Match Analysis in Volleyball: a systematic review

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A B S T R A C T

*The present article aims to review the available literature on match analysis in adult male Volleyball. Specific key words "performance analysis", "match analysis", "game analysis", "notational analysis", "tactical analysis", "technical analysis", "outcome" and "skills" were used to search relevant databases (*PubMed, Web of Science, SportDiscus, Academic Search Complete and the International Journal of Performance Analysis in Sport*). The research was conducted according to PRISMA (Preferred Reporting Items for Systematic reviews and Meta analyses) guidelines. Of 3407 studies initially identified, only 34 were fully reviewed, and their outcome measures extracted and analyzed. Studies that fit all inclusion criteria were organized into two levels of analysis, according to their research design (comparative or predictive) and depending on the type of variables analyzed (skills and their relationship with success, play position and match phase). Results show that from a methodological point of view, comparative studies where currently complemented with some predictive studies. This predictive approach emerged with the aim to identify the relationship between variables, considering their possible interactions and consequently its effect on team performance, contributing to a better understanding of Volleyball game performance through match analysis. Taking into account the limitations of the reviewed studies, future research should provide comprehensive operational definitions for the studied variables, using more recent samples, and consider integrating the player positions and match phase contexts into the analysis of Volleyball.*

Key words: *Teams sports, high performance, game analysis, Prisma, skills.*

Introduction

Volleyball is probably one of the most popular sports in the world (Reeser & Bahr, 2003). Despite its universal nature and its official history dating back more than a hundred years, there are still some uncertainties about its techniques and tactics multidimensions (João, Leite, Mesquita, & Sampaio, 2010), physiological (Trajkovic, Milanovic, Sporis, Milic, & Stankovic, 2012), nutritional and psychological needs (Valliant, Emplaincourt, & Wenzel, 2012). Therefore, there are still some ambiguities in the planning of the training process to improve performance in the competition.

To better understand the constraints that promote sporting success, match analysis (MA) has assumed a very important role in sports games (Carling, Reilly, & Williams, 2009; McGarry, O'Donoghue & Sampaio, 2013, O'Donoghue, 2015; O'Donoghue, & Holmes, 2015). Coaches were always concerned with optimising the performances of their teams given this is part of the competition (Hughes & Franks, 2008; Lago-Ballesteros & Lago-Peñas, 2010). The theme of monitoring performance has also been subjected to a lot of scientific research (Carling & Dupont, 2011; Drikos, Kountouris, Laios, & Laios, 2009; McGarry et al., 2013) and the results highlighted a number of overwhelming questions on performance of a team facing its opponents (Drikos et al., 2009; Jones, James, & Mellalieu, 2008; Liebermann et al., 2002; Marcelino et al., 2010; O'Donoghue, 2009; Palao, Santos, & Ureña, 2004).

Volleyball MA research has focused on the importance of the success and failure of the teams (Drikos et al., 2009). Usual methodology designs consist in descriptive, predictive or comparative analysis. Frequent comparisons occur between the different functional positions of the players (Alexandros & Atha-

nasios, 2011; Busca & Febrer, 2012; Laios & Kountouris, 2010; Silva, Lacerda, & João, 2013; Silva, Lacerda, & João, 2014b); between the different competitive levels and opposition quality (Marcelino, Mesquita, Andres, & Sampaio, 2009; Marcelino, Mesquita, & Sampaio, 2011; Marcelino, Sampaio, & Mesquita, 2012); between the different scoring systems (Fellingham, Collings, & McGown, 1994; Giatsis, 2003; Kovacs, 2009) and between gender (Bergeles, Barzouka, & Nikolaidou, 2009; Joao et al., 2010; Palao, Manzanares, & Ortega, 2009).

Recently there is an increase of research articles in scientific journals and specific books (Hughes & Franks, 2008; Carling et al., 2009) have been edited (McGarry et al., 2013; O'Donoghue 2015; O'Donoghue, & Holmes, 2015). However, although an increase in the amount of research, no systematic reviews are available concerning the Volleyball performance analysis.

Match Analysis scientific reviews are mostly done with distinct aims: reviews on specific methodological procedures used in MA articles (Barris & Button, 2008; Lees, 2002) and reviews that organize and systematize the scientific knowledge produced on about specific sport (Eom & Schutz, 1992; Gabbett, 2005; Lees, 2003; Karcher & Buchheit, 2014; Marcelino et al, 2011 Medeiros, Palao, Marcelino, & Mesquita, 2014; Moore, Bullough, Goldsmith, & Edmondson, 2014; Sarmento et al., 2014).

Regarding the of Volleyball MA, the vast majority of published studies are supported by purely narrative reviews, which are difficult to replicate, serving as a framework for the subject matter being dealt with, and where no statistical methods are used in the review process aimed at analysing and summarising the results.

Considering the importance of conducting systematic revi-

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ew of literature articles to produce scientifically based know-ledge (Morin, 2007), it becomes urgent to conduct more studies of this nature in MA. This increase of producing studies that systematize through a critical assessment will greatly benefit MA, as a scientific area, research predicts (Marcelino et al., 2011).

Therefore the goal of this study is to verify, through a syste-matic revision of literature, the scientific production related with the match analysis in Volleyball from published articles in the main electronic databases.

Methods

A systematic review of the available literature on match analysis in adult male Volleyball was conducted according to PRISMA (Preferred Reporting Items for Systematic reviews and Meta-analyses) guidelines, aiming to identify and characte-rize study methodologies, samples, variables and the data col-lections software used. Three independent reviewers separately conducted the analysis performed on 10 November 2014.
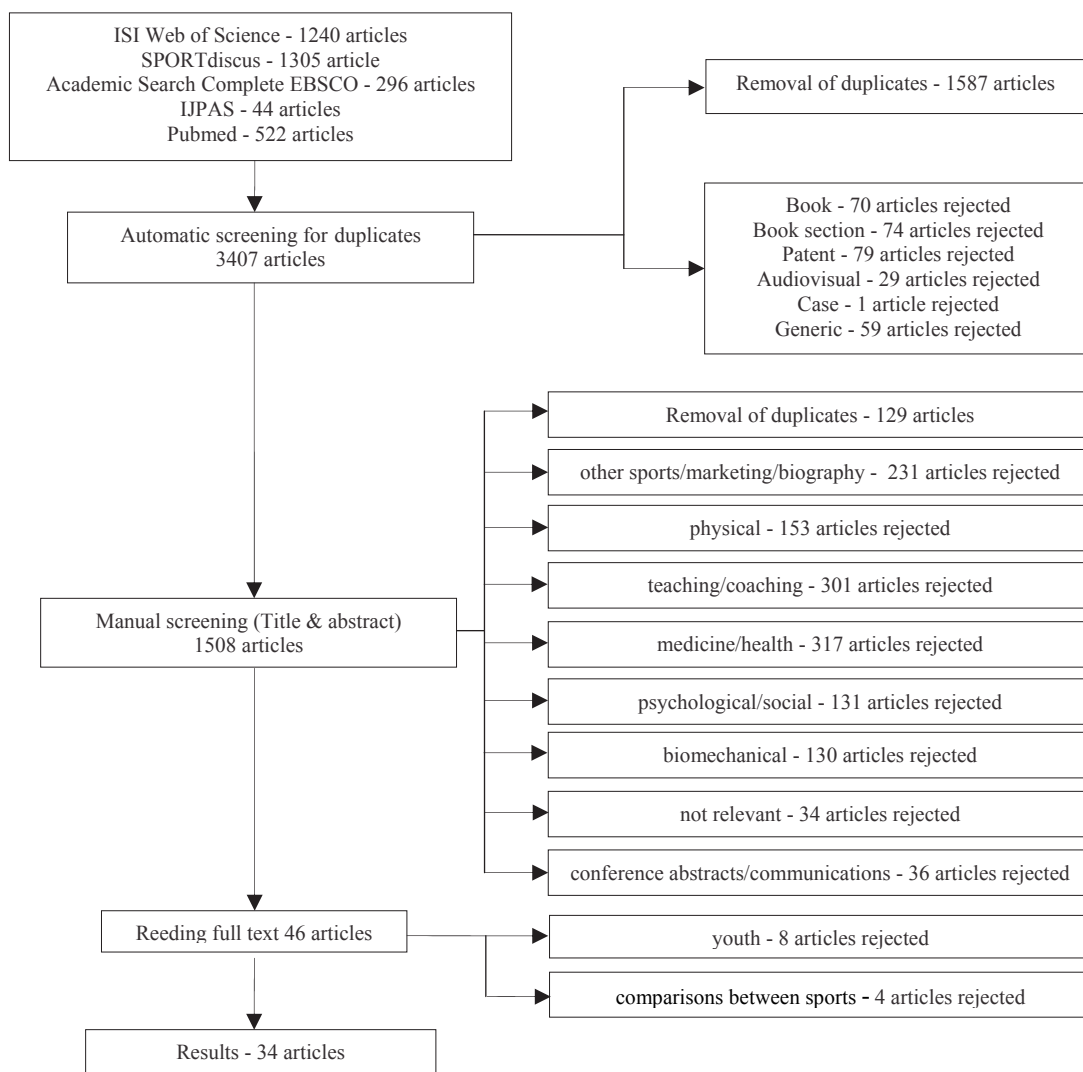
Figure 1. Flow chart of methodology used for the article search

The electronic databases used were *PubMed, Web of Scien-ce, SportDiscus and Academic Search Complete* since they are relevant, credible, representative and comprehensive (Bento, 2014; Harris, Quatman, Manring, Siston, & Flanigan, 2013). In addition to these databases, the International Journal of Perfor-mance Analysis in Sport was adopted as a data source as it is a key magazine in the field.

These databases were used to search for articles in peer-re-viewed publications using the combinations of keyword "Vol-leyball" with the following terms: "performance analysis", "match analysis", "game analysis", "notational analysis", "tacti-cal analysis", "technical analysis", "outcome" and "skills".

The inclusion criteria for these articles were: (1) relevant

data concerning technical and tactical evaluation or statistical compilation; (2) performed by amateur and/or professional adult male Volleyball; (3) written in English, French, Portugue-se or Spanish language. Studies were excluded if they: (1) rela-ted to beach volleyball or other sports; (2) thematic related to medicine, health, biomechanical, physical, psychological or te-aching; (3) did not include any relevant; (4) were conference abstracts, communications, proceedings' or news.

If there was disagreement amongst authors regarding the in-clusion of certain articles, the final decision was left to the seni-or author due to greater experience on the matter.

To organize the results, the studies were grouped according to the major research topics of match analysis that emerged

from the detailed analysis, and to the methodological strategies used.

The initial search identified 3407 titles in the referred database. Then, a reference manager software (EndNote X7, Thomson Reuters, Philadelphia, PA, USA) was used to import all available references. The duplicate ones (1587 references) and papers from non-sport science-specific journals (312 references) were removed either automatically or manually. The remaining 1508 articles were then screened for relevance based on their title and abstract, resulting in another 1462 studies being eliminated from the database. The full text of the remaining 46 articles was then read and another 12 articles were rejected due to a lack of relevance to the purpose of this study. At the end of

the screening procedure, only 34 articles remained for the systematic review (Figure 1).

Results

The first Volleyball MA research paper dates to 1992 (Eom & Schutz, 1992). However, over the next few years the production of scientific works in this area was of a residual nature. Results show a pronounced increase in the production of Volleyball MA research after 2009. Most studies were conducted from 2009 to 2012 (65% from the total took place over this period) and again there has been a decrease in production since then.

Table 1. Studies with predominantly comparative analysis according to Skills and their relationship with success.

Author	Aim of study	Sample/ *Variables*	Statistic/ *Software*	Result
Palao et al. (61)	To analyze the effect of a team's level on the performance of skills in high level volleyball	33 male matches and 23 female matches from 2000 Olympic Games. *Service, reception, spike, block and dig.*	Chi-Square Test and likelihood ratio. *VIS*	- In males, the results show a significant difference between teams' levels for the skills of spiking and blocking. The block is the skill that differentiates the teams of level 1 with the teams of level 2.
Yiannis & Panagiotis (75)	To compare the effectiveness of principal skills in men's Volleyball	38 matches from the Men's 2000 and 2004 Olympic Games. *Service, reception, attack, block and dig.*	T-test. *Without software information*	- An universal tendency of the elite men's volleyball teams to enhance their defense by reducing their block and dig faults. - There was an increase of the reception faults as a result of the improvement of the service effectiveness. -Teams' shift of tactics to win more points from their own serve.
Araújo et al. (5)	To analyze some block constraints in Elite Male Volleyball.	4351 sequences, 97 sets, from Men's 2007 World Cup. *Blocking system, effectiveness, opposition and set outcome.*	Chi-Square Test. *VROS*	- A significant relationship between block effectiveness and blocking system. - Block effectiveness and set final outcome, showed an independent relationship.
Bergeles et al. (10)	Examination and comparison of performance in attack in relationship with performance in set.	Games (M=8, F=8) from final phase of the 2004 Olympic Games. *Set and attack.*	Chi-Square Test. *Without software information*	- The higher the performance of setters, the higher the performance of attackers in both genders.
Lirola & González (39)	To analyze the reception in elite-level men's volleyball.	15 matches from Men´s 2003 World League and 2003 European Volleyball Championship. *Reception.*	Chi-Square Test and Pearson. *Excel*	- The libero player has a great importance in serve reception. There were no significant differences in the reception responding to power services, floating services or jump services between the libero and receivers.
Monteiro et al. (49)	To analyze the relationship between the set outcome and the dig and attack efficacy in side-out transition.	27 games of the Final Phase of the 2007 Men's World Cup. *Dig efficacy, attack efficacy, set outcome.*	Chi-Square Test. *VROS*	- A significant association between the attack efficacy and the set outcome since the teams that win the sets make fewer errors and have a higher efficacy in the counter-attack. - The dig efficacy is not significantly associated with the set outcome.
Araújo et al. (4)	To examine the relationship between the opponent block, compared to the hitter chosen by the setter to attack.	4531 sequences, 97 sets, from 2007 Men´s World Cup. *Hitter and the block Opposition.*	Chi-Square Test. *VROS*	- A significant association between the blockers starting points and the hitter chosen by the setter to finalize the play set. A significant association between hitter and number of blockers was also verified.

In the current review, the articles were initially grouped chronologic, according to aims, variables, methods and results obtained. It was decided that the most appropriate way to present the results would be to categorize them into two levels of analysis, depending on the type of analysis performed; comparative analysis (13 articles - 38%) and predictive analysis (21

37

Table 2. Studies with predominantly comparative analysis according to player position.

Author	Aim of study	Sample/ Variables	Statistic/ Software	Result
Papadimitrio et al. (62)	To evaluate the influence of the reception of the opponents' serve on the offensive actions and strategy.	36 matches from 98/99 Greek A1 Men's National Division (3 for each team). *Team; service, reception; type, time of set; set's area, effectiveness; type of attack, effectiveness; line-up of opponent's block*	Chi-Square Test. *Vicas analysis system*	- The quality of the reception of the opponents' serve formed the offensive strategy of the Greek setters of A1 National Division, though it did not affect the effectiveness of their sets to the attackers and the attacking strategy of the team.
Laios & Kountouris (33)	To study whether the six possible line-ups that appear during position rotations have the same efficiency for the serving team.	132 matches from A1 Men's 2005/2006 Greek Championship of Volleyball. *Won or lost the rally and position of the players.*	Chi-Square Test. *Data Volley*	- The teams performed two and a half full rotations per set and that the serving team had the disadvantage to win the rally. - With regards to the efficiency of the teams when serving, there are significant differences between the six line-ups.
Alexandros & Athanasios (2)	To analyse the action of the setter after a perfect reception.	4 matches from Men's 2009 C.E.V. CUP and 4 matches from Men's 2009 Champions League. *Service and reception.*	Chi-Square Test. *VirtualDub*	- The setters make the right choice only in half the cases and this has a significant impact on the team's attack efficiency, especially in the case of quick attacks.
Laios & Kountouris (34)	To examine whether receiving and serving team efficiency in Volleyball was dependent on the teams' line-up that emerges from the clockwise rotation of the players.	132 matches from A1 Men's 2005/2006 Greek Championship. *Point winner and line up.*	Chi-Square Test. *Data Volley*	- Rotations differ with regards to the teams' serving efficiency but not with regards to their receiving. - Most of the teams have one favored starting line-up position for the set with the setter at zone 1 when serving first and at zone 2 when receiving first. All teams utilized a maximum of two preferred starting line-ups.
Busca & Febrer (11)	To analyze the temporal fight of the volleyball Spanish high-level setter and the opponent middle-blocker to get advantage in the attack construction situations and blocking, respectively.	300 sequences of attack from 8 games of the Men's 2009 Spanish Cup volleyball. *Setter position in the rotation, placement area, according to the travel time of middle blocker and block effectiveness*	Chi-Square Test. *Without software information*	- There was some evidence that middle-blockers develop anticipated responses for 60,94% of the actions

articles - 62%); and a second-order level, depending on the type of variables analyzed (skills and their relationship with success (19 articles - 56%), player position (8 articles -24%) and match phase (7 articles -20%).

Comparative analysis

In this review the studies of comparative nature have an incidence of 38%, which followed three research lines: 1) skills and their relationship with success (Table 1); 2) player position (Table 2) and 3) match phase (Table 3).

Table 3. Studies with predominantly comparative analysis according to match phase.

Author	Aim of study	Sample/ Variables	Statistic/ Software	Result
Marcelino et al. (40)	To examine attack and serve performances in the beginning and end of the initial and final sets of volleyball matches according to the quality of opposition.	600 serves and 1,128 attacks from Men's 2007 World Cup. *Attack, service and match period.*	Cluster analysis and Double 2-point Moving Average. *VROS*	- Volleyball matches presented different profiles depending on the match period. - Considering the teams' level, a greater adaptation was found within the HIGH 3 HIGH matches according to the match period and a more strategic use of the serve and attack tactics taking into account the type of the set and the period.

Table 4 (Part 1). Studies with predominantly predictive analysis according to Skills and their relationship with success.

Author	Aim of study	Sample/ Variables	Statistic/ Software	Result
Eom & Schutz, (20)	To develop and test a method to analyze and evaluate sequential skill performances in a team sport.	72 matches from the third Federation of International Men´s Volleyball Cup. *First-order (pass-to-set, set-to-spike) and second-order (pass-to-spike) transition plays*	Log-linear procedures. O*n-line computerized system*	- There was a significant dependency in both the first-order and second-order transition plays, indicating that the outcome of a skill performance is highly influenced by the quality of a preceding skill performance.
Marcelino et al. (41)	To study performance levels in scoring skills, and to relate the results to the teams' final ranking in the tournament.	72 matches from Men´s 2005 World League. *Spike, serve, and block.*	Pearson correlation coefficients *VIS*	- Spike is the best indicator of success in high level volleyball, but only when considering relative measures. - The number of block points per game proved to be a good indicator of success in volleyball.
Moras et al. (51)	Comparative analysis between serve mode and speed and its effectiveness.	377 serves from 2004 Men's Olympic Qualification Tournament. *Service.*	ANOVA and regression *Data Volley*	- No relationship was found between serve speed and its effectiveness outcome.
Asterios et al. (6)	To determine the technical elements that could lead to a prediction to winning or losing a match by taking into account the differences of the technical elements recorded.	15 matches from Men´s 2006 Pool B World Volleyball Championship. *High, jump service; service reception and attack.*	Discriminant function analysis and Stepwise method. *Data Volley*	- ''attack after reception'' and ''quick ball attack'' emerged as the decisive factors for team qualification.
Drikos et al. (19)	To determine whether latent derivative parameters, can be better predictors than the original proportions of overall team's performance in Volleyball expressed as the ratio of sets won to the total number of sets played by the team.	132 matches from Greek Men's 2005-2006 Volleyball Championship. *Sets, service and attack.*	Pearson's and Spearman's correlation coefficients and multiple stepwise linear regression. *Data Volley*	- The findings lead to clear-cut definitions of norms both for the serving and attack efficiency ratio. The leading teams had a serving efficiency ratio of around two and an attack efficiency ratio of around three.
João et al. (28)	To identify sex differences in volleyball game-related statistics.	132 matches (M=66, F=66) from the 2007 World Championships. *Service, attack, block, set, dig and reception.*	Discriminant function analysis. *VIS*	-The fault serves, shot spikes, and reception digs were discriminating variables. - Men's volleyball games were better associated with terminal actions (errors of service), and women's volleyball games were characterized by continuous actions (in defense and attack).
Patsiaouras et al. (63)	To examine the technical skills that emerged as statistical important for volleyball men team's progress.	29 matches from 2008 Men´s Olympic Games. *Attack, service, reception and block.*	Kruskal-Wallis nonparametric test and Mann - Whitney U test showed. *Data Volley*	- There were statistically significant differences among the teams concerning the "attack errors following bad receptions" factor. - Statistically important differences were also noticed in the "attack after bad reception" between qualification round teams and teams playing in the final (Brazil-USA).
Drikos & Vagenas (18)	To identify volleyball performance indicators that best discriminate between winning and losing teams in a set according to set final score differences.	350 sets played during the 2009 Men's European Volleyball Championship. *Serve, attack, block, set, dig and reception, set and result.*	Clusters analysis, MANOVA and Discriminant function analysis. *Without software information*	- The effectiveness of attack is the most important performance indicator for all types of sets, far more for the ambivalent ones. - The discriminant function correctly classified increasing percentage of cases with increase in score difference, especially for ambivalent sets 67.3% were correctly classified.
Marcelino et al. (42)	To assess the effects of quality of opposition and match status on technical and tactical volleyball performances.	25 matches from the Men'sWorld Cup 2007. *Block, attack, serve, and set.*	Cluster analysis and Multinomial logistic regression. *VROS*	Strategic behaviour was affected by the interaction of quality of opposition and match status.

Table 4 (Part 2). Studies with predominantly predictive analysis according to Skills and their relationship with success.

Author	Aim of study	Sample/ Variables	Statistic/ Software	Result
Patsiaouras et al. (64)	To evaluate the importance of technical skills that led to the success of the national teams.	29 matches of the Men´s 2008 Beijing Olympic Games. *Service, service reception, attack, and attack blocked.*	Parametric statistical analysis. *Data Volley*	The results showed that, service points, reception errors are the skills that can influence the game result. - The attacks blocked also emerged as important factor that were decisive for winning or losing a match.
Peña et al. (65)	To determine which skills and factors better predicted the outcomes.	125 matches from 2010/11 Spanish Men's First Division Volleyball Championship. *Service, reception, attack, block, result, team category, home/away court factors, and points obtained in the break point phase.*	Multinomial logistic regression. *Data Volley*	- The variables of team category, points obtained in the break point phase, number of reception errors, and number of blocked attacks by the opponent were significant predictors of winning or losing the matches. - Odds ratios indicated that the odds of winning a volleyball match were 6.7 times greater for the teams belonging to higher rankings and that every additional point in Complex II .
Silva et al. (71)	Identify the volleyball skills that discriminate in favor of victory.	24 matches from Men's 2010 Volleyball World Championship. *Serve, attack, block, set, dig and reception and outcome).*	Discriminant function analysis. *Data Volley*	- Service points, reception errors, and blocking errors were the discriminating variables that identify the final outcome of the match (victory/defeat). - Service points were the major variable most likely associated with match success (victory).

Predictive analysis

Studies with predictive nature (62% of total screening studies), were also organized into three different research lines: 1) skills and their relationship with success (Table 4); 2) player position (Table 5) and 3) match phase (Table 6).

Volleyball MA articles were published in 12 Sports Sciences Scientific journals (*International Journal of Performance Analysis in Sport* - 58.8%, *Journal of Sports Science and Medi-cine* - 5.8%, *Journal of Strength and Conditioning Research* - 5.8%, *Perceptual and Motor Skills* - 5.8%, *International Journal of Medicine and Science of Physical Activity and Sport* - 2.9%, *International Journal of Sport Science* - 2.9%, *Journal of Human Kinetics* - 2.9%, *Journal of Physical Education & Sport / Citius Altius Fortius* - 2.9%, *Journal of Quantitative Analysis in Sports* - 2.9%, *Journal of Sports Sciences* - 2.9%, *Research Quarterly for Exercise & Sport* - 2.9%, *The Journal of Sports Medicine and Physical Fitness* - 2.9%.).

Table 5. Studies with predominantly predictive analysis according to player position.

Author	Aim of study	Sample/ Variables	Statistic/ Software	Result
Afonso et al. (1)	To examine predictors of the setting zone in elite-level men's volleyball.	21 matches from the Men's 2007 World Cup. *Setting zone, server player (type, direction, depth), reception zone, receiver player and reception type.*	Multinomial logistic regression. *Excel*	- The tennis jump serve, serves from the middle player, deep serves, reception near the end line or sidelines, reception by the zone 4 attackers when in defensive zone, and low reception all proved to impair the quality of reception, demanding the setter to play more often in the not acceptable setting zone.
Silva et al. (70)	To analyze and understand what happens when the setter is in the attack zone, identifying the skills that best discriminate for victory or defeat.	24 matches from Men's 2010 Senior Volleyball World Championship. *Service, attack, block, set, dig and reception and outcome.*	Discriminant function analysis. *Data Volley*	- The serve point, service error, excellent set, set error, attack error, excellent dig and side-out error were discriminating variables that identify the final outcome of the match.
Silva et al. (72)	To analyze the discrimination skills according to the setter position in the defense zone (Zones 1, 6, and 5).	49 matches from the semi-finals of Men's senior volleyball competitions during the biennium 2010–2012. *Service, attack, block, set, dig and reception and outcome.*	Discriminant function analysis. *Data Volley*	- The reception error, counter attack point, set error, and attack point were discriminating variables that can identify the final outcome. - Success with the match skills of attack point and counter attack point often predict a winning outcome.

Table 6. Studies with predominantly predictive analysis according to match phase.

Author	Aim of study	Sample/ Variables	Statistic/ Software	Result
Zetou et al. (77)	To present the playing characteristics of the teams in complex II and to attempt to determine which of these characteristics led to victory and to the final ranking of the teams.	38 matches from Olympic Volleyball Men's Games. *Service, block, dig and Counter attack.*	Discriminant function analysis and Stepwise method. *Data Volley*	These results conclude that "ace" in service and in counterattack remain powerful aggressive tools for high level teams and were predictors to win.
Marcelino et al. (43)	To identify the probability of winning each Volleyball set according to game location.	275 sets in the 2005 Men's Senior World League. *Set result, game location, set number and performance indicators*	Student T-test, Binary logistic regression analysis. *VIS*	- Winning a set is significantly related to performance indicators. - Home teams always have more probability of winning the game than away teams, regardless of the set number.
Castro & Mesquita (15)	To analyze possible determinants that might predict the attack tempo in the Volleyball's complex II.	28 matches from Men´s 2007 World Cup. *Attack tempo, dig type, dig zone, dig efficacy and setting zone.*	Multinomial logistic regression. *VROS*	- The dig type, dig efficacy and setting zone demonstrated predictive power of the attack tempo. - The higher frequency of the dig without all attack options is, perhaps, an explanation to the high values of the non acceptable setting zone, whose occurrence promotes a slower attack organization.
Castroet al. (16)	To identify performance indicators predicting attack efficacy in volleyball's game phase denominated Complex II.	28 matches from the Men's 2007 World Cup. *Attack efficacy, tempo, type; number of attackers available, dig efficacy, setting zone and number of blockers*	Multinomial logistic regression. *VROS*	- Power attack and Attack tempo 1 increased the probability of an Attack point. - The supremacy of Attack tempo 3 and the high frequency of two blockers and three blockers reflected the difficulty of efficient attack during Complex II.
Nikos & Elissavet (54)	To analyze the probabilistic relationships that might predict attack efficacy relating to setter's performance as a function of attack tempo in Complex I.	30 matches from 2004 Men´s Olympic Games. *Set and attack.*	Chi-Square Test, ANOVA and Multinomial logistic regression. *Without software information*	- Results on odds ratios showed that when setter's performance was excellent so that attackers made first or second tempo attacks, the probabilities of gaining a direct point were strongly increased.
Alexandros et al. (3)	To investigate the existence, strength and consistency of the home advantage effect.	6681 matches from championships of the last decade in first division Italy and Greece for both men and women. *Home advantage, win and defeat.*	Chi-square test and Markov-chain. *Web sites.*	- Home wins in games (58.1%), in sets (55.6%) and in points (50.86%) were significantly greater than the theoretically expected 50%.

Discussion

The main goal of this paper was to review the available literature on match analysis in adult male Volleyball. Thirty-four studies published between 1992 and 2014 were included in this review. The discussion section is organized into two levels of analysis, according to their research design (comparative or predictive) and depending on the type of variables analyzed (skills and their relationship with success, player position and match phase), limitations are also discussed.

Comparative analysis

Comparative studies have an incidence of 38% (13 articles), organized in three research lines: 1) skills and their relationship with success; 2) player position and 3) match phase.

1) Skills and their relationship with success

In the seven comparative studies related to game actions and their relationship with success (Table 1), the authors tried several ways of analysing the performance of the teams.

There are studies that analyse or compare all the skills of the game simultaneously and relate them with success (Palao et al., 2004; Yiannis & Panagiotis, 2005) and studies that analyse

41

only one or two skills actions and relate them with success, pointing out how they interfere with the previous action and the game or contribute to the final result (Araújo, Castro, Marcelino, & Mesquita, 2010; Araújo, Mesquita, & Marcelino, 2009; Bergeles et al., 2009; Lirola & González, 2009).

The vast majority of analysed competitions were not recent, being the most recent in 2007 (Araújo et al., 2010; Araújo et al., 2009; Monteiro, Mesquita, & Marcelino, 2009). With the natural evolution of volleyball, these data may have changed (Drikos & Vagenas, 2011), i.e. due to changes in the physical (Trajkovic et al., 2010), technical/tactical (João et al. 2010) profile of the players and the increased speed of the game, the way on how to play the game skills may no longer be the same (Marcelino et al., 2012; Peña et al. 2013; Silva et al., 2014a), and the current values may be different from those of the period.

Analysis were performed on accumulated data of performance indicators, in order to identify and quantify the performance of players in all game skills (Palao et al., 2004; Yiannis & Panagiotis, 2005) or specifically in the block (Araújo et al., 2010; Araújo et. al, 2009), attack (Bergeles et al., 2009; Monteiro et al., 2009), reception (Lirola & González, 2009) relating them, in some cases, with performance (Bergeles et al., 2009; Palao et al., 2004), efficiency (Moras, et al., 2008; Yiannis & Panagiotis, 2005), constraint (Araújo et al., 2010; Araújo et al., 2009) and result (Monteiro et al., 2009).

It is important to highlight that comparative studies enabled the identification, description and comparison of the structure and/or the game patterns, being based on more accurate methodologies, which represents a significant advance in research conducted so far.

Despite the relevance of such an approach, it was not possible for the authors to forecast the sport performance (Lames, 2006), because no reference values were found, which are essential for a better organisation of training and competition process. One of the limitations encountered was the fact that there is a need to complement this analysis with the use of stronger models, where the non-linearity of behaviours is considered (O'Donoghue, 2010).

The vast majority of studies used statistical technique as the *Chi-square test* with the exception of Yiannis and Panagiotis (2005) who used the T-test. Concerning to data collections strategies, two studies did not reference any software for data collection. The *VIS software* was used by Palao et al. (2004) and the *Volleyball Rally Observation System (VROS)* was used by Araújo et al. (2009; 2010) and by Monteiro et al. (2009).

2) Player Position

In this context five studies were performed (Table 2). Three of these studies have as common goal understanding the quality of the effect of preceding action in the execution of a certain action (Alexandros & Athanasios, 2011) or in the team offensive organization (Papadimitriou et al., 2004; Busca & Febrer, 2012). The other two studies analyzed one skill (service) (Laios & Kountouris, 2010) or two skills (service and reception) (Laios & Kountouris, 2011) according to the line-up (Laios & Kountouris, 2010; Laios & Kountouris, 2011).

With recourse to bivariate analyses, using the Chi-square test statistical technique in all these studies, these studies relate the different specific positions of the players with specific performance indicators, in terms of the effectiveness of the skills of game (Alexandros & Athanasios, 2011; Busca & Febrer, 2012 Papadimitrio et al. 2004), and in term of the line-up (Laios & Kountouris, 2010; Laios & Kountouris, 2011).

The results show that the requirements, both on a technical and tactical level (Papadimitrio et al., 2004), are distinct from player to player, according to the line-up (Laios & Kountouris,

2010; Laios & Kountouris, 2011) and the role that these play (Alexandros & Athanasios, 2011; Busca & Febrer, 2012; Papadimitrio et al., 2004,) usually have a cause-effect relationship between game skills and the tactical organization of the teams, stressing the importance of the specificity of training in light of the peculiarities of the functional specialisation.

Although the first article compared the different positions of the players with specific performance indicators, it's about ten years old (Papadimitrio et al., 2004). This topic recently sparked the interest of some researches.

Of all the studies reviewed, apart from the study performed by (Papadimitrio et al., 2004) did not show significant associations between performance indicators (reception) and the efficiency of the skills (pass and attack). The meaning of these results, contrary to the majority of research, may be due to the characteristics of the sample of this study, which may be slightly out of date, given that it refers to the 1998/1999 season of the Greek A1 Men's National Division.

On the five studies reviewed, three different observation softwares for data collection and observation were used. *Data Volley* (Laios & Kountouris, 2010; Laios & Kountouris, 2011), *Vicas Analysis System* (Papadimitrio et al., 2004) and *VirtualDub* (Alexandros & Athanasios, 2011), and the study of (Busca & Febrer, 2012) does not provide any software information.

3) Match Phase

Currently, there is very little information about the variation of performance, whether on global performance or in efficiency in game skills, throughout the different phases or critical periods of the game (Bar-Eli & Tractinsky, 2000; Navarro, Lorenzo, Gômez, & Sampaio, 2009). Proof of this is the availability of a single comparative study (Table 3) in this review (Marcelino, Sampaio, & Mesquita, 2012) making it more difficult to characterise the lines of research both in methodologies and the results.

Marcelino et al., (2012), using the software *VROS* and analyzing games from Men's 2007 World Cup, concluded that volleyball matches presented different profiles depending on the match period and that the most important points occur at the end of the set, recommending to the players to manage their effort throughout the match attempting to reach this period in optimal condition.

Given that there are differences between the periods or phases of the game, these can provide important perspectives on, for example, a more appropriate design of specific programmes on how to prepare for competitions. This information may also be useful for coaches to manage the substitutions, because knowing the physical and psychological characteristics of their athletes they can take more assertive decisions, putting the athletes in play with the best profile during each particular phase of the game.

Comparative studies are currently based on more accurate methods, which represented a significant advance in MA (Marcelino et al., 2011). The understanding of the game has improved, to the extent that contemplates the possibility of detecting differential performances on the basis of certain characteristics of the game, players and respective match skills.

Predictive analysis

In a study of this nature, its added value lies in the possibilities that these represent in the strategic training and preparation of the game (Peters & O'Donoghue, 2013), being however, more susceptible to speculation (Heazlewood, 2006). The relationship between performance indicators and the match final results allows the identification of the sports performance in competition (James 2006; O'Shaughnessy, 2006).

The articles selected in this review showed that seventeen studies (62%) used predictive analysis to study performance, organized in three research lines: 1) skills and their relationship with success; 2) player position and 3) match phase.

1) Skills and their relationship with success

From the chronological analysis (Table 4) it was seen that twelve studies were conducted, and the first study was (Eom & Schutz, 1992), going on to predictive analytics, linking game skills to success, representing a gap of 16 years. From 2008 the production of studies with this type of analysis has become more systematic, investigations aiming know the relationship between the game skills and the final result (Asterios, Kostantinos, Athanasios, & Dimitrios, 2009; Moras et al., 2008; Patsiaouras, Moustakidis, Charitonidis, & Kokaridas, 2011; Pena, Rodriguez-Guerra, Busca, & Serra, 2013; Silva, Lacerda, & Joao, 2014a), differences between gender (Joao et al., 2010), ranking (Marcelino, Mesquita, & Afonso, 2008; Marcelino, Mesquita, & Sampaio, 2011; Patsiaouras, Moustakidis, Charitonidis, & Kokaridas, 2010) and sets (Drikos et al., 2009; Drikos & Vagenas, 2011).

The common goal of these studies was to understand and determine the most effective ways to play the game, through the use of multidimensional qualitative data rather than one-dimensional frequency data, therefore improving the ability to describe the game of volleyball.

The authors used statistical techniques that have gone through log-linear procedures (Eom & Schutz, 1992), Pearson correlation coefficients (Marcelino et al., 2008; Drikoset al., 2009), Discriminant analysis (Asterios et al., 2009; Joao et al., 2010; Drikos & Vagenas, 2011; Silva et al., 2014a), Kruskal-Wallis nonparametric test and Mann - Whitney U test showed (Patsiaouras et al., 2010); Parametric statistical analysis (Patsiaouras et al., 2011), Multinomial logistic regressions (Marcelino et al., 2011; Moras et al., 2008, Pena et al., 2013).

The competitive level of the teams is an indispensable factor for this kind of analysis and should be as representative as possible (Marcelino et al., 2011). Samples used were closed to the data of publications, being only one older than two years (Eom & Schutz, 1992). Two studies were related to national championships (Drikos et al., 2009; Pena, et al., 2013), with the others relating to national teams international competitions, which leads us to think that the results can be current and consistent with the standards of today's game.

In twelve studies analysed there is a notorious tendency towards the use with increasing frequency of observation *Data Volley software*, which was used in seven studies. This software is used by most teams worldwide and allowed the access to total and detailed qualitative statistics by set and offered a wealth of various data (Drikos et al., 2009; Rodríguez-Ruizet al., 2011). These teams use scouts with vast experience in observation of the game thereby ensuring the quality in information collected.

Overall the results show that there is an effect on the quality of the playing skills in the performance of the teams (Eom & Schutz, 1992; Marcelino et al., 2011; Pena et al., 2013), pointing out that good levels of service effectiveness, attack (Asterios et al., 2009; Drikos & Vagenas, 2011; Drikos et al., 2009; Joao et al., 2010; Moras et al., 2008; Patsiaouras et al., 2010; Patsiaouras, et al., 2011; Silva et al., 2014a) and block (Marcelino et al., 2008; Silva et al., 2014b) can predict success in the final result.

2) Player position

Predictive analyses related to the positions of the players seem to be a recent research theme (Afonso, Esteves, Araujo, Thomas, & Mesquita, 2012; Silva et al., 2013; Silva et al., 2014b). The three studies included in this review (Table 5) have as their common denominator the fact that all of them do an analysis relating to setter player. Nowadays, the setter is considered essential

in a volleyball team (Matias & Greco, 2011), performing the fundamental function (Bergeles et al., 2009) of being responsible for the organization of the offensive skills of his team, either in complex I (KI) or in complex II (KII) (Castro & Mesquita, 2008; Zetou, Moustakidis, Tsigilis, & Komninakidou, 2007).

Through discriminant analysis, and using the *Data Volley software* two studies aimed to identify which game related statistics allow to predict winning and losing, when the setter is in the attack zone (Silva et al., 2013) and when the setter position in the defence zone (Silva et al., 2014b). The analysis of this variable (setter position) seems extremely important in the context of match analysis because this player is now seen as a key piece for the success of any volleyball team since his performance seems to interfere directly with the team's success (Buscà & Febrer, 2012), but surprisingly was not studied in any of the other reviewed studies.

The results show that the service, set, attack, dig and side-out were discriminating variables that identify the final outcome of the match when the setter is in the attack zone (Silva et al., 2013). When the setter was in defence zone, performance in reception, counter attack, set and attack, discriminate teams according to set final outcome (Silva et al., 2014b). Regarding the setting zone Afonso et al. (2012) using Multinomial logistic, concluded that the tennis jump serve, serves from the middle player, and low reception all proved to impair the quality of reception, demanding the setter to play more often in the not acceptable setting zone.

The above-mentioned studies present reference values of game statistics and demonstrate witch skills of the game cant interfere on the team organization or are discriminant on winning or losing the match. This profile can be of help to the coach when preparing training sessions and matches.

3) Match phase

Following research lines related to the phase of the game, six studies (Table 6) were found in this review, one of them related to Complex I (Nikos & Elissavet, 2011), three of them related to the Complex II (Castro & Mesquita, 2010; Castro, Souza, & Mesquita, 2011; Zetou, Tsigilis, Moustakidis, & Komninakidou, 2006) and two of them related to the probability of winning a set or the game depending on the game location (Alexandros, Panagiotis, & Miltiades, 2012; Marcelino, Mesquita, Andrés, & Sampaio, 2009).

Analysing the studies we can conclude that these focused on two objectives; analysing, in different complexes, the game location (Alexandros et al., 2012; Marcelino et al., 2009) and the game characteristics of the teams highlighting those taking us to victory (Zetou et al., 2006); and analysing the predictive factors of time (Castro & Mesquita, 2010) and effectiveness (Castro et al., 2011; Nikos & Elissavet, 2011) of the attack.

Regarding game location the results of the two studies performed show that home teams normally have more probability to win the points (Alexandros et al., 2012), sets and the games (Marcelino et al., 2009).

Using the same sample, methodology and observation software (*Volleyball Rally Observation System*) two studies assessed the efficacy (Castro et al., 2011) and attack time (Castro & Mesquita, 2010), in Complex II, and the conclusions presented are a reflection that the studies complement each other. Thus, the authors argue that quality of skills prior to attack interfere with the time of execution of the same (Castro & Mesquita, 2010) and that the faster and powerful the attacks are the higher the probability of getting a point (Castro et al., 2011). With an older sample of three years n = 30 matches from 2004 Men's Olympic Games (Nikos & Elissavet, 2011), but adding to the statistical calculation Chi-Square and ANOVA and only rela-

43

ting the attack with the action of the setter in Complex I, the authors also concluded that there is a relationship between the quality and speed of the attack and the performance of the setter, i.e. a good distribution provides faster and powerful attacks.

To present the playing characteristics of the teams in complex II and to attempt to determine which of these characteristics led to victory and to the final ranking of the teams in Olympic Volleyball men's games (n= 38 matches) (Zetou et al., 2006) concluded that "ace" in service and the counterattack remain powerful aggressive tools for high level teams and were predictors to win.

The trend of the results suggests the need to clarify the relationship between performance indicators and overall performance levels (victory or defeat) calling for the use of more robust methodological designs, which can be reproduced.

At a conceptual level, studies focused on three lines of research skills and their relationship with success, play position and match phase. From a methodological point of view, there is a passage of comparative studies, where the cumulative statistics were the most commonly used analysis criteria, to predictive studies.

This recent more predictive approach came up with the objective of identifying the relationship between variables, considering their possible interactions and, consequently, their effect on the performance of the team, contributing to a better understanding of the performance of the game of Volleyball through MA.

Conclusion

This systematic review shows a light balance in the production of comparative and predictive studies, although there is a supremacy of predictive studies (62%) than comparative (38%). The trend is that last researches are of predictive nature.

Although the research has two types of studies, predictive and comparative, it is possible to infer that both are complied with the same research lines: skills and their relation with success; match phase and player position.

Regarding the samples, it´s notorious that the data used in

comparative studies is older than the predictive studies. With the natural evolution of Volleyball, this data could have suffered changes, not providing essential reference values for a better organization of the training and competition process.

The game of volleyball has evolved over the years, along with the development of computer systems and software that enable knowledge and a deeper understanding of the performance phenomenon (Drikos et al., 2009, Silva et. al, 2014a). A current challenge involves the creation of suitable video sequences that can clearly identify and categorise individuals and behaviours over time and regular patterns of play. Analysing the software used in the studies of this review it is possible to infer that currently the most frequently used software are *Data Volley* (35%), *VROS* (21%) and *VIS* (12%) being noted as a limitation to the analysis of some studies (12%) that this does not make reference to the type of software or technical observation they used.

Given that it is essential to identify and quantify the stability and current behavioural standardisation in the game, in order to provide substantive and relevant feedback about the irreducibly complex nature of sports performance in competition (Marcelino et al., 2011), we recommend the adoption of more robust methodologies, capable of replication without neglecting the reliability of data, instability and variability of the materials under study, thereby helping coaches in the optimising the training process of young athletes and the implementation of more effective training methodologies in elite athletes.

Apart from the suggestions described previously, it seems relevant to replicate, with actual samples, studies of the game related skills and start to point with skills are discriminants, regarding the setter position (defensive zone (zones 1, 6 and 5) or in the attack zone (zones 4, 3 and 2)) for a future comparison of the intervention in the game complexes (KI and KII) trying to identify which rotations a team has been more or less efficient.

It is hoped that this study will provide the opportunity to explore and learn from literature that is available in Volleyball and overall to encourage researchers to study the sport.

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