Rotation 1 in high-level women's volleyball: chaos or a new tactical solution to an old problem?

Rotación 1 en el voleibol femenino de alto nivel: ¿caos o una nueva solución táctica a un problema antiguo?

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Abstract

Introduction: Volleyball demands rapid decision-making in unpredictable situations, particularly in Rotation 1 (R1) within Game Complex I. Offensive organization in this rotation directly influences side-out (KI) effectiveness in elite teams.
Objective: To identify different R1 organizations during the sideout in elite women's volleyball using social network analysis.
Methodology: Twenty-seven matches, 397 R1 side-outs, and 3,968 actions were analyzed across three offensive organizations (O1, O2, O3). Variables from complexes 0, I, and II were examined, including serve type and direction, setting conditions, attack tempo, type, zone, and effect. Data were recorded using Microsoft Excel and Lince PLUS X, reliability was tested in IBM SPSS, and four social networks were constructed in Gephi.
Results: China exclusively employed O2, while Turkey and the United States alternated between O1 and O2 or O3. Poland used only O1. China (0.93) and Turkey (0.89) showed higher attack effect point, while Poland demonstrated greater centrality in continuity, error, and block effect (0.92, 0.59, 0.65). Setting condition A showed the highest centrality across all teams (TUR 0.84; CHN 0.89; POL 0.92; USA 0.88). Attack zone 4 was more central for TUR (0.94), POL (0.94), and the USA (0.89), while zone 2 was most central for China (0.87). Attack tempo 2 showed higher centrality in Turkey (0.89), whereas tempo 3 was more prominent for China (0.85), Poland (0.86), and the USA (0.94).
Discussion: Despite high centrality for setting condition A, attack tempos 2 and 3, and attack zones 4 and 2 prevailed.
Conclusions: Adjusting side-out patterns in R1 creates new organizational dynamics that improve reception quality and attacker positioning. Training should simulate these scenarios to enhance movement efficiency, speed, and offensive unpredictability.

Keywords

Game complex I; match analysis; position 1; side-out; social network analysis.

Resumen

Introducción: El voleibol exige una toma de decisiones rápida en situaciones impredecibles, especialmente en la Rotación 1 (R1) dentro del Complejo de Juego I. La organización ofensiva en esta rotación influye directamente en la eficacia del side-out (KI) en equipos de élite.
Objetivo: Identificar las diferentes organizaciones de R1 durante el side-out en el voleibol femenino de élite mediante análisis de redes sociales.
Metodología: Se analizaron 27 partidos, 397 side-outs en R1 y 3.968 acciones distribuidas en tres organizaciones ofensivas (O1, O2, O3). Se examinaron variables de los complejos 0, I y II, incluyendo tipo y dirección del saque, condiciones de colocación, tiempo, tipo, zona y efecto del ataque. Los datos fueron registrados en Microsoft Excel y Lince PLUS X; la fiabilidad fue evaluada en IBM SPSS; y se construyeron cuatro redes sociales en Gephi.
Resultados: China utilizó exclusivamente O2, mientras que Turquía y Estados Unidos alternaron entre O1 y O2 o O3. Polonia empleó únicamente O1. China (0,93) y Turquía (0,89) presentaron mayor efecto punto del ataque, mientras que Polonia mostró mayor centralidad en continuidad, error y efecto bloqueo (0,92; 0,59; 0,65). La condición de colocación A presentó la mayor centralidad en todos los equipos (TUR 0,84; CHN 0,89; POL 0,92; USA 0,88). La zona de ataque 4 fue más central para TUR (0,94), POL (0,94) y USA (0,89), mientras que la zona 2 fue más central para China (0,87). El tiempo de ataque 2 mostró mayor centralidad en Turquía (0,89), mientras que el tiempo 3 predominó en China (0,85), Polonia (0,86) y EUA (0,94).
Discusión: A pesar de la alta centralidad de la condición de colocación A, los tiempos de ataque 2 y 3 y las zonas 4 y 2 fueron predominantes.
Conclusiones: Ajustar los patrones de side-out en R1 genera nuevas dinámicas organizativas que mejoran la calidad de la recepción y la posición de las atacantes. El entrenamiento debe reproducir estos escenarios para optimizar los desplazamientos, la velocidad y la imprevisibilidad ofensiva.

Palabras clave

Complejo de juego i; análisis del juego; posición 1; side-out; análisis de redes social

Introduction

Volleyball is a non-invasive team sport with cyclical and repetitive dynamics, combined with the inability to retain the ball, creating unpredictable and chaotic scenarios where all decisions are made while the ball is in motion (Mesquita et al., 2013; Sarruge et al., 2020). This inability to retain the ball leads to variability in the quality of the ball to be hit, which is directly related to previous actions and the possibilities for subsequent actions (Mesquita et al., 2015). In this way, volleyball can be understood as a dynamic system composed of interconnected independent parts, which can change its state over time (McGarry et al., 2010; Laporta et al., 2015; Amparo et al., 2025). This occurs through properties of self-regulation, aimed at achieving stability, and self-organization, which seeks the formation of patterns (Thelen, 2005; Walter et al., 2007; Sullivan et al., 2021). For improved organization and investigation of changes in states and gameplay patterns, tools related to performance analysis are utilized (Amparo et al., 2025).

Performance Analysis (PA) in sports is associated with the variables interpretation related to the individual (athletes) and collective (teams) performance (Marcelino et al., 2010; Nascimento et al., 2023), and in the pursuit of improving the efficiency and effectiveness of sports processes and outcomes (Garganta, 2001; Sotiropoulos et al., 2023). In this context, Match Analysis (MA), a subset of PA, observes and elucidates tactical-technical game behavior through the evaluation of intra- and inter-group and team decision-making actions, aiming to identify successful indicators in the sport and to develop new game models (Medeiros et al., 2014; Sarmento et al., 2014; Vieira et al., 2024). These analyses assist coaches and researchers in planning and controlling team training sessions, as well as enabling the individual enhancement of athletes' action effectiveness (Lamas & Morales, 2022).

In volleyball, MA has focused on performance indicators associated with outcomes, game scenarios, and the development of teams and athletes (Marcelino et al., 2010; Martins et al., 2022). Previous research on critical scenarios in volleyball has identified several key situations, such as rallies lasting between 8 and 10 seconds, with alternating performance trends depending on which team concludes the rally (Sánchez-Moreno et al., 2018), as well as instances involving consecutive attack errors that create pressure, and moments when the score approaches the match end (Martins et al., 2021).

Although volleyball encompasses six distinct game complexes, with unique interactions and characteristics (Hurst, 2016; Loureiro, 2017; Hofman et al., 2025), Complex I (KI) or side-out, which is the focus of this study, comprises the actions of reception, setting, and attacking following the opponent's serve (Hileno, Arasanz & Alcaraz, 2020; Laporta et al., 2023). The designation of rotation (R) is defined by the setter's initial position at the start of the rally (Nascimento et al., 2024). Specifically, Rotation 1 (R1) corresponds to the traditional offensive organization in which the setter is positioned in zone 1. In this configuration, the outside hitter, who typically attacks from zone 4 within the 5x1 functional system, performs the attack from zone 2. In contrast, the opposite hitter, who usually operates in zones 2 and 1, executes the attack from zone 4 during the side-out (KI) (Silva et al., 2016). This tactical organization can be considered a critical scenario related to a suboptimal game situation (Lopéz et al., 2023). Given this limitation and the scarcity of studies addressing this specific variable, elite women's volleyball teams have sought innovative strategies for R1 side-out organization. However, if a critical scenario in R1 diminishes the effectiveness of side-out in this formation, and considering the trend towards fast-paced play in elite volleyball, the question arises whether the new ways of playing in R1 represent a viable solution?

In this context, the Social Network Analysis (SNA) can serve as a tool that aids in understanding systems and subsystems through the dynamics of interactions among all their elements (Passos et al., 2011) and the system ecology helping to understand the teams tactical-technical patterns and the relationship between the game actions performance, the moment, the environment, and the opponent, forming a unique dynamic through these interactions (Nascimento et al., 2024). In this context, eigenvector centrality establishes the relevance and functionality of nodes within each network based on the characteristics and patterns of connections, resulting in understanding both the direct and indirect variable interactions and their level of importance within the overall context (Lusher, Robins & Kremer, 2010; Laporta et al., 2023). Considering the aforementioned, the objective of this study is to identify the different Rotation 1 (R1) organizations during the side-out in elite women's volleyball using social network analysis (SNA), and to evaluate the effectiveness of these organizations in R1.

Method

Sample

The matches of the top four teams of the 2023 Volleyball Nations League (VNL) (United States of America (USA), Türkiye (TUR), China (CHN), and Poland (POL)) in the offensive organization of side-out in rotation 1 were analyzed, totaling 27 matches (5 USA, 8 TUR, 9 CHN and 10 POL) 397 side-outs in R1, and 3,968 gameplay actions. The selection of these four top teams is justified as three out of four teams implemented different changes to the traditional R1 organization pattern.

Variables

To align with the outlined objective, only KI was taken into consideration, which is characterized by the actions of reception, setting, and attack (Laporta et al., 2015; Loureiro et al., 2017; Monge, 2003). Offensive organization in R1 was considered in three different formats: Organization 1 (O1) with opposite attacking the first ball side-out in zone 4; Organization 2 (O2) with opposite starting from zone 4, approaching near the net, and attacking the first side-out ball in zone 2; Organization 3 (O3) with opposite starting from zone 4, approaching near the serve line, and attacking the first side-out ball in zone 2.

Serve Direction (SD) was adapted from Vargas et al. (2018), combining the variables of Serve Zone 1, 6, and 5 (Hurst et al., 2016) with Reception Position 1 to 9 (Rocha, Laporta, Rodrigues, Guimarães, et al., 2023). For instance, when considering trajectory 56, it means that the player served from Serve Zone 5 to Reception Zone 6. The serve directions relative to Reception Zones 2, 3, and 4 were grouped into the SD-Short category. Serve Types were classified as follows: Power Jump Serve (TSPJS), characterized by displacement, an explosive jump, and ball rotation; Standing Serve (TSSS), which involves serve without a jump while being in a stationary position; and Jump-Float Serve (TSJF), characterized by no ball rotation and a uniform trajectory (Afonso et al., 2012).

The Receiver Role took into consideration the functional specialization of the player, with being a setter (RRSET), outside hitter (RROH), middle-blocker (RRMB), opposite (RROPP), and libero (RRLIB) (Sheppard et al., 2009). Setting Condition was defined based on the relationship between reception and the available attack options as follows: Setting Condition A (SCA) all attack options are available; Setting Condition B (SCB) Quick attacks are feasible but more challenging to execute, and certain attack combinations are restricted; and Setting Condition C (SCA) only slow, outside settings are viable (Hurst et al., 2016; Loureiro et al., 2017).

Attack Zone was used according to the official rules published by the International Volleyball Federation with 6 zones (FIVB, 2021). Since there was no attack at position 5 (mostly used by the libero). Attack Type was adapted from Martins et al. (2022) and Costa et al. (2011) added with ball trajectory, with Powerful Parallel/Diagonal Attack (ATPPO/ATDPO) a powerful hit on the ball, imprinting it a downward trajectory; Placed Parallel/Diagonal Attack (ATPPL/ATDPL) the ball is hit with controlled application of strength and directed to a vulnerable defensive area; Tip Parallel/Diagonal Attack (ATPTI/ATDTI) the bottom of the ball is contacted with the fingertips and directed to a vulnerable defensive area; Exploration of the Block Attack (ATEXP) purposeful attack against the opposing block, making the ball reflect out of the court: from the side or the long of the court, and Others (ATOTH).

Attack Tempo was considered as follows: Attack Tempo 1 (AT1) when the attacker is in the air or jumping during or rapidly after the set; Attack Tempo 2 (AT2) when the attacker takes two steps after the set; Attack Tempo 3 (AT3) when the attacker takes three or more steps after the set (Afonso & Mesquita, 2007; Afonso et al., 2010). Attack Effect was categorized as follows: Error (AEERR) The attacker strikes the ball into the net, is out of bounds, or violates the regulations; Block (AEBLO) the attacker's attempt is thwarted by the opponent's block; Continuity (AECON) the attack does not lead to a conclusive action and allows for a counter-attack opportunity; Point (AEPOI) the attack results in a direct point when the ball either lands in the opponent's field or is deflected out of bounds due to blocking (Marcelino et al., 2011).

Considering the game's ecological aspects and the impact of actions executed within KI on subsequent actions, we included the variable Number of Blockers in our analysis. Blocks were categorized as follows: triple block [1×3], broken triple block [1×(2 + 1)], double block [1×2], broken double block [1×(1 + 1)], single block [1×1], no block due to the setter's merit [NO BLOCK +], and no block due to the setter's mistake [NO BLOCK -] (Rocha, Laporta, Rodrigues, Lira, et al., 2023). Block Starting Position was categorized into: Closed Block the players are next to Zone 3 and the three players are close to each other [1 meter]; Open Block the 3 players are far away in the net, one in the center of the network and the other two separated about 2m; Mixed to the Right two of the players – middle-blocker and opposite – are close with about 1m – in Z2 and another (outside hitter) away from these, about 2 to 3m - in Z4 –, to block the fast set of the middle-blocker); and Mixed to the Left two of the players – central and outside hitter – are close to each other in 1m – in Z4 and another (opposite) away from these, about 2 to 3m - in Z2) (Martins et al., 2021).

Data collection

The matches were filmed in HD format (1080p), capturing the court from behind (between 7 and 9 meters away) and elevated approximately 5 meters above ground level. The videos were made available by the staff of the one team. They utilized Excel® spreadsheets to analyze video footage scenes. Variables were extensively discussed among the coaches to ensure they were unique and comprehensive in representing categories and actions. The analysis was conducted by two volleyball coaches with extensive experience as performance analysts, each with over 5 years of practice. They were trained by a highly experienced coach with over 10 years of practice, including work with national and regional teams. To validate these variables, a 5-set match from a different competition (2022 FIVB Women's Volleyball Nations League Final Phase) was jointly analyzed. Additionally, the match was reanalyzed one month later to assess intra- and inter-observer reliability, resolving any doubts. For reliability testing, 20% of actions were reanalyzed, exceeding the recommended reference value of 10% (Tabachnick & Fidell, 2013). Cohen's Kappa values ranged from 0.79 to 1.00 for intra- and inter-observer analysis, surpassing the literature's recommended threshold of 0.75 (Fleiss et al., 2013).

Data analysis

For data analysis, a Microsoft Excel spreadsheet for Microsoft 365 MSO (Version 2406 Build 16.0.17726.20078) 64-bit was used, alongside the Lince PLUS X 64 2.1.0 application (Soto-Fernández et al., 2021) for action logging. IBM SPSS Statistics 29.0.2.0 was employed for data reliability and quality control, and Gephi-0.10.1 for constructing four social networks (SNA), each corresponding to one of the analyzed teams. SNA was chosen for its comprehensive depiction of connections and specificities among all environmental variables and their relationships (Laporta et al., 2023). In this study, eigenvector centrality was utilized, wherein nodes with higher centrality are also connected to more central nodes. Thus, interaction characteristics influence node centrality, not solely their adjacent numbers (Bonacich, 2007; Nascimento et al., 2024).

When one variable is directly related to another, a connection is formed, and eigenvector centrality considers both direct and indirect connections of a node (Nascimento et al., 2024). Node size and edge thickness were manipulated, with a minimum size of 10 and a maximum of 40, to visually emphasize eigenvector centrality values (Rocha et al., 2021). The Fruchterman layout with Reigold distribution (area 100,000) was employed to organize the distribution, placing nodes with higher eigenvector centrality in the center of each sub-network (Newman, 2006).

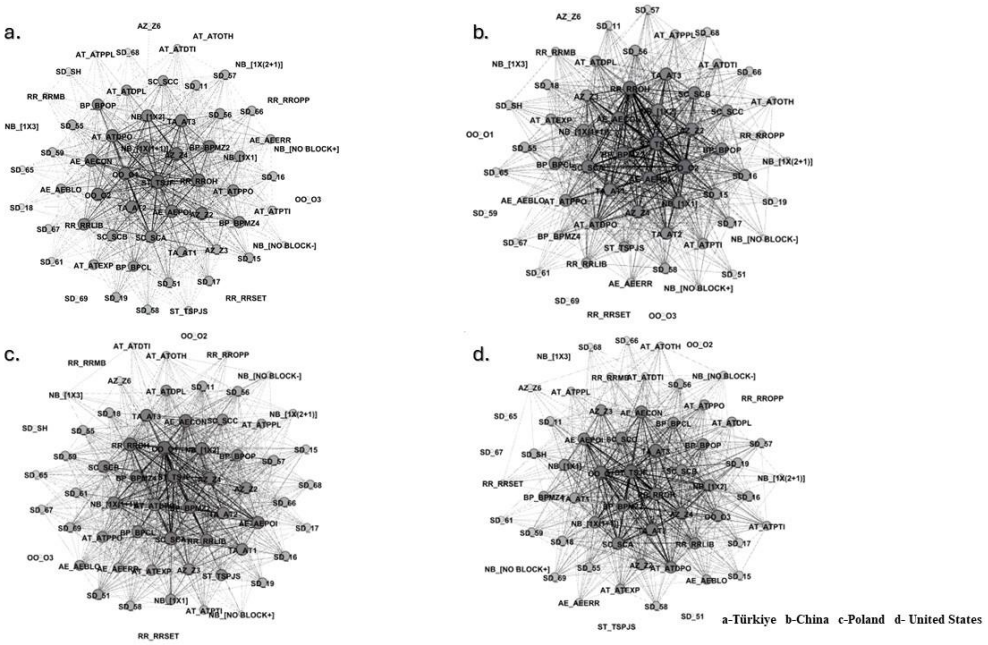
Results

Social network analysis using eigenvector centrality was conducted to create interaction maps (Figure 1) for each team in the top 4 of the 2023 VNL. Subsequently, a table displaying centrality values for each node per team was generated (Table 1).

Table 1. Eigenvector values per team.

NODES	TUR	CHN	POL	USA
Offensive organization 1	0.90	0	1	0.95
Offensive organization 2	0.90	1	0	0
Offensive organization 3	0	0	0	0.81
Serve Direction SH	0.25	0.43	0	0.58
Serve Direction 11	0.61	0.39	0.63	0.54
Serve Direction 15	0.55	0.67	0.45	0.48
Serve Direction 16	0.53	0.70	0.58	0.65
Serve Direction 17	0.59	0.64	0.41	0.47
Serve Direction 18	0.26	0.59	0.59	0.60
Serve Direction 19	0.58	0.25	0.58	0.63
Serve Direction 61	0.35	0.25	0.58	0.26
Serve Direction 65	0.27	0.36	0.38	0
Serve Direction 66	0.55	0.46	0.59	0.26
Serve Direction 67	0.43	0.25	0.43	0
Serve Direction 68	0.26	0.45	0.49	0.25
Serve Direction 69	0	0	0.59	0.50
Serve Direction 51	0.62	0.28	0.68	0
Serve Direction 55	0.63	0.59	0.57	0.54
Serve Direction 56	0.68	0.65	0.62	0.59
Serve Direction 57	0.58	0.38	0.63	0.54
Serve Direction 58	0.51	0.63	0.59	0.49
Serve Direction 59	0.51	0	0.54	0.48
Serve Types Power Jump	1	0.97	0.98	1
Serve Types Jump Float	0.42	0.66	0.76	0
Receiver Role Outside Hitter	0.94	0.91	0.95	0.91
Receiver Role Libero	0.81	0.59	0.88	0.79
Receiver Role Setter	0	0	0	0.22
Receiver Role Opposite	0	0.41	0.24	0
Receiver Role Middle-Blocker	0.25	0.44	0	0.42
Setting Condition A	0.84	0.89	0.92	0.88
Setting Condition B	0.73	0.85	0.85	0.79
Setting Condition C	0.66	0.72	0.77	0.85
Attack Tempo 1	0.68	0.84	0.82	0.68
Attack Tempo 2	0.89	0.79	0.84	0.90
Attack Tempo 3	0.87	0.85	0.86	0.94
Attack Zone 6	0	0	0.32	0.26
Attack Zone 2	0.88	0.87	0.83	0.78
Attack Zone 3	0.59	0.71	0.79	0.77
Attack Zone 4	0.94	0.85	0.94	0.89
Attack Type Placed Diagonal	0.68	0.67	0.72	0.62
Attack Type Powerful Diagonal	0.89	0.78	0.88	0.81
Attack Type Tip Diagonal	0.40	0.57	0.22	0.39
Attack Type Exploration of the Block	0.64	0.65	0.69	0.63
Attack Type Others	0	0.39	0.38	0.38
Attack Type Placed Parallel	0.26	0.48	0.57	0.44
Attack Type Powerful Parallel	0.79	0.78	0.75	0.66
Attack Type Tip Parallel	0.51	0.65	0.53	0.56
Attack Effect Error	0.54	0.46	0.59	0.39
Attack Effect Continuity	0.87	0.90	0.92	0.86
Attack Effect Point	0.89	0.93	0.88	0.84
Attack Effect Block	0.61	0.26	0.65	0.61
Block Starting Position Mixed Zone2	0.87	0.90	0.89	0.87
Block Starting Position Mixed Zone 4	0.80	0.49	0.83	0.66
Block Starting Position Open	0.78	0.78	0.79	0.79
Block Starting Position Closed	0.69	0.79	0.83	0.75
Number of Blockers [1X1]	0.71	0.84	0.71	0.79
Number of Blockers [1X2]	0.84	0.85	0.91	0.82
Number of Blockers [1X (1+1)]	0.86	0.82	0.88	0.82
Number of Blockers [1X3]	0	0	0.22	0
Number of Blockers [1X(2+1)]	0	0.26	0.41	0.25
Number of Blockers [NO BLOCK-]	0.26	0.25	0.29	0.42
Number of Blockers [NO BLOCK+]	0	0.32	0.23	0

Figure 1. Graph of the first four placed in the Volleyball Nations League 2023.



OO-Offensive organization 1, 2 and 3; SD-Serve direction; SD-SH Serve direction short; ST-TSPJS-Power jump serve, ST-TSJF jump-float serve; RROH-Receiver role outside hitter; RRSET-Receiver role setter; RRMB- Receiver role middle-blocker; RRLIB-Receiver role libero; RROPP-Receiver role opposite; SC-Setting condition A, B and C; AT-Attack tempo 1, 2 and 3; AZ-Attack zone 2, 3, 4 and 6; ATPPO-Attack type powerful parallel; ATTDPO-Attack type powerful diagonal; ATPPL-Attack type placed parallel; ATDPL-Attack type placed diagonal; ATPTI-Attack type tip parallel; ATDTI-Attack type tip diagonal; ATOTH-Attack type others; ATEXP-Attack type exploration of the block; AEERR-Attack effect error; AECON- Attack effect continuity; AEPOI-Attack effect point; AEBLO-Attack effect block; BPOP-Block starting position open; BPCL-Block starting position closed; BPMZ2-Block starting position mixed zone 2; BPMZ4-Block starting position mixed zone 4; NB-Number of blockers.

Upon observing Table 1 and Figure 1, it is identified that the eigenvector centrality for team organization in China and Poland equals 1, indicating a consistent pattern used by these teams, where the organizational form is centrally positioned interacting with most nodes. In contrast, Türkiye and the USA exhibit two possible organizational configurations, with both configurations in Türkiye sharing the same centrality value of 0.90. Regarding the serve direction for CHN, TUR, POL, and USA, the highest centrality values are found in SD 56 (0.68), SD 16 (0.70), SD 51 (0.68), and SD 16 (0.65), respectively.

Across all teams, the outside hitter exhibits values above 0.90 for the reception function, paralleled by setting conditions (Setting A) that stand out among the four teams with values above 0.84. Attack tempo 3 (0.85 to 0.94) and attack zone 4 (0.89 to 0.94) are particularly prominent among the teams, except for Turkey, where attack tempo 2 (0.89) and China, where attack zone 2 (0.87).

Regarding attack type and direction, powerful diagonal attacks are prominent (0.78 to 0.89) across all networks, with attack effect diverging between points (0.89 to 0.93) and continuity (0.86 to 0.92). Highlighted actions in blocking include mixed initial position towards zone 2 (0.87 to 0.90), blocking composition (1x2) (0.82 to 0.91), and [1x(1+1)] (0.82 to 0.86).

Discussion

The critical game scenario in R1 during side-out may interfere with task execution and attack construction due to a change in functional specialization of attacking zones by the hitters during the rally (Ritchie et al., 2016; Martins et al., 2022). Elite women's volleyball teams are exploring new organizational forms in R1. Therefore, this study aims to identify the different R1 formations during the side-out in elite women's volleyball using social network analysis and eigenvector centrality (Wäsche et al., 2017) and to evaluate the effectiveness of these organizations in R1.

The results indicate that three out of four teams employ different organizations: China exclusively uses organization 2 (O2), whereas the opposite runs close to the net and attacks in zone 2. Türkiye and the

United States alternate between the traditional and a new organization, with Türkiye adopting organization 2 (O2) and the USA adopting organization 3 (O3), where the opposite moves close to the serve line and attacks in zone 2. Poland solely uses the traditional formation (O1), with the opposite attacking in zone 4 and the outside hitter attacking in zone 2.

Most serves were directed toward zones 6 and 1, causing the ball to land behind the setter and complicating the setting action. This difficulty in setting adversely affects the outside hitter ability to attack and slows down the game, aligning with findings from previous studies. Additionally, it can be noted that a serve targeting zones 6 and 1 could disrupt movements for the opposite in non-traditional formations, as there is a tendency to bring the pass closer to zone 2, where they typically execute their attacks.

Furthermore, considering the player who performed at the reception, the serves were notably directed towards the outside hitters. In O1 formation, these hitters were positioned in zones 5 and 1, with the libero in zone 6. In O2 and O3 formations, the outside hitters were in zones 5 and 6, with the libero in zone 1. This targeting serves towards the outside hitters may be a strategy aimed at slowing down the game pace (Kitsiou et al., 2020). Concomitantly, all four teams exhibited high values of reception A, emphasizing receptions that support and facilitate movement and game flow.

The results show higher eigenvector values for attack tempo 2 and 3 in all four teams, even with good setting conditions, since new formations can make the game slower due to the movement required to organize the team's attack, and due to the predominance of attack zones on the edges (Rocha et al., 2020). Higher attack centrality values were observed in Zone 4 in three of the four teams (TUR, POL and USA), while Zone 2 was predominantly used by China. Therefore, it is understood that China, being the only team that uses only organization 2 during the side-out in R1, finds a more favorable situation with the organization proposal, resulting in a greater use of zone 2 with the opposite running close to the net to carry out the attack Laporta et al., 2021a). Studies have already found that Asian teams are more susceptible to movements and game simulations (Laporta et al., 2021b) and the opposite is one of the team's main offensive players (Costa et al., 2018).

The primary type of attack utilized by the four teams was the powerful attack directed diagonally or parallel, which is associated with reducing the opponent's chances of continuing the point from it, thereby neutralizing the opponent's defensive system (Costa et al., 2014; Costa et al., 2017; Rocha et al., 2020) and decreasing the time the team spends in R1. Regarding this, Laporta et al. (2023) analyzed the sequencing of play in women's volleyball and found that shorter sequences of game complexes are more important, especially those played in two or three complexes (K0 – KI and K0 – KI – KII).

Regarding the attack effect in R1, the teams that ranked first and second (Türkiye and China), respectively, and that used non-traditional attack organizations (O2) demonstrated a higher centrality value for the point attack effect. According to studies in the area, it is expected that with a higher frequency of powerful attacks, the overall attack effectiveness will also be higher (Costa et al., 2017). In contrast, the teams in third and fourth place, Poland (POL) and the United States (USA), presented higher centrality values for the attacking effect in terms of continuity. Regarding the attack effect we can also say that China obtained lower centrality values than the other teams in the attack block, that is, during the game, the number of opponent block points in this rotation was lower. As for the attack error, China and the United States presented lower values, while Poland, which used only the traditional formation, was the team with the highest centrality measure for this variable. Hileno et al. (2020) revealed that Spanish women's teams score at least half of their points by playing more than 3 game complexes. However, increased gameplay can lead to greater mental fatigue (Smith et al., 2016), resulting in poorer athletic performance (Sun et al., 2024; Teoldo, Dambroz, Brito, 2024). Despite the four teams showing high eigenvalues for SCA, it was expected that the blocking compositions (1X2) and (1X [1+1]) would exhibit the highest centrality values, considering the slower movement and attack tempo (attack tempo 2 and 3). These results are consistent with the literature, indicating that even under ideal setting conditions, most attack tempo utilized are tempo 2 and 3, thereby slowing down the game and facilitating decision-making and the arrival of the opposing block (Rocha et al., 2023).

Conclusions

Attempting to alter established patterns characterized by existing critical scenarios leads to the emergence of different organizations, such as the case of side-out in R1 in women's volleyball, which strives to enhance reception conditions for facilitating movements and positioning of attackers, even with slower attack times on the edges. Therefore, training environments should replicate and simulate these scenarios to aid in movements, increase game speed, enhance attack efficacy, and create greater unpredictability for the opponent's defensive system. Future studies are suggested to analyze the impact of organizations in R1 on Complex II and III, as well as to investigate whether the opponent and venue can influence the performance of these teams.

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