DETERMINANTS OF ATTACK PLAYERS IN HIGH-LEVEL MEN'S VOLLEYBALL

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Abstract:

This study aims at analysing probabilistic relationships predicting the outcomes relating to attack players in elite-level men's volleyball. Nineteen matches from the 2006 Men's World Championships were notated and the tactical indicators regarded the space-, task-, player- and efficacy-related dimensions of selected game actions (*reception, set* and *attack*) played in side-out. A multinomial logistic regression was applied, with the level of significance determined at .05. Results showed that the most relevant cues for predicting the selected attack player were related with aspects of setting (setting zone, setter position, setter type), positioning of the middle player and reception player. Overall, the selection of the attack player is highly predictable and can be anticipated through analysing a number of visual cues previous to the attack. Knowing such patterns will enhance the rate of success of the defending teams, while the attacking teams should try to create strategies of using each set of game constraints in different manners, thus diminishing the possibilities of the opponents to anticipate their actions.

Key words: performance analysis, predictive models, game patterns

Introduction

Knowledge of game patterns and situational probabilities affords preparing an accurate match plan, but also designing training programmes that better prepare the players for competing at high levels of performance (Sampaio, Janeira, Ibanez, & Lorenzo, 2006). For achieving high-level performance, a team has to be properly attuned to the affordances provided by the medium (Anson, Elliott, & Davids, 2005; Passos, et al., 2008) including a calibrated perception of a set of constraints that are individual-, environmental-, and task-related (Newell, 1986). In general, coaches of team sports assume a core role in manipulating task constraints (Cordovil, et al., 2009; Resch, May, Tomporowski, & Ferrara, 2007). In order to do so in a meaningful, task-specific manner, they must be knowledgeable of the reality of the game, which then allows them to build adjusted game models (Lames, 2003). In volleyball, these game models must fit into the two major game complexes: a) complex I, or side-out, which is the attack after serve-reception and presents more predictable initial conditions, and usually affords more structured attack sequences; and b) complex II, or transition, which is basically the counter-attack and usually assumes less structured and slower plays due to more variable initial conditions (Marcelino, César, Afonso, & Mesquita, 2008).

In men's volleyball, the attack is the deciding factor of a match (Marcelino, Mesquita, & Afonso, 2008), and is particularly determinant for success in the side-out phase at elite-level competition (Zetou, Moustakidis, Tsigilis & Komninakidou, 2007). Research on top-level men's volleyball has used mainly binary statistics (i.e. restricting the analysis to two variables each time), and has shown association between attack efficacy and: i) setter zone combined with attack tempo (Bergeles & Nikolaidou, 2011), ii) dig efficacy (Monteiro, Mesquita, & Marcelino, 2009), iii) attack tempo combined with attack type (Castro, Souza, & Mesquita, 2011; Marcelino, César, et al., 2008), iv) block cohesiveness (Afonso & Mesquita, 2011), and v) reception efficacy (Lobietti, Cabrini, & Brunetti, 2009). These studies contributed to achieving a better understanding of the game actions affecting the attack, therefore providing powerful insights into the comprehension of the game with the final target to regulate training processes more efficiently.

Nonetheless, and taking into account the dynamic nature of the game, the lens of analysis should consider the interaction between different game actions, thus respecting a non-linear approach to the phenomena (Hale, 2001). Indeed, sport performance analysis research (Hughes & Bartlett, 2002) has shown that game performance occurs under dynamical and interactive conditions that are both time- and context-dependent (McGarry, Anderson, Wallace, Hughes, & Franks, 2002; McGarry, O'Donoghue, & Sampaio, 2013). Within the game of volleyball, it is possible to consider performance indicators related with the attack that are: space-, task-, player- and efficacy-related (Marcelino, Mesquita, & Sampaio, 2011; Marcelino, Sampaio, & Mesquita, 2012; Mesquita, Palao, Marcelino, & Afonso, 2013). These indicators influence each other and allow predicting attack features, highlighting a relatively deterministic game logic that should be identified in order to provide indications to practice (Marcelino, Mesquita, Palao, & Sampaio, 2009; Marcelino, et al., 2011).

To our knowledge, up to now, few studies have applied dynamic models such as multinomial logistic regression (Afonso & Mesquita, 2011; Marcelino, Mesquita, Castro, & Sampaio, 2008; Marcelino, et al., 2011; Marcelino, et al., 2012). Researchers found a significant dependency in setter space-to-attack space and in setter space-to-attack performance, when analysing the nature and degree of relationship in first- and second-order sequential events in volleyball attack performance (Afonso & Mesquita, 2011; Marcelino, Mesquita, Castro, et al., 2008). These results showed that the efficacy of the attack is highly dependent on the features of each team, as well as on the in-game role of the attack player. In the context of team sports, volleyball presents a relatively deterministic structure, mainly derived from rules that impede invading the opponent's court and that regulate the number of contacts per player and per team in each ball possession (Marcelino, et al., 2012). As such, it is expectable that certain strong relationships between several game variables are found, affording the construction of models capable of predicting performance.

Thus, it is estimated that the identification of game characteristics, specifically within the context of side-out in the current research, makes it possible to predict which attack player will be selected for attack, and that it also provides unfolding relevant game patterns. Within this framework, it should be recognized that expertise is task- and function-specific (Williams, et al., 2008). Since players have distinct specializations and roles, their familiarity with each spatial zone and the functional relationship they establish with it may differ greatly. As such, it is relevant to analyse the players that produce the attack, considering their in-game role: opposite, left side hitter and middle player. The opposite hitter is the attacker playing opposite to the setter (e.g. if the setter is in zone 1 – the right backcourt area, the opposite hitter will be in zone 4 – the left frontcourt area). He mostly attacks in zones 1 and 2 (the right frontcourt area). The left side hitters commonly hit from zones 4 and 6 (the centre backcourt area). Finally, the middle hitters mainly attack in zone 3 (the centre frontcourt area).

The purpose of this study was, therefore, to assess the effects of some technical and tactical indicators related to space, task, players and efficacy, and regarding the attack players in side-out situations.

Methods

Sample

Nineteen matches (corresponding to thirty-four game sets) played between the first ten ranked teams (BRA, POL, BUL, SCG, ITA, FRA, RUS, JPN, GER, USA; order here by the final ranking in the competition) in the Fédération Internationale de Volleyball (FIVB) 2006 Men's World Championships were sampled. The matches played against the last teams were not analysed to ensure the homogeneity in the competitive level of all the analysed teams. Thereby, this study focused on the matches between high-level teams and high-quality opponents. From the 1,698 observed game sequences (consisting of serve, reception, set and attack played sequentially), 1,314 were analysed, corresponding to game sequences that culminated with an attack. The remaining (354) game sequences resulted in errors in reception (335) and setting (19), and were not considered in the analysis. To ensure an equal representation of the ten analysed teams, four matches of each team were sampled, with the exception of the Russian and German teams, with three matches sampled. The Ethics Committee at the Centre of Research, Education, Innovation and Intervention in Sport of University of Porto provided institutional approval for this study.

Variables

The tactical indicators used were dimensions of space (*setting zone, positioning of the middle player, setter position, reception zone)*, task (*setter type*), player (*reception player*) and efficacy (*reception efficacy*) of the selected game actions, played in side-out, i.e. first offensive organization after serve (Table 1).

The attack players were defined as regards the spatial and functional position occupied in relation to the setter: opposite hitter (OH), left side hitter near to the setter (LSH-1), left side hitter far from the setter (LSH-2), middle hitter near to the setter (MH-1), and middle hitter far from the setter (MH-2).

Table 1. Distributions of relative frequencies from the studied variables

Performance indicators	Frequency (n=1,314)	Percentage (%)
Space-related		
Setting zone[1]		
ESZ	1001	76.2
PSZ	217	16.5
ASZ	96	7.3
Positioning of the middle player		
NS-WB	786	59.8
FS-WB	215	16.4
NBM	192	14.6
FS-NB	63	4.8
NS-NB	58	4.4
Setter position		
Defensive	691	52.6
Offensive	623	47.4
Reception zone[2]		
Z1	559	42.5
Z2	460	35.0
Z3	233	17.7
Z4	62	4.7
Task-related		
Setter type		
Jump set	1108	84.3
Regular set	137	10.4
Resource	68	5.2
Player-related		
Reception player		
Libero	455	34.6
LSH-1 defensive	262	19.9
LSH-2 defensive	228	17.4
LSH-2 offensive	179	13.6
LSH-1 offensive	163	12.4
Efficacy-related		
Reception Efficacy		
Perfect	1013	77.1
Continuity 2	195	14.8
Continuity 1	106	8.1
Attack Player		
OH	417	31.7
LSH-1	299	22.8
LSH-2	283	21.5
MH-2	177	13.5
MH-1	138	10.5

Legend: [1] – According to Castro & Mesquita (2010). [2] – According to Afonso et al. (2010)
NS-WB: near to the setter and with block; NS-NB: near to the setter without (No) block; FS-NB: far from the setter without (No) block); FS-WB: far from the setter with block; NBM: without (No) block marking; ESZ: excellent setting zone; ASZ: acceptable setting zone; PSZ: not acceptable setting zone.

Procedures

All matches were video recorded, by a camera positioned approximately five metres above the playing field and approximately 20 metres back from the edge of the field, parallel with the baseline. Two previously trained operators performed data observation and registration in the computerized notational analysis system (VROS – Volleyball Rally Observation System) (Marcelino, et al., 2011). Each operator analysed a minimum of fourteen games and a maximum of eighteen games.

Reliability testing

Data reliability was assessed through intra- and inter-observer testing procedures (Atkinson & Nevill, 1998). Following a 3-week period, to prevent any learning effect, each team has reanalysed one random game. For inter-observer reliability testing, each team observed one game previously analysed by another observation team. Intra- and inter-observer agreements were assessed via the percentage error method (Hughes, Cooper, & Nevill, 2004) and all data was within acceptable levels (i.e. <5% error).

Data analysis

A multinomial logistic regression was used to evaluate the association between some tactical indicators and attack player. In this non-linear model of regression the estimated regression coefficients represent the estimated change in the log-odds, corresponding to a unit change in the corresponding explanatory variable conditional with the other explanatory variables remaining constant (Landau & Everitt, 2004). In the first procedure, the tactical indicators were tested one by one. Secondly, the adjusted model was performed with all variables, which in isolation showed some *attack player* relation (Landau & Everitt, 2004). Odds ratios (OR) and their 95% confidence intervals (CI) were calculated and adjusted for attack player. A total of 250 models were designed in order to fit all possibilities. All attack players' categories (OH, LSH-1, LSH-2, MH-1, and MH-2) were tested as the reference category for all independent variables. The tactical indicators were coded in order to allow interpretation of all possible intra-category relations. Analyses were performed using the statistical program IBM SPSS Statistics for Windows, version 19.0 (IBM Corporation, USA), and statistical significance was set at p<.05.

Results

Table 1 presents the frequencies and percentages of all variables' categories. The results identify that the OH is the most solicited attack player, followed by LSH-1, LSH-2, and, finally, middle players.

Table 2. Model and fit information for the frequency of technical and tactical indicators according to attack players

Variables		Likelihood Ratio Tests			Adjusted Model Likelihood Ratio Tests		
		χ^2	df	p	χ^2	df	p
Space	Setting zone	78.95	8	.000	22.16	8	.005
	Positioning of the middle-player	101.38	16	.00	30.62	16	.015
	Setter position	58.62	4	.000	55.00	4	.000
	Reception zone	9.55	12	.655			
Task	Setter type	43.04	8	.000	23.88	8	.002
Players	Reception player	195.72	16	.000	189.87	16	.000
Efficacy	Reception efficacy	47.93	8	.000	4.85	8	.774
Adjusted model					400.50	60	.000

Table 2 presents the model and fit information concerning the frequency of tactical indicators according to attack players. At the first stage, when the models of the multinomial logistic regression were computed with one variable at each time, the results showed that there were associations between *attack player* and *setting zone, positioning of the middle player, setter position, setter type, reception player* and *receptions efficacy.* The likelihood ratio tests (LRT) showed that the variable *reception zone* was independent of *attack player.*

At the second stage, the performed adjusted model fitted well when only the variables that showed relation with attack player (LRT=400.50, p=.000) were included. With the exception of *reception efficacy* (LRT=4.849, p=.774), all other variables exhibited a relationship with the *attack player* in the adjusted model.

Due to the large amount of data, only the results with statistical significance (p<.05) will be presented. Relationship between all categories of the dependent variable are presented in Tables 3 and 4, and emerge ordered first by level of significance and followed by odds ratios (OR), in order to estimate the odds of a specific tactical indicator occurring in association with one attack player (OH), compared to the odds of the same event happening in association with another attack player (LSH-1). Table 3 shows the relationships of players with MH-2; Table 4 shows the relationships of players with OH, LSH-1 and LSH-2.

The results have shown that when the attack was made by the opposite hitter (OH), in comparison with the MH-2, the *acceptable setting zone* (ASZ) was more frequent than *excellent setting zone* (OR=5.4) and *not acceptable setting zone* (OR=4.1). The OH attacked more often when the setter was in offensive position (OR=2.6) and made a regular (OR=31.5) or jump setting (OR=14.0) instead of a resource setting. When the services were received by the *libero*, instead of both LSH players,

the MH-2 was the player with a higher probability of attack (Table 3).

MH-1 attacked more frequently than OH when the set was made in the *excellent setting zone* than in the *acceptable setting zone* (OR=5.6), when the setter was in offensive position (OR=2.3) and made the setting in a resource situation (OR=4.8). The probability of the attack being carried out by LSH-1, LSH-2 and MH-1 instead of OH was conditioned by the reception player at several levels (Table 4).

MH-1 attacked more often than LSH-1 when the set was made in the *excellent setting zone* than in the *not acceptable setting zone* (OR=2.8), and when there was no block marking (NBM) either near to (OR=11.8) or far from the setter (OR=10.5 – with block; OR=8.2 – without block). The reception players also showed to interfere in the likelihood of the attack being carried out by MH-1, LSH-1 or LSH-2 (Table 4).

With regard to *positioning of the middle player*, results presented in Table 3 and 4 showed that when the attack was made without block marking (NBM), it was more likely that players other than the middle players would make it.

Discussion and conclusions

The aim of this study was to analyse probabilistic relationships predictive of certain outcomes relating to attack players in elite-level men's volleyball. The results revealed that the analysed teams presented very high levels of reception quality (77.1% perfect), with the libero player being the most solicited (34.6%). This player is specialized in performing the first contact, and therefore tends to cover a greater area in the court, assuming the responsibility for more reception space than other players, hence enhancing the likelihood of contacting the served ball (Mesquita, Manso, & Palao, 2007). Coherent with a good quality of the first contact, the setter was found to perform the set in the excellent zone around 76% of the times, mostly

Table 3. Multinomial logistic regression of technical and tactical indicators and attack player

	OR (95% CI)
OH vs MH-2	
Setting zone	
ASZ vs ESZ	5.4 (1.61-18.35)**
ASZ vs PSZ	4.1 (1.01-16.89)*
Setter position	
Offensive vs defensive	2.6 (1.70-3.84)***
Setter type	
Regular vs resource	31.5 (5.61-176.51)***
Jump vs resource	14.0 (3.26-59.98)***
Reception player	
LSH-1-Def vs libero	3.3 (1.82-6.10)***
LSH-1-Def vs LSH-2-Def	3.3 (1.70-6.54)***
LSH-1-Def vs LSH-1-Off	3.2 (1.57-6.63)**
LSH-2-Off vs libero	2.5 (1.32-4.87)**
LSH-2-Off vs LSH-1-Off	2.5 (1.45-5.28)*
LSH-2-Off vs LSH-2-Def	2.5 (1.24-5.23)*
Positioning of the middle-player	
NBM vs NS-WB	13.0 (1.92-87.89)**
NBM vs FS-WB	12.1 (1.74-84.40)*
NBM vs NS-NB	10.4 (1.36-80.04)*
LSH-1 vs MH-2	
Setting zone	
ASZ vs ESZ	4.4 (1.27-15.48)*
Setter position	
Offensive vs defensive	3.3 (2.16-5.03)***
Setter type	
Regular vs Resource	11.32 (1.96-65.25)**
Jump vs Resource	7.6 (1.70-33.51)**
Positioning of the middle player	
NBM vs FS-WB	13.2 (1.83-94.78)*
NBM vs NS-NB	13.0 (1.60-105.28)*
NBM vs NS-WB	12.9 (1.84-89.57)*
LSH-2 vs MH-2	
Setting zone	
ASZ vs ESZ	4.4 (1.22-15.76)*
Setter position	
Offensive vs defensive	2.4 (1.56-3.80)***
Setter type	
Regular vs Resource	10.4 (1.88-57.58)**
Reception player	
LSH-1-Def vs LSH-2-Def	28.8 (11.54-71.93)***
LSH-2-Off vs LSH-2-Def	24.3 (9.40-62.61)***
LSH-1-Def vs LSH-1-Off	12.9 (5.44-30.47)***
LSH-2-Off vs LSH-1-Off	10.8 (4.43-26.55)***
Libero vs LSH-2-Def	7.2 (3.21-16.12)***
LSH-1-Def vs libero	4.0 (2.17-7.38)***
LSH-2-Off vs libero	3.4 (1.75-6.48)***
Libero vs LSH-1-Off	3.2 (1.52-6.79)**
Positioning of the middle player	
NBM vs NS-NB	20.5 (2.45-171.50)**
NBM vs FS-WB	14.9 (2.07-106.92)**
NBM vs NS-WB	11.5 (1.67-78.99)**
MH-1 vs MH-2	
Setter position	
Offensive vs defensive	5.8 (3.46-9.70)***
Reception player	
LSH-1-Def vs LSH-1-Off	9.6 (3.79-24.38)***
LSH-1-Def vs LSH-2-Def	9.1 (3.97-20.76)***
LSH-2-Off vs LSH-1-Off	7.2 (2.67-19.40)***
LSH-2-Off vs LSH-2-Def	6.8 (2.77-16.34)***
LSH-1-Def vs libero	5.2 (2.78-10.48)***
LSH-2-Off vs libero	3.9 (1.80-8.44)**

Table 4. Multinomial logistic regression of technical and tactical indicators and attack player (Cont)

	OR (95% CI)
MH-1 vs OH	
Setting zone	
ESZ vs ASZ	5.6 (1.30-24.17)*
Positioning of the middle player	
NS-WB vs NBM	11.9 (2.09-68.08)**
FS-WB vs NBM	9.6 (1.61-57.36)*
FS-NB vs NBM	9.8 (1.44-66.28)*
Setter position	
Offensive vs defensive	2.3 (1.48-3.50)***
Setter type	
Resource vs jump	4.8 (1.05-22.14)*
LSH-1 vs OH	
Reception player	
LSH-1-Off vs LSH-2-Off	3.5 (1.80-6.89)***
LSH-1-Off vs LSH-1-Def	3.4 (1.90-6.06)***
Libero vs LSH-2-Off	3.0 (1.66-5.51)***
Libero vs LSH-1-Def	2.9 (1.75-4.81)***
LSH-2-Def vs LSH-1-Def	2.8 (1.60-4.76)***
LSH-2-Def vs LSH-2-Off	2.9 (1.51-5.43)**
LSH-2 vs OH	
Reception player	
LSH-2-Off vs LSH-2-Def	9.7 (4.41-21-35)***
LSH-1-Def vs LSH-2-Def	8.7 (4.05-18.54)***
Libero vs LSH-2-Def	7.3 (3.48-15.35)***
LSH-2-Def vs LSH-1-Off	4.3 (2.11-8.89)***
LSH-1-Def vs LSH-1-Off	3.9 (1.95-7.70)***
Libero vs LSH-1-Off	3.3 (1.68-6.37)**
Setter type	
Resource vs jump	3.7 (1.36-9.98)**
MH-1 vs OH	
Reception player	
LSH-1-Def vs LSH-1-Off	2.9 (1.34-6.36)**
LSH-1-Def vs LSH-2-Def	2.7 (1.41-5.27)**
LSH-2-Off vs LSH-2-Def	2.7 (1.29-5.61)**
LSH-2-Off vs LSH-1-Off	2.9 (1.23-6.69)*
MH-1 vs LSH-1	
Setting zone	
ESZ vs PSZ	2.8 (1.08-7.39)*
Positioning of the middle player	
NS-WB vs NBM	11.8 (1.98-70.36)**
FS-WB vs NBM	10.5 (1.67-65.43)*
FS-NB vs NBM	8.2 (1.14-58.62)*
Setter position	
Defensive vs offensive	1.8 (1.11-2.78)*
Reception player	
LSH-2-Off vs LSH-1-Off	10.1 (4.00-25.66)***
LSH-1-Def vs LSH-1-Off	10.0 (4.33-22.92)***
LSH-2-Off vs LSH-2-Def	7.8 (3.35-17.96)***
LSH-1-Def vs LSH-2-Def	7.6 (3.66-15.88)***
LSH-2-Off vs Libero	4.7 (2.24-9.81)***
LSH-1-Def vs Libero	4.6 (2.47-8.58)***
Libero vs LSH-1-Off	2.2 (1.02-4.61)*
LSH-2 vs LSH-1	
Reception player	
LSH-2-Off vs LSH-2-Def	27.7 (11.38-67.44)***
LSH-1-Def vs LSH-2-Def	24.2 (10.53-55.31)***
LSH-2-Off vs LSH-1-Off	15.3 (6.73-34.70)***
LSH-1-Def vs LSH-1-Off	13.3 (6.28-28.29)***
Libero vs LSH-2-Def	6.8 (3.23-14.40)***
LSH-2-Off vs Libero	4.1 (2.22-7.45)***
Libero vs LSH-1-Off	3.8 (1.94-7.31)***
LSH-1-Def vs Libero	3.6 (2.12-5.94)***
MH-1 vs LSH-2	
Positioning of the middle player	
FS-WB vs NBM	11.8 (1.93-72.49)**
NS-WB vs NBM	10.5 (1.82-61.09)**
NS-NB vs NBM	11.7 (1.42-96.69)*
FS-NB vs NBM	10.0 (1.42-70.68)*
Reception player	
LSH-2-Def vs LSH-2-Off	4.1 (1.68-10.07)**
LSH-2-Def vs LSH-2-Off	3.6 (1.37-9.31)**
LSH-2-Def vs LSH-1-Def	3.2 (1.28-7.84)*

* p<.05, ** p<.01, *** p<.001; CI, confidence intervals; OR, odds ratio. NS-WB: near to the setter and with block; NS-NB: near to the setter without (No) block; FS-NB: far from the setter without (No) block; FS-WB: far from the setter with block; NBM: without (No) block marking; ESZ: excellent setting zone; ASZ: acceptable setting zone; PSZ: not acceptable setting zone; Off: offensive zone; Def: defensive zone

* p<.05, ** p<.01, *** p<.001; CI, confidence intervals; OR, odds ratio. NS-WB: near to the setter and with block; NS-NB: near to the setter without (No) block; FS-NB: far from the setter without (No) block; FS-WB: far from the setter with block; NBM: without (No) block marking; ESZ: excellent setting zone; ASZ: acceptable setting zone; PSZ: not acceptable setting zone; Off: offensive zone; Def: defensive zone

using the jump set; consequently allowing middle hitters to be available to perform quick attacks in roughly 85% of the game actions. Typically, elite-level men's teams present good values of reception efficacy, allowing setters to play from a vantage point and thus build complex and quick-attack-plays when in side-out (Lobietti, et al., 2009; Zetou, et al., 2007).

It should be noted that in almost 60% of the game actions the MH moved near to the setter, as opposed to only 16.4% of movements away from the setter. This differs greatly from the results found in elite-level women's teams, where there is a balanced distribution of movements toward, away, and behind the setter (Afonso & Mesquita, 2011). This may be explained by the fact that the nearness of the middle player to the setter allows the latter to control the block better and therefore choose the setting for the attacker (e.g. if the blocker is right in front of the attacker, the setter may choose to play the ball to the attacker's left shoulder, allowing him to spike without opposition). At the same time this also creates increased uncertainty to the opponent's block, since it affords the other players better conditions to perform their attacks; namely, the fixation of the middle blocker in the centre of the net prevents this player to assist a block in the extremities of the net.

The final predictive model showed that the choice of an attack player was conditioned by setting zone, middle player's positioning, setter position, setter type, and reception player (Table 2). Furthermore, the independency of reception zone and reception efficacy with regard to the attack player permits the functional space of the attack in top-level men's volleyball to be increasingly large, not directly depending on the reception zone and efficacy. The setters at this level are able to transform adverse attack situations to favourable situations, and this is demonstrative of a sound technical-tactical ability of the setter and attackers to generate optimized conditions of attack (Afonso, Mesquita, Marcelino, & Silva, 2010; Palao, Santos, & Ureña, 2004, 2005). Hence, in top-level men's volleyball the setters are capable of applying a broad range of strategies, therefore diversifying the team's attack patterns (Marcelino, et al., 2012). Volleyball teams have created mechanisms for improving their attack options even under far-from-optimal conditions (Marcelino, et al., 2012). This induces profound changes in the concept of ideal conditions for attacking, since teams are now able to promote quick and combined attacks under a wider range of situations.

However, the *reception player* interferes with the choice of the attack player, implying that performing the task of serve-reception may alter the solicitation of the attackers. The specific information regarding such relationships may assist teams

in delineating tactical plans for serving. The relative deterministic functionality of the game of volleyball may partly explain some of these strong relationships, through impositions of the rules concerning the relative positions of players on the court before a serve is performed. It is therefore apparent that the receiver affords predicting regularities of solicitation of the left-side attackers (LSH1 and LSH2). Indeed, previous accounts referred to the possible interference of double-task (i.e. attack after reception) in the selection of the attack player (Broglio, Tomporowski, & Ferrara, 2005; Resch, et al., 2011; Sibley & Etnier, 2004). Furthermore, the MH-2 attacked more often when the libero received the ball, which is expectable, since the libero tends to present better performance in reception and MH-2, being the second quick attacker, is usually is not so versatile as the MH-1 and hence requires better conditions to attack. These evidences emphasize the team's ability in optimizing their resources, both defensively and offensively, in attempting to generate better conditions for the attack.

The *setting zone* also showed to predict the player performing the attack; namely, MHs tended to attack more often when the set was made in the excellent setting zone, while the opposite player did so when the set was performed in the acceptable setting zone. As the MH usually attacks quick sets, there is a theoretical need for a better reception quality for the setter to activate this attacker. This is consistent with their current role in high-level men's volleyball, with the MHs being determinant in the execution of quick attacks and in the creation of opportunities for attack combinations; otherwise, the opposite player is a security player, having to present a balance between scoring points and providing a solid resource to attack under more difficult situations (Castro, et al., 2011). Furthermore, when the setting occurs in the acceptable setting zone, it is still possible for the setter to activate the MHs, hence affording a more advantageous condition for the opposite player to attack. These data suggest there is a strong dependency between the setter's intervention space and the team's strategic options. As such, teams should create a wide variety of attack options for being less predictable or reliant upon the setter's intervention space. Through creating a manifold of attack options even when under sub-optimal conditions, setters will be able to unbalance the opponent's blocking and defence (Afonso, et al., 2005; Mesquita & Graça, 2002), due to producing enhanced uncertainty.

Finally, the blocking strategy of the opposing team showed to be highly dependent on the positioning of middle hitters, as their first priority, regarding a reception of good quality, is to mark these attackers. Therefore, MHs are players of considerable strategic relevancy, using their actions to provide their setters with quicker and better attack

options, and consequently aiding the other attackers to make their actions against weaker opposition (Afonso & Mesquita, 2011). Therefore, optimizing attack options is highly dependent on the tactical-strategic ability of middle hitters and of their spatial and temporal relationship with the setter. Team sports may be conceptualized as dynamic systems (McGarry, et al., 2013; Passos, et al., 2008); in this context, the actions of middle attackers seem to play a pivotal role in changing the nature of emergent game patterns.

The selection of the attack player showed to be highly predictable and can be anticipated through analysing a number of visual cues previous to the attack. Namely, an interaction between setting zone, position and type, as well as the reception player and the positioning of the MH make it possible to predict which player will be solicited to perform the attack. The selection of the attack player suggests that he has distinct strategic functions (e.g. the middle players destabilize the opponent's block), and these resources were used in accordance with the characteristics of team rotation. Knowing such patterns will enhance the rate of success of the defending teams, while the attacking teams should try to create strategies of using each set of game constraints in different manners, thus diminishing the possibilities of the opponents to anticipate their actions. In sum, our study suggests that in volleyball the attacker is dependent on the interaction of several technical and tactical indicators that change the teams' strategies, thus providing a deeper understanding of game performance and new insights for practice, competition, and research.

Future studies should investigate the attack options generated by the teams while relating them with the conditions of opposition created by an adversary, namely the creation of numerically favourable confrontations between the attack and the block. Also, new explorations should focus on analysing if the results of the present study have equivalence in more recent competitions. In other words, it would be interesting to find out if the team's strategies concerning the choice of the attack player have changed with time and/or in different competition's profiles (i.e. Olympic Games, World League, World Cups, etc.).

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