UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO

Análise da equipa de voleibol de alto nível em função da posição do distribuidor e da rotação regulamentar

TESE DE DOUTORAMENTO EM CIÊNCIAS DO DESPORTO

Miguel Alexandre Barros Teixeira Da Silva

SUPERVISOR:

Paulo Alexandre Vicente dos Santos João

Vila Real, 2016

UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO

Análise da equipa de voleibol de alto nível em função da posição do distribuidor e da rotação regulamentar

TESE DE DOUTORAMENTO EM CIÊNCIAS DO DESPORTO

Miguel Alexandre Barros Teixeira Da Silva

SUPERVISOR:

Paulo Alexandre Vicente dos Santos João

Composição do Júri:

_____

_____

_____

_____

_____

_____

_____

Vila Real, 2016

Silva, M. (2016). Análise da equipa de voleibol de alto nível em função da posição do distribuidor e da rotação regulamentar. University of Trás-os-Montes and Alto Douro, Research Centre in Sport, Health and Human Development.

E-mail: mmiguelfpv@gmail.com

This academic dissertation was submitted with the purpose of obtaining a doctoral degree in Sport Sciences according to the provisions of Portuguese DecreeLaw 107/2008 of June 25th.

"It is the mark of an educated mind to be able to entertain a thought without accepting it."

Aristotle

I dedicate this work to my Father Belmiro, Grandparents Belmiro and Florêncio and to Uncle Neca (*in memoriam*).

ACKNOWLEDGEMENTS

A minha Mãe, minha Irmã, por serem pessoas muito importantes na minha vida, obrigado por estarem presentes em todos os meus momentos bons e menos bons, sempre prontas a ouvir, ajudar e aconselhar. Muito obrigado por me ajudarem a crescer!

Por último mas os de maior importância aos meus meninos, Zé Miguel e Zé Pedro que tornam todos os momentos em que estamos juntos inesquecíveis e únicos. A verdadeira felicidade está na própria casa entre as alegrias da família e vocês são a minha alegria! À minha esposa Rita, por todo o apoio que me deu, pelas sugestões, pela preocupação constante e pelo incentivo, pelo carinho e pelo amor demonstrado ao longo destes anos e durante todo este percurso.

Hoje quero parar e agradecer, porque vocês fizeram, fazem e farão sempre parte de minha história! Eu Amo Vocês!

TABLE OF CONTENTS

LIST OF PUBLICATIONS

During the developmental stages of this thesis, some work has been published, accepted or submitted for publication in peer reviewed journals, as well as, presented at scientific meetings originating some publications in proceedings. Forthcoming we present a selection of the publications and communications specifically related with the work developed in this thesis.

PEER REVIEWED PAPERS IN INTERNATIONAL JOURNALS (ISI)

Silva, M., Lacerda, D., & João, P. V. (2013). Match analysis of discrimination skills according to the setter attack zone position in high level volleyball. *International Journal of Performance Analysis in Sport*, *13*(2), 452-460.

Silva, M., Lacerda, D., & João, P. V. (2014). Game-Related volleyball skills that influence victory. *Journal of Human Kinetics*, *41*(1), 173-179. doi: 10.2478/hukin20140045

Silva, M., Lacerda, D., & João, P. V. (2014). Match analysis of discrimination skills according to the setter defence zone position in high level volleyball. *International Journal of Performance Analysis in Sport*, *14*(2), 463-472.

PEER REVIEWED PAPERS IN INTERNATIONAL JOURNALS

Silva, M., Marcelino, R., Lacerda, D. & João, P. V. (2016). Match Analysis in Volleyball: a systematic review. *Montenegrin Journal of Sports Science and Medicine*, 1: 35-46

COMMUNICATIONS AT SCIENTIFIC MEETINGS

Oral Communications

Silva, M; Lacerda, D. & João, P.,V. (2014) Match analysis of discrimination skills according to the setter attack zone position in high level volleyball "Congresso de Ciências do Desporto, Exercício e Saúde" UTAD, 1 a 3 de maio de 2014.

Works submitted for publication:

Silva, M.; Sattler, T.; Lacerda, D. & João P. V. (2016). Match analysis according to the performance of the team rotations in Volleyball. *Kinesiology.*

FIGURES INDEX

TABLE INDEX

LIST OF ABBREVIATIONS

General Introduction

MA - Match analysis

VROS - Volleyball Rally Observation System

VIS - Volleyball Information System

Study 1

MA - Match analysis

VROS - Volleyball Rally Observation System

VIS - Volleyball Information System

Study 2

SC - Structural Canonical Coefficients

M - Mean

SD - Standard Deviation

CI - Confidence Intervals

Study 3

KI - Complex I

KII - Complex II

SC - Structural Canonical Coefficients

M - Mean

SD - Standard Deviation

Study 4

KI - Complex I

KII - Complex II

SC - Structural Canonical Coefficients

M - Mean

SD - Standard Deviation

Study 5

S - setter

OH - outside hitter

MD - middle blocker

OP - opposite

P1 - Rotation 1

P2 - Rotation 2

P3 - Rotation 3

P4 - Rotation 4

P5 - Rotation 5

P6 - Rotation 6

FRA - France

BRA - Brazil

CUB - Cuba

SRB - Serbia

ESP - Spain

BUL - Bulgaria

RUS - Russia

USA - United States of America

ARG - Argentina

ITA - Italy

CZE - Czech Republic

GER - Germany

EST - Estonia

POL - Poland

POR - Portugal

ROM - Romania

SLV - Slovenia

SVK - Slovakia

TUR - Turkey

FIN - Finland

NED - Netherlands

ABSTRACT

This dissertation aims to study the sports performance in adult male Volleyball based on match analysis. To achieve this goal, an article of systematic review and four empirical articles were written. This systematic review shows that the 34 studies included are of two types of nature, predictive and comparative, and Data Volley being the observation and data collection software more frequently used. The trend shows that the latest research is of predictive nature. Although the research is based on two types of studies, predictive and comparative, it is possible to infer that both comply with the same research lines: skills and their relation to success; match phase and player position. In the data analysis of the four empirical studies the discriminating function was used in order to identify, throughout canonical structuring coefficient, the indicators which contributed the most to establish the maximum difference between the victories and defeats. The study samples were based on adult men's national teams' matches in main competitions events (study 1 and 2 n=24 games; study 3 and 4 n=49 games). The first empirical study was conducted to identify which skills are discriminant in favour of victory. Results suggest that service points, reception errors, and blocking errors were the discriminating variables that identify the final outcome of the match (victory/defeat). Moreover, successful service points were the major variable most likely associated with match success (victory). The goal of the second study focused on analysing and understanding what happens when the setter is in the attack zone (Zones 4, 3 and 2), identifying the skills that best signpost victory or defeat. This study revealed that the service point, service error, excellent set, set error, attack error, excellent dig, and side-out error were indicative variables of the match's final outcome (victory/defeat) when the setter was in the attack zone. The third study was conducted in order to determine which match skills (discrimination skills) are related to a team's success or failure when the setter is in the defence zone (zones 1, 6 and 5). Results revealed that reception error, counter attack point, set error and attack point were discriminating variables that can identify the final outcome of the match (victory/defeat). The fourth study aimed at analysing the performance of the six volleyball regulatory rotations and identifying which rotation is the most influential on the final result of the game (victory or defeat). Results revealed that all the rotations may contribute for a global balanced performance of the team. Regarding the average point rotation difference, rotations P1, P6 and P2 were the ones that presented statistically more relevant values. Thus, we may affirm that they have influence on the victory. The present study provides, from match analysis, knowledge that would provide scientifically founded contributions for the study of performance in Volleyball considering the setter's position, crucial factor in increasing the quality of the training process and ultimately the performance in competition.

Keywords: Volleyball, match analysis, discriminant skills, setter position

RESUMO

A presente dissertação teve como objetivo estudar a performance desportiva no Voleibol sénior masculino, a partir da análise do jogo. Para o efeito, foi realizado um artigo de revisão sistemática e quatro artigos empíricos. A revisão sistemática realizada revela que os 34 estudos realizados são de dois tipos de naturezas, preditivos e comparativos, sendo o *software* de observação e recolha de dados mais utilizado o *Data Volley*. No entanto, em ambos os casos os estudos são compilados nas mesmas linhas de pesquisa: ações de jogo e sua relação com o sucesso; fase de jogo e posição do jogador. Conclui-se também que há uma tendência das pesquisas mais recentes serem de natureza preditiva. Para o tratamento estatístico dos 4 estudos empíricos procedeu-se à análise da função discriminante no sentido de identificar, através dos coeficientes canónicos estruturantes, os indicadores que mais contribuem para estabelecer a diferença máxima entre as vitórias e as derrotas. As amostras dos estudos são baseadas em jogos das principais competições de seleções nacionais, de seniores masculinos (estudo 1 e 2 n=24 jogos; estudo 3 e 4 n=49 jogos). No primeiro estudo empírico o objetivo foi identificar as ações do jogo que discriminam em função da vitória. Os resultados sugerem que o serviço ponto, a receção erro e o bloco erro foram variáveis discriminantes que identificaram o resultado final do jogo (vitória/derrota), sendo que o serviço ponto é a variável com maior probabilidade de estar relacionada com a vitória no jogo. No segundo estudo objetivou-se analisar e perceber o que acontece quando o distribuidor está na zona de ataque (Zona 4, 3 e 2), identificando as ações de jogo que melhor discriminam a favor da vitória ou da derrota. Este estudo revelou que o serviço ponto, o serviço erro, o passe excelente, o passe erro, o ataque erro, a defesa excelente e o *side-out* erro foram variáveis discriminantes que identificaram o resultado final (vitória/derrota) quando o distribuidor está na zona de ataque. O terceiro estudo foi realizado com o intuito de analisar e perceber quais são as ações de jogo que estarão adstritas ao sucesso ou insucesso, quando o distribuidor está na zona de defesa (Zona 1, 6 e 5). Os resultados revelaram que as variáveis receção erro, contra ataque ponto, passe erro e ataque ponto foram variáveis discriminantes que podem influenciar o resultado final do jogo (vitória/derrota), quando o distribuidor se localiza na zona de defesa. O quarto estudo empírico teve como objetivo analisar a performance das seis rotações regulamentares do jogo de Voleibol e identificar as rotações que mais contribuem para a vitória. Os resultados revelaram que todas as rotações podem contribuir para que o desempenho global da equipa seja equilibrado. No que concerne ao coeficiente médio entre pontos ganhos e perdidos por rotação, as rotações P1, P6 e P2 foram as que apresentaram valores estatisticamente relevantes, o que nos permite concluir que estas rotações poderão estar relacionadas com a vitória. O presente estudo proporciona, a partir de análise de jogo, conhecimento que permitirá fornecer contribuições cientificamente fundamentadas para o estudo da *performance* no Voleibol, considerando a localização do distribuidor, fator determinante, a fim de aprimorar a qualidade do processo de treino e por inerência as prestações na competição.

Palavras-chave: Voleibol, análise do jogo, ações de jogo, localização do distribuidor

RÉSUMÉ

Cette dissertation a comme objectif l'étude de la performance sportive du Volleyball masculin sénior, sur la base de l'analyse de jeu. A cet effet, il a été réalisé un article de révision systématique et quatre articles empiriques. La révision systématique montre que les 34 études incluses sont de deux types de natures, prédictives et comparatives, étant le *Software Data Volley* le plus utilise pour l'observation et la recherche de donnees. Les tendances des récentes recherches sont de nature plutôt prédictive. Bien que l'investigation ait deux types d'études, prédictives et comparatives, il est possible d'en déduire qu'elles sont centrées sur les mêmes thèmes de recherches: actions de jeux et sa relation avec le succès; phase de jeu et position du joueur. Pour le traitement statistique 4 études empiriques on a procédé à l'analyse de fonction discriminante, d'identifier à travers les coefficients structurels canoniques, les indicateurs qui contribuent le plus à établir la différence maximale entre victoires et défaites. Les études sont basées sur jeux des compétitions de sélections nationales masculines senior (étude 1 et 2 n= 24 jeux; étude 3 et 4 n=49 jeux). Dans la première étude empirique l'objectif est d'identifier les actions de jeu qui influencent la victoire. Les résultats suggèrent que le service gagnant, la réception faute et le bloc faute sont des variables qui impactent le plus sur le résultat final du jeu (victoire/défaite). Sachant que le service gagnant est la variable qui influencent le plus sur la victoire. Dans la deuxième étude l'objectif est d'analyser et de comprendre ce qui arrive quand le passeur est dans la zone d'attaque (zone 4, 3 et 2), et son influence sur la victoire ou la défaite. L'étude a révélé que le service gagnant, le service faute, la passe excellente, la passe faute, l'attaque faute, la défense excellente et le side-out (réception puis attaque) faute ont été les facteurs qui ont le plus influencés le résultat final (victoire/défaite) quand le passeur est dans la zone d'attaque. La troisième étude a été réalisée avec l'intention d'analyser et de comprendre quelles sont les actions de jeu qui sont liées au succès ou à la défaite quand le passeur est dans la zone de défense (Zone 1, 6 et 5). Les résultats ont révélés que dans cette zone, les diverses fautes réceptions, contre-attaque gagnantes, la passe faute et l'attaque gagnant ont été les facteurs qui peuvent influencer le plus le résultat final du jeu (victoire/défaite). La quatrième étude empirique a eu comme objectif d'analyser la performance des six rotations règlementaires du volleyball et d'identifier les rotations qui contribuent le plus à la victoire. Les résultats ont révélés que toutes les rotations peuvent aider à l'équilibre de l'équipe. En ce qui concerne la moyenne entre les points gagnants et les points perdus par rotation, les rotations P1, P6 et P2 ont été celles qui ont présentées statistiquement les valeurs les plus fortes, ce qui nous permet de conclure que ces rotations pourront être liées à la victoire. Cette étude de l'analyse de jeu, validée scientifiquement, nous permettra de fournir des clés de lecture sur la performance du volleyball en s'appuyant sur la localisation du passeur (facteur clé), et ce afin d'améliorer la qualité de l'entrainement et donc les prestations dans la compétition.

Mots-clefs: Volleyball, analyse de jeu, actions de jeu, localisation du passeur.

CHAPTER 1 – GENERAL INTRODUCTION

High level performance sports require available information so that coaches can make their own decisions before, during and after the competition. In that sense, there has been a growing concern in research for data that can bring advantages to the decision-making process (Drikos *et al.*, 2009; Carling and Dupont, 2011).

Coaches have always been concerned about optimizing their teams' performance since it is essential in competition (Carling *et al.*, 2009; Marcelino *et al.*, 2011). The performance monitoring theme and the increased demand for detailed data, either by match analysis (MA), or by means of other functional variables, has been the subject of various scientific research (Marcelino *et al.*, 2010). The results obtained in the surveys and studies conducted lead to the clarification of a number of prevalent questions regarding the effectiveness of a team in the confrontation with their opponents (Drikos *et al.*, 2009; Lago-Ballesteros and Lago-Peñas, 2010; Marcelino *et al.*, 2010).

The lack of theoretic and methodological manuals and the dispersion of scientific production in magazines which possess a widespread nature, until the beginning of the 1990s, had reflected itself in a non-systematic production of scientific work in MA (Marcelino *et al.*, 2011). Nevertheless, one of the first works published regarding MA was in 1920 (Hughes and Franks, 2004).

With the creation of international scientific societies, the edition of specialized scientific magazines in the constitution of autonomous research departments at universities (Tsigilis *et al.*, 2010), MA has been acquiring an important role in scientific literature related to the production of knowledge in the areas of sports sciences.

These kinds of tasks include the collection and processing of data, which allow the recognition and identification of the offensive and defensive tactic options that are used with a lesser or greater efficiency (Hughes and Franks, 2004).

The growing evolution of volleyball, nowadays, accomplishes an increase of studies and research which aim to explain and clarify questions related to technical and tactical (João *et al.*, 2010; Trajkovic *et al.*, 2012), physical (Gabbett *et al.*, 2007; Golik-Peric, 2011), and psychological (Valliant *et al.*, 2012) factors, helping in the development of the best individual performances and, as a consequence, the collective's performance. (Bergeles *et al.*, 2009).

Most MA used in the preparation and planning of the games has been mostly studies about the basic structure of the encounter's opponent, its style and main characteristics

(Ureña *et al.*, 2002; João *et al.*, 2010; Afonso *et al.*, 2012), this kind of help being considered as a complement of great validity for the coaches in training and competition (Hughes and Franks 2004).

Despite its importance being recognized, and the information that research has collected on this subject for both the domain of practice or research, there is a limited number of studies that focus on the analysis of performance of indicators which can distinguish between winning and losing ones, in particular recognizing that the teams are better in game skills for making more or less points and in which phase of the game that does happen; with the setter in the attack (Zones 4, 3 and 2); with the setter in the defence (Zones 1, 6 and 5); and in which regulatory rotation (P1, P2, P3, P4, P5, and P6).

With the aim of being able to improve training methodologies as well as the performances in competition, providing more useful indicators for coaches, players and their teams, the accomplishment of the present research seems to us relevant having five main objectives:

1st To identify, by means of a systematic revision of literature, the scientific production related with match analysis in Volleyball from published articles on main electronic databases;

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

Considering the importance of conducting a systematic review of scientific literature to produce scientifically-based knowledge (Morin, 2007), it becomes advisable to conduct more studies of this nature in MA. This increase in the production of studies that systematize based on a critical assessment will greatly benefit MA as a scientific area (Marcelino *et al.*, 2011).

2nd To identify the variables (skills of the game) which can influence the final outcome;

Understanding how skills performance indicators related scoring is useful for both athletes and coaches in all team sports (João *et al.*, 2010; Lobietti *et al.*, 2010; Marcelino *et al.*, 2010; Miskin *et al.*, 2010; Palao *et al.*, 2005; Zetou *et al.*, 2007). As most of these teams,

if not all, are subjected to highly specialized supervision in several fields, such as medical examination, physical preparation (Golik-Peric *et al.*, 2011; Trajkovic *et al.*, 2012), psychological support, diet control (Valliant *et al.*, 2012), and tactical orientation (Palao *et al.*, 2005; João *et al.*, 2010), it is important to know which game skills in volleyball most contribute to victory.

3rd and 4th To identify the game skills that can contribute to the final outcome when the setter is in the attack zone (Zone 4, 3 and 2) and when the setter is in the defence zone (Zone 1, 6 and 5);

Since authors (Palao and Ahrab–Fard, 2011) have indicated criteria to classify rotations by their importance in competitive volleyball (i.e., the court position of the setter), two stages of the match can be distinguished: when the setter is in the attack or defence zone.

Research completed in the domain of a volleyball game analysis has focused on the importance of teams' success and failure (Drikos *et al.*, 2009). There are studies which focus on the analysis of the setting associated with variables such as reception, attack and side-out (Palao *et al.*, 2005; Afonso and Mesquita, 2011; Costa *et al.*, 2011). The same studies reveal that there are dependent relations between the quality of the skill and the setting zone, between the reception efficacy and the attack zone, between attack time and effect with the number of blockers. Nevertheless, studies do not relate these variables with the setter's position (Durkovic *et al.*, 2008).

5th To identify which of the six regulatory rotations has the best performance.

In technical language an individual rotation is determined according to the current position of the setter (in rotation 1 the setter is in zone 1 (P1); in rotation 2 the setter is in zone 2 (P2), etc.) (Zadražnik *et al.*, 2009).

Regularity performance depends on the balance of the playing quality in individual rotation; however, statistical game analyses reveal that such balance is also difficult to achieve in high quality teams (Zadražnik *et al.*, 2009). In order to try to achieve this balance, teams place their players on the court accordingly, and tend to start with their stronger rotations since these are the rotations that will be repeated most often (Palao and Ahrab–Fard, 2011).

The final goal of this study is to provide results which can yield important information and represent a trustworthy database and, consequently, a helpful instrument in the process of training to improve the performance of players and teams.
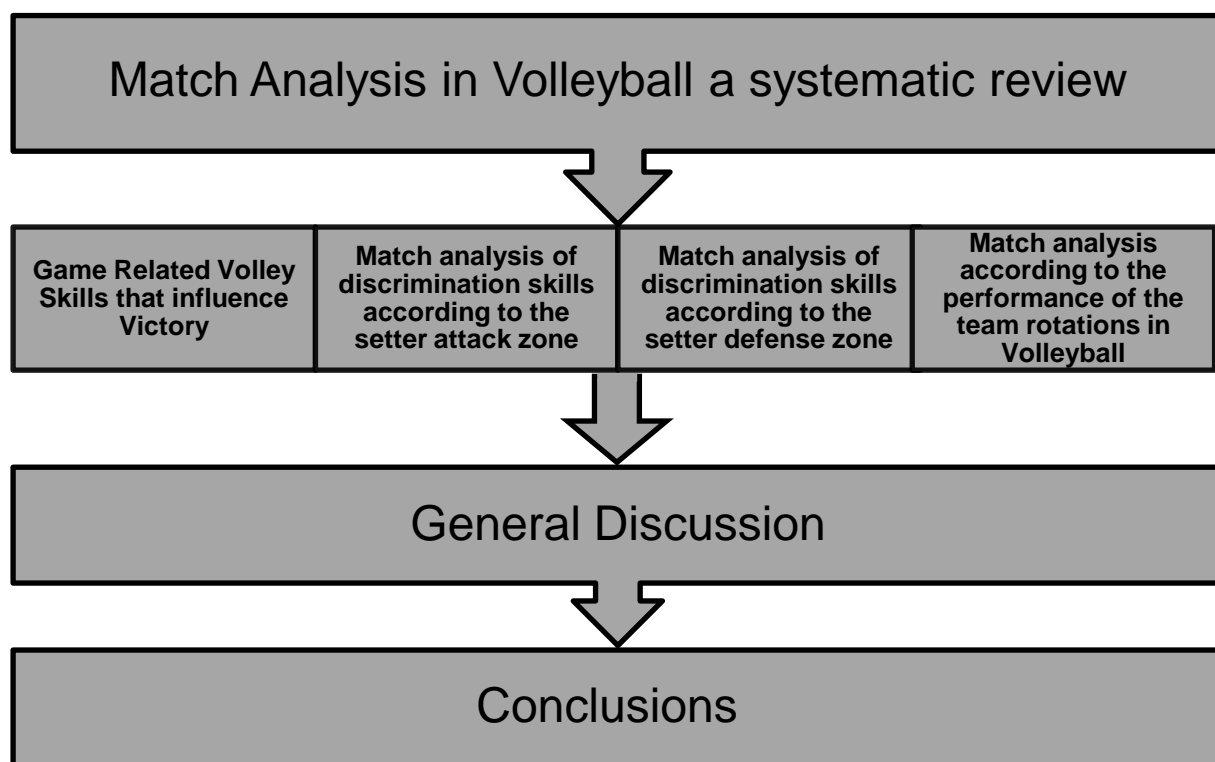
Figure1. Chronogram of Studies according the systematic review and 4 empiric subjects in this research.

CHAPTER 2 - STUDIES

Study 1: Match Analysis in Volleyball: a systematic review

Silva, M., Marcelino, R., Lacerda, D. & João, P. V. (2016). Match Analysis in Volleyball: a systematic review. **Montenegrin Journal of Sports Science and Medicine**,1: 35-46. UDC 796.325:001.891.3

Match Analysis in Volleyball: a systematic review

Miguel Silva, Rui Marcelino, Daniel Lacerda and Paulo Vicente João
University of Trás-os-Montes and Alto Douro, Research Center in Sport Sciences, Health Sciences and Human Development, CIDESD, Creative Lab Research Community at Vila Real, Portugal

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; LagoBallesteros & LagoPeñas, 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 &

Athanasios, 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; João 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 review of

_____

literature articles to produce scientifically based knowledge (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 systematic 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 characterize study methodologies, samples, variables and the data collections software used. Three independent reviewers separately conducted the analysis performed on 10 November 2014.
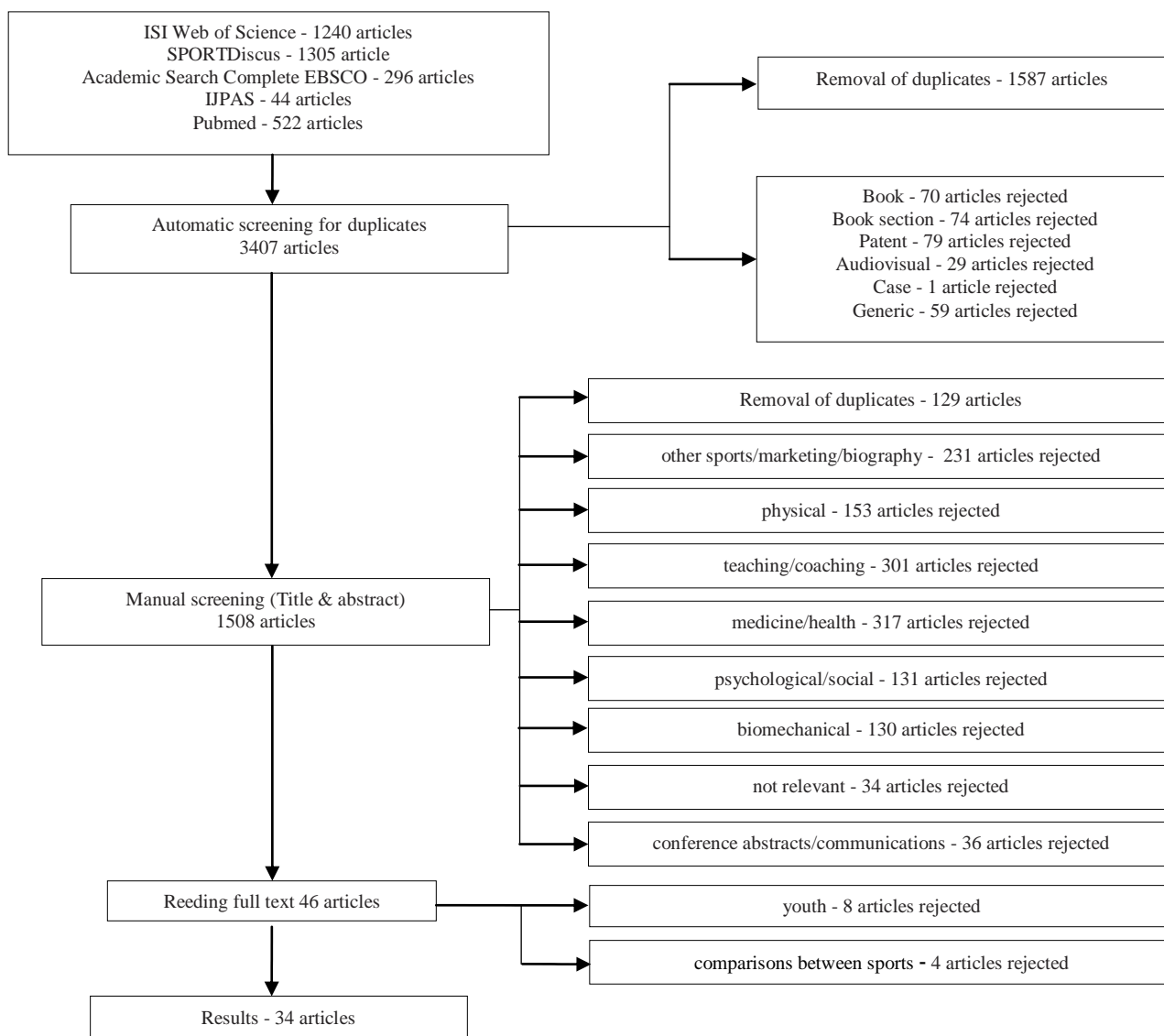
Figure 1. Flow chart of methodology used for the article search

The electronic databases used were *PubMed, Web of Science, 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 Performance 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-reviewed publications using the combinations of keyword "Volleyball" with the following terms: "performance analysis", "match analysis", "game analysis", "notational analysis", "tactical 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, Portuguese or Spanish language. Studies were excluded if they: (1) related to beach volleyball or other sports; (2) thematic related to medicine, health, biomechanical, physical, psychological or teaching; (3) did not include any relevant; (4) were conference abstracts, communications, proceedings' or news.

If there was disagreement amongst authors regarding the inclusion of certain articles, the final decision was left to the senior 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

36

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.*	ChiSquare 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.*	ChiSquare 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 elitelevel 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.*	ChiSquare 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 counterattack. 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.*	ChiSquare 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

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 lineups 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 lineups.
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 lineups.
Busca & Febrer (11)	To analyze the temporal fight of the volleyball Spanish highlevel setter and the opponent middleblocker 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

(21 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.

38

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. *Firstorder (passto 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 firstorder and secondorder 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 clearcut 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 gamerelated 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.

39

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 elitelevel 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 semifinals 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.

40

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 only

41

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 nonlinearity of behaviours is considered (O'Donoghue, 2010).

The vast majority of studies used statistical technique as the *Chisquare test* with the exception of Yiannis and Panagiotis (2005) who used the Ttest. 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 Chisquare 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 causeeffect 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 (BarEli & 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 loglinear 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), KruskalWallis 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 abovementioned 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 ChiSquare and ANOVA and only relating

43

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 com-

parative 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.

R E F E R E N C E S

Afonso, J., Esteves, F., Araújo, R., Thomas, L., & Mesquita, I. (2012). Tactical determinants of setting zone in elite men's volleyball. *Journal of Sports Science & Medicine*, *11*(1), 64-70.

Alexandros, L., & Athanasios, M. (2011). The setting pass and performance indices in Volleyball. *International Journal of Performance Analysis in Sport*, *11*(1), 34-39.

Alexandros, L., Panagiotis, K., & Miltiades, K. (2012). The existence of home advantage in volleyball. *International Journal of Performance Analysis in Sport*, *12*(2), 272-281.

Araújo, R., Castro, J., & Marcelino, R. (2010). Relationship between the Opponent Block and the Hitter in Elite Male Volleyball. *Journal of Quantitative Analysis in Sports*, *6*(4), 1-12.

Araújo, R., Mesquita, I., & Marcelino, R. (2009). Relationship between block constraints and set outcome in elite male volleyball. *International Journal of Performance Analysis in Sport*, *9*(3), 306-313.

Asterios, P., Kostantinos, C., Athanasios, M., & Dimitrios, K. (2009). Comparison of technical skills effectiveness of men's National Volleyball teams. *International Journal of Performance Analysis in Sport*, *9*(1), 1-7.

Bar-Eli, M., & Tractinsky, N. (2000). Criticality of game situa-

tions and decision making in basketball: an application of performance crisis perspective.*Psychology of sport and exercise*, *1*(1), 27-39.

Barris, S., & Button, C. (2008). A review of vision-based motion analysis in sport. *Sports Medicine*, *38*(12), 1025-1043.

Bento, T. (2014). Revisões sistemáticas em desporto e saúde: Orientações para o planeamento, elaboração, redação e avaliação. *Motricidade*, *10*(2), 107-123.

Bergeles, N., Barzouka, K., & Nikolaidou, M. E. (2009). Performance of male and female setters and attackers on Olympic-level volleyball teams. *International Journal of Performance Analysis in Sport*, *9*(1), 141-148.

Busca, B., & Febrer, J. (2012). Temporal fight between the middle blocker and the setter in high level volleyball. *International Journal of Medicine and Science of Physical Activity and Sport*, *12*(46), 313-327.

Carling, C., & Dupont, G. (2011). Are declines in physical performance associated with a reduction in skill-related performance during professional soccer match-play?. *Journal of Sports Sciences*, *29*(1), 63-71.

Carling, C., Reilly, T., & Williams, A. (Eds.). (2009). *Performance assessment for field sports*. London: Routledge.

Castro, J. & Mesquita, I. (2008). Implications of offensive spa-

cing in elite male volleyball attack characteristics, *Portugu-ese Journal of Sport Sciences, 8*(1), 114-125.

Castro, J. M., & Mesquita, I. (2010). Analysis of the Attack Tempo Determinants in Volleyball's Complex II–a Study on Elite Male Teams. *International Journal of Performance Analysis in Sport, 10*(3), 197-206.

Castro, J., Souza, A., & Mesquita, I. (2011). Attack efficacy in volleyball: elite male teams. *Perceptual and motor skills, 113*(2), 395-408. doi: 10.2466/05.25.PMS.113.5.395-408

DeCoster J (2005). Meta-Analysis. In: Kimberly K-L, ed. *Encyclopedia of Social Measurement*. New York: Elsevier: 683- 688.

Drikos, S., & Vagenas, G. (2011). Multivariate assessment of selected performance indicators in relation to the type and result of a typical set in Men's Elite Volleyball. *International Journal of Performance Analysis in Sport, 11*(1), 85-95.

Drikos, S., Kountouris, P., Laios, A., & Laios, Y. (2009). Correlates of team performance in volleyball. *International Journal of Performance Analysis in Sport, 9*(2), 149-156.

Eom, H. J., & Schutz, R. W. (1992). Transition play in team performance of volleyball: a log-linear analysis. *Research Quarterly for Exercise and Sport, 63*(3), 261-269. doi: 10.1080/02701367.1992.10608741

Fellingham, G. W., Collings, B. J., & McGown, C. M. (1994). Developing an optimal scoring system with a special emphasis on volleyball. *Research Quarterly for Exercise and Sport, 65*(3), 237-243.

Gabbett, T. J. (2005). Science of rugby league football: a review. *Journal of Sports Sciences, 23*(9), 961-976.

Giatsis, G. (2003). The effect of changing the rules on score fluctuation and match duration in the FIVB women's beach volleyball. *International Journal of Performance Analysis in Sport, 3*(1), 57-64.

Harris, J. D., Quatman, C. E., Manring, M. M., Siston, R. A., & Flanigan, D. C. (2014). How to write a systematic review. *The American Journal of Sports Medicine, 42*(11), 2761-2768. doi: 10.1177/0363546513497567.

Heazlewood, T. (2006). Prediction versus reality: The use of mathematical models to predict elite performance in swimming and athletics at the Olympic Games. *Journal of Sports Science and Medicine, 5*(4): 541-547.

Hughes, M., & Franks, I. (2008). *The essentials of performance analysis: an introduction*. London: Routledge.

James, N. (2006). The role of notational analysis in soccer coaching. *International Journal of Sports Science and Coaching, 1*(2), 185-198.

João, P. V., Leite, N., Mesquita, I., & Sampaio, J. (2010). Sex differences in discriminative power of volleyball game-related statistics. *Perceptual and motor skills, 111*(3), 893-900. doi: 10.2466/05.11.25.PMS.111.6.893-900

Jones, N. M., James, N., & Mellalieu, S. D. (2008). An objective method for depicting team performance in elite professional rugby union. *Journal of Sports Sciences, 26*(7), 691-700.

Karcher, Claude, & Buchheit, Martin. (2014). On- Court Demands of Elite Handball, with Special Reference to Playing Positions. *Sports Medicine (Auckland, N.Z.)*. doi: 10.1007/s40279-014-0164-z.

Kovacs, B. (2009). The effect of the scoring system changes in volleyball: a model and an empirical test. *Journal of Quantitative Analysis in Sports, 5*(3), 1559-0410.

Lago-Ballesteros, J., & Lago-Peñas, C. (2010). Performance in team sports: Identifying the keys to success in soccer. *Journal of Human Kinetics, 25*, 85-91.

Laios, A., & Kountouris, P. (2010). Association between the line -up of the players and the efficiency of the serving Team in Volleyball. *International Journal of Performance Analysis in Sport, 10*(1), 1-8.

Laios, A., & Kountouris, P. (2011). Receiving and serving team efficiency in Volleyball in relation to team rotation. *International Journal of Performance Analysis in Sport, 11*(3), 553-561.

Lames, M. (2006). Modelling the interaction in game sports- Relative phase and moving correlations. *Journal of Sports Science & Medicine, 5*(4), 556.

Lees, A. (2002). Technique analysis in sports: a critical review. *Journal of Sports Sciences, 20*(10), 813-828.

Lees, A. (2003) . Science and the major racket sports: a review. *Journal of Sports Sciences, 21*(9), 707-732.

Liebermann, D. G., Katz, L., Hughes, M. D., Bartlett, R. M., McClements, J., & Franks, I. M. (2002). Advances in the application of information technology to sport performance. *Journal of Sports Sciences, 20*(10), 755-769.

Lirola, D. C., & González, C. H. (2009). Research and analysis of the reception in the current high performance Men's Volleyball. *RICYDE. International Journal of Sport Science, 5*(16), 34-51.

Marcelino, R. O., Sampaio, J. E., & Mesquita, I. M. (2012). Attack and serve performances according to the match period and quality of opposition in elite volleyball matches. *The Journal of Strength & Conditioning Research, 26*(12), 3385-3391. doi: 10.1519/JSC.0b013e3182474269

Marcelino, R., Mesquita, I., & Afonso, J. (2008). The weight of terminal actions in Volleyball. Contributions of the spike, serve and block for the teams' rankings in the World League 2005. *International Journal of Performance Analysis in Sport, 8*(2), 1-7.

Marcelino, R., Mesquita, I., & Sampaio, J. (2011). Effects of quality of opposition and match status on technical and tactical performances in elite volleyball. *Journal of Sports Sciences, 29*(7), 733-741. doi: 10.1080/02640414.2011.552516

Marcelino, R., Mesquita, I., Andrés, J. M. P., & Sampaio, J. (2009). Home advantage in high-level volleyball varies according to set number. *Journal of Sports Science & Medicine, 8*(3), 352-356.

Marcelino, R., Mesquita, I., Sampaio, J., & Moraes, J. C. (2010). Study of performance indicators in male volleyball according to the set results. *Brazilian Journal of Physical Education and Sport , 24*(1), 69-78.

Marcelino, R., Sampaio, J., & Mesquita, I. (2011). Research on the game analysis: from static to dynamic modeling. *Revista Portuguesa De Ciências Do Desporto, 11*(1), 481-499.

Matias, C. J. A. D. S., & Greco, P. J. (2011). Offensive organization assessment of winners of brazilian Volleyball Superleague setters. *Brazilian Journal of Physical Education and Sport, 33*(4), 1007-1028.

McGarry, T., O'Donoghue, P., & Sampaio, J. (2013). *Routledge Handbook of Sports Performance Analysis*: Routledge

Medeiros, A. I. A., Palao, J. M., Marcelino, R., & Mesquita, I. (2014). Systematic review on sports performance in beach volleyball from match analysis. *Revista Brasileira de Cine-antropometria & Desempenho Humano, 16*(6), 698-708.

Monteiro, R., Mesquita, I., & Marcelino, R. (2009). Relationship between the set outcome and the dig and attack efficacy in elite male Volleyball game. *International Journal of Performance Analysis in Sport, 9*(3), 294-305.

Moore, R., Bullough, S., Goldsmith, S., & Edmondson, L. (2014). A Systematic Review of Futsal Literature. *American Journal of Sports Science and Medicine, 2*(3), 108-116.

45

Moras, G., Peña, J., Rodríguez, S., Vallejo, L., Tous-Fajardo, J., & Mujika, I. (2008). A comparative study between serve mode and speed and its effectiveness in a high-level volleyball tournament. *The Journal of Sports Medicine and Physical Fitness*, (48), 31-36.

Morin E (2007). Restricted Complexity, General Complexity. In: Gershenson C, Aerts D, Edmonds B, eds. *Science and us: Philosophy and Complexity*. Singapore: World Scientific: 1-25.

Navarro, R. M., Lorenzo, A., Gómez, M. A., & Sampaio, J. (2009) Analysis of critical moments in the league ACB 2007-08. *Sports Phycology Magazine*, *18*(3), 391-395.

Nikos, B., & Elissavet, N. M. (2011). Setter's performance and attack tempo as determinants of attack efficacy in Olympic-level male volleyball teams. *International Journal of Performance Analysis in Sport*, *11*(3), 535-544.

O'Donoghue, P. (2009). Interacting performances theory. *International Journal of Performance Analysis in Sport*, *9*(1), 26-46.

O´Donoghue, P. (Ed.). (2010). *Research methods for sports performance analysis*. London: Routledge.

O'Shaughnessy, D. M. (2006). Possession versus position: strategic evaluation in AFL. *Journal of Sports Science & Medicine*, *5*(4), 533-540.

O'Donoghue, P. (2015). *An Introduction to Performance Analysis of Sport*. London: Routledge.

O'Donoghue, P., & Holmes, L. (2015). *Data Analysis in Sport*. London: Routledge.

Palao, J. M., Manzanares, P., & Ortega, E. (2009). Techniques used and efficacy of volleyball skills in relation to gender. *International Journal of Performance Analysis in Sport*, *9*(2), 281-293.

Palao, J. M., Santos, J. A., & Ureña, A. (2004). Effect of team level on skill performance in volleyball. *International Journal of Performance Analysis in Sport*, *4*(2), 50-60.

Papadimitriou, K., Pashali, E., Sermaki, I., Mellas, S., & Papas, M. (2004). The effect of the opponents' serve on the offensive actions of Greek setters in volleyball games. *International Journal of Performance Analysis in Sport*, *4*(1), 23-33.

Patsiaouras, A., Moustakidis, A., Charitonidis, K., & Kokaridas, D. (2010). Volleyball technical skills as winning and qualification factors during the Olympic Games 2008. *International Journal of Performance Analysis in Sport*, *10*(2), 115-120.

Patsiaouras, A., Moustakidis, A., Charitonidis, K., & Kokaridas, D. (2011). Technical Skills Leading in Winning or Losing Volleyball Matches During Beijing Olympic Games. *Journal of Physical Education & Sport/Citius Altius Fortius*, *11*(2), 149-152.

Peña, J., Rodríguez-Guerra, J., & Serra, N. (2013). Which skills

and factors better predict winning and losing in high-level men's volleyball?. *The Journal of Strength & Conditioning Research*, *27*(9), 2487-2493. doi: 10.1519/JSC.0b013e31827f4dbe

Peters, D. M., & O'Donoghue, P. (Eds.). (2013). *Performance analysis of sport IX*. Routledge.

Reeser, J., & Bahr, R. (2003). *Handbook of Sports Medicine and Science: Volleyball*. Massachusetts: Blackwell Science Ltd.

Rodriguez-Ruiz, D., Quiroga, M. E., Miralles, J. A., Sarmiento, S., de Saá, Y., & García-Manso, J. M. (2011). Study of the technical and tactical variables determining set win or loss in top-level European men's volleyball. *Journal of Quantitative Analysis in Sports*, *7*(1), 1-15.

Sarmento, H., Marcelino, R., Anguera, M. T., Campaniço, J., Matos, N., & Leitão, J. C. (2014). Match analysis in football: a systematic review. *Journal of sports sciences*, *32*(20), 1831-1843.

Silva, M., Lacerda, D., & João, P. V. (2013). Match analysis of discrimination skills according to the setter attack zone position in high level volleyball. *International Journal of Performance Analysis in Sport*, *13*(2), 452-460.

Silva, M., Lacerda, D., & João, P. V. (2014a). Game-Related volleyball skills that influence victory. *Journal of Human Kinetics*, *41*(1), 173-179. doi: 10.2478/hukin-2014-0045

Silva, M., Lacerda, D., & João, P. V. (2014b). Match analysis of discrimination skills according to the setter defence zone position in high level volleyball. *International Journal of Performance Analysis in Sport*, *14*(2), 463-472.

Trajkovic, N., Milanovic, Z., Sporis, G., Milic, V., & Stankovic, R. (2012), The effects of 6 weeks of preseason skill-based conditioning on physical performance in male volleyball players. *Journal of Strength and Conditioning Research,* *26*(6), 1475-80.

Valliant, M., Emplaincourt, H., & Wenzel R. (2012), Nutrition education by a registered dietician improves dietary intake and nutrition knowledge of a NCAA female volleyball team. *Nutrients,* *4*(6) 506–516.

Yiannis, L., & Panagiotis, K. (2005). Evolution in men's volleyball skills and tactics as evidenced in the Athens 2004 Olympic Games. *International Journal of Performance Analysis in Sport*, *5*(2), 1-8.

Zetou, E., Moustakidis, A., Tsigilis, N., and Komninakidou, A. (2007), Does Effectiveness of Skill in Complex I Predict Win in Men's Olympic Volleyball Games?, *Journal of Quantitative Analysis in Sports, 3*(4), 1-9.

Zetou, E., Tsigilis, N., Moustakidis, A., & Komninakidou, A. (2006). Playing characteristics of men's Olympic Volleyball teams in complex II. *International Journal of Performance Analysis in Sport*, *6*(1), 172-177.

M. Silva

University of Trás-os-Montes and Alto Douro, Research Center in Sport Sciences, Health Sciences and Human Development, CIDESD, Creative Lab Research Community at Vila Real, Rua la Lousada, Edifício S. José II, 7º Dir. 5050-262 Peso da Régua, Portugal
e-mail: mmiguelfpv@gmail.com

46

Study 2: Game-Related Volleyball Skills that Influence Victory

Silva, M., Lacerda, D., & João, P. V. (2014). Game-Related volleyball skills that influence victory. **Journal of Human Kinetics**, *41*(1), 173-179. doi: 10.2478/hukin20140045
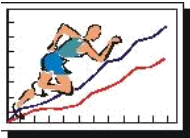
Game-Related Volleyball Skills that Influence Victory

by

Miguel Silva [1], Daniel Lacerda [1], Paulo Vicente João [1,2]

The aim of the present study was to identify the volleyball skills that discriminate in favour of victory. Twenty-four games (n=24) from the Senior Men's Volleyball World Championship played in Italy in 2010 were chosen and analyzed with Data Volley software. The discriminating function was used to identify the discriminating variables, using a canonical structuring coefficient of |SC| ≥ .30. The results suggest that service points, reception errors, and blocking errors were the discriminating variables that identify the final outcome of the match (victory/defeat). Moreover, successful service points were the major variable most likely associated with match success (victory). In this sense, increasing the effectiveness of service should be a top priority in coaching elite volleyball teams.

Key words: volleyball, games-related statistics, performance, results, skills

Introduction

The evolution of training in volleyball has been reflected in the increased homogeneity of high-level athletes' characteristics (Sheppard et al., 2009). Top teams are similar in average body height, and in physical and technical performances (Gabbett et al., 2007). Hence, matches between the best teams are often very balanced. Understanding how the skill performance indicators relate to scoring of points is useful for athletes and coaches in all team sports (Lobietti, et al., 2010; Marcelino et al., 2010; Miskin et al., 2010; Palao et al., 2005; Zetou et al., 2007). As most of these teams, if not all, are subject to highly specialized supervision in several fields such as medical examination, physical preparation (Golik-Peric et al., 2011; Trajkovic et al., 2012), psychological support, diet control (Valliant et al., 2012) and tactical orientation (João et al., 2010; Palao et al., 2005), it is important to know which skills in volleyball contribute most to victory.

When examining the different skills performance on display in a volleyball match (serving, blocking, attacking, reception, setting, and defense), it seems reasonable that the team that makes the fewest errors should be the one that is most likely to succeed. The results observed by Castro et al. (2011) and Drikos et al. (2009) revealed a significant influence of serve and attack efficacy (those that result in direct point) on the match outcome.

Attacks, blocks, and serves, due to the possibility of scoring a direct point, are considered Scoring Skills (Marcelino et al., 2010). On the other hand, the defense, setting, and reception procedures are termed Non Scoring Skills (Marcelino et al., 2010) and therefore should, at first glance, contribute less to a win. Despite this classification it is important to acknowledge those skills that most discriminate in favour of victory. Moreover, these analyses have been mostly based on the relation between

[1] - *Department of Sports Sciences, University of Trás-os-Montes and Alto Douro (UTAD), Vila Real - Portugal.*

[2] - *CIDESD - UTAD - Research Unit, Sport Sciences, Exercise and Health Department, University of Trás-os-Montes and Alto Douro, Vila Real - Portugal.*

efficacy and success. However, in some studies (Bergeles, et al., 2009; Buscà and Febrer, 2012) it has been proven that in elite teams, error in some skills may indicate a higher level of risks taken rather than technical problems.

While recognizing the significance of information from previous research on this topic, we could notice a lack of studies in volleyball that focus on the analysis of performance factors distinguishing winning teams from losing ones. Therefore, the aim of the present study was to identify the skills that discriminate in favour of victory. It seems appropriate to conduct this research in order to improve training methodologies and performance in competition, providing useful indicators for coaches, players and their teams.

Material and Methods

The sample in this study was composed of 24 matches (n=24) from the 2010 FIVB Men's World Championships in Italy, with a total of 90 sets played; 24670 separate actions were analyzed: 4083 services, 3434 receptions, 4906 attacks (3030 from side-out and 1876 from counter attack), 2109 blocks, 1933 digs, and 3299 sets. The data were collected and analyzed with Data Volley software.

This sample was chosen because it consisted of high-level matches from the last World Championship. To ensure that the analysis focused on balanced high-level matches, the matches of the 12 best teams (3rd phase) were chosen, ending with the match to award the first and second places (final).

Measures

The dependent variables considered were the result of the match (victory and defeat). The independent variables were chosen in accordance with suggestions by other authors, including terminal actions such as serves, blocks, and side out attacks (complex I, composed by reception, setting and attack) and attacks in counter attack (complex II, constituted by defense, setting and attack) (João et al., 2010; Marelic et al., 2004; Palao et al., 2004).

Due to the fact that several authors (João et al., 2006; Maia and Mesquita, 2006; Palao et al., 2004) have referred to reception, setting, and defense as essential factors in the development of a match, we also included these variables in our research design.

This study considered only actions that could be determined to be absolute successes or failures, since they may be more easily associated with the final outcome. We omitted continuity skills because they do not reflect the mastery of a particular skill, but rather a set of skills.

Side-out (or complex I), reception, setting, and attack.

Counter-attack (or complex II), service, block, dig, setting, and attack.

Procedures / Data collection

The data were collected using Data Volley software. By applying this software it is possible to display and print at any time analytical reports detailing any and all information needed to objectively evaluate the performance of the team. This program allows access to total and by set detailed qualitative statistics, offering a wealth of data for researchers and coaches. Twenty-two of the 24 teams present at the competition used this software, what confirms the utility and validity of the information provided by the software.

Reliability

The reliability of the observations was tested, presenting intra-observer Cohen's Kappa values between 0.96 and 1, and Cohen's Kappa inter-observer values of 0.98 and 1, which meant that the data were reliable. Reliability analysis of the data was carried out with the SPSS (18), using a significance degree of 5%.

Statistical Analysis

To identify which variables discriminated by result, a discriminant analysis was computed, using a coefficient structure superior of |SC| ≥.30 (Tabachnick and Fidell, 1996) to determine the indicators that contributed most to differences between victories and defeats. Corresponding effect sizes (Hedge's g and 95% confidence intervals) were also calculated to evaluate the magnitude of the statistically significant differences. All data were analyzed with the statistical package SPSS for Windows, release 18.0 (SPSS, Inc., Chicago, IL). Effect sizes were assessed with Comprehensive Meta-Analysis (Version 2.0) and statistical significance was set at 5%.

Results

The means and the standard deviations of game-related statistics are presented in Table 2. The

discriminant analysis yielded statistically significant differences (p<.05) between victories and defeats. Only the side-out error variable (g=1.33) presents significant differences that are possible to be analyzed with this effect size.

As seen in Table 3, the average vector that contributed most to discrimination between defeat and victory was composed of the serve point (SC=0.42), reception errors (SC= -0.35) and blocking errors (SC=0.32). The remaining variables did not show significant contributions to the structure of the linear function. The obtained function presents a statistically significant difference $\chi 2$ = 25.143, p≤.05, with a canonical correlation of .96.

Table 1

Game-related Skills description

Skills	Description
Service error	Error occurred in the service
Serve point	Efficacy with service
Reception error	Error occurred in reception
Excellent reception	Efficacy in reception
Attack error	Error occurred in attack
Attack point	Efficacy with attack
Side out error	Error reception, set and attack
Side out point	Efficacy with reception, set and attack
Counter attack error	Error after defense, set and attack
Counter attack point	Efficacy after defense, set and attack
Blocking error	Error occurred in the block
Blocking point	Efficacy with block
Dig error	Error occurred in the defense
Excellent dig	Efficacy in defense
Set error	Error occurred in the sets
Set excellent	Efficacy with a sets

Table 2

Means and standard deviations of game-related statistics by result (victory or defeat), effect size and 95% CI.

Game-related statistics	n	Defeat M ± SD	n	victory M ± SD	F	p	Effect Size (Hedges's g)	CI 95%
Service error	951	13.00 ± 3.52	1093	16.25 ± 4.27	2.29	.156	-0.82	-0.91, -0.73
Serve point	72	2.67 ± 1.51	92	4.75 ± 2.12	4.17	.064	-1.10	-1.43, -0.77
Reception error	325	3.83 ± 2.23	294	4.13 ± 2.17	0.06	.810	-0.13	-0.29, 0.02
Excellent reception	565	27.00 ± 7.07	522	23.88 ± 9.70	0.44	.519	0.37	0.25, 0.49
Attack error	609	12.50 ± 3.02	566	8.88 ± 3.98	3.46	.088	1.02	0.90, 1.15
Attack point	1113	44.00 ± 11.37	1237	54.25 ± 11.96	2.62	.131	-0.87	-0.96, -0.79
Side-out error	352	8.67 ± 2.73	291	5.13 ± 2.53	628	.028*	1.33	1.16, 1.51
Side-out point	758	29.83 ± 6.08	794	34.50 ±10.25	0.97	.343	-0.55	-0.65, -0.45
Counter Attack error	89	3.83 ± 2.04	443	3.75 ± 2.05	0.01	.941	0.03	-0.18, 0.26
Counter Attack point	248	14.17 ± 5.67	275	19.75 ± 5.60	3.37	.091	-0.98	-1.17, -0.80
Blocking error	69	16.50 ± 6.25	94	15.25 ± 3.11	0.24	.630	0.26	-0.04, 0.57
Blocking point	173	8.67 ± 3.20	273	12.25 ± 3.77	3.50	.086	-1.00	-1.20, -0.80
Dig error	42	13.50 ± 6.77	80	13.50 ± 3.21	0.00	1.000	0.00	-0.37, 0.37
Excellent Dig	320	15.17 ± 7.33	323	10.75 ± 6.18	1.50	.245	0.65	0.49, 0.81
Set error	40	1.83 ± 0.75	18	1.75 ± 1.16	0.02	.882	0.08	-0.46, 0.64
Set excellent	1368	21.33 ± 6.71	1302	20.13 ± 7.32	0.10	.757	0.17	0.09, 0.24

M: means; SD: standard deviation; f: ratios; g: Hedges's g;
CI 95% confidence intervals.
* p<.05

Table 3

Discriminant function structure
coefficients and tests of statistical significance.

Game related statistics	SC
Serve point	.42*
Reception error	-.35*
Blocking error	.32*
Side-Out error	-.25
Blocking point	.15
Attack error	-.15
Service error	.12
Excellent dig	-.10
Dig error	.07
Set excellent	.07
Counter Attack error	.06
Excellent reception	-.05
Attack point	.03
Counter Attack point	.03
Side-Out point	.02
Set error	.02
Wilks' Lambda	.07
Eigenvalue	13.1
Canonical correlation	.96

* $|SC| \geq .30$.

Discussion

The main results of this study showed that the skills that discriminate in favour of victory are the serve point and surprisingly, blocking errors. On the other side, reception errors were the only variable that discriminated in favour of defeat.

Our results clearly point to the importance of the serve point in determining victory. This result becomes even more relevant when we pay attention to the value of its effect size (-1.10), which is quite high and allows for generalization of results. Because the teams are evenly balanced, when a match gets close to the end, this skill (serving) may be associated with victory. Our results confirm the observations of Zetou et al. (2007), who mention that the ace (direct serve) is a predictor of victory in high performance teams.

In accordance with Marelic et al. (2004), the team that serves better has a tendency to win more sets. A more attentive analysis of the results highlights the fact that the number of serves that

result in direct points was very low, but higher in the winning teams. Serve errors were also less frequent in winning teams.

In fact, some researchers believe that teams that are at a disadvantage in the set take more risks while serving, probably because they have nothing to lose (João et al., 2010; Marelic et al., 2004). By risking more strategically, these teams also end up failing more frequently, consequently increasing the percentage of errors made (Marelic et al., 2004; Yiannis et al., 2004). On the other hand, if the serve is risky, opponent reception will be more difficult, increasing error probability. Our results discriminate reception error in defeat so the teams with low efficacy in this skill are more likely to lose the game.

It is important, therefore, to increase the efficacy of the serve, since it is considered a terminal action (Marelic et al., 2004), and may result in a direct point. In that sense, we can infer that the serve is of crucial importance in the performance of volleyball teams. The importance of practicing this skill in the training process is

quite clear.

Literature regarding blocking skills in volleyball pointed to its importance for the match outcome (Afonso et al., 2010; Palao et al., 2004). Surprisingly, our results revealed that blocking errors discriminate in favour of victory. Errors in blocking may result in one of the following three situations: (1) point for the opposing team, (2) continuity of the match by the team itself (if the defense is good), or (3) continuity for the opposing team. According to these possibilities our results suggest that in high level balanced volleyball teams blocking errors result in more frequent continuity situations than in scoring points.

The organization of the opposition's first line of defense, through strategies and triple block formations, may increase the probability of successful blocking. This fact may also be a consequence of the speed of the ball, the variability of the setting, and the trajectory, making it difficult to effectively organize blocks (Afonso et al., 2005; Zetou et al., 2007). The diversity of results that may arise when this skill is employed may explain why studies of blocking errors have yielded mixed results. A thorough analysis of our results shows that the winning teams made more blocks (block points and block errors).

Palao (2008) concluded that successful blocking offers more chances to win. In addition, the block is the first terminal action that the opposition may take to the opponent's attack, and may result in a direct point.

Regarding reception errors, our results suggest that this factor, as would be expected, may be associated with defeat. Several studies have verified a positive association between efficacy in reception and the final result of the match (João et al., 2006; Laios and Kountouris, 2005; Maia and Mesquita, 2006). Even though reception is not a terminal action, a perfect reception allows the setter to organize the team offensively with all the possibilities of attack, increasing the probability of winning the match (João et al., 2010). In elite teams, like the ones analyzed in the present study, the receiving players are very experienced, so only errors in reception discriminated for result.

In conclusion, as the world's top teams continue to become more similar and balanced, competition must be evaluated in terms of performance details. Some skills are more important than others as they are associated with success; while poor performance in other skills leads to failure. In order to improve performance, coaches must prepare their teams, evaluate the opponent, and focus on the skills that may discriminate in favour of victory and improve the factors that result in failure. Our results highlight the importance of serving successfully, improving blocking continuity situations, as well as, minimizing errors in reception.

The results of this study of the last World Championship confirm that an effective serve is a variable that may be used to predict success. Therefore, serve training is crucial, and should be taken in consideration in different contexts and moments during the match, using several types of strategies and scenarios that may cause imbalances between teams at the same sports level.

The study's most interesting finding is that errors are also associated with victory. In fact, blocking errors discriminated in favour of victory, but winning teams had a higher percentage of successful blocks. Blocking continuity situations should also play an important role in training concepts.

Finally, reception errors discriminated in favour of defeat, which highlights the importance of practicing this skill to avoid failure.

References

Afonso J, Mesquita I, Palao J. Relationship between the use of commit-block and the numbers of blockers and the block effectiveness *Int J Perform Anal Sport*, 2005; 5(2): 36-45

Afonso J, Mesquita I, Marcelino R, Silva J. Analysis of the setter's tactical action in high-performance women's volleyball. *Kinesiology*, 2010; 421: 82-89

Bergeles N, Barzouka K, Nikolaidou M. Performance of male and female setters and attackers on Olympic-level Volleyball teams. *Int J Perform Anal Sport*, 2009; 9: 141-148

Buscà B, Febrer J. Temporal fight between the middle blocker and the setter in high level volleyball. *Rev. int. med. cienc. act. fís. deporte*, 2012; 12(46): 313-327

Castro J, Souza A, Mesquita I. Attack efficacy in volleyball: Elite male teams. *Percept motor skill*, 2011; 113(2): 395-408

Drikos S, Kountouris P, Laios A, Laios Y. Correlates of Team Performance in Volleyball. *Int J Perform Anal Sport*, 2009; 9(2): 149-156

Gabbett T, Boris G, Nathan D. The use of physiological, anthropometric, and skill data to predict selection in a talent-identified junior volleyball squad. *J Sport Sci*, 2007; 25 (12): 1337-1344

Golik-Peric D, Drapsin M, Obradovic B. Short-Term Isokinetic Training Versus Isotonic Training: Effects on Asymmetry in Strength of Thigh Muscles. *J Hum Kinet*, 2011; 30: 29-35

João P, Leite N, Mesquita I, Sampaio J. Sex differences in discriminative power of volleyball game-related statistics. *Percept motor skill*, 2010; 111(3): 893-900

João P, Mesquita I, Sampaio J, Moutinho C. Comparative analysis between libero and priority receivers on the offensive organization, from the serve reception on the volleyball game. *Rev Port Cien Desp*, 2006; 6(3): 318-322

Laios Y, Koutouris P. Evolution in men's volleyball skills and tactics as evidenced in the Athens 2004 Olympic Games. *Int J Perform Anal Sport*, 2005; 5(2): 1-8

Lobietti R, Coleman S, Pizzichillo E, Merni F. Landing techniques in volleyball. *J Sport Sci*, 2010; 28(13), 1469-1476

Maia N, Mesquita I. Study of zones and efficacy of the reception according the receiver player in female senior volleyball. *Rev. bras. educ. fís. esporte*, 2006; 20(4): 257-270

Marcelino R, Mesquita I, Sampaio J, Moraes J. Study of performance indicators in male volleyball according to the set results. *Rev. bras. educ. fís. esporte*, 2010; 24 (1): 69-78

Marelic N, Resetar T, Jankovic V. Discriminant analysis of the sets won and the sets lost by one team in a1 Italian volleyball league – a case study. *Kinesiology*, 2004; 36(1): 75-82

Miskin M, Fellingham G, Florence L. Skill Importance in Women's Volleyball. *J. Quant. Anal. Sports*, 2010; 6 (2): 5, 1-12

Palao J. Options for analysis of the volleyball score sheet. *Int J Perform Anal Sport*, 2008; *8*(2): 26-43

Palao J, Santos J, Ureña A. Effect of setter's position on the spike in volleyball. *J hum movement stud*, 2005; 48(1): 25-40

Palao J, Santos J, Ureña A. Effect of team level on skill performance in volleyball. *Int J Perform Anal Sport*, 2004; 4(2): 50-60

Sheppard J, Gabbett, Tim J, Stanganelli L. An Analysis of Playing Positions in Elite Men's Volleyball: Considerations for Competition Demands and Physiologic Characteristics. *J Stren Cond Res*, 2009; 23(6): 1858-1866

Tabachnick B, Fidell L. *Using Multivariate Statistics*. 3ª ed. New York: *Harper Collins Publishers*, Inc; 1996

Trajkovic N, Milanovic Z, Sporis G, Milic V, Stankovic R. The effects of 6 weeks of preseason skill-based conditioning on physical performance in male volleyball players. *J Stren Cond Res*, 2012; 26(6): 1475-1480

Valliant M, Emplaincourt H, Wenzel R, Garner B. Nutrition Education by a Registered Dietitian Improves Dietary Intake and Nutrition Knowledge of a NCAA Female Volleyball Team. *Nutrients*, 2012; 4: 506-516

Yiannis L, Panagiotis K, Ioannis A, Alkinoi K. A comparative Study of the Effectiveness of the Greek national Men's Volleyball Team with Internationally Top-Ranked Teams. *International Journal of Volleyball Research*, 2004; 4-9

Zetou E, Moustakidis A, Tsigilis N, Komninakidou A. Does Effectiveness of Skill in Complex I Predict Win in Men's Olympic Volleyball Games? *J. Quant. Anal. Sports*, 2007; 3(4): 1559-1570

Corresponding author:

Paulo Vicente João Ph.D
Institution: University of Trás-os-Montes and Alto Douro, Vila Real - Portugal.
Address: UTAD Quinta de Prados, Apartado 202, 5001-911 Vila Real, Portugal
Phone: 00351 965 884 853
Fax: 00351 254 615 357
E-mail: pvicente@utad.pt

Study 3: Match analysis of discrimination skills according to the setter attack zone position in high level volleyball

Silva, M., Lacerda, D., & João, P. V. (2013). Match analysis of discrimination skills according to the setter attack zone position in high level volleyball. **International Journal of Performance Analysis in Sport**, *13*(2), 452-460.

Match analysis of discrimination skills according to the setter attack zone position in high level volleyball

Miguel Silva[1], Daniel Lacerda[1] and Paulo Vicente João[2]

[1] University of Trás-os-Montes e Alto Douro at Vila Real, Portugal.

[2] Research Center for Sport Sciences, Health and Human Development (CIDESD) Portugal

Abstract

The aim of this study focuses on analyzing and understanding what happens when the setter is in the attack zone (zones 4, 3 and 2), identifying the skills that best discriminate for victory or defeat. Twenty four matches (n=24) played during the Men's Senior Volleyball World Championship – Italy 2010 were taken and analyzed with Data Volley Software. For the data analysis the discriminating function was used in order to identify the discriminating variables through the canonical structuring coefficient |SC| ≥ .30. This study revealed that 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 (win/lose) when the setter was in the attack zone (zones 4, 3 and 2). At the same time it showed us why teams can lose. Teams without attack, side-out, service and distribution skills can hardly win games because these skills are essential for offense building and winning.

Keywords: Volleyball, match analysis, performance, result, setter position, skills.

1. Introduction

The game of volleyball, by its functional dynamics profile and regulatory compliance, is considered a game of unpredictable nature even though it possesses a relatively deterministic logic. Volleyball is organized into six game skills and in a sequential and chronologic logic (Buscà and Febrer, 2012): service, reception, setting, attack, block and dig (Durkovic *et al*., 2008).

These skills are conditioned by the individual and collective performance of the players. In this sense there is a functional specialization that determines the success of a volleyball game. Nowadays, the setter is considered essential in a volleyball team (Matias and 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)

(Guerra, 2007; Zetou *et al*., 2007; Castro and Mesquita, 2008). This player is now seen as a key piece for the success of any volleyball team since the setting skills taken by the setter seem to interfere directly with the team's success (Buscà and Febrer, 2012).

The research held in the domain of the analysis of a volleyball game has been focused on the importance of the success and failure of the teams (Drikos *et al*., 2009). In the literature there are studies that focus on the analysis of the setting associated with variables such as the reception, attack and side-out (Palao *et al*., 2005; César and Mesquita, 2006; Afonso and Mesquita, 2011; Costa *et al*., 2011).

The same studies reveal that there are dependency relations between the quality of the skill and the setting zone, between the reception efficacy and the attack zone, between the attack time and effect with the number of blockers. Nevertheless, studies do not relate the variables with the setter's position (Durkovic *et al*., 2008).

Volleyball has suffered due to major adjustments in line with rule changes to the game and the appearance of new functions, such as the libero. With high level teams the matches become extremely balanced, necessitating the need of understanding if the teams that win have the best skills in scoring more points or by making fewer errors. The goal of this study focuses on analyzing and understanding what happens when the setter is in the attack zone (zones 4, 3 and 2), identifying the skills that best discriminate for victory or defeat.

2. Methods

The sample for this study was taken from the Men's Senior Volleyball World Championships – Italy 2010. This was composed of n= 24 matches, corresponding to 90 sets. 1599 sequences were analyzed with 1957 services, 1656 receptions, 2351 attacks (1481 from side-out and 870 from counter attack), 320 blocks, 863 digs and 1582 sets. The choice of this sample was, as criteria, the last World Championship (only national team matches).

The observation of the matches started in the 3rd phase of the event and ended with the final. The participating teams where the top 12 ranked teams in the event: Brazil, Cuba, Serbia, Italy, Russia, United States, Bulgaria, Germany, Argentina, Czech Republic, France and Spain.

The observations were made from October 410, 2010, during the 2010 FIVB Men's Volleyball World Championship, in the Italian cities of Rome, Florence and Modena.
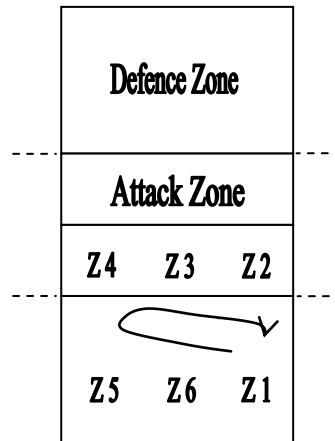
Figure 1. The setter make the rotation according the clockwise diretion: Z1, to Z6, to Z5 (defence zone) and Z4 to Z3, to Z2 (Attack zone).

In this study, the dependent variables considered were the result of the match (victory and defeat). The independent variables were chosen through the suggestions of other studies: terminal skills such as service, block and attack (Palao *et al*., 2004; Marcelino *et al*., 2008; Castro *et al*., 2011). Due to the fact that some authors referred to, in other studies, as an essential procedure for the development of the match, we also included the reception, the setting and the dig (Palao *et al*., 2004; João *et al*., 2006; Maia and Mesquita, 2006) (Table 1).

Table 1. Game related skills description

Game related	Description
Service error	Error occurred in the service
Serve point	Service that end in point
Reception error	Error occurred in reception
Excellent reception	Efficacy in reception
Attack error	Error occurred in attack
Attack point	Efficacy that end in point
Side out error	Response to the service that culminates in error in reception, or in set or in the attack
Side out point	Response to the service that culminates in efficacy in the reception, set and attack
Counter attack error	Error after defense, set and attack
Counter attacker point	Efficacy after defence, set and attack
Blocking error	Error occurred in the block
Blocking point	Efficacy in the block that end in point
Dig error	Error occurred in the defence
Excellent dig	Efficacy in defence
Set error	Error occurred in the set
Set excellent	Efficacy in the set

The data were collected through *Data Volley Software*. This software allows us to access total and detailed qualitative statistics by set, bringing more abundance and wealth of data to the researcher and to the coach. Twenty-two of the Twenty-four teams present in this competition used this software.

31

In order to check the consistency of the observations, an intra-observer and inter-observer reliability were performed after 15 days in a random sample of five games (20% of the sample according to the literature (Häyrinen, 2004; Zetou at al., 2007). The inter-rater reliability of the data/kappa (Gwet, 2008) had agreement coefficients and intra observer Cohen's Kappa (see data reliability – table 2).

Table 2. Reliability, intra-observer and inter-observer
with a space interval of 15 days.

Game-related statistics	Intra-observer		Inter-observer	
	1°	2°	1°	2°
Service error	0.97	0.98	0.94	0.97
Serve point	0.96	0.97	0.94	0.95
Reception error	0.95	0.96	0.93	0.94
Excellent reception	0.93	0.94	0.92	0.93
Attack error	0.92	0.95	0.95	0.96
Attack point	0.95	0.96	0.92	0.94
Side-out error	0.95	0.93	0.94	0.95
Side-out point	0.93	0.94	0.93	0.94
Counter Attack error	0.95	0.96	0.92	0.94
Counter Attack point	0.94	0.97	0.95	0.98
Block error	0.93	0.95	0.92	0.94
Block point	0.95	0.97	0.91	0.95
Dig error	0.94	0.96	0.96	0.97
Excellent dig	0.93	0.94	0.94	0.97
Set error	0.92	0.93	0.96	0.98
Set excellent	0.98	0.99	0.95	0.96

The reliability analysis of the data was developed with the statistics program PASW Statistics 18, having established a statistic significance degree of 5%.

For the statistical treatment, an analysis of the discriminating function was conducted in such a way as to identify, through the structural canonical coefficients (SC), the indicators that most contribute to the game in order to establish the maximum difference between the victories and the defeats. A discriminant analysis was computed, and a coefficient structure was considered relevant to the linear composites superior of $|SC| \geq .30$ (Tabachnick and Fidell, 1996). The level of significance was established at 5%. Calculation of the results was done by SPSS software version 17.0.

3. Results

The means and the standard deviations of game-related statistics are presented in Table 3. The discriminant analysis yielded statistically significant differences in the serve point game-related statistics examined ($p<.05$) when the setter is in the attack zone (zones 4, 3 and 2). Only the serve point variable presents significant differences.

The calculation of the discriminant function was held through the method of forced entry, where all the dependant variables entered simultaneously in the analysis. The outcome of the

discriminant analysis, for the present result, was a 100%. The function obtained yielded a statistically significant fit (χ^2=6,931, p<.05), with a canonical correlation of .96.

Table 3. Means and standard deviations of game-related statistics by result (win or lose) by skills when the setter stay in attack zone.

Game-related statistics	Defeat		Victory		F	p
	M	SD	M	SD		
Service error	6.00 ± 1.00		4.50 ± 2.12		1.25	0.346
Serve point	1.00 ± 0.00		3.50 ± 0.71		45.00	0.007*
Reception error	2.33 ± 1.15		1.00 ± 0.00		2.40	0.219
Excellent reception	13.33 ± 7.64		12.50 ± 2.12		0.02	0.895
Attack error	6.33 ± 2.52		4.50 ± 2.12		0.70	0.463
Attack point	25.33 ± 10.60		27.50 ± 0.71		0.08	0.802
Side-out error	4.33 ± 3.21		3.00 ± 1.41		0.28	0.632
Side-out point	16.33 ± 5.69		18.50 ± 0.71		0.26	0.646
Counter Attack error	2.00 ± 1.73		1.50 ± 0.71		0.14	0.735
Counter Attack point	9.00 ± 5.00		9.00 ± 1.41		0.00	1.000
Block error	9.00 ± 5.29		9.50 ± 0.71		0.02	0.908
Block point	5.67 ± 3.51		7.50 ± 0.71		0.48	0.538
Dig error	9.00 ± 5.20		8.00 ± 1.41		0.06	0.816
Excellent dig	8.67 ± 5.77		8.00 ± 2.83		0.02	0.893
Set error	1.33 ± 0.58		1.50 ± 0.71		0.09	0.789
Set excellent	11.33 ± 5.13		12.00 ± 8.49		0.01	0.917

*M:*means; *SD:* standard deviation; *f:* ratios; * *p*<.05

Table 4 contains the structure coefficients that describe the profiles of volleyball game related statistics, which differentiate between defeat and victory performances. The larger size of a structure coefficient indicates a greater contribution of a game-related statistic to discriminate differences between defeat and victory. The discriminant function reflected the strong influence of serve point (*SC*=.96), service error (*SC*=.83), excellent set (*SC*=.76), set error (*SC*=.65), attack error (*SC*=.51), excellent dig (*SC*=.33) and side-out error (*SC*=.30). The remaining game-related statistics did not have relevant contributions for the structure of the linear function.

Through the analysis of table 4, we are able to observe that the discriminant variables possibly associated with defeat are the service error, side-out error, set error and attack error. The variables that may be associated to victory are the excellent dig, excellent set and serve point.

Table 4. Discriminant function structure coefficients and tests of statistical significance.

Game-related statistics	SC
Serve point	.96*
Service error	.83*
Set excellent	.76*
Set error	.65*
Attack error	.51*
Excellent dig	.33*
Side-out error	.30*
Counter Attack error	.28
Counter Attack point	.20
Excellent reception	.19
Dig error	.19
Block point	.14
Block error	.09
Side-out point	.09
Attack point	.05
Reception error	.00

*$|SC| \geq .30$

4. Discussion

Nowadays, the attack is responsible for the bigger percentage of winning points in volleyball (Costa *et al*., 2011). In reference to all of the discriminant variables observed, only the setting is not classified as a scoring skill (skills that result in a direct point).

With the purpose of being able to have greater variability and unpredictability in options of attack, the setting action is fundamental for the organization of the attack; i.e., the excellent set is essential due to the necessity of good offensive management in the teams.

The response to the serve, also named side-out, and the attack are two situations in which the teams should have success, since these are two moments of the match where the most points can be obtained as a reflex of the attack superiority (Drikos *et al*., 2009).

In volleyball, when the setter is in the attack zone (zones 4, 3 and 2) he has four options of attack; however, these could turn into restrictions. In contrast, when he's penetrating the defensive zone, he may have five options of attack. Therefore, the offensive organization of the team should be very well defined, so that the setter may act with efficacy.

In this sense, it seems that a dependency relation might exist between the quality of the setting and the final result of the match. This is because when this skill is done in an excellent way, either the side-out or the attack will have better conditions to be successful and the team will have a higher probability of wining.

Palao *et al*. (2005) studied the effect of the position of the setter in the attack in volleyball during the Sydney 2000 Olympic Games. Specifically, they studied the effect of the attack point in

the side-out and in the counter attack, verifying a better percentage, 51.8% and 44.2% respectively, when the setter was in the defensive zone (zones 1, 6 and 5).

Currently, in high level volleyball there is a growing trend toward the importance of the service, in which whoever has greater efficacy in these skills can reach a higher rate of success (Durkovi *et al.*, 2008). In the present study, these skills also present as discriminant variables in the result of the game, which leads to the deduction that the effective accomplishment of this skill creates extreme difficulties in the execution of the reception and to the offensive organization.

The literature shows us that the service loses more points than it wins (Costa *et al.*, 2011). This superiority, the percentage of losing points in regards to the winning points is justified by the fact that the teams continue to risk the execution of this skill of the game. That is, they give high importance to being able to create difficulties for the opposing team in the only skill where they have the ball perfectly controlled.

Therefore, when the setter is in the attack zone (zones 4, 3 and 2) the teams take more risk in the service. This is because the ability of the setter to intervene in the block is less compared to the other blockers, since their performance during this skill continues to be deficient (Amasay, 2008). Conversely, the opponent team, as a bigger offensive power through zone 4, ends up taking advantage of the potential deficiencies of the opposition by the setter to block. The use of a lower player substitution (usually the setter) by a higher player may lead to the victory of the game, if this player has a successful performance (João *et al.*, 2010).

This is a normal situation used by coaches at the end of a set, even if it is not proven to be the most effective strategy. Nevertheless, coaches continue to try to use the height of the tallest players to their advantage, as well as the rules of volleyball (substitutions and timeouts), in order to positively effect the outcome of the set or match.

In this way, the results of the present study confirm the high influence of the serve point, excellent set and excellent dig over the final result of the match. These variables should therefore be a concern in the training and sportive formation of young setters; investment in these skills should be viewed as preparation for high level volleyball.

Continuity skills were left out of this study since they do not inform us of the conclusion of the play; in other words, we chose to include only the success or failure skills.

5. Conclusion

The results of this study, which refer to the World Championship held in 2010, show that when the setter is in the attack zone (zones 4, 3 and 2), the skills of the game that may dictate the final result and are most associated with victory include the serve point, excellent set and excellent dig. The skills that may be associated with defeat are the service error, attack error and side-out error.

These results are essential for training and competition. The service is the first action of the game and is also the first weapon of attack. Therefore, if we are able to raise the efficacy of the serve point we may be able to influence the entire offensive organization of the opponent in the side out. In contrast, the performance of the setter should be maintained to the highest level

(execution of high percentage of an excellent set) in order to maintain the offensive performance of the team.

Although not foreseen, it was interesting to verify that the excellent dig ends up being discriminated, capable of being associated with victory. We can state that the teams that have a better defence are those capable of gaining advantage on the scoreboard and possibly win the match.

The results of this study help us to understand why teams may not win. When teams do not have successful skills of attack, side-out, service and setting, they rarely win the match because these skills are essential to the offensive structure of the team and consequently to the success of the volleyball game.

Apart from the suggestions described previously, it seems relevant to study the intervention of a high level setter when he is positioned in the defensive zone (zones 1, 6 and 5) for a future comparison of the intervention in the game complexes (KI and KII).

6. References

Afonso, J. and Mesquita, I. (2011), Determinants of block cohesiveness and attack efficacy in high level women's volleyball, **European Journal of Sport Science**, 11(1), 6975.

Amasay, T. (2008), Static Block Jump Techniques in Volleyball: Upright Versus Squat Starting Positions, **Journal of Strength and Conditioning Research**, 22(4), 12421248.

Bergeles, N., Barzouka, K. and Nikolaidou, M. (2009), Performance of male and female setters and attackers on Olympic level Volleyball teams, **International Journal of Performance Analysis of Sport**, 9, 141148.

Buscà, B. and Febrer, J. (2012), Temporal fight between the middle blocker and the setter in high level volleyball, **International Journal of Medicine and Science of Physical Activity and Sport**, 12(46), 313327.

Castro, J. and Mesquita, I. (2008), Implications of offensive spacing in elite male volleyball attack characteristics, **Portuguese Journal of Sport Sciences**, 8(1), 114125.

Castro, J., Souza, A. and Mesquita I. (2011), Attack efficacy in volleyball: elite male teams, **Perceptual and Motor Skills**, 113(2), 395-408.

Costa, G., Ferreira, N., Junqueira, G., Afonso, J. and Mesquita, I. (2011), Determinants of attack tactics in Youth male elite volleyball, **International Journal of Performance Analysis in Sport,** 11, 96104.

Costa, G., Mesquita I., Greco, P., Ferreira, N. and Moraes J. (2011), Relation service, reception and attack in male junior volleyball, **Motriz,** 17(1), 1118.

Darlington, R.B. (1990) **Regression and Linear Models**, New York, McGrawHill.

Drikos, S., Kountouris, P., Laios, A. and Laios, Y. (2009), Correlates of Team Performance in Volleyball, **International Journal of Performance Analysis of Sport, Cyncoed**, 9(2),149156.

Durkovic, T., Marelic, N., and Resetar, T. (2008), Influence of position of players in rotation on differences between winning and losing teams in volleyball, **International Journal of Performance Analysis in Sport**, 8(2), 815.

Gwet, K. (2008) Variance estimation of NominalScale Inter-Rater Reliability with Random Selection of Raters. **Psychometrika**, 71, 407 430. Doi:10.1007/s1133600790548

Häyrinen, M. (2004). Differences between winning and losing teams in men's European top-level volleyball. In P. O'Donoghue & M. Hughes (Eds.), ***Proceedings of VI Conference Performance Analysis***: 168177. St. Mary's.

João, P., Leite, N., Mesquita, I. and Sampaio, J. (2010), Sex difference in discriminative power of volleyball game-related statistics, **Perceptual and Motor Skills**, 11(3),893900.

João, P., Mesquita, I., Sampaio, J., & Moutinho, C. (2006), Comparative analysis between libero and priority receivers on the offensive, **Portuguese Journal of Sport Sciences**, 6(3), 318328.

Maia, N. and Mesquita, I. (2006), Study of zones and efficacy of the reception according the receiver player in female senior volleyball, **Brazilian Journal of Physical Education and Sport**, 20(4), 25770.

Marcelino, R., Mesquita, I., and Sampaio, J. (2008), Home Advantage and set outcome in high level volleyball, **Journal of Sport Sciences**, 26(SI), 73.

Matias, C. and Greco, P. (2011), Offensive organization assessment of winners of Brazilian Volleyball, **Brazilian Journal of Physical Education and Sport**, 33(4), 10071028.

Palao, J., Santos, J. and Ureña, A. (2005), The effect of setter´s position on the spike in volleyball, **Journal of Human Movement Studies**, 48(1), 2540.

Palao, J.; Santos, J. and Ureña, A (2004), Effect of team level on skill performance in volleyball, **International Journal of Performance Analysis in Sport**, 4(2), 5060.

Tabachnick, B. and Fidell, L. (1996), Using Multivariate Statistics. 3ª ed. New York: Harper Collins Publishers, Inc.

Zetou, E., Moustakidis, A., Tsigilis, N., and Komninakidou, A. (2007), Does Effectiveness of Skill in Complex I Predict Win in Men's Olympic Volleyball Games?, **Journal of Quantitative Analysis in Sports**, 3(4), 19.

Correspondence:
Paulo Vicente João – Ph.D
Faculty of Sports Sciences
University of Trás-os-Montes e Alto Douro at Vila Real
Parque Desportivo da UTAD
Apartado 1013 5001801 - Vila Real - Portugal
Email: pvicente@utad.pt

Study 4: Match analysis of discrimination skills according to the setter defence zone position in high level volleyball

Silva, M., Lacerda, D., & João, P. V. (2014). Match analysis of discrimination skills according to the setter defence zone position in high level volleyball. **International Journal of Performance Analysis in Sport**, *14*(2), 463-472.

Match analysis of discrimination skills according to the setter defence zone position in high level volleyball

Miguel Silva[1], Daniel Lacerda[1] and Paulo Vicente João[2]

[1] PhD. Student, University of Trás-os-Montes e Alto Douro at Vila Real, Portugal

[2] Research Center for Sport Sciences, Health and Human Development (CIDESD) Portugal

Abstract

This study aimed to analyze the discrimination skills according to the setter position in the defence zone (Zones 1, 6 ,and 5) in forty nine matches (n = 49) played during the semifinals of men's senior volleyball competitions during the biennium 2010–2012 (World Championship; European League; World Cup; European Championship; World League; Olympic Games). For data analysis using Data Volley Software, the discriminating function identified the discriminating variables with the canonical structuring coefficient |SC| ≥ 0.30. Results revealed that the reception error, counter attack point, set error, and attack point were discriminating variables that can identify the final outcome (i.e., win or loss) of the match when the setter was in the defence zone. In effect, this study helps to explain why volleyball teams win; success with the match skills of attack point and counter attack point often predict a winning outcome. As such, the study provides substantial contributions for volleyball training and competition.

Keywords: Volleyball, Match Analysis, Performance, Outcome, Setter Position, Discrimination Skills

1. Introduction

In volleyball, both observation and match analysis allow researchers to characterize a great diversity of technical procedures in diversified situational contexts. The tactical principles of these procedures not only undergird the collective structure of any volleyball team (João et al., 2010), but are also important for optimizing the training process and helping the development of concepts and strategies aimed to improve the efficacy of both individual and collective performance (Garganta, 2009). On the court, where they succeed quickly, technical skills are in great demand yet also require the continuous revaluation of the game situation, for each play is influenced by previous plays and, in turn, influence future plays (Durkovic et al., 2008; Buscà and Febrer, 2012).

Among rules that outline match play in volleyball, the position and rotation rules and rules about the court zone stipulate the different skills and actions that can be performed depending on the court position of the player: the attack zone (Zones 4, 3, and 2) or the defence zone (Zones 1, 6, and 5). Since authors (Palao and Ahrab–Fard, 2011) have indicated criteria to classify rotations by their importance in competitive volleyball (i.e., the court position of the setter), two stages of the match can be distinguished: when the setter is in either the attack or defence zone.

39

The 5:1 system (five attackers and one setter) is currently used by high performance teams, which means that only one player is responsible for organizing the offensive plays either in complex I (KI) or side-out and either in complex II (KII) or counter attack (Zetou et al., 2007; Castro and Mesquita, 2008). As such, this player is crucial to the success of any volleyball team (Matias and Greco, 2011) and plays a fundamental role (Bergeles at al., 2009), since setting decisions interact directly with the team's success (Buscà and Febrer, 2012).

Research on volleyball match analysis has recently focused on the importance of team success and failure (Drikos et al., 2009). Some studies particularly focus on analyzing settings associated with the variables of reception, attack, and side-out (Palao et al., 2005; Amasay, 2008; Afonso and Mesquita, 2011; Costa et al., 2011). These studies also show that the quality of action depends on the setting zone, both between the reception efficacy and attack zone and between the time and effect of the attack and number of blockers. Nevertheless, these studies do not relate the variables to the setter position (Durkovic et al., 2008).

As the technical staff involved in volleyball becomes multidisciplinary and increasingly consists of scouts (João et al., 2010), coaches (Trajkovic et al., 2012), doctors, nutritionists, and psychologists (Valliant et al., 2012), the best training methodologies can better reach all teams and players and, in turn, make teams more competitive. Since the games became more equal, there is a greater need to understand if teams that win are better in the execution of match skills by scoring more points or by making fewer errors. Consequently, this study aimed to determine which match skills (discrimination skills) are related to a team's success or failure when the setter is in the defence zone.

2. Methods

This study's sample included 49 matches retrieved from the following events: the 2010 Volleyball World Championship (n = 4), the 2010 European League (n = 4 matches), the 2011 World Cup (n = 5 matches), the 2011 European Championships (n = 12 matches), the 2011 World League (n = 4 matches), the 2011 European League (n = 4 matches), the 2012 Olympic Games, (n = 8 matches), the 2012 European League (n = 4 matches), and the 2012 World League (n = 4 matches). All events and matches consisted only of men on senior national teams. Criteria for inclusion were that each event had to host at least four competition matches, each match had to occur at least at the semifinal level, and the match had to include two teams ranked in the top 8.
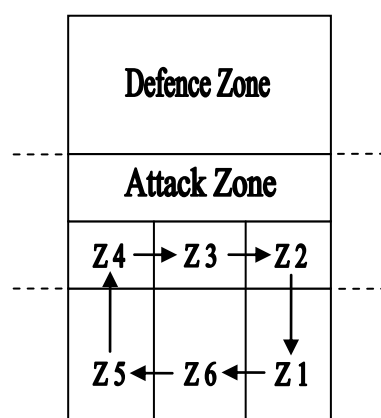

Figure 1. The setter make the rotation according the clockwise diretion:
Z1, to Z6, to Z5 (defence zone) and Z4 to Z3, to Z2 (Attack zone).

In this study, the dependent variable was the result of the match (e.g., either victory or defeat). As recommended by earlier studies, the independent variables of terminal skills (e.g., service block and attack) were chosen (Palao et al., 2004; Marcelino et al., 2008; Castro et al., 2011). Our study also examined the variables of reception, setting, and dig, given that other authors have considered these variables to be essential procedures for a match's development (Palao et al., 2004; Maia and Mesquita, 2006; João et al., 2010) (Table 1).

Table 1. Game-related skills descriptions.

Game-related skills	Description
Service error	Error occurred in the service
Serve point	Service that end in point
Reception error	Error occurred in reception
Excellent reception	Efficacy in reception
Attack error	Error occurred in attack
Attack point	Efficacy that end in point
Side-out error	Response to the service that culminates in error in reception, in the set, or in the attack
Side-out point	Response to the service that culminates in efficacy in the reception, set, and attack
Counter attack error	Error after defence, set, and attack
Counter attacker point	Efficacy after defence, set, and attack
Blocking error	Error occurred in the block
Blocking point	Efficacy in the block that end in point
Dig error	Error occurred in the defence
Excellent dig	Efficacy in defence
Set error	Error occurred in the set
Set excellent	Efficacy in the set

Data were collected by scouts of national teams with at least 5 years of experience by using software named Data Volley Software, which allowed access to total and detailed qualitative statistics by set and offered a wealth of various data (Drikos et al., 2009; Rodríguez-Ruiz et al., 2011). More specifically, Data Volley Software allows users to scout each volleyball skill with a complete evaluation, including the result of the skill event, the type of hit, and the starting and arrival zones, as well as to access detailed information (e.g., the number of players blocking and type of error).

To check the consistency of our observations, intra and inter-observer reliability were performed by two observer experts after 15 days in a random sample of 10 games (20% of the sample according to the literature) (Zetou et al., 2007). The inter-rater reliability of the data/kappa (Gwet, 2008) revealed agreeable coefficients, and Cohen's kappa suggested data reliability for the intra-observer (Cohen's kappa 0.92 and 1) and inter-observer (Cohen's Kappa of 0.91 and 1).

Statistical analysis was performed and the discriminating function conducted in such a way as to identify through the structural canonical coefficients (SC) the indicators that contributed most to the game, which was performed in order to establish the maximum difference between victories and defeats. A discriminant analysis was computed, after which a coefficient structure was considered relevant to the linear composites superior of $|SC| \geq 0.30$ (Tabachnick and Fidell, 1996). Significance was established at $p \leq 0.05$.

Table 2. Reliability of intra and inter-observer data with a space interval of 15 days.

Game-related statistics	Intra-observer		Inter-observer	
	1º	2º	1º	2º
Service error	0.96	0.97	0.95	0.96
Serve point	0.95	0.98	0.94	0.96
Reception error	0.93	0.96	0.93	0.95
Excellent reception	0.93	0.94	0.91	0.93
Attack error	0.92	0.93	0.94	0.97
Attack point	0.95	0.96	0.93	0.95
Side-out error	0.96	0.94	0.91	0.94
Side-out point	0.92	0.93	0.92	0.94
Counter attack error	0.97	0.98	0.93	0.94
Counter attack point	0.95	0.97	0.97	0.98
Block error	0.93	0.94	0.92	0.93
Block point	0.96	0.97	0.93	0.96
Dig error	0.94	0.96	0.95	0.97
Excellent dig	0.96	0.97	0.96	0.97
Set error	0.95	0.98	0.94	0.97
Set excellent	0.96	0.98	0.96	0.97

3. Results

Table 3 shows the results of the initial invariable study, which compared average values of the analyzed variables to the final result (e.g., defeat or victory) in all matches played when the setter is in the defence zone. Only two variables (e.g., reception error and counter attack point) presented significant differences.

Table 3. Means and standard deviations of game related statistics by outcome
(e.g., win or loss) by skills when the setter is in the defence zone.

Game-related statistics	Defeat	Victory	F	p
	M ± SD	M ± SD		
Service error	5.98 ± 2.99	6.49 ± 2.91	0.70	0.404
Serve point	1.94 ± 2.03	2.36 ± 1.82	1.14	0.289
Reception error	3.02 ± 2.22	2.00 ± 1.29	7.44	0.008*
Excellent reception	8.83 ± 4.79	8.38 ± 4.10	0.24	0.629
Attack error	4.55 ± 1.90	4.21 ± 2.13	0.67	0.416
Attack point	23.89 ± 7.09	26.28 ± 6.53	2.87	0.094
Side-out error	2.74 ± 1.60	2.49 ± 1.74	0.54	0.462
Side-out point	16.47 ± 5.44	17.36 ± 5.02	0.68	0.411
Counter attack error	1.81 ± 1.07	1.72 ± 1.35	0.11	0.736
Counter attack point	7.43 ± 3.02	8.91 ± 3.42	5.01	0.028*
Block error	9.04 ± 4.28	9.60 ± 4.40	0.38	0.538
Block point	4.98 ± 3.09	5.77 ± 2.43	1.88	0.174
Dig error	6.40 ± 4.90	6.19 ± 4.37	0.05	0.825
Excellent dig	6.26 ± 4.47	6.30 ± 4.89	0.00	0.965
Set error	0.51 ± 0.90	0.23 ± 0.43	3.58	0.062
Set excellent	22.79 ± 5.82	25.49 ± 5.49	2.36	0.549

M: mean; *SD:* standard deviation; *f:* ratios; **$p \leq 0.05$

Calculating the discriminant function was supported by the method of forced entry, in which all dependent variables were entered simultaneously in the analysis. For this study's results, the outcome of the discriminant analysis was 100%. The function obtained yielded a statistically significant fit (χ^2=20,498, $p \leq 0.05$) with a canonical correlation of 0.86.

As shown in Table 4, the composition of the average vector that contributed most to differentiating defeat and victory was the reception error (SC = 0.54), counter attack point (SC = 0.44), set error (SC = 0.37), and attack point (SC = 0.33). The remaining variables did not show relevant contributions to the structure of the linear function found.

Table 4. Discriminant function structure coefficients and tests of statistical significance.

Game-related statistics	SC
Reception error	0.54*
Counter attack point	0.44*
Set error	0.37*
Attack point	0.33*
Block point	0.27
Serve point	0.21
Service error	0.16
Side-out point	0.16
Attack error	0.16
Side-out error	0.14
Block error	0.12
Set excellent	0.12
Excellent reception	0.09
Counter attack error	0.06
Dig error	0.04
Excellent dig	0.00

$|SC| \geq .30$

Results suggest that the discriminant variables possibly associated with defeat are the reception error and set error, while counter attack point and attack point may be related to victory.

4. Discussion

Previous studies have revealed the expanded use of the offensive zone for attack during volleyball matches, often at the expense of the defence zone (Ureña et al., 2002). When the setter is in the defence zone, he usually has five attack options, which is preferable to his being in the attack zone, in which he has only four. As such, the attack is unquestionably the skill most important to scoring points and has thus proven decisive to the offensive strategy of any volleyball team (Drikos et al., 2009; Miskin et al., 2010; Costa et al., 2011; Nikos and Elissavet, 2011). With attacks, teams win a large percentage of points compared to the total number of actions; so much so that nearly half of all attacks executed have resulted in a scored point (Charitonidis at al., 2007; Zetou et al., 2007; Patsiaouras at al., 2009; Patsiaouras at al., 2010).

In a volleyball match, the attack can occur in either a side-out or counter attack situation. In this study, these two skills were differentiated to access new, more detailed information (total attacks = side-out + counter attack).

Some authors (Ureña et al., 2002; Zetou et al., 2007) have stated that attacks reveal greater efficiency in the side-out situation. The results of these studies support our study's in regards to the discriminant variables, the counter attack point, and the attack point.
As the match skill with the greatest number of executions and the most widespread use for obtaining points, the attack is also the skill in which errors most often occur (Drikos et al., 2009; Palao at al., 2009). Therefore, if the efficacy of the attack point either in the counter attack or side-out can be increased, then the probability of winning will also increase.

If a team is effective in side-out, then it can usually achieve a balanced scoreboard in order to continue the match. By adding an efficient counter attack, this team will gain the necessary conditions to win the match, since it can gain points by attacking in a counter attack situation.

Two non-terminal skills are also suggested as discriminant variables possibly associated with defeat: reception error and set error. In volleyball, points can be obtained only with terminal skills (e.g., service, attack, block), yet all previous skills influence the final decision and thus the match's final result (Rabaz et al., 2013).

In the present study, we demonstrated that more errors in reception and in setting may be associated with failure (i.e., winning teams failed less in reception and had better setting). At the same time, a negative performance in reception may interfere in the setter's performance and thereby influence the entire offensive organization of the team in the side-out (Nikos and Elissavet, 2011).Therefore, failure to obtain the point at that time of the match allows the opponent to distance itself on the scoreboard and, in turn, increase the probability of defeat. These results suggest a causal relation between both actions (i.e., when the reception is poor, the probability of experiencing a poor setting increases). Several authors vouch for this statement by having underscored that technical skills in a volleyball match are sequential and have a high level of demand, as well as that each decision is influenced by the previous and, in turn, influences what happens next (Durkovic et al., 2008; Nikos and Elissavet, 2011; Buscà and Febrer, 2012).

According to several other studies, reception is a factor that greatly influences the organization of the offensive manoeuvre and describes a relationship between the quality of reception and a team's success (Ureña et al., 2002; Gubellini et al., 2005; Maia and Mesquita, 2006; João et al., 2010). However, reception is nevertheless dependent upon the type of serve performed by the opponent (Ureña et al., 2002).

Our results also showed that the set error when the setter is in the defence zone may be associated with defeat. This finding is likely related to a possible conflict in the reception lines between the receivers and setter, since there is a need to displace the setter that reduces reception quality. Regardless of reception quality, top teams usually manage to overcome these difficulties and to score, even if this skill is not perfected.

This study is limited by its gender focus, in that the present results cannot be extrapolated to women's volleyball given match dynamics and that some skills will have different influence.

5. Conclusion

The presented study helps to explain which match skills in men's volleyball are related to a team's success or failure when the setter is in the defence zone.

We have shown that skills possibly associated with victory are the counter attack point and attack point, while reception error and set error are possibly related to defeat.

In line with the described results and by acknowledging that skills are interdependent, it is necessary to improve reception efficacy in order to increase a team's offensive organization. In this sense, improved reception quality also implies a better performance regarding the setting, which with increase it is possible to improve a team's offensive strategy.

Altogether, this study helps to explain why teams win, for success with the match skills of attack point and counter attack point increase a team's likelihood of never being defeated. As such, our work provides a substantial contribution for volleyball training and competition.

6. References

Afonso, J. and Mesquita, I. (2011), Determinants of block cohesiveness and attack efficacy in high-level women's volleyball, **European Journal of Sport Science**, 11(1), 6975.

Amasay, T. (2008), Static Block Jump Techniques in Volleyball: Upright Versus Squat Starting Positions, **Journal of Strength and Conditioning Research**, 22(4), 12421248.

Bergeles, N., Barzouka, K. and Nikolaidou, M. (2009), Performance of male and female setters and attackers on Olympic level Volleyball teams, **International Journal of Performance Analysis of Sport**, 9, 141148.

Buscà, B. and Febrer, J. (2012), Temporal fight between the middle blocker and the setter in high level volleyball, **International Journal of Medicine and Science of Physical Activity and Sport**, 12(46), 313327.

Castro, J. and Mesquita, I. (2008), Implications of offensive spacing in elite male volleyball attack characteristics, **Portuguese Journal of Sport Sciences**, 8(1), 114125.

Castro, J., Souza, A. and Mesquita, I. (2011), Attack efficacy in volleyball: elite male teams, **Perceptual and Motor Skills**, 113(2), 395-408.

Charitonidis, K., Vatsiaouras, A. and Charitonidi, M. (2007), Comparison terms of the effectiveness of technical skills between the Greek national volleyball team and other European national teams, **Inquiries in Sport & Physical Education**, 5(3), 431436.

Claver, F., Jiménez, R., Gil, A., Domíguez, M., Arroyo, M. and Perla M. (2013), Relationship between performance in game actions and the match result: a study in volleyball training stages. **Journal of Human Sport & Exercise**, 8(1), 651659.

Costa, G., Ferreira, N., Junqueira, G., Afonso, J. and Mesquita, I. (2011), Determinants of attack tactics in Youth male elite volleyball, **International Journal of Performance Analysis in Sport,** 11, 96104.

Costa, G., Mesquita I., Greco, P., Ferreira, N. and Moraes J. (2011), Relation service, reception and attack in male junior volleyball, **Motriz,** 17(1), 1118.

Drikos, S., Kountouris, P., Laios, A. and Laios, Y. (2009), Correlates of Team Performance in Volleyball, **International Journal of Performance Analysis of Sport, Cyncoed**, 9(2),149156.

Durkovic, T., Marelic, N., and Resetar, T. (2008), Influence of position of players in rotation on differences between winning and losing teams in volleyball, **International Journal of Performance Analysis in Sport**, 8(2), 815.

Garganta, J. (2009), Trends of tactical performance analysis in team sports: Bridging the gap between research, training and competition. **Portuguese Journal of Sports Sciences**, 9(1), 81-89.

Gubellini, L., Lobietti, R. and Di Michele, R. (2005), Statistics in volleyball: the Italian professionals leagues. **Scientific Fundaments of Human Movement and Sport Practice**, 21(2), 323334.

Gwet, KL. (2008), Computing inter-rater reliability and its variance in the presence of high agreement. **British Journal of Mathematical and Statistical Psychology**, 61(1), 2948.

João, P., Leite, N., Mesquita, I. and Sampaio, J. (2010), Sex difference in discriminative power of volleyball game-related statistics, **Perceptual and Motor Skills**, 11(3),893900.

João, P., Mesquita, I., Sampaio, J., & Moutinho, C. (2006), Comparative analysis between libero and priority receivers on the offensive, **Portuguese Journal of Sport Sciences**, 6(3), 318328.

Maia, N. and Mesquita, I. (2006), Study of zones and efficacy of the reception according the receiver player in female senior volleyball, **Brazilian Journal of Physical Education and Sport**, 20(4), 25770.

Marcelino, R., Mesquita, I., and Sampaio, J. (2008), Home Advantage and set outcome in high level volleyball, **Journal of Sport Sciences**, 26(SI), 73.

Matias, C. and Greco, P. (2011), Offensive organization assessment of winners of Brazilian Volleyball, **Brazilian Journal of Physical Education and Sport**, 33(4), 10071028.

Miskin, M., Fellingham, G. and Florence L. (2010), Skill Importance in Women's Volleyball. **Journal of Quantitative Analysis in Sports**, 6(2), 114.

Nikos, B. and Elissavet, NM. (2011), Setter's performance and attack tempo as determinants of attack efficacy in Olympic level male volleyball teams**. International Journal of Performance Analysis in Sport**, 11(3), 535544.

Palao, J. and Ahrab–Fard, I. (2011), Side-out success in relation to setter's position on court in women's college volleyball. **International Journal of Applied Sports Sciences**, 23(1), 155167.

Palao, J., Santos, J. and Ureña, A. (2005), The effect of setter´s position on the spike in volleyball, **Journal of Human Movement Studies**, 48(1), 2540.

Palao, J.; Santos, J. and Ureña, A (2004), Effect of team level on skill performance in volleyball, **International Journal of Performance Analysis in Sport**, 4(2), 5060.

Patsiaouras, A., Charitonidis, K., Moustakidis, A. and Kokaridas, D. (2009), Comparison of technical skills effectiveness of men's National volleyball teams. **International Journal of Performance Analysis in Sport**, 9(1), 17.

Patsiaouras, A., Moustakidis, A., Charitonidis K. and Kokaridas, D. (2010), Volleyball technical skills as winning and qualification factors during the Olympic Games 2008. **International Journal of Performance Analysis in Sport**, 10 (2), 115120.

Rodríguez-Ruiz, D., Quiroga, M., Miralles, J. Sarmiento, S., Saá, Y. and GarcíaMans, J. (2011), Study of the technical and tactical variables determining set win or loss in top-level European men's volleyball. **International Journal of Performance Analysis in Sport**, 7 (1), 115.

Tabachnick, B. and Fidell, L. (1996), Using Multivariate Statistics. 3ª ed. New York: Harper Collins Publishers, Inc.

Trajkovic, N., Milanovic, Z., Sporis, G., Milic, V. and Stankovic, R. (2012), The effects of 6 weeks of preseason skill based conditioning on physical performance in male volleyball players. **Journal of Strength and Conditioning Research**, 26(6), 147580.

Ureña, A., Calvo, R. and Lozan C. (2002), A study of serve reception in the top level of Spanish male volleyball after the introduction of the libero player. **International Journal of Medicine and science of Physical Activity and Sport**, 2, 3949.

Valliant, M., Emplaincourt, H. and Wenzel R. (2012), Nutrition education by a registered dietician improves dietary intake and nutrition knowledge of a NCAA female volleyball team. **Nutrients**, 4, 506–516.

Zetou, E., Moustakidis, A., Tsigilis, N., and Komninakidou, A. (2007), Does Effectiveness of Skill in Complex I Predict Win in Men's Olympic Volleyball Games?, **Journal of Quantitative Analysis in Sports**, 3(4), 19.

Correspondence:
Paulo Vicente João – Ph.D
Faculty of Sports Sciences
University of TrásosMontes e Alto Douro at Vila Real
Parque Desportivo da UTAD
Apartado 1013 5001801 - Vila Real - Portugal
Email: pvicente@utad.pt

Study 5: Match analysis according to the performance of the team rotations in Volleyball

Match analysis according to the performance of the team rotations in Volleyball

Miguel Silva[1]; Tine Sattler[3]; Daniel Lacerda[1] and Paulo Vicente João[2]

[1] PhD. Student, University of Trás-os-Montes e Alto Douro at Vila Real, Portugal

[2] Research Center in Sport Sciences, Health Sciences and Human Development, CIDESD, Creative Lab Research Community, Portugal

[3] Faculty of Sport, University of Ljubljana

Corresponding author:

MD Miguel Alexandre Silva

University of Trás-os-Montes e Alto Douro at Vila Real, Portugal

Rua da Lousada Edifício S. José II, 7º Dir.

5050-262 Peso da Régua Portugal,

Phone number: +351 914 919 055

email: mmiguelfpv@gmail.com

Abstract

The present article aims to analyze the performance of the six volleyball regulatory rotations and to identify which rotation is the most contributing on final result of the game (victory or defeat). 49 matches played during the 2010 Volleyball World Championship; 2010 European League; 2011 World Cup; 2011 European Championships; 2011 World League, 2011 European League; 2012 Olympic Games; 2012 European League and 2012 World League were taken and analyzed with Data Volley Software. For the data analysis the discriminating function was used in order to identify the discriminating variables through the canonical structuring coefficient |SC| ≥ .30. The results revealed that all the rotations may contribute for a global balanced performance of the team. Regarding the average point rotation difference, the rotations P1, P6 and P2 were the ones that presented relevant statistical values so we may affirm that they have influence in the victory. This study can also help the coaches to understand if the player's positions are the best according to their individual qualities, helping them to decide if it is beneficial to change some players on the playing positions or maybe the team just needs more drill in some rotations to be more effective.

Keywords: *volleyball; game analysis; rotations; line-up*

Introduction

Volleyball, as team sport where the direct confrontation between one or more players is key, is becoming more and more a strategic-tactical sport (João, Leite, Mesquita, & Sampaio, 2010; Rodríguez-Ruiz et al., 2011; Silva, Lacerda, & João, 2014b). There are many studies addressing playing performance, efficiency and the importance of volleyball elements (Castro, Souza, & Mesquita, 2011; Drikos & Vagenas, 2011; Marcelino, Mesquita, & Sampaio, 2011; Nikos & Elissavet, 2011; Patsiaouras, Moustakidis, Charitonidis, & Kokaridas, 2010; Patsiaouras,

Moustakidis, Charitonidis, & Kokaridas, 2011; Peña, Rodríguez-Guerra, & Serra, 2013; Silva, Lacerda, & João, 2014a).

Throughout history, volleyball became a sport with increased demands of physical, psychological (Maciel et al., 2009), technical and tactical domain (João et al., 2010; Palao, Santos, & Ureña, 2004). This is reflected in a higher number of balanced games and in the specialization of playing roles (Maciel et al., 2009; Rocha & Barbanti, 2007).

Each of the six players that compose the starting line-up is obliged to occupy a regulatory zone (zone 1, 2, 3, 4, 5 or 6). Due to the rotation rule imposed by the regulation and compliance with certain tactical principles the coach defines in each zone a player with specific characteristics (setter (S), outside hitter 1 and 2 (OH), middle blocker 1 and 2 (MD), opposite (OP)) will play. However, these characteristics should not confuse the players from their current rotation.

The rotation is determined according to the current position of the setter; in rotation 1 (P1) the setter is in zone 1; in rotation 2 (P2) the setter is in zone 2 etc. (Zadražnik, Marelić, & Rešetar, 2009). The attack players are positioned in zone 4, 3 and 2, and they mostly participate in the attack and block. The players on the defence zone are positioned in zone 1, 6 and 5 (See figure 1) and they are mostly participating on the defence.

A winning team is characterized by a group of individuals are all driven towards the same direction, sharing common goals and values (Bergeles, 2009). One of the most important factors for success of a volleyball team is the cohesion of the players. Even a team full of talented players can have difficulty playing well together (Garganta, 2009).

Winning or losing depends of a large number of factors (Durković, Marelić, & Rešetar, 2008). One of them can be the efficiency in technical and tactical solutions in the different phases of the game, when the team is in Side-out or KI (reception, set, and attack after reception) and Counter

Attack or KII (serve, block, defence and counter attack) (João et al., 2010; Palao et al., 2004; Silva et al., 2014b; Zadražnik et al., 2009).

Success of the team can also depend on the balance of the efficiency in each rotation; however statistical analysis of games reveal that such balance is difficult to achieve also in high quality teams (Zadražnik et al., 2009). To get a better balance between rotations the coaches start the match usually with the most efficient rotation, to get advantage from opponent team at beginning and usually this rotation will be the most repeated (Palao & Ahrab–Fard, 2011).

The official Volleyball regulations require that before each set the coach should give the referees the starting line-up (shirt number of the player written in each zone) (FIVB, 2012) (See Figure 1).

Some coaches are saying that the strategy of the game begins when they decide the starting line-up. It defines in which zone of the court the players start the match, knowing that balanced quality performance through all the rotations is one of the key factors to win (Durković, Marelić, & Rešetar, 2009). A significant number of coaches prefer to start the match in P1 when the team is in KII (starting serve) or in P2 when the team is playing in KI (starting with reception) (Laios & Kountouris, 2011). However starting the match in P6 is the second option in many cases.

The starting line-up on the court can influence the efficiency of the team. The performance of the team also depends of other factors like: anthropometric characteristics, physical condition/fitness (Trajkovic, Milanovic, Sporis, Milic, & Stankovic, 2012), tactical and technical knowledge (João et al., 2010; Palao et al., 2004, 2010), as well as cognitive abilities and personality traits (Valliant, Emplaincourt, & Wenzel, 2012).

For a better understanding of the details of the game the coaches are using statistical reports (O'Donoghue & Holmes, 2015). With statistical reports they can analyze the game by many factors

and one of them is also in which rotation the team was more or less successful. This information can help in the training process to put less efficient rotations in balance; it can also be used for research purposes (Silva *et al.*, 2013; Silva, Lacerda, & João., 2014b; Zadražnik *et al.*, 2009).

The aim of our study is to analyze the performance of the rotations and to identify which rotation is the most contributing on final result of the game (victory or defeat), and understand if the teams performances are different concerning their positions in the international ranking.

Methods

The sample of this study was composed by a total of 49 matches for men's senior national teams. All match data was taken from the 2010 Volleyball World Championship, n=4 matches; 2010 European League, n=4 matches; 2011 World Cup, n=5 matches; 2011 European Championships, n=12 matches; 2011 World League, n=4 matches; 2011 European League, n=4 matches; 2012 Olympic Games, n=8 matches; 2012 European League; n=4 matches and 2012 World League, n=4 matches.

For the composition of the sample were taken into account the following criteria:

 - Minimum 4 matches from each competition (semifinals and finals);

 - All matches from the top 8 ranking teams of each competition;

 - Matches from the final stages of the main volleyball competitions.

In this study we used one dependent variable (Victory and defeat) and six independent variables (rotations P1, P2, P3, P4, P5 and P6) (See Figure 1).
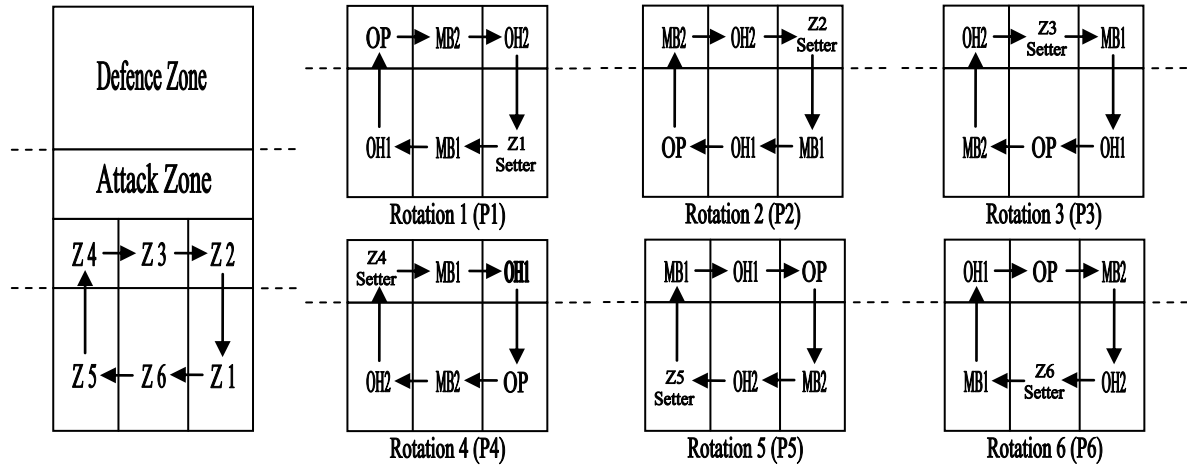
Figure 1. The setter make the 6 rotations according the clockwise diretion: Z1, to Z6, to Z5 (defence zone) and Z4 to Z3, to Z2 (Attack zone), his location determines the name of each rotation.

All data was collected by volleyball scouters (min 5 years of experience) of their national teams using *Data Volley Software*. This software allows the access to all details of competition, match, set, point, rotation and a lot of other details of the game (Drikos et al., 2009; Rodríguez-Ruiz et al., 2011; Silva et al., 2014).

With *Data Volley Software* is possible to display and print analytical reports at any time. In the reports we can identify all the performance values of the players and teams with many information's that allow the coach the opportunity to decide at any time of the game or practice (Silva et al., 2014). The majority of the top teams in the world use this software (Drikos et al., 2009; Rodríguez et al., 2011).

To collect all the data of our study we analyzed the match report of each game. In what concerns the match report we were mostly focused in the performance of each team for all six rotations.

For consistency, the scouters observation was performed intraobserver and interobserver reliability from two experts using random sample of ten games (20% of the sample according to the literature) in repeated analyze after 15 days (Zetou, Tsigilis, Moustakidis, & Komninakidou, 2006).

The inter-rater reliability of the data/kappa (Gwet, 2008) had agreement coefficients and intra observer Cohen's Kappa. The reliability of the observation was tested, presenting values of intra observer Cohen's Kappa of 0,99 and 1 and inter observer Cohen's Kappa of 0,98 and 1, which means that the data is reliable. The reliability of Data volley software data was confirmed by Pena, Rodriguez-Guerra, Busca and Serra (2013).

For the methodology of the study descriptive statistics were used. The discriminating function was conducted to identify through the structural canonical coefficients (SC) the regulatory rotation which is the most efficient in the game to establish the difference between winning and defeated teams. A discriminant analysis was computed, and a coefficient structure was considered relevant to the linear composites superior of $|SC| \geq .30$ (Tabachnick & Fidell, 1996). The significance was established at 5%.

Results

Table 1 shows the results which compared average values of the six regulatory rotations analyzed according to the final result (e.g., defeat or victory) in all matches played. The discriminant analysis yielded statistically significant differences in all of the six regulatory rotations examined ($p<.05$).

Table 1. Means and standard deviations of statistics by rotation (win or lose).

Rotation statistics	Defeat		Victory		F	p
	M	SD	M	SD		
(P1)	1,63	4,05	1,47	3,55	16,036	,000*
(P2)	1,40	3,08	1,37	3,79	15,498	,000*
(P3)	0,96	4,74	1,08	3,48	5,861	,017*
(P4)	1,52	3,86	1,90	3,22	22,503	,000*
(P5)	0,46	3,72	1,69	3,68	8,206	,005*
(P6)	2,65	3,94	1,76	4,06	29,313	,000*

*M:*means; *SD:* standard deviation; *f:* ratios; * *p<.05*

The calculation of the discriminant function was held through the method of forced entry, where all the dependant variables entered simultaneously in the analysis. The outcome of the discriminant

analysis, for the present result, was a 100%. The function obtained yielded a statistically

significant fit (χ^2=71,567, p<.05), with a canonical correlation of .73.

Table 2 contains the structure coefficients that describe the profiles of volleyball game statistics, by regulatory rotation, which differentiate between defeat and victory performances. The larger size of a structure coefficient indicates a greater contribution of regulatory rotation statistic to discriminate differences between defeat and victory. The discriminant function reflected the strong influence of P6 (*SC*=.51), P1 (*SC*=.37) and P2 (*SC*=.37). The remaining regulatory rotations (P5, P4 and P3) statistics did not have relevant contributions for the structure of the linear function.

Table 2. Discriminant function structure coefficients and tests of statistical significance.

Rotation statistics	SC
(P6)	,51*
(P1)	,37*
(P2)	,37*
(P4)	,29
(P5)	,27
(P3)	,22

*|SC| ≥ .30

Through the analysis of table 2, we are able to observe that the discriminant regulatory rotations possibly associated with defeat are the P5, P4 and P3. The regulatory rotations that may be associated to victory are the P6, P1, and P2.

Analyzing individual teams results, they show that of the twenty-one teams present in various competitions analyzed in P1 the Portuguese team (POR) is the team that has the best average point rotation difference, followed by the teams of the Czech Republic (CZE) and France (FRA), respectively (Figure 2).
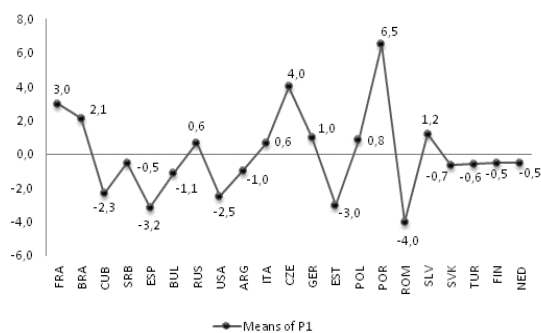
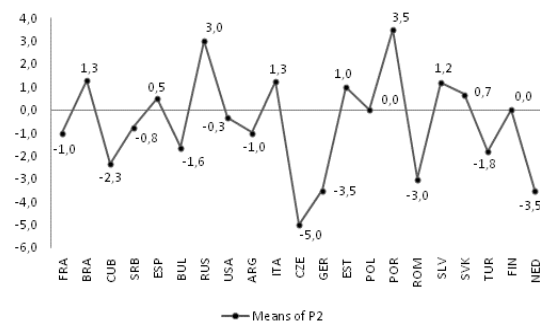**Figure 2.** Means by teams on rotation 1 (P1)

Figure 3. Means by teams on rotation 2 (P2)

In P2 (Figure 3) the results show that of the teams studied the Portuguese team (POR) is the one with better average point rotation difference, followed by the teams of Russia (RUS) Brazil (BRA) and Italy (ITA) respectively.

In P3 (Figure 4) the results show that from the teams observed the team of Brazil (BRA) and Spain (ESP) are the ones that get the best results, followed by the team of Italy (ITA).

Figure 4. Means by teams on rotation 3 (P3)

Figure 5. Means by teams on rotation 4 (P4)

In P4 (Figure 5) the results show that the best average point rotation difference performances were obtained by the team of Slovakia (SVK) and Netherlands (NED), followed by the Czech Republic (CZE) and Turkey (TUR).

In P5 (Figure 6) the results show that Portugal (POR) is the one that present best average point rotation difference performance, followed by the team of Turkey (TUR), Serbia (SRB) and Finland (FIN).
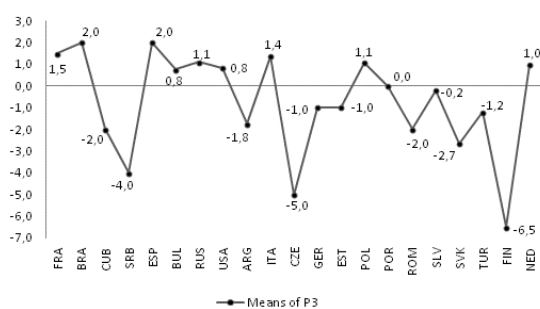
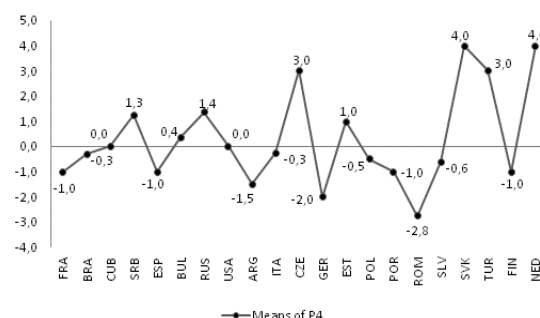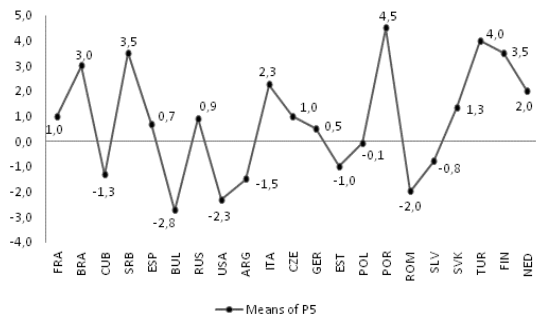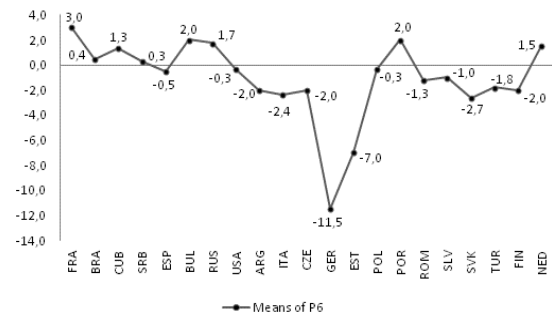**Figure 6.** Means by teams on rotation 5 (P5)

Figure 7. Means by teams on rotation 6 (P6)

In P6 (Figure 7) the results show that the best average point rotation difference performances were obtained by the team of France (FRA), followed by the teams of Bulgaria (BUL) and Portugal (POR).

Discussion

Currently in the literature, there is a lack of studies which analyze rotations in volleyball. The conducted studies until now (Durković et al., 2009; Durkovic et. al., 2008; Laios & Kountouris, 2010; Laios & Kountouris, 2011), and the acta performed (Zadražnik et al., 2009) were based on the performances of the six Volleyball skills (service, reception, set, block, attack and defence) in each of the six game rotations.

Of the four studies, two (Durković et al., 2009; Durkovic et. al., 2008) were conducted with female samples from youth teams and the other two studies (Laios & Kountouris, 2010; Laios & Kountouris, 2011) focus their investigation in National Championships of adult males.

The results of this study show the existence of statistically significant differences in all of the six regulatory rotations examined, which allows us to conclude that all rotations have an effect to the overall performance of the team and can influence the final result of the game. Thus, as much higher is the teams balance in efficiency levels during the six rotations, much higher will be the technical-tactical regularly, increasing the probability of winning the game

Zadražnik et al., (2009) also concluded, despite the sample of the study belonging to a female competition, that the regularity of a team it is influenced by the balance of playing quality in the

six individual rotations. Trying to get this balance, teams start the sets with their stronger rotations because these are the rotations that will be repeated more often (Palao, & Ahrab–Fard, 2011).

From the values shown in Table 2 we can affirm that the results of discriminant function reflected strong influence, between defeat and victory, in three out of the six rotations: P6, P1, and in P2, so it is possible to conclude that these rotations are associated to victory.

The results of the study in A1 division of the men's Greek Championship of Volleyball for the 2005–2006, performed by Laios and Kountouris, (2010) also demonstrated better values when the setter is in zone 1, 6 and 4 and it is not an easy case to decide the starting positions of the team's players in order to use more times the most efficient rotation.

In P6 the values found may be justified by the fact that in side-out or KI on a system 5x1 (system in which all the observed teams play: five attackers and one setter, which means that only one player, the setter, is responsible for organizing the offensive plays either in side-out or KI and counter attack or KII) with 3 receivers in the reception line the setter is very close to the ideal setting zone (between zones 2 and 3) with the more effective players at net positions and close to the attack action zone. The setter has the possibility to combine all the attack options either by the number of available players to attack (3 players at the net and 1 at the second line) either in speed or in attack times.

The fact of having 3 players very close (middle blocker 2, outside hitter 2, opposite) makes it possible to play in very fast times in a very short space of the net being able to create time crisis situations between zone 3 and 2, on the other side makes it also possible to focus the opponent block in these positions between zone 3 and 2 (although it also depends; first of the quality of reception and second from tactic of blocking), providing greater distance so that the attack player placed at zone 4 may attack in a superiority offensive position.

Regarding the positioning in counter attack or KII the first line of block is the one that seems to us more balanced because theoretically it's composed by potentially good blockers. Regarding the

attack in P6, the team possesses their best two scorers at their most comfortable zones, and extreme of the net (the opposite in zone 2 and the best outside hitter in zone 4).

In tactical terms in the P1 rotation the setter is at the defensive zone, which means that in side-out or KI all the net positions are occupied by offensive players. In side-out or KI the setter is in an uncomfortable position of penetration by the fact that he's placed at a considerable distance from the ideal setting zone and also at the intersection of the trajectory of potentially stronger opponent's service.

This constraint is minimized by the protection of the service trajectory by a receiver player, by the setter trajectory until the ideal setting area and by the offensive complexity that the team may create.

At the observed sportive level the two first basics are of common sense and are safeguarded by organizational questions at the reception line with three players, in the 5x1 match system, the issue on the tactical complexity is supported by inherent questions to the number of players in system (ready and available to attack) and attack times. This complexity may be at the basis of the association of the P1 rotation to the victory, so consider this.

In P1 at side-out or KI the team has three spikers at net positions (the opposite (in Z4), the middle blocker 2 (in Z3) and the outside hitter 2 (in Z2) and an offensive player in the defence zone (outside hitter 1). This context allows the setter to build offensive plays with superiority of offensive players (4) versus blockers (3) in addition to promoting advantageous situations of attack in different times and in very close zones. The most obvious example to express this reflection is the offensive situation in a system with a pipe ball (second line attack by zone 6), attacked carried out practically in the same space of the middle blocker but at different times.

Another reason that we believe should be highlighted is the fact that in this rotation the setter is moving to the ideal setting zone with a very wide viewing angle, always facing the opposite side as

well as the left side of the court which allows a clear view of the behavior of three of the four spikers available on his team.

The highest influence values are in the P2, when the setter is in the attack zone, which means one less option of attack available in the net and this player might have to block the opponent attack, even not being, traditionally, a specialist player in this skill it can be justified by the fact teams that win the game managed the attack more successfully from the defence zone of the court and probably have good levels of efficiency service, in these rotations.

It is interesting to notice that our results don't show a strong influence in rotations 4, 3 and 5.

Respecting P4 and P5, when the team is in side-out or KI phase, to arrive to the optimal position for setting the attack (between zones 2 and 3) the setter has a long distance to go. During this transition the setter also has to turn towards zone 4, resulting in a momentary loses of visual contact with the ball. Despite the teams having extraordinary setters, who could solve technical-tactical situations in these rotations, this kind of constraint allows us to conclude that the game in these two rotations is more slower, predictable and less diverse.

In situation of counter attack or KII this low influence can be associated to the fact of the opponent team trying to explore its attack from the zone where the opponent setter is blocking, knowing that this player is not an expert in this skill (Araújo, Mesquita, & Marcelino, 2009; Zadražnik et al. 2009).

On P3 the setter is situated in the attack zone. In this type of situations, when the setter is by the net with only two attacking players nearby, is, in the tactical sense, is considerably different from the situation when he is at the defence zone of the court with three available attacking players along the net (Silva et al., 2013; Silva et al., 2014b).

This difference in the number of available attackers perhaps, at this level of competition, can justify the weak influences of P3 in the final result of the game, in addition the fact that the setters

have the probability to make a block and they are usually the worst blocking players in the team (Maciel et. al., 2009).

Concerning the analysis of the results by team we can conclude that the top teams usually don't have a rotation that is fundamental to achieve victory in the game. However the worst teams ranked have, clearly, higher average point rotation difference values in one or two rotations compared to the others.

Thus, this balance of performances that top teams distribute by six rotations may explain the greater success that they have. High levels of efficiency and effectiveness at every phase of the can easily achieve a better playing regularity. This regularity depends of the balance of the playing quality in individual rotation; however statistical analysis of games reveal that such balance is difficult to achieve also in high quality teams (Zadražnik et al., 2009).

Conclusion

Even though we have the notion that the values found in some teams may be influenced by the reduced number of observed matches or by the uneven final score, we noticed a certain consistency in the values found on the best ranked teams. Therefore we may assess that even though all the rotations may contribute for a global balanced performance of the team, in what concerns the average punctual coefficient the rotations P1, P6 and P2 were the ones that presented statistically relevant values, leading us to affirm that they have influence in the victory.

Even if these are the results found, we should mention that the balance and the punctual stability in all the rotations must be the goal in building a starting line-up, potentiating thus the unbalance through technical tactical contexts that may try to overcome the difficulties imposed by the opponent team and improve the efficacy.

In high level sport (presented in this sample), the search for efficacy does not go through exclusively by making the most of the potential of each player in each game skill but above all to

use those skills to the advantage of the team through the improvement and consolidation of the context and tactical complexity.

However, sometimes coaches decide their starting line-up also according to opponent team qualities; e.g. some coaches try to avoid his weaker blocker on opponent best attacker with different rotation.

Seeing the positive or close to zero values, presented in most of the rotations, by the observed teams in this study and also the best ranked teams (Brazil, France, Italy, Poland) we may affirm that these balanced values have direct correlation over the team performance and posterior final ranking. This statement led us to assess that the punctual homogeneity by rotation is a relevant factor being able to condition the final score (victory or defeat).

Therefore we state that the construction and definition of the line-up must be a factor that the coach must have in consideration when willing to potentiate the individual and collective performance of his team.

Future research should consider how variables such as service, reception and block cam possibly influence the team's performance in the six rotations, as well the tactical organization used by them.

In future studies we may also carry out an assessment/inquiry with the purpose of questioning the coaches about the factors that they consider relevant for the definition and creation of the starting line-up of their team and the influence of the characteristics showed by the opponent teams for the changes that they may do in each match.

Practical Applications

This study emphasizes the need of balancing the playing quality in individual rotations, by considering the interaction between technical and tactical dimensions. In particular, the results might have helped to reveal the need to explore certain skills in certain rotations and the need for

players to perceive the importance of high values of efficiency on those skills may predict victory, managing their effort throughout the match attempting to execute those skills in optimal condition.

It might be beneficial to coaches to increase practice game skills in stress situations, particularly at the end of the training drills that simulate competition scenarios.

This study can also help the coaches to understand if the player's positions are the best according to their individual qualities, helping them to decide if it is beneficial to change some players positions or maybe the team just needs more drill in some rotations to be more effective.

References

Araújo, R., Mesquita, I., and Marcelino, R. (2009), Relationship between block constraints and set outcome in elite male volleyball, *International Journal of Performance Analysis in Sport*, 9(3), 306-313.

Bergeles, N., Barzouka, K., & Nikolaidou, M. E. (2009), Performance of male and female setters and attackers on Olympic level volleyball teams. *International Journal of Performance Analysis in Sport*, *9*(1), 141-148.

Castro, J., Souza, A., and Mesquita, I. (2011), Attack efficacy in volleyball: elite male teams, *Perceptual and motor skills*, 113(2), 395-408. doi: 10.2466/05.25.PMS.113.5.395408

Drikos, S., and Vagenas, G. (2011), Multivariate assessment of selected performance indicators in relation to the type and result of a typical set in Men's Elite Volleyball, *International Journal of Performance Analysis in Sport*,11(1), 85-95.

Drikos, S., Kountouris, P., Laios, A. and Laios, Y. (2009), Correlates of Team Performance in Volleyball, *International Journal of Performance Analysis of Sport, Cyncoed*, 9(2),149-156.

Durković, T., Marelić, N. and Rešetar, T. (2009), Rotation analysis of teams` performances at 2003 youth European volleyball championship. *Kinesiology*, 41, 60-65

Durković, T., Marelić, N., and Rešetar, T. (2008), Influence of the position of players in rotation on differences between winning and losing teams in volleyball. *International Journal of Performance Analysis in Sport*, *8*(2), 8-15.

Garganta J. (2009), Trends of tactical performance analysis in team sports: Bridging the gap between research, training and competition. *Portuguese Journal of Sports Sciences*, 9(1), 81-89.

Gwet, K. L. (2008), Computing inter-rater reliability and its variance in the presence of high agreement. *British Journal of Mathematical and Statistical Psychology*, 61(1), 29-48.

João, P., Leite, N., Mesquita, I. and Sampaio, J. (2010), Sex difference in discriminative power of volleyball game-related statistics, *Perceptual and Motor Skills*, 11(3), 893-900 doi: 10.2466/05.11.25.PMS.111.6.893900.

Laios, A., and Kountouris, P. (2010), Association between the line-up of the players and the efficiency of the serving Team in Volleyball, *International Journal of Performance Analysis in Sport*, 10(1), 1-8.

Laios, A., and Kountouris, P. (2011), Receiving and serving team efficiency in Volleyball in relation to team rotation, *International Journal of Performance Analysis in Sport,* 11(3), 553-561.

Maciel, R. N., Morales, A. P., Barcelos, J. L., Nunes, W. J., Azevedo, M. M. A., & Silva, V. F. (2009), Relação entre tempo de reação e função específica em jogadores de voleibol. *Fitness Performance Journal*, *8*(6), 39-59.

Marcelino, R., Mesquita, I., and Sampaio, J. (2011), Effects of quality of opposition and match status on technical and tactical performances in elite volleyball, *Journal of Sports Sciences*, 29(7), 733-741. doi: 10.1080/02640414.2011.552516

Nikos, B., and Elissavet, N. M. (2011), Setter's performance and attack tempo as determinants of attack efficacy in Olympic level male volleyball teams, *International Journal of Performance Analysis in Sport*, 11(3), 535-544.

O'Donoghue, P., and Holmes, L. (2015), *Data Analysis in Sport*. London: Routledge.

Official Volleyball Rules 2013-2016 Published by FIVB in 2012 – www.fivb.org

Palao, J. and Ahrab–Fard, I. (2011), Side-out success in relation to setter's position on court in women's college volleyball. *International Journal of Applied Sports Sciences*, 23(1), 155-167.

Palao, J. M., Santos, J. A., and Ureña, A. (2004), Effect of team level on skill performance in volleyball, *International Journal of Performance Analysis in Sport*, 4(2), 50-60.

Patsiaouras, A., Moustakidis, A., Charitonidis, K., and Kokaridas, D. (2010), Volleyball technical skills as winning and qualification factors during the Olympic Games 2008, *International Journal of Performance Analysis in Sport*,10(2), 115-120.

Patsiaouras, A., Moustakidis, A., Charitonidis, K., and Kokaridas, D. (2011), Technical Skills Leading in Winning or Losing Volleyball Matches During Beijing Olympic Games, *Journal of Physical Education & Sport/Citius Altius Fortius*,11(2), 149-152.

Peña, J., Rodríguez-Guerra, J., and Serra, N. (2013), Which skills and factors better predict winning and losing in high-level men's volleyball?, *The Journal of Strength & Conditioning Research*, 27(9), 2487-2493. doi: 10.1519/JSC.0b013e31827f4dbe

Rocha, M. A., & Barbanti, V. J. (2007), Analysis of jumping in the spike, block and set skills of female volleyball players, *Brazilian Journal of Kinanthropometry and Human Performance*, *9*(3), 284-290.

Rodriguez-Ruiz, D., Quiroga, M. E., Miralles, J. A., Sarmiento, S., de Saá, Y., and García-Manso, J. M. (2011), Study of the technical and tactical variables determining set win or loss in top-level European men's volleyball, *Journal of Quantitative Analysis in Sports*, 7(1), 1-15. doi: 10.2202/15590410.1281

Silva, M., Lacerda, D., and João, P. V. (2013), Match analysis of discrimination skills according to the setter attack zone position in high level volleyball, *International Journal of Performance Analysis in Sport*, 13(2), 452-460.

Silva, M., Lacerda, D., and João, P. V. (2014a), Game-Related volleyball skills that influence victory, *Journal of Human Kinetics*, 41(1), 173-179. doi: 10.2478/hukin20140045

Silva, M., Lacerda, D., and João, P. V. (2014b), Match analysis of discrimination skills according to the setter defence zone position in high level volleyball, *International Journal of Performance Analysis in Sport*, 14(2), 463-472.

Tabachnick, B. and Fidell, L. (1996), *Using Multivariate Statistics*. 3ª ed. New York: Harper Collins Publishers, Inc.

Trajkovic, N., Milanovic, Z., Sporis, G., Milic, V., and Stankovic, R. (2012), The effects of 6 weeks of preseason skill based conditioning on physical performance in male volleyball players, *Journal of Strength and Conditioning Research*, 26(6), 1475-1480.

Valliant, M., Emplaincourt, H., and Wenzel R. (2012), Nutrition education by a registered dietician improves dietary intake and nutrition knowledge of a NCAA female volleyball team, *Nutrients*, 4(6) 506–516. doi: 10.3390/nu4060506

Zadražnik, M., Marelić, N., and Rešetar, T. (2009), Differences in rotations between the winning and losing teams at the youth European volleyball championships for girls. *Acta Universitatis Palackianae Olomucensis. Gymnica*, *39*(4).

Zetou, E., Tsigilis, N., Moustakidis, A., and Komninakidou, A. (2006), Playing characteristics of men's Olympic Volleyball teams in complex II, *International Journal of Performance Analysis in Sport*, 6(1), 172-177.

CHAPTER 3 – GENERAL DISCUSSION

In the end of this systematic review and four empiric studies, we tried to follow the line of research in Match Analysis in Volleyball, and the first article, **Match Analysis in Volleyball a systematic review**, shows a light balance in the production of comparative and predictive studies, although there is a supremacy of predictive ones. The trend is that the latest research is of a predictive nature.

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

The volleyball game has evolved over the years, along with the development of computer systems and software that enable greater 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 which can clearly identify and categorise individuals and behaviours over time and regular patterns of play. By Analysing the software used in the studies of this review, it is possible to infer that the most frequently used software at this time are *Data Volley*, *VROS* and *VIS*. However, this is worth stating that as a limitation to the analysis of some studies, they do not make a reference to the type of software or technical observation employed.

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 data's reliability, instability and variability of the materials under study, thereby helping coaches in optimising the training process of young athletes and the implementation of more effective training methodologies in elite athletes.

We believe it is necessary to provide more information near the immediate coaches, because the knowledge of the game has changed in the last few years and new roles were implemented giving a different importance to some players. In the beginning, the setter was the most important player, whereas nowadays if teams do not have good middle blockers or good opposite players, they have a lesser chance to match the opposite team.

According to the second article, Game-Related Volleyball Skills that Influence Victory, our results discriminate reception error in defeat; therefore, teams with low efficacy in this skill are more likely to lose the game.

Regarding reception errors, our results suggest that this factor, as would be expected, may be associated with defeat. Several studies have verified a positive association between efficacy in

reception and the final outcome of the match (João *et al.*, 2006; Laios and Kountouris, 2005; Maia and Mesquita, 2006). Even though reception is not a terminal action, a perfect reception allows the setter to organize the team offensively with all the possibilities of attack, increasing the probability of winning the match (João *et al.*, 2010). In elite teams, such as the ones analysed in the present study, the receiving players are very experienced, so only errors in reception discriminated for the result.

The results of this study confirm that an effective serve is a variable which may be used to predict success. Therefore, serve training is crucial and should be taken into consideration in different contexts and moments during the match, using several types of strategies and scenarios that may cause imbalances between teams at the same sports level.

For that reason, it is important to increase serve efficacy, since it is considered a terminal action (Marelic *et al.*, 2004), and may result in a direct point. In that sense, we can infer that the serve is of crucial importance in the performance of volleyball teams. The importance of practicing this skill in the training process is quite clear.

Literature regarding blocking skills in volleyball pointed out its importance for match outcome (Afonso *et al.*, 2010; Palao *et al.*, 2004). Surprisingly, our results revealed that blocking errors discriminate in favour of victory. The blocking skill may result in one of the following situations: point for the team or for opposing, continuity of the match by the team itself (if the defence is good), or continuity for the opposing team. According to these possibilities, our results suggest that blocking skills, in balanced high performance volleyball teams, probably result in more frequent continuity situations than in scoring points.

The organization of the opposition's first line of defence, by means of strategies and triple block formations, may increase the probability of successful blocking. This fact may also be a consequence of the speed of the ball, the variability of the setting, and the trajectory, making it difficult to effectively organize blocks (Afonso *et al.*, 2005; Zetou *et al.*, 2007). The diversity of results which may arise when this skill is employed might explain why studies of blocking errors have generated mixed results. A thorough analysis of our results shows that the winning teams make more blocks (block points and block errors).

Palao (2008) concluded that successful blocking offers more chances to win. In addition, the block is the first terminal action that the opposing team may take towards the opponent's attack, and may result in a direct point.

Regarding the third article, Match analysis of discrimination skills according to the setter attack zone position in high level volleyball, the skills of the game which may dictate the

final result and are most associated with victory include the serve point, excellent set and excellent dig. The skills that may be associated with defeat are service error, attack error and side-out error.

The attack is responsible for the greatest percentage of winning points in volleyball (Costa *et al.*, 2011). In reference to all of the discriminant variables observed, only setting and dig are not classified as a scoring skill (skills that result in a direct point).

The service is the first action of the game and it is also the first weapon of attack. Therefore, if we are able to increase the efficacy of the serve point, we may be able to influence the entire offensive organization of the opponent in the side out.

Therefore, when the setter is in the attack zone (zones 4, 3 and 2) the teams take greater risks in the service. This is because the ability of the setter to intervene in the block is less compared to the other blockers, since their performance during this skill continues to be deficient (Amasay, 2008). On the other hand, the opponent team, as a better offensive power through zone 4, ends up taking advantage of the potential deficiencies of the opposition by the setter to block. The use of a shorter player substitution (usually the setter) by a higher player, may lead to the victory of the game, if this player has a successful performance (João *et al.*, 2010).

The excellent set is pointed out as a discriminant skill to victory. Hence, the performance of the setter should be maintained at the highest level (execution of high percentage of an excellent set) in order to maintain the offensive performance of the team.

Although not foreseen, it was interesting to verify that the excellent dig eventually became a discriminant skill, capable of being associated with victory. We can state that the teams which have a better defence are those capable of gaining advantage on the scoreboard and possibly win the match.

The results of this study help us understand why teams may not win. When teams do not have successful skills of attack, side-out, service and setting, they rarely win the match since these skills are essential for the team's offensive structure and consequently to the success of the volleyball match.

According to the fourth article, Match analysis of discrimination skills according to the setter defence zone position in high level volleyball, results show that skills possibly associated with victory are the counter attack point and attack point, while reception error and set error are possibly related to defeat.

Previous studies have revealed the expanded use of the offensive zone for attack during volleyball matches, often at the expense of the defence zone (Ureña *et al.*, 2002). When the setter is in the defence zone, he usually has five attack options, which is preferable to his being in the attack zone in which he has only four.

As such, the attack is unquestionably the most important skill for scoring points and has thus proven decisive for the offensive strategy of any volleyball team (Drikos *et al.*, 2009; Miskin *et al.*, 2010; Costa *et al.*, 2011; Nikos and Elissavet, 2011). With attacks, teams win a large percentage of points compared to the total number of actions; so much so that nearly half of all attacks executed have resulted in a scored point (Charitonidis at al., 2007; Zetou *et al.*, 2007; Patsiaouras at al., 2009; Patsiaouras at al., 2010).

In the present study, we demonstrated that more errors in reception and in setting may be associated with failure (i.e., winning teams failed less in reception and had better setting). At the same time, a negative performance in reception may interfere in the setter's performance and thereby influence the entire offensive organization of the team in the side-out (Nikos and Elissavet, 2011; Rabaz *et al.*, 2013).

Our results also revealed that set error when the setter is in the defence zone may be associated with defeat. This finding is likely related to a possible conflict in the reception lines between the receivers and setter, since there is a need to displace the setter and that reduces reception quality. Regardless of reception quality, top teams usually manage to overcome these difficulties and score, even if this skill is not perfected.

Altogether, this study helps explain why teams win, as success with the match skills of attack point and counter attack point increase a team's likelihood of never being defeated.

Finally the fifth article, Match analysis according to the performance of the team rotations in Volleyball, shows that all the rotations may contribute for a global balanced performance of the team. In what concerns the average punctual coefficient, rotations P1, P6 and P2 were the ones that presented statistically relevant values, leading us to affirm that they have influence in the victory.

There are a few studies which analyse rotations in volleyball. The conducted studies until now (Durković *et al.*, 2009; Durkovic *et al.*, 2008; Laios and Kountouris, 2010; Laios and Kountouris, 2011), and the acta performed (Zadražnik *et al.*, 2009) were based on the performances of the six Volleyball skills (service, reception, set, block, attack and defence) in each of the six game rotations.

The results of this study show the existence of statistically significant differences in all of the six regulatory rotations examined, which allows us to conclude that all rotations have an effect on the overall performance of the team and can influence the final result of the game. Thus, the higher the team's balance in efficiency levels during the six rotations, much higher will be the technical-tactical regularly, increasing the probability of winning the game.

The fact of having 3 very close players (middle blocker 2, outside hitter 2, opposite) makes it possible to play at high speed at a very short space of the net being able to create time crisis situations between zone 3 and 2. On the other hand it also makes it possible to focus the opponent's block in these positions between zone 3 and 2 (although it also depends: firstly of the quality of reception and secondly from tactic of blocking), providing greater distance so that the attack player placed at zone 4 may attack in a superior offensive position.

Concerning team results analysis, we can conclude that the top teams do not usually have a rotation that is fundamental to achieve victory in the game. However, the worst teams ranked clearly have higher average point rotation difference values in one or two rotations compared to the others.

As a consequence, this balance of performances which top teams distribute in six rotations may explain the greater success that they have. High levels of efficiency and effectiveness at every phase can easily achieve a better playing regularity. This regularity depends of the balance of the playing quality in individual rotation; however, statistical analysis of games reveal that such balance is difficult to achieve also in high quality teams (Zadražnik et al., 2009).

In high level sport (presented in this sample), the search for efficacy does not exclusively follow by making the most of the potential of each player in each game skill, but above all to use those skills to the advantage of the team through the improvement and consolidation of the context and tactical complexity.

However, sometimes coaches decide their starting line-up also according to opponent team qualities; e.g. some coaches try to avoid their weakest blocker against opponent's best attacker with a different rotation.

CHAPTER 4 – CONCLUSIONS

The aim of this research was to analyse the high performance game of the adult male Volleyball players. Using match analysis, we have produced knowledge that will provide scientifically sound contributions to the study of performance in Volleyball considering the setter's location; initially studying the game in its global skills; a second phase depending on the setter's location (attack zone (Zones 4, 3 and 2) or defence zone (Zones 1, 6, and 5), and finally find out which of the six regulatory rotations (P1, P2, P3, P4 P5 or P6) is more effective.

Due to the possibility that there are differences in sports performance depending on the setter location, it is justifiable that studies are concluded to characterize the game skills in order to provide contributions to the process of training in high level volleyball.

This matter is the motto for structuring and completing this research, and in particular for the design of studies that had been drawn up, which were progressively demonstrating the different influence of performance variables studied depending on the setter's location.

The final considerations presented here are the result of combined and integrated analysis, as well as the specific contribution of the systematic review and each of the four empirical studies conducted.

The first study, **Match Analysis in Volleyball: a systematic review** reveals a light balance in the production of comparative (38%) and predictive (62%) studies and both were complied according to the same research lines: skills and their relation with success; match phase and player position.

Regarding the samples, it is notorious that the data used in comparative studies is older than the predictive studies, being the software *Data Volley* (35%) the most frequently used on researches, followed by *VROS* (21%) and *VIS* (12%).

In this review the adoption of more robust methodologies, capable of replication without neglecting the reliability of data, instability and variability of the materials under study and replicate them with actual data samples was recommended. This opened a window to our following studies of the game related skills pointing which skills are discriminant, regarding the setter position (defensive zone (zones 1, 6 and 5) or in the attack zone (zones 4, 3 and 2)) trying to identify which rotations a team have been more or less efficient.

In the second study, **Game-Related Volleyball Skills that Influence Victory**, the results showed that some skills are more associated with success, whereas poor performance in other skills leads to failure. The skills that discriminate in favour of victory are serve point and blocking errors. On the other hand, reception errors were the only variable that indicated possible defeat.

An effective serve is a variable that may be used to predict success but the study's most interesting finding is that errors are also associated with victory. In fact, blocking errors discriminated in favour of victory, but winning teams had a higher percentage of successful blocks.

Regarding reception errors, our results suggest that this factor, as would be expected, may be associated with defeat.

In the third study, **Match analysis of discrimination skills according to the setter attack zone position in high level volleyball**, results show that when the setter is in the attack zone (zones 4, 3 and 2), the skills of the game that may dictate the final result and are most associated with victory are the serve point, excellent set and excellent dig. The skills that may be associated with defeat are the service error, attack error and side-out error.

It was interesting to verify that the excellent dig is associated with victory. We can state that the teams that have a better defence are those capable of gaining advantage on the scoreboard and possibly win the match.

In the fourth study, **Match analysis of discrimination skills according to the setter defence zone position in high level volleyball**, we have shown that skills possibly associated with victory are the counter attack point and attack point, while reception error and set error are possibly related to defeat.

The line with the results described and by acknowledging that skills are interdependent, it is necessary to improve reception efficacy in order to increase a team's offensive organization. In this sense, improved reception quality also implies a better performance regarding the setting, which could improve the team's offensive strategy when increased.

At last, the fifth study, **Match analysis according to the performance of the team rotations in Volleyball**, whose results show a certain consistency in the values found on the best ranked teams. Therefore, we may conclude that even though all the rotations may contribute for a global balanced performance of the team, in what concerns the average punctual coefficient rotations P1, P6 and P2 were the ones that presented statistically relevant values so we may affirm that they may have influence in the victory.

Regardless of the fact that these are the results found, we should mention that the balance and the punctual stability in all the rotations must be the goal in building a starting line-up, potentiating thus the unbalance by means of technical-tactical contexts that may try to overcome the difficulties imposed by the opponent's team and improve the efficacy.

The positive or close to zero values presented in most of the rotations by the best ranked teams observed in this study (Brazil, France, Italy, Poland) may state that these balanced values have direct correlation over the team performance and posterior final ranking. This statement led us to assess that the punctual homogeneity by rotation is a relevant factor when it comes to the final score (victory or defeat).

CHAPTER 5 – PRACTICAL APPLICATIONS

In Team Sports, especially in volleyball, an evolution in the development of the players' and teams' competences at tactical, technical, physical and psychological levels has been observed. This natural tendency has driven the speakers from academic and practical fields to make efforts and work in synergy to obtain better comprehension of the match and therefore to potentiate a high level of performance.

It is relevant to affirm that this way of being and acting has valid repercussions in the training process and in competitions. Therefore we believe that the studies presented are relevant and decisive since they can possibly provide data for a more profound knowledge of the match and guide new methodological training applications more consistent and precise.

Thus, in view of the data obtained from the studies presented, we believe relevant to note the following impact for the competition and training:

a) necessity to promote a bigger offensive capacity in the rotations when the setter stands at the net positions. This should make the coach consider questions of offensive complexity which should be addressed whilst training and used in the matches. The regularity of carrying out double substitutions during the match may also be a question to address either in training or in competition.

b) necessity to increase the training volume and potentiate the development of players' expertise in the execution of technical gestures (serve point and block) which have influence on the victory. On the other hand, make the best use of the team in tactical and technical terms that minimize to the maximum the possibility of performing a bad reception. The training of the different lines of reception to different serves and with the placement of the libero as priority in some zones may reduce this negative influence and therefore add more value to a satisfactory final result. The same can be considered regarding the defensive questions. Potentiate in training a better relation between the first and second line of defence as well as using experts in the execution of the technical gesture block in some moments of the match in substitution for a frail player.

c) necessity to increase the volume of service, attack and side out training, based on the improvement of all possible contexts, technical and tactical.

d) potentiate and capitalize the rotation in which the setter is at position one (P1), six (P6) and two (P2), since these are the rotations that most contribute to the victory, as well as to potentiate the offensive complexity in the remaining rotations (P5, P4 and P3) in such way to minimize the score disparity and reduce the influence of these in the defeat.

CHAPTER 6 - SUGGESTIONS FOR FUTURE RESEARCH

The presented studies show that we are headed for a greater and better scientific knowledge of the match and its variables. As a result, as in any science, these results will contribute for further research.

We believe that the set of assumptions approached and which sustain the obtained results should direct future studies for the detailed thematic of space-time about the efficacy of technical skills and their contribution to the offensive process.

The evaluation of the performance during the match and the moment of the match, namely the individual or collective behaviour in terms of number of match skills and its success in crucial moments of the match and set, identifying if there is any difference in the performance of the teams and the players in the initial and final moments of the match/set or in the balanced, unbalanced or very unbalanced moments of the scoreboard.

Equally it is fundamental to understand weather the results found come from the tactical context of the team or depend on the efficacy and individual efficiency of certain players in certain moments/rotations.

CHAPTER 7 - REFERENCES

Afonso, J., and Mesquita, I. (2011), Determinants of block cohesiveness and attack efficacy in high level women's volleyball. **European Journal of Sport Science,** 11(1), 69-75. doi: 10.1080/17461391.2010.487114.

Afonso, J., Esteves, F., Araújo, R., Thomas, L., and Mesquita, I. (2012), Tactical determinants of setting zone in elite men's volleyball. **Journal of Sports Science & Medicine**, 11(1), 64-70.

Afonso, J., Mesquita, I., and Palao, J. M. (2005), Relationship between the use of commit-block and the numbers of blockers and block effectiveness**. International Journal of Performance Analysis in Sport**, *5*(2), 36-45.

Amasay, T. (2008), Static Block Jump Techniques in Volleyball: Upright Versus Squat Starting Positions. **Journal of Strength and Conditioning Research**, 22(4), 1242-1248.

Bergeles, N., Barzouka, K., and Nikolaidou, M. E. (2009), Performance of male and female setters and attackers on Olympic level volleyball teams. **International Journal of Performance Analysis in Sport**, 9(1), 141-148.

Carling, C., and Dupont, G. (2011), Are declines in physical performance associated with a reduction in skill-related performance during professional soccer match play?. **Journal of Sports Sciences**, 29(1), 63-71.

Carling, C., Reilly, T., and Williams, A. (Eds.) (2009), **Performance assessment for field sports**. London: Routledge.

Costa, G., Mesquita I., Greco, P., Ferreira, N., and Moares J. (2011), Relation service, reception and Attack in male junior Volleyball. **Motriz. Journal of Physical Education**, 17 (1), 11-18. http://dx.doi.org/10.5016/19806574.

Drikos, S., Kountouris, P., Laios, A., and Laios, Y. (2009), Correlates of team performance in volleyball. **International Journal of Performance Analysis in Sport**, 9(2), 149-156.

Durković, T., Marelić, N. and Rešetar, T. (2009), Rotation analysis of teams` performances at 2003 youth European volleyball championship. **Kinesiology**, 41, 60-65

Durkovic, T., Marelic, N., and Resetar, T. (2008), Influence of position of players in rotation on differences between winning and losing teams in volleyball. **International Journal of Performance Analysis in Sport**, 8(2), 8-15.

Gabbett, T., Georgieff, B., and Domrow, N. (2007), The use of physiological, anthropometric, and skill data to predict selection in a talent identified junior volleyball squad. **Journal of Sports Sciences**, *25*(12), 1337-1344.

Golik-Peric, D., Drapsin, M., Obradovic, B., and Drid, P. (2011), Short-term isokinetic training versus isotonic training: effects on asymmetry in strength of thigh muscles. **Journal of Human kinetics**, 30, 29-35.

Hughes, M., and Franks, I. M. (2004), **Notational Analysis of Sport: Systems for Better Coaching and Performance in Sport**. London: Routlege.

Hughes, M., and Franks, I. (2008), **The essentials of performance analysis: an introduction**. London: Routledge.

João, P. V., Leite, N., Mesquita, I., and Sampaio, J. (2010), Sex differences in discriminative power of volleyball game-related statistics. **Perceptual and motor skills**, 111(3), 893-900. doi: 10.2466/05.11.25.PMS.111.6.893900

João, P. V., Mesquita, I., Sampaio, J., and Moutinho, C. (2006), Comparative analysis between libero and priority receivers on the offensive organization, from the serve reception on the volleyball game. **Portuguese Journal os Sport Sciences**, *6*(3), 318-328.

Lago-Ballesteros, J., and Lago-Peñas, C. (2010), Performance in team sports: Identifying the keys to success in soccer. **Journal of Human Kinetics**, 25, 85-91.

Laios, A. and Kountouris, P. (2005), Evolution in men's volleyball skills and tactics as evidenced in the Athens 2004 Olympic Games. **International Journal of Performance Analysis in Sport**, *5*(2), 1-8.

Laios, A., and Kountouris, P. (2010), Association between the line-up of the players and the efficiency of the serving Team in Volleyball. **International Journal of Performance Analysis in Sport**, 10(1), 1-8.

Laios, A., and Kountouris, P. (2011), Receiving and serving team efficiency in Volleyball in relation to team rotation. **International Journal of Performance Analysis in Sport**, 11(3), 553-561.

Lobietti, R., Coleman, S., Pizzichillo, E., and Merni, F. (2010), Landing techniques in volleyball. **Journal of Sports Sciences**, 28(13), 1469-1476.

Maia, N., and Mesquita, I. (2006), Study of zones and efficacy of the reception according the receiver player in female senior volleyball. **Brazilian Journal of Physical Education and Sport**, 20(4), 257-270.

Marcelino, R., Mesquita, I., Andrés, J. M. P., and Sampaio, J. (2009), Home advantage in high level volleyball varies according to set number. **Journal of Sports Science & Medicine**, 8(3), 352-356.

Marcelino, R., Sampaio, J., and Mesquita, I. (2011), Research on the game analysis: from static to dynamic modeling. **Revista Portuguesa de Ciências do Desporto**, 11(1), 481-499.

Marelić, N., Rešetar, T., and Janković, V. (2004), Discriminant analysis of the sets won and the sets lost by one team in A1 Italian volleyball league-A case study. **Kinesiology**, *36*(1), 75-82.

McGarry, T., O'Donoghue, P., and Sampaio, J. (2013), **Routledge Handbook of Sports Performance Analysis**: Routledge

Miskin, M., Fellingham, G., and Florence, L. (2010), Skill Importance in Women's Volleyball. **Journal of Quantitative Analysis in Sports**, 6(2), 1–14

Morin, E., (2007), **Restricted Complexity, General Complexity.** In: Gershenson C, Aerts D, Edmonds B, eds. Science and us: Philosophy and Complexity. Singapore: World Scientific: 1-25.

Nikos, B., and Elissavet, N. M. (2011), Setter's performance and attack tempo as determinants of attack efficacy in Olympic level male volleyball teams, **International Journal of Performance Analysis in Sport**, 11(3), 535-544.

O'Donoghue, P. (2015), **An Introduction to Performance Analysis of Sport**. London: Routledge.

O'Donoghue, P., and Holmes, L. (2015), **Data Analysis in Sport.** London: Routledge.

Palao, J. M. (2008), Options for analysis of the volleyball score sheet. **International Journal of Performance Analysis in Sport**, *8*(2), 26-43.

Palao, J. M., and Ahrab–Fard, I. (2011), Side-out success in relation to setter's position on court in women's college volleyball. **International Journal of Applied Sports Sciences**, 23(1), 155–167.

Palao, J. M., and Ureña, A. (2004), Effect of team level on skill performance in volleyball. **International Journal of Performance Analysis in Sport**, 4(2), 50-60.

Palao, J. M., and Ureña, A. (2005), The effect of setter´s position on the spike in volleyball. **Journal of Human Movement Studies**, 48(1), 25-40.

Patsiaouras, A., Moustakidis, A., Charitonidis, K., and Kokaridas, D. (2010), Volleyball technical skills as winning and qualification factors during the Olympic Games 2008. **International Journal of Performance Analysis in Sport**,10(2), 115-120.

Patsiaouras, A., Moustakidis, A., Charitonidis, K., and Kokaridas, D. (2011), Technical Skills Leading in Winning or Losing Volleyball Matches During Beijing Olympic Games. **Journal of Physical Education & Sport/Citius Altius Fortius**,11(2), 149-152.

Silva, M., Lacerda, D., and João, P. V. (2014), Game-Related volleyball skills that influence victory. **Journal of Human Kinetics**, 41(1), 173-179. doi: 10.2478/hukin20140045

Trajkovic, N., Milanovic, Z., Sporis, G., Milic, V., and Stankovic, R. (2012), The effects of 6 weeks of preseason skill based conditioning on physical performance in male volleyball players. **Journal of Strength and Conditioning Research**, 26(6), 1475-1480.

Tsigilis, N., Grouios, G., Tsorbatzoudis, H., and Koidou, I. (2010), Impact factors of the sport sciences journals: Current trends, relative positions, and temporal stability. **European Journal of Sport Science**, *10*(2), 81-90.

Ureña, A., Calvo, R., and Lozan, C. (2002), A study of serve reception in the top level of Spanish male volleyball after the introduction of the libero player. **International Journal of Medicine and science of Physical Activity and Sport**; 2, 39-49.

Valliant, M., Emplaincourt, H., and Wenzel R. (2012), Nutrition education by a registered dietician improves dietary intake and nutrition knowledge of a NCAA female volleyball team. **Nutrients**, 4(6) 506–516.

Zadražnik, M., Marelić, N., and Rešetar, T. (2009), Differences in rotations between the winning and losing teams at the youth European volleyball championships for girls. **Acta Universitatis Palackianae Olomucensis. Gymnica**, *39*(4).

Zetou, E., Moustakidis, A., Tsigilis, N., and Komninakidou, A. (2007), Does Effectiveness of Skill in Complex I Predict Win in Men's Olympic Volleyball Games? **Journal of Quantitative Analysis in Sports**, 3(4), 1-9.