

U. PORTO



FACULDADE DE DESPORTO
UNIVERSIDADE DO PORTO

Performance desportiva no voleibol de praia masculino de alto rendimento: Estudo aplicado nos escalões sub-19, sub-21 e senior

Alexandre Igor Araripe Medeiros

Orientador

José Manuel Palao, PhD

Co-orientadores

Isabel Mesquita, PhD

Rui Marcelino, PhD

Dissertação apresentada com vista à obtenção do grau de Doutor no âmbito do curso de Doutoramento em Ciências do Desporto, organizado pelo Centro de Investigação e Inovação em Desporto (CIFI²D), da Faculdade de Desporto da Universidade do Porto, nos termos do Decreto-Lei nº 74/2006 de 24 de Março.

Porto, 2014

Medeiros, A. (2014). Performance Desportiva no Voleibol de Praia Masculino de Alto Rendimento. Estudo Aplicado nos Escalões Sub-19, Sub-21 e Senior.

Porto: A. Medeiros. Dissertação de Doutoramento em Ciências do desporto apresentada à Faculdade de Desporto da Universidade do Porto.

PALAVRAS-CHAVE: Voleibol de Praia; Indicadores de Performance; Especialização Funcional do Jogadores; Escalões Etários.

Financiamento

A presente dissertação foi financiada pela Coordenação de Aperfeiçoamento de Pessoal de Nível Superior através de uma Bolsa de Doutorado (BEX 0688/12-6/2015).



Hoje me sinto mais forte,
Mais feliz, quem sabe,
Eu só levo a certeza
De que muito pouco sei,
Ou nada sei.

(Renato Teixeira)

Dedicatória

Às minhas tias (Maria do Carmo e
Judite Maria — *in memoriam*).

A vida ensinou-me a dizer-vos
adeus, sem tirá-las do meu coração.

Dedicatória

À minha família, a Mara (minha esposa) e meus sogros que
me apoiaram e incentivaram na realização deste sonho.

Amo todos vocês.

Agradecimentos

Assim como num Jogo de Voleibol de Praia, a elevada capacidade estratégica e a versatilidade das pessoas envolvidas nesta tarefa foram determinantes ao longo deste processo. Deste modo, gostaria de expressar os meus sinceros agradecimentos a todos os que me ajudaram e suportaram ao longo desta caminhada:

Ao professor Doutor José Manuel Palao, pela orientação e apoio constante que muito elevaram os meus conhecimentos científicos e, sem dúvida, muito estimularam o meu desejo de querer, sempre, aprender mais e a vontade constante de fazer o meu melhor. Agradeço também a forma de como recebeu-me em Murcia, e a confiança que em mim depositou.

À professora Doutora Isabel Mesquita, pela co-orientação deste trabalho, pelo valioso apoio científico, oportunidade e incentivo demonstrado não somente ao longo do desenvolvimento deste trabalho, mas também ao longo destes seis anos em Portugal.

Ao professor Doutor Rui Marcelino, pela co-orientação deste trabalho, pela imprescindível colaboração na construção deste documento. Sou imensamente agradecido pelas horas e conselhos que muitas das vezes determinaram o caminho a ser seguido. Agradeço também a forma de como recebeu-me em sua casa.

Ao professor Doutor Gilmário Ricarte, por ter aceite o convite de ser o tutor deste trabalho. Agradeço também a sua amizade e por tudo que tem feito pelo Voleibol de Praia Brasileiro.

Aos professores Enrique Ortega e Pilar, pela amizade, conversas e a maneira que me receberam em sua casa. *MUCHAS GRACIAS!*

Aos professores, Danilo, Liana, Diana, Ralciney, Carlão, Mônica, Rossman, pelos ensinamentos que me proporcionaram na UNIFOR.

Á todos os professores da FADEUP, em especial ao professor João Paulo, Ricardo Fernandes, André Seabra, José Maia, Rui Farias, José Oliveira,

Fernando Tavares, Júlio Garganta, António Fonseca, pela amizade e por todos os ensinamentos.

À Karla e Kelly, companheiras de trabalho, pela parceria formada ao longo destes anos. O meu MUITO OBRIGADO pela oportunidade de conhecer um pouco desta vossa realidade, que é a área da Biomecânica.

Aos amigos do Voleibol de Praia, Adriano Carneiro, Raquel Vasconcelos, Roberto Lopes, Luciana Lopes, Luizão, Danielle Lodetti, Oliveira, Franco Neto, Rossini, Rodrigo Saunders pelo total apoio ao longo destes anos.

Aos amigos Portugueses Miguel Maia e João Brenha, pela oportunidade e confiança no meu trabalho. O meu MUITO OBRIGADO pela vossa amizade!

Ao amigos do Sporting Clube de Espinho, Hugo Silva, Filipe Vitó, Pedro Teixeira, Ricardo Teixeira, Orlando Coelho pela amizade e confiança no meu trabalho. Nunca vou esquecer do nosso título conquistado frente ao Benfica.

Ao Pedro Novais, funcionário da biblioteca da Faculdade de Desporto da Universidade do Porto, obrigado pela atenção de sempre.

À Margarida, my English teacher, for her patience, for Sundays that I made you work, I will be eternally grateful. Thank you very much!

Ao professor Antônio Barroso Lima, pela amizade, conversas e principalmente por ter sido um grande incentivador da minha vinda a Portugal.

Ao Benjamin, Ronald Rocha, Francisco Oliveira, Reis, Gonçalo Sapage, Filipe Rocha, pela preciosa atenção e colaboração na recolha de dados desta Dissertação.

Ao amigo Policarpo, pelo grande apoio durante o treinamento para a observação dos dados desta tese.

Aos amigos Antônio García de Alcara Serrano e Fuensanta, por me receberem de braços abertos em sua casa durante as minhas idas a Murcia. A minha casa estará sempre de portas abertas para vos receber. *MUCHAS GRACIAS!*

Ao Pedro Teixeira (Vitas) e sua família, pela atenção durante minha estadia em Portugal. Aguardo a vossa visita em minha casa!

Ao amigo Manuel Coelho e sua família, pela atenção e incentivo durante esta caminhada em Portugal. Os meus sinceros AGRADECIMENTOS!

Aos amigos Clarice Martins, Luís, Gustavo Silva, Mafalda, Érika, Diogo, Tiago Correia, Pedro Alves, Dênis, Renata, Anelise Gaya, Diana, Bruno, Celso, Izaura, Lara Carneiro, Valdir Junior, Tiago Burnay, Joana Ribeiro, Paula Gonçalves, António Ramos Silva, pela amizade, apoio e incentivo durante todo este processo.

Aos amigos Michele e Beth, o meu sincero agradecimento pelo vosso apoio e encorajamento.

Aos amigos do voleibol e da “salinha”, Rui Araújo, Ana Sousa, Patrícia Coutinho, José Afonso, Mário Farias, Diana Santos, Ruben Gomes, Cláudio Farias, pelas conversas (que não foram poucas..), pelas discussões, pelos ensinamentos, por todo o apoio que me proporcionaram ao longo destes anos em Portugal, por serem minha família em terras “Lusas”, o meu MUITO OBRIGADO!

À minha família, em especial minha mãe (Maria Auxiliadora), meus irmãos (Helder e Karine), minhas tias (Maria do Carmo e Judite Maria — *in memoriam*), meus avós (Helder e Cleide) e meus sogros (Raimundo Nonato e Margarida). O meu MUITO OBRIGADO por me proporcionarem SEMPRE todas as condições para eu me manter tranquilo e focado nesta tarefa, que por vezes parecia de todo impossível.

À Mara, por ser a pessoa que és. OBRIGADO por todo incentivo, compreensão e sobretudo MUITA PACIÊNCIA ao longo destes anos. Nos momentos mais difíceis, que não foram raros neste longo período do outro lado do oceano, sempre acreditou que eu chegaria ao final desta difícil, porém gratificante etapa. 1000 desculpas pelo tempo que não passamos juntos durante a realização deste trabalho.

À Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES - Brasil, pelo apoio institucional que nos concedeu, possibilitando-nos uma dedicação “exclusiva” a esta investigação.

Índice geral

Índice de Figuras	xiiiv
Índice de Tabelas	xxi
Resumo	xxi
Abstract	xxi
Resumen	xxv
Lista de Abreviaturas	xxvii
1. Introdução	1
1.1. Justificação e pertinência do estudo.....	3
1.2. Problemas e Objetivos do Estudo.....	8
1.3. Estrutura da Dissertação.....	10
1.4. Referências bibliográficas.....	14
2. Estudo Teórico	23
Systematic review on sports performance in beach volleyball from match analysis: Analysis of sports performance in beach volleyball.....	23
3. Estudos Empíricos	45
3.1. Estudo Empírico 1 Physical and temporal characteristics of under 19, under 21 and senior male beach volleyball players.....	47
3.2. Estudo Empírico 2 Effects of technique, age and player's role on serve and attack efficacy in high level beach volleyball players.....	71
3.3. Estudo Empírico 3 Differences in performance between winning and losing in Under 19, Under 21 and Senior male beach volleyball.....	89
4. Considerações finais	109

Índice de Figuras

Estudo Empírico 1

Figure 1 – Teams' performance levels computed through two-step cluster analysis...53

Figure 2 – Sample division into three groups according to quality of opposition.....54

Estudo Empírico 2

Figure 1 – Standardized mean difference and meta-analysis assessing the serve efficacy in relation to the technique (SS vs. JS, SS vs. FJS, and JS vs. FJS) and player role (defender and blocker)80

Figure 2 – Standardized mean difference and meta-analysis assessing the attack efficacy in relation to the technique (spike vs. shot) and player role (defender and blocker)81

Estudo Empírico 3

Figure 1 – Standardized mean difference assessing the number of points obtained in complex of the game of teams in relation to the result of set (winning vs. lose). The Shaded area represents the smallest (trivial differences) worthwhile change (see “Mehods”)97

Figure 2 – Standardized mean difference assessing the total number of points and errors of teams in relation to the result of set (winning vs. lose). The Shaded area represents the smallest (trivial differences) worthwhile change (see “Mehods”)98

Figure 3 – Standardized mean difference assessing the performance coefficients of teams in relation to the result of set (winning vs. lose). The Shaded area represents the smallest (trivial differences) worthwhile change (see “Mehods”)99

Índice de Tabelas

1. Introdução

Tabela 1 – Resumo da estrutura e dos conteúdos incluídos na dissertação.....13

2. Estudo Teórico

Table 1 – Synopsis of empiric studies focusing on performance analysis in BV from match analysis.....28

Estudo Empírico 1

Table 1 – Descriptive statistics of temporal and physical variables. Data are means (\pm SD)57

Table 2 – Descriptive statistics of temporal and physical variables according to quality of opposition. Data are means (\pm SD)58

Table 3 – Model information for the association between groups of different ages and temporal and physical variables according to quality of opposition.....60

Table 4 – Adjusted model for temporal and physical variables.....61

Estudo Empírico 2

Table 1 – Descriptive analysis of the serve and attack efficacy according to player role and age group (mean \pm stand. deviation)78

Estudo Empírico 3

Table 1 – Descriptive analysis of the total number of points won by complex of the game, total number of points and errors, and performance coefficients of the teams in relation to the result of the set (winner vs. loser). Data are means (\pm SD)96

Resumo

A presente dissertação teve como propósito estudar a performance desportiva no voleibol de praia masculino, a partir da análise do jogo, nos escalões sub-19, sub-21 e sénior. Para o efeito, foi realizado um artigo de revisão sistemática e três artigos empíricos. Foram analisados 19.938 ações de jogo, 3.514 *rallies* e 94 *sets* dos Campeonatos do Mundo sub-19, sub-21 e sénior (2010-2011). No primeiro artigo empírico avaliou-se o efeito da especialização funcional dos jogadores em relação a algumas características físicas e temporais do jogo, considerando a qualidade de oposição. Os resultados evidenciaram que nos jogos equilibrados o tempo de descanso entre os *rallies* e a quantidade de saltos dos defensores foram superiores nos escalões seniores em relação aos sub-19 e sub-21. No segundo artigo empírico analisou-se o efeito da técnica de execução e especialização funcional dos jogadores na eficácia do serviço e do ataque. Os defensores foram mais eficazes no serviço em apoio e flutuante nos escalões sub-19 e sub-21, enquanto os seniores registaram maior eficácia no serviço em suspensão e flutuante. Independentemente do escalão, os bloqueadores obtiveram melhores eficácias no serviço em apoio e flutuante. No ataque, enquanto no escalão sénior não houve diferenças em função da especialização funcional dos jogadores, nos escalões sub-19 e sub-21 os jogadores tiveram eficácias ligeiramente superiores na variante potente. No terceiro artigo empírico verificou-se possíveis diferenças em alguns indicadores de performance, em função de ganhar ou perder o *set*. Os pontos obtidos no complexo 2 diferenciaram as equipas vencedoras das derrotadas. Além disso, as diferenças verificadas nos coeficientes de performance das ações de jogo e na maneira de como os pontos são obtidos entre as equipas que perdem e ganham o *set*, sugerem a necessidade de incluir diferentes indicadores de performance para analisar o jogo. O presente estudo revela informações de destaque acerca da performance dos jogadores, atendendo a idade e especialização funcional, fator determinante no incremento da qualidade do processo de treino e competição.

Palavras-chave: VOLEIBOL DE PRAIA; INDICADORES DE PERFORMANCE; ESPECIALIZAÇÃO FUNCIONAL DOS JOGADORES; ESCALÕES ETÁRIOS.

Abstract

This dissertation aimed to study the sports performance in male beach volleyball, from the game analysis, in under-19, under-21, and senior. For the purpose, an article of systematic review and three empirical articles were done. A total of 19.938 game actions, 3.514 rallies and 94 sets of Men's World Championships under-19, under-21 and senior (season 2010-2011), were analysed. The first empirical study evaluated the effect of players' role in relation to physical characteristics of the players and temporal aspects of the game, taking into account the quality of opposition. The results showed that, in balanced games, rest time between rallies and number of jumps performed by defenders were higher in seniors than under-19 and under-21. The second empirical study analysed the effect of technique of execution and players' role on serve and attack efficacy. The defenders were more effective in standing serve and float jump serve in under-19 and under-21, while the seniors showed greater efficacy in jump serve and float jump serve. Regardless of the category, blockers had better efficacy in standing serve and float jump serve. In attack, while in senior there was no difference according to the players' role, in under-19 and under-21 the players had slightly higher efficacies using the spike. In the third empirical study possible differences were verified in some performance indicators, in relation to winning or losing the set. The points obtained in complex 2 differentiated the winning from the losing teams. Furthermore, the differences in the performance coefficients of game actions and the way in which the points are obtained between the teams that win and lose the set, suggest the need to include different performance indicators to analyse the game. The present study provides relevant information about the performance of the players in relation to age and players' role, determining factor in order to increase the quality of the training process and competition.

Keywords: BEACH VOLLEYBALL; PERFORMANCE INDICATORS; PLAYER ROLE; AGE GROUPS.

Resumen

El objetivo de esta tesis doctoral fue estudiar el rendimiento deportivo en voley-playa masculino desde el análisis del juego en función de la categoría de edad (sub-19, sub-21, y senior). Para ello, se realizó un trabajo de revisión sistemática y tres trabajos empíricos. La muestra empleada fue de 19.938 acciones de juego, 3.514 fases de juego, y 94 sets de los campeonatos del mundo de voley-playa masculino sub-19, sub-21, y senior de la temporada 2010-2011. El primer trabajo empírico estudió el efecto de la categoría de edad, el rol de juego, y el nivel de oposición sobre la temporalidad y las acciones físicas realizadas por los jugadores. Los resultados muestran que en los partidos balanceados, el tiempo de descanso entre *rallies* y los saltos realizados por los defensores fue mayor en categoría senior que en categoría sub-19 y sub-21. El segundo trabajo empírico estudió el efecto de la técnica de ejecución del saque y del ataque, la categoría de edad, y el rol de juego sobre la eficacia del saque y del ataque. Los defensores fueron más efectivos utilizando el saque en apoyo y el saque en salto flotante en sub-19 y sub-21. Los defensores seniors mostraron mayor eficacia utilizando el saque en salto potente y el saque en salto flotante. Independientemente de la categoría, los bloqueadores tuvieron mejores eficacia en el saque en apoyo y en saque en salto flotante. En ataque, mientras en senior no hubo diferencias de acuerdo al rol de juego, en sub-19 y sub-21, los bloqueadores y defensores senior presentaron ligeras eficacias usando el remate. El tercer trabajo empírico estudió las diferencias en algunos indicadores de rendimiento en función del ganar o perder el set. Los puntos obtenidos en el complejo 2 fueron la variable que mejor diferenciaron a los ganadores y perdedores. Las diferencias en el coeficiente de rendimiento y la forma de conseguir los puntos entre ganadores y perdedores muestran la necesidad de emplear diferentes indicadores de rendimiento para analizar el juego. Este trabajo proporciona información sobre el rendimiento de los jugadores en relación a su edad y su rol, factores determinantes para guiar el proceso de entrenamiento y analizar el juego.

Palabras claves: VOLEY-PLAYA, INDICADORES DE RENDIMIENTO, ROL, CATEGORÍA DE EDAD.

Lista de Abreviaturas

MA – Match Analysis

BV – Beach Volleyball

FIVB – Federation of International Volleyball

RS – Rally Point System

SO – Side Out Scoring System

U19 – Under 19

U21 – Under 21

Senior – Senior

ANOVA – Analysis of Variance

OR – Odds Ratio

CI – Confidence Interval

ICC – Intraclass Correlation Coefficients

SEM – Standard Error of Measurement

LRT – Likelihood Ratio Test

SPSS – Statistical Package for the Social System

SS – Standing Serve

JS – Jump Serve

FJS – Float Jump Serve

IV – Indoor Volleyball

SMD – Standardized Mean Differences

ESCI – Exploratory Software for Confidence Intervals

CAPES – Coordenação de Aperfeiçoamento de Pessoal de Nível Superior

TEBEVOL – Manual for Observation Instrument of Techniques and Efficacy in Beach Volleyball

K1 – Complexo de Jogo 1

K2 – Complexo de Jogo 2

K3 – Complexo de Jogo 3

K4 – Complexo de Jogo 4

Símbolos

X^2 – Chi-square

1. Introdução

1.1 Justificação e pertinência do estudo

O jogo de Voleibol de Praia (VP), tem constituído na atualidade, uma modalidade desportiva com elevado impacto no mundo do Desporto. Originalmente concebido com objetivos recreativos, que ainda hoje se mantém, foi evoluindo de forma lógica e sistemática até atingir o alto nível de competição atual (FIVB, 2014). Com uma elevada popularidade, especialmente nas últimas duas décadas, o VP tem apresentado uma média de 30 eventos por ano, com mais de 60 países participantes, 3.000 atletas ativos e mais de 10 milhões em prémios de jogo (FIVB, 2014).

O aumento de popularidade do VP tem legitimado o interesse crescente de especialistas e investigadores a elevarem-no a objeto de estudo. Neste sentido, a investigação científica tem contribuído com indicações valiosas para a melhoria da qualidade do treino e, concomitantemente, para o rendimento desportivo em geral.

A investigação centrada na análise da performance no VP tem abrangido diferentes áreas do conhecimento no sentido de contribuir para uma perspectiva, simultaneamente, mais holística e profunda sobre o desenvolvimento da excelência desportiva. Segundo Hughes and Bartlett (2002), nos desportos coletivos isto é possível através da análise de diferentes indicadores, entre os quais se destaca: a) indicadores gerais do jogo (*outcome*); b) indicadores biomecânicos; c) indicadores físicos; e d) indicadores tático-técnicos. Entre os aspectos analisados no VP, os mais estudados são os indicadores biomecânicos (Buscà et al., 2012; Tilp et al., 2008), antropométricos (Palao et al., 2008), fisiológicos (Magalhães et al., 2011; Medeiros et al., 2012), psicológicos (Belem et al., 2014; Noce et al., 2008; Stefanello, 2007; Vieira et al., 2013), físicos (Palao et al., 2014; Pérez-Turpin et al., 2014; Riggs & Sheppard, 2009), tático-técnicos (Giatsis, 2003; Giatsis & Panagiotis, 2008; Giatsis & Tzetzis, 2003; Giatsis et al., 2005; Grgantov et al., 2005; Koch & Tilp, 2009; Lopez-Martinez & Palao, 2009; Michalopoulou et al., 2005; Ronglan & Grydeland, 2006; Yiannis, 2008). Estes indicadores de

performance têm contribuído para ajudar a definir e precisar aspectos do rendimento desportivo (Hughes & Bartlett, 2004; Hughes & Bartlett, 2002), relevando-se de grande importância para o apoio no planeamento das equipas numa perspetiva de longo prazo (Mesquita et al., 2013).

Deste vasto leque de indicadores de performance, os tático-técnico e os físicos tem assumido particular destaque no VP. Dado o adversário no VP ter a possibilidade de antecipadamente identificar o jogador atacante, este tem de possuir atributos táticos invejáveis onde joga um papel decisivo a antecipação (Verdejo et al., 1994). O maior determinismo do jogo de VP, em relação ao voleibol *indoor*, por ser jogado apenas por dois jogadores, torna-o aparentemente mais previsível (Mesquita, 2009a). Contudo, o jogador só é capaz de ter eficácia nas opções táticas quando possui um vasto repertório técnico adaptativo e inverosímil face à necessidade de “ludibriar” o adversário (Mesquita, 2009a). Deste modo, a rota da excelência, na construção das competências do jogador de VP, inscreve-se na conjugação de atributos que tornam o jogador de VP detentor de capacidades de antecipação excecionais. Mais especificamente, ser preciso e flexível tecnicamente, possuindo uma boa condição física específica expressa, fundamentalmente, no binómio força-resistência (Mesquita, 2009b).

No que concerne, em particular, aos indicadores físicos do jogo de VP, a capacidade de saltos dos jogadores tem sido objeto de estudo na agenda dos investigadores. Estes estudos tem mostrado a importância desta variável porquanto permite-lhes melhor desempenho na realização de suas funções no jogo (Palao et al., 2008; Pérez-Turpin et al., 2008). Adicionalmente, as características temporais do jogo também se tem mostrado importante na análise da performance desportiva no VP, porquanto podem afetar as características físicas dos jogadores (ex: a continuidade do *rally* aumenta o número de ações, contactos, saltos e remates, realizado pelos jogadores) (Giatsis & Papadopoulou, 2003; Palao et al., 2014).

Não obstante, estes indicadores (físicos e tático-técnico) tem sido frequentemente analisados através da *Análise do Jogo* (Hughes and Franks,

2004), contribuindo de forma substancial para o conhecimento de características, regularidades, e particularidades dos comportamentos assumidos pelas equipas e jogadores no decorrer das competições e treinos (Marcelino et al., 2011). Esta disciplina de estudo tem demonstrado que o estudo do jogo tem relação direta com o binômio jogador/jogo, pois é a partir desta conjugação que são identificados as prováveis tendências e o adequado encaminhamento do processo avançado de preparação e organização do jogo (Garganta, 1997).

Entretanto, as áreas de produção de estudos realizados neste âmbito são referenciadas a partir de diferentes denominações, de entre as quais se destacam: a Observação do Jogo (*game observation*), a Análise do Jogo (*match analysis*) e Análise Notacional (*notational analysis*) (Garganta, 1997). Todavia, a expressão mais utilizada na literatura é a *Análise do Jogo* (Garganta, 1997; Winkler, 1988), na medida em que se identifica com a análise que é feita aos dados, análise essa que, evidentemente, implica uma necessária Observação do Jogo e registo ou notação dos dados (Garganta, 1997).

Com o crescente aumento da investigação no VP através da análise do jogo, tem vindo a tornar-se necessário passar de caracterizações gerais da performance dos jogadores/equipas para mais específicas e detalhadas. À semelhança do voleibol *indoor*, no VP verificou-se a utilização sistemática dos seguintes procedimentos de jogo: serviço, recepção, distribuição, ataque, bloco e defesa (Oliveira, 2007). Contudo, a investigação especializada no VP tem vindo a incidir, especialmente, nas ações de serviço e de ataque (Giatsis and Tzetzis, 2003; Michalopoulou *et al.*, 2005), dado a sua maior predição em relação as ações de continuidade (defesa, distribuição e recepção) na performance final dos sets e do jogo (Coleman, 2002).

Desta forma, é possível encontrar com alguma facilidade no jogo de VP, sequências de jogo que consolidam padrões de desenvolvimento

condicionados pelo regulamento. Dentro desta sequência cíclica, os complexos de jogo¹ diferenciam-se (Kleschov et al., 1980; Palao & Ureña, 2002; Palao, 2001), assumindo assim, que o jogo possui características próprias em situações específicas.

Palao (2001) sugere um proposta na qual organiza o jogo em três complexos. O autor refere que a jogada construída após recepção do serviço tem particularidades que a distinguem das demais, designando-a como complexo 1 ou KI. Entende também que a primeira jogada de ataque – contra-ataque para ser mais preciso – da equipe que serviu tem especificidades próprias – condicionadas pela qualidade do serviço – e, então, classifica-a como complexo 2 ou KII. O autor também considera que, a partir deste momento, todas as jogadas seguintes são iguais entre si, independentemente da equipe que está a executá-las e considera este o complexo 3 ou complexo 4, dependendo se a equipa vem de K1 ou de K2.

Embora a investigação no VP sobre a análise da performance a partir da análise do jogo tenha aumentado significativamente na última década (Mesquita et al., 2013), a maioria dos estudos de referência disponíveis na literatura especializada tem sido obtido através de estudos realizados em equipas seniores (Belem et al., 2014; Buscà et al., 2012; Giatsis & Panagiotis, 2008; Giatsis et al., 2005; Grgantov et al., 2005; Koch & Tilp, 2009; Lopez-Martinez & Palao, 2009; Magalhães et al., 2011; Medeiros et al., 2012; Michalopoulou et al., 2005; Palao et al., 2008; Palao et al., 2014; Riggs & Sheppard, 2009; Ronglan & Grydeland, 2006; Tilp et al., 2008; Yiannis, 2008). A escassez de informações sobre a performance desportiva nos escalões de mais jovens provoca um deficit de conhecimento nesta área, fazendo com que os treinadores organizem o processo de formação dos desportistas a partir de

¹ Complexo de jogo – são estruturas de jogo que determinam, entre outros aspectos, a maior ou menor estabilidade das condições iniciais de organização das ações (Beal, 1989; Monge, 2003; Moutinho, 2000; Palao, Santos, & Ureña, 2002).

critérios genéricos e ou subjetivos. Estudos realizados no handebol (Oliveira et al., 2014), no basquetebol (Lorenzo et al., 2010), no futebol (Abade et al., 2013; Buchheit & Mendez-Villaneuva, 2014), no voleibol *indoor* (Costa et al., 2012; Dávila-Romero et al., 2012; García-Hermoso et al., 2013) e no VP (Quiroga et al., 2014) têm sugerido que as variações nas características da performance verificadas entre os jogadores mais jovens e os seniores requerem que o planeamento do treino seja adequado e específico à idade e as características dos jogadores (Harley et al., 2010). Além disso, o desenvolvimento dos aspectos antropométricos (altura, peso, composição corporal, somatotipo, etc.) e os anos de experiência podem influenciar os aspectos físicos (força, resistência aeróbia, anaeróbia, etc.), técnicos e táticos (Gabbett et al., 2006).

Adicionalmente, e mais recentemente, nos desportos coletivos, os estudos a partir da análise do jogo tem considerado a especialização funcional dos jogadores, dado se perceber que esta variável pode está associada a diferentes perfis de performance. O conhecimento detalhado sobre as características específicas dos jogadores pode ajudar os treinadores a estabelecer programas de treino mais específicos, para além de fornecer dados que ajudarão na detecção de talentos e desenvolvimento das habilidades específicas das posições dos jogadores (Sibila et al., 2004; Skoufas et al., 2003) conforme se verificou em estudos realizados no basebol (Laudner et al., 2010), no handebol (Kruger et al., 2014), no basquetebol (Abdelkrim et al., 2010; Matthew & Delextrat, 2009), no futebol (Gonçalves et al., 2014; Miller et al., 2002), no voleibol *indoor* (Rocha & Barbanti, 2007; Sheppard et al., 2009) e no VP (Palao et al., 2014). A confirmação empírica da vantagem de considerar a especialização funcional do jogador em algumas modalidades, conduziu a necessidade de equacionar a integração da função dos jogadores nos estudos realizados no VP. Um dos aspectos que pode afetar a performance dos jogadores no VP, é sem dúvida a sua especialização (bloqueador e defensor especialista) (Homborg & Papageorgiou, 1994). Embora esses jogadores (bloqueador e defensor especialista) apresentem funções distintas na defesa, todos têm de servir e atacar. Assim, o papel desempenhado pelo jogador na defesa pode influenciar a eficácia e execução das ações de jogo. Todavia, até

o momento, apenas um estudo foi encontrado na literatura especializada no VP. Este estudo mostrou que o bloqueador realiza mais saltos (33 saltos) do que o defensor especialista (28 saltos) por set (Palao et al., 2014).

A investigação sobre a performance desportiva no VP a partir da análise do jogo têm recorrido fundamentalmente, à estatística bivariada, onde a resposta final é considerada como uma visão simples e redutora ou informação estática (Pfeiffer & Perl, 2006; Silva, 2000). Tal método estatístico não contempla o contexto sequencial do jogo, ignorando as interações dinâmicas (Lames & McGarry, 2007). Embora estes estudos, (com um enfoque de natureza descritiva e comparativa) tenham contribuído para um avanço significativo da investigação, permitindo identificar, descrever e comparar a estrutura e/ou padrões de jogo, não permitiu, ainda, explicar e prever o rendimento desportivo.

Os escassos estudos realizados assentes na análise preditiva da performance, a partir de indicadores táticos-técnicos, evidenciam que o VP ainda dá os primeiros passos no que concerne ao perscrutar de modelos preditores da performance. Estes estudos podem fornecer informações substantivas para a estratégia de preparação das equipas e jogadores no treino e na competição (Volossovitch & Ferreira, 2013).

1.2. Problemas e Objectivos do Estudo

O presente trabalho debruçou-se sobre o interesse pelo estudo de alguns indicadores de performance, predominantemente tático-técnicos, no VP masculino (sub-19, sub-21 e sénior). Neste sentido, importou examinar em que medida variáveis como a idade e a especialização funcional (defensores e bloqueadores) dos jogadores no jogo interferiram na performance desportiva. Considerando o enquadramento teórico anteriormente apresentado, os problemas de pesquisa do presente estudo configuraram as seguintes questões:

1. Será que algumas características físicas (quantidade de saltos verticais e remates realizados pelos jogadores) e temporais do jogo (duração do *set*, tempo total de descanso, tempo total de trabalho, duração do *rally*, tempo de descanso entre os *rallies*) se diferenciam nos escalões sub-19, sub-21 e sénior? As características físicas são afetadas pela especialização funcional dos jogadores no jogo (defensor e bloqueador) e pela qualidade de oposição nos escalões sub-19, sub-21 e sénior? A qualidade de oposição afeta as características temporais do jogo nos escalões sub-19, sub-21 e sénior?
2. Será que a eficácia do serviço e do ataque são afetadas pela técnica de execução e especialização funcional dos jogadores (defensor e bloqueador) nos escalões sub-19, sub-21 e sénior?
3. Será que os indicadores de performance (pontos obtidos nos diferentes complexos de jogo, número de pontos e erros das ações terminais, coeficiente de performance das ações de jogo) diferem entre equipas vencedoras e derrotadas nos escalões sub-19, sub-21 e sénior?

Com base nas questões de pesquisa enunciadas, emergiram os seguintes objetivos do presente trabalho:

- Avaliar o efeito da especialização funcional dos jogadores (defensores especialistas e bloqueadores) em VP em relação a algumas variáveis físicas dos jogadores e temporais do jogo nos escalões sub-19, sub-21 e sénior, considerando a qualidade de oposição.
- Verificar os tipos de serviço e ataque mais utilizado no VP em função da especialização funcional dos jogadores nos escalões sub-19, sub-21 e sénior. Analisar o efeito da técnica de execução e da especialização funcional dos jogadores na eficácia do serviço e do ataque nos escalões sub-19, sub-21 e sénior.
- Averiguar possíveis diferenças nos indicadores de performance entre equipas vencedoras e derrotadas nos escalões sub-19, sub-21 e sénior.

1.3. Estrutura da Dissertação

A presente dissertação foi estruturada de acordo com as normas orientadoras de redação e apresentação de dissertações da Faculdade de Desporto da Universidade do Porto (FADEUP, 2009). A configuração desta dissertação baseou-se no modelo escandinavo, que integra um documento composto por “uma ‘coleção’ de artigos prontos para publicação em revistas com revisão de pares e, se possível, indexadas e com fator de impacto” (FADEUP, 2009). A opção por este modelo possibilitou o espaço crítico e o debate através da submissão e publicação dos estudos, bem como a divulgação dos resultados com maior brevidade.

Em função da adoção deste modelo, os artigos já publicados ou submetidos para publicação foram apresentados com a formatação das citações e das referências bibliográficas de acordo com as normas de publicação das respectivas revistas. Deste modo, a presente dissertação foi, assim, estruturada em quatro capítulos.

O capítulo I constituiu a introdução da presente dissertação, onde foi concretizado o enquadramento teórico, justificando a pertinência do estudo. Para além disso, foram ainda expostos os problemas de pesquisa e os propósitos deste estudo, bem como a estrutura da dissertação através de um quadro sinóptico dos estudos.

O capítulo II foi composto por um artigo de revisão bibliográfica intitulado *Systematic review of sports performance in beach volleyball from match analysis* [Revisão sistemática sobre a performance desportiva no voleibol de praia a partir da análise do jogo]. Este estudo surgiu da necessidade de se realizar uma revisão sistemática da investigação empírica realizada até ao momento sobre a performance desportiva no voleibol de praia a partir da análise do jogo, considerando-se para o efeito artigos que integravam estudos empíricos em jornais com revisão de pares, sendo este procedimento considerado essencial para conferir rigor e validade científica a uma revisão

sistemática centrada na investigação empírica em determinado domínio (Wallhead & O'Sullivan, 2005). A realização deste estudo permitiu um conhecimento alargado sobre as ferramentas conceptuais e metodológicas em uso acerca da performance do VP a partir da análise do jogo. Este artigo de revisão estabeleceu bases teóricas que auxiliaram o desenho e desenvolvimento dos estudos empíricos subsequentes.

O capítulo III integrou os três estudos empíricos conduzidos durante esta investigação.

O Estudo 1, intitulado *Physical and temporal characteristics of under 19, under 21 and senior male beach volleyball players* [Características físicas e temporais dos jogadores masculinos de voleibol de praia nos escalões sub-19, sub-21 e sénior], avaliou o efeito da especialização funcional dos jogadores (defensores e bloqueadores) sobre algumas características físicas dos jogadores e temporais do jogo, considerando a qualidade de oposição, nos escalões sub-19, sub-21 e sénior. O efeito da especialização funcional dos jogadores, considerando a qualidade de oposição, nos escalões sub-19, sub-21 e sénior foram analisados através da análise de variância (ANOVA), do t-test para medidas independentes e da regressão logística multinomial.

O Estudo 2, intitulado *Effects of technique, age and player's role on serve and attack efficacy in high level beach volleyball players* [Efeito da técnica e da especialização funcional na eficácia do serviço e do ataque em jogadores masculinos de voleibol de praia nos escalões sub-19, sub-21 e sénior] analisou o efeito da técnica de execução e da especialização funcional dos jogadores na eficácia do serviço e do ataque nos escalões sub-19, sub-21 e sénior, através da magnitude do efeito baseada em diferenças de médias estandardizadas.

O Estudo 3, intitulado *Differences in performance between winning and losing teams in under-19 under-21 and senior male beach volleyball players* [Diferenças na performance entre equipas vencedoras e derrotadas nos escalões sub-19, sub-21 e sénior] analisou possíveis diferenças nos indicadores de performance entre equipas vencedoras nos escalões sub-19,

sub-21 e sénior, através da magnitude do efeito baseada em diferenças de médias estandardizadas.

O capítulo IV incorpora as considerações finais, alicerçadas nas conclusões parcelares dos estudos empíricos realizados. Para o efeito, interpretam-se relacionam-se e sintetizam-se os resultados obtidos, com o propósito de se obter uma visão integradora das conclusões dos diferentes estudos. Neste capítulo, são também indicadas sugestões para futuros estudos, sugestões estas que emergem com o intuito de contribuir para o acervo de conhecimento acerca da performance desportiva no VP, a partir das temáticas e metodologias aplicadas. Finalmente, indicam-se recomendações para o domínio da prática, particularmente direcionadas para o processo de preparação das equipas que promovam, não somente, um conhecimento sólido dos percursos do desenvolvimento a longo prazo do atleta, mas igualmente o entendimento aprofundado do jogo de forma a fornecer contributos qualificadores do processo de treino.

As referências bibliográficas referentes a cada capítulo surgem no final dos mesmos. A bibliografia relativa a cada estudo é apresentada no seu final em concordância com as normas da revista a que foram submetidos. O quadro 1, apresenta a estrutura e os conteúdos da dissertação, no qual se designam os títulos dos estudos, os autores e as revistas científicas onde os artigos foram submetidos, diferenciando-se os estudos que já foram aceites para publicação e os que ainda se encontram em fase de revisão.

Tabela 1: Resumo da estrutura e dos conteúdos incluídos na dissertação

Capítulo I Introdução	
	Introdução abrangendo a justificação e pertinência do estudo, problemas de pesquisa, objetivos do estudo e estrutura da dissertação
Capítulo II Estudo Teórico	
	Medeiros, A., Palao, J.M., Marcelino, R., Mesquita, I., (2014). Systematic review of sports performance in beach volleyball from match analysis. <i>Brazilian Journal Kinanthropometry Human Performance</i> , 16(6) aceite para publicação em 17 de Fevereiro de 2014. (2014 Impact Factor: 0.296).
Capítulo III Estudos Empíricos	
Estudo 1	Medeiros, A., Marcelino, R., Mesquita, I., Palao, J.M., (2014). Physical and temporal characteristics of under 19, under 21 and senior male beach volleyball players. <i>Journal of Sports Science & Medicine</i> , 13(3), 658-665. (2014 Impact Factor: 0.898).
Estudo 2	Medeiros, A., Palao, J.M., Marcelino, R., Mesquita, I., (2014). Effects of technique, age and player's role on serve and attack efficacy in high level beach volleyball players. <i>International Journal of Performance Analysis in Sport</i> , aceite para publicação em 27 de Agosto de 2014 (2014 Impact Factor: 0.845).
Estudo 3	Medeiros, A., Mesquita, I., Marcelino, R., Palao, J.M., (2014). Differences in performance between winning and losing teams in under 19, under 21 and senior male beach volleyball. <i>Em fase de preparação</i> .
Capítulo IV Considerações Finais	
	Considerações finais da dissertação, integrando e sintetizando os conhecimentos mais relevantes e apontando recomendações para o domínio da prática para futuras investigações.

1.4. Referências Bibliográficas

- Abade, E., Goncalves, B., Leite, N., & Sampaio, J. (2014). Time-motion and physiological profile of football training sessions performed by under 15, under 17 and under 19 elite Portuguese players. *International Journal of Sports Physiology and Performance*, 9(3), 463-470.
- Abdelkrim, B., Chaouachi, A., Chamari, K., Chtara, M., & Castagna, C. (2010). Positional role and competitive-level differences in elite-level men's basketball players. *Journal of Strength & Conditioning Research*, 24(5), 1346-1355.
- Beal, D. (1989). Basics team system and tactics. In FIVB (Ed.), *Coaches Manual I* (pp. 333-356).
- Belem, I., Caruzzo, N., Junior, J., Vieira, J., & Viera, L. (2014). Impact of coping strategies on resilience of elite beach volleyball athletes. *Revista Brasileira de Cineantropologia & Desempenho Humano*, 16(4), 447-455.
- Buchheit, M., & Mendez-Villaneuva, A. (2014). Effects of age, maturity and body dimensions on match running performance in highly trained under-15 soccer players. *Journal of Sports Sciences*, 32(13), 1271–1278.
- Buscà, B., Moras, G., Peña, J., & Rodríguez-Jiménez, S. (2012). The influence of serve characteristics on performance in men's and women's high-standard beach volleyball. *Journal of Sports Sciences*, 30(3), 269–276.
- Coleman, J. (2002). Scouting opponents and evaluating team performance. In D. Shondell (Ed.), *The Volleyball Coaching Bible* (pp. 321-346): Champaign: Human Kinetics.
- Costa, G., Afonso, J., Brant, E., & Mesquita, I. (2012). Differences in game patterns between male female youth volleyball. *Kinesiology*, 44(1), 60-66.

- Dávila-Romero, C., García-Hermoso, A., & Saavedra, J. M. (2012). Discriminatory power of final game actions volleyball in formative stages. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte*, 12(48), 745-755.
- FADEUP. (2009). *Normas e orientações para a redacção e apresentação de dissertações e relatórios*. Porto: Faculdade de Desporto da Universidade do Porto.
- FIVB. (2014). Discovering beach volleyball. *Beach volleyball - Be part of the success*. Retrieved 10/07/2014, from <http://www.fivb.org>.
- Gabbett, T., Georgieff, B., Anderson, S., Cotton, B., Savovic, D., & Nicholson, L. (2006). Changes in skill and physical fitness following training in talent-identified volleyball players. *Journal of Strength & Conditioning Research*, 20(1), 29-35.
- García-Hermoso, A., Dávila-Romero, C., & Saavedra, J. M. (2013). Discriminatory power of game-related statistics in 14-15 year age group male volleyball, according to set. *Perceptual & Motor Skills*, 116(1), 132-143.
- Garganta, J. (1997). *Modelação táctica do jogo de Futebol. Estudo da organização da fase ofensiva em equipas de alto rendimento*. Porto: Júlio Garganta. Probation report presented to Doutoramento.
- Giatsis, G. (2003). The effect of changing the rules on score fluctuation and match duration in the FIVB womens beach volleyball. *International Journal of Performance Analysis in Sport*, 3(1), 57-64.
- Giatsis, G., & Panagiotis, Z. (2008). Statistical analysis of men's FIVB beach volleyball team performance. *International Journal of Performance Analysis in Sport*, 8(1), 31-43.
- Giatsis, G., & Papadopoulou, S. (2003). Effects of reduction in dimensions of the court on timing characteristics for men's beach volleyball matches. *International Journal of Volleyball Research*, 6(1), 6-9.

- Giatsis, G., & Tzetzis, G. (2003). Comparison of performance for winning and losing beach volleyball teams on different court dimensions. *International Journal of Performance Analysis in Sport*, 3(1), 65-74.
- Giatsis, G., Zetou, E., & Tzetzis, G. (2005). The effect of rule changes for the scoring system on the duration of the beach volleyball game. *Journal of Human Movement Studies*, 48(1), 15-23.
- Gonçalves, B., Figueira, B., Maçãs, V., & Sampaio, J. (2014). Effect of player position on movement behaviour, physical and physiological performances during an 11-a-side football game. *Journal of Sports Sciences*, 32(2), 191-199.
- Grgantov, Z., Kati, R., & Mareli, N. (2005). Effect of new rules on the correlation between situation parameters and performance in beach volleyball. *Coll Antropol*, 29(2), 717 - 722.
- Harley, J., Barnes, C., Portas, M., Lovell, R., Barrett, S., Paul, D., & Weston, M. (2010). Motion analysis of match-play in elite U12 to U16 age-group soccer players. *Journal of Sports Sciences*, 28(13), 1391-1397.
- Homberg, S., & Papageorgiou, A. (1994). *Handbook for beach volleyball*: Luxemburg: Meyer & Meyer Verlag.
- Hughes, M., & Bartlett, R. M. (2004). *The use of performance indicators in performance analysis. Notational Analysis of Sport. System for better coachin and performance in sport* (2 ed.). London: Routledge.
- Hughes, M. D., & Bartlett, R. M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, 20, 739-754.
- Kleschov, Y., Tiurin, V., & Furaev, Y. (1980). *Preparación táctica de los Voleibolistas* (2 ed.). La Havana: Pueblo y Educación.
- Koch, C., & Tilp, M. (2009). Beach volleyball techniques and tactics: a comparison of male and female playing characteristics. *Kinesiology*, 41(1), 52-59.

- Kruger, K., Pilat, C., Uckert, K., Frech, T., & Mooren, F. (2014). Physical performance profile of handball players is related to playing position and plying class. *Journal of Strength & Conditioning Research*, 28(1), 117-125.
- Lames, M., & McGarry, T. (2007). On the search for reliable performance indicators in game sports. *International Journal of Performance Analysis in Sport*, 7(1), 62-79.
- Laudner, K., Moore, S., Sipes, R., & Meister, K. (2010). Functional hip characteristics of baseball pitchers and position players. *American Journal of Sports Medicine*, 38(2), 383-387.
- Lopez-Martinez, A. B., & Palao, J. M. (2009). Effect of Serve Execution on Serve Efficacy in Men's and Women's Beach Volleyball. *International Journal of Applied Sports Sciences*, 21(1), 1-16.
- Lorenzo, A., Gómez, M. Á., Ortega, E., Ibáñez, S. J., & Sampaio, J. (2010). Game related statistics which discriminate between winning and losing under-16 male basketball games. *Journal of Sports Science and Medicine* 9, 664-668.
- Magalhães, J., Inácio, M., Oliveira, E., Ribeiro, J., & Ascensão, A. (2011). Physiological and neuromuscular impact of beach-volleyball with reference to fatigue and recovery. *Journal of Sports Medicine & Physical Fitness*, 51, 66-73.
- Marcelino, R., Sampaio, J., & Mesquita, I. (2011). Investigação centrada na análise do jogo: da modelação estática à modelação dinâmica. *Revista Portuguesa de Ciências do Desporto*, 11(1), 481-499.
- Matthew, D., & Delextrat, A. (2009). Heart rate, blood lactate concentration, and time-motion analysis of female basketball players during competition. *Journal of Sports Sciences*, 27(8), 813-821.
- Medeiros, A., Loureiro, A., Oliveira, J., & Mesquita, I. (2012). Estudo da variação de indicadores da performance no decurso do jogo em voleibol de praia. *Revista Portuguesa de Ciências do Desporto*, 12(1), 73-86.

- Mesquita, I. (2009a). O ensino e treino da técnica nos jogos desportivos. In A. Rosado & I. Mesquita (Eds.), *Pedagogia do desporto* (pp. 165-184). Lisboa: FMH-UTL.
- Mesquita, I. (2009b). *Relatório de metodologia I Voleibol*. Relatório apresentado às provas de agregação da Faculdade de Desporto da Universidade do Porto.
- Mesquita, I., Palao, J. M., Marcelino, R., & Afonso, J. (2013). Performance analysis in indoor volleyball and beach volleyball. In T. McGarry, P. O. Donoghue & J. Sampaio (Eds.), *Routledge handbook of sports performance analysis* (pp. 367-379). Routledge.
- Michalopoulou, M., Papadimitriou, K., Lignos, N., Taxildaris, K., & Antoniou, P. (2005). Computer analysis of the technical and tactical effectiveness in Greek beach volleyball. *International Journal of Performance Analysis in Sport*, 5(1), 41-50.
- Miller, T., White, E., Kinley, K., Congleton, J., & Clark, M. (2002). The effects of training history, player position, and body composition on exercise performance in collegiate football players. *Journal of Strength and Conditioning Research*, 16(1), 44-49.
- Monge, M. (2003). Propuesta estructural del desarrollo del juego en Voleibol. In I. Mesquita, C. Moutinho & R. Faria (Eds.), *Investigação em Voleibol. Estudos Ibéricos* (pp. 142-150). Porto: Faculdade de Ciências do Desporto e de Educação Física de Universidade do Porto.
- Moutinho, C. (2000). *Estudo da estrutura interna das acções da distribuição em equipas de Voleibol de alto nível de rendimento. Contributo para a caracterização e prospectiva do jogador distribuidor*. Porto: Carlos Moutinho. Doctor Thesis presented to Faculty of Sport, University of Porto.
- Noce, F., Santos, I., Samulski, D., Carvalho, S., Santos, R., & Mello, M. (2008). Monitoring levels of stress and overtraining in an elite Brazilian female

volleyball athlete: case study *Revista de Psicología del Deporte*, 17(1), 25-41.

Oliveira, R. M. M. (2007). *Análise da performance tática no voleibol de elevado rendimento desportivo. Estudo em equipas participantes na liga Mundial 2005*. Porto: Rui Oliveira. Mestrado Thesis presented to Faculdade de Desporto da Universidade do Porto.

Oliveira, T., Abade, E., Gonçalves, B., Gomes, I., & Sampaio, J. (2014). Physical and physiological profiles of youth elite handball players during training sessions and friendly matches according to playing positions. *International Journal of Performance Analysis in Sport*, 14, 162-173.

Palao, J. M. (2001). *Incidencia de las rotaciones sobre el rendimiento del ataque y bloqueo en Voleibol*. Espanha: José palao. Doctor Thesis presented to Universidad de Granada.

Palao, J. M., Gutiérrez, D., & Frideres, J. E. (2008). Height, weight, body mass index, and age in beach volleyball players in relation to level and position. *Journal of Sports Medicine & Physical Fitness*, 48(4), 466-471.

Palao, J. M., Valades, D., Manzanares, P., & Ortega, E. (2014). Physical actions and work-rest time in men's beach volleyball. *Revista Motriz de Educação Física*, 20(3), 257-261.

Palao, J., M., Santos, J. A. & Ureña, A. (2002). *Incidencia del rendimiento de los complejos de juego por rotaciones sobre la clasificación final de los JJOO de Sydney 2000*. Paper presented at the Congreso internacional sobre entrenamiento deportivo - "Tendencias actuales en el Voleibol mundial de máximo nivel", Valladolid.

Pérez-Turpin, J. A., Zmijewski, P., Jimenez-Olmedo, J. M., Jové-Tossi, M. A., Martínez-Carbonell, A., Suárez-Llorca, C., & Andreu-Cabrera, E. (2014). Effects of whole body vibration on strength and jumping performance in volleyball and beach volleyball players. *Biology of Sport*, 31(3), 239-245.

Pérez-Turpin, J. A., Cortell-Tormo, J. M., Chinchilla-Mira, J. J., Cejuela-Anta, R., & Suárez-Llorca, C. (2008). Analysis of jump patterns in competition

- for elite male Beach Volleyball players. *International Journal of Performance Analysis in Sport*, 8, 94-101.
- Pfeiffer, M., & Perl, J. (2006). Analysis of tactical structures in team handball by means of artificial neural networks. *International Journal of Computer Science in Sport*, 5(1), 4-14.
- Quiroga, M. E., Sarmiento, S., Palomino, A., Rodríguez, D., & García-Manso, J. (2014). Características antropométricas de los jugadores españoles de voley playa. Comparación por categorías. *International Journal of Morphology*, 32(1), 22-28.
- Riggs, M. P., & Sheppard, J. M. (2009). The relative importance of strength and power qualities to vertical jump height of elite beach volleyball players during the counter-movement and squat jump. *Journal of Human Sport & Exercise*, 4(3), 221-236.
- Rocha, M., & Barbanti, V. (2007). Analysis of jumping in the spike, block and set skills of female volleyball players. *Brazilian Journal Kinanthropometry Human Performance*, 9(3), 284-290.
- Ronglan, L. T., & Grydeland, J. (2006). The effects of changing the rules and reducing the court dimension on the relative strengths between game actions in top international beach volleyball. *International Journal of Performance Analysis in Sport*, 6(1), 1-12.
- Sheppard, J., Gabbett, T., & Stanganelli, L. (2009). An analysis of playing positions in elite men's volleyball: considerations for competition demands and physiologic characteristics. *Journal of Strength and Conditioning Research*, 23(6), 1858-1866.
- Sibila, M., Vuleta, D., & Pori, P. (2004). Position related differences in volume and intensity of large scale cyclic movements of male players in handball. *Kinesiology*, 36, 58-68.
- Silva, J. (2000). *A importância de indicadores do jogo na discriminação da vitória e da derrota em andebol*. Relatório apresentado às provas de

aptidão pedagógica e científicas da Faculdade de Desporto da Universidade do Porto.

- Skoufas, D., Kotzamanidis, C., Hatzikotoylas, K., Bebetos, G., & Patikas, D. (2003). The relationship between the anthropometric variables and throwing performance in handball. *Journal of Human Movement Studies*, 45, 469-484.
- Stefanello, J. (2007). Situações de estresse no vôlei de praia de alto rendimento: um estudo de caso com uma dupla olímpica. *Revista Portuguesa de Ciências do Desporto* 7(2), 232-244.
- Tilp, M., Wagner, H., & Muller, E. (2008). Differences in 3D kinematics between volleyball and beach volleyball spike movements. *Sports Biomechanics*, 7, 386-397.
- Verdejo, D., Gosálbez, G., & Sánchez-Gontán, F. (1994). *Voley playa: Aprendizaje, entrenamiento y organización*. Madrid: Alianza Editorial.
- Vieira, L., Carruzo, N., Aizava, P., & Rigoni, P. (2013). Análise da síndrome de "burnout" e das estratégias de "coping" em atletas brasileiros de vôlei de praia. *Rev Bras Educ Fís Esporte*, 27(2), 269-276.
- Volossovitch, A., & Ferreira, A. (2013). Da descrição estática à predição dinâmica. A evolução das perspectivas de análise da performance nos jogos desportivos coletivos In A. Volossovitch & A. Ferreira (Eds.), *Fundamentos e aplicações em análise do jogo*. Lisboa: FMH-Edições.
- Wallhead, T., & O'Sullivan, M. (2005). Sport Education: physical education for the new millennium? *Phy Edu Sport Pedagog*, 10(2), 181-210.
- Winkler, W. (1988). A new approach to the video analysis of tactical aspects of soccer. In T. Reilly, K. Davids & W. Murphey (Eds.), *Science and football* (pp. 368-372). Londres.
- Yiannis, L. (2008). Comparison of the basic characteristics of men's and women's beach volley from the Athens 2004 Olympics. *International Journal of Performance Analysis in Sport*, 8(3), 130-137.

2. Estudo Teórico

Systematic review on sports performance in beach volleyball from match analysis: Analysis of sports performance in beach volleyball

Medeiros, A.¹, Palao, J.², Marcelino, R.³, Mesquita, I.¹

¹ Centre of research, education, innovation and intervention in Sport (CIFI2D), Faculty of Sport, University of Porto.

² University of Murcia. Faculty of Sport Sciences. Murcia. Spain.

³ University of Trás-os-Montes e Alto Douro. Research Center in Sport, Health and Human Development (CIDESD). Vila Real. Portugal.

Artigo aceite para publicação na revista *Revista Brazilian Journal Kinanthropometry Human Performance*, 16(6).

Abstract

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

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

Introduction

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

factors that lead to performance improvement and therefore to sports success⁵.
6.

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

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

Methods

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

screening and eliminating articles that did not follow the previously established inclusion criteria, 18 empirical articles focusing on BV from MA were considered. The reduced number of articles is due to the fact that MA is relatively recent as a scientific area, in addition to the scarcity of studies on BV, as previously reported.

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

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

Author/Year/Country	Aim of study	Sample and variables	Statistic	Result
Giatsis et al ²⁰	To compare the performance between winners and losers, before and after changes in the court size.	34 male sets (2000 and 2001 Greek Championship). <i>Efficacy (serve, reception and attack).</i>	T-test.	<ul style="list-style-type: none"> - Before changes in the court size, the success was dependent on the quality of reception; - After changes in the court size, the success became more dependent on the efficacy of the attack and the reduction of errors.
Giatsis et al ¹⁹	To compare the temporal characteristics of work and rest between matches in the 8x8m and 9x9m court.	33 male sets (2000 and 2001 Greek Championship). <i>Rallies, time-outs and rest time.</i>	T-test.	<ul style="list-style-type: none"> - Significant increase of 1 second on the duration of the rally in the 8x8m court; - Significant decrease on work-rest ratio (1:2-3)* in the 8x8m court. <p>* 1minute of work for 2-3 minutes of rest</p>
Giatsis ²²	To compare the rally scoring system and side out scoring system in relation to duration and fluctuation score.	582 female matches (2000 and 2001 FIVB tournaments). <i>Duration of matches and number of rallies.</i>	Anova.	<ul style="list-style-type: none"> - Significant increase (6 minutes) on the duration of match in the rally scoring system; - Losing teams decreased more 3,5 rallies in 3rd set in the rally scoring system.
Giatsis et al ²³	To assess the performance of teams after the reduction in court dimensions.	34 male sets (2000 and 2001 Greek Championship). <i>Efficacy (reception and attack)</i>	T-test.	<ul style="list-style-type: none"> - The reduction in court dimensions produced better conditions for the execution of the attack (result of a better reception);
Mesquita et al ¹¹	To identify and associate the type of attack with its efficacy, match status and type of block.	27 male sets (2002 World Tour and World Cup). <i>Block (type); attack (type, efficacy and zone); complex of the game.</i>	Chi-square.	<ul style="list-style-type: none"> - 84% of attacks are performed in the presence of block; - Attacks in the presence of blocks have a positive outcome.

Mesquita et al ¹⁰	To identify and associate the type of attack with the attack zones.	27 male sets (2002 World Tour and World Cup). <i>Type and attack zone.</i>	Chi-square.	<ul style="list-style-type: none"> - Power attack was the most used and more effective; - Significant associations between: type of attack and its efficacy; ranking classification and type of attack; match status and type of attack. - Zones 2 (39%) and 4 (38%) were the most used by attackers.
Michalopoulou et al ¹⁴	To assess the efficacy of game actions between winning and losing teams.	120 male sets (2000 Greek Championship). <i>All the game actions.</i>	Anova and Chi-square.	<ul style="list-style-type: none"> - Winning teams had better efficacy in serve and attack.
Grgantov et al ²⁷	To assess the impact of game actions according to final result before and after changes in the rules.	129 sets (old rules) and 74 sets (new rules) (1995 and 1996 Croatian championship). <i>All the game actions.</i>	Regression.	<ul style="list-style-type: none"> - Before changes in the rules, the attack was the action with the greatest influence on success, followed by reception, dig, block, counterattack and serve; - After changes, attack was followed by block, counterattack, dig and serve; - The reception showed no significant relationship with success of the attack after changes in the rules.
Ronglan et al ²¹	To assess the quality and efficacy of game actions after changes in the rules.	34 male matches (1999 and 2002 FIVB World Tour tournaments between). <i>All the game actions.</i>	Mann-Witney	<ul style="list-style-type: none"> - Significant decrease in points (4%) and serve errors (3%), attack points (6%); - Significant increase in actions and block points (4%).

Giatsis et al ³⁰	To compare the characteristics of the match between winning and losing teams according to the type of match (two or three sets).	118 male matches. (2003 FIVB World Tour tournament). <i>Efficacy (serve, attack, block and dig).</i>	T-test.	<ul style="list-style-type: none"> - Better efficacy on game actions won by 2-0; - Better performance in the total of points gain in games won by 2-1.
Turpin et al ⁸	To analyze and quantify the types of jumps performed by players.	10 players / 9 male sets (2005 European championship). <i>Jumps (attack, serve and block).</i>	Frequencies, means and standard deviations.	<ul style="list-style-type: none"> - Jumps (219 per match, 100 per set and 6 per rally); - Attack (44%), block (39%) and serve (17%).
Yiannis ¹⁶	To compare the game actions and their efficacy according to gender.	16 male matches and 15 female matches (2004 Olympic Games) <i>All the game actions.</i>	Chi-square.	<ul style="list-style-type: none"> - Significantly greater use of jump serve and power attack in male games.
Koch et al ¹³	To identify the typical sequence of game actions.	18 female matches. (2007 World Tour). <i>All the game actions.</i>	Chi-square.	<ul style="list-style-type: none"> - After a perfect reception, the players perform more type shot attacks (55%) than power attacks (45%). - The jump serve increases 8% errors in reception.
Koch et al ¹⁷	To compare the game actions according to gender.	14 male matches and 15 female matches. (2005 World Tour). <i>All the game actions.</i>	Chi-square.	<ul style="list-style-type: none"> - In male matches, there was greater frequency of jump serve, frontal reception, overhand pass, offensive block, dig from power attack, attack on the cross-court; - In female matches, there was greater frequency of float jump serve, defensive block, and dig from shots.

Lopez-Martinez et al ¹²	To assess the relationship between serve action and its manner of execution as well as its efficacy according to gender.	13 male sets and 11 female sets. (2003 World Tour and 2004 Olympic Games). <i>Serve (type, zone, destination, efficacy) and action outcome.</i>	Chi-square.	<ul style="list-style-type: none"> - The jump serve showed more errors and more points in both genders; - In males, the use of jump serve, zone 3 (to serve) and destinations 3 and 6 (had better efficacy) were the most used; - In females, the jump serve for destination 2 was the most used and had better efficacy; for the other types of serve, there was a greater variation of the zone in comparison to males.
Buscà et al ¹⁸	To assess the relationship between types of serve and speed according to the final tournament ranking and the influence of serve efficacy on the rally outcome.	23 male sets and 22 female sets. (2008 World Tour). <i>Serve (type and efficacy).</i>	T-test, Mann-Whitney and Chi-square.	<ul style="list-style-type: none"> - Serve with medium speed in male and with low and high speed in female, resulted in a greater balance between positive and negative on the rally outcome; - In females, serve with high speed was the most used by players with top positions in the rankings.
Chinchilla et al ⁹	To analyze the differences between offensive zones according to gender.	18 sets (2005 European championship) <i>Offensive zones.</i>	Frequencies.	- The most used zones in men were: 1, 2, 4 and 5; whereas in women, zones 1 and 5 were predominant.
Jiménez et al ¹⁵	To analyze types of serve according to the match status.	8 male sets (2005 European championship). <i>Type of serve.</i>	Chi-square.	- Significant decrease in jump serve from 1 st moment (1 st to 7 th point; 89,7%) to 3 rd moment (15 th to 21 st point; 27,3%).

Results

Descriptive and comparative analysis

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

After a descriptive approach, studies of comparative nature with high incidence were assessed (77,8%), which followed three research lines: 1) functional dependence of game actions and their relationship with success¹⁰⁻¹⁵; 2) performance analysis according to gender¹⁶⁻¹⁸ and 3) effect of changes in rules on game performance¹⁹⁻²³.

Functional dependence of game actions and their relationship with success

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

Lopez-Martinez et al.¹², analyzed the relationship between type of serve and way of execution with its efficacy. The authors analyzed male (13 sets) and

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

Koch et al.¹³ analyzed associations between serve and reception; set and attack; reception and attack (18 female matches – 2007 World Championship). The findings confirmed a significant relationship only between reception and attack. Following a perfect reception, players performed more shots (type of attack) (55%) than power spikes (45%). Following a bad reception, players opted for power spike, and when the quality of reception was perfect, they opted for greater variability in the type of attack.

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

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

Analysis of performance according to gender

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

and power attack in the male match. The authors observed inequalities in the players' muscle power, as one of the main factors in the type of match played.

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

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

Effect of changes in rules on game performance

Regarding research focused on changes in rules imposed by FIVB in 2000, several studies were concerned in trying to understand how these changes affected game performance. These changes involved a new program of rules from the 2000 Olympic Games in Sydney, including: reduction in the court

dimensions (from 9x9m to 8x8m), change in score system (side-out to point per rally) and possibility of serve touching the net²⁴.

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

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

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

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

obtained by losing teams in the third set was 3.5 points more in “RS” when compared to “SO”.

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

From the analysis of these studies, it can be seen that changes in rules do not seem to have achieved the effect expected by FIVB²⁴ in decreasing the match duration, making it more attractive and, consequently more visible in the media. In addition, the results of these studies seem to reflect a more demanding match, in relation to the physical component of players.

Predictive analysis of performance

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

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

Discussion

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

Although studies have mainly focused on a descriptive and comparative nature (88.9%), it is possible to infer that these complied, partially, with some of the aims of the performance analysis of BV focused on MA, as for instance the description of match patterns, the identification and analysis of associations between game actions and their relation with success. It is noteworthy that in studies of comparative nature, referenced samples belong to matches played over five years ago. With the natural evolution of BV, these data could have suffered changes, namely in the way of serve execution, due to the physical profile of players and game speed. In this type of study, the research was conducted based on the analysis of accumulated data of performance indicators, with the aim of identifying and quantifying the physical performance of players, as well as knowing specific game profiles for each gender. It is important to highlight that studies of descriptive-comparative nature considered here only allowed identifying, describing and comparing the structure and/or the

patterns of the match. Studies of comparative nature were based on more accurate methodologies, representing a significant advance in research. Despite the relevance of such approach, it has not yet allowed explaining and predicting sport performance²⁹⁻³¹, besides not providing essential reference values for a better organization of the training and competition process. Meanwhile, these limitations have been taken into account by researchers, emphasizing the need for complementing these analyses with the use of stronger models, where the non-linearity of behaviours is considered³².

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

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

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

supported cues that could provide insights to better define the pathways of long-term athlete development.

Final considerations

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

Acknowledgements

This study was supported by CAPES (Brazilian Ministry of Education), Doctoral scholarship program (BEX 0688/12-6/2012-2014).

References

1. Hughes M, Franks I. Notational analysis - a review of the literature. In: Hughes M, Franks I, editors. *Notational Analysis of Sport Systems for better coaching and performance in sport*. Second ed. London: Routledge; 2004. p. 99-107.
2. Ortega E, Villarejo D, Palao JM. Differences in game statistics between winning and losing rugby teams in the six nations tournament. *J Sport Sci Med* 2009;8(4):523-7.

3. Shearer DA, Thomson R, Mellalieu SD, Shearer CR. The relationship between imagery type and collective efficacy in elite and non elite athletes. *J Sport Sci Med* 2007;6(2):180-7.
4. Nevill A, Atkinson G, Hughes M. Twenty-five years of sport performance research in the *Journal of Sport Sciences*. *J Sport Sci* 2008;26(4):413-26.
5. Martin J, Campo J, Barriopedro M, Nogueira M. Análisis de juego desde el modelo competitivo: un ejemplo aplicado al saque en Voleibol. *Kronos* 2004;2(5):37-45.
6. Marcelino R, Mesquita I, Sampaio J. Investigação centrada na Análise do Jogo: da modelação estática à modelação dinâmica. *Rev Port Cien Desp* 2011;11(1):481-99.
7. Wallhead T, O'Sullivan M. Sport Education: physical education for the new millennium? *Phy Edu Sport Pedagog* 2005;10(2):181-210.
8. Pérez-Turpin JA, Cortell-Tormo JM, Chinchilla-Mira JJ, Cejuela-Anta R, Suárez-Llorca C. Analysis of jump patterns in competition for elite male Beach Volleyball players. *Int J Perform Anal Sport* 2008;8:94-101.
9. Chinchilla-Mira JJ, Pérez-Turpin JA, Martínez-Carbonell JA, Jove-Tossi MA. Offensive zones in beach volleyball: differences by gender. *J Hum Sport Exerc* 2012;7(3):727-32.
10. Mesquita I, Teixeira J. The spike, attack zones and the opposing block in elite male beach volleyball. *Int J Voll Res* 2004;7(1):57-62.
11. Mesquita I, Teixeira J. Caracterização do processo ofensivo no voleibol de praia masculino de elite Mundial, de acordo com o tipo de ataque, a eficácia e o momento do jogo. *Rev Bras Cienc Esporte* 2004;26(1):33-49.
12. Lopez-Martinez AB, Palao JM. Effect of Serve Execution on Serve Efficacy in Men's and Women's Beach Volleyball. *Int J App Sport Sci* 2009;21(1):1-16.
13. Koch C, Tilp M. Analysis of beach volleyball action sequences of female top athletes. *J Hum Sport Exerc* 2009;4(3):272-83.

14. Michalopoulou M, Papadimitriou K, Lignos N, Taxildaris K, Antoniou P. Computer analysis of the technical and tactical effectiveness in Greek Beach Volleyball. *Int J Perform Anal Sport* 2005;5:41-50.
15. Jiménez-Olmedo J, Penichet-Tomás A, Sáiz-Colomina S, Martínez-Carbonell J, Jove-Tossi M. Serve analysis of professional players in beach volleyball. *J Hum Sport Exerc* 2012;7(3):706-13.
16. Yiannis L. Comparison of the basic characteristics of men's and women's beach volley from the Athens 2004 Olympics. *Int J Perform Anal Sport* 2008;8:130-7.
17. Koch C, Tilp M. Beach volleyball techniques and tactics: a comparison of male and female playing characteristics. *Kinesiology* 2009;41(1):52-9.
18. Buscà B, Moras G, Peña J, Rodríguez-Jiménez S. The influence of serve characteristics on performance in men's and women's high-standard beach volleyball. *J Sport Sci* 2012;30(3):269–76.
19. Giatsis G, Papadopoulou S, Dimitrov P, Likesas G. Comparison of Beach Volleyball Team Performance Parameters After a Reduction in the Court's Dimensions. *Int J Voll Res* 2003;6(1):1-5.
20. Giatsis G, Tzetzis G. Comparison of performance for winning and losing beach volleyball teams on different court dimensions. *Int J Perform Anal Sport* 2003;3(1):65-74.
21. Ronglan LT, Grydeland J. The effects of changing the rules and reducing the court dimension on the relative strengths between game actions in top international beach volleyball. *Int J Perform Anal Sport* 2006;6:1-12.
22. Giatsis G. The effect of changing the rules on score fluctuation and match duration in the FIVB womens beach volleyball. *Int J Perform Anal Sport* 2003;3:57-64.
23. Giatsis G, Papadopoulou S. Effects of reduction in dimensions of the court on timing characteristics for men's beach volleyball matches. *Int J Voll Res* 2003;6(1):6-9.

24. Federação Internacional de Voleibol. Official beach volleyball rules Lausanne, Switzerland: FIVB; 2001.
25. Grgantov Z, Kati R, Mareli N. Effect of New Rules on the Correlation between Situation Parameters and Performance in Beach Volleyball. *Coll Antropol* 2005;29(2):717 - 22.
26. Giatsis G, Tili M, Zetou E. The height of the women's winners FIVB Beach Volleyball in relation to specialization and court dimensions. *J Hum Sport Exerc* 2011;6(3):497-503.
27. Tili M, Giatsis G. The height of the men's winners FIVB Beach Volleyball in relation to specialization and court dimensions. *J Hum Sport Exerc* 2011;6(3):504-10.
28. Giatsis G, Panagiotis Z. Statistical Analysis of Men's FIVB Beach Volleyball Team Performance. *Int J Perform Anal Sport* 2008;8:31-43.
29. Lames M. Modelling the interaction in game sports - Relative phase and moving correlations. *J Sport Sci Med* 2006;5(4):556-60.
30. McGarry T, Franks I. Development, Application, and Limitation of Stochastic Markov Model in Explaining Championship Performance. *Res Q Exercise Sport* 1996;67(4):406-15.
31. McGarry T, Franks I. A stochastic approach to predicting competition squash match-play. *J Sport Sci* 1994;12(6):573 - 84.
32. O'Donoghue P. *Research Methods for Sports Performance Analysis*: Routledge; 2010.
33. Gréhaigne J, Godbout P, Bouthier D. The teaching and learning of decision making in team sports. *Quest* 2001;53(1):59-76.
34. Volossovitch A. *Análise dinâmica do jogo de andebol. Estudo dos factores que influenciam a probabilidade de marcar golo Lisboa*: Ana Volossovitch; 2008.

35. Noakes T, Gibson A, Lambert E. From catastrophe to complexity: a novel model of integrative central neural regulation of effort and fatigue during exercise in humans. *Br J Sports Med* 2004;38(4):511-4.
36. Heazlewood T. Prediction versus reality: The use of mathematical models to predict elite performance in swimming and athletics at the Olympic Games. *J Sport Sci Med* 2006;5(4):541-7.
37. García-Manso J, Martín-González J, Silva-Grigoletto M. Los sistemas complejos y el mundo del deporte. *Rev Andal Med Deporte* 2010;3(1):13-22.
38. McGarry, Anderson D, Wallace S, Hughes M, Franks I. Sport competition as a dynamical self-organizing system. *J Sport Sci* 2002;20(10):771-81.

3. Estudios Empíricos

3.1. Estudo Empírico 1

Physical and temporal characteristics of under 19, under 21 and senior male beach volleyball players

Medeiros, A.¹, Marcelino, R.², Mesquita, I.¹, Palao, J.³

¹ Centre of research, education, innovation and intervention in Sport (CIFI2D), Faculty of Sport, University of Porto.

² University of Trás-os-Montes e Alto Douro. Research Center in Sport, Health and Human Development (CIDESD). Vila Real. Portugal.

³ University of Murcia. Faculty of Sport Sciences. Murcia. Spain.

Artigo publicado na revista Journal of Sports Science & Medicine, 13(3), 658-665.

Abstract

This study aimed to assess the effects of age groups and players' role (blocker vs. defender specialist) in beach volleyball in relation to physical and temporal variables, considering quality of opposition. 1101 rallies from Under 19 (U19), 933 rallies from Under 21 (U21), and 1480 rallies from senior (senior) (Men's Swatch World Championships, 2010-2011) were observed using video match analysis. Cluster analysis was used to set teams' competitive levels and establish quality of opposition as "balanced", "moderate balanced" and "unbalanced" games. The analyzed variables were: temporal (duration of set, total rest time, total work time, duration of rallies, rest time between rallies) and physical (number of jumps and number of hits done by defenders and blockers) characteristics. A one-way ANOVA, independent samples t-test and multinomial logistic regression were performed to analyze the variables studied. The analysis of temporal and physical characteristics showed differences considering age group, player's role and quality of opposition. The duration of set, total rest time, and number of jumps done by defenders significantly increased from the U19 to senior category. Multinomial logistic regression showed that in: a) balanced games, *rest time between rallies* was higher in seniors than in U19 or U21; *number of jumps* done by defenders was higher in seniors than in U19) and U21; b) moderate balanced games, *number of jumps* done by defenders was higher in seniors than in U21 and *number of jumps* done by blockers was smaller in U19 than U21 or seniors; c) unbalanced games, no significant findings were shown. This study suggests differences in players' performances according to age group and players' role in different qualities of opposition. The article provides reference values that can be useful to guide training and create scenarios that resemble a competition, taking into account physical and temporal characteristics.

Key-words: logistic regression, match analysis, age groups, performance, quality of opposition, player role.

Introduction

Research in performance analysis focused on beach volleyball (BV) has been increasing in recent years with the purpose to provide relevant information on features, patterns, and specificities of teams' behaviors within competitive contexts, providing valuable data for guiding practice and research alike. As in indoor volleyball, BV is a team sport characterized by its intermittent nature, fluctuating randomly from brief periods of maximal or near maximal activity to longer periods of moderate and low intensity activity (Arruda and Hespanhol, 2008; Magalhães et al., 2011). For this reason, the knowledge of the temporal characteristics is vital to guide the training process with emphasis on science-based programs (Giatsis and Papadopoulou, 2003). Most studies on sports temporal profiles (Alves et al., 2012; Cronin et al., 2007; Girard et al., 2007; Smekal et al., 2000) have been done in senior high performance competitions (World Championships, Olympic Games, etc.). In BV, these studies performed in male games in the World Tour, showed that on average, set duration is about 21-23 minutes, number of rallies per set is about 39-40, the total rest time and rally duration is 17 minutes and 8.5 seconds, respectively (Giatsis et al., 2005; Palao et al., 2012). In addition, the temporal characteristics of the game can have an effect on the physical characteristics (e.g. the continuity of the rally duration increases the number of actions done by players; contacts, jumps, hits, etc.) (Giatsis and Papadopoulou, 2003). The studies, performed in male games in the World Tour, showed that the players perform on average 100 jumps per set, and six jumps per rally (Pérez-Turpin et al., 2008).

Although research done on BV has analyzed these variables, especially in seniors, the level of the opponents' game has not been considered. Therefore, the quality of opposition assumes great relevance in explaining the relevant behaviors of teams and players (Mesquita and Marcelino, 2013). Some of the situational variables (such as quality of opposition) can have a marked effect on sports performance (Lago, 2009; Marcelino et al., 2010, 2011; Marcelino et al., 2012; Miguel-Ángel et al., 2013; O'Donoghue and Mayes, 2013; Taylor et al., 2008). Indeed, the relationships between quality of opposition and efficacy in net sports actions (Marcelino et al., 2010; O'Donoghue et al., 2008) have

already been identified. In indoor volleyball, Marcelino et. al (2012) demonstrated that quality of opposition interacted with performance in serve and attack, revealing that teams exhibited different offensive strategies according to their opponents. Despite the demonstrated effect of quality of opposition on sport performance, BV studies persist in analyzing performance of teams and players disregarding the competitive level of their opponents.

Additionally, in BV, one of the aspects that affect physical characteristics of players, at least in defense and in counter-attack actions, is the player's role: blocker and defense specialist (Homberg and Papageorgiou, 1994). The blocker may execute more jumps because they block every attack of the opponent. The defense specialist may have more contacts and/or hits if they get to do the defense and counter-attack. The player's role is directly associated with different performance profiles. This association has been highlighted in baseball (Laudner et al., 2010), basketball (Abdelkrim et al., 2010; Matthew and Delextrat, 2009), football (Miller et al., 2002), and indoor volleyball (Rocha and Barbanti, 2007; Sheppard et al., 2009). In BV, only one study was found that differentiates physical actions performed by players. This study showed that the blocker executes more jumps (33 jumps) than the defender specialist (28 jumps) per set (Palao et al., 2013). Therefore, the differences in their physical and anthropometric characteristics allow them to perform differently in the game (Palao et al., 2008). Thus, it is crucial to analyze temporal and physical characteristics in BV, taking into account the quality of opposition and the player's role.

Furthermore, the studies on beach volleyball involving the physical and temporal characteristics have been performed only in senior high performance competitions (Giatsis et al., 2005; Palao et al., 2012; Pérez-Turpin et al., 2008). Nevertheless, it has been suggested that due to the innate differences in performance capabilities between young players and senior players, it would be inappropriate to apply physical demands of senior players to young players (Harley et al., 2010). Therefore, the purpose of the present study was to assess the effects of age groups (U19, U21 and senior) and players' role (blocker vs. defender specialist) in BV in relation to physical and temporal variables,

considering the quality of opposition.

Method

The study sample consisted of 1101 rallies (30 sets of 15 games) from U19, 933 rallies (24 sets of 12 games) from U21, and 1480 rallies (40 sets of 20 games) from senior. Only actions from first and second sets of the games were observed. The analysed variables were the following: temporal (duration of set, total rest time, total work time, duration of rallies, rest time between rallies) and physical (number of jumps and number of hits done by defenders and blockers) characteristics. The number of jumps by defender and blocker included all the jumps from serves, attacks and blocks. A player was categorized as a defender when he participated less than 20% of the times in a block (Tili and Giatsis, 2011). Moreover, the number of serves and attacks done over the net categorized the number of hits. These variables were studied to describe the physical efforts made by different age groups, according to the quality of opposition and player role. The studied variables are part of the observation instrument (TEBEVOL) designed and validated by Palao and Manzanares (2009).

Data were collected from games of the Men's Swatch Youth World Championships 2010 (U19), Swatch Junior World Championships 2010 (U21) and Swatch World Championships 2011 (senior). All competitions were organized by FIVB (Fédération Internationale de Volleyball).

The analyzed sets were recorded using a camera (sony digital video; Dcr – SR37). The camera was positioned at the grandstand at a distance of approximately ten meters from the baseline to have a frontal view in order to show the full court. The digital camera clock timed the duration of the whole work and rest. Total work time was defined as the time from when the player hits the ball for serving, until the referee blows the whistle, concluding the rally. Total rest time was defined as the time between two rallies.

A two-step cluster analysis (Distance Measure: Log-likelihood; Clustering Criterion: Schwarz's Bayesian Criterion) was used to classify the teams into performance levels (Figure 1). The number of clusters was fixed in three, as

recommended by Taylor and co-workers (Taylor et al., 2008); and the variables used for the calculation were: points in the end of the competition, total of sets won, total of victories. After the cluster analysis, the sample was divided into three groups according to the quality of opposition teams (Figure 2).

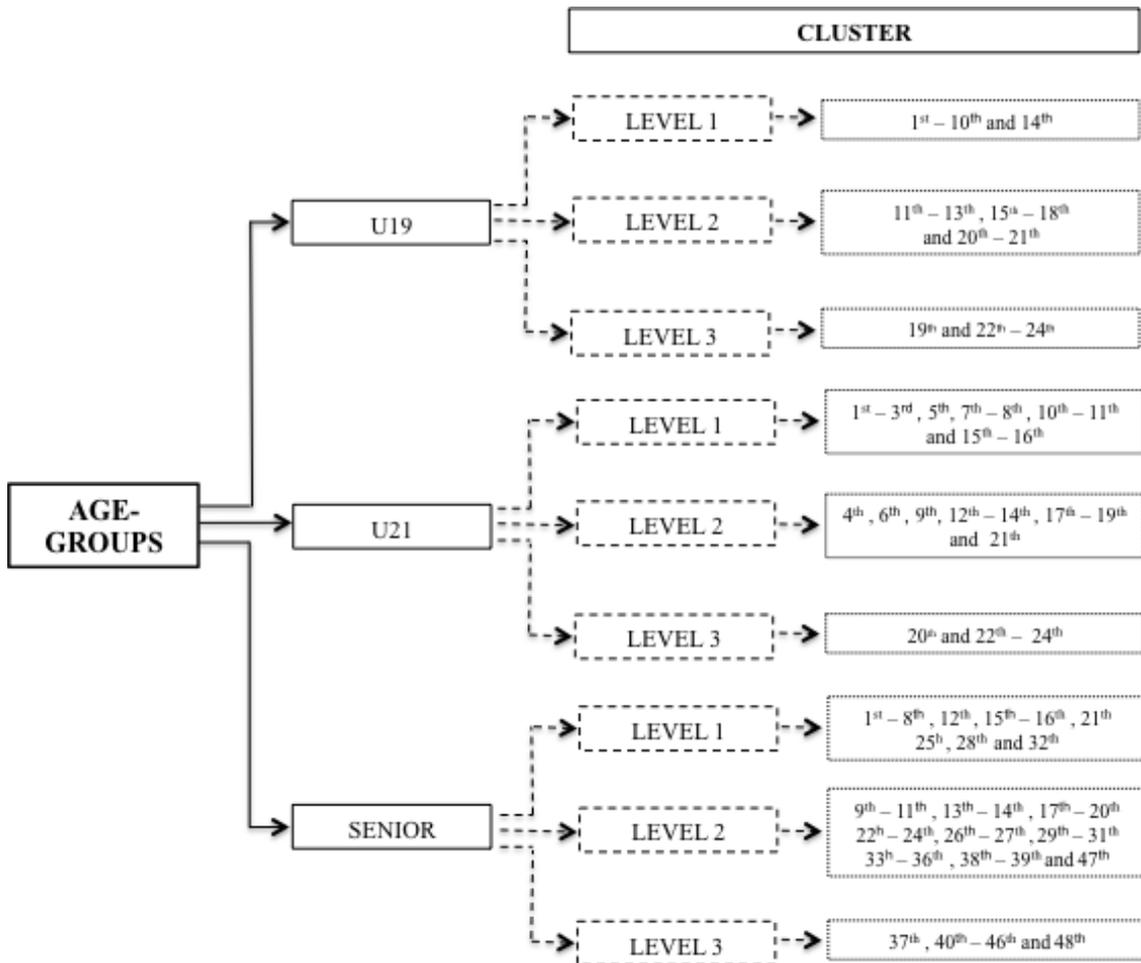


Figure 1 - Teams performance levels computed through two-step cluster analysis.

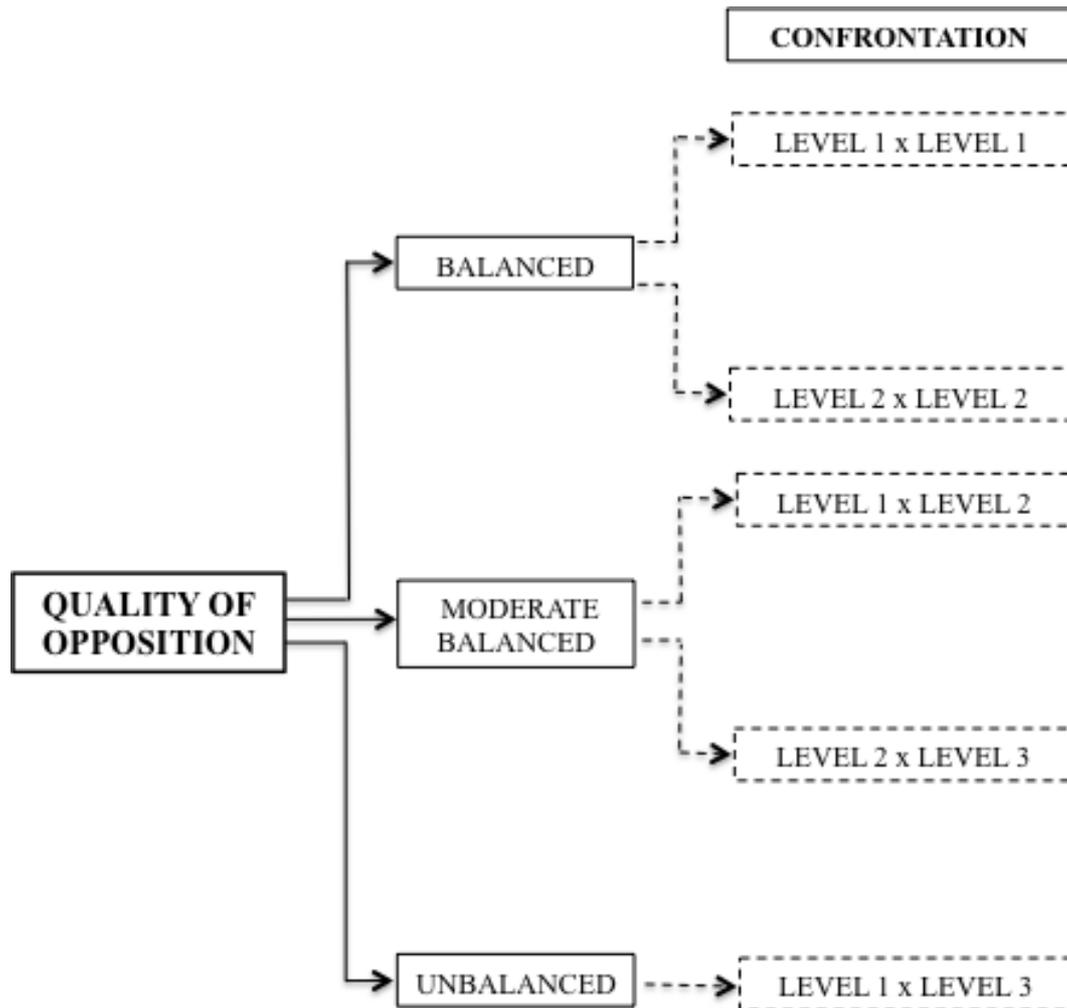


Figure 2 - Sample division into three groups according to quality of opposition.

Observations were done by an observer who was trained during three sessions of two hours each following the criteria established by Anguera (1991; 2003) and Behar (1993). The observer had a Master in high performance training with specialization in BV and had been a BV coach for ten years.

To guarantee reliability of the observations, intra- and inter-observer agreements were assessed. After a 3-week period of original observations, to prevent from any learning effect, the observer reanalyzed 14 random sets (14.9% of total analyzed sets). For inter-observer reliability testing, another observer analyzed 12 random sets (12.7% of total analyzed sets) that had previously been analyzed by the original observer. For physical variables, agreements between measurements were assessed via percentage error

method (James et al., 2007) together with Intraclass Correlation Coefficients ($ICC_{2,1}$) (Atkinson and Nevill, 1998); and for temporal variables, agreements between measurements were assessed through mean difference between observations (original vs reliability proposed) together with 95% confidence intervals (Atkinson and Nevill, 1998). In addition, measurement errors were assessed by standard error of measurement (SEM) and the SEM%. The Bland-Altman graphs were formed to give a visual interpretation of the data as well as to determine reproducibility bias (Bland and Altman, 1986, 2010). The reliability values obtained were: percentage error <5%; $ICC > 0.96$; mean differences <5%; $SEM < 3.7\%$.

Statistical analysis

Initially, descriptive and inferential analyses were conducted without considering the quality of opposition. A one-way ANOVA was performed to study the differences between the age groups. When equal variances were found, they were followed up with Bonferroni post-hoc testing while when unequal variances were found, the Brown-Forsythe test with Dunnett's T3 post-hoc testing was done (Ntoumanis, 2001). An Independent samples t-test was made to study the differences in jumps and hits between defender and blocker in each group.

In the second stage, a multinomial logistic regression was used to evaluate the association between groups of different ages and temporal or physical variables according to quality of opposition and player role. First, variables were tested one by one. Then, the adjusted models were run with all variables which showed significant differences in relation to different age groups (Landau and Everitt, 2004). Odds ratios (OR) and their 95% confidence intervals (CI) were calculated and adjusted for different age groups. The likelihood ratio test (LRT) was used to identify variables that had association with the age groups. Analyses were carried out for the three different qualities of oppositions (balanced, moderate balanced and unbalanced). Analyses were performed using the SPSS software (version 20.0, IBM corporation, Chicago, IL) and statistical significance was set at $p < 0.05$.

Results

Table 1 presented the means and standard deviations of all temporal and physical variables. The duration of set ($F_{2,75} = 5,446$; $p=0.006$), total rest time ($F_{2,75} = 5,542$; $p=0.006$), the number of jumps made by defenders ($F_{2,91} = 7,207$; $p=0.001$) and the total number of jumps ($F_{2,91} = 9,223$; $p=0.001$) showed significantly higher values in the senior category when compared with the U19 and U21 categories. Blockers did a significant higher number of jumps than defenders in U19 ($t_{47}=-6.21$, $p=0.001$), U21 ($t_{46}=-5.81$, $p=0.001$) and senior category ($t_{78}=-10.16$, $p=0.001$). Defenders did a significant higher number of hits than blockers in senior category ($t_{78}=2.65$, $p=0.010$). When the quality of opposition was considered, in balanced games, the temporal and physical variables tend to have higher values in the senior category. In moderate balanced games and unbalanced games, these variables did not maintain the same pattern along the different age groups (Table 2).

Table 1. Descriptive statistics of temporal and physical variables. Data are means (\pm SD).

Variable		U19 (n = 30)	U21 (n = 24)	Senior (n = 40)	Total group (n = 94)
Temporal variables	Duration of set (min:sec)	16:19 (02:26) ^a	18:02 (03:05)	18:52 (02:28) ^a	18:01 (02:49)
	Total rest time (min:sec)	11:38 (01:54) ^{b, c}	13:31 (02:46) ^c	13:46 (02:06) ^b	13:12 (02:25)
	Total work time (min:sec)	04:41 (00:49)	04:55 (00:38)	05:05 (00:35)	04:56 (00:40)
	Duration of rallies (min:sec)	00:07 (00:01)	00:07 (00:01)	00:08 (00:01)	00:08 (00:01)
	Rest time between rallies (min:sec)	00:21 (00:03)	00:20 (00:02)	00:21 (00:03)	00:21 (00:03)
	Number of rallies (points)	35.8 (4.4)	38.1 (4.8)	37.3 (2.8)	37.2 (3.9)
Physical variables	Number of jumps done by defender	35.8 (11.0) ^{d, e}	41.4 (14.1) ^e	45.8 (8.1) ^{d, e}	41.5 (11.5)
	Number of jumps done by blocker	60.0 (18.2) ^e	64.4 (13.4) ^e	66.8 (10.3) ^e	64.0 (14.2)
	Total number of jumps	95.8 (19.6) ^d	105.4 (18.2)	112.6 (11.4) ^d	105.5 (17.5)
	Number of hits done by defender	38.3 (8.7)	43.5 (11.5)	43.3 (7.8) ^f	41.7 (9.4)
	Number of hits done by blocker	39.7 (10.0)	38.9 (10.0)	38.7 (7.8) ^f	39.1 (9.0)
	Total number of hits	78.0 (11.1)	82.4 (11.7)	81.9 (8.2)	80.8 (10.2)

^a p=0.004 for differences between U19 and senior; ^b p=0.006 for differences between U19 and senior; ^c p=0.030 for differences between U19 and U21; ^d p=0.001 for differences between U19 and senior; ^e p=0.001 for differences between defender and blocker; ^f p=0.010 for differences between defender and blocker.

Table 2. Descriptive statistics of temporal and physical variables according to quality of opposition. Data are means (\pm SD).

Variable	U19			U21			Senior			
	BAL (n = 18)	MODBAL (n = 06)	UNBAL (n = 06)	BAL (n = 14)	MODBAL (n = 06)	UNBAL (n = 04)	BAL (n = 18)	MODBAL (n = 14)	UNBAL (n = 08)	
Temporal variables	Duration of set (min:sec)	16:17 (02:04)	17:02 (03:10)	15:20 (02:09)	19:35 (02:28)	15:36 (02:20)	18:12 (03:31)	20:09 (01:48)	17:47 (02:36)	16:52 (01:36)
	Total rest time (min:sec)	11:30 (01:25)	12:20 (02:28)	10:50 (01:56)	14:33 (02:15)	12:11 (03:06)	13:08 (02:58)	15:01 (01:34)	12:35 (02:01)	12:17 (01:06)
	Total work time (min:sec)	04:46 (00:53)	04:42 (00:59)	04:29 (00:29)	05:01 (00:26)	04:40 (00:53)	05:04 (00:38)	05:07 (00:27)	05:12 (00:41)	04:35 (00:32)
	Duration of rallies (min:sec)	00:08 (00:01)	00:07 (00:01)	00:08 (00:00)	00:07 (00:01)	00:08 (00:01)	00:07 (00:01)	00:08 (00:01)	00:08 (00:01)	00:07 (00:01)
	Rest time between rallies (min:sec)	00:19 (00:01)	00:21 (00:01)	00:25 (00:07)	00:20 (00:02)	00:21 (00:02)	00:18 (00:01)	00:23 (00:02)	00:19 (00:02)	00:20 (00:01)
	Number of rallies (points)	36.3 (4.2)	36.7 (5.6)	33.5 (2.9)	40.1 (4.7)	34.4 (3.8)	39.5 (3.1)	38.1 (2.0)	36.6 (3.5)	36.0 (2.8)
Physical variables	Number of jumps done by defender	33.7 (12.0)	40.8 (10.8)	37.2 (7.4)	42.6 (13.0)	35.2 (7.7)	46.5 (23.8)	47.7 (8.5)	44.6 (6.8)	43.5 (9.3)
	Number of jumps done by blocker	65.3 (18.8)	49.2 (14.0)	54.8 (16.0)	65.2 (10.1)	69.0 (20.5)	54.5 (7.0)	66.4 (8.3)	67.1 (11.8)	67.1 (13.0)
	Total number of jumps	99.0 (20.9)	90.0 (20.6)	92.0 (14.8)	107.8 (11.9)	104.2 (24.1)	101.0 (30.0)	114.1 (8.3)	111.7 (13.1)	110.6 (15.0)
	Number of hits done by defender	38.3 (9.4)	39.3 (8.8)	37.3 (7.8)	45.3 (12.5)	38.8 (10.7)	44.3 (9.9)	43.9 (7.5)	43.4 (6.8)	41.5 (10.5)
	Number of hits done by blocker	43.3 (10.6)	34.3 (6.6)	34.3 (6.1)	39.5 (10.7)	40.0 (11.5)	35.3 (5.4)	39.9 (6.7)	38.8 (9.0)	35.6 (7.8)
	Total number of hits	81.6 (11.2)	73.7 (10.0)	71.7 (8.6)	84.8 (9.4)	78.8 (15.9)	79.5 (13.7)	83.8 (6.4)	82.2 (9.0)	77.1 (9.5)

BAL: Balanced, MODBAL: Moderate balanced, UNBAL: Unbalance

The multinomial logistic regression models (variables tested one by one) showed that, concerning temporal variables, in balanced games there were associations between age groups (U19, U21 and senior) and duration of set, total rest time, rest time between rallies, and number of rallies (Table 3). In unbalanced games there were associations between age groups and rest time between rallies and number of rallies. The LRT identified some variables (total work time and duration of rallies) that were independent of age groups.

Regarding the physical variables, the results showed that in games played between teams of the same quality, there were associations between age groups and number of jumps done by defenders. In moderate balanced games, the age group was associated with number of jumps done by defenders and number of jumps done by blockers. The LRT identified some variables (total number of jumps, number of hits done by defenders, number of hits done by blockers, and total number of hits) that were independent of age groups.

In the second stage, the adjusted model (for temporal variables) fits well the two qualities of opposition (balanced games: LRT = 40.90, $p = 0.001$ and unbalanced games: LRT = 11.15, $p = 0.025$) (Table 3). The results showed an association between age groups and rest time between rallies in games played between teams of the same quality (balanced games: LRT = 12.17, $p = 0.002$). Although the adjusted model showed statistical significance in the unbalanced games, no associations were found with any variable. The adjusted model (for physical variables) fits the two qualities of opposition (balanced games: LRT = 13.32, $p = 0.001$ and moderate balanced games: LRT = 14.30, $p = 0.006$) (Table 3). Results showed an association between the age group and number of jumps done by defenders (balanced games: LRT = 13.32, $p = 0.001$ and moderate balanced games: LRT = 6.76, $p = 0.034$) and number of jumps done by blockers (moderate balanced games: LRT = 8.35, $p = 0.015$).

Table 3. Model information for the association between groups of different ages and temporal and physical variables according to quality of opposition.

Variable	Chi-square of likelihood ratio tests			
	Balanced (n = 50)	Moderate balanced (n = 26)	Unbalanced (n = 18)	
	χ^2	χ^2	χ^2	
Temporal variables	Duration of set	16.85***	3.81	3.22
	Total rest time	20.07***	0.16	3.13
	Total work time	2.11	3.03	2.87
	Duration of rallies	3.86	3.67	0.56
	Rest time between rallies	21.80***	4.89	8.57*
	Number of rallies	6.38*	1.91	8.02*
	Adjusted model	40.90***	9.64	11.15*
	Duration of set	2.50		
	Total rest time	1.99		
	Rest time between rallies	12.17**		3.13
Number of rallies	5.72		2.58	
Physical variables	Number of jumps done by defender	13.32***	5.95*	1.67
	Number of jumps done by blocker	0.10	7.54*	4.48
	Total number of jumps	2.15	3.91	0.22
	Number of hits done by defender	5.04	1.94	1.55
	Number of hits done by blocker	1.76	1.54	0.15
	Total number of hits	1.07	2.80	1.84
	Adjusted model	13.32***	14.30*	
	Number of jumps done by defender	13.32***	6.76*	
	Number of jumps done by blocker		8.35*	

*p < 0.05, ** p < 0.01, *** p < 0.001.

Relationships between all categories of studied variables are ordered by odds ratios (OR) in table 4, in order to estimate the odds of a temporal or physical indicator appearing in one age group compared with the odds of the same event happening in another age group. Results showed that, in games played between teams of the same quality (balanced games), the rest time between rallies was higher in senior category than in U19 (OR = 4.34) or U21 (OR = 1.99). For physical variables, the results showed that in balanced games, the number of jumps done by defenders was smaller in U19 category (OR = 1.14) and U21 category (OR = 1.09) when compared with senior category. In moderate balanced games, the number of jumps done by defenders was higher in senior category than in U21 category (OR = 1.21); and the number of jumps done by blockers was smaller in U19 category than U21 category (OR = 1.14) or senior category (OR = 1.12).

Table 4. Adjusted model for temporal and physical variables.

	Variable	OR	95% CI
Temporal variables	Balanced		
	Rest time between rallies		
	Senior vs U19 ^a	4.34	1.04 - 18.16*
	U21 vs U19 ^a	2.18	0.57 - 8.30
	Senior vs U21 ^a	1.99	1.08 - 3.67*
Physical variables	Balanced		
	Number of jumps done by defender		
	Senior vs U19 ^a	1.14	1.05 - 1.24**
	U21 vs U19 ^a	1.09	1.01 - 1.18*
	Senior vs U21 ^a	1.05	0.98 - 1.12
	Moderate Balanced		
	Number of jumps done by defender		
	Senior vs U19 ^a	1.00	0.86 - 1.16
	U21 vs U19 ^a	0.82	0.66 - 1.02
	Senior vs U21 ^a	1.21	1.01 - 1.46*
Number of jumps done by blocker			
Senior vs U19 ^a	1.12	1.00 - 1.25*	
U21 vs U19 ^a	1.14	1.01 - 1.28*	
Senior vs U21 ^a	0.99	0.92 - 1.06	

*p < 0.05, ** p < 0.01,^aReference category; OR=odds ratio; CI=confidence intervals.

Discussion

The aim of this paper was to assess the effects of age groups (U19, U21 and senior) and players' role (blocker vs. defender specialist) in BV in relation to physical and temporal variables, considering the quality of opposition. Overall, when the quality of opposition was not considered, results showed that the temporal (duration of set and total rest time) and physical characteristics (number of jumps done by defenders) significantly increased from the U19 to senior category. The pattern of the physical and temporal variables in the U19 category shows differences when compared with the senior and U21 categories; whereas, the pattern between senior and U21 categories is similar. Although the duration of the rally and the rest time between rallies remained unchanged in all the categories, the increase of the set duration in the senior category was due to a significant increase in total rest time and a slight increase in total work time of players in this category. This suggests that the more

experienced players can manage better the effort throughout the game, adopting recovery strategies (such as moving sand, cleaning glasses, communicating with partners, etc.) among them. Therefore, the aspect that differentiates senior players from players of younger categories (U19 and U21) might be their ability to manage their rest periods.

In all age groups (U19, U21 and senior category), blockers did significantly more jumps than defenders specialist. This result is due to the different players' roles and therefore, the players need an individualized training of strength and conditioning according to the demands of the game. In senior categories, the defender specialist did significantly more hits than blocker, showing that the tendency of the participation in the attack by the defender specialist, is higher than the blocker. These findings can be related to the serve being directed to the defender specialist due to their lower height (Palao et al., 2008), trying to increase the changes of defense of the serving team, which seems to be strategically better according to the present study.

When the quality of opposition was considered, results showed that there was an interaction between age groups with the temporal (rest time between rallies) and physical (number of jumps done by defenders and blockers) variables. The results showed that in unbalanced games, this quality of opposition has not interfered in the studied variables. This may be due to the unbalance in these games, independently of the age group (U19, U21 and senior), where the teams adopt different strategies (technical and tactical) that were not observed in this study, as found by Marcelino et al. (2011) in indoor volleyball. The authors reported that the teams adopt riskier decisions when the games are more unbalanced and choose for safer tactical options when the games are more balanced. However, as this study includes a small number of matches in this quality of opposition (unbalanced), no solid conclusions can be obtained from analyzing possible differences in some variables between age groups. Furthermore, future studies are needed to clarify this aspect.

In balanced and moderate balanced games, results showed significant differences in rest time between rallies and number of jumps done by defenders

and blockers between age groups. In relation to rest time between rallies, in the senior category, the athletes adopted a different strategy to control the effort when compared with the younger categories (U19 and U21). The average rest time between rallies in the senior category (23 seconds) is three seconds longer than the U21 category (20 seconds) and four seconds more than the U19 category (19 seconds). The high-intensity and short recovery periods, would suggest that beach volleyball players require well-developed creatine phosphate and glycolytic energy systems as well as reasonably well-developed oxidative capabilities (Arruda and Hespanhol, 2008; Magalhães et al., 2011). Indeed, the senior players may be more evolved tactically, using recovery strategies in order to better manage effort and create new strategies for the next rally. However, there is no scientific evidence showing a decrease in performance during the game caused by a shorter rest time between rallies, emphasizing the need for future research on this thematic.

The evolution of strategic game is also seen in the number of jumps done by the defenders. This is supported by the increase in the number of jumps done by the defenders in the senior category compared with the U19 category. In the senior category, as the players may be tactically more evolved, they tend to serve more often to defender specialist players in order to increase their defense options of the serving team. Therefore, defender specialist players may perform more side-out attacks, contributing for a higher total number of jumps during the game. In essence, these findings suggest that in the balanced games the teams are strategically more evolved and provide all the resources to gain advantage over opponents. Moreover, the training prescription for BV should take into account the player role (defenders and blockers) in each age group.

This study suggests that in BV, the behavior of some physical variables undergo changes according to age group and players' role in different qualities of opposition. Furthermore, the changes in strategy of teams according to the quality of opposition provide a deeper understanding on game performance, contributing new ideas for practice, competition and research.

Conclusion

This study emphasizes the need for a deeper look into the performance of sports, considering the interaction between the quality of opposition and the age group of the teams. The analysis of the temporal and physical characteristics showed their interference on teams' performance considering the age group and quality of opposition, where the senior players take advantage by varying their effort and strategies. Particularly, our results might have helped to reveal the need to explore the differences between age groups, player role and change in strategy in younger categories when the games are performed between balanced and moderately balanced teams. Nevertheless, our results evidenced that senior players (defender and blockers) perform more jumps and have more rest time between rallies than younger players. From a practical point of view, coaches should be aware that in senior categories, the sets are longer and a higher number of jumps is done by players; Moreover, the need of training according to the physical and temporal demands of the game; Thus, it is important to develop recovery strategies (such as moving sand, cleaning glasses, communicating with partners, etc.) in order to compete better. This aspect must be included in the training of players in earlier age stages. The player role is another aspect to be taken into consideration during the training by strength and conditioning coaches. The results of this study give reference values that can be useful to guide physical training and specific training and to create scenarios that resemble a competition, taking into account the physical and temporal characteristics according to player role.

KEY POINTS

- Players roles, quality of oposition, and competitive level of the teams influence physical and temporal characteristics, and they may be taken into consideration during the training by strength and conditioning coaches and coaches.
- More experienced players adopt strategies to better manage their effort and rest time between rallies.
- The game strategy affects the physical actions done by players (e.g. tendency to serve more to one player of the team affects the number of jumps performed by this player).

References

- Abdelkrim, B., Chaouachi, A., Chamari, K., Chtara, M., & Castagna, C. (2010). Positional role and competitive-level differences in elite-level men's basketball players. *Journal of Strength & Conditioning Research*, 24 (5), 1346-1355.
- Alves, R., Robles, C., Pasqua, L. , Artioli, G., Roschel, H., Solis, M., Tobias, G., Klansener, C., Bertuzzi, R., Franchini, E., Junior, A. , & Gualano, B. (2012). Anthropometric, physiological, performance, and nutritional profile of the Brazil National Canoe Polo Team. *Journal of Sports Sciences*, 30 (3), 305-311.
- Anguera, M. (1991). Manual de prácticas de observación [Manual observation practices] (3 ed.).Trillas; México.
- Anguera, M. . (2003). Observational methods (general). In: *Encyclopedia of Psychological Assessment*. Ed: R. Fernández-Ballestores. Sage; London.
- Arruda, M., & Hespanhol, J. (2008). *Physiology of volleyball*. Phorte; São Paulo.
- Atkinson, G., & Nevill, A. (1998). Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sport Medicine*, 26 (4), 217-238.

Behar, J. (1993). Sesgos del observador. In: *Metodología observacional en la investigación psicológica [Observational methodology in psychological research]*. Ed: M. Anguera. Barcelona: Promotions and publications University

Bland, J., & Altman, D. (1986). Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*, 8 (8476), 307-310.

Bland, J., & Altman, D. (2010). Statistical methods for assessing agreement between two methods of clinical measurement. *International Journal of Nursing Studies*, 47 (8), 931-936.

Cronin, J., Jones, J., & Hagstrom, J. (2007). Kinematics and kinetics of the seated row and implications for conditioning. *Journal of Strength and Conditioning Research*, 21 (4), 1265-1270.

Giatsis, G., & Papadopoulou, S. (2003). Effects of reduction in dimensions of the court on timing characteristics for men's beach volleyball matches. *International Journal of Volleyball Research*, 6 (1), 6-9.

Giatsis, G., Zetou, E., & Tzetzis, G. (2005). The effect of rule changes for the scoring system on the duration of the beach volleyball game. *Journal of Human Movement Studies*, 48 (1), 15-23.

Girard, O., Chevalier, R., Hairard, M., Sciberras, P., Hot, P., & Millet, G. (2007). Game analysis and energy requirements of elite squash. *Journal of Strength and Conditioning Research*, 21 (3), 909-914.

Harley, J., Barnes, C., Portas, M., Lovell, R., Barrett, S., Paul, D., & Weston, M. (2010). Motion analysis of match-play in elite U12 to U16 age-group soccer players. *Journal of Sports Sciences*, 28 (13), 1391-1397.

Homberg, S., & Papageorgiou, A. (1994). *Handbook for beach volleyball*. Meyer & Meyer Verlag.

James, N., Taylor, J., & Stanley, S. (2007). Reliability procedures for categorical data in Performance Analysis. *International Journal of Performance Analysis in Sport*, 7 (1), 1-11.

- Lago, C. (2009). The influence of match location, quality of opposition, and match status on possession strategies in professional association football. *Journal of Sports Sciences*, 27 (13), 1463–1469.
- Landau, S., & Everitt, B. . (2004). *A handbook of statistical analysis using SPSS*. London: Chapman & Hall/CRC Press.
- Laudner, K., Moore, S., Sipes, R., & Meister, K. (2010). Functional hip characteristics of baseball pitchers and position players. *American Journal of Sports Medicine*, 38 (2), 383-387.
- Magalhães, J., Inácio, M., Oliveira, E., Ribeiro, J., & Ascensão, A. (2011). Physiological and neuromuscular impact of beach-volleyball with reference to fatigue and recovery. *Journal of Sports Medicine & Physical Fitness*, 51, 66-73.
- Marcelino, R., Mesquita, I., & Sampaio, J. (2010). Efficacy of the volleyball game actions related to the quality of opposition. *The Open Sports Sciences Journal*, 3, 34-35.
- Marcelino, R., Mesquita, I., & Sampaio, J. (2011). Effects of quality of opposition and match status on technical and tactical performance in elite volleyball. *Journal of Sports Sciences*, 29 (7), 733-741.
- Marcelino, R., Sampaio, J. , & Mesquita, I (2012). Attack and serve performances according to the match period an quality of opposition in elite volleyball matches. *Journal of Strength and Conditioning Research*, 26 (12), 3385-3391.
- Matthew, D., & Delextrat, A. (2009). Heart rate, blood lactate concentration, and time–motion analysis of female basketball players during competition. *Journal of Sports Sciences*, 27 (8), 813–821.
- Mesquita, I., & Marcelino, R. (2013). O efeito da qualidade de oposição e do match status no rendimento das equipas [The effect of the quality of opposition and match status on teams of performance]. In: *Fundamentos e aplicações em análise do jogo [Fundamentals and applications in game analysis]*. Ed: A. Volossovitch & A. Ferreira (Eds.): Lisbon: Faculty of Human Motricity.

Miguel-Ángel, G., Lago, C., & Pollard, R. (2013). Situational variables. In: *Routledge handbook of sports performance analysis*. Ed: T. McGarry, P. O. Donoghue & J. Sampaio (Eds.): Routledge.

Miller, T., White, E., Kinley, K. , Congleton, J. , & Clark, M. . (2002). The effects of training history, player position, and body composition on exercise performance in collegiate football players. *Journal of Strength and Conditioning Research*, 16 (1), 44-49.

Ntoumanis, N. (2001). A step-by-step guide to SPSS for sport and exercise studies.

O'Donoghue, P., & Mayes, A. (2013). Performance analysis, feedback and communication in coaching. In: *Routledge handbook of sports performance analysis*. Ed: T. McGarry, P. O' Donoghue & J. Sampaio (Eds.): Routledge.

O'Donoghue, P., Mayes, A., Edwards, K., & Garland, J. (2008). Performance Norms for British National Super League Netball. *International Journal of Sports Science & Coaching*, 3 (4), 501-511.

Palao, J., Gutiérrez, D., & Frideres, J. E. (2008). Height, weight, body mass index, and age in beach volleyball players in relation to level and position. *Journal of Sports Medicine & Physical Fitness*, 48 (4), 466-471.

Palao, J., & Manzanares, P. (2009). Manual del instrumento de observación de las técnicas y la eficacia en voley-playa (TEBEVOL) VERSIÓN 1.0. <https://sites.google.com/site/tebevol/>. [Manual for observation instrument of techniques and efficacy in beach-volleyball]. Murcia, Spain.

Palao, J., Valades, D. , Manzanares, P., & Ortega, E. . (2013). Physical actions and work-rest time in men's beach volleyball. *Revista Motriz de Educação Física, in press*.

Palao, J., Valades, D., & Ortega, E. (2012). Match duration and number of rallies in men's and women's 2000-2010 FIVB World Tour Beach Volleyball. *Journal of Human Kinetics*, 34, 99-104.

Pérez-Turpin, J.A., Cortell-Tormo, J.M., Chinchilla-Mira, J.J., Cejuela-Anta, R., & Suárez-Llorca, C. (2008). Analysis of jump patterns in competition for elite male Beach Volleyball players. *Int J Perform Anal Sport*, 8, 94-101.

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

Sheppard, J., Gabbett, T. , & Stanganelli, L. . (2009). An analysis of playing positions in elite men`s volleyball: considerations for competition demands and physiologic characteristics. *Journal of Strength and Conditioning Research*, 23 (6), 1858-1866.

Smekal, G., Duvillard, S., Rhacek, C., Pokan, R., Hofmann, P., Baron, R., Tschan, H., & Bachl, N. (2000). A physiological profile of tennis match play. *Physical Fitness and Performance*, 999-1005.

Taylor, J., Mellalieu, S., James, N., & Shearer, D. (2008). The influence of match location, quality of opposition, and match status on technical performance in professional association football. *Journal of Sports Sciences*, 26 (9), 885-895.

Tili, M., & Giatsis, G. (2011). The height of the men`s winners FIVB Beach Volleyball in relation to specialization and court dimensions. *Journal of Human Sport & Exercise*, 6 (3), 504-510.

ACKNOWLEDGMENTS: This research was supported by CAPES (Brazilian Ministry of Education), Doctoral grants program (BEX 0688/12-6/2012-2014).

3.2. Estudo Empírico 2

Effects of technique, age and player's role on serve and attack efficacy in high level beach volleyball players

Medeiros, A.¹, Mesquita, I.¹, Marcelino, R.², Palao, J.³

¹ Centre of research, education, innovation and intervention in Sport (CIFI2D), Faculty of Sport, University of Porto.

² University of Trás-os-Montes e Alto Douro. Research Center in Sport, Health and Human Development (CIDESD). Vila Real. Portugal.

³ University of Murcia. Faculty of Sport Sciences. Murcia. Spain.

Artigo aceite para publicação na revista International Journal of Performance Analysis in Sport.

Abstract

The aim of the present study was to assess effects of technique of execution, age and player's role on serve and attack efficacy. A total of 1.100 serves and 1.165 attacks from under-19, 927 serves and 1.015 attacks from under-21, and 1.564 serves and 1.854 attacks from senior were assessed through video match analysis. Techniques considered for serve were standing serve (SS), jump serve (JS) and float jump serve (FJS); and for attacks were spike and shot. All players were analysed according to their role (defenders or blockers). Results showed that defenders in under-19 and under-21 had better efficacy using SS and FJS, while in senior category the best efficacy was obtained through JS and FJS. Blockers had better efficacy using SS and FJS in all categories. The attack efficacy seems to be independent of player role, although it is related to technique and age. While in senior category attack efficacy was similar using spike and shot, in younger categories it was slightly higher when using spike. This study suggests that serve and attack present different efficacy profiles when considered the technique of execution, player role and age, and therefore it should be considered when planning training programs for teams throughout different phases of athlete development.

Keywords: Match analysis, age group, performance.

1. Introduction

In recent years, research in performance analysis on beach volleyball (BV) has significantly increased (Mesquita *et al.*, 2013). In most instances, these studies have focused on biomechanical (Tilp *et al.*, 2008; Buscà *et al.*, 2012), physical (Medeiros *et al.*, 2014; Palao *et al.*, 2014; Riggs and Sheppard, 2009) and, technical and tactical indicators (Koch and Tilp, 2009; Lopez-Martinez and Palao, 2009; Mesquita and Teixeira, 2004; Yiannis, 2008). These studies have often been used with the purpose of providing thorough information on features, patterns, and specificities of teams' behaviours within competitive contexts, providing valuable data for guiding practice and research alike.

The technical and tactical indicators have often been analysed from match analysis (Hughes and Franks, 2004). Research has focused, especially, on the impact of rule changes (reduction of court size and the adoption of a rally score system) in these indicators (Giatsis and Papadopoulou, 2003; Giatsis and Tzetzis, 2003; Giatsis, 2003; Giatsis *et al.*, 2003; Ronglan and Grydeland, 2006). Among the game actions studied, serve and attack have been highlighted due to their influence on the final outcome, since these game actions have a greater influence on points obtained by teams (Giatsis and Tzetzis, 2003; Michalopoulou *et al.*, 2005). These studies showed that the outcome of a BV game is affected by the efficacy of the two game actions, serve and attack.

Several studies in BV conducted on these variables (serve and attack) have only been addressed to senior teams playing at the highest levels, showing scarcity of research with younger age groups. Some researchers (Buscà *et al.*, 2012; Jiménez-Olmedo *et al.*, 2012; Koch and Tilp, 2009; Lopez-Martinez and Palao, 2009) found that the jump serve is most used in male games. Furthermore, López-Martinez and Palao (2009) concluded that although the jump serve was the most used and most effective by male players, it was also the one that showed more error in its execution. In relation to the attack, the spike was the most effective technique and the most used by male players (Koch and Tilp, 2009; Mesquita and Teixeira, 2004; Yiannis, 2008). Nevertheless, these studies did not consider the player role (defender and blocker). In team sports, studies from match analysis have been recently considering player role as it can present different performance profiles (Abdelkrim *et al.*, 2010; Laudner *et al.*, 2010; Matthew and Delextrat, 2009; Rocha and Barbanti, 2007; Sheppard *et al.*, 2009). In BV, although these players (defenders and blockers) present distinct functions in defence, all have to serve and attack. Thus, the role performed by the player in defence can influence the efficacy and technique of execution of the serve and attack. Moreover, due to variations in performance characteristics across age groups (Harley *et al.*, 2010), the study of efficacy should consider the technique of execution, age and player role.

To the best of our knowledge, only one study in BV analysed physical performance of players taking into account player role (defenders and blockers) and age. Medeiros et al., (2014) found that the number of jumps performed by defenders and blockers demonstrates different profiles according to age groups. Thus, according to these authors, player role and competitive level of teams influence physical characteristics, and they should be taken into consideration during training by coaches and strength and conditioning coaches.

In this sense, the study of serve and attack efficacy considering the technique of execution, age and player role at the same time, can provide reference values that may help coaches to adjust training programs and objectives to competitions. Moreover, it can offer new insights to design training programs for long-term athlete development. Therefore, this study can give fruitful insights to optimize the preparation process of teams and assist in developing concepts and strategies capable of increasing players' and teams' efficacy. Thus, the aim of the present study was to assess serve and attack efficacy according to the technique of execution and player's role (blocker vs. defender specialist) in under-19, under-21 and senior male BV players

2. Methods

2.1. Sample and variables

The study sample consisted of 1.100 serves and 1.165 attacks (30 sets of 15 matches) from under-19 (U19), executed by 32 players; 927 serves and 1.015 attacks (24 sets of 12 matches) from under-21 (U21), executed by 30 players; and 1.564 serves and 1.854 attacks (40 sets of 20 matches) from senior (senior), executed by 46 players. Actions were collected from their respective World Championships (season 2010 and 2011). All competitions were organized by FIVB (Fédération Internationale de Volleyball). Only actions from first and second sets of the matches were observed. The studied variables are part of the observation instrument (Manual for observation instrument of techniques and efficacy in beach volleyball - TEBEVOL) designed and validated

by Palao and Manzanares (2009). The analyzed variables were the following: serve efficacy (Standing Serve - SS, Jump Serve - JS and Float Jump Serve - FJS) and attack efficacy (spike and shot). Serve and attack efficacy was assessed in a gradual 5-point scale, 0 represents a mistake and 4 represents a point, as described by Palao and Manzanares (2009). With the categories of serve and attack, the performance coefficient was calculated (sum of attempts per category multiplied by the value of the category and divided by total attempts). These variables were studied to describe the efficacy carried out by different age groups, according to player role (defender and blocker). A player was categorized as a defender when he participated less than 20% of the times in a block (Tili and Giatsis, 2011).

2.2. Procedures

The analysed sets were recorded using a digital video camera, which was positioned at the grandstand at a distance of approximately ten meters from the baseline to have a frontal view in order to show the full court.

To guarantee reliability of the observations, intra- and inter-observer agreements were assessed via percentage error method (Hughes *et al.*, 2004; James *et al.*, 2007). After a 3-week period of original observations, to avoid any learning effect, the observer reanalysed 14 random sets (14.9% of total analysed sets). For inter-observer reliability testing, another observer analysed 12 random sets (12.7% of total analysed sets) that had previously been analysed by the original observer. The reliability values obtained were <5% error. Observations were done by an observer who was trained during three sessions of two hours each following the criteria established by Anguera (1991; 2003) and Behar (1993). The observer had a Master's in high performance training with specialization in BV and had been a BV coach in high competition level for ten years.

2.2. Statistical analysis

Data were analysed for practical significance using magnitude-based inferences (Hopkins *et al.*, 2009). This qualitative approach was used due to the fact that traditional statistics do not often indicate the magnitude of an effect, which is typically more relevant to athletic performance than any statistically significant effect (Buchheit and Mendez-Villanueva, 2013). Differences between attack efficacy in relation to technique (spike vs. shot) and serve efficacy (SS vs. FJS, SS vs. JS and, JS vs. FJS) were assessed via standardized mean differences (SMD), computed with pooled variance, and respective 95% Confidence Intervals (95% CI) (Cohen, 1988). Magnitude thresholds for difference in a mean were described using the following scale: 0-0.2 trivial, >0.2-0.6 small, >0.6-1.2 moderate, >1.2-2.0 large, and >2.0 very large (Hopkins, 2010). If the 95% confidence intervals overlapped small positive and negative values, the magnitude was deemed to be the observed magnitude (Hopkins *et al.*, 2009). Additional meta-analysis was also conducted to assess whether U19, U21, senior, defender and blocker players change from SS to JS, SS to FJS, JS to FJS and spike to shot across the analysed different spatial areas (see figures 1 and 2). Summary measures were calculated using random-effects models that consider both within-analysis and between-analysis variations (Cumming, 2013b). All statistical computations were performed using the software ESCI (Exploratory Software for Confidence Intervals) (Cumming, 2013a).

3. Results

The descriptive analysis (mean \pm standard deviation) of serve (SS, JS and FJS) and attack efficacy (spike and shot) according to age group and player role is presented in Table 1. The SMD in serve (SS vs. JS, SS vs. FJS and FS vs. FJS) and attack efficacy (spike vs. shot) in relation to the technique are represented in figures 1 (items a, b and c) and 2, in which the shaded areas indicate thresholds of the observed magnitude effects between game variables.

Table 1. Descriptive analyze of serve and attack efficacy according to player role and age group (mean±stand. deviation).

Variable	Defender						Blocker					
	U19		U21		Senior		U19		U21		Senior	
	%	Efficacy	%	Efficacy	%	Efficacy	%	Efficacy	%	Efficacy	%	Efficacy
Serve												
Standing serve	21.6	1.86±0.80	28.6	1.87±0.78	6.2	1.30±1.08	31.3	1.61±0.61	18.5	1.64±0.77	27.2	1.85±0.77
Jump serve	43.6	1.60±0.67	34.7	1.57±0.61	33.9	1.67±0.66	19.9	1.47±0.88	20.5	1.27±0.82	19.1	1.45±0.93
Float jump serve	34.7	1.77±0.41	36.7	1.76±0.47	59.9	1.90±0.41	48.8	1.74±0.53	60.9	1.82±0.48	53.7	1.84±0.41
Total occurrence	n=573		n=479		n=803		n=527		n=448		n=761	
Attack												
Spike	38.4	2.78±1.33	40.0	2.78±1.40	46.2	2.63±1.21	34.9	2.67±1.38	39.1	2.78±1.35	49.1	2.68±1.36
Shot	61.6	2.52±1.15	60.0	2.48±1.17	53.8	2.65±1.14	65.1	2.58±1.14	60.9	2.46±1.21	50.9	2.55±1.16
Total occurrence	n=544		n=545		n=989		n=621		n=470		n=865	

In relation to analysis of serve, especially in senior category, a small difference was observed between the efficacy of SS and JS (figure 1, item a) for defenders (better efficacy of JS) and blockers (better efficacy of SS). Meta-analysis revealed a small difference between the efficacy of SS and JS (See figure 1, item a) only for blockers. The differences presented indicated that, in this group (blocker), the players have better efficacy using the SS when compared to JS.

For senior category, a moderate difference was observed between the efficacy of SS and FJS for defenders (figure 1, item b). Meta-analysis did not reveal differences between the efficacy of SS and JS (See figure 1, item b) in all the groups.

A moderate difference was observed between the efficacy of JS and FJS for blockers in U21 category and, for defenders and blockers in senior category (See figure 1, item c). Meta-analysis revealed a small difference between the efficacy of JS and FJS (figure 1, item c) for U21, senior and blocker. The differences presented indicated that, in these three groups (U21, senior and blocker), players have better efficacy using FJS when compared to JS.

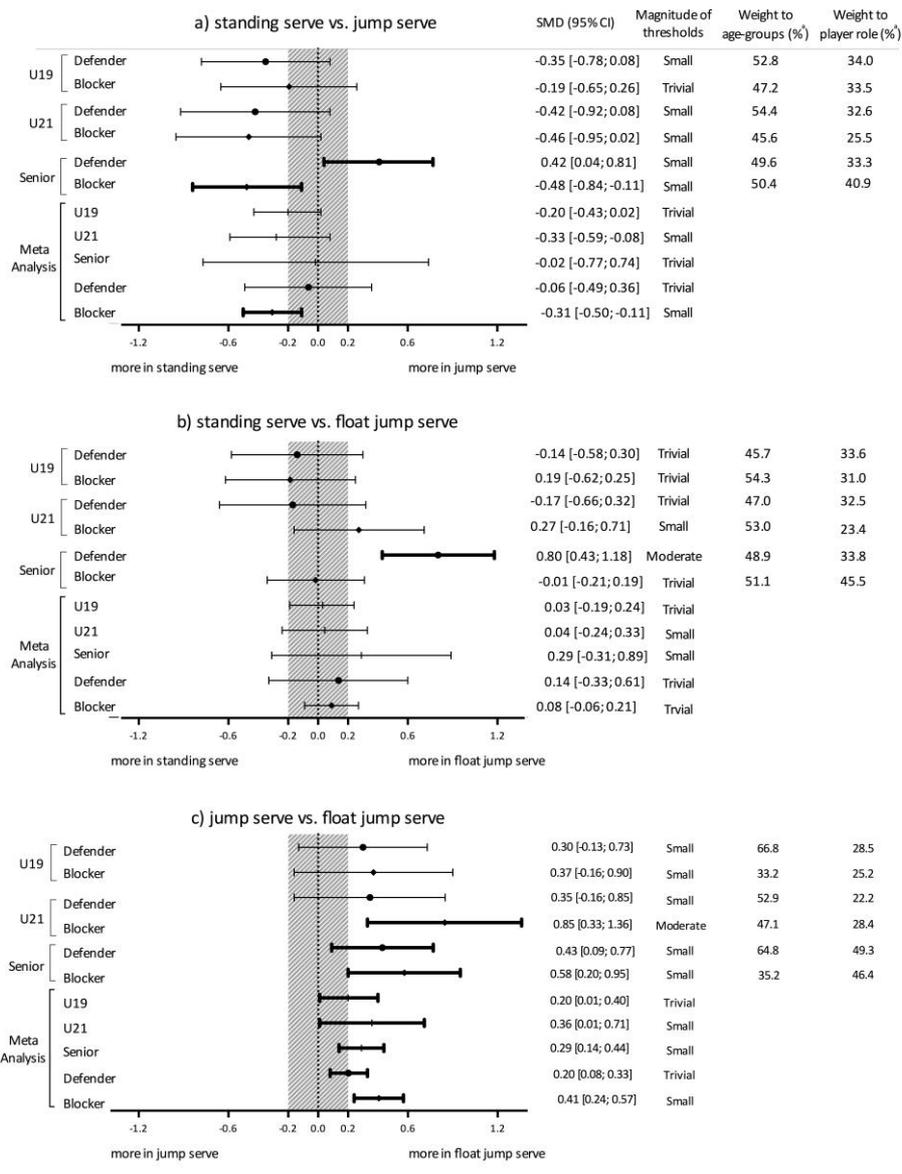


Figure 1. Standardized mean difference and meta-analysis assessing the serve efficacy in relation to the technique (SS vs. JS, SS vs. FJS, and JS vs. FJS) and player role (defender and blocker).

^aWeights are from random-effects analysis.

Abbreviation: SMD = standardized mean difference.

The shaded area represents the smallest (trivial differences) worthwhile change (see “Methods”).

Results showed that attack efficacy were not different according to technique (spike vs. shot) (figure 2), although defenders and blockers from younger categories (U19 and U21) showed a slightly higher efficacy with the spike. There was only an exception revealed in the meta-analysis showing a small difference between the efficacy of spike and shot (figure 2) for U21. The difference presented indicated that in this group players have better efficacy using spike when compared to shot.

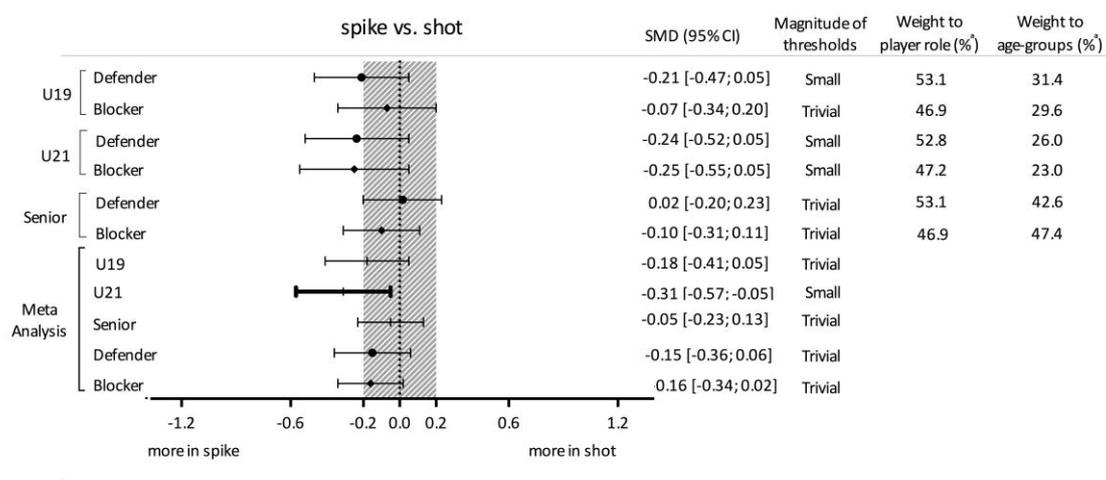


Figure 2. Standardized mean difference and meta-analysis assessing the attack efficacy in relation to the technique (spike vs. shot) and player role (defender and blocker).

^aWeights are from random-effects analysis.

Abbreviation: SMD = standardized mean difference.

The shaded area represents the smallest (trivial differences) worthwhile change (see “Methods”).

4. Discussion

The study aimed to assess the serve and attack efficacy according to the technique of execution and player’s role (blocker vs. defender specialist) in U19, U21 and senior male BV players. Overall, findings showed that serve efficacy varies according to the techniques used, player role and players’ age. On the other hand, the attack efficacy seems to be independent of the player role, although it is related to the technique of execution and players’ age.

Relatively to the serve, the FJS was the most used by defenders and blockers in all categories, with the exception of defenders in U19 category, where JS presented the highest frequency. These findings show that players used more serves that create greater difficulties in opponent's reception through ball fluctuation (i.e. FJS) (Takeshi *et al.*, 2010) or directions of the ball to specific zones of the court. Differences were found in efficacy according to the technique of execution between defenders and blockers in different categories. The blockers from all categories had better efficacy using SS and FJS. This could be due to their higher height (Palao *et al.*, 2008) that allows them a better angle incidence in the opponent court with ball fluctuation and not requiring an additional physical load that could affect their next actions (i.e. block).

For defenders, regardless of the category, players had better efficacy using FJS. However, while in younger categories there were also better efficacies using SS, seniors had better efficacies using JS. Since younger players do not evaluate properly the risk of their actions, until they accumulate experience, they use the serves (i.e., SS and FJS) that allow more balance between point and error and, consequently, more chance to achieve success.

Previous studies showed that the JS was the most used and most effective serve in men's BV (Buscà *et al.*, 2012; Jiménez-Olmedo *et al.*, 2012; Koch and Tilp, 2009; Lopez-Martinez and Palao, 2009). These differences may be related to the fact that these studies did not consider the player role, which can influence the results due to the technical and tactical strategies adopted by the players that are dependent on their role and physical demands. Although there is no empirical evidence, the change in the type of ball in 2009 may have also affected its fluctuation and thereby the efficacy of the different techniques. Future studies in BV should consider the analysis of the ball fluctuation in different types of serve as well as its influence with efficacy, considering the player role.

Regarding the attack, defenders and blockers in U19 and U21 categories had a slightly better efficacy using the spike; whereas in senior category, there was equilibrium of the players' efficacy between spike and shot. This may be

because the more experienced players (senior) are strategically more evolved and make use of all the resources to gain advantage over opponents. Despite some studies in senior competitions having shown that the spike was the most effective technique (Koch and Tilp, 2009; Mesquita and Teixeira, 2004; Yiannis, 2008) they favoured the use of percentages as a measure of evaluation, which might not be suitable to identify the relationship between points earned, points lost or total attempts. As a result, to obtain this information it is necessary to refer to values of performance coefficients (Coleman *et al.*, 1969) that consider all executions done in this calculation, thus providing more qualitative information in sports performance (Marcelino *et al.*, 2010), as the one used in this study. Further research should emphasize the use of performance coefficient in order to provide more reliable and helpful information about players and teams performance.

Results showed different patterns on the technique used to perform the attack throughout different age groups, from an imbalance use of shot and spike in younger categories to a balanced use in seniors. The greater use of shot in U19 and U21 may be related to the players' ability to control the ball or their fatigue. Moreover, the balance between the use of spike and shot in the senior category could be due to the fact that these players are more tactically evolved and, therefore use more resources to gain advantage over opponents. Our results do not corroborate with previous studies (Koch and Tilp, 2009; Mesquita and Teixeira, 2004; Yiannis, 2008), which showed a higher use of spike by senior players. These differences can be the result of the game evolution in need for more tactical demands in order to manage the risk through technical variability, requiring further research to confirm this tendency.

In brief, serve efficacy showed to be more dependent on player role than attack efficacy. Indeed, serve efficacy undergoes changes according to the technique of execution, player role and age of players. On the other hand, attack efficacy seems to be independent of the player role, although it is related to the technique of execution and category. These findings allow a deeper understanding on game performance, particularly about the need to consider the specificity of game action to plan and design training programs. Thus, serve

and attack should be trained taking into account the players' role throughout their development, in order to perform the technique that can lead them to achieve a better performance in the game. Moreover, further studies are needed to contextualize the conditions where the players' executions are performed (e.g. wind, momentum or quality of opposition), as in BV these factors can affect game performance.

5. Acknowledgements

This research was supported by CAPES (Brazilian Ministry of Education), Doctoral grants program (BEX 0688/12-6/2012-2014).

6. References

- Abdelkrim, B., Chaouachi, A., Chamari, K., Chtara, M., Castagna, C. (2010). Positional role and competitive-level differences in elite-level men's basketball players. *Journal of Strength & Conditioning Research*, 24(5), 1346-1355.
- Anguera, M. (1991). *Manual de prácticas de observación [Manual observation practices]* (3 ed.). Trillas; México.
- Anguera, M. . (2003). Observational methods (general). In R. Fernández-Ballesteros (Ed.), *Encyclopedia of Psychological Assessment* (Vol. 2). Sage; London.
- Behar, J. (1993). Sesgos del observador. In M. Anguera (Ed.), *Metodología observacional en la investigación psicológica [Observational methodology in psychological research]* (Vol. 2). Barcelona: Promotions and publications University
- Buchheit, M., Mendez-Villanueva, A. (2013). Supramaximal intermittent running performance in relation to age and locomotor profile in highly-trained young soccer players. *Journal of Sports Sciences*, 31(13), 1402-1411.
- Buscà, Bernat, Moras, Gerard, Peña, Javier, Rodríguez-Jiménez, Sergio. (2012). The influence of serve characteristics on performance in men's and women's high-standard beach volleyball. *Journal of Sports Sciences*, 30(3), 269–276.

Cohen, J. . (1988). *Statistical power analysis for the behavioral sciences* (2 ed.): Hillsdale, NJ: Lawrence Erlbaum Associates.

Coleman, J. E., Neville, B., Gordon, B. (1969). A statistical system for volleyball and its use in Chicago Women's Assn. *International Volleyball Review*, 17, 72-73.

Cumming, G. (2013a). *The new statistics: Estimation for better research*. Retrieved from <http://www.thenewstatistics.com>.

Cumming, G. (2013b). *The new statistics: why and how*. *Association for psychological science*, 1-21.

Federation Internationale de Volleyball. (2012). *FIVB official volleyball rules 2013-2016*. Retrieved 10/07/2014, from <http://www.fivb.org/EN/BeachVolleyball/Rules/rules.htm>.

Giatsis, G., Papadopoulou, S. (2003). Effects of reduction in dimensions of the court on timing characteristics for men's beach volleyball matches. *International Journal of Volleyball Research*, 6(1), 6-9.

Giatsis, G., Tzetzis, G. (2003). Comparison of performance for winning and losing beach volleyball teams on different court dimensions. *International Journal of Performance Analysis in Sport*, 3(1), 65-74.

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

Giatsis, George, Papadopoulou, Sophia, Dimitrov, Panagiotis, Likesas, George. (2003). Comparison of beach volleyball team performance parameters after a reduction in the court's dimensions. *International Journal of Volleyball Research*, 6(1), 1-5.

Harley, J., Barnes, C., Portas, M., Lovell, R., Barrett, S., Paul, D., Weston, M. (2010). Motion analysis of match-play in elite U12 to U16 age-group soccer players. *Journal of Sports Sciences*, 28(13), 1391-1397.

Hopkins, W. (2010). Linear models and effect magnitudes for research, clinical and practical applications. *Sport science*, 14, 49-57.

Hopkins, W., Marshall, S, Batterham, A., Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine & Science in Sports & Exercise*, 41(1), 3-12.

Hughes, M., Cooper, S., Nevill, A. (2004). Analysis of notation data: Reliability. In I. Franks & M. Hughes (Eds.), *Notational Analysis of Sport: Systems for Better Coaching and Performance in Sport* (pp. 189-204): Abingdon, United Kingdom: Routledge.

Hughes, M., Franks, I. (2004). *Notational Analysis of Sport. Systems for better coaching and performance in sport. (Second Edition ed.)*. London: Routledge.

James, N., Taylor, J., Stanley, S. (2007). Reliability procedures for categorical data in Performance Analysis. *International Journal of Performance Analysis in Sport*, 7(1), 1-11.

Jiménez-Olmedo, J., Penichet-Tomás, A., Sáiz-Colomina, S., Martínez-Carbonell, J., Jove-Tossi, M. (2012). Serve analysis of professional players in beach volleyball. *Journal of Human Sport & Exercise*, 7(3), 706-713.

Koch, C., Tilp, M. (2009). Beach volleyball techniques and tactics: a comparison of male and female playing characteristics. *Kinesiology*, 41(1), 52-59.

Laudner, K., Moore, S., Sipes, R., Meister, K. (2010). Functional hip characteristics of baseball pitchers and position players. *American Journal of Sports Medicine*, 38(2), 383-387.

Lopez-Martinez, A. B., Palao, J. M. (2009). Effect of Serve Execution on Serve Efficacy in Men's and Women's Beach Volleyball. *International Journal of Applied Sports Sciences*, 21(1), 1-16.

Marcelino, R., Mesquita, I., Sampaio, J., Moraes, J. (2010). Estudo dos indicadores de rendimento em voleibol em função do resultado do set. *Revista Brasileira Educação Física Esporte*, 24(1), 69-78.

Matthew, D., Delextrat, A. (2009). Heart rate, blood lactate concentration, and time–motion analysis of female basketball players during competition. *Journal of Sports Sciences*, 27(8), 813–821.

Medeiros, A., Palao, J.M., Marcelino, R., Mesquita, I. (2014). Physical and temporal characteristics of under 19, under 21 and senior male beach volleyball players. *Journal of Sports Science & Medicine*, (13), 658-665.

Mesquita, I., Palao, J.M., Marcelino, R., Afonso, J. (2013). Performance analysis in indoor volleyball and beach volleyball. In Tim McGarry, Peter O' Donoghue, & Jaime Sampaio (Eds.), *Routledge handbook of sports performance analysis*: Routledge.

Mesquita, I., Teixeira, J. (2004). Caracterização do processo ofensivo no voleibol de praia masculino de elite Mundial, de acordo com o tipo de ataque, a eficácia e o momento do jogo. *Revista Brasileira de Ciências do Esporte*, 26(1), 33-49.

Michalopoulou, M., Papadimitriou, K., Lignos, N., Taxildaris, K., Antoniou, P. (2005). Computer analysis of the technical and tactical effectiveness in Greek Beach Volleyball. *International Journal of Performance Analysis in Sport*, 5, 41-50.

Palao, J., Gutiérrez, D., Frideres, J.E. (2008). Height, weight, body mass index, and age in beach volleyball players in relation to level and position. *Journal of Sport Medicine & Physical Fitness*, 48(4), 466-471.

Palao, J., Manzanares, P. (2009). Manual del instrumento de observación de las técnicas y la eficacia en voley-playa (TEBEVOL) VERSIÓN 1.0. <https://sites.google.com/site/tebevol/>. [Manual for observation instrument of techniques and efficacy in beach-volleyball]. Murcia, Spain.

Riggs, Michael P., Sheppard, Jeremy M. (2009). The relative importance of strength and power qualities to vertical jump height of elite beach volleyball players during the counter-movement and squat jump. *Journal of Human Sport & Exercise*, 4(3), 221-236.

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

Ronglan, L.T., Grydeland, J. (2006). The effects of changing the rules and reducing the court dimension on the relative strengths between game actions in top international beach volleyball. International Journal of Performance Analysis in Sport, 6, 1-12.

Sheppard, J., Gabbett, T., Stanganelli, L. (2009). An analysis of playing positions in elite men's volleyball: considerations for competition demands and physiologic characteristics. Journal of Strength and Conditioning Research, 23(6), 1858-1866.

Takeshi, A., Shinichiro, I., Kazuya, S., Akihiro, H. (2010). Aerodynamics of a new volleyball. Procedia Engineering, 2, 2493-2498.

Tili, M., Giatsis, G. (2011). The height of the men's winners FIVB Beach Volleyball in relation to specialization and court dimensions. Journal of Human Sport & Exercise, 6(3), 504-510.

Tilp, Markus, Wagner, Herbert, Muller, Erich. (2008). Differences in 3D kinematics between volleyball and beach volleyball spike movements. Sports Biomechanics, 7, 386-397.

Yiannis, L. (2008). Comparison of the basic characteristics of men's and women's beach volleyball from the Athens 2004 Olympics. International Journal of Performance Analysis in Sport, 8, 130-137.

3.3. Estudo Empírico 3

Differences in performance between winning and losing in Under 19, Under 21 and Senior male beach volleyball

Medeiros, A.¹, Mesquita, I.¹, Marcelino, R.², Palao, J.³

¹ Centre of research, education, innovation and intervention in Sport (CIFI2D), Faculty of Sport, University of Porto.

² University of Trás-os-Montes e Alto Douro. Research Center in Sport, Health and Human Development (CIDESD). Vila Real. Portugal.

³ University of Murcia. Faculty of Sport Sciences. Murcia. Spain.

Artigo submetido.

Abstract

This study aimed to compare beach volleyball performance indicators between winning and losing teams in different age groups. A total of 6.095 game actions from Under-19 (U19), 5.138 game actions from Under-21 (U21), and 8.705 game actions from senior (senior) (Men's World Championships, 2010-2011) were observed using video match analysis. The variables assessed were: number of points won in complex of the game, number of points and errors by game action (serve, attack in side-out, attack in counterattack, block, and other errors); and performance coefficient of game actions (serve, reception, set in side-out, set in counterattack, attack in side-out, attack in counterattack, block, and dig). Data were analysed for practical significance using magnitude-based inferences. The three age groups presented similar game patterns. A total of 15 performance indicators of different aspects of the game differentiate winning and losing teams. This study suggests the need to consider the interaction between the different performance indicators in different age groups. The article provides a new perspective to monitor beach volleyball coaches and performance analysts, emphasizing the need of having a holistic approach for a proper understanding of game dynamics.

Keywords: Match analysis, age group, performance.

1. Introduction

Match analysis in team sports, such as beach volleyball (BV), can contribute to a better knowledge of the game and to understand its key factors (McGarry, 2009). However, the way in which technical and tactical actions are measured can give a distorted impression of a performance (Hughes & Franks, 2004). Not all game actions and phases have the same impact on the game outcome (Rodriguez-Ruiz et al., 2011). Thus, if only the way points are scored is considered, the representation of the performance indicators can be compromised because the rest of the actions of the game have not been considered in the analysis (Hughes & Franks, 2004). To properly understand

the game, information about different actions and phases must be included when team performance is analysed.

For a proper understanding of game dynamics, these performance indicators must be studied in different levels and ages (Lorenzo, Gómez, Ortega, Ibáñez, & Sampaio, 2010). The current knowledge about the influence of the performance capabilities (anthropometric, physical and psychological) between young players and senior players is well known and these players might use different strategies and tactics to win games (Gerodimos, Manou, Kellis, & Kellis, 2005; Harley et al., 2010). However, the available information is related only to senior players, showing not enough research with younger players. (Giatsis & Panagiotis, 2008; Giatsis & Tzetzis, 2003; Michalopoulou, Papadimitriou, Lignos, Taxildaris, & Antoniou, 2005). These studies concluded that the actions that best predict the game or set success in senior male BV teams were the attack (points and opponent errors) and serve. To the best of our knowledge, no study has studied the performance of the different phases. Therefore, a better knowledge of the specificities of senior and younger categories will help to understand the aspects that influence game success and its evolution through players' development process. This information can help to understand the game dynamics and guide training programs and objectives for competitions throughout long-term athlete development. Thus, the aim of the present study was to compare the beach volleyball performance indicators between winning and losing teams in different age groups (U19, U21 and senior).

2. Methods

2.1. Sample and variables

The study sample consisted of 30 sets (1.100 serves, 786 attacks in side-out, 404 attack in counterattack, 807 blocks, 900 receptions, 1.170 sets in side-out, 350 set in counterattack, 578 digs) from U19, executed by 32 players; 24 sets (927 serves, 714 attacks in side-out, 316 attack in counterattack, 722 blocks, 784 receptions, 975 sets in side-out, 255 set in counterattack, 445 digs) from

U21, executed by 30 players; and 42 sets (1.564 serves, 1.289 attacks in side-out, 588 attack in counterattack, 1.296 blocks, 1.370 receptions, 1.282 sets in side-out, 463 set in counterattack, 853 digs) from senior, executed by 46 players. Actions were collected from their respective World Championships (season 2010 and 2011). All competitions were organized by FIVB (Fédération Internationale de Volleyball).

The Ethics Committee at the Centre of Research, Education, Innovation and Intervention in Sport, University of Porto provided institutional approval for the study.

The study variables assessed were the following: total number of points won by complex of the game or game phase (K1, K2, K3, and K4); total number of points and errors by game action (serve, attack in side-out (K1), attack in counterattack (K2 + K3 + K4), block and other errors); and performance coefficient of game actions proposed by Coleman (1975) (serve, attack in side-out (K1), attack in counterattack (K2 + K3 + K4), block, reception, set in side-out (K1), set-counterattack (K2 + K3 + K4), and dig). The K1 is defined as the game phase when the team that receives the serve performs in a sequential order the actions of reception, set, and attack, while the K2 describes the situation when the opposing team performs actions of serve, block, dig, set of counterattack, and counterattack sequentially (Zetou, Moustakidis, Tsigilis, & Komninakidou, 2007; Zetou, Tsigilis, Moustakidis, & Komninakidou, 2006). The K3 or K4 designate all subsequent plays, depending on whether the team started the rally in K1 or in K2, respectively (Palao, 2004).

Only actions from the first and second sets of the matches were observed. The third set was not considered for this study, since the number of points and rallies is significantly smaller than in the previous sets. This is a consequence of the rules of the game, namely the number of points needed to win a set (Federation Internationale de Volleyball, 2012).

The studied variables are part of the observation instrument (Manual for observation instrument of techniques and efficacy in beach volleyball - TEBEVOL) designed and validated by Palao and Manzanares (2009).

2.2. Procedures

The analysed sets were recorded using a digital video camera, which was positioned at the grandstand at a distance of approximately ten meters from the baseline to have a frontal view in order to show the full court.

2.3. Reliability testing

To guarantee reliability of the observations, intra- and inter-observer agreements were assessed via the percentage error method (Hughes, Cooper, & Nevill, 2004; James, Taylor, & Stanley, 2007). After a 3-week period of original observations the observer reanalysed 14 random sets (14.9% of total analysed sets), so as to prevent from any learning effect. For inter-observer reliability testing, another observer analyzed 12 random sets (12.7% of total analysed sets) that had previously been analyzed by the original observer. The reliability values obtained were <5% error and considered acceptable for all variables recorded. Observations were done by an observer who was trained during three sessions of two hours each, following the criteria established by Anguera (1991; 2003) and Behar (1993). The observer had a Master in high performance training with specialization in BV and had been a BV coach for ten years.

3. Statistical Analyses

Data were then analysed for practical significance using magnitude-based inferences (Cumming, 2013; Hopkins, Marshall, Batterham, & Hanin, 2009). This qualitative approach was used because traditional statistical approaches often do not indicate the magnitude of an effect, which is typically more relevant to athletic performance than any statistically significant effect (Buchheit & Mendez-Villanueva, 2013). The standardized mean difference (SMD) or Cohen's *d*, computed with pooled variance and respective 95% Confidence Intervals (95% CI) (Cohen, 1988), was used to evaluate the differences in i) points by complexes of the game, ii) total of points and errors, and iii)

performance coefficients of the teams, between winning and losing teams. Thresholds values for Cohen's d statistics were 0-0.2 trivial, >0.2-0.6 small, >0.6-1.2 moderate, >1.2-2.0 large, and >2.0 very large. If the 95% CI overlapped small positive and negative values, the magnitude was deemed to be the observed magnitude (Hopkins et al., 2009).

All statistical computations were performed in RStudio (version 0.98.977) using the Package *compute.es* (version 0.2-3) (Cooper, Hedges, & Valentine, 2009).

4. Results

Table 1 presents the descriptive analysis (mean \pm standard deviation) of the total number of points won in complex of the game, total number of points and errors, and performance coefficients of the teams according to the result of the set (winners vs. losers).

Table 1. Descriptive analysis of the total number of points won in complex of the game, total number of points and errors, and performance coefficients of the teams in relation to the result of the set (winner vs. loser). Data are means (\pm SD).

		U19		U21		Senior	
		Winners	Losers	Winners	losers	Winners	Losers
Number of points in complex of the game	K1	9.34 (2.53)	8.56 (2.03)	10.92 (2.62)	9.96 (2.72)	10.45 (2.30)	10.00 (1.88)
	K2	10.00 (3.03)	4.94 (3.15)	8.31 (2.80)	4.42 (2.40)	7.91 (2.40)	4.21 (2.22)
	K3	1.44 (0.93)	1.41 (1.20)	1.46 (1.50)	1.46 (1.25)	1.55 (1.22)	1.43 (1.19)
	K4	0.75 (0.87)	1.66 (1.16)	0.65 (0.73)	1.31 (1.35)	0.96 (0.96)	1.70 (1.07)
Number of points and errors	Serve points (aces)	1.50 (1.41)	0.75 (1.00)	1.15 (1.26)	0.54 (0.75)	0.79 (0.92)	0.34 (0.61)
	Serve errors	2.63 (1.83)	2.91 (1.79)	2.19 (1.44)	2.85 (2.52)	1.96 (1.43)	2.09 (1.43)
	Attack points (side-out)	6.56 (2.56)	5.47 (2.26)	8.58 (2.80)	6.96 (2.95)	8.41 (2.24)	7.82 (2.27)
	Attack errors (side-out)	2.38 (1.14)	1.19 (1.10)	1.65 (1.41)	1.46 (1.18)	1.93 (1.39)	1.04 (1.00)
	Attack (counterattack)	4.47 (2.02)	2.25 (1.60)	3.96 (1.72)	2.00 (1.73)	3.96 (1.97)	2.52 (1.70)
	Attack errors (counterattack)	1.03 (0.95)	0.69 (1.01)	0.65 (1.17)	0.92 (1.07)	0.64 (0.89)	0.68 (0.91)
	Block points	0.97 (0.92)	0.47 (0.66)	1.58 (1.36)	0.58 (0.74)	1.45 (1.31)	0.82 (1.00)
	Block errors	1.31 (1.23)	1.13 (1.01)	1.38 (1.13)	1.85 (1.57)	1.70 (1.31)	1.43 (1.31)
Other errors	1.44 (1.14)	1.47 (1.09)	1.46 (1.55)	1.15 (0.95)	1.59 (1.57)	0.71 (1.28)	
Performance coefficients	Serve	1.56 (0.22)	1.69 (0.22)	1.52 (0.20)	1.59 (0.19)	1.49 (0.21)	1.58 (0.16)
	Attack (side-out)	2.78 (0.54)	2.26 (0.35)	2.96 (0.43)	2.45 (0.53)	2.94 (0.42)	2.54 (0.27)
	Attack (counterattack)	2.77 (0.62)	2.28 (0.68)	2.46 (0.67)	2.13 (0.55)	2.70 (0.56)	2.30 (0.63)
	Block	1.31 (1.02)	1.63 (1.01)	1.32 (0.92)	1.89 (0.97)	1.26 (0.80)	1.77 (0.82)
	Reception	2.13 (0.21)	2.03 (0.16)	2.25 (0.24)	2.16 (0.25)	2.34 (0.19)	2.21 (0.18)
	Set (side-out)	2.34 (0.28)	2.18 (0.25)	2.44 (0.19)	2.34 (0.28)	2.47 (0.22)	2.41 (0.20)
	Set (counterattack)	2.18 (0.31)	2.02 (0.45)	2.15 (0.26)	2.06 (0.18)	2.26 (0.32)	2.11 (0.31)
	Dig	1.30 (0.33)	0.90 (0.25)	1.17 (0.40)	0.89 (0.22)	1.06 (0.28)	0.90 (0.31)

K1: Complex 1, K2: Complex 2, K3: Complex 3, K4: Complex 4, side-out: K1, counterattack: K2 + K3 + K4.

The performance in K1 and K3 was the same for the teams (U19, U21, and senior) that won and lost their sets. Teams that won obtained the higher performances in K2 (with large differences compared with loser teams) and the lower performance in K4 (Figure 1, panels: a, b, c).

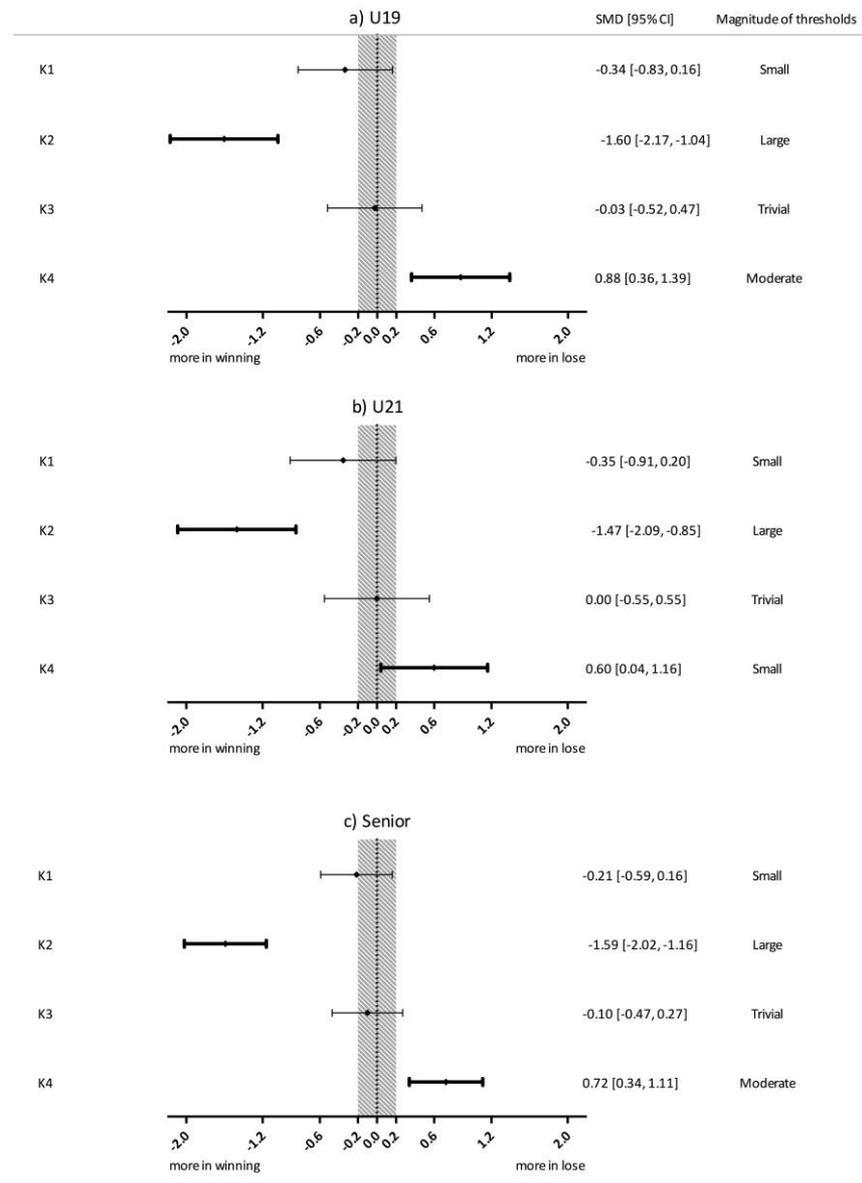


Figure 1. Standardized mean difference assessing the number of points obtained in complex of the game of teams in relation to the result of set (winning vs. lose). The Shaded area represents the smallest (trivial differences) worthwhile change (see “Methods”).

In all categories, the teams that won the sets obtained more points by serve, attack (K2, K3, and K4) and by block compared to the teams that lost the sets (Figure 2, panels: a, b, c). On the whole, in U19 and senior the teams that won the sets get more points through opponent errors in attack-K1 (Figure 2, panels: a, c), and in senior through other errors (Figure 2, panels: c).

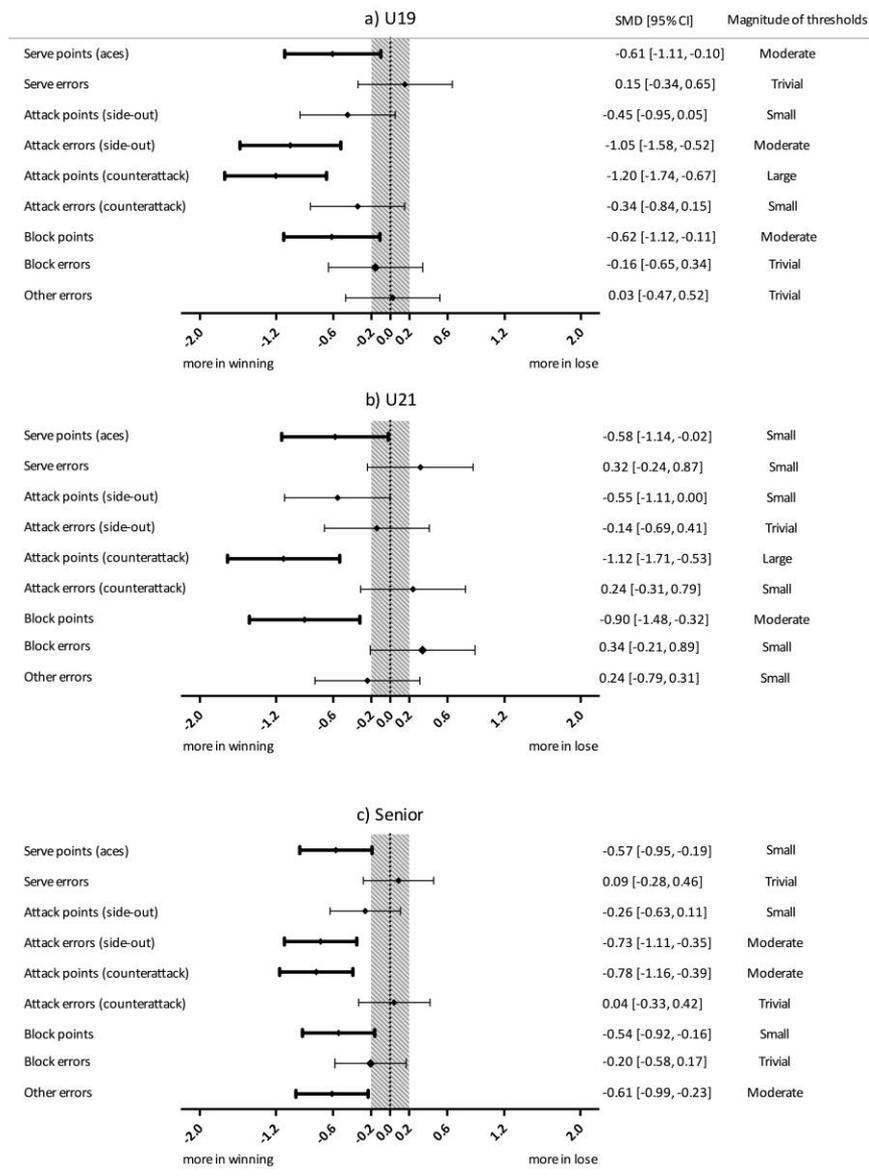


Figure 2. Standardized mean difference assessing the total number of points and errors of teams in relation to the result of set (winning vs. lose). The Shaded area represents the smallest (trivial differences) worthwhile change (see “Methods”).

When comparing the performance coefficient of game actions between winning and losing teams (figure 3), results showed higher values for winning teams in the generality of game actions, with exception for performance coefficient of serve and block. In these game actions the losing teams showed small (U19: block; U21: serve and block; senior: serve and block) to moderate (U19: serve) differences in the performance coefficient, presenting higher values in relation to winning teams.

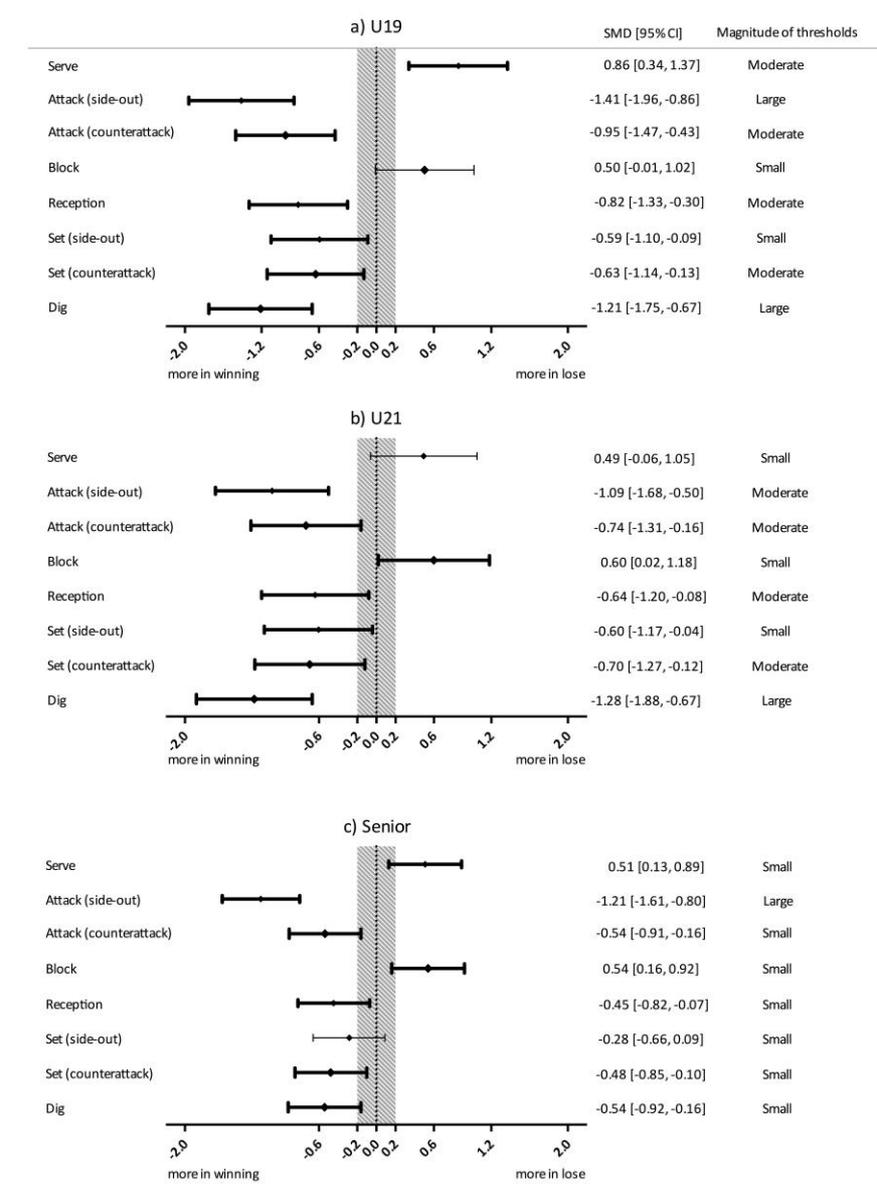


Figure 3. Standardized mean difference assessing the performance coefficients of teams in relation to the result of set (winning vs. lose). The Shaded area represents the smallest (trivial differences) worthwhile change (see “Methods”).

5. Discussion

In the present study, we compared beach volleyball performance indicators according to the final result of the sets (i.e. winning the set vs. losing the set) in different age groups (U19, U21 and Senior). The variables studied combined performance indicators regarding complex of the game (game phases), way points are obtained, and performance coefficient of game actions in order to provide a broad perspective of how sets are won by male beach volleyball teams. This approach differs from previous studies (Giatsis & Tzetzis, 2003; Michalopoulou, Papadimitriou, Lignos, Taxildaris, & Antoniou, 2005) that analysed differences between winners and losers and only considered one perspective (coefficients, efficacy percentages, or way points are obtained). These indicators have emerged in the specific literature of the modality, most often providing more substantial information on the team's performance in competition (Marcelino, Mesquita, & Afonso, 2008; Marcelino, Mesquita, Palao, & Sampaio, 2009; Marcelino, Mesquita, Sampaio, & Anguera, 2009).

Data show in the three age group studies that the game phase that differentiates winning and losing is the K2. Although the points obtained by winners in this phase reduce, as the age advances, they are the ones that make the teams win or lose the set. Winning teams achieve more points in this phase due to more serve points (aces), points from attack opponent errors (not in U21), counterattack points, block points, and points from other errors (only in seniors). These results differ from previous researches found in indoor volleyball, where the side-out phase (K1) was found to be the best predictor to win the set due to the better efficacy for teams that win the set in this game phase (Costa, Afonso, Brant, & Mesquita, 2012; Palao, 2004, 2008). These differences may be explained due to the fact that the efficacy was calculated using a percentage in these studies. In our study, winning teams have also better performance in side-out because they obtained similar points in less trials. However, the present study analyses the contribution of each phase on winning the set, where and how points are obtained. The analysis of the contribution of each phase to winning and losing the set can be misinterpreted if we consider only the efficacy of each phase (Palao, 2008), since this approach

does not allow us to know how points are obtained in each phase and their contribution to the game.

Regarding the game phase, data also show that losing teams achieved more points in K4. Therefore, losing teams, when they are in defence and rallies are long, win more rallies than winning teams by pushing harder and trying to recover the adverse scoring situation. However, due to the low number of points obtained in this game, its incidence on the game is reduced. In the sample studied, 85-90% of the points are obtained through the side-out and counterattack phase.

An evolution in the influence of the performance indicators on the game is observed through the different age group studies. Nevertheless, in senior category, the effect size of the performance indicators between winners and losers is small. Several factors can cause these differences, such as years of experience, styles of play, which reduce the differences between the teams (Gabbett & Georgieff, 2007; Sheppard, Nolan, & Newton, 2012; Zapartidis, Varelziz, Gouvali, & Kororos, 2009). Nonetheless, more studies are needed to know the cause of this reduction in differences between winners and losers considering all the aspects that affect performance (technical, physical, psychological, etc.).

In all age groups studied, we found a large quantity of performance indicators (fifteen) that differentiated winning and losing teams. Some of these performance indicators are positive and some negative. These findings confirm the proposal by Hughes and Bartlett (2002) on the need to collect enough information about the game that allows giving a broad perspective of the game. The positive performance indicators (such as points obtained in K2 phase, number of points obtained through the serve, attack-counterattack and block, and performance coefficients of serve, attack in side-out, attack in counterattack, block, reception, set in side-out, set in counterattack, and dig) show where the winning teams are doing better or how they are achieving the points. In our study, the negative performance indicators show the teams' procedure to achieve the victory. Losing teams present better performance

coefficient in serve and block than winning teams. The cause of these results is that although winning teams scored more points through the serve and block, they also lost more points (errors). This balance shows the risk assumed by the winning teams. However, this risk is only one of the factors that distinguish winning from losing teams (Marelic, Resetar, & Jankovic, 2004; Rodriguez-Ruiz et al., 2011).

From our findings, it is important to consider the interaction between the different performance indicators, providing enough information on performance of teams and players (Hughes & Bartlett, 2002). For example, in BV as in net and wall games, if we only use efficacy percentages to evaluate the game actions of the teams, it cannot be possible to know the proper perspective of the game because it does not give us information about how the points were obtained or lost (game phase and actions). This information is necessary to provide more qualitative information in sports performance (Marcelino, Mesquita, Sampaio, & Moraes, 2010).

In general, an evolution from U19 to senior teams can be observed in the game. The ability to build the offensive system by the team increased, and this involved reduction in serve and dig efficacy. This tendency is also documented in indoor volleyball (García-Alcaraz, Palao, & Ortega, 2014). While the age advances, there is an increase in reception performance enabling a better building of the offensive system (Palao, Santos, & Urena, 2006). The results of the present study may add new knowledge for coaches and performance analysts, emphasizing the need of having a holistic approach for a proper understanding of game dynamics.

In brief, data show that the interaction between the number of points obtained in each game phase, number of points and errors, and performance coefficient of game actions, allow establishing the difference between winning and losing teams in these levels of competition (international male beach volleyball). From a practical point of view, coaches can use this information to establish goals for players and teams in practices and matches in each age group, which can be

guided in a positive way (achievable goals), taking into account the interaction between the different performance indicators.

6. Acknowledgements

This research was supported by CAPES (Brazil), Doctoral grants program (BEX 0688/12-6/2012-2015).

7. References

Anguera, M. (1991). Manual de prácticas de observación [Manual observation practices] (3 ed.). Trillas; México.

Anguera, M. (2003). Observational methods (general). In R. Fernández-Ballesteros (Ed.), *Encyclopedia of Psychological Assessment* (Vol. 2). Sage; London.

Behar, J. (1993). Sesgos del observador. In M. Anguera (Ed.), *Metodología observacional en la investigación psicológica [Observational methodology in psychological research]* (Vol. 2). Barcelona: Promotions and publications University.

Buchheit, M., & Mendez-Villanueva, A. (2013). Supramaximal intermittent running performance in relation to age and locomotor profile in highly-trained young soccer players. *Journal of Sports Sciences*, 31(13), 1402-1411.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2 ed.): Hillsdale, NJ: Lawrence Erlbaum Associates.

Coleman, J. E. (1975). *A statistical evaluation of selected volleyball techniques at the 1974 World's volleyball Championships.*, J. Coleman, United States.

Cooper, H., Hedges, L., & Valentine, J. (2009). *The handbook of research synthesis and Meta-Analysis* (2nd ed.). New York: Russell Sage Foundation.

- Costa, G., Afonso, J., Brant, E., & Mesquita, I. (2012). Differences in game patterns between male female youth volleyball. *Kinesiology*, *44*(1), 60-66.
- Cumming, G. (2013). The new statistics: Estimation for better research. Retrieved from <http://www.thenewstatistics.com>.
- Federation Internationale de Volleyball. (2012). FIVB official volleyball rules 2013-2016. *FIVB: official website of the Federation Internationale de Volleyball*. Retrieved 10/07/2014, from <http://www.fivb.org/EN/BeachVolleyball/Rules/rules.htm>
- Gabbett, T., & Georgieff, B. (2007). Physiological and anthropometric characteristics of Australian junior national, state, and novice volleyball players. *J Strength Cond Res*, *21*(3), 902-908.
- García-Alcaraz, A., Palao, J. M., & Ortega, E. (2014). Technical-tactical performance profile of reception according to competition category in men volleyball. *Kronos*, *13*(1).
- Gerodimos, V., Manou, V., Kellis, E., & Kellis, S. (2005). Body composition characteristics of elite male basketball players. *Journal of Human Movement Studies*, *49*, 115-126.
- Giatsis, G., & Tzetzis, G. (2003). Comparison of performance for winning and losing beach volleyball teams on different court dimensions. *International Journal of Performance Analysis in Sport*, *3*(1), 65-74.
- Harley, J., Barnes, C., Portas, M., Lovell, R., Barrett, S., Paul, D., & Weston, M. (2010). Motion analysis of match-play in elite U12 to U16 age-group soccer players. *Journal of Sports Sciences*, *28*(13), 1391-1397.
- Hopkins, W., Marshall, S., Batterham, A., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine & Science in Sports & Exercise*, *41*(1), 3-12.
- Hughes, M., & Bartlett, R. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, *20*, 739-754.

- Hughes, M., Cooper, S., & Nevill, A. (2004). Analysis of notation data: Reliability. In M. Hughes & F. I. (Eds.), *Notational Analysis of Sport: Systems for Better Coaching and Performance in Sport* (2nd ed., pp. 189–204): Abingdon, UK: Routledge.
- Hughes, M., & Franks, I. (2004). *Notational Analysis of Sport. Systems for better coaching and performance in sport.* (M. Hughes & I. Franks Eds. Second Edition ed.). London: Routledge.
- James, N., Taylor, J., & Stanley, S. (2007). Reliability procedures for categorical data in Performance Analysis. *International Journal of Performance Analysis in Sport*, 7(1), 1-11.
- Lorenzo, A., Gómez, M. Á., Ortega, E., Ibáñez, S. J., & Sampaio, J. (2010). Game related statistics which discriminate between winning and losing under-16 male basketball games. *Journal of Sports Science and Medicine*, 9, 664-668.
- 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 of Sport*, 8(2), 1-7.
- Marcelino, R., Mesquita, I., Palao, J. M., & Sampaio, J. (2009). Home advantage in high-level volleyball varies according to set number. *Journal of Sports Science and Medicine*, 8, 352-356.
- Marcelino, R., Mesquita, I., Sampaio, J., & Anguera, M. (2009). Home advantage in high-level volleyball [Ventaja de jugar en casa en voleibol de alto rendimiento]. *Revista de Psicología del Deporte*, 18(2), 181-196.
- Marcelino, R., Mesquita, I., Sampaio, J., & Moraes, J. (2010). Estudo dos indicadores de rendimento em voleibol em função do resultado do set [Study of performance indicators in male volleyball according to the set results]. *Brazilian Journal of Physical Education and Sport*, 24(1), 69-78.

- Marelic, N., Resetar, T., & Jankovic, 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. (2009). Applied and theoretical perspectives of performance analysis in sport: Scientific issues and challenges. *International Journal of Performance Analysis in Sport*, 9(1), 128-140.
- Michalopoulou, M., Papadimitriou, K., Lignos, N., Taxildaris, K., & Antoniou, P. (2005). Computer analysis of the technical and tactical effectiveness in Greek Beach Volleyball. *International Journal of Performance Analysis in Sport*, 5(1), 41-50.
- Palao, J., Santos, J., & Urena, A. (2006). Effect of reception and dig efficacy on spike performance and manner of execution in volleyball. *Journal of Human Movement Studies*, 51(4), 221-238.
- Palao, J. M. (2004). Incidencia de los complejos de juego y la posición del colocador sobre el rendimiento en competición. *RendimientoDeportivo.com*, 9, 42-52.
- 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., & Manzanares, P. (2009). *Manual for observation instrument of techniques and efficacy in beach-volleyball*. Murcia, Spain.
- 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), Article 7. doi: 10.2202/1559-0410.1281
- Sheppard, J., Nolan, E., & Newton, R. (2012). Changes in strength and power qualities over two years in volleyball players transitioning from junior to senior national team. *Journal of Strength and Conditioning Research*, 26(1), 152-157. doi: 10.1519/JSC.0b013e31821e4d5b

- Zapartidis, I., Vareltzis, I., Gouvali, M., & Kororos, P. (2009). Physical fitness and anthropometric characteristics in different levels of young team handball players. *The Open Sports Sciences Journal*, 2, 22-28.
- Zetou, E., Moustakidis, A., Tsigilis, N., & 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), Article 3 (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, 172-177.

4. Considerações Finais

A presente dissertação teve como propósito analisar a performance do jogo de voleibol de praia masculino nos escalões sub-19, sub-21 e sénior. Neste sentido, intentou-se a partir da análise do jogo produzir conhecimento que permitisse fornecer contributos cientificamente fundados para a análise da performance no voleibol de praia, considerando a idade dos jogadores. Devido a possibilidade de existirem diferenças na performance desportiva entre os escalões sub-19, sub-21 e sénior, justifica-se a realização de estudos que caracterizam as exigências físicas e/ou tático-técnica dos jogadores no sentido de fornecer contributos qualificadores do processo de treino no voleibol de praia de elite. Esta preocupação constitui o mote para realização desta investigação e, em particular para o delineamento dos estudos que compõe a mesma, os quais foram progressivamente demonstrando a natureza das diferentes relações entre as variáveis de performance estudadas.

As considerações finais aqui plasmadas, resultam da análise conjugada e integrada dos contributos particulares de cada um dos três estudos empíricos realizados. Na parte final destas considerações, serão indicadas algumas ilações para o âmbito da prática, bem como sugestões para investigações futuras na área da performance desportiva em VP a partir da análise do jogo.

A influência da especialização funcional dos jogadores, e da qualidade de oposição sobre algumas características físicas e temporais das equipas nos escalões sub-19, sub-21 e sénior foi demonstrada no Estudo 1, designado *Physical and temporal characteristics of under 19, under 21 and senior male beach volleyball players*. Este estudo permitiu retirar as seguintes ilações:

- i) Ao contrário do desenho metodológico mais comum, que passa pela identificação e quantificação dos perfis de jogo e da performance física dos jogadores, este estudo analisou o efeito da especialização funcional dos jogadores e da qualidade de oposição sobre as características físicas e temporais do jogo nos escalões sub-19, sub-21 e sénior, tendo em conta a sua possível interação. Desta forma, verificou-se que a duração do set, o tempo total de descanso, a quantidade de saltos realizados pelos defensores e a quantidade total de saltos aumentaram

significativamente do escalão sub-19 para o escalão sénior. Além disso, em todos os escalões estudados (sub-19, sub-21 e sénior), os bloqueadores realizaram significativamente mais saltos que os defensores. Esta diferenciação em função da idade e da especialização funcional dos jogadores apela para a sua consideração ao nível da prescrição do treino individualizado.

- ii) Ao ter-se em conta a qualidade de oposição, acedeu-se a um conhecimento mais “filtrado” sobre os possíveis efeitos da idade e da especialização funcional dos jogadores sobre as características físicas e temporais das equipas. Esta análise permitiu concluir que o descanso entre os *rallies* e a quantidade de saltos realizados pelos defensores e bloqueadores interagiu com os escalões estudados. Nos jogos equilibrados (*balanced*), o descanso entre os *rallies* e a quantidade de saltos realizados pelos defensores foram significativamente superiores nos escalões seniores quando comparados com os escalões sub-19 e sub-21. No que concerne aos jogos moderadamente equilibrados (*moderate balanced*), a quantidade de saltos realizados pelos defensores foi significativamente mais elevada no escalão sénior quando comparado com o escalão sub-21; Por sua vez, a quantidade de saltos realizados pelos bloqueadores foi significativamente menor no escalão sub-19 quando comparado com os escalões sub-21 e sénior. O conhecimento destes resultados revela-se importante na prescrição do treino para cada escalão considerando a especialização funcional dos jogadores (defensor e bloqueador). Adicionalmente, nos jogos desequilibrados (*unbalanced*), não se verificou qualquer interação da qualidade de oposição com as variáveis estudadas em nenhum dos escalões. Estes achados parecem sugerir que nos jogos mais desequilibrados as estratégias adotadas são indiferentes para o resultado final. Possivelmente, existirá um diferencial técnico acentuado que gera o desequilíbrio no marcador. Este fator mereceria uma análise mais cuidada em futuros estudos.

Os resultados do estudo 2, intitulado *Effects of technique, age and player's role on serve and attack efficacy in high level beach volleyball players*, indicaram que a eficácia do serviço variou de acordo com a técnica utilizada, idade e especialização funcional dos jogadores. Assim, concluiu-se que, os defensores dos escalões sub-19 e sub-21 e os bloqueadores de todos os escalões, apresentaram melhor eficácia utilizando o serviço em apoio e o flutuante, enquanto os defensores do escalão sénior mostraram ser mais eficazes utilizando o serviço em suspensão e o flutuante. Adicionalmente, os resultados deste estudo mostraram que o serviço flutuante foi o mais utilizado pelos defensores e bloqueadores em todos os escalões. Por sua vez, a eficácia do ataque mostrou não variar entre defensores e bloqueadores, embora estivesse relacionada com a técnica de execução e a idade dos jogadores.

Os defensores e bloqueadores dos escalões sub-19 e sub-21 tiveram uma eficácia ligeiramente superior utilizando o ataque potente (*spike*), enquanto no escalão sénior, defensores e bloqueadores obtiveram uma eficácia semelhante utilizando o ataque potente e o ataque colocado (*shot*). Adicionalmente, o ataque colocado foi mais utilizado pelos defensores e bloqueadores dos escalões mais jovens (sub-19 e sub-21), enquanto no escalão sénior, houve um equilíbrio na utilização do ataque potente e do ataque colocado pelos defensores e bloqueadores.

O conhecimento destes resultados sugere a necessidade de considerar a idade e a especialização funcional dos jogadores (defensor e bloqueador) durante o processo de treino, a fim de executarem uma técnica mais adequada (de acordo com as exigências do jogo) podendo levar os jogadores a alcançarem uma melhor performance no jogo.

Apesar do contributo que estes resultados têm para o conhecimento específico do jogo de voleibol de praia, uma mais-valia deste estudo reside na metodologia aplicada para determinar as diferenças entre as ações de jogo (serviço e ataque) e as técnicas utilizadas. O recurso a estatísticas progressivas (incluindo estimativas baseadas em “*effect sizes*”, “*confidence intervals*” e “*meta-analysis*”) utilizando inferências baseadas em estimativas

(Cumming, 2012), revelou-se uma estratégia interessante para avaliar a performance desportiva a partir da análise do jogo (Buchheit & Mendez-Villanueva, 2013). Importa salientar que este tipo de análise foca o pensamento de estimação, na qual interessa conhecer qual o tamanho do efeito. Mais se acrescenta o contributo que a meta-análise teve neste estudo, porquanto através de uma estimativa mais precisa, permitiu analisar os defensores e bloqueadores de forma integrada, contribuindo para uma melhor compreensão acerca da performance dos jogadores em cada escalão.

A relevância da análise obtida no estudo 2, conduziu naturalmente ao último estudo empírico desta dissertação, intitulado *Differences in performance between winning and losing teams in under 19, under 21 and senior male beach volleyball*. Os resultados deste estudo demonstraram que os pontos obtidos no complexo 2 (para as equipas que ganha o *set*) diferenciaram as equipas vencedoras das derrotadas. Além disso, as diferenças achadas nos coeficientes de performance das ações de jogo e na maneira de como os pontos são obtidos entre as equipas que perdem e ganham o *set*, sugerem a necessidade de incluir diferentes indicadores de performance para analisar a performance desportiva no voleibol de praia. Estes achados contribuem com uma nova perspectiva para monitorar a performance desportiva no voleibol de praia. A estratégia de incluir diferentes indicadores de performance (que permita obter informações sobre as fases de jogo, forma de obtenção dos pontos e efeito das ações sobre o jogo) para estabelecer as diferenças entre os vencedores e os derrotados em equipas neste nível de competição (Campeonato Mundial de Voleibol de Praia Masculino) parecem ser mais adequada.

No seguimento do presente estudo, e com base nos resultados obtidos, apresentam-se algumas sugestões para futuros estudos e recomendações para o aprimoramento e qualificação dos processos de treino e de competição.

Uma das sugestões para futuros estudos é a inclusão de variáveis que possam interferir nas regularidades acontecimentais do jogo, como é o caso do resultado do jogo no momento (do inglês, *match status*). O surgimento deste

fenómeno como objeto de estudo tem na sua génese a convicção de que as equipas/jogadores jogam de forma diferenciada em função do resultado momentâneo do jogo. Testa-se a hipótese de averiguar se as estratégias adotadas pelas equipas/jogadores são alteradas de acordo com a situação do marcador (estar a ganhar, a perder ou empatados), de forma a perscrutar acerca dos marcadores que poderão explicar as alterações ocorridas (Mesquita & Marcelino, 2013). Mais se acrescenta que variáveis deste calibre podem permitir uma visão mais holística, multifacetada e integradora da performance das equipas/jogadores.

Após a evidência, no presente estudo, da interferência da qualidade de oposição em alguns aspectos físicos dos jogadores e temporais do jogo, considera-se que será relevante realizar investigações centradas nos aspectos tático-técnicos. Deste modo, será possível verificar possíveis interações entre estas variáveis e a idade dos jogadores, tendo em conta a qualidade da oposição. Tal permitirá entender a evolução da organização do jogo e da adaptação das equipas aos constrangimentos impostos pela natureza da oposição estabelecida no momento.

Face à informação pertinente fornecida pela utilização das estatísticas progressivas (incluindo estimativas baseadas em “*effect sizes*”, “*confidence intervals*” e “*meta-analysis*”) nas eficácias do serviço e do ataque, aconselha-se o recurso a esta metodologia, em referência ao estudo de outras ações de jogo, considerando a idade e a especialização funcional dos jogadores, bem como o efeito da relação entre o *match status* e a qualidade de oposição. Tal poderá fornecer uma visão holística e integradora do comportamento dos jogadores/equipas e, concomitantemente, do rendimento.

Considerando a inexistência de estudos de referência disponíveis na literatura especializada no VP sobre os escalões mais jovens, os resultados do presente estudo parecem contribuir com informações relevantes acerca da performance das equipas/jogadores de VP numa perspectiva de formação a longo prazo e, em certa medida, fornecer contributos qualificadores do processo de treino.

De facto, a idade e a especialização funcional dos jogadores considerando a qualidade de oposição das equipas afetaram as características físicas e temporais do jogo, devendo estes aspectos serem considerados nos processos de preparação para as competições. Neste estudo, quando os jogos foram realizados entre equipas com o mesmo nível de oposição, os tempos de descanso entre os *rallies* e a quantidade de saltos realizado pelos jogadores defensores foram maiores no escalão sénior quando comparados com os escalões mais jovens (sub-19 e sub-21). Neste sentido, devido à intensidade do jogo ser mais elevada no escalão sénior, os treinadores dos escalões mais jovens devem atribuir especial atenção ao trabalho físico envolvendo a resistência específica das ações explosivas e as estratégias de descanso entre os *rallies*, tais como as conversas com o parceiro durante um *rally* e outro. Estas estratégias poderão ser importantes numa perspectiva a médio e longo prazo, porquanto os jogadores irão defrontar-se com estas situações num futuro próximo. Já a maior quantidade de saltos realizados pelos jogadores defensores no escalão sénior, sugere uma prescrição de treino individualizada por parte dos treinadores e preparadores físicos. Sendo estes jogadores os que mais recebem o serviço durante o jogo, será importante enfatizar os saltos de ataque e contra ataque durante os treinos, no sentido de se prepararem de forma mais adequada para a competição, uma vez que chegam a realizar até três jogos por dia.

O facto da idade e da especialização funcional dos jogadores interferirem na eficácia do serviço e do ataque deverá também ser considerado na preparação das competições. Sugere-se, então, que os treinadores das equipas focalizem o treino do serviço e do ataque, enfatizando as tendências gerais do jogo, tipo de serviço, tipo de ataque e a carga física dos jogadores, atendendo às exigências de cada escalão e à especialização funcional dos jogadores. Além disso, os resultados obtidos neste estudo poderão ser utilizados no processo de treino e/ou competição fornecendo valores de referência para o controle da eficácia destas ações.

Os resultados da presente dissertação demonstraram ainda que, independente dos escalões, os pontos obtidos no complexo 2 (para as equipas que ganham

o set) diferenciaram as equipas vencedoras das derrotadas. Além disso, diferenças foram encontradas nos coeficientes de performance das ações de jogo e na maneira de como os pontos são obtidos entre as equipas que perdem e ganham o set. Neste sentido, deverá ser dada particular atenção à interação destes indicadores aquando da monitorização das equipas por parte dos treinadores. Devido a importância dos pontos obtidos no complexo 2 em todos os escalões nas equipas que ganham o set, sugere-se que os treinadores desenvolvam metodologias de treino que visem aumentar o rendimento do serviço e do bloco, controlando os erros cometidos nas ações do complexo 1 e a eficácia no contra ataque. Nomeadamente, os erros do oponente através do risco assumido no serviço e no bloco poderão ser particularmente importantes no sucesso das equipas e, por isso, devem ser enfatizadas no processo de treino.

Referências Bibliográficas

- Buchheit, M., & Mendez-Villanueva, A. (2013). Supramaximal intermittent running performance in relation to age and locomotor profile in highly-trained young soccer players. *Journal of Sports Sciences*, 31(13), 1402-1411.
- Cumming, G. (2012). *Understanding the new statistics. Effect sizes, confidence intervals, and meta-analysis*: Ciudad: Routledge.
- Mesquita, I., & Marcelino, R. (2013). O efeito da qualidade de oposição e do match status no rendimento das equipas [The effect of the quality of opposition and match status on teams of performance]. In A. Volossovitch & A. Ferreira (Eds.), *Fundamentos e aplicações em análise do jogo [Fundamentals and applications in game analysis]* (pp. 133-152). Lisbon: Faculty of Human Motricity.