6 and R6*RZ6) achieved better reception performance than those received in RZ5 in the same rotations, or in RZ1 during R3 and R6. The R2*RZ1 formation also performed better when the libero received in RZ1 than the R2*RZ5 formation. It therefore appears that the libero's position within the reception structure enhances the performance of the zone in which they are positioned. However, no better results were obtained in the R4*RZ1 and R5*RZ1 interactions compared to other back-row reception zones, despite the libero being responsible for the reception in RZ1. This could be due to the libero assuming greater spatial responsibility (Marcelino et al., 2014), attempting to partially relieve their teammates of the reception burden to facilitate their involvement in the attack, which may result in a deterioration in the quality of their own reception (López et al., 2022; Rocha et al., 2023). The lower performance in RZ5 (in four of the six rotations) probably just reflects that it is a harder situation for reception. Players are usually further from the typical 2–3 area (Afonso et al., 2012), receptions close to the left touchline tend to be less effective (López et al., 2025) and everything has to connect quickly with the attack, which adds pressure (Marcelino et al., 2014; Molina-Martín et al., 2022). In many cases, players move a bit deeper to be ready for the next action, but this can actually make the reception itself more difficult (Paulo et al., 2016).

Some authors have theorised that variations among players in the same position might influence the effectiveness of their actions (Martins et al., 2022b). It has thus been suggested that teams might seek to balance their attacking rotations by positioning the outside hitter with the best attacking performance near the setter (OHN) (Martins et al., 2022a; Santos, 1992), while the outside hitter away (OHA) would be a player with a lower attacking ability but better ball control (Rocha et al., 2023). However, this study found lower performance in the reception zones usually occupied by OHN: R2*RZ5, R3*RZ5 and R6*RZ1; but also with OHA: R3*RZ1 and R6*RZ5. The R1*RZ5 interaction with low performance should be treated with caution, as although this is not the OHA's usual reception zone, some top-level women's teams are employing alternative K1 set-ups for R1, with OHNs receiving in RZ5 instead of the traditional RZ1 (Klein et al., 2025).

Strengths and limitations

Although this study was conducted using a large sample comprising nearly 18,000 plays from the two most representative competitions in elite women's volleyball in 2024 (the Olympics and the VNL), certain limitations must be taken into account. The results obtained are based on the elite level and should not be generalised to lower-level or men's teams. The rule introduced by the FIVB in 2025, allowing regular substitutions between receivers after the serve has been taken, could lead to changes that affect the applicability of this study. Although it appears that such an action would only be feasible for serves executed using the spin jump technique, which involve a higher toss prior to contact. Finally, this study did not take into account behavioural variables such as the serve technique used, its speed or trajectory; nor contextual variables such as match status or opponent level, which would allow for a better understanding of how the execution of the return affects players' performance in different game situations.

Despite these limitations, this study has captured all the actions from the competitions analysed, representing a realistic approach to competition during 2024. This ecological validity is a major strength of the study. Finally, this study represents a step forward in understanding women's volleyball and serves as a benchmark for assessing its future development and the effects of implementing new regulations affecting off-position play.

Conclusions

The results of this study show that the rotation of the receiving team and the receiving zone significantly affect reception performance in elite-level women's volleyball. The highest reception frequency occurred in RZ5 regardless of rotation, possibly with the intention of avoiding the libero's involvement and triggering the

reception-to-attack transition by the outside hitter in the front row. This was followed in frequency by RZ6, RZ1 and RZ3, with significant differences in frequency between rotations, attributable to avoiding serves directed at the libero.

With regard to reception zone performance contextualised by rotation, it was found that the libero's position affected performance, being superior to that of other zones when she received in RZ6 (R1, R3 and R6), and in RZ1 (only in R2). The OHN's position also appears to influence reception performance, with lower performance levels coinciding with their usual reception zone in several rotations: R2*RZ5, R3*RZ5 and R6*RZ1.

The results of this study confirm that the analysis of reception zones and their effectiveness must always be contextualised within the receiving team's rotations, thus providing a practical framework to understand and improve reception performance in high-level women's volleyball. In light of the new regulatory changes established.

We believe that this study applicable in the preparation of top-level women's teams for competition. On the one hand, it enables improvements to be made to the training methodology for receiving, by identifying and increasing the practice of the most frequently occurring patterns in each rotation, as well as by proposing modifications to the structures that can help mitigate underperformance in certain areas. On the other hand, it enables the identification, at a general level, of the most vulnerable areas for reception in each rotation, allowing for the establishment of appropriate serving strategies. However, it is important to remember that the trends detected at a general level may not hold true when conducting individualised analyses. Finally, this study can serve as a benchmark for assessing the impact of the new rules currently in the trial phase, which will be implemented in 2026 and may affect the position of the receivers and reception performance.

As a future line of research, it would be particularly relevant to examine how the new regulation allowing players to move across the court from the moment the ball is tossed for the serve, affects reception performance and side-out efficiency. Two possible outcomes are hypothesised: a decrease in performance for the receiver executing the pre-reception switch, or a levelling of reception performance across rotations due to the adoption of more fixed reception zones.

Disclosure statement

No potential conflict of interest was reported by the author(s).

The author declares no conflicts of interest. The author declares that no generative AI or AI-assisted technologies were used in the writing, editing, or preparation of this manuscript.

Funding

The author(s) reported there is no funding associated with the work featured in this article.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Informed consent

Informed consent was not required, as the data were obtained from publicly available recordings and no personal or sensitive data were used.

Generative AI statement

No generative AI or AI-assisted technologies were used in the preparation of this manuscript.

References:

- Afonso, J., Esteves, F., Araújo, R., Thomas, L., & Mesquita, I. (2012). Tactical determinants of setting zone in elite men's volleyball. *Journal of Sports Science and Medicine*, 11(1), 64–70.
- Bari, M. A., Al Mijbilee, A. A. A., Nuhmani, S., Iqbal, A., & Alghadir, A. H. (2023). Analysis of the kinematic variables that predict jump serve efficacy among volleyball players. *Medicine (United States)*, 102(31), E34471. <https://doi.org/10.1097/MD.00000000000034471>
- Barzouka, K., Sotiropoulos, K., Drikos, S., Kitsiou, A., & Angelonidis, Y. (2021). Current trends of the serve skill in relation to the in-game roles of the elite volleyball players: Comparison between genders. *Journal of Human Sport and Exercise*, 16(2), 317–331. <https://doi.org/10.14198/jhse.2021.162.08>
- Callejón, D., & Hernández, C. (2009). Estudio y análisis de la recepción en el Voleibol Masculino de Alto Rendimiento. *RICYDE. Revista Internacional de Ciencias Del Deporte*, 5(16), 34–51. <https://doi.org/10.5232/ricyde2009.01603>
- Ciuffarella, A., Russo, L., Masedu, F., Valenti, M., Izzo, R. E., & De Angelis, M. (2013). Notational Analysis of the Volleyball Serve. *Timisoara Physical Education and Rehabilitation Journal*, 6(11), 29–35. <https://doi.org/10.2478/tperj-2013-0013>
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112(1), 155–159. <https://doi.org/10.1037/0033-2909.112.1.155>
- Costa, G. de C. T., Mesquita, I., Coutinho, P., Evangelista, B. F. de B., Milistetd, M., Freire, A. B., Moreira Ferreira, A., & Ugrinowitsch, H. (2024). Determinant factors of attack efficacy in high-level volleyball:

- what does distinguish the middle-attacker performance? *Kinesiology*, 56(1), 3–11.
<https://doi.org/10.26582/k.56.1.1>
- Costa, G. de C. T., Ugrinowitsch, H., Castro, H. O., Greco, P., Evangelista, B. F., & Malheiros, L. M. (2017). Predicting Factors of Zone 4 Attack in Volleyball. *Perceptual and Motor Skills*, 0(0), 1–13.
<https://doi.org/10.1177/0031512517697070>
- Do Nascimento, M. H., Laporta, L., Vieira, P. H. C., Rodrigues, M. C. J., Rocha, A. C. R., Rangel, C. C., Freire, A. B., Guimarães, J. da S., Pedrosa, G. F., Ugrinowitsch, H., & Costa, G. D. C. T. (2025). How do match location and opponent level influence complex I offensive strategy in men's volleyball? The case of the Brazilian Men's Superleague. *Journal of Human Sport and Exercise*, 20(4), 1265–1276.
<https://doi.org/10.55860/qm882954>
- Drikos, S., Angelonidis, Y., & Sobonis, G. (2018). The role of skills in winning in different types of set in women's volleyball. *International Journal of Performance Analysis in Sport*, 18(6), 950–960.
<https://doi.org/10.1080/24748668.2018.1528714>
- Drikos, S., Fatahi, A., Molavian, R., Ahmed Al-Ryami, S. A., Sotiropoulos, K., & Barzouka, K. (2024). Volleyball: similar game for men and women? Factors characterising successful performance in Olympic Games 2021 regarding genders. *International Journal of Performance Analysis in Sport*, 1–13.
<https://doi.org/10.1080/24748668.2024.2411870>
- Drikos, S., Sotiropoulos, K., Barzouka, K., & Angelonidis, Y. (2020). The contribution of skills in the interpretation of a volleyball set result with minimum score difference across genders. *International Journal of Sports Science and Coaching*, 15(4), 542–551. <https://doi.org/10.1177/1747954120930307>
- FIVB. (2024). *Official Volleyball Rules 2025-2028*. FIVB.
- Giatsis, G., Drikos, S., & Lola, A. (2022). Analysis of match report indicators in men's volleyball olympics and world championships (2014–2021) depending on the type of final score. *International Journal of Sports Science and Coaching*. <https://doi.org/10.1177/17479541221086779>
- Haberman, S. J. (1978). *Analysis of quantitative data*. ACADEMIC PRESS, INC.
- Hurst, M., Loureiro, M., Valongo, B., Laporta, L., Nikolaidis, P. T., & Afonso, J. (2016). Systemic mapping of high-level women's volleyball using social network analysis: The case of serve (K0), side-out (KI), side-out transition (KII) and transition (KIII). *International Journal of Performance Analysis in Sport*, 16(2), 695–710. <https://doi.org/10.1080/24748668.2016.11868917>
- João, P. V., & Pires, P. M. (2015). Eficácia do Side-out no Voleibol sénior masculino em função do jogador interveniente Effectiveness of Side-Out in the male senior volleyball according intervention player. *Motricidade*, 11(4), 142–150. <https://doi.org/10.6063/motricidade.6302>
- Kaya, F., Binali, E., & Paçacı, S. (2024). The Effects of Skill-Based Factors on The Results of High-Level Volleyball Games. *Int Journal of Physical Education Sport and Technologies*, 5(1), 10–18.
<https://www.researchgate.net/publication/379653075>
- Klein, C. N., Costa, G. D. C. T., Afonso, J., Loureiro, M., Clemente, F., Pedrosa, G. F., & Laporta, L. (2025). Rotation 1 in high-level women's volleyball: chaos or a new tactical solution to an old problem? *Retos*, 75, 187–198. <https://doi.org/10.47197/retos.v75.117328>
- Lames, M., & McGarry, T. (2007). On the search for reliable performance indicators in game sports. *International Journal of Performance Analysis in Sport*, 7(1), 62–79.
<https://doi.org/10.1080/24748668.2007.11868388>
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159–174.
- López, E., Díez-Vega, I., & Molina, J. J. (2021). Effect of serve on reception and side-out performance in relation to ball's contact with the net and type of serve, in high level male volleyball. *RICYDE. Revista Internacional de Ciencias Del Deporte*, 17(63), 56–68. <https://doi.org/10.5232/ricyde2021.06305>
- López, E., Díez-Vega, I., & Molina, J. J. (2022). Reception and performance in high level male volleyball: A relational study. *Journal of Human Sport and Exercise*, 17(2), 1–15.
<https://doi.org/10.14198/jhse.2022.172.16>
- López, E., López-Serrano, C., Hernández Gonzalez, C., & Molina Martín, J. J. (2025). How serve origin-destination and receiver contact point shape reception in elite women's volleyball. *Journal of Sports Sciences*, 1–11. <https://doi.org/10.1080/02640414.2025.2598175>
- López, E., Molina, J. J., Díaz-Bento, M. S., & Díez-Vega, I. (2023). Spike performance in K1: influence of rotation and reception area on high level men's volleyball teams. *Retos. Nuevas Tendencias En Educación Física, Deporte y Recreación*, 48(1), 213–221. <https://doi.org/10.47197/retos.v48.93875>
- López-Serrano, C., Moreno, M. P., Mon-López, D., & Molina, J. J. (2022). In the Opinion of Elite Volleyball Coaches, How Do Contextual Variables Influence Individual Volleyball Performance in Competitions? *Sports*, 10(156), 1–16. <https://doi.org/10.3390/sports10100156>

- Maia, N., & Mesquita, I. (2006). Estudo das zonas e eficácia da recepção em função do jogador recebedor no voleibol sênior feminino. *Revista Brasileira de Educação Física e Esporte*, 20(4), 257–270.
<https://doi.org/10.1590/S1807-55092006000400004>
- Marcelino, R., Afonso, J., Moraes, J. C., & Mesquita, I. (2014). Determinants of attack players in high-level men's volleyball. *Kinesiology*, 46(2), 234–241.
- Martins, J. B., Afonso, J., Mendes, A., Santos, L., & Mesquita, I. (2022a). Inter-player variability within the same positional status in high-level men's volleyball. *Retos*, 46(1), 129–137.
<https://doi.org/10.47197/retos.v46.93624>
- Martins, J. B., Afonso, J., Mendes, A., Santos, L., & Mesquita, I. (2022b). Inter-team variability in game play under critical game scenarios: A study in high-level men's volleyball using social network analysis. *Nuevas Tendencias En Educación Física, Deporte y Recreación*, 43(1), 1095–1105.
<https://doi.org/10.47197/RETOS.V43I0.90505>
- Martins, J. B., Mesquita, I., Mendes, A., Santos, L., & Afonso, J. (2021). Inter-team variability in high-level women's volleyball from the perspective of Social Network Analysis: an analysis in critical game scenarios. *International Journal of Performance Analysis in Sport*, 21(4), 564–578.
<https://doi.org/10.1080/24748668.2021.1924524>
- Marzano-Felisatti, J. M., Guzmán, J. F., & Priego-Quesada, J. I. (2022). Latest Trends in Technical-Tactical Analysis of High-Level Volleyball. Systematic Review. *Retos*, 46(1), 874–889.
<https://doi.org/10.47197/retos.v46.91579>
- Mesquita, I., Palao, J. M., Marcelino, R., & Afonso, J. (2013). Indoor Volleyball and Beach Volleyball. In T. McGarry, P. O'Donoghue, & J. Sampaio (Eds.), *Routledge Handbook of Sports Performance Analysis* (Number 10872, pp. 367–379). Routledge. <https://doi.org/10.4324/9780203806913.ch29>
- Molina-Martín, J. J., Díez-Vega, I., & López, E. (2022). Reception-Attack Transition in Volleyball: Analysis of Spike Effectiveness. *Apunts Educación Física y Deportes*, 149(3), 53–62.
[https://doi.org/10.5672/apunts.2014-0983.es.\(2022/3\).149.06](https://doi.org/10.5672/apunts.2014-0983.es.(2022/3).149.06)
- Palao, J. M., Santos, J. A., & Ureña, A. (2004). Efecto del tipo y eficacia del saque sobre el bloqueo y el rendimiento del equipo en defensa. *Rendimiento Deportivo. Com*, 8, 1–24.
- Paulo, A., Zaal, F. T. J. M., Fonseca, S., & Araújo, D. (2016). Predicting Volleyball Serve-Reception. *Frontiers in Psychology*, 7(1694), 1–9. <https://doi.org/10.3389/fpsyg.2016.01694>
- Pawlik, D., & Mroczek, D. (2023). Influence of jump height on the game efficiency in elite volleyball players. *Scientific Reports*, 13(8931), 1–10. <https://doi.org/10.1038/s41598-023-35729-w>
- Petrů, J., & Vencúrik, T. (2024). The effect of jump topspin serve speed on reception quality in men's volleyball. *Physical Activity Review*, 12(2), 11–19. <https://doi.org/10.16926/par.2024.12.17>
- Polychronopoulos, G., Lamprogeorgou, M., Drikos, S., Gortsila, E., Sotiropoulos, K., & Barzouka, K. (2025). The influence of serve on the organisation of the block in high-level volleyball across genders. *Journal of Physical Education and Sport*, 25(4), 805–814. <https://doi.org/10.7752/jpes.2025.04086>
- Rentero, L., João, P. V., & Moreno, M. P. (2015). Analysis of the libero's influence in different match phases in volleyball. *Revista Internacional de Medicina y Ciencias de La Actividad Física y Del Deporte*, 15(60), 739–756. <https://doi.org/10.15366/rimcafd2015.60.008>
- Rocha, A. C., Laporta, L., Andre Barbosa de Lira, C., Modenesi, H., Figueiredo, L. S., & Costa, G. D. C. T. (2021). Complex I in male elite volleyball: an interactional analysis according to reception location. *International Journal of Performance Analysis in Sport*, 22(1), 1–13.
<https://doi.org/10.1080/24748668.2021.2003961>
- Rocha, A. C., Laporta, L., Rodrigues, G., Barbosa de Lira, C., Castro, H. D. O., & Costa, G. de C. (2023). Is it possible for the reception and the player- receiver to influence the offensive construction in volleyball ? An ecological vision and Intragame procedural relationships in high-level teams. *International Journal of Performance Analysis in Sport*, 23(4), 319–333. <https://doi.org/10.1080/24748668.2023.2229204>
- Salas, C., & Molina, J. J. (2009). *Voleibol Táctico* (1ª). Paidotribo.
- Santos, J. A. (1992). *Estudio sobre las variaciones en el rendimiento en equipos de voleibol de élite a través de la información obtenida mediante un sistema estadístico informatizado*. Universidad de Granada.
- Silva, M., Marcelino, R., Lacerda, D., & João, P. V. (2016). Match Analysis in Volleyball: a systematic review. *Montenegrin Journal of Sports Science and Medicine*, 5(1), 35–46.
- Sotiropoulos, K., Drikos, S., Papadopoulou, S. D., & Barzouka, K. (2021). Characterizing adaptations of serve indicators in top-level male volleyball among seasons. *International Journal of Sports Science and Coaching*, 16(3), 784–792. <https://doi.org/10.1177/1747954120978920>
- Stamm, R., Stamm, M., Vantsi, M., & Jairus, A. (2016). Comparative Analysis of Serve and Serve Reception Performance in Pool B of European Men's Volleyball Championship 2015. *Papers on Anthropology*, 25(2), 55–69. <https://doi.org/10.12697/poa.2016.25.2.06>
- Stutzig, N., Zimmermann, B., Büsch, D., & Siebert, T. (2015). Analysis of game variables to predict scoring and performance levels in elite men's volleyball. *International Journal of Performance Analysis in Sport*, 15(3), 816–829. <https://doi.org/10.1080/24748668.2015.11868833>

- Tabachnick, B., & Fidell, L. (1983). *Using multivariate statistics* (7th ed.). Pearson Education.
- Ureña, A., & Moreno, M. P. (2024). Definición de los componentes del juego en voleibol desde un enfoque sistémico. *Retos: Nuevas Tendencias En Educación Física, Deporte y Recreación*, 57, 570–580. <https://doi.org/10.47197/retos.v57.106594>
- Ureña, A., Santos, J. A., Martínez, M., Calvo, R., & Oña, A. (2000). La facilitación defensiva a través del saque en el voleibol femenino de alto nivel. *Motricidad. European Journal of Human Movement*, 6, 175–189.
- Valhondo, A., Fernandez-Echeverria, C., Gonzalez-Silva, J., Claver, F., & Moreno, M. P. (2018). Variables that Predict Serve Efficacy in Elite Men's Volleyball with Different Quality of Opposition Sets. *Journal of Human Kinetics*, 61(1), 167–177. <https://doi.org/10.1515/hukin-2017-0119>
- Vieira, P. H., Laporta, L., Pedrosa, G., Santana, A. F., Freire, A. B., Rangel, C., Clemente, F. M., Leonardi, T. J., & Costa, G. de C. (2024). Sequencing of game complexes in women's volleyball: are there differences according to the set played? *Human Movement*, 25(4), 96–104. <https://doi.org/10.5114/hm/194773>
- Wang, M., & Wang, J. (2025). Comparative analysis of first-attack performance in elite women's volleyball at the 2020 and 2024 Olympic Games. *Frontiers in Sports and Active Living*, 7(1). <https://doi.org/10.3389/fspor.2025.1658390>
- Zadražnik, M., Marelić, N., & Rešetar, T. (2009). Differences in rotations between the winning and losing teams at the youth European volleyball championships for girls. *Acta Universitatis Palackianae Olomucensis. Gymnica*, 39(4), 33–40.
- Zetou, E., Moustakidis, A., Tsigilis, N., & Komninakidou, A. (2007). Does Effectiveness of Skill in Complex I Predict Win in Men's Olympic Volleyball Games? *Journal of Quantitative Analysis in Sports*, 3(4). <https://doi.org/10.2202/1559-0410.1076>