PREDICTORS OF ATTACK EFFICACY AND ATTACK TYPE IN HIGH-LEVEL BRAZILIAN WOMEN'S VOLLEYBALL

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Original scientific paper
UDC: 796.325:796.12.577.4-55.2(81)

Abstract:

The purpose of this study was to analyse the influence of the quality of reception, attack tempo, and block type on attack efficacy and attack type in high-level women's volleyball. Eighteen matches from the Brazilian Women's Superleague 2011/2012 were analysed (n=2,348 attack actions). Multinomial logistic regression was applied to construct models predicting the influence of explanatory variables on the attack efficacy and attack type. The results showed that attack errors were associated to double block (OR=1.48), while attacks resulting in action continuity were associated with double block (OR=1.40) and triple block (OR=1.97). Receptions affording all attack options (OR=0.54) and powerful attacks (OR=0.34) reduced game continuity. In conclusion, attack tempo was negatively correlated with the quality of settings, suggesting that slower attack tempos afford the attacker more time to prepare and to create momentum for performing the action.

Key words: *performance analysis, game variables, predictive models*

Introduction

The interactions between opposing teams promote the emergence of unique game patterns (Hughes & Bartlett, 2002; O'Donoghue, 2009). This specificity is highly related to the current constraints and critical events inherent to the variability of game situations (Afonso, Esteves, Araújo, Thomas, & Mesquita, 2012). Therefore, sequential patterns common to a set of matches, levels of performance, and competitions are likely to emerge (Afonso & Mesquita, 2011). In the same vein, and considering that in volleyball the attack is the action most critically related to attaining a victory, it is relevant to attempt to understand game patterns that afford the achievement of superior attack efficacies (Afonso, et al., 2012; Castro & Mesquita, 2008; Costa, Afonso, Brant, & Mesquita, 2012; Laios & Kountouris, 2004; Marcelino, Mesquita, Castro, & Sampaio, 2008; Palao, Santos, & Ureña, 2005).

Indeed, research in volleyball has devoted much effort to analysing attack efficacy (César & Mesquita, 2006; Maia & Mesquita, 2006; Marcelino, César, Afonso, & Mesquita, 2009; Marcelino, Mesquita, & Sampaio, 2010; Rocha & Barbanti, 2004), as well as its relationship with the result in a set (Laios & Kountouris, 2005; Palao, et al., 2005) and in a match (Castro & Mesquita, 2008; Marcelino, et al., 2008), and also the technique used to perform the attack (Afonso, Mesquita, & Palao, 2005; Castro & Mesquita, 2008; Mesquita & César, 2007; Palao, Manzanares, & Ortega, 2009).

The effect of other game actions on attack efficacy, such as receptions (Asterios, Kostantinos, Athanasios, & Dimitrios, 2009; Barzouka, Nikolaidou, Malousaris, & Bergeles, 2006; João, Mesquita, Sampaio, & Moutinho, 2006; Nikos, Karolina, & Elissavet, 2009), settings (Afonso & Mesquita, 2011; César & Mesquita, 2006; Costa, Ferreira, Junqueira, Afonso, & Mesquita, 2011; Costa, Mesquita, Grego, Ferreira, & Moraes, 2011; Palao, Santos, & Ureña, 2007), and number of blockers (Afonso, et al., 2005) have also been scrutinized in literature.

It is known that high-quality receptions create better conditions for the attack and enhance the likelihood of scoring a point (Mesquita, Manso, & Palao, 2007; Papadimitriou, Pashali, Sermaki, Mellas, & Papas, 2004; Rocha & Barbanti, 2004), stimulating the utilization of quicker attacks. Quicker

attack tempos provide advantages for the offensive system, constraining the defensive structuring by the opposing team (Asterios, et al., 2009), specifically the blocking actions. Blocking errors have also been reported to decrease the chances of winning a match (Peña, Rodríguez-Guetta, Buscà, & Serra, 2013). This factor is quite relevant, as the relationship between attack and block is able to predict winning or losing the set (Marcelino, Mesquita, & Sampaio, 2011; Rocha & Barbanti, 2006). With respect to the employed attack technique or attack type, high-level performance tends to correlate well with powerful attacks (Castro, Sousa, & Mesquita, 2011; Costa, Ferreira, et al., 2011), despite the need for adapting this action to the demands of each play (Mesquita, 2005). According to Castro, Souza and Mesquita (2011), powerful attacks are defined in opposition to off-speed attacks. The former privilege power and strength, while the latter refer to slower attacks privileging placement over power. As most current data reports to men's volleyball, there is interest in researching these phenomena in women's volleyball.

Comparing the game as played by men or by women, it is observed that three variables tend to show significant gender differences: service type, attack tempo and attack type (Costa, et al., 2012). Women's volleyball shows predominance of service without jumping, placed attacks and slow attack tempos, enhancing the likelihood of counter-attacks (Costa, et al., 2012). It is suggested that in women's volleyball one of the most important clues for the blockers is the availability of the opponent's middle player to attack quick sets (Afonso & Mesquita, 2011), which will vary depending on the problems emerging from the game. Thus, this variable will induce the use of different blocking strategies that should be taken into account.

In this context, a great body of research has applied bivariate statistics, but this approach has a limited scope, since it only allows relating two variables per analysis. If the intention is to create models capable of predicting performance, multiple variables and their interactions must be factored in (Afonso & Mesquita, 2011). Therefore, the concept of probabilities should be applied when analysing team sport (Ranyard & Charlton, 2006; Ward & Williams, 2003), and statistical analysis attempting to detect game patterns should apply multivariate analyses (Lames & McGarry, 2007), respecting the complexity of the game and following the trends of research using log-linear analysis (Eom & Schutz, 1992), lag sequential analysis (Afonso, Mesquita, Marcelino, & Silva, 2010), and multinomial logistic regression (Afonso & Mesquita, 2011; Bergeles & Nikolaidou, 2011; Costa, et al., 2012).

Furthermore, most studies have been conducted in men's volleyball (Costa, Mesquita, et al., 2011; Palao, et al., 2009; Rocha & Barbanti, 2004), with research in women's volleyball being scarce. Notable exceptions are the works of Afonso and Mesquita (2011), and also Afonso et al. (2010). The purpose of this study was to analyse the associations between quality of reception, attack tempo, and block type and to reveal how these explain the performance with regard to attack efficacy and attack type in Brazilian high-level women's volleyball. In sum, two predictive models will be attempted: one for attack efficacy, another for attack type.

Methods

Sample and procedures

The sample was composed of the teams that have participated in the qualification phase of the Brazilian Women's Superleague 2011/2012. Brazil has ranked consistently in the top three national teams of world women's volleyball (please consult the official FIVB site for details: www.fivb.org), and most of its players play in the Brazilian Superleague. Eighteen matches were analysed with the total of 2,348 attack actions. Specifically, three matches were analysed for each team. All the matches were recorded from the top of the court (i.e. *circa* 7-9 metres behind the end line), and the camera was positioned nearly three metres above ground level for better visualization. A Sony camera was used, with a definition of 1080p HD and a sampling rate of 60Hz. The observers were previously trained in order to achieve consistency in the criteria and quality in coding the data (Cohen's Kappa for intra- and inter-observer reliability above 0.75). They had a minimum of five years of experience in volleyball coaching and possessed a degree in Physical Education.

Variables

For evaluating the quality of reception, the instrument of Eom and Schutz (1992) was adapted. The reception errors were disregarded since they did not allow the attack to occur. The following rating scale was determined:

- 1 – Poor reception: leaves no possibility of an organized attack, with only one attacker available for the attack.
- 2 – Moderate reception: opens possibility of an organized attack, but not all the attackers are available for the attack; more specifically, inhibits quick attacks.
- 3 – Excellent reception: gives the opportunity for an organized attack, with all the attackers being available for the attack.

Attack tempo corresponds to the timing of 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), were used:

- 1st tempo of attack: the attacker takes off during or slightly after the set;
- 2nd tempo of attack: the attacker takes two or three steps after the set;
- 3rd tempo of attack: the attacker waits until the ball reaches the peak of the ascending trajectory, and only then starts a three-step approach.

Attack type was categorized following the suggestion of Costa, Ferreira et al. (2011):

- 1 – Powerful attack: a powerful hit at the ball, imprinting a downward trajectory;
- 2 – Placed attack: there is a control of the power applied to the ball, directing the hit to an unguarded space.

Block type corresponds to the number of blockers opposing the attack and their collective cohesion. To analyse this variable five categories were used:

- 1 – Triple block or 3x1: corresponds to a cohesive triple block (no space between the hands of the blockers);
- 2 – Broken triple block or (2+1)x1: three blockers, with two of them being compact and close, while a space opens between one blocker and the remaining players in the block;
- 3 – Double block or 2x1: cohesive double block;
- 4 – Broken double block or (1+1)x1: two blockers with an open space in the middle of the block;
- 5 – Simple block or 1x1: one-player block.

Attack efficacy was evaluated using the adapted instrument of Eom and Schutz (1992) and Marcelino et al. (2011), and considered six categories:

- Attack error: attacker fails (net, out or fault);
- Blocked attack: blocking the opponent and scoring through blocking;
- Continuity with an organized counter-attack: the attack action does not result in a terminal action and allows an organized counter-attack;
- Continuity with the ball kept with the attacking team (after bouncing off the block): after the attack, the ball touches the block and allows reorganizing the attack;
- Continuity with no organized attack: after the defence, the counter-attack occurs with difficulty in its organization, with few options available;
- Attack point: a direct point from the attack as the ball hits the opponent's court, or the ball has been deflected by the block, the defence has been unsuccessful, or block error has occurred.

Statistical procedures and reliability

Descriptive statistics were applied in order to determine the frequencies and percentages for each variable. Multinomial logistic regression was applied to construct two models that could predict the influence of explanatory variables. For attack efficacy the following variables were considered: *quality of reception*, *attack tempo*, *attack type* and *block type*; as for attack type, *quality of reception*, *attack tempo* and *block type* were considered. In the first step, the variables were tested individually, in order to identify the existence of a significant association with the response variable (crude odds ratio). Whenever this presupposition was verified, that variable was included in the adjusted model (adjusted odds ratio), following the procedures of Afonso and Mesquita (2011). The final model for attack type included the variables *quality of reception* and *attack tempo*, while the final model for attack efficacy encompassed *quality of reception*, *attack tempo*, *attack type* and *block type*.

To analyse the association between the explanatory variable and the response variable some categories were merged, since the *n* fell short of the demands of the multinomial logistic regression (the minimum asked is 5% in each cell). Therefore, in the variable *quality of reception* two categories were adopted: reception not allowing an organized attack, and reception allowing an organized attack. As for the *block type*, the number of blockers was considered: simple, double or triple blocks. Cataloguing of *attack efficacy* considered *attack error, continuity* and *attack point*. These categories are exhaustive, exclusive and exhibit coherence with the functional structure of volleyball.

For calculating reliability, 20% of the actions were re-analysed, surpassing the reference value of 10% (Tabachnick & Fidell, 2013). Cohen's Kappa ranged from 0.82 to 0.98 for inter-observer reliability, and between 0.81 and 1.00 for intra-observer reliability (Table 1). Hence, all values fulfilled the criterion of 0.75 as suggested in literature (Fleiss, 2003).

Table 1. Inter-observer and intra-observer reliability

Cohen's Kappa	Inter-observer	Intra-observer
Quality of reception	0.94	0.91
Attack tempo	0.82	0.81
Attack type	0.91	1.00
Block type	0.98	0.99
Attack efficacy	0.93	0.98

Results

Table 2 presents the descriptive analysis results for the game variables, with the corresponding frequencies and percentages.

Table 3 shows the relationship between the attack type and the remaining variables of the game. Quality of reception and attack tempo showed to be predictors of attack type.

Table 4 presents the adjusted model regarding attack efficacy.

In comparing continuity with attack points, again the number of blockers emerged as a predictive

Table 2. Frequency analysis of the game variables

Variables	n	%
Quality of reception		
Poor reception	246	10.5
Moderate reception	938	39.9
Excellent reception	1,164	49.6
Attack tempo		
1st tempo of attack	393	16.8
2nd tempo of attack	340	14.5
3rd tempo of attack	2,344	68.7
Attack type		
Powerful attack	1,430	61.0
Placed attack	914	39.0
Block type		
Triple block	59	2.5
Broken triple block	48	2.0
Double block	1,073	46.0
Broken double block	600	25.7
Simple block	557	23.8
Attack efficacy		
Attack error	172	7.3
Blocked attack	193	8.2
Continuity 1	355	15.1
Continuity 2	201	8.6
Continuity 3	519	22.2
Attack point	908	38.7

Table 3. Adjusted model of game variables in relation to attack type

Powerful attack [a]		OR Crude	OR Adjusted	p
Placed attack	Quality of reception			
	Poor reception	3.499	4.553	≤.001
	Moderate reception	1.554	1.766	≤.001
	Excellent reception[b]			
	Attack tempo			
	1st tempo of attack	1.339	1.875	≤.001
	2nd tempo of attack	1.317	1.759	≤.001
	3rd tempo of attack[b]			

[a] Reference category of the response variable
[b] Reference category of the explanatory variable

factor. Namely, both the double and triple blocks augmented the occurrence likelihood of continuity, in detriment of an attack point being scored. Furthermore, the reception allowing an organized attack benefited the occurrence of attack points, and the same effect was observed when considering powerful attack in comparison to placed attacks.

Table 4. Adjusted model of game variables regarding attack efficacy

Attack point[a]		OR Crude	OR Adjusted	p
Attack error	Quality of reception			
	Reception allowing organized attack	0.720	0.847	.495
	Reception not allowing organized attack[b]			
	Attack tempo			
	1st tempo of attack	0.725	0.837	.342
	2nd tempo of attack	0.814	0.919	.649
	3rd tempo of attack[b]			
	Attack type			
	Powerful attack	0.858	0.850	.242
	Placed attack[b]			
	Block type			
	Triple block	1.907	1.714	.131
	Double block	1.573	1.472	.020
	Simple block[b]			
Continuity of the game	Quality of reception			
	Reception allowing organized attack	0.366	0.540	<.001
	Reception not allowing organized attack [b]			
	Attack tempo			
	1st tempo of attack	0.891	1.021	.876
	2nd tempo of attack	0.734	0.817	.154
	3rd tempo of attack[b]			
	Attack type			
	Powerful attack	0.331	0.346	<.001
	Placed attack [b]			
	Block type			
	Triple block	2.630	1.978	.009
	Double block	1.470	1.405	.005
	Simple block[b]			

[a] Reference category of the response variable
[b] Reference category of the explanatory variable

Discussion and conclusions

The present study was aimed at analysing match regularities in the context of Brazilian top-level women's volleyball. Specifically, it was intended to search for predictors of attack efficacy and attack type. The data showed that attack errors were associated with double blockers, while continuity was associated with double blockers and triple blockers. In men's volleyball triple block usually promotes more attack errors (e.g. Marcelino, et al.,

2011). Our study showed that in women's volleyball the attackers tend to lower the assumed risk in their actions avoiding powerful attacks. In men's volleyball it has been observed that points made in complex II increase the likelihood of winning the game. Inversely, reception errors and blockers errors decrease this chance, demonstrating that a powerful and aggressive game enhances the likelihood of scoring a point and consequently winning the game (Peña, et al., 2013). It was further observed that receptions allowing organized play and powerful attacks reduce game continuity. In this sense the quality of reception constraints the possibilities of attack, as has been demonstrated previously (Rocha & Barbanti, 2004, 2006; João, et al., 2006). Indeed, receptions of good quality promoted enhanced attack efficacy, showing the influence of the reception quality on the offensiveness of the attack (João, et al., 2006). Conversely, poorer receptions coupled with double and triple blocks stimulating the effect of continuity in attack, in line with similar research in men's volleyball (Castro, et al., 2011; Costa, Ferreira, et al., 2011; Marcelino, et al., 2011).

With respect to attack tempo, the quickest attack tempos (1 and 2) were associated with increased occurrence of placed attack, evidencing that attack tempo negatively correlated with the quality of setting the ball. This reveals differences with respect to previous research in men's volleyball, in which quicker attack tempos promoted superior attack efficacies (Costa, Ferreira, et al., 2011), and therefore higher emergence of powerful attacks. The use of more placed services, and also of slower and less powerful attacks in women's volleyball had already been verified (Costa, et al., 2012), although trends in service may vary according to in-game role (Quiroga, et al., 2010). This trend can be explained by the fact that slower attack tempos afford a hitter more time to prepare and to create momentum for performing the action, even though he/she will likely be facing an opposition with more blockers. Consequently, the blockers tend to analyse the availability of fast attackers and create strategies for anticipating the blocks according to the type of game played, thus making a functional concept for the defensive system (Afonso & Mesquita, 2011). The present study evidenced that in Brazilian top-level women's volleyball there is still a need for implementing more aggressive blocking systems with more blockers, as well as more compact blocks.

Furthermore, placed attacks were associated with receptions of *poor* and *moderate* quality. Hence, good serves, inducing a decrease in the quality of serve reception, afford better defensive organization and enhance the likelihood of success in counter-attack, corroborating the results obtained by Rocha and Barbanti (2004), although the latter concerned men's volleyball. In another study, Costa, Mesquita et al. (2011) have demonstrated that low quality reception reduces the possibility to score from attack, since it limits the construction of offensive play. As for attack efficacy, placed attack promoted more continuity, showing that slower attacks afford the defenders more time to move and to contact the ball.

These findings suggest that quick and attack combinations followed by powerful attacks should be incorporated into the game (hence, they need to be more thoroughly developed in training processes), but are deeply dependent on the quality of serve receptions. Teams could also practice using powerful attacks under sub-optimal conditions, for example, after poor receptions, in order to emancipate the attack aggressiveness from reception quality to a greater extent. As for the team in the counter-attack phase, the serve emerges as a very powerful tool for unbalancing the opposing serve reception and, consequently, for inhibiting quick attack plays. Otherwise, the attack tempo was not decisive for determining attack efficacy, and slow attack tempos were predominant. A possible explanation might be due to the stage of the championship that was used in this observation (i.e. qualification phase). In the initial stages of a competitive season, new players are introduced into teams and their collective strategies are not yet well consolidated. As quick attacks require perhaps the greatest degree of coordination between players, it is expected that patterns involving these attacks will take longer to consolidate. Therefore, it is likely that in later stages of the season the attack tempo will positively affect attack efficacy.

Future research should also observe and analyse the relationships between the blocking system and quality reception, as well as the attack strategies according to different qualities of reception, taking into account variables such as match status and quality of the opposition (Marcelino, Sampaio, & Mesquita, 2012).

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Submitted: July 19, 2013
Accepted: June 5, 2014

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