Rev Bras Cineantropom Hum

original article

DOI: http://dx.doi.org/10.5007/1980-0037.2017v19n1p74

Factors associated to performance efficacy of technical-tactical actions in volleyball

Fatores associados à eficácia no desempenho das ações técnico-táticas do voleibol

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Abstract – The aim of the study was to investigate the factors associated to performance efficacy of technical-tactical actions in volleyball. Based on the protocol of the Instrument for Technical and Tactical Performance Assessment in Volleyball (IAD-VB), 44.025 match actions performed by male and female athletes from u-15, u-16 and u-17 finalist teams of the 2010 Santa Catarina Volleyball Championship in Brazil were observed. Data were analyzed on SPPS 21 software using the logistic regression technique, adopting 5% significance level for the interpretation of results. Adjusted model explained 51.40% efficacy variance, and the factors associated with this variable were decision making, adjustment, efficiency, and competition level.

Key words: Observation; Regression analysis; Sport performance; Volleyball.

Resumo – *O objetivo do estudo foi investigar os fatores associados à eficácia no desempenho das ações técnico-táticas do voleibol. Com base no protocolo do Instrumento de Avaliação do Desempenho Técnico-Tático do Voleibol (IAD-VB), observaram-se 44.025 ações de jogo desempenhadas por atletas de equipes finalistas do Campeonato Catarinense de Voleibol de 2010, nas categorias mirim (sub-15 anos), infantil (sub-16) e infanto-juvenil (sub-17), nos naipes masculino e feminino. Os dados foram analisados no programa SPSS 21 a partir da técnica de regressão logística binária, adotando-se nível de 5% de significância para a interpretação dos resultados. O modelo ajustado explicou 51,40% da variância da eficácia, e os fatores associados a esta variável foram a tomada de decisão, o ajustamento a eficiência e a categoria de disputa.*

Palavras-chave: *Análise de regressão; Desempenho Esportivo; Observação; Voleibol.*

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Received: 04 March 2016
Accepted: 18 December 2016

INTRODUCTION

The evaluation of the technical-tactical performance of athletes in team sports, although being a complex task due to the random and dynamic characteristics of such sports[1,2], becomes important in the sense of identifying the potentialities and weakness of players in training and competition situations. Specifically in competitions, the comparison of results of athletes of the same team or of distinct participating teams allows the reorganization of teaching-learning-training activities in function of the individual and collective characteristics presented in the game[3], and contributes to stimulate the learning process[4].

The technical gesture used in the execution of a particular skill or game action is conditioned by the momentary and unpredictable tactic of the game[5], and materializes in the sports teams under the form of defensive and offensive actions, both individual and collective. In this way, the process of evaluating sports performance should always take into account the multidimensionality in the domain of skills, addressing not only aspects related to know-how (efficiency) and achievement of results according to the action purposes (efficacy), but also the cognitive-motor ability to adjust the dynamics of movements to the game scene (adjustment to situations and decision making), which is determinant for the technical-tactical performance in team sports[6].

Supported on increasingly robust theoretical bases and on the advancement of technological resources, game analysis has progressively sought to predict and contextualize athletes' behaviors in real game / competition situations. This becomes possible from the understanding of the game as a complex system of random and dynamic relationships, which triggers multiple problem situations that influence athletes' performance[7,8].

In volleyball, technical-tactical performance components (adjustment, decision making, efficiency and efficacy) are in constant interaction, considering that the actions of this sport are highly linked and interdependent due to the impossibility of retaining the ball and the limited number of contact with the ball in each play[5]. In fact, the result (efficacy) of each technical-tactical action performed is influenced both by the outcome of previous actions and by the athlete's behavior in the present moment, also contributing to influence the subsequent actions[9-11], or even to determine score / loss during the game.

In order to overcome the simple description of the level of efficacy of athletes in games, it is necessary to evaluate it in a more thorough way, articulating it with the other performance components and with other factors that may be associated to its interpretation. In this way, the present study aims to investigate the factors associated with the efficacy of athletes of volleyball training categories in the performance of specific technical-tactical actions of the sport during the final phase of a competition.

METHODOLOGICAL PROCEDURES

This observational study adopted the technique of notational analysis[12] to analyze all the technical-tactical actions (n = 44,025) performed by athletes of teams that competed in the finals of the 2010 Santa Catarina Volleyball Championship belonging to U-15 (four male and six female teams), U-16 (four male and six female teams) and u-17 (four male and six female teams) categories. After authorization from the Volleyball Federation of Santa Catarina, the research project was submitted and approved by the Ethics Committee for Research with Human Beings of a public Higher Education institution of the state of Santa Catarina / Brazil (Protocol No. 377.922).

Data were collected from filming of 48 games of teams investigated (u-15 = 17, u-16 = 17, u-17 = 14). Two camcorders (Sony Handycam) were placed behind the serving areas of both teams (one in each zone) and aligned with the center of the court, so that a wide and clear view of the athletes' movement and technical-tactical actions was obtained during the match. The actions performed during the games were later recorded in specific observation grids and analyzed based on the proposal of the Instrument for Technical and Tactical Performance Assessment in Volleyball (IAD-VB)[13]. In addition to validation of content by experts with experience in volleyball, IAD-VB has high levels of intra-rater (Kappa = 0.84) and inter-rater reproducibility (intraclass correlation coefficient = 0.78)[13].

In the process of evaluating actions (serve, reception, setting, attack, block and defense), the IAD-VB considers four components: adjustment, decision making, efficiency and efficacy. Adjustment is defined as the player's ability to read the game and all elements that surround it, acting in order to establish the best action; decision-making consists of the ability to observe and analyze quickly and to define the best response to be given in certain situations when the player is in the possession of the ball; efficiency is characterized as the process of performing basic fundamentals related to the technical part of the sport; and efficacy is defined as the result obtained by the execution of fundamental skills of the game[13].

The information recorded in observation grids was inserted and descriptively and inferentially analyzed using the SPSS statistical software (Statistical Package for the Social Sciences), version 21. Independent variables were: gender (male, female); competition level (u-15, u-16 and u-17); level of experience (higher, lower); decision-making (inadequate, intermediate, adequate); adjustment (inadequate, intermediate, adequate) and efficiency (inadequate, intermediate, adequate). Specifically for the analysis of variable efficacy response, "inadequate" and "intermediate" categories, originally proposed by IAD-VB, were grouped into "inadequate" category.

The criteria used to classify adequate efficiency in each volleyball game action were: direct point / ace (serve); point when sending the ball directly to the opponent's court or placing the ball in the setting zone properly (reception); attack without blocking or with simple or broken blocking (setting); direct point (attack and block); continuity of the action by the

team itself (defense). In the classification of the sport experience, criterion used in another research carried out with athletes from volleyball training categories was adopted[14]. In this sense, more experienced athletes were those who, at the time of data collection, had five years or more of sports practice and have participated in five or more championships (state, national and / or international level).

Descriptive analysis showed efficacy prevalence (simple and percentage frequency), considering the independent variables. The inferential analysis, in turn, was performed in two stages. In the first, crude binary logistic regression models were applied to test the level of association of efficacy with each of the independent variables. As inclusion criteria, at this stage, significance level of 20% ($\alpha = 0.20$) was considered. In the second step, adjusted binary logistic regression was applied for final model testing. In this process, the Forward (Wald) method was used to select variables that met the inclusion criterion established in the first step. As a criterion for entry of variables into the model, as well as for the interpretation of odds ratios (OR), significance level of 5% was adopted. The criterion for establishing the reference categories of each independent variable in the inferential analysis was the lower prevalence of adequate efficacy in that category compared to the other categories, which was obtained from the descriptive analysis.

RESULTS

The analysis of games totaled 44,025 technical and tactical volleyball actions, of which 15,957 were carried out by 10 u-15 teams, 13,396 by 10 u-16 teams and 14,672 by 9 u-17 teams. In total, 16,493 actions were performed by male athletes (12 teams) and 27,532 by female athletes (17 teams). Regarding the level of experience, more than 2/3 of actions were performed by athletes with less than five years of experience in the sport.

In the analysis of the prevalence of performance efficacy considering the independent variables (Table 1), predominance of actions with inadequate efficacy regardless of gender, competition level, level of experience, quality of adjustment and efficiency quality was verified. The only variable that presented distinct behavior was decision making ("appropriate" category), which presented higher prevalence of adequate efficacy (75.5%).

The difference of prevalence of adequate efficacy between genders was small (0.3%), and females had higher percentage (35.8%). When comparing the competition levels, it was verified that the highest prevalence of adequate efficacy occurred in the u-16 category (38%), and the lowest in the u-15 category (32.6%). This profile was similar when considering the level of experience of athletes investigated, as little more than 1/3 of actions were performed with adequate efficacy by less experienced athletes (35.1%) and by those with at least five years of volleyball practice (36.9%). Regarding the performance components, it was observed that the percentages of adequate efficacy were higher in cases of adequate decision-making, adjustment and efficiency.

Table 1. Prevalence of efficacy considering the independent variables

Factors	Category	Efficacy	
		Inadequate n (%)	Adequate n (%)
Gender	Male	10.640 (64.5)	5.853 (35.5)
	Female	17.686 (64.2)	9.846 (35.8)
Competition level	u-15	10.756 (67.4)	5.201 (32.6)
	u-16	8.306 (62.0)	5.089 (38.0)
	u-17	9.264 (63.1)	5.409 (36.9)
Level of experience	Higher	8.922 (63.1)	5.212 (36.9)
	Lower	19.384 (64.9)	10.480 (35.1)
Adjustment	Inadequate	556 (94.1)	35 (5.9)
	Intermediate	6.372 (82.9)	1.317 (17.1)
	Adequate	21.398 (59.9)	14.347 (40.1)
Decision making	Inadequate	5.992 (98.3)	106 (1.7)
	Intermediate	18.287 (85.4)	3.131 (14.6)
	Adequate	4.047 (24.5)	12.462 (75.5)
Efficiency	Inadequate	2.483 (87.4)	357 (12.6)
	Intermediate	6.418 (71.0)	2.623 (29.0)
	Adequate	19.425 (60.4)	12.719 (39.6)

The adjusted logistic regression model presented statistical significance ($p < 0.001$) and was able to explain 51.40% (G^2 Nagelkerke = 51.40) the efficacy variance. Specifically, efficacy was shown to be associated with decision-making, adjustment and efficiency components, as well as to competition level (Table 2). The level of experience, which showed significant association in the crude analysis, did not confirm this relationship in the adjusted analysis.

The likelihood of an athlete to achieve adequate efficacy in the technical-tactical action was higher in the u-16 category (OR = 1.36) in relation to the u-15 category. On the other hand, the likelihood of an athlete achieving adequate efficacy was 11% lower in the u-17 category than in the u-15 category (OR = 0.89).

Regarding decision making, it was verified that the likelihood of an athlete to achieve adequate efficacy was higher when making intermediate decision than when making inadequate decision (OR = 10.21). In the same direction, the likelihood of adequate efficacy was greater when the athlete made an adequate decision than when making an inadequate decision (OR = 200.27). Regarding adjustment, it was verified that the likelihood of adequate efficacy was higher when the athlete made intermediate (OR = 1.66) and adequate adjustment (OR = 3.57) compared to inadequate adjustment.

Efficiency presented a distinct behavior when analyzed through crude regression in relation to adjusted regression. In the first case, it was verified that the likelihood of occurrence of adequate efficacy in the performance of actions was 2.84 times higher when the athlete presented intermediate

efficacy, and 4.55 times higher when presenting adequate efficiency, when compared to when the athlete performed inadequate movement technique. In the adjusted analysis, on the other hand, it was verified that the likelihood of achieving adequate efficacy was 40% lower when the athlete presented intermediate efficiency and 64% lower when the athlete presented adequate efficiency. The evidence found in the adjusted analysis diverged from the profile observed in the descriptive analysis, which indicated higher prevalence of intermediate and adequate efficiency.

Table 2. Factors associated with efficacy[1] in the performance of technical-tactical actions in volleyball

Factors[2]	Crude Logistic Regression		Adjusted Logistic Regression	
	Likelihood ratio (95%CI)	p	Likelihood ratio (95%CI)	p
Gender		0.561	-	
Male	1			
Female	1.01 (0.97; 1.05)			
Competition level		<0.001*		<0.001*
u-15	1		1	
u-16	1.27 (1.21; 1.33)		1.36 (1.27; 1.45)	<0.001*
u-17	1.21 (1.15; 1.27)		0.89 (0.83; 0.95)	0.001*
Level of experience		<0.001*		0.856
Higher	1		-	
Lower	1.08 (1.04; 1.13)			
Adjustment		<0.001*		<0.001*
Inadequate	1		1	
Intermediate	3.28 (2.32; 4.64)		1.66 (1.14; 2.42)	0.008*
Adequate	10.65 (7.56; 15.00)		3.57 (2.43; 5.22)	<0.001*
Decision making		<0.001*		<0.001*
Inadequate	1		1	
Intermediate	9.68 (7.96; 11.77)		10.21 (8.38; 12.43)	<0.001*
Adequate	174.07 (143.19; 211.61)		200.27 (164.10; 244.43)	<0.001*
Efficiency		<0.001*		<0.001*
Inadequate	1		1	
Intermediate	2.84 (2.52; 3.21)		0.60 (0.52; 0.70)	<0.001*
Adequate	4.55 (4.07; 5.10)		0.36 (0.31; 0.42)	

[1] Variable Response: Efficacy (1 = Effective; 0 = Ineffective); [2] Method for the selection of independent factors / variables: Forward: Wald; * Statistically significant result (considering $\alpha = 0.05$).

DISCUSSION

The higher incidence of actions observed among females in the present study is due to the fact that there were more female teams (17 F, 12 M) and, consequently, more games played, many of them with final score of 3 sets to 2. In addition, the characteristics inherent to the women's game, whose point disputes tend to be longer than in men's games, justify the great difference in the number of actions, since there is a greater chain of

actions in each rally. In women matches, most points are usually obtained during game complex II (counter-attack, starting from the defense of the opponent's attack), unlike the characteristics of men's games, in which there is a high incidence of points during complex I (attack from the reception of the service)[15].

Athletes in the more advanced categories (u-16 and u-17) presented greater likelihood of adequate efficacy than players of the u-15 category, confirming the studies that consider volleyball a sport of late specialization[16,17], whose beginning of systematic practice is recommended from the age of 13 years[18]. The sporting experience, on the other hand, was not associated with efficacy, which diverges from the results of investigations that indicate that athletes' knowledge and decision-making capacity are attributes developed over time and are fundamental for good performance in team sports[19,20]. Experience is one of the predictors of children's performance in basketball matches[20] and is associated with the level of performance of volleyball athletes of more experienced categories (u-16 and u-17), where the teaching-learning-training processes become more specialized[14]. In addition to the fact that sports experience has the potential to exert a certain influence on performance, it is important to point out that other psychological factors, such as intrinsic motivation[21] and cognitive state anxiety[22], may contribute to change the level of performance presented in team sports, even among more experienced athletes. Considering that such factors were not addressed in the present study, further investigations should be carried out that analyze their influence on the technical-tactical performance of athletes with different levels of sports experience.

The evidence found in this study indicates that the components of sports performance are associated with adequate efficacy in technical-tactical actions. In fact, athletic performance may be higher when athletes have the capacity to adequately perform the technical and tactical components of the game[13], given the interdependence of these aspects in team sports[23]. The competitive success of the volleyball athlete is determined by tactical-strategic abilities (from cognitive development), in which adjustment and decision-making are fundamental[24].

It should be emphasized that individual and collective tactics in volleyball must be strictly linked to the technical performance of athletes[5]. Due to the constant changes of ball possessions and the impossibility of retaining the ball, the precision of movements is determinant for the adequate linking of the game actions, as well as to obtain the dominion of the game. In addition, good collective performance depends on each athlete's ability / capacity to control movements with proficiency and to make effective decisions about motor response[25].

The relationship between increased likelihood of being effective and decreased efficiency seems to be associated with the poor experience of most of athletes investigated, coupled with the need to quickly adjust to the ball's trajectory and make quick decisions. In fact, volleyball's random and unpredictable characteristic[26] requires players to constantly read the

game play so that it is possible to determine the best motor response to each game situation. It is also emphasized that efficiency cannot always be a good predictor of efficacy in volleyball game actions, either because only certain efficiency indicators can adequately predict the variance of efficacy results of the suspension touch (in attack situations) and the forearm pass (in defensive situations), or because the demands of tasks interfere in the type of relationship established between both[5].

In the present study, decision-making was the component that most stood out in the relation to adequate efficacy in game actions, considering that the likelihood of an athlete to be effective was more than 200 times greater (adjusted analysis) when he / she made an adequate decision than when he / she made an inadequate decision. The abilities of observation and rapid analysis, as well as of decision about the best response to be given in certain situations when one is in possession of the ball[27], have been emphasized in different studies, mainly due to its association with success in games[6,21,28]. One aspect that deserves attention is that decision-making capacity depends not only on the objective contextual factors of the game, but also on the athlete's perception of these situations[29] and on elements related to attention and emotion[21,22].

More experienced volleyball players usually act based on the familiarity they perceive between the problem situation presented by the game and certain situations previously experienced in the sport, performing the action typically more adequate to solve the present problem[30]. In this way, coaches need to balance explicit and implicit instruction strategies[25], offering many problem situations in which players try to make decisions to discover solutions, as well as qualified guidelines regarding possible motor responses to the problems presented. Thus, the adoption of systematic training strategies for reflection and decision-making is suggested from the initial stages of volleyball training, considering its potential for the positive development of athletes in the long term.

It is necessary to emphasize that the present study has some limitations. Although only teams participating in the final phase of the state championship of Santa Catarina were selected, the analysis of the actions of athletes did not take into account the moment of the match in which they were performed. Depending on the timing and situation of the game, players may be influenced to make certain decisions to ensure the victory of their team (e.g., increasing the setting frequency to the best team striker) or to try to induce the other team to make a mistake (to force the serve, to direct the serve to the opposing player with more difficulty in reception), but this possibility of analysis was not included in this investigation.

CONCLUSION

This study presented evidence of association between efficacy and variables decision-making, adjustment, efficiency and competition level. The great influence exerted by the decision-making indicates that success in

volleyball is in fact very closely associated with intelligent performance. The dynamicity characteristic of this sport requires the players to quickly and appropriately process the information, as well as to perform actions that allow anticipating the reading of the game made by the opponents and, consequently, cause imbalance in the other team.

As the adjusted model was able to explain just over half of the variation in efficacy, there is a need to broaden the scope and depth of the technical-tactical performance analysis in volleyball training categories. In addition to addressing psychological factors such as competitive motivation, anxiety and stress, future investigations could include the context of the game in the analysis of actions performed, considering variables such as number and time of the set, the partial result of the game and the opponent's quality, which are factors that may also directly influence the technical-tactical performance of volleyball athletes.

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