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Inter-player variability in game patterns in high-level women's volleyball: A study with Outside Hitters (Near vs. Away) using Social Network Analysis

Variabilidad entre jugadores en los patrones de juego en el voleibol femenino de alto nivel: Un estudio con bateadores externos (Cerca versus Lejos) usando Análisis de Redes Sociales

João Bernardo Martins, Isabel Mesquita, Ademilson Mendes, Letícia Santos & José Afonso

Centre for Research, Education, Innovation and Intervention in Sport (CIFI2D), Faculty of Sport of the University of Porto, Portugal.

Abstract

A wide body of research on team sports has focused on positional status based differences, providing information on inter-player variability according to the functional roles within the game. However, research addressing inter-player variability within the same positional/function status is scarce. The present article presents an analysis of inter-player variability within the same positional status during critical moments, in high-level women's volleyball, using Social Network Analysis. Attack actions of the outside hitters near (OHN) and away (OHA) from the setter were analysed in ten matches from the 2019 Volleyball Nations League Finals (268 plays). Two independent Eigenvector Centrality networks were created, one for OHN and another for OHA. Main results: (a) in side-out with ideal setting conditions, the OHA used more tips and exploration of the block than the OHN; under non-ideal setting conditions, the OHN had slower attack tempos than the OHA; (b) OHA used tip and directed attacks after error situations while OHN was typically not requested after error situations; (c) in transition, OHN typically attacked after having performed a previous action, performing a dual task within each ball possession, while OHA only attacked when there was no prior action; (d) there were also inter-positional similarities, with both OHN and OHA preferring a strong attack in ideal conditions during KI and KIV, and slower tempos in transition in non-ideal conditions. Conclusions: Even within the same positional status, there seems to be subtle, but relevant inter-player variability. Consequently, coaches should devote careful attention when assigning players to positional statuses.

Keywords: performance analysis; match analysis; team sports; volleyball; variability.

Resumen

Un amplio conjunto de investigaciones sobre deportes de equipo se ha centrado en las diferencias basadas en el estado posicional, proporcionando información sobre la variabilidad entre jugadores de acuerdo con los roles funcionales dentro del juego. Sin embargo, la investigación que aborda la variabilidad entre jugadores dentro del mismo estado posicional/de función es escasa. El presente artículo presenta un análisis de la variabilidad entre jugadores dentro del mismo estado posicional durante momentos críticos, en el voleibol femenino de alto nivel, utilizando Análisis de Redes Sociales. Las acciones de ataque de los bateadores externos cerca (OHN) y fuera (OHA) del colocador fueron analizadas en diez partidos de las Finales de la Liga de Naciones de Voleibol de 2019 (268 jugadas). Se crearon dos redes independientes de centralidad de autovector, una para OHN y otra para OHA. Resultados principales: (a) en KI de ajuste ideales, la OHA utilizó más consejos y exploración del bloque que el OHN; en condiciones de ajuste no ideales, el OHN tenía tempos de ataque más lentos que el OHA; (b) OHA utilizó ataques de propina y dirigidos después de situaciones de error, mientras que OHN normalmente no se solicitó después de situaciones de error; (c) en transición, OHN típicamente atacado después de haber realizado una acción anterior, realizando una doble tarea dentro de cada posesión de la balón, mientras que OHA sólo atacó cuando no había acción previa; (d) también hubo similitudes inter-posicionales, con OHN y OHA prefiriendo un ataque fuerte en condiciones ideales durante KI y KIV, y tempos más lentos en transición en condiciones no ideales. Conclusiones: Incluso dentro del mismo estado posicional, parece haber una variabilidad entre jugadores sutil, pero relevante. Por lo tanto, los entrenadores deben dedicar una atención cuidadosa al asignar jugadores a los estados posicionales.

Palabras clave: análisis de rendimiento; análisis de partidos; deportes de equipo; voleibol; variabilidad.

Correspondence/correspondencia: João Bernardo Martins
Centre for Research, Education, Innovation and Intervention in Sport (CIFI2D), Faculty of Sport of the University of Porto, Portugal.
Email: joao_10z@hotmail.com

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Introduction

Match Analysis (MA) is the process of recording and classifying game actions and observing and recording the various relevant variables that occur in a game (Hodges & Franks, 2008; Seabra & Dantas, 2006). As such, MA plays an important role in structuring and optimizing information, and in assisting with the development of players and teams in sports (Butterworth, O'Donoghue, & Cropley, 2013). Research focused on understanding variability in performance has considered the differences between teams arising at different competitive levels (Méndez, Gonçalves, Santos, Ribeiro, & Travassos, 2019; Yi, Gómez, Liu, & Sampaio, 2019), with less attention devoted to variations in performance within the same competitive level (Castelão, Garganta, Afonso, & Da Costa, 2015).

There is a substantial body of research focused on position status based differences that provides information on inter-player variability according to functional role. For example, defenders, midfielders, and forwards in football have shown differences in movement behaviour, with all being closer and more coordinated with their specific centroid of position (this effect being stronger for midfielders and weaker in forwards; Gonçalves, Figueira, Maças, & Sampaio, 2014). Midfielders and defenders have also been shown to differ in terms of the organization of each team during competition (Moura, Santana, Vieira, Santiago, & Cunha, 2015). A recent study by Clemente, Sarmento and Aquino (2020) has shown that performance variability in the pass differs between positional status. Other studies have identified inter-player differences in technical performance based on positional status. For example, defenders have been shown to perform more attacking and pass-related actions, midfielders make more passes, being related to organisational aspects, and forwards are superior in attack actions (Liu, Gómez, Gonçalves, & Sampaio, 2016). Critically, research focused on the inter-player variability associated with game patterns has, thus far, only considered football, and has not extended to other team sports such as volleyball.

Volleyball is a team sport that has two players per positional status (two outside hitters and two middle-blockers). As such, there can be subtle inter-player variability within a single positional status. While prior research has focused on positional differences between players, studies that address inter-player variability within the same positional status are scarce. This sub-theme requires attention because it will help identify intra-individual differences including like the ones that occur within players, short-term within the task, or in frequent repetitions within the same task, or between tasks, or in long periods (de Ribaupierre & Lecerf, 2018).

Investigating variability in positional statuses is appropriate across game contexts and situations, including critical game moments. Multiple past studies of different team sports have analysed game moments to understand, for example, the predictive and explanatory variables of game moments (Ferreira, Volossovitch, & Sampaio, 2014), and to identify the balance of the game (Ferreira, Volossovitch, Gomes, & Infante, 2010). Critical moments are understood with moments that have changes in the state of the game (such as unbalances in score) that end up occurring at certain intervals of time of the game and consequently these differences increase the impact on the result and the final action of the player and the game (Ferreira et al., 2014). The overarching aim of this study was to analyse inter-player variability within the same positional status, during critical moments of high-level women's volleyball, using Social Network Analysis (SNA) with Eigenvector Centrality (detailed information on SNA is provided in the methods).

Methods

Participants

We analysed 10 matches (41 sets) from the final phase of the 2019 women's Volleyball Nations League (VNL), which comprised six national teams (Brazil, the United States, Poland, Italy, Turkey, and China). A total of 268 plays with the outside hitters (near vs. away) were examined. We analysed 'Critical moments', which were defined as the attack from 16 points (from the 1st to the 4th sets) or 10 points (only in the 5th set) (Marcelino, Mesquita, & Sampaio, 2011). Ethical approval for the study was given by the Ethics Committee at the Centre of Research, Education, Innovation, and Intervention in Sport of the University of Porto (09 2020 CEFADE).

Measures

Table 1 presents the study variables. Similar to other sports, volleyball has several game phases, usually defined in the literature as game complexes (Hurst, Loureiro, Valongo, Laporta, Nikolaidis, & Afonso, 2016; Laporta, Afonso, Valongo, & Mesquita, 2019). Each game complex represents a subsystem of the game as whole: while game complexes are interdependent, they have their own set of features (Laporta, Valongo, Afonso, & Mesquita, 2021). In this vein, volleyball is organised in seven interdependent game complexes with distinct game flow characteristics (Hurst et al., 2016): Complex 0 (K0) or serve, Complex I (KI) or side-out, Complex II (KII) or side-out transition, Complex III (KIII) or transition, Complex IV (KIV) or attack coverage, Complex V (KV) or freeball, and Complex VI (KVI) or downball. K0 corresponds to the serve (Hileno & Buscà, 2012), however, despite having a strong relationship with KII, it presents itself as its own category, because it is one of the possible actions that allows to score. KI or side-out refers to the attack after serve-reception, being characterized by reception, setting and offensive organization (Mesquita, Palao, Marcelino, & Afonso, 2013). KII refers to the side-out transition, which includes the block, defense, counterattack setting and counterattack after the opponent's side-out (Mesquita et al., 2013). According to the literature (Palao, Santos, & Ureña, 2004), KII corresponds to the recovery of possession, through defense with the help of the block, allowing an ability to neutralize the opponent's attack and organize the counterattack of our team. KIII corresponds to the transition of transition, which, despite including, the block-defense-setting-offensive organization, has different characteristics from the previous complex, especially in terms of setting conditions, zones and attack tempos (Afonso, Laporta, & Mesquita, 2017; Hurst et al. 2016). As for complex IV (KIV or attack coverage), it can be characterized by the recovery of the ball and restructuring of the offensive phase (coverage-setting-offensive organization) after the ball touches the block and returns to the court of the attacking team (Hileno & Buscà, 2012). KV corresponds to the freeball, i.e., plays where the opponent has serious difficulty in attacking organization and therefore an easy ball is expected (Hileno & Buscà, 2012).

In the same vein as KV, the KVI (downball) is similar to the freeball, but the opponent has the chance to use a downward trajectory; therefore, this game complex presents mixed characteristics of a freeball and a proper counterattack (Ramos, Afonso, & Martins, 2016). We chose not to analyse K0 because our analysis focused on attack actions. Figure 1 synthesizes the sequence of actions within the volleyball game and the game complexes where they occur.

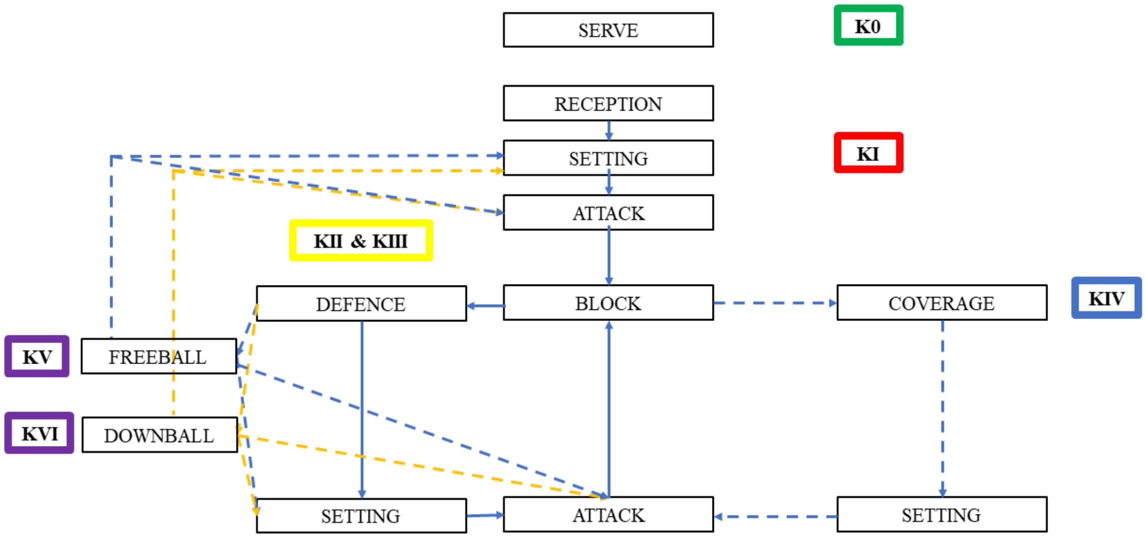

Figure 1. Seven functional game complexes of volleyball.

The independent variable of this study was positional status of the attack player. This had two categories (Millán-Sánchez, Morante Rábago, & Ureña, 2017): outside hitter near the setter (OHN) and outside hitter away from the setter (OHA). In KI to KVI, the following dependent variables were studied:

(a) *Setting conditions* (Laporta, Afonso, & Mesquita, 2018a): (i) all attack options available (SCA), (ii) quick game, but no combined moves available (SCB), and (iii) only attackers from the extremities or background court available (SCC).

(b) *Attack zone/Combination* (AZ/Comb) (Data Volley, 2019): (i) quick tempo in Z4 (CombX4), (ii) high tempo in Z4 (CombV4), (iii) quick tempo in Z2 (CombX2), and (iv) high tempo in Z2 (CombV2).

(c) *Action preceding the attack* (pa): (i) receiving or defending (Awpa), and (ii) no prior action – without receiving or defending (Anpa).

(d) *Type of attack* (TpA) (Data Volley, 2019): (i) strong attack (TpSA), (ii) directed attack (TpDA), (iii) tip (TpTip), and (iv) exploration of the block (TpExpB).

(e) *Effect of previous attacks* (pAE/pTE): (i) no error (AaNOE), (ii) one previous same attacker error (1psAE), (iii) two previous errors of the same attacker (2psAE), (iv) one previous team error (1pTE), (v) two previous team errors (2pTE), and (vi) loss of three consecutive points (Aa3PC).

(f) *Distance of the attacker to the net* (An): (i) close to the net, from the net until 2.5 m (ACn), (ii) away from the net, from 2.5 m to end of court (AAn).

(g) *Attack efficacy* (AE) (Data Volley, 2019): (i) perfect (AE#), (ii) positive (AE+), (iii) exclamatory (AE!), (iv) negative (AE-), (v) poor (AE/), and (vi) error (AE=).

(h) *Block opposition* (BOp) (adapted from Costa, Afonso, Barbosa, Coutinho, & Mesquita, 2014): (i) without blockers (B0), (ii) simple block (B1), (iii) double block (B2), and (iv) triple block (B3).

Each variable was considered a node in the network.

Table 1. Synthesis of variables and categories

Variables	**Category/Description**		**Complex**
	Game actions		
Function of the attack player (FNC)	Outside hitter near setter (OHN)	Outside hitter away setter (OHA)	KI to KVI
Setting Conditions (SC)	A (SCA) B (SCB)	C (SCC)	KI to KVI
Attack Zone/Combination (AZ/Comb)	X4 (CombX4) V4 (CombV4)	X2 (CombX2) V2 (CombV2)	KI to KVI
Action preceding the attack (pa)	With previous action (Awpa)	No prior action (Anpa)	KI to KVI
Type of attack (TpA)	Strong attack (TpSA) Directed attack (TpDA)	Tip (TpATip) Exploration of the block (TpAExpB)	KI to KVI
Effect of previous attacks (pAE/pTE)	No error (AaNOE) 1 previous same attacker error (1psAE) 2 previous errors of the same attacker (2psAE)	1 previous team error (1pTE) 2 previous team errors (2pTE) Loss of 3 consecutive points (Aa3PC)	KI to KVI
Distance of the attacker to the net (An)	Away from the net (AAn)	Close to the net (ACn)	KI to KVI
Attack Efficacy (AE)	#: Perfect (AE#) +: Positive (AE+) !: Exclamatory (AE!)	-: Negative (AE-) /: Poor (AE/) =: Error (AE=)	KI to KVI
Block opposition (BOp)	No Blockers (B0) Simple block (B1)	Double block (B2) Triple block (B3)	KI to KVI

Design and procedures

A spreadsheet was created in Microsoft Excel 2018 for Windows (Microsoft Office 365 ProPlus, EUA) with "Macros" controls to list the essential codes automatically. The data collection in this tool was performed in a timeline containing the entire sequence of game actions with the respective complex preceding the variable. Three of the authors, all with more than five years' experience, were trained in this instrument. Throughout the process, two reliability tests were performed (1st: after four months of testing the instrument; and 2nd: five months after) to ensure consistency when applying the criteria. During the months of training, weekly online conferences were held to explain any requests and to debate any divergences that appeared. All the matches were analysed after being recorded in high definition (1080p) from the end of the court. The first inter-reliability test was part of an exploratory study of a play-off in the 2018/2019 Portuguese championship (Martins, Afonso, Coutinho, Fernandes, & Mesquita, 2021). Cohen's kappa values for all variables were above 0.75 (range: 0.774 to 0.997). Due to the extent of the tool and some grade of redundancy, we applied a basic version.

Later, an inter-observer reliability test was performed using two high-level women's matches (in the 2018/2019 quarterfinals CEV Challenge Cup and the 2018/2019 final of the Brazilian Women's Superliga, n = 8 sets), with a total of 134 plays. Finally, the last test of reliability was conducted with 159 plays of two matches from the 2018/2019 final of the Brazilian Men's Superliga, totalling nine sets. In all inter-observer reliability tests, the variables presented values greater than 0.75 (Fleiss, Levin, & Paik, 2013). To calculate reliability for the present study, we used 10% of the total sample (27 plays) (Tabachnick & Fidell, 2007). Cohen's Kappa ranged from 0.990 to 0.999 for inter-observer reliability, surpassing the common threshold of 0.75 defined in the literature (Fleiss et al., 2013).

Statistical analysis

Because data collection was done using an original and specific tool created in Microsoft Excel 2018, the data was later exported and analysed using SPSS for Windows (version 26, IBM®, USA). This included a descriptive analysis to identify potential errors, followed by a cross tabulation analysis. Next, SNA was used to analyse inter-player variability at critical moments. In SNA, interaction networks analyse the degree of connection and specificity in the different phases of a game, thus helping to identify the most influential actions in the flow of the game (Wäsche, Dickson, Woll, & Brandes, 2017). SNA also captures networks of relationships, visually translated into nodes interconnected by edges (Borgatti, 2005). Although the most widely used measure in SNA is Degree Centrality (Gama et al., 2014; McLean, Salmon, Gorman, Stevens, & Solomon, 2018), Eigenvector Centrality has the advantage of also weighting direct connections based on their indirect connections (Bonacich, 2007). Moreover, while it is common for studies using MA to centre SNA around the behaviours of individual players (Ribeiro, Silva, Duarte, Davids, & Garganta, 2017), it is possible to apply the same tools to analyse relationships between game actions, sequences, and game complexes, as has been successfully implemented in volleyball (Hurst et al., 2016; Laporta, 2018a, 2018b, 2019), and thus providing a thorough understanding of the game dynamics (Passos, Davids, Araújo, Paz, Minguéns, & Mendes, 2011).

Gephi© 0.9.2 software was used to create directed networks and analyse the connections and their weights using Eigenvector Centrality. First, variables (game actions) were divided into each game complex sequentially based on the game events in volleyball, with each game action identified as a node. Next, using Gephi, direct and indirect connections between the nodes were calculated, and thus the weight of the variables and their influence in the game were calculated at critical moments. The node sizes were manipulated, differing from a value of 100 and 300, to provide good graphic difference. These values are an arbitrary and relative measure. The size of a node represents the degree of visual contrast between variables, while the edges between nodes correspond to the variable thickness in order to better reflect the values of Eigenvector Centrality (Bonacich, 2007).

Edges are defined in units (number of connections), meaning thicker edges signify a greater number of connections between two nodes (Laporta et al., 2018a). A direct link was created between two variables if they were simultaneous or consecutive. For example, attack zone occurs simultaneously with type of attack, so some categories of the attack zone will connect with the attack type category. However, attack zone is preceded by setting conditions and followed by block opposition, thus making new direct connections to these two variables. However, there are no direct links between the attack zone and the action preceding the attack (reception and/or defense) because they are not followed consecutively. Consequently, Eigenvector Centrality offers a method for calculating the weight of indirect connections, such as attack zone and reception or defence.

In sum, SNA can be used to demonstrate the complex dynamics of the game actions in critical moments within each phase of the game, and to highlight the decisive role of each node (Martins et al., 2021).

Results

For each OH position we created an interaction network using Eigenvector Centrality (Figure 2 - 3). For each respective network, complexes were organized with each colour: KI (red), KII (green), KIII (purple), KIV (yellow), KV (grey), and KVI (orange). Two EC networks were created. In total, we counted amongst all networks (Table 2): 236 nodes (OHN = 123; OHA = 113) and 1604 edges (OHN = 863; OHA = 741).

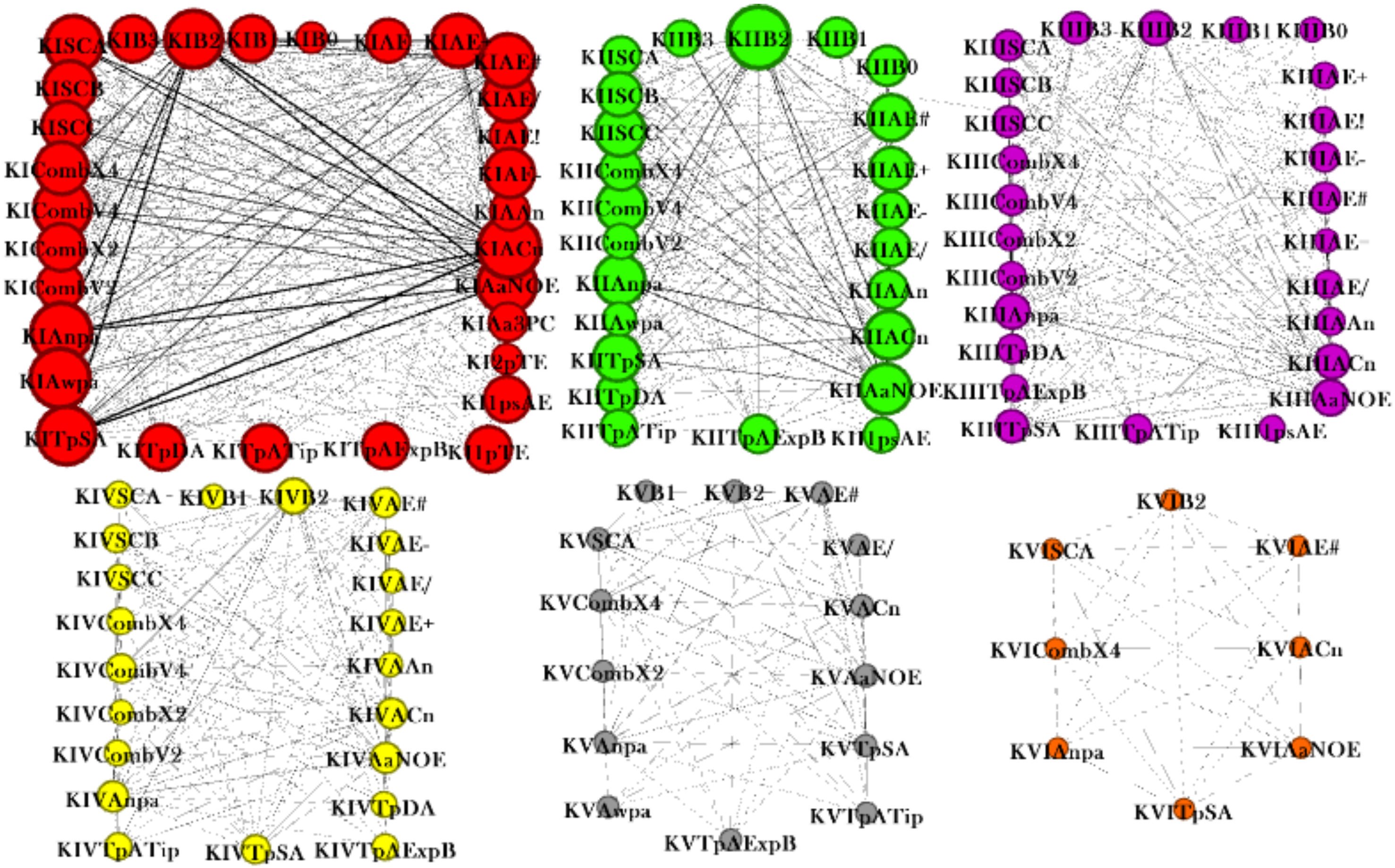

Figure. 2. Outside Hitter Near (OHN), with Eigenvector Centrality. Terminology: On each node, the codes are represented by the name of the complex, followed by the variable and its category. The codes for the different variables are: FNC – function of the attack player; SC – setting conditions; Comb – attack zone/combinations; pa – action preceding the attack; TpA – type of attack; pAE/pTE – effect of previous attacks; An – distance of the attacker from the net; AE – attack efficacy; and BOp – block opposition.

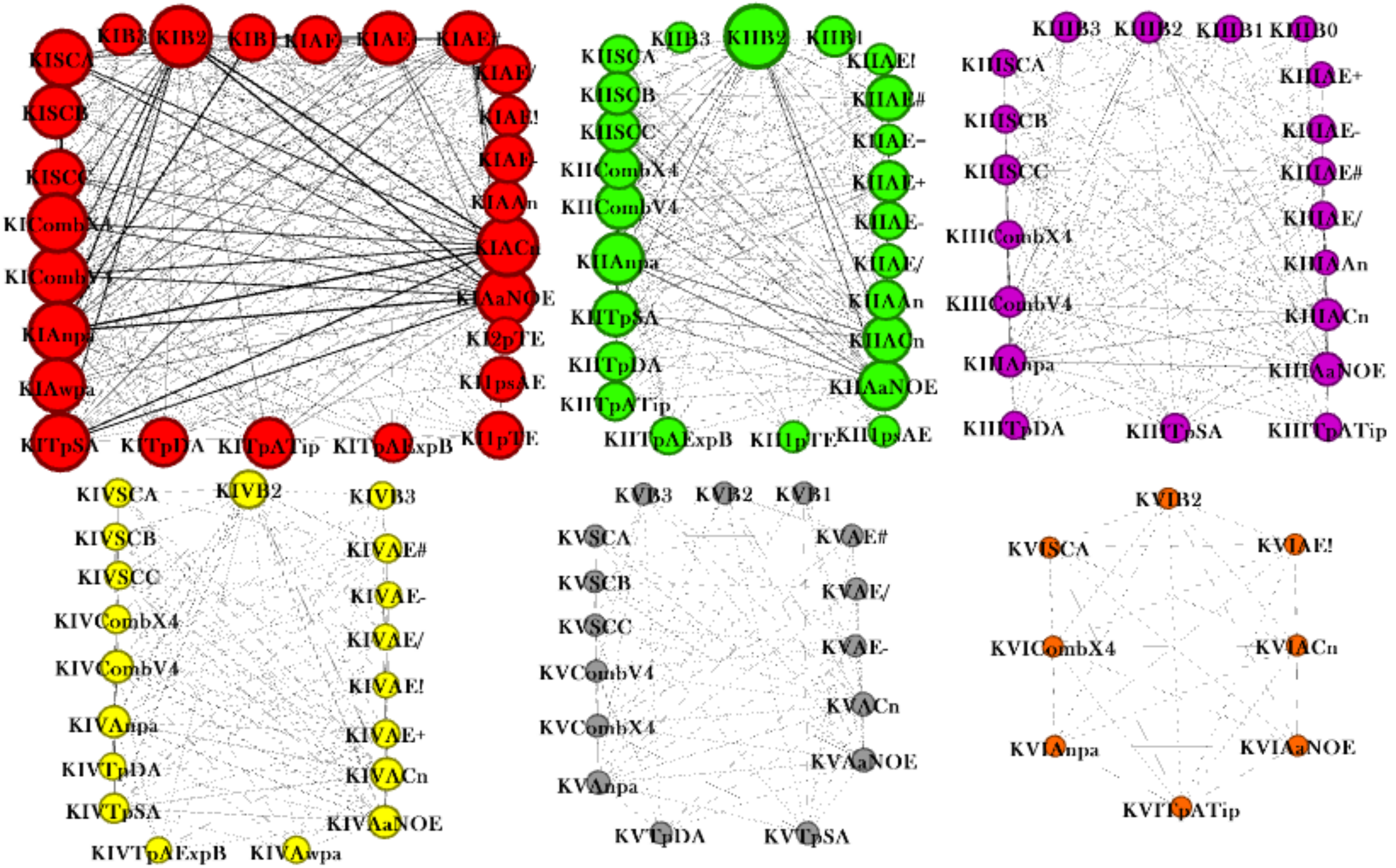

Figure. 3. Outside Hitter Away (OHA), with Eigenvector Centrality. Terminology: Please consult legend of Figure 2

Table 2. Outside hitter near and outside hitter away Eigenvector Centrality values for Complex:

Complex	**Variables**	**Eigenvector Centrality values**	
		Outside Hitter Near	**Outside Hitter Away**
KI	Setting conditions (SC)	SCA (0.874); SCB (0.777); SCC (0.694)	SCA (0.853); SCB (0.767); SCC (0.738)
	Attack Zone/Combination (Cmb)	CombV4 (0.881); CombX4 (0.775); CombV2 (0.622); CombX2 (0.660)	CombX4 (0.909); CombV4 (0.892)
	Action preceding the attack (pa)	Anpa (0.957); Awpa (0.942)	Anpa (0.918); Awpa (0.794)
	Type of attack (TpA)	TpSA (0.911); TpATip (0.646); TpDA (0.618); TpAExpB (0.613)	TpSA (0.866); TpATip (0.698); TpDA (0.655); TpAExpB (0.429)
	Effect of previous attacks	AaNOE (0.921); 1pTE (0.616); 1psAE (0.615); Aa3PC (0.442); 2pTE (0.254)	AaNOE (0.877); 1pTE (0.619); 1psAE (0.568); 2pTE (0.378)
	Distance of the attacker to the net (An)	ACn (0.994); AAn (0.456)	ACn (0.932); AAn (0.526)
	Attack efficacy (AE)	AE# (0.802); AE+ (0.778); AE/ (0.750); AE- (0.703); AE= (0.561); AE! (0.428)	AE# (0.741); AE+ (0.748); AE/ (0.673); AE- (0.664); AE= (0.625); AE! (0.478)
	Block opposition (BOp)	B2 (0.894); B1 (0.629); B3 (0.629); B0 (0.262);	B2 (0.949); B1 (0.612); B3 (0.486)
KII	Setting conditions (SC)	SCC (0.713); SCB (0.573); SCA (0.444);	SCC (0.544); SCB (0.533); SCA (0.434)
	Attack Zone/Combination (Cmb)	CombV4 (0.709); CombX4 (0.521); CombV2 (0.358)	CombV4 (0.641); CombX4 (0.497)
	Action preceding the attack (pa)	Anpa (0.725); Awpa (0.317)	Anpa (0.723)
	Type of attack (TpA)	TpSA (0.655); TpDA (0.515); TpAExpB (0.438); TpATip (0.406);	TpSA (0.589); TpDA (0.447); TpATip (0.434); TpAExpB (0.395)
	Effect of previous attacks	AaNOE (0.723); 1psAE (0.359)	AaNOE (0.694); 1pTE (0.265); 1psAE (0.261)
	Distance of the attacker to the net (An)	ACn (0.677); AAn (0.456)	ACn (0.643); AAn (0.458)
	Attack efficacy (AE)	AE# (0.634); AE+ (0.556); AE/ (0.440); AE- (0.399); AE! (0.154)	AE# (0.587); AE+ (0.480); AE- (0.412); AE/ (0.329); AE! (0.259); AE= (0.244)
	Block opposition (BOp)	B2 (0.99); B0 (0.482); B1 (0.468); B3 (0.390)	B2 (0.99); B3 (0.249); B1 (0.047)
KIII	Setting conditions (SC)	SCA (0.254); SCC (0.270); SCB (0.193)	SCC (0.224); SCB (0.176); SCA (0.164)
	Attack Zone/Combination (Cmb)	CombV4 (0.258); CombV2 (0.201); CombX4 (0.190); CombX2 (0.155)	CombV4 (0.245); CombX4 (0.187)
	Action preceding the attack (pa)	Anpa (0.356)	Anpa (0.284)
	Type of attack (TpA)	TpSA (0.304); TpDA (0.223); TpATip (0.210); TpAExpB (0.162)	TpSA (0.212); TpATip (0.183); TpDA (0.181)
	Effect of previous attacks	AaNOE (0.378); 1psAE (0.135)	AaNOE (0.301)

	Distance of the attacker to the net (An)	ACn (0.344); AAn (0.188)	ACn (0.267); AAn (0.112)
	Attack efficacy (AE)	AE# (0.257); AE- (0.223); AE/ (0.185); AE+ (0.149); AE! (0.154); AE= (0.089)	AE- (0.189); AE/ (0.180); AE# (0.179); AE+ (0.125);
	Block opposition (BOp)	B2 (0.336); B3 (0.285); B0 (0.114); B1 (0.131)	B2 (0.247); B3 (0.223); B1 (0.158); B0 (0.125)
KIV	Setting conditions (SC)	SCB (0.194); SCA (0.157); SCC (0.131)	SCB (0.414); SCA (0.196); SCC (0.182)
	Attack Zone/Combination (Cmb)	CombX4 (0.219); CombX2 (0.100); CombV2 (0.138)	CombV4 (0.289); CombX4 (0.196)
	Action preceding the attack (pa)	Anpa (0.259)	Anpa (0.280); Awpa (0.162)
	Type of attack (TpA)	TpSA (0.208); TpATip (0.165); TpAExpB (0.146); TpDA (0.131)	TpSA (0.226); TpDA (0.160); TpAExpB (0.136)
	Effect of previous attacks	AaNOE (0.252)	AaNOE (0.289)
	Distance of the attacker to the net (An)	ACn (0.245); AAn (0.101)	ACn (0.289)
	Attack efficacy (AE)	AE# (0.230); AE+ (0.131); AE- (0.101); AE/ (0.096)	AE# (0.196); AE+ (0.189); AE/ (0.139); AE- (0.143); AE! (0.133)
	Block opposition (BOp)	B2 (0.366); B1 (0.100)	B2 (0.414); B3 (0.168)
KV	Setting conditions (SC)	SCA (0.062)	SCA (0.047); SCB (0.047); SCC (0.043);
	Attack Zone/Combination (Cmb)	CombX4 (0.052); CombX2 (0.037)	CombX4 (0.060); CombV4 (0.043)
	Action preceding the attack (pa)	Anpa (0.052); Awpa (0.037)	Anpa (0.081)
	Type of attack (TpA)	TpSA (0.051); TpAExpB (0.040); TpATip (0.038)	TpSA (0.060); TpDA (0.043)
	Effect of previous attacks	AaNOE (0.062)	AaNOE (0.081)
	Distance of the attacker to the net (An)	ACn (0.062)	ACn (0.081)
	Attack efficacy (AE)	AE# (0.052); AE/ (0.037)	AE# (0.047); AE/ (0.047); AE- (0.043)
	Block opposition (BOp)	B2 (0.055); B1 (0.038);	B1 (0.047); B2 (0.047); B3 (0.043)
KVI	Setting conditions (SC)	SCA (0.018)	SCA (0.022)
	Attack Zone/Combination (Cmb)	CombX4 (0.018)	CombX4 (0.022)
	Action preceding the attack (pa)	Anpa (0.018)	Anpa (0.022)
	Type of attack (TpA)	TpSA (0.018)	TpATip (0.022)
	Effect of previous attacks	AaNOE (0.018)	AaNOE (0.022)
	Distance of the attacker to the net (An)	ACn (0.018)	ACn (0.022)
	Attack efficacy (AE)	AE# (0.018)	AE! (0.022)
	Block opposition (BOp)	B0 (0.018)	B2 (0.022)

The table 2 was organized by complexes and by sequence of actions of the volleyball game, however, within each variable its categories were expressed in a decreasing way according to the Eigenvector Centrality. Next, we present an individual report of the positions of the outside hitter, by complex in relation to the weight of the variables (nodes). And later, the main differences and similarities between the two contexts in a broader context stand out.

In KI, the outside hitter near (OHN) was requested mainly with SCA. The main preference in attack was with slower attack tempos in Z4 (CombV4). The strong attack was the preference and near from the net. Mostly, the attacks took place without action prior to the action (i.e., there was an attack without receiving the player) and no error of the player and team. The players attacked against a double block, however they showed excellent efficacy in attack (point attack). Already, the nodes with the least weights were: SCC, CombX2, TpAExpB, AAn, AE! and B0. In KII, the ONH attacked mainly in SCC, with the high ball attack being the most requested. They occurred essentially without prior action. The strong attack was the most frequent, with setting close to the net. The OHN in attack confronted mainly a double block, but good efficacy (AE#) was found. The nodes with less weight were: SCA, CombV2, TpATip, AAn, AE! and B3. In KIII, SCA predominated, with continuation of the high attack tempos and strong attacks. It was only sought without prior defense action with predominant perfect attack efficacy and having confronted a double block. The less weighty nodes found were: SCB, CombX2, TpAExpB, AAn, AE= and B1. In KIV, OHN was requested: SCB, quick ball attack, strong attack, attacker near the net, no error in previous action (player and team), perfect attack efficacy and double block of opposition. Nodes with the least weights were: SCC, CombV2, TpDA, AAn, AE/ and B1. In KV and KVI, OHN always played with SCA and quick attack tempos, remaining strong attack as a preference, being performed near the net. The opposition was majority with double block in KV, and no blockers in KVI, however in both complexes efficacy remained with tendency to point attack. The nodes with less weight were: CombX2, TpATip, AE/ and B1.

Outside hitter away (OHA), in KI, was requested mainly SCA with quick attack tempos, and strong attack being the main preference. The attack near from the net was the most weight. Generally, the attacks took place without defense and without player/team error's. And, excellent efficacy in attack was found despite the opposition of two players on the block. Already, the nodes with the least weights were: SCC, CombV4, TpAExpB, 2pTE, AE! and B3. In KII, OHA was requested by the setter in SCC, having preference for high ball attack. Most of the attacks occurred near the net and were not requested with prior defense action. As in the previous complex, the strong attack was the preference having presented a perfect efficacy. Double block opposition were predominated. Nodes with the least weights were: SCA, CombX4, TpAExpB, 1PsAE, AAn, AE= and B1. In KIII, OHA was less sought after, however, we highlighted: preference with SCC with high ball attack and strong attack. The preference for attack near the net remained, along without defence action before the attack. Contrary to previous complexes, the attack efficacy (more prevalent) was weaker (EA-), with double block of opposition. The less weighty nodes found were: SCA, CombX4, TpDA, AE+ and B0. In KIV, OHA was requested under SCB, through high ball attacks, and strong attack was the main preference. The preference for attack was maintained without previous action, the net's maximum, allowing a high efficacy despite the double opponent block. The less weighty nodes are: SCC, CombX4, TpAExpB, AE! and B3. In KV and KVI, the OHA showed similarities in the game approach: SCA, quick ball (CombX4), attack without prior action and without consecutive errors of the players/team. In KV, efficacy was higher (AE#) than KVI (AE!) , probably because block opposition is higher in the second (B2) than in the first (B1). The less weighty nodes are: SCC, CombV4, TpDA, AE- and B3.

The main differences between the two positional statuses of the same function (OHN vs. OHA) were: (a) in KI, OHA were more likely to use tip and exploration of the block than OHN in cases of SCA; (b) in SCC setting conditions, OHN had slower attack tempos than OHA and had more variety of attacks (strong, tip or directed); (c) in KI, OHA used the strong attack and exploration of the block after performing a previous action while OHN only used the other types of attack; (d) after consecutive errors in attack, OHA were found to have more skill in attack, through the use of the tip or directed attack, while OHN were not requested after team or player errors; (e) OHN, due to playing near the setter, are able to attack in Z2 while OHA are not; (f) in KII and KIII, OHN differed from OHA in that they were more central after previous actions (e.g., in defence); (g) OHA were more efficient in this complex than OHN; (h) OHA were generally less sought after than OHN in KIII and KIV, but with differences depending on setting conditions, with OHA with SCC and OHN with SCA; (i) in KIV, OHA were less efficient in attack that OHN due to the greater block opposition (double and triple).

Some similarities in inter-player game patterns were also found: (a) in KI, both positions were mostly central when setting conditions were SCA; (b) in KI and KIV, quick attack tempos in Z4 were dominant with a preference for the strong attack; (c) when setting conditions were SCC in the side-out, the greatest tendency was to use the strong attack; (d) after consecutive errors in the attack, both positional statuses always sought a strong attack; (e) in KII, both positional statuses were most central under SCC with a quick ball tempo in attack; (f) in KIII, OHN and OHA sought to vary the attack regardless of setting, varying between the strong attack, tip, and directed attack; (g) in KIV, regardless of the setting conditions, both OHA and OHN used quick attack tempos; (h) in KV and KI, both positional statuses showed a greater preference for the quick attack and strong attack; (i) most attacks for both OH functions had a double block opposition.

Discussion

Past research has concentrated on positional status-based differences to provide information about inter-player variability according to the functional roles within the game (Clemente et al., 2020; Gonçalves et al., 2014; Moura et al., 2015). However, there have been few investigations addressing inter-player variability within the same function. The goal of this study was to analyse inter-player variability between outside hitters near (OHN) and away (OHA) from the setter during critical moments in high-level women's volleyball.

A major finding of the study was that there were several differences between positional statuses of the same function. With ideal setting conditions in KI, OHA were more likely to use tip and exploration of the block than OHN, who were more likely to use the strong attack. In KII and KIII, non-ideal setting conditions prevailed, reinforcing the opinion of Laporta et al. (2019) that teams have become comfortable and well-adjusted to playing under these restrictions. Contrary to what has been shown by Lima, Palao, Moreira and Clemente (2019), OHN only used tip when a double action preceding the attack (e.g., reception or defence), probably due to the high number of consecutive actions and the short amount of time to make decisions (Larkin, Mesagno, Berry, & Spittle, 2018). The exploration of the block and tip attacks were more central by the OHA than the OHN, and mainly in SCC, confirming the idea that the OH further away from the setter has performances of greater control and security, possibly due to the higher risk characteristics of the other players of the team (opposite and middle-blocker; Lima et al., 2019). OHA were more efficient than OHN in KII and KIII, probably because they were more likely to seek an attack at the net with three attackers (Papadimitriou, Pashali, Sermaki, Mellas, & Papas, 2017). Finally, in KIII and KIV, OHA were generally less sought after than OHN, although this was dependent on setting conditions, with OHA less sought after in SCC and OHN less sought after with SCA.

Another important set of results that emerged from the data was the similarities between OHA and OHN. Both positional statuses focused more on ideal setting conditions in KI, with quick attack tempos in Z4. With ideal setting conditions both positional statuses had quick attack tempos, while in non-ideal conditions slower tempos typically prevailed, as has been commonly shown in research (Laporta et al., 2019). Also consistent with the literature, both OHA and OHN players focused more on the strong attack in the three types of setting conditions, regardless of whether this was after an attack error action of the team or player. In KIV, regardless of the setting conditions, OHA and OHN both used high attack tempos, probably to acquire greater safety in the game and play on the opponent's error (Laporta, Afonso, & Mesquita, 2018a). In all complexes, most attacks between OH's were with a double block opposition, as supported by Stamm, Stamm, Torilo, Thomson and Jairus (2016). As expected, in KV and KVI there was low difficulty in the setting conditions, with both positional statuses playing much more in system, through quick attack tempos. This study contradicts previous research that highlights the need for coaches to develop moments outside the system (Hurst et al., 2016; Laporta et al., 2018b), although it seems important to us to detail each stage of the game in the training process, through the game marker (creating critical moments), we should apply real game situations depending on the complex.

The results of this study have implications for coach practices during training. For example, the observed differences between positional statuses of the same function allows coaches to identify, based on the characteristics of the attackers, which players best occupy each sub-positional status (Laporta et al., 2018a; Martins et al., 2021). With a need to extend the study sample to draw firmer conclusions, future studies should continue to conduct more refined research on critical scenarios.

Conclusions

The current investigation makes a positive contribution to the Performance Analysis literature because it demonstrates that there is inter-player variability within the same player role in situations of high pressure. Research using SNA should be further developed, as it permits an understanding of the complex nature within the same player function.

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