

DETERMINANT FACTORS OF ATTACK EFFICACY IN HIGH-LEVEL MEN'S VOLLEYBALL: WHAT DOES DISTINGUISH THE MIDDLE-ATTACKER PERFORMANCE?

Gustavo De Conti Teixeira Costa¹, Isabel Mesquita², Patrícia Coutinho², Breno Ferreira de Britto Evangelista³, Michel Milistedt⁴, Auro Barreiros Freire⁵, Arthur Moreira Ferreira⁶, and Herbert Ugrinowitsch⁶

¹Federal University of Goiás, Mato Grosso do Sul, Brazil

²University of Porto, Porto, Brazil

³Maringá Club, Maringá, Brazil

⁴Federal University of Santa Catarina, Santa Catarina, Brazil

⁵PUC Minas, Belo Horizonte, Brazil

⁶Federal University of Minas Gerais, Belo Horizonte, Brazil

Original scientific paper

DOI 10.26582/k.56.1.1

Abstract:

This study aimed to identify determinant factors of attack efficacy considering the effects of reception, attack tempo, attack performance, setting type and attack type. Firstly, 19,454 offensive actions of complex I of the Brazilian Volleyball Men's Super League were considered and analyzed separately from the middle, wing, and opposite attacker standpoints. The middle attack was the most effective, so the 5,259 offensive actions were analyzed considering the setting type and the attack direction. The independent variables were the quality of reception, type and direction of attack, whereas attack performance was the dependent variable. We found that the middle attack efficacy was related to excellent receptions, right tempo and left tempo (near the setter), and power attack. The results can afford coaches with the key information for better training plan designs and preparation for competition.

Key words: *factors in sport performance, tactics, performance, attack efficacy*

Introduction

Game analysis is necessary to detect patterns and regularities in the behavior of the players (McGarry, Anderson, Wallace, Hughes, & Franks, 2002), information that can be used to optimize training processes and team performance (Lames & McGarry, 2007; McGarry, 2009). Specifically, in volleyball, several studies have been developed to understand the factors that mostly contribute to team performance and the victory of the game (Peña, Rodriguez-Guerra, Buscà, & Serra, 2013). In this context, the attack is an action considered critically related to winning the set and the game (Costa, Ferreira, Junqueira, Afonso, & Mesquita, 2011; Monteiro, Mesquita, & Marcelino, 2009).

Considering the deterministic structure of volleyball game, with the number of touches constraint and the non-invasive character (Mesquita, 2005), researchers are devoted to understanding what game patterns afford the achievement of supe-

rior attack efficacies (e.g., Afonso, Esteves, Araújo, Thomas, & Mesquita, 2012; Marcelino, Mesquita, & Sampaio, 2011; Palao, Santos, & Ureña, 2004). However, the studies have shown high dependency of the attack efficacy and performance on previous actions, such as reception (João & Pires, 2015, Silva, Lacerda, & João, 2014b), setting type (Afonso, Mesquita, Marcelino, & Silva, 2010, Afonso, et al., 2012), attack tempo (Bergeles & Nikolaidou, 2011), and the attack type (Costa, et al., 2011).

The effect of reception is mostly recognized as a significant predictive factor of scoring points during an attack (Conti, et al., 2018, Costa, et al., 2017). For the reception effect, the relationships between reception and attack options are considered, which are classified as: a) all available attack options; b) quick attacks are possible, but they are more difficult to perform and some attack combinations are inhibited; and c) slow attack and off-court lifts are the most possible (Hurst, et al., 2016). High-quality

receptions are associated with better setting conditions and, consequently, better conditions for the attack, which could be observed in the availability of all attack players (Afonso, & Mesquita, 2011; Barzouka, Nikolaidou, Malousaris, & Bergeles, 2009; Silva, Lacerda, & João, 2014a), fast attack tempos (Palao, Santos, & Ureña, 2007), and powerful attacks (Costa, et al., 2011, 2017). These favorable conditions are consequently related to an increased likelihood of scoring a point (Costa, et al., 2011, Peña, et al., 2013).

The attack tempo and the attack type are also significant predictors of attack efficacy (Conti, et al., 2018; Costa, et al., 2017). The attack tempo considers the relationship between the attacker and setting and is classified as: a) first tempo attack, when the attacker is in the air or jumps during or quickly after the setting; b) second tempo attack, when the attacker takes two steps after lifting for setting; and c) third tempo attack, when the attacker takes three or more steps after lifting for setting (Costa, et al., 2012). In addition, the type of attack considers the relationship between force implemented to the ball and the technique. Therefore, the type of attack is classified as: a) powerful attack, when the attack is performed powerfully using the palm of the hand in a downward trajectory; b) placed attack, when the attack is performed using the palm of the hand but with power control, directing the ball to a defensive vulnerable location; and, c) tip, when the attack is performed using the fingertips, directing the ball to a defensive vulnerable location (Costa, et al., 2011).

Considering the emergent patterns of the game, the effectiveness of the offensive organization is mainly based on a higher number of attack options, faster attack tempos, and powerful attacks (Mesquita, Palao, Marcelino, & Afonso, 2013, Silva, Marcelino, Lacerda, & João, 2016). These variables have been recognized as the ones with the most influence on the efficacy of complex I (Lobietti, Cabrini, & Brunetti, 2009; Paulo, Zaal, Fonseca, & Araújo, 2016).

Studies have shown that faster attacks (first and second tempos) are associated with winning attack points, which is not observed in slower attacks (third tempo) (Garcia-de-Alcaraz, Ortega, & Palao, 2017). This association could be explained by the difficulty in the organization of the opponent's defensive system, particularly blocking actions (Bergeles & Nikolaidou, 2011; Pinto, Vale, & Vicente, 2018). Moreover, the powerful and technical attacks have been the most used during games (Costa, et al., 2017, Conti, et al., 2018). The powerful attacks (i.e., attacks that privilege power) are defined in opposition to off-speed attacks (i.e., slower attacks privileging placement instead of power) (Castro,

Souza, & Mesquita, 2011). In this context, empirical evidence has shown that scoring is associated with powerful attacks, and its use is related to the situational constraints related to the opponent's defensive organization (Klaricic, Grgantov, & Jelaska, 2018).

Considering the importance of faster attack tempos and diversified offensive options for attack efficacy, the performance of the middle-attacker becomes of great interest since this is a player that could hit the fastest attack tempos (i.e., first tempo) (Hileno, Garcia-de-Alcaraz, Buscà, Salas, & Camerino, 2018; Millán-Sánchez, Rábago & Epa, 2019). For example, Millán-Sánchez, Parra-Royón, Benítez, and Espa (2020) found that in male teams, the side-out performance improved when the setter moved at least one meter less than 30°. Thus, middle-attacker availability constitutes an outstanding variable when considering the dynamic nature of volleyball (Afonso, et al., 2010). Curiously, only a few studies have examined the performance of this player when considering attack efficacy (Peiró, et al., 2016). For example, Costa et al. (2016) analyzed the offensive game performed by the middle attacker in complex I (i.e., the attack organization after the opponent's service [Afonso & Mesquita, 2007], and found that the middle attacks occurred mostly after high-quality receptions, being the most frequent attack scoring point as well as the most powerful one. Moreover, the authors highlighted that the middle attack had a positive effect on the winning score since it decreased the chances of the opponents' defense due to the reduced time for defensive organization. Despite the importance of such findings, little is known about the middle-attacker performance. Indeed, there is a lack of knowledge concerning the type of setting (i.e., right tempo, left tempo, back tempo, and seven) specifically performed to the middle-attacker. The study of setting type and the attack type and its relationship with the attack efficacy performed by the middle-attacker is of utmost importance since it could provide us with more evidence about the most effective strategies for scoring a point when analyzing the game played by the middle attacker.

Therefore, this study had two objectives. The first one was to identify the predictive factors of the attack efficacy on the side-out (transition I). We analyzed the side-out because the higher efficacy in side-out is related to the victory in sets, games, and the final position in championships (Ugrinowitsch, et al., 2014). The second goal was to analyze the middle-attacker's performance, considering the setting type and the attack direction that could be performed by this player.

For this objective, we considered the effects of reception, attack tempo, attack performance, setting type, and attack type.

Methods

Sample

A total of 19,454 offensive actions observed in complex I (i.e., side-out – the attack organization after the service of the opposite team) (Afonso & Mesquita, 2007; Costa, et al., 2011) were obtained from 142 matches of the 2015 Brazilian Volleyball Men's Super League. This total of matches represents 94% of the matches and covers from 22 to 26 matches observed of each team, aiming at data homogeneity. However, since the first attack tempo increases the possibilities of score points (Costa, et al., 2017, 2018), particularly in complex I, the sample was composed of 5,259 first tempo attack actions.

Variables

For all attack actions performed for the middle-attackers, the effects of the variables of reception, attack tempo, attack performance, setting type, and attack type were analyzed. To analyze specifically the attack efficacy of the middle-attacker, the variables particularly related to this player were further considered, namely the setting type and some of the variables of the attack type (i.e., the attack direction that could be performed by this player: hard-driven parallel attack to zone 6, hard-driven diagonal attack to zone 1 and zone 5, and placed attack).

Effects of reception: this variable considers the quality of reception and its influence on the attack organization. In order to analyze the quality of reception, the instrument of Eom and Schutz (1992) was adapted. The following rating scale was determined:

- Poor quality reception (C): leaves no possibility of an organized attack, with only wing attackers available for the attack. Since we investigated the middle-attacker, receptions C were not analyzed in this study;
- Moderate quality reception (B): offers the possibility of an organized attack but not all the attackers are available for the attack organization; more specifically, inhibits quick attacks;
- Excellent quality reception (A): gives the opportunity of an organized attack, with all the attackers available for the attack organization.

Attack tempo: corresponds to the timing of an attack action as regards the temporal relationship between the attacker, the setter, and the ball (Selinger & Ackermann-Blount, 1986). The adapted categories defined by Afonso et al. (2010) are presented below, but since the aim of the study was to investigate the middle-attacker, we analyzed only the first tempo attack.

- First tempo attack: the attacker takes off during or slightly after the setting;
- Second tempo attack: the attacker takes two or three steps after the setting;

- Third tempo attack: the attacker waits until the ball reaches the peak of the ascending trajectory, and only then starts a three-step approach.

Attack performance: corresponds to the consequent result of the attack action. This variable was evaluated using the adapted instrument of Eom and Schutz (1992) and Marcelino et al. (2011), and considered the following categories:

- Attack error: the attacker failed (the ball was played to the net, out, or fault);
- Blocked attack: the attacker was blocked by the opponent (the last one scores a point through blocking);
- Defense: the attack action did not result in a terminal action allowing, therefore, the continuity of the game by the opponent and an organized counter-attack;
- Attack point: a direct point from the attack as the ball hit the opponent's court, or the ball was deflected by the block, the defense was unsuccessful, or block error occurred.

When considering the attacks made exclusively by the middle-attacker, the direction of the attack was taken into account according to the specificity of this attacker (Costa, et al., 2016). Thus, the following categories were used:

- Hard-driven parallel attack to zone 6: attack done by players of zone 3, with a downward trajectory, directed to zone 6, by imprinting a powerful hit on the ball;
- Hard-driven diagonal attack to zone 1: attack done by players of zone 3 with a downward trajectory directed to zone 1 by imprinting a powerful hit on the ball;
- Hard-driven diagonal attack to zone 5: attack done by players of zone 3 with a downward trajectory directed to zone 5 by imprinting a powerful hit on the ball;
- Placed attack: attack done by players of zone 3 using the fingers to direct the ball to an unguarded space.

The attacks exploring the block (i.e., the ones that contact the block) were included in the previously mentioned categories according to their power and direction.

Setting type: corresponds to the type of setting specifically performed to the middle-attacker. The distance between the setter and the middle attacker and their positions (near to or far from and in front or behind the setter, respectively) were taken into account since these characteristics interfere with the type of setting. The following categories were considered:

- Right tempo (positive): the attack is performed in front or near the setter; the ball is played to the right side of the attacker's body central axis;
- Left tempo (negative): the attack is performed in front or near the setter; the ball is played to the left side of the attacker's body central axis;

- Back tempo: the attack is performed behind and near the setter;
- Seven: the attack is performed in front and away from the setter.

The middle attack offensive actions performed behind and away from the setter were not considered as a category since they did not occur in the observed matches. All the variables are organized in Table 1.

Data collection

All matches were recorded from the top of the court; the camera was positioned seven to nine meters behind the end line of the court and nearly three meters above the ground level (the distance and position were tested in the pilot study). This position cannot be changed because it is a championship rule. A Sony camera with 1080p HD resolution and 60 Hz of frequency was used for this purpose. The images were analyzed through Data Volley Software, a reliable system used in tactical training of middle blockers (Neculai, 2020).

Five observers were previously trained in order to achieve consistency in the criteria and quality of coding the data. They had a minimum of five years of experience as volleyball scouts and possessed a degree in Physical Education. Moreover, the five observers were high-level volleyball coaches and they were employed to conduct performance anal-

yses through videos. All the observers analyzed 25% of the sample and repeated the same analysis ten days later. The lowest interclass correlation between the observers was 90%.

Statistical procedures

Descriptive statistics were applied in order to determine the frequencies and percentages of the attack performance according to the attackers' functional specialization. For the prediction data analysis, multinomial regression was used to analyze the relation of the independent variables with the dependent variables one by one. The variables showing correlation were used to make the adjusted model that verified the predictive power and influence of each of the independent variables on the dependent variable. Thus, a predictive model of the attack performed by the middle-attacker was elaborated. The independent variables were the quality of reception as well as type and direction of the attack, whereas attack performance was the dependent variable. The gross odd ratios (OR) were calculated, i.e., possibilities of an event to occur when analyzing the dependent variable with the independent variable one by one, that is, without considering the regression model. The adjusted odd ratios (ORA) were also calculated, i.e., possibilities for the event to occur when analyzing the dependent variable with the independent one within

Table 1. Variables analyzed during middle-attacker's actions

Direction	Effects of reception	Attack tempo	Attack performance	Attack direction	Setting type
Hard-driven parallel attack with the palm of the hand to zone 6	Poor quality reception (C): only wing attackers are available	First tempo of attack: take-off during or slightly after the setting	Attack error: attack played to the net, out or fault	Hard-driven parallel attack to zone 6: powerful attack from zone 3, with a downward trajectory to zone 6	Right tempo (positive): the attack is performed closer to the setter, and the ball is set on the right side of the attacker
Hard-driven diagonal attack with the palm of the hand to zone 1 and zone 5	Moderate quality reception (B): inhibit quick attacks	Second tempo of attack: take two or three steps after the setting	Blocked attack: attack blocked with the opponent's point	Hard-driven diagonal attack to zone 1: powerful attack from zone 3, with a downward trajectory to zone 1	Left tempo (negative): the attack is performed close to the setter, and the ball is set on the left side of the attacker
Placed attack, using the fingers	Excellent quality reception (A): all the attackers are available	Third tempo of attack: three steps approach after the ball reaches the peak of its ascending trajectory	Defense: attack with the opponent dig and organized counter-attack	Hard-driven diagonal attack to zone 5: powerful attack from zone 3, with a downward trajectory to zone 5	Back tempo: the attack is performed behind and closer to the setter
			Attack point: attack touches the opponent's court, block or defense without continuity, or block error	Placed attack: attack done by players of zone 3 using the fingers to direct the ball to an unguarded space	Seven: the attack is performed in front and from 1 to 2 m away from the setter

the model, that is, considering the influence of all the independent variables on the dependent variable. Thus, the predictor variables were analyzed simultaneously, so that the effect of each variable was adjusted for the effect of the others. In the treatment of the data, the significance value of 5% ($p \leq .05$) was adopted, and the SPSS software (Statistical Package for the Social Sciences) version 20.0 for Windows was used.

Reliability

For assessing reliability, 20% of the actions were re-analyzed, surpassing the reference value of 10% (Tabachnick & Fidell, 2013). The Cohen's Kappa values for inter-observer and intra-observer reliability, respectively, were: effects of reception = 0.98 and 0.96; setting type = 0.90 and 0.92; attack tempo = 0.94 and 0.96; attack type = 1.00 and 1.00; attack efficacy = 1.00 and 1.00. Hence, all these values fulfilled the criterion of 0.75 as suggested in literature (Fleiss, 2003).

Results

Table 2 presents the descriptive data regarding the effect of the attack according to the attackers' functional specialization. Significant differences were observed in the efficacy of the attack in relation to the player's functional specialization ($\chi^2 (2) = 353.74$; $p < .00001$). Thus, the effectiveness of the attack performed by the middle-attacker (3.40 ± 0.93) was higher than the attack performed by the wing attacker (3.12 ± 1.01) or opposite attacker (3.08 ± 1.08).

Table 3 presents the predictive factors of the effect of the setting type when considering the middle-attacker exclusively. The results showed that

the dependent variable was predicted by the independent variable ($\chi^2 = 297.775$, $p < .0001$), and the right tempo increased the odds of the hard-driven diagonal attack to zone 5, the hard-driven diagonal attack to zone 1, and the hard-driven parallel attack to zone 6 (OR: 1.684; OR: 1.481; OR: 1.392, respectively). The left tempo increased the odds of the hard-driven diagonal attack to zone 5 and the hard-driven diagonal attack to zone 1 (OR: 3.308; OR: 4.202, respectively). In addition, the back tempo increased the chances of the hard-driven parallel attack to zone 6 (OR: 1.420).

Table 2. Descriptive analysis of the effect of the middle-attacker

Middle-attacker		Player's functional specialization Middle-attacker	
Attack performance	Point scored	Occurred	3453
		% Attack efficacy	32.60%
		% By opposition	65.66%
	Defense	Occurred	842
		% Attack efficacy	22.54%
		% By opposition	16.01%
	Blocked attack	Occurred	597
		% Attack efficacy	18.49%
		% By opposition	11.35%
	Attack error	Occurred	367
		% Attack efficacy	19.34%
		% By opposition	6.98%
Total	Occurred	5259	

Table 3. Predictive factors of the effect of the setting type performed to the middle-attacker

Setting type ^a	Odds ratio (OR)	I.C. 95%		p	
		Inferior limit	Inferior limit		
Right tempo	Hard-driven diagonal attack to zone 5	1.684	1.278	2.219	.0001*
	Hard-driven diagonal attack to zone 1	1.481	1.103	1.988	.009*
	Hard-driven parallel attack to zone 6	1.392	1.052	1.842	.020*
	Placed attack ^b				
Left tempo	Hard-driven diagonal attack to zone 5	3.308	2.450	4.467	.0001*
	Hard-driven diagonal attack to zone 1	4.202	3.079	5.734	.0001*
	Hard-driven parallel attack to zone 6	1.305	.953	1.788	.097
	Placed attack ^b				
Back tempo	Hard-driven diagonal attack to zone 5	1.122	.835	1.508	.444
	Hard-driven diagonal attack to zone 1	1.306	.957	1.782	.092
	Hard-driven parallel attack to zone 6	1.420	1.060	1.902	.019*
	Placed attack ^b				

^a Reference category: Seven.

^b This parameter is set to zero because it is redundant.

* Difference to $p < .05$.

Table 4. Predictive factors of the effect of the attack performed by the middle-attacker

Attack performance ^a		Odds ratio (OR)	Odds ratio adjusted (ORA)	I.C. 95%	
				Inferior limit	Upper limit
Attack point	Reception A	2.028	2.049	1.642	2.557
	Reception B ^b				
	Right tempo	1.766	1.751	1.309	2.343
	Left tempo	2.920	2.927	2.138	4.007
	Back tempo	1.315	1.296	.947	1.774
	Seven ^b				
	Hard-driven diagonal attack to zone 5	4.072	3.618	2.433	5.381
	Hard-driven diagonal attack to zone 1	2.873	2.444	1.632	3.658
	Hard-driven parallel attack to zone 6	3.447	3.536	2.359	5.299
	Placed attack ^b				
Defense	Reception A	.970	.981	.763	1.263
	Reception B ^b				
	Right tempo	.721	.730	.524	1.017
	Left tempo	1.069	1.161	.817	1.649
	Back tempo	1.156	1.196	.849	1.684
	Seven ^b				
	Hard-driven diagonal attack to zone 5	.429	.423	.285	.628
	Hard-driven diagonal attack to zone 1	.398	.383	.256	.573
	Hard-driven parallel attack to zone 6	.389	.383	.255	.576
	Placed attack ^b				
Blocked attack	Reception A	1.134	1.121	.861	1.461
	Reception B ^b				
	Right tempo	.952	.947	.666	1.347
	Left tempo	1.291	1.278	.880	1.856
	Back tempo	1.210	1.211	.838	1.750
	Seven ^b				
	Hard-driven diagonal attack to zone 5	1.327	1.297	.823	2.043
	Hard-driven diagonal attack to zone 1	1.163	1.115	.701	1.773
	Hard-driven parallel attack to zone 6	1.166	1.157	.726	1.845
	Placed attack ^b				

^a Reference category: Attack error.

^b This parameter is set to zero because it is redundant.

* Difference at $p < .05$

Table 4 presents the predictive factors of the attack performance when considering only the middle-attacker. The results showed that the dependent variable was predicted by the independent variables ($\chi^2 = 639.05$, $p < .0001$), and the excellent quality reception, right tempo, left tempo, the hard-driven diagonal attack to zone 5 (ORA: 2.049, ORA: 2.927, ORA: 3.618, ORA: 2.444, ORA: 3.536, respectively) increased the odds of scoring a point. Additionally, the hard-driven diagonal attack to zone 5, the hard-driven diagonal attack to zone 1, and the hard-driven parallel attack to zone 6 reduced the odds of defense (ORA: 423; ORA: 383; ORA: 383, respectively).

Discussion and conclusions

This study aimed to analyze the predictive factors of attack efficacy in high-level male volleyball, taking into account the effects of reception, attack tempo, attack performance, setting type, and attack type. Globally, the results revealed that the attack point is more likely to occur after high-quality receptions (reception A), first attack tempos and hard-driven attacks. Moreover, faster attacks and hard-driven attacks decrease the chances of the opponents' defense and high-quality receptions. Previous studies also indicate that one of the predictive factors of attack efficacy is a high-quality reception, which promotes a better attack organ-

ization (Costa, et al., 2018). Accordingly, high-quality receptions afford the setter excellent setting conditions to organize a more complex attack and faster attack tempos with all attackers (Bergeles & Nikolaidou, 2011; Peiró, et al., 2016). Consequently, attack actions become more unpredictable and the opposite defensive organization less effective, which increases the possibility of points scoring (Costa, et al., 2011; Klaricic, et al., 2018). In this context, the middle attacker can be considered the most important player to attack actions' unpredictability.

When considering specifically the most effective attack of the middle players, they showed high attack efficacy. This result is consistent with previous studies that highlighted the determinant role of the middle attacker in quick attacks and, therefore, in increasing the odds of scoring a point (Costa, et al., 2016; Marcelino, Afonso, Moraes, & Mesquita, 2014). Thus, middle attackers have been considered of strategic relevance since their actions are used to provide their setters with quicker and better attack options (Afonso & Mesquita, 2011).

Concerning the predictive factors of attack performance, the results showed that the efficacy of the middle attackers was predicted by excellent quality receptions, right and left tempos and the hard-driven diagonal attack to zone 5. Moreover, powerful attacks (diagonal and parallel alike) are associated with reduced odds of defense success. As several studies have shown, the quality of the reception predicts the performance of the attack (Costa, et al., 2018; Peña, et al., 2013). Considering that the middle attacker usually attacks quick sets and, therefore, tends to attack more often when the set was made in an excellent setting zone, it could be said that there is a theoretical need for a high reception quality for the setter to set balls to the middle attacker (Costa, et al., 2016; Peiró, et al., 2016).

The novelty of this study refers to a higher chance of winning an attack point after the right (positive) and left tempo (negative) setting type. This relation may be explained by the fact that the game held near the setter improves speed and accuracy, mainly when using the positive and negative setting type, which increases the uncertainty in the opponents' block and restricts the opponents' defensive system (Peiró, et al., 2016). More specifically, during the fast middle attack, the middle blocker

has to choose between jumping to block the middle attacker or trying to block the wing or opposite attacker; and the defender has less time to see the set ball (i.e., since it is really fast) and moves trying to arrive at the best position for defense. Following this reasoning, the decrement in block and defense efficacy is a consequence of the fast middle attack. Thus, the vicinity of the middle-hitter to the setter allows the latter to control the block better and, therefore, to make better decisions regarding offensive organization (Peiró, et al., 2016).

Another novelty of this study is related to the effect of the setting type performed by the middle attacker. Here, results showed that the right and left tempo increased the odds of the hard-driven diagonal attack to zone 5 and zone 1, while the back tempo increased the chances of the occurrence of the hard-driven parallel attack to zone 6. These results are in line with the study by Costa et al. (2016), when the left and right tempo settings were efficient strategies to score points in high-level men's volleyball. The use of powerful attacks by the middle attacker with these specific directions could be explained by the quality of the opponents' block. Here, the use of diagonal directions to zone 5 and zone 1 when facing a left or a right tempo could be explained as a decision to avoid a well-formed and rigid block structure presented by the opposite team. On the other hand, the decision to use a powerful parallel attack to zone 6 with a back tempo setting type could indicate that the block was broken (i.e., not well-formed) at the moment of attack. Thus, right, left and back tempo setting types seem to be used as game variations from situational demands changing the attack strategy to increase the blocking uncertainty.

Therefore, the ability of the middle attacker together with other potential factors such as technical proficiency of the players (both attackers and blockers), the height the block reaches, or even the psychological features, may be more relevant for attack efficacy than the quality of block opposition (Afonso & Mesquita, 2011; Mesquita & Graça, 2002; Queiroga, Matias, Greco, Graça, & Mesquita, 2005). This idea may be due to the nature of volleyball, which is a game of non-invasion, where the blocker cannot directly interfere with the attacker; hence, the latter always has the advantage.

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.
- Afonso, J., & Mesquita, I. (2007). Pilot study on the relationship between attack play and attack tempo in women's volleyball. *Portuguese Journal of Sport Sciences*, 7(Suppl.1), 46-47.
- Afonso, J., & Mesquita, I. (2011). Determinants of block cohesiveness and attack efficacy in high-level women's volleyball. *European Journal of Sport Science*, 11(1), 69-75. doi: 10.1080/17461391.2010.487114
- Afonso, J., Mesquita, I., Marcelino, J., & Silva, J. (2010). Analysis of the setter's tactical action in high-performance women's volleyball. *Kinesiology*, 42(1), 82-89.
- Barzouka, K., Nikolaidou, M.E., Malousaris, G., & Bergeles, N. (2009). Performance excellence of male setters and attackers in complex I and II on volleyball teams in the 2004 Olympic Games. *International Journal of Volleyball Research*, 9(1), 19-24. doi: 10.1080/24748668.2009.11868470
- Bergeles, N., & Nikolaidou, M.E. (2011). Setter's performance and attack tempo as determinants of attack efficacy in Olympic level male volleyball teams. *International Journal of Performance Analysis in Sport*, 11(3), 535-544. doi: 10.1080/24748668.2011.11868571
- Castro, J., Souza, A., & Mesquita, I. (2011). Attack efficacy in volleyball: Elite male teams. *Perceptual and Motor Skills*, 113(2), 395-408. doi: 10.2466/05.25.PMS.113.5.395-408
- Conti, G., Afonso, J., Brant, E., & Mesquita, I. (2012). Differences in game patterns between male and female youth volleyball. *Kinesiology*, 44(1), 60-66.
- Conti, G., Freire, A., Evangelista, B., Pedrosa, G., Ugrinowitsch, H., & Castro, H. (2018). Brazilian high-level men's volleyball: Characterization of the attack performed by the opposite player. *Kinesiology*, 50(1), 211-217. doi: 10.26582/k.50.2.4
- Costa, G.C.T., Castro, H.O., Evangelista, B.F., Malheiros, L.M., Greco, P.J., & Ugrinowitsch, H. (2017). Predicting factors of zone 4 attack in volleyball. *Perceptual and Motor Skills*, 124(3), 621-633. doi: 10.1177/0031512517697070
- Costa, G.C.T., Castro, H.O., Freire, A.B., Evangelista, B.F., Pedrosa, G.F., Ugrinowitsch, H., & Praça, G.M. (2018). High level of Brazilian men's volleyball: Characterization and difference of predictive factors of back row attack. *Motricidade*, 14(1), 58-65. doi: 10.6063/motricidade.12221
- Costa, G.C.T., Ceccato, J.S., Evangelista, B.F.B., Freire, A.B., Oliveira, A.S., Milistetd, M., Rodrigues, H.A., & Ugrinowitsch, H. (2016). Tactic determinants of game practiced by middle attacker in men's volleyball. *Brazilian Journal of Kinanthropometry and Human Performance*, 18(3), 371-379. doi: 10.5007/1980-0037.2016v18n3p371
- Costa, G.C.T., Ferreira, N., Junqueira, G., Afonso, J., & Mesquita, I. (2011). Determinants of attack tactics in youth male elite volleyball. *International Journal of Performance Analysis in Sport*, 11(1), 96-104. doi: 10.1080/24748668.2011.11868532
- Eom, H.J., & Schutz, R.W. (1992). Statistical analyses of volleyball team performance. *Research Quarterly for Exercise and Sport*, 63(1), 11-18. doi: 10.1080/02701367.1992.10607551
- Fleiss, J.I. (2003). *Statistical methods for rates and proportions* (3rd ed.). Wiley-Interscience.
- García-de-Alcaraz, A., Ortega, E., & Palao, J.M. (2017). Effect of age group on male volleyball players' technical-tactical performance profile for the spike. *International Journal of Performance Analysis in Sport*, 15(2), 668-686. doi: 10.1080/24748668.2015.11868823
- Hileno, R., Garcia-de-Alcaraz, A., Buscà, B., Salas, C., & Camerino, O. (2018). What are the most widely used and effective attack coverage systems in men's volleyball? *Journal of Human Kinetics*, 62(1), 111-121. doi: 10.1515/hukin-2017-0163
- Hurst, M., Loureiro, M., Valongo, B., Laporta, L., Nikolaidis, T.P., & 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. doi: 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 the side-out in senior men's volleyball as a function of the player involved] *Motricidade*, 11(4), 142-150. doi: 10.6063/motricidade.6302
- Klaricic, I., Grgantov, Z., & Jelaska, I. (2018). Prediction of efficiency in elite volleyball: Multiple regression approach. *Acta Kinesiológica*, 12(1), 79-85.
- 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. doi: 10.1080/24748668.2007.11868388
- Lobietti, R., Cabrini, P., & Brunetti, M. (2009). The side-out complex in volleyball: The effect of reception and attack performance with the final score. *International Journal of Performance Analysis in Sport*, 9(3), 390.
- 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.
- Marcelino, R., Mesquita, I., & Sampaio, J. (2011). Effects of quality of opposition and match status on technical and tactical performances in elite volleyball. *Journal of Sports Sciences*, 29(7), 733-741. doi: 10.1080/02640414.2011.552516
- McGarry, T. (2009). Applied and theoretical perspectives of performance analysis in sport: Scientific issues and challenges. *International Journal of Performance Analysis in Sport*, 9(1), 128-140. doi: 10.1080/24748668.2009.11868469

- McGarry, T., Anderson, D.I., Wallace, S.A., Hughes, M.D., & Franks, I.M. (2002). Sport competition as a dynamical self-organizing system. *Journal of Sports Sciences*, 20(10), 771-781. doi: 10.1080/026404102320675620
- Mesquita, I. (2005). A contextualização do treino no voleibol: a contribuição do construtivismo. [The contextualization of the volleyball training: The contribution of construtivismo.] In D. Araújo, *O contexto da decisão – acção táctica no desporto* (1st ed.; pp. 355-378). Lisboa: Coleção Visão e Contextos das Ciências do Desporto.
- Mesquita, I., & Graça, A. (2002). Probing the strategic knowledge of an elite volleyball setter: A case study. *International Journal of Volleyball Research*, 5(1), 6-12.
- Mesquita, I., Palao, J.M., Marcelino, R., & Afonso, J. (2013). Performance analysis in indoor volleyball and beach volleyball. In T. McGarry, P. O'Donoghue & J. Sampaio (Eds.), *Routledge handbook of sports performance analysis* (pp. 367-379). London: Routledge.
- Millán-Sánchez, A., Parra-Royón, M.J., Benítez, J.M., & Espa, A.U. (2020). Ability to predict side-out performance by the setter's action range with first tempo availability in top European male and female teams. *International Journal of Environmental Research and Public Health*, 17, 6326. doi: 10.3390/ijerph17176326
- Millán-Sánchez, A., Rábago, J.C.M., & Espa, A.U. (2019). The middle blocker in volleyball: A systematic review. *Journal of Human Sport and Exercise*, 14(1), 24-46. doi: 10.14198/jhse.2019.141.03
- Monteiro, R., Mesquita, I., & Marcelino, R. (2009). Relationship between the set outcome and the dig and attack efficacy in elite male volleyball game. *International Journal of Performance Analysis in Sport*, 9(3), 294-305. doi: 10.1080/24748668.2009.11868486
- Neculai, H. (2020). The importance of using the “Data Volley” Software and of the “Data Video” System in the tactical training of the middle blocker for official games. *Gymnasium*, XXI(1), 34-41. doi: 10.29081/gsjesh.2020.21.1.03
- Palao, J.M., Santos, J.A., & Ureña, A. (2007). Effect of the manner of spike execution on spike performance in volleyball. *International Journal of Performance Analysis in Sport*, 2(Suppl. 1), 126-138. doi: 10.1080/24748668.2007.11868402
- Palao, J., Santos, J., & Ureña, A. (2004). Effect of team level on skill performance in volleyball. *International Journal of Performance Analysis in Sport*, 4(2), 50-60. doi: 10.1080/24748668.2004.11868304
- Paulo, A., Zaal, F.T.J.M., Fonseca, S., & Araújo, D. (2016). Predicting volleyball serve-reception. *Frontiers in Psychology*, 7, 1694. doi: 10.3389/fpsyg.2016.01694
- Peiró, M.S., Parra, M., León, J., Fradua, L., Benítez, J.M., & Ureña, A. (2016). Relationship between middle hitter and setter's position and its influence on the attack zone in elite men's volleyball. *International Journal of Performance Analysis in Sport*, 16(2), 523-538. doi: 10.1080/24748668.2016.11868906
- Peña, J., Rodríguez-Guerra, J., Buscà, B., & Serra, N. (2013). Which skills and factors better predict winning and losing in high-level men's volleyball? *Journal of Strength and Conditioning Research*, 27(9), 2487-2493. doi: 10.1519/JSC.0b013e31827f4dbe
- Pinto, R., Vale, S., & Vicente, P. (2018). The action of the middle blocker according to the opposing offensive organization in volleyball. *Journal of Sports Sciences*, 6, 178-185. doi: 10.17265/2332-7839/2018.03.007
- Queiroga, M.A., Matias, C.J.A.S., Greco, P.J., Graça, A., & Mesquita, I. (2005). *A dimensão do conhecimento tático-estratégico do levantador de alto nível: um estudo realizado com levantadores da seleção brasileira de voleibol*. [A dimension of the tactic-strategic knowledge of the high-level setter: A study with the volleyball Brazilian teams' setters.] *Revista Mineira de Educação Física*, 2, 111-119.
- Selinger, A., & Ackermann-Blount, J. (1986). *Arie Selinger's power volleyball*. New York, NY: St. Martin's Press.
- Silva, M., Lacerda, D., & João, P.V. (2014b). Game-related volleyball skills that influence victory. *Journal of Human Kinetics*, 41, 129-137. doi: 10.2478/hukin-2014-0045
- Silva, M., Lacerda, D., & João, P.V. (2014a). Match analysis of discrimination skills according to the setter defense zone position in high level volleyball. *International Journal of Performance Analysis in Sport*, 14(2), 463-472. doi: 10.1080/24748668.2013.11868661
- Silva, M., Marcelino, R., Lacerda, D., & João, P. (2016). Match analysis in volleyball: A systematic review. *Montenegrin Journal of Sports Science and Medicine*, 5(1), 35-46.
- Tabachnick, B., & Fidell, L. (2013). *Using multivariate statistics* (6th ed.). Boston: Allyn & Bacon.
- Ugrinowitsch, H., Lage, G.M., Santos-Naves, S.P., Dutra, L.N., Carvalho, M.F.S.P., Coca Ugrinowitsch, A.A., & Benda, R.N. (2014). Transition I efficiency and victory in volleyball matches. *Motriz: Revista de Educação Física*, 20(1), 42-46. doi: 10.1590/S1980-65742014000100006

Received: 2020, March 09

Accepted: 2021, November 06

Published Online First: February 19, 2024

Correspondence to:

Herbert Ugrinowitsch

Universidade Federal de Minas Gerais

School of Physical Education, Physiotherapy and Occupational therapy

Av. Antônio Carlos, 6627, CEP 31270-901, Pampulha, Belo Horizonte, Brazil

Phone/Fax: +5531 34092393

Email: herbertu@ufmg.br