

Systematic review on sports performance in beach volleyball from match analysis

Revisão sistemática sobre a performance desportiva no voleibol de praia a partir da análise do jogo

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Abstract – The present article aimed to perform a systematic review of the available literature in relation to the analysis of sports performance in beach volleyball from match analysis. *Web of Science*, *SportDiscus*[®], *PubMed*, *Scopus* and *Academic Search Complete* databases were used to identify peer-reviewed published articles. The authors conducted a content analysis according to goals, variables of analysis and methods used in studies. In general, three research lines were determined: analysis of the functional dependence of the game actions and their relation with success, performance according to gender, and the effect of changing the rules on the game performance. In relation to methodology, an evolution from descriptive studies to studies of comparative nature can be seen and, more recently, there has been a focus on predictive nature. This new trend breaks with the research based on simple cause and effect relations, and focuses on the analysis of the game events, namely related to tactical-technical performance indicators, in a non-linear and interactive way, considering the game as a complex and dynamic system. The limitations of the studies analyzed show the need for further studies to investigate the identification of game patterns for the different game levels; integration of situational variables in the study of the performance of teams (such as match status and the quality of opposition).

Key words: Beach volleyball; High performance; Match analysis.

Resumo – O objetivo deste estudo consistiu numa revisão sistemática da investigação empírica realizada sobre a performance desportiva no voleibol de praia a partir da análise do Jogo. As bases de dados *Web of Science*, *SportDiscus*[®], *PubMed*, *Scopus* e *AcademicSearch Complete* foram utilizadas para identificar os artigos empíricos com revisão de pares publicados. Procedeu-se a uma análise de conteúdo em função dos objetivos, variáveis de análise e métodos utilizados nos estudos. Em termos gerais, emergem três linhas de investigação: a análise da dependência funcional das ações de jogo e a sua relação com o sucesso, a performance em função do sexo e o efeito da mudança das regras na performance do jogo. Ao nível metodológico, destaca-se uma evolução de estudos descritivos para comparativos e mais recentemente, um enfoque de natureza preditivo. Esta nova tendência rompe com a análise do jogo baseada em relações simples de causa e efeito e aponta para a análise dos eventos do jogo, nomeadamente, ao nível dos indicadores tático-técnicos da performance, de forma não linear e interativa, considerando o jogo como um sistema complexo e dinâmico. As limitações patentes nos estudos analisados projetaram a necessidade de se investigar no futuro: a identificação de padrões de jogo para os diferentes níveis de jogo; a integração de variáveis situacionais no estudo da performance das equipas (isto é, o resultado no momento e a qualidade de oposição).

Palavras-chave: Análise do jogo; Alto rendimento; Voleibol de praia.

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INTRODUCTION

Match analysis (MA) with focus on the performance of team sports has raised the interest of many specialists and researchers who aim at identifying the variables that best define the preparation process of teams and players¹⁻³ due to the need for better understanding the environment that promotes success in sports. Nevill et al.⁴ reported that MA is an important means to gain deep and sustained knowledge of competition sports, thus, being an essential element in the coach's intervention throughout the training process in the selection of factors that lead to performance improvement and therefore to sports success^{5,6}.

In the scope of MA, volleyball is a theme of interest in research, where an evolution of problems in studies and applied methodological designs have been recognized⁶. Researchers have tried to find explanations in the attempt to identify factors that are significant for sports performance and, specially how they relate to induce efficacy, taking into account the complex nature and dynamics of the match⁶.

Concerning studies carried out in beach volleyball (BV), no review article was found in journals with peer review up to the present time. The lack of scientific articles in this research field hinders the identification of current research lines as well as avenues to explore in further research, which emphasize the need for overcoming this gap. In this sense, the systematic review carried out in this article, focused on empiric research in BV performance from MA, intends to contribute to the increase of knowledge about this sport, and therefore, to be useful for future research in this area.

METHODS

A search was performed on Web of Science, SportDiscus, PubMed, Scopus and Academic Search Complete databases. The search terms used were: 'beach volleyball', 'game analysis', 'match analysis', 'notational analysis', 'performance analysis', 'performance indicators', 'technical analysis', 'tactical analysis' and 'video analysis'. Initially, all studies showing one of the key words were selected. However, in order to ensure the scientific quality of the reviewed papers, only articles that integrated empirical studies in journals with peer review were chosen; being this procedure considered essential to provide accuracy and scientific validity to a systematic review focused on empirical research in a particular domain⁷. The scientific studies selected for this review included the period from 2003 to October 2013. Initially, 2419 studies were identified (Web of Science: 193; Sport Discus: 1299; PubMed: 49; Scopus: 130; Academic Search Complete: 748). The same articles repeated in different databases and not related to the topic proposed were not included. After screening and eliminating articles that did not follow the previously established inclusion criteria, 18 empirical articles focusing on BV from MA were considered. The reduced number of articles is due to the fact that MA is relatively recent as a scientific area, in addition to the scarcity of studies on BV, as previously reported.

Initially, the articles were grouped according to aims, variables and methods (Box 1). Subsequently, the classification of articles allowed grouping them according to the type of analysis (descriptive, comparative and predictive analysis). In relation to studies of comparative nature, as they are of greater number and show greater thematic diversity, they were divided into: studies that analyze the functional dependence of game actions and their relationship with success; studies that analyze performance according to gender; and studies that analyze the effect of changes in rules in game performance.

Box 1. Synopsis of empiric studies focusing on performance analysis in BV from match analysis.

Author/Year/Country	Aim of study	Sample and variables	Statistic	Result
Giatsis et al. ²⁰	To compare the performance between winners and losers, before and after changes in the court size .	34 male sets (2000 and 2001 Greek Championship) <i>Efficacy (serve, reception and attack).</i>	T-test.	– Before changes in the court size, the success was dependent on the quality of reception; – After changes in the court size, the success became more dependent on the efficacy of the attack and the reduction of errors.
Giatsis et al. ¹⁹	To compare the temporal characteristics of work and rest between matches in the 8x8m and 9x9m court.	33 male sets (Greek Championship 2000 and 2001). <i>Rallies, time-outs and rest time.</i>	T-test.	– Significant increase of 1 second on the duration of the rally in the 8x8m court; Significant decrease on work-rest ratio (1:2-3)* in the 8x8m court. * 1minute of work for 2-3 minutes of rest
Giatsis ²²	To compare the rally scoring system and side out scoring system in relation to duration and fluctuation score.	582 female matches (2000 and 2001 FIVB tournaments). <i>Duration of matches and number of rallies.</i>	Anova.	– Significant increase (6 minutes) on the duration of match in the rally scoring system; – Losing teams decreased more 3,5 rallies in 3 rd set in the rally scoring system.
Giatsis et al. ²³	To assess the performance of teams after the reduction in court dimensions.	34 male sets (2000 and 2001 Greek Championship). <i>Efficacy (reception and attack)</i>	T-test.	– The reduction in court dimensions produced better conditions for the execution of the attack (result of a better reception);
Mesquita et al. ¹¹	To identify and associate the type of attack with its efficacy, match status and type of block.	27 male sets (2002 World Tour and World Cup). <i>Block (type); attack (type, efficacy and zone); complex of the game.</i>	Chi-square.	– 84% of attacks are performed in the presence of block; – Attacks in the presence of blocks have a positive outcome.
Mesquita et al. ¹⁰	To identify and associate the type of attack with the attack zones.	27 male sets (2002 World Tour and World Cup). <i>Type and attack zone.</i>	Chi-square.	– Power attack was the most used and more effective; – Significant associations between: type of attack and its efficacy; ranking classification and type of attack; match status and type of attack. – Zones 2 (39%) and 4 (38%) were the most used by attackers.
Michalopoulou et al. ¹⁴	To assess the efficacy of game actions between winning and losing teams.	120 male sets (2000 Greek Championship). <i>All the game actions.</i>	Anova and Chi-square.	– Winning teams had better efficacy in serve and attack.
Grgantov et al. ²⁷	To assess the impact of game actions according to final result before and after changes in the rules.	129 sets (old rules) and 74 sets (new rules) (1995 and 1996Croatian championship). <i>All the game actions.</i>	Regression.	– Before changes in the rules, the attack was the action with the greatest influence on success, followed by reception, dig, block, counterattack and serve; – After changes, attack was followed by block, counterattack, dig and serve; – The reception showed no significant relationship with success of the attack after changes in the rules.

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Ronglan et al. ²¹	To assess the quality and efficacy of game actions after changes in the rules.	34 male matches (1999 and 2002 FIVB World Tour tournaments between). <i>All the game actions.</i>	Mann-Witney	<ul style="list-style-type: none"> – Significant decrease in points (4%) and serve errors (3%), attack points (6%); – Significant increase in actions and block points (4%).
Giatsis et al. ³⁰	To compare the characteristics of the match between winning and losing teams according to the type of match (two or three sets).	118 male matches. (2003 FIVB World Tour tournament). Efficacy (<i>serve, attack, block and dig</i>).	T-test.	<ul style="list-style-type: none"> – Better efficacy on game actions won by 2-0; – Better performance in the total of points gain in games won by 2-1.
Turpin et al. ⁸	To analyze and quantify the types of jumps performed by players.	10 players / 9 male sets (2005 European championship). <i>Jumps (attack, serve and block).</i>	Frequencies, means and standard deviations.	<ul style="list-style-type: none"> – Jumps (219 per match, 100 per set and 6 per rally); – Attack (44%), block (39%) and serve (17%).
Yiannis ¹⁶	To compare the game actions and their efficacy according to gender.	16 male matches and 15 female matches (2004 Olympic Games) <i>All the game actions.</i>	Chi-square.	– Significantly greater use of jump serve and power attack in male games.
Koch et al. ¹³	To identify the typical sequence of game actions.	18 female matches. (2007 World Tour). <i>All the game actions.</i>	Chi-square.	<ul style="list-style-type: none"> – After a perfect reception, the players perform more type shot attacks (55%) than power attacks (45%). – The jump serve increases 8% errors in reception.
Koch et al. ¹⁷	To compare the game actions according to gender.	14 male matches and 15 female matches. (2005 World Tour). <i>All the game actions.</i>	Chi-square.	<ul style="list-style-type: none"> – In male matches, there was greater frequency of jump serve, frontal reception, overhand pass, offensive block, dig from power attack, attack on the cross-court; - In female matches, there was greater frequency of float jump serve, defensive block, and dig from shots.
Lopez-Martinez et al. ¹²	To assess the relationship between serve action and its manner of execution as well as its efficacy according to gender.	13 male sets and 11 female sets. (2003 World Tour and 2004 Olympic Games). <i>Serve (type, zone, destination, efficacy) and action outcome.</i>	Chi-square.	<ul style="list-style-type: none"> - The jump serve showed more errors and more points in both genders; - In males, the use of jump serve, zone 3 (to serve) and destinations 3 and 6 (had better efficacy) were the most used; - In females, the jump serve for destination 2 was the most used and had better efficacy; for the other serve types, there was a greater variation of the zone in comparison to males.
Buscà et al. ¹⁸	To assess the relationship between serve types and speed according to the final tournament ranking and the influence of serve efficacy on the rally outcome.	23 male sets and 22 female sets. (2008 World Tour). <i>Serve (type and efficacy).</i>	T-test, Mann-Whitney and Chi-square.	<ul style="list-style-type: none"> – Serve with medium speed in male and with low and high speed in female, resulted in a greater balance between positive and negative on the rally outcome; – In females, serve with high speed was the most used by players with top positions in the rankings.
Chinchilla et al. ⁹	To analyze the differences between offensive zones according to gender.	18 sets (2005 European championship). <i>Offensive zones.</i>	Frequencies.	– The most used zones in men were: 1, 2, 4 and 5; whereas in women, zones 1 and 5 were predominant.
Jiménez et al. ¹⁵	To analyze serve types according to the match status.	8 male sets (2005 European championship). <i>Serve type.</i>	Chi-square.	– Significant decrease in jump serve from 1 st moment (1 st to 7 th point; 89,7%) to 3 rd moment (15 th to 21 st point; 27,3%).

RESULTS

Descriptive and comparative analysis

Studies of descriptive nature are in an early stage in BV research, with a relatively low number (11,1% studies). From the studies analyzed, those of Turpin et al.⁸ and Chinchilla-Mira et al.⁹ stand out. In the first study, the authors quantified the type of jumps performed in 9 male sets of the 2005 European BV Championship, and concluded that players perform approximately 219 jumps during a match, 100 jumps per set and 6 jumps per rally. This study showed that 44% of jumps were present in attack actions, 39% in block actions and 17% in serve actions. In the second study, the authors analyzed the offensive zones in 18 sets (male and female) of the 2005 European BV Championship and concluded that offensive zones differ between genders. In males, the most used zones were 1, 2, 4 and 5, whereas in females, zones 1 and 5 were predominantly used.

After a descriptive approach, studies of comparative nature with high incidence were assessed (77.8%), which followed three research lines: 1) functional dependence of game actions and their relationship with success¹⁰⁻¹⁵; 2) performance analysis according to gender¹⁶⁻¹⁸ and 3) effect of changes in rules on game performance¹⁹⁻²³.

Functional dependence of game actions and their relationship with success

In this context, the study by Mesquita et al.¹⁰ is relevant. The authors studied potential aspects that affect the efficacy of attack in BV from 27 male sets of the 2002 World Tour and the World Championship. Significant associations were observed between: type of attack (way of execution) and actions that precede it; type of attack and its efficacy; type of block opposition and attack efficacy; level of players' performance and match status with the type of attack used. Regarding the relationship between attack and block opposition, and between attack and way of execution, Mesquita et al.¹¹ verified that 84% of attacks are performed in the presence of block, and frequently have a positive outcome.

Lopez-Martinez et al.¹², analyzed the relationship between type of serve and way of execution with its efficacy. The authors analyzed male (13 sets) and female matches (11 sets) from the 2003 World Tour of and 2004 Olympic Games. The results showed significant associations between type of serve and its efficacy. Jump serve revealed a greater number of errors and obtained a greater number of aces in relation to standing serve for both genders. In males, zone 3 was the most used; while in females, a zone variation in relation to the type of serve was verified. In the jump serve, males obtained better efficacy in zones 3 and 6 and zone 2 for females.

Koch et al.¹³ analyzed associations between serve and reception; set and attack; reception and attack (18 female matches – 2007 World Championship). The findings confirmed a significant relationship only between reception and attack. Following a perfect reception, players

performed more shots (type of attack) (55%) than power spikes (45%). Following a bad reception, players opted for power spike, and when the quality of reception was perfect, they opted for greater variability in the type of attack.

Michalopoulou et al.¹⁴ assessed the efficacy of game actions between winning and losing teams in matches (120 sets) of the 2000 Greek Championship. The results showed that winning teams had better efficacy in serve and attack when compared with losing teams.

Recently, Jiménez-Olmedo et al.¹⁵ analyzed types of serve (way of execution) according to the period in the set in 8 male sets of the 2005 European BV Championship. The results showed a significant decrease of the jump serve from the 1st period (1st to 7th point; 89.7%) to the 3rd period (15th to 21st point; 27.3%).

Analysis of performance according to gender

In this review, three studies according to the gender of teams were found, which shows the lack of studies on this specific analysis. Yiannis¹⁶ compared serve, reception, attack, block and dig techniques with their efficacy in the 2004 Olympic Games among males (16 matches) and females (15 matches). The results showed significant differences in the way the match was played according to the gender of players, namely the more frequent use of jump serve and power attack in the male match. The authors observed inequalities in the players' muscle power, as one of the main factors in the type of match played.

Likewise, Koch et al.¹⁷ compared male matches (14 matches) and female matches (15 matches) of a tournament (Grand Slam) organized by the Federation of International Volleyball (FIVB) in 2005. The results showed significant differences in the match played by both genders for all actions (serve, reception, block, set, attack and dig). Regarding serve, jump serve was the most used in male matches, while float jump serve was the most used in female matches. The frontal variant of reception and overhand pass were the most used by males. In block, males preferred a more offensive technique, whereas females opted for a more defensive one. In turn, the use of digs from shots occurred more frequently in female matches, whereas in male matches, digs from power attack were more frequent; moreover, in attack, males hit the ball more frequently in cross-court than females.

In a more recent study, Buscà et al.¹⁸ investigated the relationship between serve speed and its efficacy in relation to the final tournament ranking and the rally outcome, in both genders. The sample was collected from 23 male sets and 22 female sets during a tournament organized by FIVB (World Tour) in 2008. In both genders, the results showed no significant differences between serve ball speed and its efficacy. However, when the ball speed was categorized into three groups (low, medium and high speed), there was a better balance between positive and negative results with medium speeds for males and low and high speeds for females. Moreover, players in high ranking had higher prevalence of serve with the high ball speed. There was no relationship between rally outcome and serve efficacy.

Effect of changes in rules on game performance

Regarding research focused on changes in rules imposed by FIVB in 2000, several studies were concerned in trying to understand how these changes affected game performance. These changes involved a new program of rules from the 2000 Olympic Games in Sydney, including: reduction in the court dimensions (from 9x9m to 8x8m), change in score system (side-out to point per rally) and possibility of serve touching the net²⁴.

Giatsis et al.¹⁹ studied the changes in performance (reception and attack) of male BV teams after the reduction in the court dimensions, in a total of 33 sets of the 2000 and 2001 Greek Championship. The results showed no significant differences in attack efficacy before and after the changes in rules. According to the authors, this may be due to the increase in the reception efficacy, which allowed players better attack conditions, and the use of different types of offensive tactics.

Giatsis et al.²⁰ investigated and compared the performance between winning and losing teams in matches of the 2000 and 2001 Greek Championship, played in 9x9m (6 matches) and 8x8m courts (9 matches). After changes in court dimensions and score system, the results showed that the performance of game actions that contributed most for success changed significantly. While before changes in rules, the reception quality was what most contributed to the success of teams, after the changes, it became more dependent on the attack efficacy and reduced errors.

In turn, Ronglan et al.²¹ analyzed the effect of changes in rules in the serve, reception, set, attack and block efficacy of 34 male matches in tournaments organized by FIVB between 1999 and 2002. The results showed a significant reduction in the serve points (4%), serve errors (3%), and attack points (6%) and a significant increase in the block actions and block points (4%). In relation to dig actions, the study showed no significant differences. These results seem to justify the need for greater specialization between blockers and defenders.

With regard to this research line, Giatsis²² studied the differences between two systems: “rally point system (RS)” and “side out scoring system (SO)” in the match duration and the score fluctuation in female matches organized by FIVB. The author analyzed 582 matches from 22 tournaments between 2000 and 2001. The results showed a significant increase in the average duration of matches of approximately 6 minutes. Additionally, the average number of points obtained by losing teams in the third set was 3.5 points more in “RS” when compared to “SO”.

Giatsis et al.²³ recorded and compared temporal characteristics of work and rest in 36 male sets of the 2000 and 2001 Greek Championship played in 9x9m (6 matches) and 8x8m courts (10 matches). After the change in the court size, the results showed a significant increase of approximately one second on the average rally duration, and significant decrease in work-rest ratio to 1:2-3, when compared to the 9x9m court (1:2-6).

From the analysis of these studies, it should be highlighted that changes in rules do not seem to have achieved the effect expected by FIVB²⁴ in decreasing

the match duration, making it more attractive and, consequently more visible in the media. In addition, the results of these studies seem to reflect a more demanding match, in relation to the physical component of players.

Predictive analysis of performance

The articles selected in this review showed that only two studies (11.1%), used predictive analysis to study performance. Grgantov et al.²⁵ assessed, in 129 sets according to the old rules and 74 sets according to the new rules, the impact of the different game actions in relation to their final result (win or lose), before and after changes in rules in male tournaments of the Croatian BV Championship. The results showed that the changes in rules altered the performance structure. Before changes, the action that most influenced the success of teams was the attack, followed by reception, dig, block, counter-attack and serve. After changes in rules, attack was followed by block, counter-attack, dig and serve; in turn, reception showed no significant relationship with the attack success. These results seem to be associated with the reduction of the court dimensions (9x9m to 8x8m) with the new rally point system, leading the opponent to gain the point when there is a serve error. Moreover, some studies^{26,27} showed that there was an increase in the height of players after the changes in rules, thus reception in bad conditions could be more easily compensated with the set and power attack, performed without the best match conditions.

Giatsis et al.²⁸ analyzed the importance of four actions (serve, attack, block and dig) in the final result of the match (win or lose) and the type of match (two or three sets) in 59 matches (118 sets) in male FIVB tournaments. The results showed that in matches won by 2-0, players had better performance in almost every game action analyzed, and the opponents' attack errors were the most important factor that contributed to success. In matches won by 2-1, players had better performance only in the total of win points, not being possible to establish an explanatory pattern of the winning teams' performance in relation to losing teams. However, it is not clear if the unit of analysis used in this study was based on sets, matches or game actions; hence this could be a limitation of this study, for instance, if the analysis was based on matches, some game actions could be counterbalanced among sets.

DISCUSSION

The discussion of this study follows a sistematization that considers the research lines focused on MA in BV, having as reference the methodological and design nature of the studies performed.

Although the research have mainly focused, on a descriptive and comparative nature (88.9%), it is possible to infer that these studies complied, partially, with some of the aims of the performance analysis of BV focused on MA, as for instance the description of match patterns, the identification and analysis of associations between game actions and their relation with success. It

is noteworthy that in studies of comparative nature, referenced samples belong to matches played over five years ago. With the natural evolution of BV, these data could have suffered changes, namely in the way of serve execution, due to the physical profile of players and game speed. In this type of study, the research was conducted based on the analysis of accumulated data of performance indicators, with the aim of identifying and quantifying the physical performance of players, as well as knowing specific game profiles for each gender. It is important to highlight that studies of descriptive-comparative nature considered here only allowed identifying, describing and comparing the structure and/or the patterns of the match. Studies of comparative nature were based on more accurate methodologies, representing a significant advance in research. Despite the relevance of such approach, it has not yet allowed explaining and predicting sport performance²⁹⁻³¹, besides not providing essential reference values for a better organization of the training and competition process. Meanwhile, these limitations have been taken into account by researchers, emphasizing the need for complementing these analyses with the use of stronger models, where the non-linearity of behaviours is considered³².

Gréhaigne et al.³³ have criticized the excessive research using descriptive and comparative analysis in MA and the lack of research of predictive nature. This type of analysis seems to be relevant since it could provide substantial information about the strategic preparation of teams and players in training and competition³⁴.

The lack of studies based on predictive analysis of performance, from technical-tactical indicators, show that BV is still taking its first steps with regard to models for predicting performance from MA. Although the recognition of team sports as complex and dynamic systems^{34,35} frequently uses linear analyses, models of interactive analyses should be considered in future research in BV. Thus, the resource to predictive models seems to be essential for the evolution of knowledge in this area, however, according to Heazlewood³⁶, abusive speculations should be avoided..

From this review, it is possible to identify limitations in empirical research on BV, which show: lack of studies that do not consider the interaction between tactical-technical indicators and physical indicators, which shows to be increasingly more decisive in BV performance; lack of studies that consider situational variables, as the match status or opposition quality, taking into account their possible influence on players and team performance^{37,38}. These limitations should be considered in future research in order to provide a deeper knowledge of the BV performance and thereby identify suitable game patterns for different competitive levels. Such research line would provide scientifically supported cues that could provide insights to better define the pathways of long-term athlete development.

FINAL CONSIDERATIONS

According to studies of this systematic review, it is possible to recognize that BV is still in a primary stage in relation to research focused on MA. On

a conceptual level, studies mainly include three research lines: functional dependence between game actions and their relationship with success, performance analysis according to gender, and the effect of changes in rules on the match in 2001. From a methodological point of view, there is an evolution from descriptive studies to comparative ones, where cumulative statistics were the analysis criteria most frequently used. Recently, a predictive approach has emerged in order to identify the relationship between variables considering their possible interactions and, consequently, their effect on the team performance, contributing to a better understanding of BV performance from MA.

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