

# ANALYSIS OF THE SETTING AND PREDICTIVE FACTORS OF THE EFFECT OF ATTACK ACCORDING TO GAME ECOLOGY: THE CASE OF FEMALE VOLLEYBALL

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## Abstract:

The objective of this study was to identify how the ecological variables influence the setter during the setting and what were the predictive factors of the attack effect among Brazilian teams ranked from the 1<sup>st</sup> to 4<sup>th</sup> place in the volleyball Women's Super-League in 2016-2017. We analyzed 768 attacks from 10 matches played among the teams. A descriptive analysis was performed and, to identify how the setting location differed in relation to the ecological variables, the one-way ANOVA (factor 1 = setting location) was used. In addition, multinomial logistic regression was performed to understand the predictive factors of the effect of the attack. The significance level was set at 5% ( $p \leq .05$ ) and the SPSS software version 20.0 was used. The results showed the setting location differed according to the distance between the setter and the central attacker, the distance between the setter and the central blocker, and the distance between the setter and the blocker of position 4. Besides, it was observed that the powerful attack and the blocking touch were predictive factors of the effect of the attack. Thus, it is concluded that the decision-making for the action of the setting is based on the availability of the central attacker and the configuration of the blockers, the powerful attack reduces the chances of defense and the blocking touch reduces the chances of scoring by attacking.

**Key words:** volleyball, game analysis, game ecology

## Introduction

The observational analysis that allows understanding what are the game aspects that influence sports performance (Barreiro & Silva, 2016; Clemente, Martins, Mendes, & Silva, 2016) is not recent in sports (Eom & Schutz, 1992; Hughes & Bartlett, 2002). In the case of volleyball, it has been observed that the attack is the most researched skill, and the predictive factors of the effect of this are the fast ball setting for the 1<sup>st</sup> and 2<sup>nd</sup> tempo (García-de-Alcaraz, Ortega, & Palao, 2015; Mesquita, Palao, Marcelino, & Afonso, 2013) and powerful parallel and diagonal attacks (Costa, et al., 2017b, Conti, et al., 2018). In addition, the quality of the opposing team makes it possible to manage the risk at the decision-making (García-de-Alcaraz & Marcelino,

2017), which results in changes in the type of game practiced (Costa, et al., 2017a), suggesting that situational constraints must be taken into account when analyzing a volleyball game (Paulo, Davids, & Araújo, 2017; Ramos, et al., 2017).

In this context, the performance is a resultant of the adaptation of actions to the dynamic aspects of the game (Araújo, Davids, & Hristovski, 2006; Davids, Araújo, & Seifert, 2015) and interaction with the opponent lays the ecological variables (Paulo, Davids, et al., 2017). Thus, in interactions of the environment-athlete system, under the specific constraints of sports tasks, we can see that the possibilities of relevant actions are based on behaviors that emerge from the following systems: performance-environment, perception-affordances,

and affordances-action (Araújo, Hristovski, Seifert, Carvalho, & Davids, 2017). In this context, when considering the effect of the attack, it is observed that the setting is one of the ecological variables that affects most the opposition faced by the attack (Afonso, Esteves, Thomas, Araújo, & Mesquita, 2012; Afonso, Mesquita, Marcelino, & Silva, 2010), where the decision-making by the setter is associated with the setter's own performance (Conejero, Claver, Fernández-Echeverría, & Moreno, 2017).

However, knowing that most of research in this area has been dedicated to understanding the game in a generalized way and that ecological analysis has little been used in performance analysis (Hileno, García-de-Alcatraz, Busca, Salas, & Camerino, 2018), the present research aimed to identify how the ecological variables, which conform the situational constraints, influenced the setting, as well as the predictive factors of the effect of the attack in teams ranked between the 1<sup>st</sup> and 4<sup>th</sup> place in the Brazilian women's volleyball super league.

## Method

### Sample

The sample consisted of the observations of 768 attacks, considering 10 matches between the teams ranked from the 1<sup>st</sup> to 4<sup>th</sup> place in the 2016-2017 Brazilian Women's Super League. Only the receptions that allowed the organized attack with all actors were considered, due to the limitations of the Kinovea software, considering that only the top shooting was used from the back of the court. This sample is relevant as Brazilian women's volleyball is internationally ranked among the top four national teams ([www.fivb.org](http://www.fivb.org)) and most of its players participate in the Brazilian Super League.

### Variables

*Ecological variables.* In order to understand how the environmental variables interfere in the setting, we analyzed the distances between the setter and a) the central attacker, b) the central blocker, c) the blocker of position 4 and d) the blocker of position 2. For this purpose, the software Kinovea was used, and for the distances between the setter and position 4, positive values were assigned, considering the location where the setting was performed, while for the distances between the setter and position 2 were assigned negative values. In addition, the respective distances were calculated immediately when the setter touched the ball. The software calibration was done from the center line, the lateral lines and the volleyball net, specifically the distance between the antennas.

*Attack tempo.* For this analysis we used the instrument proposed by Afonso et al. (2010), where:

- 1<sup>st</sup> tempo: the attacker jumped during or immediately after the setting, being able to occur a step after the setter;
- 2<sup>nd</sup> tempo: the attacker performed two or three steps after the setting; and
- 3<sup>rd</sup> tempo: the attacker waited for the ball to reach the peak of the upward trajectory and only then began the attack.

*Type of attack.* The type of attack was analyzed according to the instrument proposed by Costa, Ferreira, Junqueira, Afonso, and Mesquita (2011), being:

- Powerful attack: Attack performed with power in descending trajectory.
- Off-speed attack: Attack performed with power control, directing the ball to a vulnerable defensive location.
- Tipping: The ball is contacted at the bottom with the fingertips and directed to a vulnerable defensive site.

*Number of blockers.* Corresponds to the number of blockers that face the opposing attack. Thus, the following categories were obtained:

- No blocking (1x0): Corresponds to the absence of blockers due to the excellence of setting.
- Simple blocking (1x1): One-player blocking.
- Double broken blocking (1 + 1x1): Corresponds to an uncompact two-player blocking.
- Double compact blocking (2x1): Corresponds to a two-player blocking, being able to be compacted or not.
- Broken triple blocking (2 + 1x1): This corresponds to a three-player non-compacted blocking.
- Triple compact blocking (3x1): Corresponds to a three-player compacted blocking.
- No blocking due to the poor quality of the setting (1x0E): Corresponds to the absence of blockers due to the poor quality of the setting.
- Blocking touch: Corresponds to the attack where the ball touched the block. Thus, this variable is dichotomous, making it possible to identify whether or not the ball touched the blocking.

*Effect of the attack.* To analyze the effect of the attack the instrument was used proposed by Marcelino, Mesquita, and Sampaio (2011), obtaining the following categories:

- Error: Attacker failed by hitting the ball on the net, going out or there has been some infraction in the rules.
- Blocking: Attacker failed in attack due to the opponent's block.
- Defense: The attack action did not result in a terminal action and allowed the opposing counter-attack.
- Point: The attack resulted in a direct point.

## Data collection procedure

All games were recorded from top perspective, i.e. about 7-9 meters behind the court back line, and the camera was positioned approximately three meters above the ground level for better viewing of scenes. The observers were physical education professionals with at least five years of experience in the function of observational analyzers. For calculation of reliability, 20% of the actions were re-analyzed, exceeding the reference value of 10% (Tabachnick & Fidell, 2013). Cohen's Kappa values for both the inter- and intra-observer reliability were between 0.85 and 1.00, being higher than the reference value of 0.75 (Fleiss, 2003).

## Statistical procedures

Descriptive analysis was performed and, to identify how the setting location differed in relation to the ecological variables, the ANOVA was used to a factor, and the factor was the location of the setting. In addition, the multinomial logistic analysis was performed for the categorical variables, observing the relation of the independent variables with the dependent variable one-by-one. In this context, the effect of the attack was consid-

ered as the dependent variable and independent variables were the type of attack and blocking touch, since the attack tempo and the number of blockers had no association with the effect of the attack. In the treatment of the data the significance value of 5% ( $p \leq 0.05$ ) was adopted and the SPSS software version 20.0 was used.

## Results

The descriptive analysis of the ecological variables in relation to the location of settings execution is shown in Table 1. The one-way ANOVA showed the location of the setting differed in relation to the distance between the setter and the central attacker [ $F(4.763) = 30.903$ ;  $p < .001$ ], the distance between the setter and the central blocker [ $F(4.763) = 3.35$ ;  $p < .01$ ] and the distance between the setter and the blocker of position 4 [ $F(4.763) = 4.05$ ;  $p < .01$ ]. Tukey's *post-hoc* analysis showed that 1) when considering the distance between the setter and the central attacker: the settings for position 6 were different from the other locations, the settings for the central attacker differed from the settings for the opposite attacker and the settings for the opposite attacker differed from settings for the left side

Table 1. Descriptive analysis of the ecological variables regarding the setting place

Ecological variables	Setting location	N	%	Mean±SD
Distance between the setter and the central attacker *	Central	298	39%	0.53±1.94m
	Opposite	147	19%	2.05±1.46m
	Left side	233	30%	0.52±1.93m
	Back row (6)	62	8%	-0.71±1.72m
	Back row (1)	28	4%	1.25±1.97m
	Total	768	100%	0.75±1.98m
Distance between the setter and the central blocker *	Central	298	39%	1.16±0.72m
	Opposite	147	19%	1.36±0.74m
	Left side	233	30%	1.11±0.75m
	Back row (6)	62	8%	1.05±0.88m
	Back row (1)	28	4%	1.36±0.87m
	Total	768	100%	1.18±0.76m
Distance between the setter and the blocker of position 4*	Central	298	39%	-0.85±0.91m
	Opposite	147	19%	-0.67±0.88m
	Left side	233	30%	-0.80±0.96m
	Back row (6)	62	8%	-1.10±1.05m
	Back row (1)	28	4%	-0.34±1.25m
	Total	768	100%	-0.80±0.95m
Distance between the setter and the blocker of position 2*	Central	298	39%	3.71±0.84m
	Opposite	147	19%	3.68±0.91m
	Left side	233	30%	3.64±0.90m
	Back row (6)	62	8%	3.74±1.00m
	Back row (1)	28	4%	3.33±1.42m
	Total	768	100%	3.67±0.91m

Note. \*  $p < .05$ .

Table 2. Descriptive analysis of game procedures in relation to the effects of the attack

Game procedures			Effect of attack			Total	
			Error	Defense	Point		
Attack tempo	1 <sup>st</sup> tempo	Occurred	31	119	143	293	
		% Attack tempo	10.6%	40.6%	48.8%	100%	
	2 <sup>nd</sup> tempo	Occurred	62	192	221	475	
		% Attack tempo	13.1%	40.4%	46.5%	100%	
Type of attack	Powerful	Occurred	82	229	330	641	
		%Type of attack	12.8%	35.7%	51.5%	100%	
	Off-speed	Occurred	6	37	18	61	
		%Type of attack	9.8%	60.7%	29.5%	100%	
	Tipping	Occurred	5	45	16	66	
		%Type of attack	7.6%	68.2%	24.2%	100%	
Numbers of blockers	1 x 1	Occurred	25	83	107	215	
		% n° of blockers	11.6%	38.6%	49.8%	100%	
	1 x 1+1	Occurred	20	96	115	231	
		% n° of blockers	8.7%	41.6%	49.8%	100%	
	1 x 2	Occurred	46	128	127	301	
		% n° of blockers	15.3%	42.5%	42.2%	100%	
	1 x 2+1	Occurred	0	1	4	5	
		% n° of blockers	0.0%	20.0%	80.0%	100%	
	1 x 3	Occurred	0	0	1	1	
		% n° of blockers	0.0%	0.0%	100.0%	100%	
	1 x 0	Occurred	0	0	7	7	
		% n° of blockers	0.0%	0.0%	100.0%	100%	
	1 x 0E	Occurred	2	3	3	8	
		% n° of blockers	25.0%	37.5%	37.5%	100%	
	Blocking touch	Yes	Occurred	52	148	136	336
			% Blocking touch	15.5%	44.0%	40.5%	100%
No		Occurred	41	163	228	432	
		% Blocking touch	9.5%	37.7%	52.8%	100%	

Table 3. Predictive factors of the effects of the attack

Effect of attack <sup>a</sup>	N	%	p raw	OR raw	p adjusted	OR adjusted	CI 95% for OR		
							Lower limit	Upper limit	
Defense	Powerful attack	229	73.6%	0.017	0.310	0.025*	0.327	0.123	0.872
	Off-speed attack	37	11.9%	0.560	0.685	0.575	0.696	0.196	2.469
	Tipping <sup>b</sup>	45	14.5%						
	Blocking touch	148	47.6%	0.16	0.72	0.616	0.883	0.544	1.435
	No blocking touch <sup>b</sup>	163	52.4%						
Point	Powerful attack	330	90.7%	0.66	1.26	0.315	1.717	0.599	4.924
	Off-speed attack	18	4.9%	0.93	0.94	0.974	1.023	0.260	4.023
	Tipping <sup>b</sup>	16	4.4%						
	Blocking touch	136	37.4%	0.001	0.47	0.001*	0.440	0.274	0.707
	No blocking touch <sup>b</sup>	228	62.6%						

Note. <sup>a</sup> The reference category for the dependent variable is the attack error. <sup>b</sup> The reference category for the independent variable. \* p<.05.

attacker; 2) when considering the distance between the setter and the central blocker: the settings for the opposite attacker differed from the settings for the left side attacker; 3) when considering the distance between the setter and the blocker of position 4: the settings for the back row attacker of position 6 differed from the settings for the opposite and the back row attacker of position 1.

The descriptive analysis of game procedures, categorical variables, in relation to the effects of the attack, is represented in Table 2.

The analysis of the predictive factors of the effects of the attack was statistically significant ( $\chi^2=60.063$ ;  $p<.0001$ ), as shown in Table 3.

## Discussion and conclusions

The objectives of the present research were to identify how the ecological variables influence the setting, as well as the predictive factors of the effect of the attack when considering the confrontations between the teams ranked between the 1<sup>st</sup> and 4<sup>th</sup> place in the women's volleyball super league in Brazil. When analyzing the ecological variables, it was noticed that the location of the setting differed according to the distance between the setter and the central attacker, the distance between the setter and the central blocker, and the distance between the setter and the blocker of position 4. Thus, these results corroborate literature, assuming that ecological theory points out that perception regulates the action according to the information available in the environment (Davids, et al., 2015), as sports performance is understood as a dynamic and complex system (Davids, Araújo, Hristovski, Passos, & Chow, 2012). In this context, the situational constraints demand athletes' involvement in exploratory behaviors in order to seek and establish effective solutions to respond to the restrictions of competitive performance change (Davids, et al., 2012). In a general analysis, it was observed that the setters adopted setting strategy that forced the central blocker to move by greater displacements, fact that would make the adversary defensive organization difficult. In this way, it is observed that the setter's decision-making is based on the configuration of the blocking that, on the other hand, affects the conformation of the opposing defensive system (Denardi, et al., 2017; Marcelino, Afonso, Moraes, & Mesquita, 2014; Pinto, Vale, & Vicente, 2018). Thus, knowing that the blocking is a decisive skill for the victory in volleyball (Oliveira, Valladares, Vaz, & João, 2016; Peña & Casals, 2016), setters make decisions based on situational constraints, a fact that leaves the setting unpredictable. Notwithstanding, other variables may influence the setter's decision, such as the attacker quality, but this variable was not in focus in this research. As a practical implication, in relation to the distance of the central attacker, it was noted, for example,

that the setting for the back row attacker of position 6 occurred when the central attacker performed a running for the back 1<sup>st</sup> tempo ball or slide, setting that occurred behind the setter, as well as the setting for the opposite attacker occurred when the central attacker was distant and in front of the setter in a play named inside shoot. In addition, when the central attacker was close to the setter, the settings were for the central or for the left site attacker, differing from the settings performed for the opposite. In this bias, when considering the distance between the setter and the blockers, it was observed that when the central blocker was in front of the setter, it was chosen to set the ball to the opposite and when the blocker of position 4 was close to the setter, suggesting that the blocker would help in blocking the attack performed by the central attacker, it was chosen to set for the opposite attacker in positions 1 or 2.

The descriptive analysis of the categorical variables showed that the use of the second attack tempo, double blocking, powerful attack and the attack where the ball did not touch the blocking were more frequent. These results corroborate the literature that shows the highest occurrence of the 2<sup>nd</sup> attack tempo (Costa, et al., 2016a, 2016b, 2017b; Conti, et al., 2018; Palao, Santos, & Ureña, 2007) and double blocking (Ramos, et al., 2017). The analysis of the predictive factors of the effect of the attack showed that the powerful attack reduces the chances of defense (adjusted OR: 0.327). These results corroborate the study by Costa et al. (2017b) that demonstrated the reduction of continuity of game after powerful attacks. However, the results disagree with the study by Conti et al. (2018) who observed an increase in the chances of continuity after powerful attack, specifically when it occurred at position 1. Although there are differences in the predictive factors pointed out in the present research, it is observed that this fact can be related with the specific analysis of the mentioned articles, since they analyzed the attacks performed at positions 4, 2 and 1 of men's super league. In disagreement with the literature, it was observed that the attack tempo and the powerful attack were not shown as predictive factors of the point of attack. The literature shows that the 1<sup>st</sup> and 2<sup>nd</sup> attack tempo and powerful attacks predict the point of attack (Costa, Afonso, Barbosa, Coutinho, & Mesquita, 2014; Costa, et al., 2017b; Stutzig, Zimmermann, Busch, & Siebert, 2015). Probably, this difference was due to the need of playing with fast balls when facing high quality teams. As in this study, we observed only the confrontations between the four best teams of the championship, playing fast from receptions that allow organized attack with all options of attack and attacking with power were essential factors and were not performance differentiators. It is known that the game played in women's volleyball is of

the sustaining type, that is, constituted by a greater amount of defense than the game played in men's volleyball (Costa, et al., 2017a; Costa & Freire, 2017; Mesquita, et al., 2013), it can be suggested that the attacks performed with power aim, initially, at the conquest of the point and, in case this does not occur, it may achieve the limitation of the offensive construction.

Another predictive factor of the effect of the attack was the blocking touch, and there is a reduction in the chances of scoring when the ball touches the blocking (adjusted OR:0.440). These results are in agreement with the literature since the blocking and defense skills are predictive factors of the victory in the game (García-de-Alcaraz, et al., 2015; Oliveira, et al., 2016). In this bias, when the blocking touches the attacked ball, it is easier to set the defense, due to the reduction of attack power, as well as the possibility of the blocking directly score; therefore those factors are predictive of the victory of the game (Oliveira, et al., 2016).

The results of the present research suggest that the decision-making for the setting action, by receptions that allow the organized attack with all actors,

is based on the availability of the central attacker for attacking and on the configuration of the blocking, as the setters adopted setting strategies that force the central blocker to move out by greater displacements. It was also observed, in relation to the predictive factors of the effect of the attack, that the powerful attack reduces the chances of defense and the blocking touch reduces the chances of scoring by the attack. Although the objective of this study was limited to investigating the predictive factors of the effect of the attack and how the ecological variables influence the setting, it is hoped that the results found may contribute to a better understanding of volleyball teams' success. In addition, this study has, as a practical implication, the possibility of understanding tactical strategies of setting used in the confrontation of the high level teams of the Brazilian super league, allowing, from this knowledge, new tactical configurations seeking the unpredictability in the setting. As a suggestion for future research, one must investigate whether such evidence exists in male volleyball and in international high-level volleyball competitions.

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