VANESSA DA SILVA LIMA

INDICADORES DE DESEMPENHO TÁTICO-TÉCNICO NO *TIE-BREAK*: ESTUDO NO VOLEIBOL DE PRAIA FEMININO DE ALTO NÍVEL

JOÃO PESSOA ,2023

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A Tese **Indicadores de Desempenho Tático-Técnicos no Tie-Break: estudo no Voleibol de Praia Feminino de Alto Nível.**

Elaborada por Vanessa da Silva Lima

Foi julgada pelos membros da Comissão Examinadora e aprovada para obtenção do título de DOUTOR EM EDUCAÇÃO FÍSICA na Área de Concentração: Saúde, Desempenho e Movimento Humano.

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RESUMO

O *tie-break* é o terceiro e decisivo set nas partidas de voleibol de praia, onde o primeiro time que pontuar 15 pontos com vantagem de dois pontos para adversário vence esse set e a partida. É um momento crítico do jogo onde é testada a capacidade dos atletas de performar melhor. Dessa forma, o comportamento das equipes neste momento pode determinar o desempenho técnico-tático e o sucesso da equipe. Os indicadores técnicos e táticos estão entre os mais estudados na análise do jogo no voleibol de praia. Contudo, os contextos de jogo como *match period, set result, final score difference* e *set period* ainda são pouco estudados. O objetivo do estudo foi investigar os indicadores de desempenho táctico-técnicos em diferentes contextos no *tie-break* em jogos com nível de oposição equilibrada no voleibol de praia feminino de alto nível. As ações de jogo de todos os sets *tie break* disputados entre equipes oposição equilibrada nos *FIVB Women's Beach Volleyball World Championships* (2019 e 2022) foram observadas por meio da análise de vídeo. O TEBEVOL foi utilizado como instrumento de observação. As variáveis analisadas foram: indicadores técnicos e táticos (ataque, recepção, levantamento, ataque, bloqueio e defesa) nas fases de jogo (*side-out*, contra-ataque (Complexos II, III, IV)), resultado do *tie-break* (vitória e derrota), tipo de *tie-break* pela diferença de pontos finais (mínima: 2 pontos, média: 3-4 pontos, máxima: >5 pontos) e período do *tie-break* (inicial: 1 ao 5 ponto, intermediário: 6 ao 10 e final 11 ao final do *tie-break*). Teste t e inferência baseada em magnitude foram utilizados para comparar os indicadores entre as equipes vencedoras e perdedoras do *tie break* de forma geral e baseado na diferença final de pontos. Modelos generalizados foram usados para investigar a influência do resultado do *tie-break* e dos períodos do *tie-break* nos indicadores, a associação dos indicadores em cada período com as chances de vitória no *tie-break* e a relação entre os indicadores de desempenho no período final em cada resultado do *tie-break* e a sua margem de vitória. Os resultados mostraram diferenças significativas para equipes vencedoras do *tie-break* em pontos KII, erros do adversário no ataque KIII, bloqueio total e eficácia de ataque *side-out* e contra-ataque. A maioria das mudanças ocorreu para equipes vencedoras com mais de 5 pontos na diferença final. O saque e o bloqueio KII se destacaram no placar médio, enquanto o ataque de *side-out* diferenciou os vencedores na mínima diferença no placar. Os períodos intermediário e final do *tie-break* nos times vencedores influenciaram de forma positiva o ataque de *side-out.* Os times com melhor performance no bloqueio (período inicial, intermediário e final) e defesa (período inicial), ataque de contra-ataque (período final), ataque de *side-out* (período final) assim como menos erros de saque (período intermediário e final) aumentam as chances de vitória no *tie break* disputado entre oponentes com mesmo nível de oposição. Conclui-se que a maioria dos indicadores de desempenho estudados foram diferentes nos vencedores e perdedores conforme a diferença placar final e o período no tie-break jogado.

Palavras-chave: análise do jogo, variáveis situacionais, indicadores de performance, cenários críticos.

ABSTRACT

Tie break is the third and decisive set in beach volleyball matches, where the first team to score 15 points with a two-point advantage over the opponent wins that set and the match. It is a critical moment of the game where the ability of the athletes to give their best is tested. Thus, the team's behavior at this time can determine its technical and tactical performance and the success of the team. Technical and tactical indicators are among the most studied in the analysis of the game in beach volleyball. However, match contexts such as set type, set period, and match period are still little studied. The aim of the study was to investigate the technical and tactical performance indicators in the tiebreak of elite women's beach volleyball. Game actions of all tie break sets (n = 31) played between balanced opposition teams in the FIVB Women's Beach Volleyball World Championships (2019 and 2022) were observed by video analysis. TEBEVOL was used as an observation instrument. The variables analyzed were: technical and tactical indicators (attack, reception, set, attack, block, and dig) of the game phases (side-out, counter-attack (complexes II, III, IV)), tie-break result (win and loss), tie break type by victory margin (minimum: 2 points, medium: 3-4 points, maximum: >5 points), and tie break period (initial: 1 to 5 points, intermediate: 6 to 10, and final 11 at the end of tie break). Inferential analysis with practical significance indicated indicators of differences between tie break outcomes in general and based on the final point difference. Generalized models were used to influence the result and the period on indicators, the association of indicators in each period with the chances of winning, and the relationship between the indicators of performance in the final period in each outcome and the difference of end points. The results showed significant differences for winning teams in KII points, opponent errors in KIII attack, block, and attack efficacy. Most changes occurred for winning teams with more than 5 points in the final difference. The serve and KII block stood out in the middle scoring, while the side-out attack was more important in the smallest difference in the scoring. The intermediate and final periods of the tie break for the winning teams positively influenced the side-out attack. Teams with the best performance in the block (initial, intermediate, and final periods) and dig (initial period), counter-attack attack (final period), side-out attack (final period), as well as fewer serve errors (intermediate and final period), increase their chances of winning the tie break. It is concluded that most of the performance indicators studied were different for winners and losers depending on the difference in the final score and the period in the tie-break played.

Keywords: match analysis, performance indicators, situational variables, game phase.

RESUMEN

Tie-break es el tercer y decisivo set en los partidos de voleibol playa, donde el primer equipo que consiga 15 puntos con dos puntos de ventaja sobre el rival gana ese set y el partido. Es un momento crítico del juego donde se pone a prueba la capacidad de los atletas para desempeñarse mejor. De esta forma, el comportamiento de los equipos en ese momento puede determinar el desempeño técnico-táctico y el éxito del equipo. Los indicadores técnicos y tácticos se encuentran entre los más estudiados en el análisis del juego de voleibol playa. Sin embargo, los contextos del juego, como el período del partido, el resultado del set, la diferencia en el marcador final y el período del set, todavía están poco estudiados. El objetivo del estudio fue investigar indicadores de desempeño técnico-táctico en diferentes contextos en desempates en juegos con nivel de oposición equilibrada en el voleibol playa femenino de alto nivel. Las acciones de juego de todos los sets tie-breaks jugados entre equipos rivales equilibrados en el Campeonato Mundial de Voleibol de Playa Femenino FIVB (2019 y 2022) se observaron mediante análisis de video. Se utilizó TEBEVOL como instrumento de observación. Las variables analizadas fueron: indicadores técnicos y tácticos (ataque, recepción, levantamiento, ataque, bloqueo y defensa) en las fases de juego (side-out, contraataque (Complejos II, III, IV)), resultado del tie-break (victoria y derrota).), tipo de desempate por diferencia de puntos finales (mínimo: 2 puntos, media: 3-4 puntos, máximo: >5 puntos) y periodo de desempate (inicial: 1 a 5 puntos, intermedio: 6 a 10 y 11 finales al final del tie-break). Se utilizó la prueba T, la inferencia basada en magnitud y modelos generalizados. Los resultados mostraron diferencias significativas para los equipos ganadores del tie-break en puntos KII, errores del oponente en el ataque KIII, bloqueo total y efectividad del ataque lateral y contraataque. La mayoría de los cambios se produjeron para los equipos ganadores con más de 5 puntos en la diferencia final. El saque y el bloqueo de KII destacaron en el puntaje promedio, mientras que el ataque lateral diferenciaba a los ganadores por la mínima diferencia en el puntaje. Los periodos intermedio y final del tie-break de los equipos ganadores influyeron positivamente en el ataque lateral. Los equipos con mejor desempeño en bloqueo (período inicial, intermedio y final) y defensa inicial), ataque de contraataque (final), ataque lateral (final) así como menos errores de servicio (intermedio y final) aumentar las posibilidades de ganar en el tie break jugado entre oponentes con el mismo nivel de oposición. Se concluye que la mayoría de los indicadores de desempeño estudiados fueron diferentes para ganadores y perdedores dependiendo de la diferencia en el puntaje final y el período en el tie-break jugado.

Palabras clave: análisis de juego, variables situacionales, indicadores de desempeño, escenarios críticos.

SUMÁRIO

1 INTRODUÇÃO

O voleibol de praia é um esporte de alto rendimento que vem se destacando no cenário esportivo mundial desde a década de 90. (PALAO; VALADES; ORTEGA, 2012). Desde então, o esporte cresceu rapidamente tornou-se um dos eventos mais populares dos Jogos Olímpicos e mantem um alto nível de participação dos atletas em todas as competições mundiais (FIVB, 2023). Na última década, esse crescimento foi acompanhado pela ascensão das investigações científicas com foco na análise do jogo (LIMA *et al*., 2023).

Neste cenário competitivo, a análise do jogo é uma importante ferramenta para atletas, treinadores e analistas no entendimento das situações de jogo que influenciam o desempenho, na compreensão dos constrangimentos que promovem o sucesso esportivo para melhorar o jogo da equipe (MARTINS, et al., 2022) e para identificar os indicadores de desempenho considerados “chaves” para o sucesso do time (McGARRY, 2009).

Além disso, o sucesso e popularidade de um esporte com o público envolve a possibilidade de um jogo emocionante. A emoção de um jogo vem comumente da incerteza do resultado (SU-LIN et al., 1997), que aumenta quando jogo está empatado (JEON; PARK, 2020). Nesse momento em que um desempate será disputado, os competidores são incentivados a adaptarem-se continuamente as situações e traçar estratégias para superá-las, tornando o ambiente ainda mais emocionante e jogável (JEON; PARK, 2020).

Durante um jogo de voleibol de praia, um desempate conhecido como *tie-break* é disputado quando as equipes estão empatadas em 1 a 1 em sets regulares para determinar o vencedor da partida (FIVB, 2023). Isso ocorre em 33% de todas os jogos de e em 41,6% dos jogos entre oponentes equilibrados nos torneios femininos de voleibol de praia da FIVB e os seus resultados mostraram-se independentes dos resultados nos sets anteriores (LILLICH et al., 2023). Nestes jogos, um *tie-break* é vencido pela dupla que primeiro marcar 15 pontos no sistema de pontos por *rally*, sendo requerida uma vantagem mínima de dois pontos ao final (FIVB, 2023).

Dessa forma, por ser decisivos para vencer a partida (O’DONOGHUE; SIMMONDS, 2019), o *tie-break* é considerado um momento crítico do jogo em que é testada a capacidade dos atletas de desempenharem melhor quando é

mais importante (CARLSTEDT, 2004). Isto pode afetar o comportamento dos jogadores, especialmente no controle do estresse físico e psicológico e influenciar o desempenho em pontos jogados (O'DONOGHUE, 2001; O'DONOGHUE; SIMMONDS, 2019). Além disso, o nível crítico durante o set decisivo pode flutuar dinamicamente, dependendo das mudanças nas condições (CARLSTEDT, 2004). Quanto mais próximo estiver o placar entre as equipes ao final de um set, maior será a importância dos pontos disputados por cada equipe devido ao aumento do nível crítico (MORRIS, 1997; DRIKOS *et al*., 2018). Portanto, o comportamento dos jogadores em um momento único decisivo pode determinar o desempenho tático-técnico (MARCELINO; SAMPAIO; MESQUITA, 2012).

A análise do desempenho tático-técnico das equipes é prática comum durante um jogo, em torneios e/ou em competições (STANKOVIC *et al*., 2019). Além disso, interesse da comunidade cientificas nessas estatísticas seguem em alta dentre as publicações no vôlei de praia e são as unidades de análises mais estudadas nas pesquisas da análise do jogo neste esporte (LIMA *et al*., 2023). Dessa forma, diferentes tipos de indicadores são usados para caracterizar os padrões da equipe vencedora, incluindo ações de ponto único (por exemplo, ataque, saque e bloqueio) e essas ações por fase do jogo (ou seja, *side-out* ou contra-ataque) ou complexos (por exemplo, I, II, III ou IV), bem como os coeficientes de desempenho das ações (saque, recepção, levantamento, ataque, bloqueio e defesa) em suas respectivas fases do jogo (GIATSIS; ZAHARIADIS, 2008; MEDEIROS *et al* ., 2017; GIATSIS *et al*., 2023).

A vitória nos sets e no resultado da partida no voleibol de praia estão diretamente relacionadas aos pontos obtidos (KUMAR *et al*., 2021) e aos coeficientes de desempenho das ações do jogo (MEDEIROS *et al*., 2017). Estudos anteriores indicam que eficácia do ataque (GIATSIS; ZAHARIADIS, 2008; GIATSIS et al., 2023), do ataque no *side out* (PALAO; ORTEGA, 2015), do saque (MICHALOPOULOU *et al*., 2005) e do bloqueio (MEDEIROS *et al*., 2017), além os pontos em contra-ataque *(*KUMAR et al., 2021) e em erros de ataque do oponente (GIATISIS, 2022) foram os fatores que contribuíram para vencer no de voleibol de praia. Contudo, predominância das investigações no jogo masculino a partir de sets regulares com poucas investigações do jogo das equipes femininas e a inclusão de variáveis contextuais como *tie-breaks.*

Considerando diferentes contextos de jogo no voleibol de praia, o desempenho bem-sucedido nessas ações importantes para vitória podem diferir conforme: equilíbrio nos placares finais dos sets regulares (equilibrados *vs* desequilibrados); momento do jogo (set regular *vs tie-break*; período inicial *vs* final do set) que o(a) jogador(a) está executando suas ações (GIATSIS *et al*.,2022; JIMÉNEZ-OLMEDO *et al*., 2012; 2014) e do nível de qualidade do seu adversário (GEA; MOLINA, 2015; ŠIMAC; GRGANTOV; MILIĆ, 2017; MEDEIROS *et al*., 2017).

A diferença de pontuação, o período do set e o nível de oposição estão entre as variáveis contextuais consideradas relevantes na visão dos treinadores de elite no voleibol *indoor* para mensuração da performance na competição (LÓPEZ-SERRANO *et al*., 2022). Entretanto, existe uma lacuna de informações relacionadas as investigações em cenários críticos e contextuais no jogo feminino no voleibol de praia. Até onde se sabe, nenhum estudo prévio explorou a performance dos vencedores do *tie break* em diferentes constrangimentos contextuais do jogo na categoria feminina adulta no alto rendimento, considerando a igualdade do nível de oposição competitiva.

Diante do exposto, percebe-se a relevância em investigar os indicadores tático-técnicos do *tie-break* de acordo com seu resultado, considerando contextos como as diferenças de pontuações finais e diferentes períodos ao longo do set, com as seguintes questões relacionadas (1): Quais indicadores tático-técnicos diferenciam times vencedores e perdedores no *tie-break* no voleibol de praia feminino de alto rendimento?; (2) Existe diferença entre os indicadores para vitória no *tie-break* de acordo a diferença de pontos no seu placar final?; (3) Existe influência do resultado e do período do *tie-break* nos indicadores de desempenho?; (4) Quais interações entre os indicadores e os períodos estão associados com mais chances de vitória no *tie-break*?

De acordo com a literatura, tem-se como hipóteses que um número superior de indicadores diferencia vencedores e perdedores nos *tie-breaks* em geral e no *tie-break* com máxima diferença de pontuação final. Quanto mais próxima estiver a pontuação final, menos indicadores diferenciam vencedores e perdedores no desempate, sendo os indicadores por fase do jogo mais representativos do que elementos de pontos únicos. Além disso, espera-se que o desempenho das ações de saque, ataque, bloqueio sejam influenciados pelo

período do jogo de forma positiva para vencedores e negativas para os perdedores, especialmente no primeiro e último períodos. Ainda, as ações de bloqueio no último período aumentem as chances de vitória no *tie-break.*

Os achados dessas questões podem apresentar importantes implicações práticas para treinadores e atletas. Além disso, a quantificação das ações que afetam os resultados dos jogos é crucial para os treinadores gerirem as características do treino e da competição (DRIKOS et al., 2018; DRIKOS et al., 2020; GARCA-DE- ALCARAZ; MARCELINO, 2017; STANKOVIC, 2019; GIATSIS et al., 2023). Ainda, na competição de alto nível aumenta-se a exigência de conhecimento dos fatores de desempenho para alcançar o sucesso (KUMAR et al.,2021).

2 OBJETIVOS

2.1 Geral

O objetivo é investigar o comportamento dos indicadores desempenho técnico e tático em diferentes contextos no *tie-break* em jogos com nível de oposição equilibrada no voleibol de praia feminino.

2.2 Específicos

a) Identificar as características e os tópicos de tendências de pesquisa na análise do jogo no voleibol de praia a partir de indicadores bibliométricos com análise de citação.
b) Comparar indicadores tático-técnicos entre equipes vencedoras e perdedoras no *tie-break* de acordo com a diferença de pontos finais.
c) Verificar a influencia da interação entre o resultado cada período *do tie-break* nos indicadores tático-técnicos.
d) Analisar a associação dos indicadores ao longo dos diferentes periodos do *tie break e* resultado do *tiebrek*.
e) Investigar a relação da interação entre os indicadores de desempenho no período final em cada resultado e a diferença de pontos finais.

3 REVISÃO DE LITERATURA

Para efeito desta revisão da literatura se optou em dividi-la em três subtópicos relacionados aos: (I) Estrutura do jogo de voleibol de praia , (II) Análise do jogo , e (III) Análise de jogo no voleibol de praia . Nesse sentindo, adotou-se uma revisão narrativa para sumarização do copor de evidências relevantes sobre as questões formuladas e visa situar o leitor sobre as caracteristicas das investigações estudadas até o presensente momento sobre o tema.

3.1 Estrutura do jogo no voleibol de praia

O voleibol de praia é um esporte de cooperação e oposição que confronta duas equipes de dois jogadores divididas por uma rede e sobre uma superfície de areia (NATALI et al., 2017), cujo objetivo é marcar pontos, disputado em melhor de 3 sets no sistema de pontos de *rally.* O ponto é conquistado nas seguintes condições: quando é bem-sucedida em fazer a bola tocar a quadra adversária; quando a equipe oponente comete uma falta; quando a equipe oponente recebe uma penalização. Para vencer o jogo, a dupla deve vencer dois sets na disputa melhor de três. Os dois primeiros sets são regulares e o terceiro set decisivo (*tie-break*) disputados em 21 e 15 pontos, respectivamente, com diferença mínima de dois pontos no final do set (FIVB, 2023).

A duração do jogo de voleibol de praia na categoria adulta no alto rendimento, envolvendo partidas da fase classificatória e eliminatória, apresentou-se entre 30 e 64 minutos e envolvendo entre 78 e 96 *rallies*. A média de duração total e quantidade de sets disputados em partidas de três sets foi de, respectivamente, de 40 ± 17 minutos e 94 ± 36 *rallies* no feminino e 42 (± 14) minutos e 96 (± 16) *rallies* no masculino (PALAO; VALADES; ORTEGA, 2012).

Os sets regulares tiveram média de duração foi 18 min 10 s ± 2 min 16 s e no *tie break* foi 14 min 24 s ± 49 s nos torneios mundiais femininos adultos. Além disso, a proporção de *rallys* que duraram menos de 10 segundos foi de 80%, entre 10 e 20 segundos foi de 19% e mais de 20 segundos foi de 1%. (HAYRINEN; TAMPOURATIZIS, 2012).

O jogo feminino na categoria adulta apresentou uma duração média do *rally* aproximadamente de 7.1 e uma relação trabalho repouso de 1:3.38 (NATALI et al., 2019). Nas categorias de base (sub 18, 19, 20, 21 e 22) o tempo de jogo e de trabalho mostraram-se constantes. Os *rallys* duraram aproximadamente 6 segundos, a relação trabalho-repouso mostrou-se entre 1:3.31 (sub-19) e 1:4.26 (sub-21) (PÉREZ-TURPIN et al., 2019). Já o jogo masculino apresentou duração *rally* de 8 (± 1) segundos para categoria adulta e 7 (±1) para categoria de bases. Ainda na categoria adulta, a relação trabalho-repouso foi de 1 para 4 (PALAO et al., 2014).

Classicamente o *rally* no voleibol de praia divide-se em duas fases*: side-out* e contra-ataque (GIATSIS; TZETZIS, 2003). Dentro dessas duas fases estão as seis ações do voleibol de praia: saque, recepção, levantamento, ataque, bloqueio e defesa (PALAO et al., 2019). As ações no *rally* possuem caráter sequencial e cíclico (PÉREZ-TURPIN et al.,2019) e desenvolvem desde o momento do golpe de saque pelo sacador até que a bola esteja fora de jogo.

A jogada construída após recepção do serviço que inicia o *rally* é chamada de *side-out* ou complexo I (KI) (recepção de saque, levantamento e ataque). Entende-se que a primeira jogada de ataque da equipe que serviu tem especificidades próprias – condicionadas pela qualidade do serviço – e, então, classifica-a como complexo II (KII) (saque, bloqueio, defesa e contra-ataque) e faz parte da fase de contra-ataque. Considera-se que, a partir deste momento, todas as jogadas de contra-ataque seguintes do *rally* são iguais entre si, independentemente da equipe que está a executá-las, sendo este o complexo III ou IV. (PALAO; ORTEGA, 2015; MEDEIROS et al., 2017).

Na fase de *side out* os dois jogadores precisam ter a capacidade de receber, definir e atacar para jogar o jogo com sucesso (KOCH; TILP, 2009). Já durante a fase de contra-ataque existe os jogadores executam dois papeis diferentes baseados nas prioridades de ações de bloqueio ou defesa-(GIATSIS; TILI; ZETOU, 2011). Dessa forma, a atribuição para os jogadores da função prioritária de bloqueio ou/e defesa, determinam sua especialização em bloqueadores, defensores especialistas ou jogadores universais. Contudo, o papel desempenhado pelo jogador na fase de contra-ataque pode influenciar a eficácia e execução das ações de jogo. (MEDEIROS et al., 2014c; JIMENEZ-

OLMEDO; PENICHET-TOMAS, 2017 a; JIMENEZ-OLMEDO; PENICHET-TOMAS, 2017b).

3.2 Análise do jogo

O jogo apresenta-se como o cenário esportivo real no esporte, sendo a “Análise do Jogo” uma área de destaque na análise do desempenho, pois ao estudar a relação direta jogador/jogo são identificados as prováveis tendências e o adequado encaminhamento do processo de preparação e organização do jogo (GARGANTA, 2001; O’DONOGHUE, 2010). A análise do jogo produz informações baseadas em vários indicadores de desempenho (HUGHES; BARTLETT, 2002) a partir da seleção e combinação de elementos-chave (O’DONOGHUE, 2010) para impactar positivamente na obtenção dos melhores desempenhos (PÉREZ-TURPIN et al., 2019), preferências táticas e o comportamento da estrutura estratégica e técnica (BARREIRA et al., 2020).

Ressalta-se que, a “Análise do Jogo” (*match analysis)* referência os estudos realizados neste âmbito em conjunto com outras denominações como Observação do Jogo (*game observation)* e Análise Notacional (*notational analysis*) (GARGANTA, 2001) . Hughes e Franks (2004) pontuam que se atribui a denominação de análise notacional no esporte quando se objetiva anotar/registrar o desempenho, para que os elementos-chave desse desempenho possam ser quantificados de maneira válida e consistente. Entretanto, considera-se que nos procedimentos de Análise do Jogo ocorre uma necessária observação do jogo e registro dos dados, e por isso, a expressão é mais utilizada (GARGANTA, 2001).

Os estudos na análise do jogo que utilizam métodos observacionais seguem método científico rigoroso e flexível e permite a análise do comportamento espontâneo em um contexto natural (ANGUERA, 2011). Paralelamente a isso ocorre a evolução dos recursos tecnológicos que refinam as investigações, com sistemas computadorizados e tecnologias digitais para coletar, gerir e organizar as imagens de vídeo (BARRIS; BUTTON, 2008)

Tem tornando-se cada vez mais frequente as análises do jogo que consideram abordagens ecológicas e dinâmicas, como possíveis

condicionadores dos comportamentos/desempenho esportivos em relação contexto e aos constrangimentos situacionais (McGARRY et al., 2002). Dentre elas, estão condições meteorológicas, a influência do terreno de jogo, momentos do jogo com destaque para qualidade de oposição, *match status* e local da partida (MARCELINO; SAMPAIO; MESQUITA, 2011).

A relevância de considerar a qualidade de oposição está relacionada a Teoria das Performances Interativas, na qual a competição desportiva é resultado da interação direta das performances entre dois atletas ou equipes, considerando-se a possibilidade de a performance dos competidores ser influenciada pela dos seus adversários (O'DONOGHUE, 2009). Destaca-se que é importante determinar critérios que possam ser agrupados para determinar a qualidade de oposição, não se atendo apenas uma divisão das classificações finais das competições para conseguir melhor representação ecológica (MEDEIROS et al., 2014b)

Match status é a denominação utilizada para identificar o resultado situado no momento jogo em que se obtém o registro da realização de determinada ação ou performance obtida. Essa variável pode ser denominada ainda na literatura pelas expressões "*game situation*" ou "*game momentum*" (JONES; BRAY; OLIVIER, 2005). A relevância dessa variável está no pressuposto que as equipes jogam de forma diferente dependendo do resultado momentâneo do jogo, tendendo a ser diferente ao longo de todo o jogo. Busca-se, então, averiguar se a mudança de estratégias de acordo com a mudança na situação do placar: ganhando (intervalo [1; + [.), perdendo ( ]-∞; -1] ou empatando (MARCELINO; SAMPAIO; MESQUITA, 2011).

Além do match status (vantagem, desvantagem e empate), outras variáveis contextuais relacionadas ao momento são estudadas na análise do jogo dentre elas: *match period* (set 1, set 2 e set 3); período do set (fase inicial, fase média, fase final), diferença de escore no período final do set (mínima, média e máxima diferença). O momento do jogo apresenta alta relevância no estudo dos jogos esportivos. Diferentes momentos carregam características técnicas, características fisiológicas e psicológicas únicas, que podem determinar o desempenho, particularmente em ações cada período de jogo específico poderia ter diferentes efeitos no comportamento dos jogadores,

especialmente em controlar o estresse físico e psicológico (O'DONOGHUE, 2017).

Nos esportes jogados em sets e pontos, como por exemplo o voleibol de praia, o set final ou decisivo conhecido como *tie-break* é um período do jogo em que resultado de partida que está empatada será decidido. Por essa razão, é um momento com características de estresse físico e psicológico únicos que podem determinar o desempenho na conquista dos pontos (O'DONOGHUE, 2021). Os pontos nesse contexto decisivo para vencer as partidas tem mais importância quando comparados a contextos não decisivos (KNIGHT; O'DONOGHUE, 2012). De modo que, os melhores jogadores dispendem esforço físico adicional e esforço mental nos pontos importantes enquanto relaxavam nos pontos sem importância. Os jogadores percebem que os pontos mais importantes são jogados no final do set; assim, eles conseguem poupar seus melhores esforços para os pontos decisivos. Com isso, períodos iniciais recebem atenção pela teoria que o sucesso inicial pode predizer o resultado final, já os períodos finais são relatados por todos como períodos dos jogos com papel determinante no final do resultado (MARCELINO et al., 2012).

A importância de considerar cenários críticos na análise do jogo está fundamentada segundo Carlstedt (2004) na Teoria dos Momentos Críticos. Esta teoria propõe que os fatores psicológicos são mais cruciais para o desempenho durante períodos especificamente delineados de competição e explica como as medidas de personalidade, comportamental e psicofisiológica selecionadas influenciam a performance desportiva quando ela conta mais. A teoria sustenta que o desempenho deve ser estudado no micro nível para entender mais da variação estatística na equação de performance que pode ser atribuída a fatores psicológicos. Isto significa que o desempenho deve ser visto no contexto de interações e medidas de resultados longitudinais de micro desempenho derivadas de análises de momentos críticos da competição. A análise de cenários críticos de jogo, tanto em momentos críticos como não críticos, pode teoricamente fornecer uma perspectiva inovadora sobre o desempenho do jogo, ajudando a diferenciar cenários críticos versus não críticos e, portanto, fornecendo informações mais refinadas informações para os treinadores agirem.

3.3 Análise do jogo no voleibol de praia

As investigações cientificas que se centram da análise do jogo cresceram na última década no voleibol de praia (ALVARADO-RUANO; LOPE MARTINEZ, 2022). O estado atual da pesquisa na análise do jogo no voleibol de praia demonstra um crescimento 75% entre 2012-2022 comparada a década anterior, mas pesquisas ainda estão em fase precursora (LIMA et al., 2023) neste esporte relativamente novo (PALAO et al., 2015).

Dessa forma, a narrativa do estado da arte da análise do jogo no voleibol de praia nesse tópico é realizada com base em uma busca sistematizada nas principais bases de dados (Web of Science Core Collection (WoS) e SportiDiscus) em um primeiro momento em 2019 e atualizada em 2022. A estratégia escolhida foi a busca utilizando as seguintes combinações de acordo como Medeiros et al. (2014) e Silva et al., (2016): “*Beach Volleyball* " *AND "game analysis" OR "notational analysis" OR "match analysis" OR "performance analysis" OR "performance indicators" OR "technical analysis" OR "tactical analysis" OR "video analysis” OR "video recordis”.* O processo metodológico do levantamento foi realizado por dois pesquisadores independentes. Os artigos eram elegíveis se fossem publicados ou aceitos, com texto completo em inglês ou espanhol, publicados até 2022.

Os critérios de elegibilidade podem ser observados na estratégia PECOS: (P) jogadores de vôlei de praia, independentemente de sexo/gênero, faixa etária, habilidade, nível competitivo ou nível de especialização; (E) a análise de partidas (análise notacional) em jogos oficiais é considerada como exposição; (C) Não são necessárias comparações de resultados; (O) os resultados foram quaisquer efeitos nos indicadores de desempenho medidos durante os jogos; (S) o desenho do estudo limitou-se à metodologia observacional/notacional com qualquer tipo de análise de jogo quantitativa e/ou qualitativa. Após a triagem e exclusão de artigos duplicados e que não atendiam aos critérios de elegibilidade, foram incluídos para a revisão narrativa um total de 44 (2 revisões; 42 artigos) documentos sobre voleibol de praia. Após a análise de conteúdo dos artigos, optou-se por subdividir este tópico em: indicadores de desempenho esportivo no jogo de voleibol de praia, indicadores-

tático técnicos e o resultado no jogo do voleibol de praia e indicadores técnico-táticos em diferentes contextos de jogo.

A maioria dos estudos que têm buscado compreender o voleibol de praia a partir da análise do jogo, com foco em indicadores de desempenho físicos (PALAO et al., 2014; NATALI et al., 2019), temporais (PALAO; VALADES; ORTEGA, 2012; NATALI et al., 2019), técnicos e táticos (KOCH; TILP, 2009; BUSCA et al.,2012; MEDEIROS et al., 2014c; PALAO et al., 2019; JIMENEZ-OLMEDO; PUEO; PENICHET-TOMÁS, 2016, GIATIS, 2023) concentram suas investigações no jogo masculino a partir de sets regulares com poucas investigações do jogo das equipes femininas e a inclusão de *tie-breaks.*

Além disso, tem sido estudado a relação entre os indicadores de desempenho e contextos do jogo como resultado do jogo (vencer ou perder) (GIATSIS; TZETZIS, 2003 MEDEIROS et al., 2017, KUMAR et al., 2021; GIATIS et al.,2023,), nível competitivo (GEA; MOLINA, 2013; 2015), gênero **(**YIANNIS, 2008**)**, categoria competitiva (MEDEIROS et al., 2014), diferença de escore final do jogo (GIATSIS; PANAGIOTIS, 2008;) ou do set (COSTA et al, 2022), período do set (JIMÉNEZ-OLMEDO et al., 2012) e qualidade de oposição (MEDEIROS et al., 2014a). Todavia, no estudo dessas relações, as investigações no jogo feminino são em set regulares, apresentando uma lacuna de investigação no *tie-break.*

3.3.1 Indicadores de desempenho esportivo no jogo de voleibol de praia

Em uma primeira fase, a análise do jogo no voleibol de praia focou-se nos aspectos temporais e mudanças nas regras (GIATSIS, 2003), análises estatísticas de times vencedores e perdedores (GIATSIS; PANAGIOTIS, 2008) e comparação das ações tático-técnicas entre homens e mulheres (KOCH; TILP, 2009). Ao longo do tempo além das características físicas e temporais (PALAO et al., 2014; NATALI et al., 2019), evolui nas investigações das questões tático-técnicas (CHINCHILLA-MIRA et al., 2012; LINK; WENNING, 2019) e conferiu discreta atenção a interação entre os indicadores e as variáveis contextuais do jogo, como qualidade de oposição, período do set,

equilíbrio do set (MEDEIROS et al., 2014a; JIMENEZ-OLMEDO et al., 2014; GIATSIS., 2022).

De forma geral, as características temporais do jogo são importantes para nortear a especificidade de preparação física das equipes. A mudança nos sistemas de pontuação e tamanho da quadra (regras do jogo), nos anos 2000, impulsionou investigações relacionadas a duração do jogo e número de *rallies* (PALAO; VALADES; ORTEGA, 2012). Logo, alterações dessa natureza demostram efeito nas características físicas, uma vez que maior ou menor tempo de trabalho correlaciona-se com quantidade de saltos e contatos realizados pelos jogadores (PALAO et. al, 2014).

Os indicadores tático-técnicos assumiram papel de destaque nas pesquisas no voleibol de praia (GIATSIS; TZETZIS, 2003; LOPEZ-MARTINEZ; PALAO, 2009; CHINCHILLA-MIRA et al., 2012) pela possibilidade de conhecimento do comportamento das equipes adversarias e consequente poder decisivo de antecipação tática. Isto potencializa-se devido ao fato de ser jogado apenas por dois jogadores por equipe, aumentando sua previsibilidade.

Nas técnicas aplicadas no movimento de ataque e saque, o ataque potente e o saque em suspensão foram os mais utilizados por jogadores no vôlei de praia e mais eficazes para conquistar o ponto (KOCH; TILP, 2009). Ressalta-se que, ao observar as ações que antecedem o ataque, a eficácia da recepção teve uma relação direta com a eficácia do ataque e a conquista do *rally* (PALAO et al., 2019).

Percebe-se que as investigações cientificas passaram de caracterizações gerais dos jogadores e das equipes para estudos mais específicos, considerando o nível competitivo das equipes (ŠIMAC; GRGANTOV; MILIĆ, 2017), as fases do jogo (LINK; WENNINGER, 2019), e o efeito dos indicadores para resultado do jogo (PAPADOPOULOU; GIATSIS; BAKIRTZOGLOU, 2020, KUMAR et al., 2021).

Os estudos mais específicos são em sua maioria comparam os padrões de jogo em diferentes situações e contextos (LINK; WENNINGER, 2019; PEREZ-TUPIN et al., 2019) . Embora as modelagens preditivas tenham se configurando como uma mudança de paradigma no que diz respeito à forma de analisar e entender o jogo (KUMAR et al., 2021), predizer o rendimento final ainda é um desafio, assim como contemplar o contexto sequencial do jogo a

partir de interações dinâmicas que auxilia no entendimento do caráter situacional, contínuo e sequencial do jogo.

Recentemente, verificou-se que as estatísticas de jogo, independe do tipo de modelagens, relacionados aos indicadores de desempenho no voleibol de praia permanecem sendo tópicos de interesse da comunidade cientifica, especialmente relacionado aos indicadores tático-técnicos. Além disso, as ações técnico-táticas são as mais estudadas e comumente relacionadas ao espaço e à tarefa (LIMA et al., 2023). A análise das ações táticas e técnicas pode ser um importante indicador de sucesso, dando padrões e tendências de desempenho (PALAO et al., 2019).

3.3.2 Indicadores tático-técnicos e contexto no jogo do voleibol de praia

No contexto do resultado (vitória e derrota), o efeito do desempenho dos indicadores tático-técnicos no sucesso do resultado já foi descrito seja no nível do *rally*, do set e/ou de jogo. As equipes que vencerem os sets, no campeonato grego nos anos 2000, tiveram maior eficácia de saque quando comparado as equipes que perderam os sets (MICHALOPOULOU et al., 2005). Giatsis e Tzetis (2003) verificaram que além da eficácia de ataque, o menor número de erros foram os fatores que mais contribuíram para o sucesso das equipes após as mudanças nas dimensões da quadra (9x9 para 8x8) e no sistema de pontuação (para *rally*). Antes destas alterações, a qualidade de recepção mostrava-se mais relevante. Ainda no impacto da mudança nas regras e impacto nas ações do jogo em relação ao resultado, nos torneiros masculinos foi possível evidenciar a mudança no comportamento dos indicadores no sucesso das equipes, a recepção perdeu protagonismo para bloqueio como segunda ação mais relevante depois do ataque (GRGANTOV; KATIĆ; MARELIĆ, 2005).

O resultado do jogo pode ser obtido em dois tipos de partidas (2 ou 3 sets) e as ações relevantes para a vitória podem ser especificadas para tipo de partida. Nas partidas vencidas por 2 sets a 0, os jogadores apresentaram melhores desempenho em quase todas as ações quando comparadas as

outras conformações de resultado, sendo os erros de ataque do adversário o fator mais importante para as vitórias (GEORGE; PANAGIOTIS, 2008).

Palao e Ortega (2015) encontraram para as equipes vencedoras dos sets coeficientes, proporções e eficácia significativamente para o ataque no *side*-out, saque, recepção, levantamento e defesa. O sucesso foi alcançado pelas equipes masculinas de voleibol de praia por meio da interação de diferentes habilidades e jogo.

Nas equipes de categoria de base masculina as equipes vencedoras tiveram melhor desempenho no saque e contra-ataque (KII) por meio de erros de ataque dos oponentes, pontos de bloqueio e de ataque no contra-ataque (MEDEIROS et al., 2017).

Kumar et al., (2021) verificou que sete fatores estavam relacionados com vitórias em competições masculinas, cinco fatores foram positivamente relacionados (*break point,* ponto de serviço, porcentagem de pontos de ataque, bloqueio, erro do oponente) enquanto dois fatores (erro de recepção e erro de ataque) foram negativamente relacionado à vitória. No caso da competição feminina, sete fatores também foram relacionado à vitória, com quatro fatores (*break point,* porcentagem de pontos ataque, bloqueio e erro do oponente) foram positivamente relacionados enquanto três fatores (erro de recepção, erro de ataque, e atacado bloqueado) foram negativamente relacionados com a vitória.

Recentemente, Giatisis (2022) demostrou que os vencedores no campeonato mundial de voleibol de praia em todos os tipos de set tiveram melhor desempenho em todas as habilidades de pontuação (saque, ataque, bloqueio), eficiências de ataque e saque em comparação com seus oponentes.

Ataque, saque e bloqueio são as ações mais estudadas em ambas as modalidades (BUSCA et al., 2012; MEDEIROS et al., 2014; GIATSIS; LOPEZ-MARTINEZ; GEA, 2015; LINK; WENNINGER, 2019) Faz sentido que essas variáveis sejam as mais utilizadas na literatura científica devido à sua ligação com o resultado do *rally*, pois são ações terminais que podem resultar em um ponto, determinar o desenvolvimento do jogo e levar uma equipe à vitória ou derrota (STANKOVIC et al., 2019).

Destaque-se que diferentes contextos de jogo podem proporcionar diferentes métricas no desempenho bem-sucedido das ações durante o jogo, entre eles: qualidade de oposição, nível competitivo e momentos da partida e/ou do set.

O desafio de jogar uma partida disputada contra jogadores com classificação semelhante durante uma competição podem impactar ainda mais no desempenho de indicadores. Nesse sentido, apenas o estudo de Medeiros *et al*., (2014a) considera a qualidade de oposição utilizando um conjunto de critérios que estabelecem três níveis de jogos a partir da análise *de cluster.* Em jogos equilibrados número de ações técnicas que são realizadas com saltos pelos defensores foi maior no adulto do que que nas categorias de base. Já nos jogos desequilibrados não foram encontrados achados significativos.

Por outro lado, tem sido mais comum o estudo do nível competitivo, seja dos jogadores, equipes ou campeonatos, relacionados ao comportamento dos indicadores de desempenho no voleibol de praia. Nos campeonatos, as partidas do torneio principal, por exemplo, são mais equilibradas que as da rodada de qualificação (PALAO; VALADES; ORTEGA, 2012). A relação entre a posição dos jogadores no ranking final do torneio e a eficácia das ações de saque apresentou uma maior prevalência de sucesso
em saque com alta velocidade nos jogadores com posições mais altas no ranking final (BUSCÁ et al., 2012).

Duplas femininas de nível nacional apresentam comportamento defensivo diferente das de nível internacional no voleibol de praia, com maior número de erros de bloqueio para as primeiras colocadas no campeonato espanhol (GEA; MOLINA, 2013), porém sem diferença na segunda linha defensiva (GARCÍA; MARTÍN, 2014). No comportamento do padrão de saque, as duplas femininas adultas de nível internacional apresentam saques com trajetórias longas, transversais e com lateralidade, enquanto nas equipes de nível nacional as trajetórias são paralelas com centralidade (GEA; MOLINA, 2015).

Jogadores de voleibol de praia bem-sucedidos apresentaram coeficientes de eficácia significativamente maiores em comparação com os jogadores menos bem sucedidos em todas os seis elementos técnicos e táticos básicos analisadas do jogo. As maiores diferenças foram encontradas na fase

de *side-out* no levantamento, recepção e ataque (ŠIMAC; GRGANTOV; MILIĆ, 2017).

Na perspectiva dos diferentes períodos do jogo, Jimenez-Olmedo em seus estudos (JIMÉNEZ-OLMEDO et al., 2012; 2014) estabelece três momentos importantes ao longo do set no voleibol de praia, no qual atribuem potencial de influenciar no comportamento dos jogadores. No primeiro momento (F1) são analisadas as ações executadas entre o primeiro e o sétimo ponto (1 a 7), no segundo período (F2) entre o oitavo e decimo quartos pontos (8 a14) e no terceiro e último (F3) entre o décimo quinto e o vigésimo primeiro (15 a 21) em sets regulares. No primeiro período do set (ponto 1 ao 7) o saque com salto é o mais usado. Já no terceiro período (15 ao 21), quando o final do set se aproxima, os saques preferidos são do tipo flutuante com salto no masculino e sem salto no feminino, pois oferecem mais garantias de sucesso (JIMÉNEZ-OLMEDO et al., 2012; 2014).

Na investigação do sistema defensivo nos jogadores universitários de voleibol de praia, relacionado eficácia das ações de bloqueio nos sistemas de defesa (1:2 ou 3:1) ao longo do set, encontrou-se que o sistema 2:1 apresentou maior eficácia do que 1:2 nos dois últimos períodos intermediário e final (JIMENEZ-OLMEDO; PUEO; PENICHET-TOMÁS, 2016). A análise da evolução das ações ao longo dos sets apresenta diferenças entre F1 e F3 para as ações de bloqueio mais utilizadas: linha, saída de rede e diagonal (JIMENEZ-OLMEDO; PENICHET-TOMAS, 2017a).

4. MÉTODOS

4.1 Desenho do Estudo

Caracteriza-se como estudo observacional, nomoteticco, pontual e multidimensional (ANGUERA,2011), de natureza descritiva comparativa e associativa. O caráter descritivo caracteriza-se por apresentarem análises cumulativas de medidas globais de rendimento tendo como objetivo primordial identificar, descrever e caracterizar indicadores de rendimento. No comparativo é possível detectar performances diferenciais em função de determinados contextos do jogo. A associativa busca compreensão das relações existentes entre os indicadores de rendimento e os resultados dos jogos permite a identificação da performance em competição.

4.2 Amostra

A amostra incluiu 31 sets *tie-break* de jogos com qualidade de oposição *balanced* da categoria adulta feminina do campeonato mundial em 2019 (n=17), 2022 (n=14). Estas competições são uma das competições mais importantes do voleibol de praia organizada pela Federação Internacional de Voleibol (FIVB).

A seleção da amostra foi feita de acordo com os seguintes critérios:

a) foram estabelecidos três níveis de equipes (1, 2 e 3) a partir de uma análise de cluster de duas etapas (Medida de Distância: Probabilidade de registro; Critério de agrupamento: *Bayesian de Schwarz*) foi usado para classificar as equipes em níveis desempenho. Como recomendado por Taylor et al., (2008), Marcelino et al., (2012) e Medeiros et al., (2014), o número de clusters foi fixado em três e as variáveis utilizadas para o cálculo foram: total de jogos, pontos no final da competição, total de sets vencidos e perdidos, total de vitórias e derrotas. Estes dados foram coletados no site da FIVB. Após a análise do cluster, a amostra foi dividida em três grupos de acordo com a qualidade de equipes de oposição (Figura 1).

b) todos os sets *tie break* jogados entre equipes nível 1x1 e nível 2x2 foram analisados, totalizando 50% dos sets dos jogos que tiveram o set

decisivo em ambas as competições. Ressalta-se que não tiveram sets *tie-break* em confrontos nível 3 x 3.

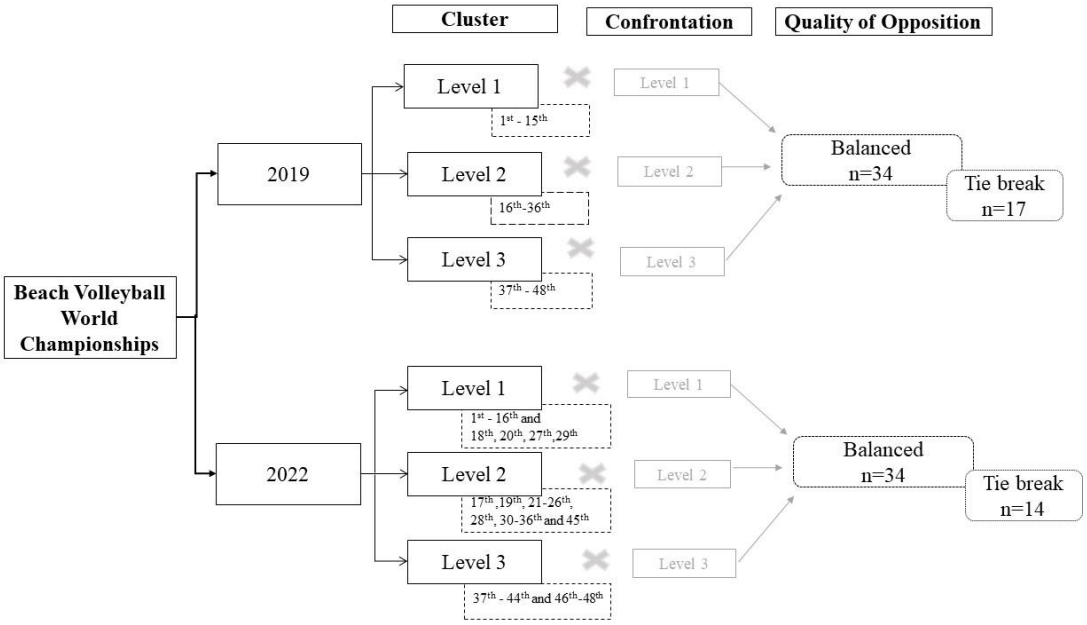

Figura 1. Seleção da amostra de acordo com a qualidade de oposição.

4.3 Procedimentos para coleta de dados

A primeira etapa consistiu na coleta dos registros em vídeo dos jogos. Todos os jogos foram filmados durante as competições por um Analista da Performance utilizando uma câmera de vídeo fixa e tripé. A câmera foi posicionada na arquibancada a uma distância aproximadamente de 10 metros da linha de base (linha de fundo da quadra) e em posição elevada com altura aproximadamente de 3 metros, possibilitando visão frontal boa, perspectiva de linhas e referências da quadra e, assim, a observação de todas as ações dos jogos, de acordo com os critérios pré-estabelecidos para a análise da dimensão considerada (MEDEIROS et al., 2014a). As gravações foram armazenadas em HD externo para posterior análise. Os vídeos foram analisados em um notebook (DELL®) com tela de alta definição de 15 polegadas. O software *Kinovea*® foi utilizado para auxiliar na análise de vídeo das partidas.

A técnica de observação utilizada é análise centrada no jogo (O'DONOGHUE, 2005). Esse tipo de investigação centrada tem contribuído de

forma substancial para o conhecimento de características, regularidades e particularidades dos comportamentos assumidos pelas equipes e jogadores no decorrer das competições (MARCELINO; SAMPAIO; MESQUITA, 2011)

Na segunda etapa, para garantir um protocolo de observação imparcial, os observadores foram devidamente formados e treinados com antecedência. As observações serão realizadas por especialistas em treinamento esportivo e com experiência no VP. Estes realizaram um processo de formação com três sessões de duas horas cada, seguindo os critérios para observação sugeridas por Anguera (2003).

Este processo de formação dos observadores foi dividido em duas partes relacionadas: a fase preparatória (mais teórica) com o objetivo de familiarizar os observadores com a conduta ou o comportamento de observar, onde os observadores poderão fazer perguntas sobre o processo de categorias que compõe o esquema de observação e que possam conhecer os tipos de registos que irão utilizar durante o processo de observação; a segunda fase (mais prática) incluirá atividades práticas que ajudará os observadores sobre como deverão realizar os registos durante o processo de observação.

As atividades que foram realizadas no processo de formação foram*:* a) Seleção de grupo de observadores, distribuição escrita e explicação dos sistemas de categorias e folha de registro; b) Exibição de exemplos de situações competitivas e gravações de outros Campeonatos Mundiais, para registro em conjunto, determinação de estratégias para categorias mais conflitantes; c) Registro individual e verificação dos acordos entre os observadores; d) Seleção de dois observadores com mais alto nível de concordância; e) Registro conjunto dos dois observadores selecionados para consenso em categorias conflitantes e posterior verificação de acordos alcançados; f) Registro final de quatro sets para teste final de confiabilidade .

Para garantir a confiabilidade das observações, foram calculados percentuais de acordos inter-observador e intra-observador. Para variáveis nominais, foi calculado um coeficiente de fiabilidade de Kappa (COHEN, 1968), nas quais, as observações apresentaram níveis de confiabilidade inter-observador e intra-observador superior a 0.85.

Por fim, alcançada a confiabilidade desejada, os jogos selecionados para compor a amostra foram observados. Durante esse processo, para evitar

qualquer efeito de aprendizagem, o observador analisou após quatro semanas da primeira observação, 10 % dos jogos totais analisados de forma aleatória. Para confiabilidade entre observadores, outros observadores analisaram também aleatoriamente 10% do total de jogos analisados anteriormente (TABACHINICK; FIDELL, 2007).

4.4 Instrumento

No presente estudo foi utilizado o Manual de Instrumento de observação das técnicas e da eficácia em Voleibol de Praia (TEBEVOL) desenhado e validado por Palao e Manzanares (2009) e Palao, Lopez e Ortega (2015), no qual explica as características do instrumento de observação e da folha de registro. Este instrumento foi projetado para recolher a informação das ações do jogo a partir das filmagens das partidas, dentre elas: ao contexto de jogo e informações da partida, ações realizadas pelos jogadores (tipo de técnica, zona realizada, ação prévia, pontualidade e eficácia da ação técnica). Para avaliar eficácia, utiliza-se escala de quatro ou cinco valores ou categorias. O menor valor indica erro e o maior valor a melhor eficácia possível (ex. ponto).

4.5 Variáveis de estudo

As variáveis analisadas serão: resultado do *tie-break* (vitória e derrota), tipo de *tie-break* de acordo com diferença no placar final, período do set *tie-break* e indicadores de performance tático-técnicos (saque, recepção, levantamento, ataque, bloqueio e defesa) por fase de jogo (*side-out* e contra-ataque (complexo II, III, IV)).

Tipo de *tie-break*: a categorização do tipo de *tie-break* foi realizada estatisticamente por meio de análise de cluster (NORUSIS, 2006) e produziu três clusters com a melhor distinção possível de acordo com a diferença de pontuação final do desempate: a) 2 pontos (mínima diferença de pontos), b) 3-4 pontos (média diferenças de pontos), c) acima de 5 pontos (máxima diferença de pontos).

Período do set *tie-break*: para verificar o momento do set, cada set será dividido em três períodos em início (P1), intermediário (P2) e final (P3), (JIMÉNEZ-OLMEDO et al., 2012;2016; 2017). sendo: P1- do ponto 1 ao 5, P2-

do ponto 6 ao 10 e P3- 11 até o final do set (JIMEZ-OLMEDO, PUEO, PENICHET-TOMAS, 2016, GARCIA-DE-ALCARAZ; USERO, 2019).

Indicadores de performance técnicos e tático: as variáveis foram número de pontos e erros de ataque, bloqueio e saque e coeficientes de performance do saque, recepção, levantamento, ataque, bloqueio e defesa. Considerando tanto como ações totais do jogo, como por fase ou complexo de jogo em side out (complexo I) e contra-ataque (complexo II, III e IV). A avaliação da eficácia dos complexos, deverá ser registado a eficácia que se produza na última ação realizada no complexo. Para tanto, as eficácias das ações técnicas foram avaliadas, de acordo com instrumento TEBEVOL:

- Saque: saque que vai para fora, não supera a rede ou que o sacador comete falta; saque que é neutralizado com uma recepção perfeita, permitindo ao distribuidor/a realizar todos os tempos de ataque de maneira ótima; saque que não permita uma recepção perfeita, mas permita enviar a bola ao atacante com opções de construir algum tipo de ataque; Saque que não permita uma recepção adequada e que anula todas as opções de ataque da equipe adversária e saque que cai no campo do adversário ou que a recepção não permita a continuidade em jogo.
- Levantamento: levantamento em que a jogadora comete falta em contato ou sem contato não há possibilidade da continuidade no jogo; levantamento que permita a continuidade no jogo, mas que não permita que a jogada conclua em ataque; levantamento que permita o ataque, mas com alguma restrição para as melhores condições de ataque e levantamento que permita um ataque sem limitação, com todas as melhores opções para o atacante.
- Ataque: ataque que vai para fora, não supera a rede, ou qualquer ação que resulte em erro para o ataque e ponto para a equipe adversária; ataque que finaliza em campo adversário e permita as máximas opções de ataque, com uma defesa perfeita; ataque que finaliza no próprio campo e que não permita nenhuma opção de ataque da própria equipe; ataque que não permita uma defesa ou cobertura perfeita, dificultando a ação do atacante em segundo contato para optar por todos os tempos de ataque de maneira óptima, dirigindo ao próprio campo ou para o

campo do adversário; ataque que finaliza no campo do adversário e não permita nenhuma opção de ataque da equipe adversária; ataque que finaliza no próprio campo e que permita uma defesa ou cobertura perfeita, facilitando a ação do atacante em segundo contato, optando por todos os tempos de ataque.

- Bloqueio: bloqueio que vai para fora, não supera a rede, ou qualquer ação que resulte em erro para o bloqueio e ponto para a equipe adversária; bloqueio que finaliza no campo da equipe que defende e permite todas as opções de ataque, resultando uma defesa perfeita na equipe adversária; bloqueio que finaliza em campo da equipe que ataca e não permite nenhuma opção de ataque; bloqueio que implica uma defesa ou cobertura, limitando todas as opções da equipe que bloqueia, dificultando a ação do atacante no segundo contato e disponibilizando todos os tempos de ataque, quer no próprio campo ou no campo adversário; bloqueio que finaliza em campo da equipe que defende e não permite nenhuma opção de ataque da equipe adversária; bloqueio que finaliza em campo da equipe que ataca e permite uma defesa ou cobertura perfeita, facilitando a ação do atacante no segundo contato e disponibilizando todos os tempos de ataque.
- Defesa: defesa que cai no campo da equipe analisada ou que não permita continuidade no jogo; defesa que não permita alguma opção de ataque da equipe analisada, mas possibilita a continuidade no jogo; defesa que dificulta a ação do atacante em segundo contato, disponibilizando todos os tempos de ataque de maneira ótima; defesa que permita o atacante optar por todos os tempos de ataque de maneira óptima.
- Recepção: recepção que cai no campo da equipe analisada ou que não permita a continuidade no jogo; recepção que anula qualquer opção de ataque da equipe analisada, mas possibilite a continuidade no jogo; recepção que dificulta a ação do atacante em segundo contato, disponibilizando todos os tempos de ataque de maneira óptima; recepção perfeita que permita o atacante optar por todos os tempos de ataque de maneira óptima.

4.6 Análise Estatística

Na análise descrita foram utilizados média, desvio padrão e frequências (absoluta e relativa) de acordo com a natureza das variáveis, estratificadas nos resultados de vitória e derrota. Além disso, estatísticas descritivas foram usadas para caracterizar os indicadores de desempenho técnico-tático de acordo com o resultado tanto para diferença de pontuação final do *tie break* quanto para diferentes períodos do set. Para análise inferencial foi verificada a normalidade dos dados e então aplicado teste para comparar a diferença média das variáveis de acordo com resultado, tipos de *tie break* e os períodos do *tie break.*

O teste t de amostras independentes foi utilizado para comparar os indicadores de desempenho técnico-tático entre vencedores e perdedores e em todos os tipos de sets. Devido à distribuição não normal de algumas variáveis, foi considerado o teste de homogeneidade de variância no teste t para amostras independentes. Quando os dados violaram o pressuposto de homogeneidade de variância, foram utilizados os procedimentos da estatística t para variações desiguais. O nível alfa foi definido em 0,05. As análises estatísticas foram realizadas utilizando SPSS 22.0 ® (Statistical Package for the Social Sciences, SPSS Inc).

Tamanhos de efeito (ES) em intervalos de confiança (IC) de 95% usando diferenças padronizadas em médias (SDMs) foram calculados para a magnitude da mudança no desempenho para cada indicador tático-técnico, que foi rotulada como: d (0,01) = muito pequeno, d (0,2) = pequeno, d (0,5) = médio, d (0,8) = grande, d (1,2) = muito grande e d (2,0) = enorme (SAWILOWSKY, 2009). Ressalta-se foram utilizadas as diferentes versões de medidas de tamanho de efeito na família d (LAKENS, 2013).

Os ES foram relatados usando o Δ de Glass para variâncias desiguais, o d de Cohen para variâncias iguais e a correção aplicada de Hedges (g de Hedge) para corrigir o viés em pequenas amostras nos grupos de diferença final da pontuação do desempate. O tamanho do efeito da linguagem comum, também chamado de probabilidade de superioridade, foi relatado além do d to de Cohen ou g de Hedgee para facilitar a interpretação do tamanho do efeito. As ES foram realizadas em planilha suplementar do Microsoft Excel® de Lakens (2013) e gráficos no GraphPad Prism®.

O método de *Generalized Estimation Equations* (GEE) foi aplicada para identificar a influência das interações do período do set *tie break* e resultado do *tie break* nas variáveis técnicas e táticas. Teste *post-hoc* Bonferroni foi realizado para estabelecer comparações entre os grupos. Considerando as variáveis eventos discretos ou contínuos testamos o modelo log-lineares com distribuição binominal negativa como recomendado por Nevill et al., (2002). Este quando comparado a outras possíveis distribuições apresentou o menor critério de ajuste do modelo.

Além disso, uma regressão logística binaria pelo GEE estimou as probabilidades associadas performances dos indicadores em cada período ao resultado do tie break (vitória (1) ou derrota (0)). Conforme sugerido por Crawley (2007), a simplificação do modelo foi realizada pela seleção *backward* das variáveis de cada modelo completo e pelo estabelecimento de um modelo para cada indicador de desempenho do grupo (número de pontos e erros, coeficientes de desempenho para a fase side-out e coeficientes de desempenho para a fase de contra-ataque). A seleção do modelo foi baseada no menor QIC. A significância estatística dos efeitos fixos associados às covariáveis incluídas no modelo foi avaliada pelo teste de *Wald*. Não há evidências de heterocedasticidade nos resíduos. As relações foram determinadas pela razão de chances e seus intervalos de confiança de 95%. O nível alfa foi definido em 0,05. As análises estatísticas foram realizadas utilizando SPSS 22.0 ® (Statistical Package for the Social Sciences, SPSS Inc) e gráficos no GraphPad Prism®.

Ademais, para realizar a bibliométrica de artigos sobre análise de jogo de voleibol de praia, o pacote *"Bibliometrics"* do software RStudio versão 4.02 e as ferramentas do software VOSviewer foram utilizados para realizar estudos bibliométricos descritivos (perfil de pesquisa), científicos, análises de mapeamento (análise de citações) e os respectivos gráficos.

4.7 Aspectos Éticos

Esta pesquisa foi submetida a apreciação de um Comitê de Ética Humana, uma vez que se configura a utilização de bancos de dados (jogos filmados), cujas informações são agregadas, com possibilidade de identificação

individual. Tendo sido aprovada pelo Comitê de Ética em Pesquisa da UECE via Plataforma Brasil.

5 RESULTADOS E DISCUSSÃO

Esta tese foi estruturada no formato de artigos conforme possibilidade apresentada na norma n 001/2015 do PAPGED UPE/UFPB. A execução desta tese resultou na produção de 3 artigos originais que compõem o capítulo de resultados e discussão apresentados a seguir:

O primeiro artigo intitulado ***Status of Match Analysis Research in Indoor and Beach Volleyball: A bibliometric analysis*** foi publicado na revista *RETOS*.

O segundo artigo intitulado ***Technical-tactical performance difference between winning and losing teams in a women's beach volleyball tie break*** será submetido na revista *Internacional Performance Analysis.*

O terceiro artigo provisoriamente intitulado ***Technical-tactical performance indicators to be explored in each tiebreak period to win elite women's beach volleyball matches.***

5.1 Artigo 1

2023, Retos, 50, 838-848

Status of Match Analysis Research in Indoor and Beach Volleyball: A bibliometric analysis
Situación de los estudios de investigación en voleibol y de vóley playa: Un análisis bibliométrico

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Abstract. Over the last decade, the growth of match analysis in indoor and beach volleyball indicates the relevance of the subject to provide a structured and up-to-date picture of the state of the art. The purpose of this article was to present a bibliometric analysis of articles on match analysis in indoor and beach volleyball. A total of 179 and 44 articles from indoor and beach volleyball, respectively, indexed in Web of Science or Scopus were reviewed. Outcome measures were extracted and analyzed using R Bibliometrics package or VOSviewer software. Bibliometric indicators of productivity included: number of articles published per year, most productive authors, institutions, countries and journals, top-10 most cited articles, most frequent topics, and authors co-authorship. Match analysis was covered in 82.3% in volleyball and 75% in beach volleyball in the last ten years, with most articles published in few journals. Authors affiliated in institutions from Portugal (volleyball) and Spain (beach volleyball) seemed to have made the largest contribution to this area. The trending topics of the most cited studies included quality of opposition (volleyball) and tactical-technical aspects (beach volleyball). In both sports, tactical-technical actions were the most studied units of analysis, with the international-level adult male game being the most investigated. In conclusion, this study provides research profiling, classifications for the initial research phase and research direction for future research in this subject area.
Keywords: scientific production, performance analysis, sports performance, bibliometric.

Resumen. Durante la última década, el crecimiento del análisis de partidos en voleibol de sala y de playa indica la relevancia del tema para proporcionar una imagen estructurada y actualizada del estado del arte. El propósito de este artículo fue presentar un análisis bibliométrico de artículos sobre análisis de partidos en voleibol de sala y de playa. Se revisaron un total de 179 y 44 artículos de voleibol de playa y sala, respectivamente, indexados en Web of Science o Scopus. Las medidas de resultado se extrajeron y analizaron mediante el paquete R Bibliometrics o el software VOSviewer. Los indicadores bibliométricos de productividad incluyeron: número de artículos publicados por año, autores más productivos, instituciones, países y revistas, los 10 artículos más citados, temas más frecuentes y coautoría de los autores. El análisis de partidos se cubrió en un 82,3 % en voleibol y en un 75 % en voleibol de playa, y la mayoría de los artículos se publicaron en pocas revistas. Los autores afiliados a instituciones de Portugal (voleibol) y España (voleibol de playa) parecen haber hecho la mayor contribución a esta área. Los temas de tendencia de los estudios más citados incluyeron la calidad de la oposición (voleibol) y los aspectos técnico-tácticos (voleibol de playa). En ambos deportes, las acciones técnico-tácticas fueron las unidades de análisis más estudiadas, siendo el juego masculino adulto de nivel internacional el más investigado. En conclusión, este estudio proporciona perfiles de investigación, clasificaciones para la fase de investigación inicial y dirección de investigación para futuras investigaciones en esta área temática.
Palabras clave: producción científica, análisis del rendimiento, rendimiento deportivo, bibliometría.

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Introduction

Indoor volleyball has originated beach volleyball, hence, both sports have similar game structures and belong to the same federation. Indoor and beach volleyball are among the most popular events at the Olympic Games. In the last two decades, both sports have grown rapidly (FIVB, 2023). This happened in part due to the overwhelming spectator/TV viewer success and to the great success of world competitions. Indoor volleyball is now one of the big five international sports with the largest international sports federation in the world. And beach volleyball is rather a young international top-level sport that continues to amaze with the high level of athletes' participation at all world competitions (FIVB, 2023).

In line with this sport trend, scientific investigations that focus on sports performance analysis remain on the rise (Martin et al., 2021). Performance analysis via match analysis is a topic of current interest in Sports Science (Fernández-Echevérria et al., 2017), which includes indoor and beach volleyball (Medeiros et al., 2014; Silva et., 2016). This involves understanding the constraints that promote sporting success to improve the team's game (McGarry, 2009; Martins, et al., 2022). Match analysis is perhaps one of the most important tools that coaches need to analyze games. Therefore, it has an important place in the scientific literature related to knowledge production in Sport (Fernández-Echevérria et al., 2017). Consequently, the growth of scientific investigations makes this scope an interesting subject of bibliometric studies.

Bibliometric studies are quantitative studies of production, growth, maturation, and consumption of scientific publications using bibliometric techniques (Moral-Muñoz

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et al., 2020). Researchers, institutions and countries evaluate performance through bibliographic indexes based on publications (i.e. titles, journals, authors, institutions, etc.) and citations data (Aria & Cuccurullo, 2017). In addition, it is possible to explore the relationships among the analysis items and perform a topological and temporal representation of the cognitive and social structure of a given field of research by science mapping analysis (Van-Eck & Waltman, 2010).

Recently, the use of bibliometric analysis to quantify specific research fields or journals has become more common (Feng et al., 2022). There are several bibliometric studies related to sports modalities (Mamani-Jilaja et al., 2023), such as in badminton (Blanca-Torres et al. 2020), handball (Ibáñez, Gil & Chenoll, 2021), basketball (Maciel et al., 2019), football (Adán et al., 2020), or soccer (Garcia-Angulo & Ortega., 2015). Nevertheless, there is a gap in bibliometric studies regarding indoor and beach volleyball.

Previous qualitative reviews conducted by Alvarado Ruano & Lopez Martinez, 2022; Silva et al., 2016; and Medeiros et al. 2014, Mesquita et al.,2013 offer some insights in specific aspects of the area. However, compared to traditional literature review methods, the bibliometric analysis is advantageous for a better understanding of the evolution of research in a multidimensional, visual and objectivity analysis (Feng et al., 2022). That said, great potential remains related to research in indoor and beach volleyball match analysis, as the overall bibliometric scientific landscape has not been thoroughly analyzed so far.

All things considered, it is intended to identify the characteristics and trends of research in the scientific production on the subject. Therefore, this study aims to explore a bibliometric analysis and science mapping of match analysis in indoor and beach volleyball. This investigation can guide researchers to identify currently relevant, research topics and gaps, provide guidance for future research pathways, as well as collaboration opportunities.

Methods

Database and search strategy

Data were extracted from two databases: Scopus and Web of Science (WoS). Both databases have a large collection of journals and are widely used in various research (Liu & Avello, 2021; Lastella et al., 2020). Also, they are used to address high quality results by including complete bibliometric data (Diem & Wolter, 2013). To ensure a high quality, two classic index types in the WoS were selected, including Core Collection and Scielo Citation Index.

The search terms used in the formula were based on systematic reviews related to match analysis in indoor volleyball and beach volleyball conducted respectively by Silva et al., (2016) and Medeiros et al., (2014). The two keywords "Beach Volleyball" or "Volleyball" were typed in association using the operator "AND" with the keywords that represented match analysis (See figure 1).

As usual in bibliometric analyses performed in literature searches (Lastella et al., 2020), the types of reports selected were articles and reviews, in English, Spanish and Portuguese (due to the specificity of the theme), published without a low time frame limit and included all publications until the end of December 2022.

Furthermore, due to the broad range of different research areas addressed by WoS, we focused on Sports Science only. In this way, the reports identified for screening and eligibility were 1.730 in Scopus and 1.235 in WoS related to indoor volleyball and 250 in Scopus and 2.596 in WoS related to beach volleyball. The overall search strategy employed in the current study is shown in Figure 1.

Eligibility criteria

Eligibility criteria might be observed in the PECOS strategy: (P) beach volleyball or indoor volleyball players, regardless of sex/gender, age group, skill, competitive level, or level of expertise; (E) the analysis of matches in(notational analysis) in official games is considered as exposure; (C) No comparisons required outcomes; (O) outcomes were any effects on indicators of performance measured during games; (S) study design was limited to observational/notational methodology with any type of quantitative and/or qualitative game analysis.

Thus, a manual review of titles, abstracts and, if necessary, full text was performed, with the aim of excluding articles with experimental study design in no official games or small-sided games, with the use of electronic performance (i.e. global positioning system) and tracking systems and other sports (i.e sitting volleyball). Methodological research was performed by two independent researchers (F.R. and I.D.), and later evaluated by a third researcher (V.L.) in case of uncertainty between the two researchers regarding eligibility. Based on the final search, a csv (Scopus) or plain text (WoS) files were exported from the databases and were imported into bibliometric tools and executed to unify files, remove duplicate articles, replace abbreviations with their full designation, and determine bibliometric features in the extracted data.

After reports exclusion and analysis of duplicates in automatic and manual databases, a total of 179 (3 reviews; 176 articles) reports on indoor volleyball and 44 (2 reviews; 42 articles) on beach volleyball were included in the bibliometric analysis (Figure 1).

Analysis of bibliometric data

"Bibliometrics" package in RStudio software version 4.02 and VOSviewer software tools were used to conduct descriptive bibliometric (research profiling), scientific mapping analyses (citation analysis) and the respective graphs (Moral-Muñoz et al., 2020). Specific tools for bibiometric analysis were chosen because R package bibliometrix and corresponding web interface biblioshiny (Aria & Cuccurullo, 2017) can run the large number of different analyses, while Java program VOSviewer software (Van-

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Eck & Waltman, 2010) provides excellent network visualizations. Excel 365® and GraphPad Prism were also used. Results were presented through graphs, tables and network visualisation maps.

In this bibliometric study, general performance analysis of research component contributions (research profiling) was analyzed on three different level metrics: source (e.g. journals), author (e.g., institutions) and document (e.g. articles) using publication counts that reflect productivity and citations to measure impact and influence. Furthermore, relationships among the components (scientific mapping) and social structures of knowledge were analyzed (Aria & Cuccurullo, 2017).

Final analysis included the 10 most relevant journals and authors, the five most relevant countries and institutions, authors' and countries' Collaboration Network, 10 top-cited articles, and the most frequent thematic information. The Hirsch index (h-index) of the leading journals and authors was also reported as a proxy measure of the influence (Brand & Brook, 2016) on the set of analyzed publications. Additionally, journal impact factor (JIF) and CiteScore were reported for the leading journals publishing match analysis research in indoor and beach volleyball, as they are commonly used measures of scientific influence of scholarly journals (Lastella, Memon & Vicent, 2020). JIF data was obtained from the Journal Citation Report (JCR) in 2021, and CiteScore (https://journalmetrics.scopus.com/) from Elsevier. Detailed categories and variables analyzed are presented in Table 1.

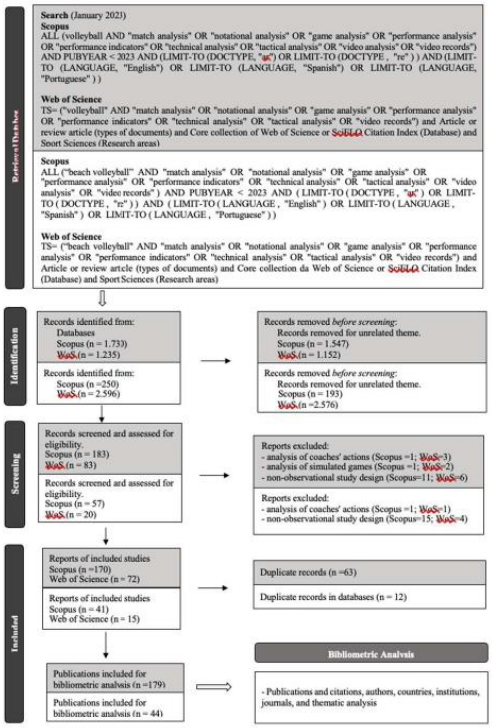

Figure 1. Flow diagram of research strategy and article selection of bibliometric study in indoor and beach volleyball. Gray and white colours refer to indoor and beach volleyball (respectively).

Table 1.
Bibliometric metrics, categories, variables, and statistic tools.

Metrics	Item / information	Variables	Analysis
Overview	Annual Scientific Production	Number of articles published per year Annual growth rate Stratified growth rate (SGR)*	R package bibliometrix/biblioshiny
Source	Most relevant journals	Number of articles published in the journal Total of citations per journal Bradford's Law H-index Journals index 2021 (JCR and Cite Score)	R package bibliometrix/biblioshiny
Authors	Most relevant authors. Author's local impact Authorship pattern	-Number of authors -Top-five authors in number of articles published -Total Citation of articles published by author -Lotka's Law coefficient estimation -Average number of authors per article	R package bibliometrix/biblioshiny
	Countries' Scientific Production	-Top-five countries in number of articles -published by authors. -Total citation of articles published by authors and affiliation countries	R package bibliometrix/biblioshiny
	Most productive institutions	-Top-five institutions: number of all co-authors for each paper	R package bibliometrix/biblioshiny
Social Structure	Authors and Countries network collaboration	-Co-authorship Network Visualization Map	VOSviewer
Documents	Top 10 most Cited articles	-Top-ten list of manuscripts sorted by number of citations	R package bibliometrix/biblioshiny
	Most frequent thematic information	Number of articles that covered specific topics about: a) Match context - Unit of analysis - Gender - Competitive level - Competitive category -Match Status - Quality of opposition - Home/Away Advantage - Result (win or loss) of the match, set, and rally b) Game situation - Temporal characteristics - Phase or Complex c) Technical-tactical situations - Player's role -Actions (skill) - Space or task#	Exel

* SGR was based on the equation: (Ending Value − Beginning Value)/Beginning Value] × 100 [refe). Ending Value is the final number of articles published in the period. Beginning Value is the initial number of articles published in the period. #information regarding manner of execution (technique, temporal and spatial situations, and performance). and the efficacy of action.

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Results

Annual Scientific Production

Research related to match analysis in indoor volleyball and beach volleyball began to appear in the scientific community from the 1990s and 2000s, respectively. In the first decade, four and zero articles were computed in indoor and beach volleyball, respectively. Between 2003 and 2012 proven results increased 7 times in the publication of articles in volleyball and the annual scientific production in beach volleyball totaled 11 articles. After 2013, indoor volleyball academic production was 147 articles (a 5x increase over the previous decade) and beach volleyball 33 articles (a 3x increase) until 2022. The most productive years in indoor volleyball were 2018 (n=22), 2016 and 2021 (19 articles each). 2014 (n=6) and 2019 and 2020 (n=5) were the most productive in beach volleyball (Figure 2). Overall, the annual growth rate at Scopus was 7.4% in indoor volleyball from 1992-2022 and 2.4% in beach volleyball from 2005-2022. SGR was 600% (2003-2012) and 425% (2013-2022) in indoor volleyball and 200% (2013-2022) in beach volleyball.

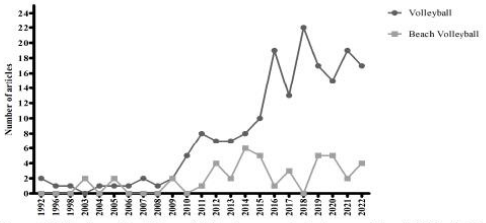

Figure 2. Number of articles published per year in indoor and beach Volleyball. Years without publications were removed.

Most Relevant journals

In total, 46 journals included indoor volleyball studies, while 25 published articles related to beach volleyball. 37.9% and 76.0%. of indoor and beach volleyball studies, respectively, included in this review belonged to top-five journals that published in this area.

Among all the relevant journals, the International Journal of Performance Analysis in Sport is a leader among source disseminating research on match analysis in indoor and beach volleyball with 27 (15%) and 6 (13.6%) articles, respectively. Besides, it showed the highest impact on the research field in the set of publications, its h-index (15 indoor volleyball and 4 beach volleyball) stood out from the remaining source titles.

The journal's indexing status complements descriptive information for the top- five on the lists. The highest impact factor among the top-five most relevant journals is the Journal of Human Kinetics (JIF =2.923 Cite Score = 4.0) and Journal of Sports Science and Medicine (JIF = 4.0; Cite Score 5.2), indoor and beach volleyball, respectively (Table 2).

In addition, through the application of Bradford's Law (Bradford, 1934), an uneven distribution of articles in journals was noted. A large number of articles were found in a small number of journals. As shown in Figure 3, in the core, only 5 (10%) journals concentrated 37.9% (n=68) of all publications in indoor volleyball and 3 (12%) journals published 34% (n=15) of all studies related to beach volleyball. The opposite happens in zone 3, a high number of journals (33;70.2% indoor volleyball and 14;50% beach volleyball) with few articles (58;32.4% and 14;31.8%, respectively).

Table 2.
Top-five journals publishing in indoor and beach volleyball match analysis.

	Journals	Articles	TC	H- index	Cite Score 2021	JIF 2021
Volleyball	International Journal of Performance Analysis in Sport	27	488	15	3.7	2.4
	Journal of Human Kinetics	12	162	7	4.0	2.9
	Journal of Physical Education and Sport	10	45	5	2.2	-
	Revista Internacional de Medicina y Ciencias de la actividad física y del Deporte	10	34	3	2.2	-
	Journal of Human Sport and Exercise	9	46	4	2.1	0.28*
Beach Volleyball	International Journal of Performance Analysis in Sport	6	49	4	3.7	2.4
	Journal of Human Sport and Exercise	5	30	3	2.1	0.28*
	Journal of Physical Education and Sport	4	18	2	2.2	-
	Frontiers in Psychology	2	12	2	4.0	4.2
	Journal of Sports Science and Medicine	2	26	2	5.2	4.0
	Kinesiology	2	61	2	2.4	1.1

Legend: TC= total citation; JIF = Journal Impact Factor. * Journal Citation Indicator published by a journal over a recent three-year period.

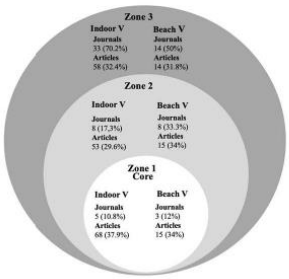

Figure 3. Dispersion of scientific production in Bradford rings related to match analysis in indoor (V) and beach volleyball (V).

Most relevant authors and author's local impact

A total of 302 authors published 179 articles in indoor volleyball, while 78 published 44 articles in beach volleyball. The average number of authors per document was 4.17 and 3.56 in indoor volleyball and beach volleyball, respectively. In addition, author productivity through Lotka's Law was 61.5% (n=186) on indoor volleyball and 61.3% on beach volleyball (n=48). Lotka's Law (Lotka, 1926) postulates that about 60%of authors make only one contribution in their field of study.

The top-ten most productive authors in indoor volleyball concerning the number of studies published were from

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Spain (n=4), Portugal (n=3), Greece (n=2) and Brazil (n=1). The number one at the list of the most productive authors (Figure 4) with articles published (n=30), citations (n=849) and local h-index (n=15) was Isabel Mesquita from the University of Porto (Portugal), the majority published as a senior/last author. Among the top-ten authors, Gustavo Conti (n=15), Sotirios Drikos (n=9) and Antonio Garcia-de-Alcaraz (n=9) had the highest number of publications as the first author.

On the other hand, the top-ten authors in beach volleyball (Figure 4) were from Spain (n=5), Portugal (n=2), Greece ((n=1), Brazil (n=1) and Germany (n=1). Jose Palao (Spain), currently in the University of Wisconsin (USA), was first ranked in publications (n=11), with the highest number of citations (n=134) and local h-index (n=8). Among the top-ten authors, Jose Palao (n=6), George Giatsis (n= 6) and Alexandre Medeiros (n=5) had the highest number of published articles as first authors.

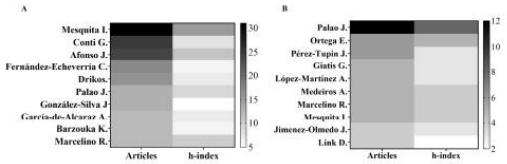

Figure 4. Top-ten most productive (number of articles) authors and h-index in (A)indoor and (B) beach volleyball match analysis.

Countries' Scientific Production

Authors from 28 countries contributed to publications in the area, 15 on indoor and 13 beach volleyball. The top-five countries were mostly Europe, except Brazil and United States of America. A total of 210 authors from these top-five countries published the articles included in this bibliometric study: 165 (54.6.% in indoor volleyball) and 45 (57.6% in beach volleyball). Spain was the most productive country in both modalities and Portugal and Greece ranked second in indoor and beach volleyball, respectively (Figure 5). The three countries with the highest number of citations in articles by authors affiliated to their institutions were: Portugal (n=1229) followed by Spain (n=69) and Brazil (n=39) in volleyball, while in beach volleyball the sequence was Spain (n=217), Portugal (n=59) and Greece (n=40).

Most productive institutions

Authors from 34 and 31 affiliations published on match analysis in indoor and beach volleyball, respectively. The top-five most productive institutions were from the top-five most productive countries. The University of Porto (Portugal) was ranked the first place as the most active institution in indoor volleyball (13.5% of publications), while the University of Alicante (Spain) was the most productive institution in beach volleyball (24.4%) (Figure 5). The institutions ranked second and third were University of Extremadura (10.3%) and University of Athens (10.15) in indoor volleyball, University of Athens (9.6%) and Catholics University of Saint Anthony (8.8%) in beach volleyball.

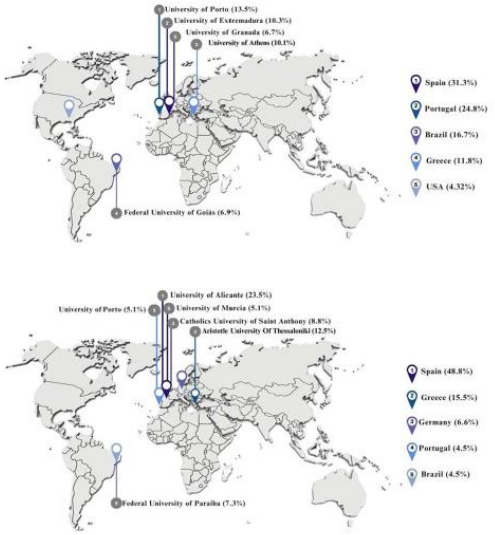

Figure 5. Top-five most productive countries and institutions in indoor (upper panel) and beach volleyball (lower panel) match analysis.

Authors and Countries Collaboration Network (Co-authorship)

Co-authorship network analysis produced a map for authors using VOSviewer and the number of documents for each author is indicated by the size of the colored dot (Figure 6). International co-authorships have shown 31.21% and 29.27% in indoor and beach volleyball, respectively.

The largest set of connected items in network visualization map on indoor volleyball comprised 213 authors in twenty different color clusters. Analysis shows the co-authorship connections between the authors group affiliated in Portugal (i.e., cluster led by Mesquita and by Afonso), Spain (i.e., cluster led by Fernandez -Echeverria) and Brazil (i.e. cluster led by Costa Conti) institutions. Among all of them, the strongest collaboration was presented by Afonso (link strength=99) and Mesquita (link strength=91). In beach volleyball, the network encompassed 15 clusters relating 90 items and some were not connected to each other. The largest connection set had 58 items. The yellow cluster comprised 10 Spanish authors: Palao (link strength=29), Ortega (link strength=14) and Pérez-Tupin (link strength=18) affiliated in Spain were the strongest collaborators among the networks. Also, it was noted that there was a connection between the affiliated authors in Spain (red cluster) and Greece (dark blue cluster lead by Giatsis); Spain (yellow) with Portugal (light blue) and led by the most relevant authors from the top-ten list.

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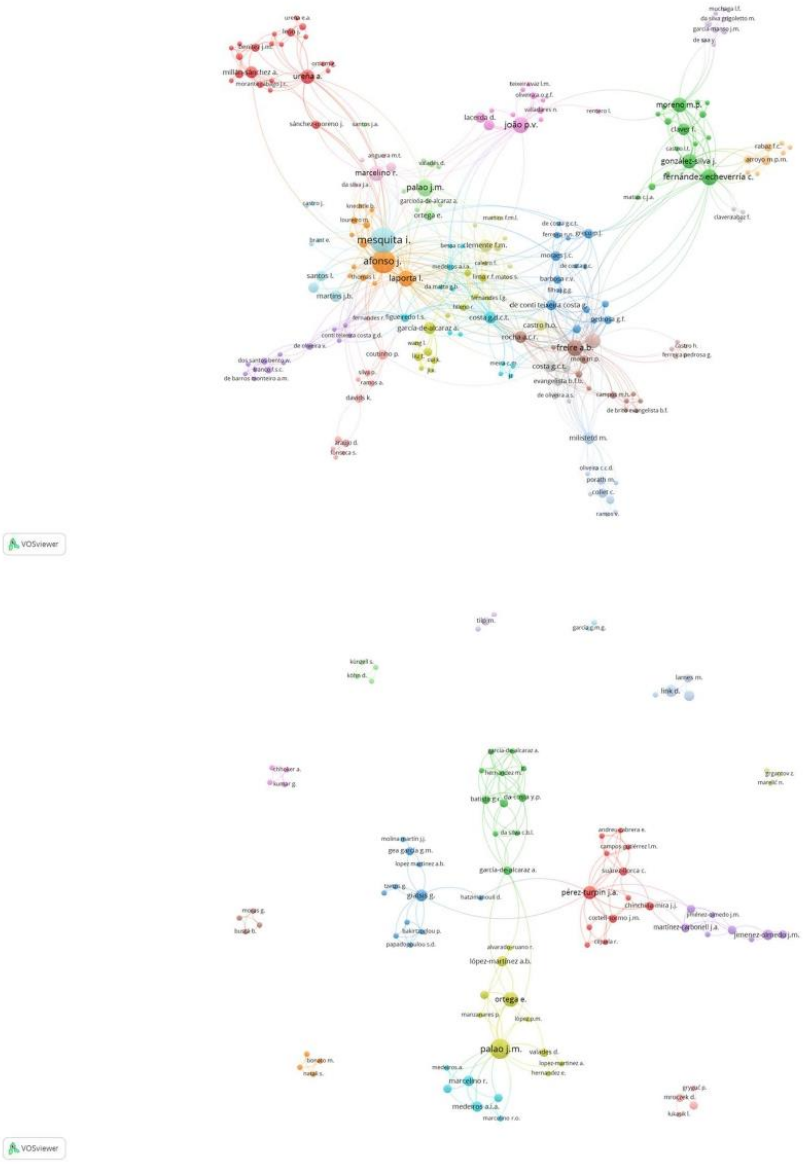

Figure 6. Network visualization map of author documents with more than one contribution in indoor volleyball (upper panel) and beach volleyball (lower panel).

Top 10 most cited articles

The most cited study in indoor volleyball was "Statistical Analyses of Volleyball Team Performance" in the Research Quarterly for Exercise and Sport (107 citations), published in 1992 (3.34 average citations per year) (Table 3). Articles that studied attack, contextual scenarios such opponent's quality and home/away advantage and statistics of technical-tactical elements related to victory and defeat were among the 10 most cited. On the other hand, in beach volleyball, the most cited paper was "Beach volleyball techniques and tactics: a comparison of male and female playing characteristics", published in 2009 in the Kinesiology, with 51 citations and 1.67 average citations per year (Table 3). Differences in the pattern of technical-tactical, physical, and temporal game in relation to age, gender, play role are among the most cited articles.

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Table 3.
Top- 10 most cited articles in indoor and beach volleyball match analysis.

	Cited by	Authors	Title	Year	Source title	Citations per year
Volleyball	102	Marcelino R., Mesquita I., Sampaio J.	Effects of quality of opposition and match status on technical and tactical performances in elite volleyball	2011	Journal of Sports Sciences	7.85
	83	Afonso J., Mesquita I., Marcelino R., Silva J.A.	Analysis of the setters tactical action in high-performance women's volleyball	2010	Kinesiology	5.93
	67	Raab M., Gula, B., Gigerenzer G.	The hot hand exists in volleyball and is used for allocation decisions	2012	Journal of Experimental Psychology: Applied	5.58
	67	Castro J., Souza A., Mesquita I.	Attack efficacy in volleyball: elite male teams	2011	Perceptual and Motor Skills	6.20
	65	Peña J., Rodrigues-Gerra J., Buscá B., Serra N.	Which skills and factors better predict winning and losing in high-level men's volleyball?	2013	Journal of Strength Conditioning Research	5.91
	63	Marcelino R., Sampaio J., Mesquita I.	Attack and serve performances according to the match period and quality of opposition in elite volleyball matches	2012	Journal of Strength Conditioning Research	6.11
	62	Costa G., Afonso J., Brant E., Mesquita I.	Differences in game patterns between male and female youth volleyball	2012	Kinesiology	5.17
	60	Afonso J., Esteves F., Araújo R., Thomas L., Mesquita I.	Tactical determinants of setting zone in elite men's volleyball	2012	Journal of Sports Science and Medicine	5.0
	57	Marcelino R., Mesquita I., Palao J., Sampaio J.	Home advantage in high-level volleyball varies according to set number	2009	Journal of Sports Science and Medicine	3.80
	52	Afonso J., Mesquita I.	Determinants of block cohesiveness and attack efficacy in high-level women's volleyball	2011	European Journal of Sport Science	4.00
Beach Volleyball	51	Koch C., Tilp M.	Beach volleyball techniques and tactics: a comparison of male and female playing characteristics	2009	Kinesiology	1.67
	28	Grgantov Z., Katic R., Marelic N.	Effect of new rules on the correlation between situation parameters and performance in beach volleyball	2005	Collegium Antropologicum	1.17
	21	Medeiros A., Marcelino R., Mesquita I., Palao J.	Physical and temporal characteristics of under 19, under 21 and senior male beach volleyball players	2014	Journal of Sports Science and Medicine	2.10
	20	Palao J., Valades D., Ortega E.	Match duration and number of rallies in men's and women's 2000-2010 FIVB world tour beach volleyball	2012	Journal of Human Kinetics	1.67
	20	Giatsis G., Zetou E., Tzetzis G.	The effect of rule changes for the scoring system on the duration of the beach volleyball game	2005	Journal of Human Movement Studies	1.05
	19	Buscá B., Moras G., Javier P.A., Rodriguez-Jiménez S.	The influence of serve characteristics on performance in men's and women's high-standard beach volleyball	2012	Journal of Sports Sciences	1.58
	17	Palao J.M., Valades D., Manzanares P., Ortega E.	Physical actions and work-rest time in men's beach volleyball	2014	Motriz	2.22
	16	Medeiros A., Mesquita I., Marcelino R., Palao J.	Performance differences between winning and losing under-19, under-21 and senior teams in men's beach volleyball	2017	International Journal of Performance Analysis in Sport	2.29
	14	Medeiros A., Marcelino R., Mesquita I., Palao J.	Effects of technique, age and player's role on serve and attack efficacy in high level beach volleyball players	2014	International Journal of Performance Analysis in Sport	1.40
	13	Natali S., Ferioli D., La Torre A., Bonato M.	Physical and technical demands of elite beach volleyball according to playing position and gender	2019	Journal of Sports Medicine Physical Fitness	4.33

Most frequent thematic information

Table 4 shows the variables related to study topics: the group of variables related to match context (unit of analysis, gender, competitive level and category, result of play, and situational variables) and variables related to game situations (temporal characteristics and phase or complex) and technical-tactical actions (play role, space/task and actions).

The most studied unit of analysis was technical and tactical actions in indoor (62.5%) and beach volleyball (64.2%), followed by match (12.5%) and set (26.2%) in indoor and beach volleyball, respectively. Gender showed that nearly half of the studies (56.2% indoor and 45.2% beach volleyball) were conducted with males. In match analysis in indoor and beach volleyball, 78.9% and 90.5 % of data related to high-level adult category games highlighted on international games (53.9% in indoor and 83.3% in beach volleyball), with the World Championships (35.7%) in indoor volleyball and the World Tour (45.7%) in beach volleyball being the most studied competitions. The association between victory and defeat has shown that less than 20% of the studies investigated the result of the game (16.4% indoor and 14.3% beach volleyball), the result of the set (13,6% indoor and 9.5% beach volleyball) and/or the result of the rally (3.4% indoor and 14.3% beach volleyball). Among the situational variables, the quality of opposition was considered in 20.4% and 23.8% of indoor and beach volleyball studies, respectively, match status in less than 10 % indoor and 14.3 % beach volleyball and home advantage only in 3.4% and 0 % in indoor and no study in beach volleyball.

Game situation has shown that temporal characteristics presented 6.2% (indoor volleyball), 28.5% (beach volleyball) and phase or complex 34% (indoor volleyball) and 21.4% (beach volleyball). Regarding technical-tactical actions, the player's role was 27.8% in indoor volleyball and 21.4% in beach volleyball. In addition, space and/or tasks of technical actions were the focus of 94.8% of studies in

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indoor volleyball and 78.5% in beach volleyball. Attack (73% indoor and 69.7% beach volleyball) and serve (59.2% indoor and 63.6% beach volleyball) were the most studied actions, followed by reception in indoor volleyball (50.2%) and blocking in beach volleyball (48.4%). Continuing actions, such as defense (25.9%) in indoor volleyball and set (25%) and defense (25%) in beach volleyball were less studied.

Table 4.
Most frequently thematic related to match analysis in indoor and beach volleyball.

		Indoor Volleyball		Beach Volleyball	
		Frequency	Percentage	Frequency	Percentage
Sample					
Unit of analysis	Technical-tactical actions	110	62.5%	27	64.2%
	Rally	13	7.3%	8	19.0%
	Complex	16	9.0%	5	11.9%
	Set	18	10.2%	11	26.2%
	Match	22	12.5%	9	21.4%
Contextual variables					
Gender	Male	99	56.2%	19	45.2%
	Female	44	25.0%	9	21.4%
	Both	26	14.7%	13	30.9%
	Non- specific	7	3.9%	1	2.4%
Competitive level	National	86	48.8%	7	16.7%
	International	95	53.9%	35	83.3%
	Olympic Games	22	23.1%	8	22.8%
	World Championships	34	35.7%	9	25.7%
	World Tour*/Grand Prix/Cup	32	33.6%	16	45.7%
	European Championships/ League	17	17.8%	8	22.8%
Competitive category	Adult	139	78.9%	38	90.5%
	Under	47	26.7%	5	11.9%
Result of the match (win or loss).	No	148	83.5%	36	85.7%
	Yes	22	16.4%	6	14.3%
Result of the set (win or loss).	No	152	86.3%	38	90.5%
	Yes	24	13.6%	4	9.5%
Rally result (win or loss).	No	170	96.5%	36	85.7%
	Yes	6	3.4%	6	14.3%
Match Status	No	160	90.9%	36	85.7%
	Yes	16	9.1%	6	14.3%
Quality of opposition	No	140	79.5%	32	76.2%
	Yes	36	20.4%	10	23.8%
Home/Away Advantage	No	170	96.5%	42	100%
	Yes	6	3.4%	0	0%
Game situation					
Temporal Characteristics	No	165	93.7%	30	71.4%
	Yes	11	6.2%	12	28.5%
Phase or complex	No	116	65.9%	33	78.5%
	Yes	60	34.0%	9	21.4%
Technical-tactical situations					
Player's role	No	127	72.1%	33	78.5%
	Yes	49	27.8%	9	21.4%
Space and/or task	No	9	5.1%	9	21.4%
	Yes	167	94.8%	33	78.5%
Actions	Attack	122	73.0%	23	69.7%
	Serve	99	59.2%	21	63.6%
	Block	73	43.7%	16	48.4%
	Reception	84	50.2%	14	42.4%
	Defense (Dig)	43	25.9%	10	30.3%
	Set	76	45.5%	10	30.3%

Discussion

This study aimed to conduct a bibliometric analysis of the scientific production related to match analysis in indoor and beach volleyball. The first records found in the databases dated from about 30 and 20 years ago on volleyball and beach volleyball, respectively. This demonstrates the young nature of these research areas. Quantitative differences were observed in the annual pattern of scientific production between the modalities. Among other possible causes are the early origin of volleyball, its greater popularity, and a relative time factor difference in the year of the inclusion of both modalities in the Olympic Games and the consequent impact on their development and on the scientific interest.

Gradually, the number of articles published started increasing as the years progressed and has varied alternatively. This evolution is coherent with the precursor stage phases proposed in Price's Law (Price, 1963), which showed a development of the scientific field in four stages: the precursor stage, the exponential growth, the consolidation of the body knowledge, and the decrease in the production. Thus, there is a promising research field related to research in match analysis in indoor and beach volleyball that can still

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be developed until reaching the consolidation stage.

The top-five journals published one third and more than half of the papers in indoor and beach volleyball, respectively. There is an unequal distribution of articles published in the journals, with many articles found in a small number of journals. This suggests that the research field was not considered in depth by many journals, suggesting an innovative and youthful nature of the field under study (Bradford, 1934). In addition, the identification of the most productive journals was supplemented with the analysis of the journal's quality performance. This information is important to help submission decisions made by researchers to disseminate their findings related to match analysis in indoor and beach volleyball and is one of the things they have in mind when choosing the magazine or journal to publish.

A similar pattern was observed on highly productive countries, leading affiliations and on the most relevant authors. In both modalities, the increase in scientific production in the last decade was led by European countries and affiliated authors, especially Portugal in indoor volleyball and Spain in beach volleyball. This could be due to several factors, e.g., Europe is the region that most hosted world championships and tournaments in both sports according to the International Volleyball Federation (FIVB). This fact can attract the interest of sports scientists to study match analysis of one of the modalities, which reinforces academic development and consequently scientific production (Grix & Carmichael, 2012).

In the list of the most relevant authors, it was possible to note that the most prolific author received the highest number of citations and had the best h-index. The consistency indicates that the academic or the academic team have a decisive influence in the area (Liu & Avello, 2021). Besides, the analysis of co-authorships showed that the top-ten most relevant authors led the main clusters and had different collaborations among themselves. It is common that international researchers seek prominent authors in their respective areas for co-authorship (Chen, Zhang & Fu, 2019). Moreover, a small number of co-authors collaborated in the same article, with the vast majority coming from the same country and affiliations. Spanish, Portuguese, Greeks and Brazilians engaged in strong collaboration with affiliated authors in their own countries. This could be explained by the geographic proximity and the use of a common language, which are important factors in choosing collaborators (Larivière et al.,2006).

The analysis of international collaboration among the most productive countries revealed that some collaborate more than others. Portuguese and Spanish authors tend to collaborate more frequently with foreign authors while USA and Greece engage in very little overseas collaboration in indoor and beach volleyball, respectively. History, language and cultural similarity might explain these collaboration networks (Luukkonen et al.,1992). Each author's national culture can affect the outcomes of research contributing to cultural biases, which underlines the relevance of collaborations among different culture groups. International collaboration in academic research is an important strategy for countries to expand their production and innovation in the academic scene (Chen, Zhang & Fu, 2019).

The number of citations shows the impact of the publication on the scientific community (Niebles Nuñez et al., 2023). Trends in research in match analysis identified from the list of the most cited articles in indoor volleyball highlighted statistics of technical-tactical indicators and the relationship to the outcome game, as well as situational variables such as opponent's quality and home/away advantage. On the other hand, at beach volleyball top, these variables have not yet appeared in the list of the most cited articles, with the player's role and the profile of physical, temporal, and tactical -technical actions being still highlighted. This might be attributed, partly to a greater number of publications over time in indoor volleyball, in which research has already evolved beyond descriptive studies (Mesquita et al, 2013), seeking to consider important factors that influence players' behavior and, consequently, their technical and tactical actions in the game (Martins, et al., 2022). This demonstrates a greater reader's interest related with contextual game variables.

It was still possible to verify that the contextual game variables deserved more attention. Home advantage that has largely been understudied in indoor volleyball and not yet considered in beach volleyball studies, while the quality of opposition and match status were considered by some researchers in both modalities. An analysis of these variables might be crucial to study real game demands in match analysis (López-Serrano et al., 2022).

Furthermore, in match analysis, situations related to teams' victory and defeat are of great interest (Drikos, Angelonidis & Sobonis (2018), although the number of studies is still small in indoor and beach volleyball. This is due to the complexity that sports performance presents, since multiple factors affect the game (Marzano-Felisatti, et al., 2022). Game performance is an individual, environmental and task-related restriction product (Garcia-de-alcaraz & Usero, 2019).

Player's role and game phase have showed that many studies in both modalities had not considered the game phase (complex) as a specific variable of the technical- tactical actions. In volleyball, players' role is more frequently highlighted in the studies that in beach volleyball, since the dynamics of the players number provides tactical roles distinct from the execution of technical-tactical actions both in the attack and counterattack phases.

Technical-tactical actions are the most studied related to space and task and are often observed in both modalities. Attack, serve and block are the most studied actions in both modalities (Giatisis, 2022). It makes sense that these variables are the most used in the scientific literature due to their link with the rally result, as they are terminal actions that can result in a point, determine the development of the game, and lead a team to victory or defeat (Stankovic et al., 2019).

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Another factor worth noting is the greater interest in studying male gender, high level and senior. These results can be compared with those obtained by other authors in collective sports such as futsal (Palazon, Ortega, & Garcia-Angulo, 2015) and badminton (Blanca &Torres, 2020). Women's and the basic categories should be further studied for a better understanding of what happens in the female game and young players.

The current study provided some insights into the scientific production of match analysis in indoor and beach volleyball. The main strength which allowed a broader analysis of scientific production for both modalities was the use of two widely explored databases in sport science, Scopus an WoS, strict selection criteria, no year limitation for publications, highlighted trends and also the least explored research, and data on the impact of citation (h-index). Further studies should identify the different lines of research based on co-authorsip clusters and describe the most relevant contributions and authors in each one.

Finally, there are some limitations to be acknowledged. No-indexed journal and publications in Scopus and WoS databases might have not been recognized, therefore they were not included. This also happened with publications indexed only in the SPORTDiscus database because it did not provide bibliometric information for statistical tools. Although the current investigation includes the most relevant collection of articles, the analysis could have included other databases, e.g., PubMed. Further, the bibliometric indicators of the present study were taken directly from Scopus and WoS databases, and in some cases, there may be information inaccuracies in the authors' names and institutions, which is a common limitation of bibliographic databases (Lastella, Memon & Vicent, 2020).

Conclusion

The current state of research in indoor and beach volleyball match analysis has been growing significantly in the last decade (2012-2022) in both modalities and research in this field is still in the precursor stage. The bibliometric indicators point to large contributions from European authors, countries, and their institutions. As trend topics, the publications with the greatest impact on the scientific community in indoor volleyball focused on contextual variables of the game, such as opposition quality, or technical-tactical actions statistics, while in beach volleyball game situations, e.g., the player's role and technical - tactical actions still have a significant impact. In addition, the most studied topics related to the context and game situations in both modalities are the technical-tactical actions, specifically attack and serve, which occur in the high-level international male adult game. Victory/Defeat and situational variables are still less studied. Given the above, this study can provide the sport scientific community valuable information on the state of the art of scientific production and a new insight on match analysis on both modalities.

Declaration of conflict of interest

The authors declare no conflict of interest. Authors of the current article are among the top ten authors on match analysis research in indoor and beach volleyball. They did not participate in data analysis and therefore, did not have any influence on the results.

References

Adán, L., García-Angulo, A., Gómez-Ruano, M. A., Sainz de Baranda, P., & Ortega-Toro, E. (2020). Análisis bibliométrico de la producción científica en fútbol femenino. *Journal of Sport & Health Research*, *2*(3):302-317.

Alvarado Ruano, R., & López Martínez, A. B. (2022). Analysis of technical-tactical factors in beach volleyball: a systematic review. *Cultura_Ciencia_Deporte* [CCD], 17(52).

Aria, M., & Cuccurullo,C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of informetrics*, v. 11, n. 4, pp. 959-

Blanca-Torres, J. C., Ortega, E., Nikolaidis, P., & Torres-Luque, G. (2020). Bibliometric analysis of scientific production in badminton. *Journal of Human Sport and Exercise*, 15(2), 267-282.

Bradford, S. C. (1934). Sources of information on specific subjects. *Engineering*, 137, 85-86.

Bradshaw, C., & Brook, B. (2016). How to Rank Journals. *PLoS One*, 11(3), [e0149852].

Chen, K., Zhang, Y., & Fu, X. (2019). International research collaboration: An emerging domain of innovation studies?. *Research Policy*, 48(1), 149-168.

.Diem, A., & Wolter, S. C. (2013). The use of bibliometrics to measure research performance in education sciences. *Research in higher education*, 54(1), 86-114.

Drikos, S., Angelonidis, Y., & Sobonis, G. (2018). The role of skills in winning in different types of set in women's volleyball. *International Journal of Performance Analysis in Sport*, 18(6), 950-960.

Feng, L., Feng, L., Shang, S., Feng, X., Kong, Y., and Bai, J. (2022). Evolution and trend analysis of research hotspots in the field of pollution-intensive industry transfer—based on literature quantitative empirical study of China as world factory. *Front. Environ. Sci.* 10, 732734.

Fernandez-Echeverria, C., Mesquita, I., González-Silva, J., Claver, F., & Moreno, M. P. (2017). Match analysis within the coaching process: a critical tool to improve coach efficacy. *International Journal of Performance Analysis in Sport*, 17(1-2), 149-163.

FIVB (2023). Volleyball Game History. Retrieved on March 31, 2023, from the World Wide Web: https://www.fivb.com/en/volleyball/thegame_glossary/ history.

Garcia-Angulo, A., & Ortega, E. (2015). Bibliometric

2023, Retos, 50, 838-848

analysis of scientific production over the goalkeeper in soccer. *Revista Iberoamericana de Psicología del Ejercicio y el Deporte*, 10(2), 205-214

García-de-Alcaraz, P. A., & Usero, L. (2019). Influence of contextual variables on performance of the libero player in Top-Level women's volleyball. *Journal of human kinetics*, 70, 199.

Grix, J., & Carmichael, F. (2012). Why do governments invest in elite sport? A polemic. *International journal of sport policy and politics*, 4(1), 73-90.

Ibáñez, A. P., Gil, J. M., & Chenoll, M. P. (2021). Bibliometric study of scientific production on handball. *Movimento*, 26.

Lastella, M., Memon, A. R., & Vincent, G. E. (2020). Global research output on sleep research in athletes from 1966 to 2019: a bibliometric analysis. *Clocks & sleep*, 2(2), 99-119.

Larivière, V., Archambault, É., Gingras, Y., & Vignola-Gagné, É. (2006). The place of serials in referencing practices: Comparing natural sciences and engineering with social sciences and humanities. *Journal of the American Society for Information Science and Technology*, 57(8), 997-1004.

Liu, Y., & Avello, M. (2021). Status of the research in fitness apps: A bibliometric analysis. *Telematics and Informatics*, 57, 101506.

López-Serrano, C., Moreno Arroyo, M. P., Mon-López, D., & Molina Martín, J. J. (2022). In the Opinion of Elite Volleyball Coaches, How Do Contextual Variables Influence Individual Volleyball Performance in Competitions?. *Sports*, 10(10), 156.

Lotka, A. J. (1926). The frequency distribution of scientific productivity. *Journal of the Washington academy of sciences*, 16(12), 317-323.

Luukkonen, T., Persson, O., & Sivertsen, G. (1992). Understanding patterns of international scientific collaboration. *Science, Technology, & Human Values*, 17(1), 101-126.

Maciel, L. F. P., Araldi, F. M., Folle, A., & Andrade, A. (2019). Produção científica relacionada ao basquetebol em teses e dissertações brasileiras: análise bibliométrica. *Movimento* (Porto Alegre), 25, 25027.

Mamani-Jilaja, D., Huayanca-Medina, P. C. ., Casa-Coila, M. D. ., Vilca-Apaza, H.-M. ., & Romero-Carazas, R. (2023). Bibliometric analysis of scientific production in collective sports. *Retos*, *49*, 853–8.

Marcelino, R., Mesquita, I., & Sampaio, J. (2011). Effects of quality of opposition and match status on technical and tactical performances in elite volleyball. *Journal of sports sciences*, 29(7), 733-741.

Martin, D., O Donoghue, P. G., Bradley, J & McGrath, D (2021): Developing a framework for professional practice in applied performance analysis, *International Journal of Performance Analysis in Sport*.

Martins, J. B., Afonso, J., Mendes, A., Santos, L., & Mesquita, I. (2022). Inter-team variability in game play under critical game scenarios: a study in high-level men's volleyball using social network analysis. *Retos*, *43*, 1095–1105.

Marzano-Felisatti, J. M., Guzmán Luján, J. F., & Priego-Quesada, J. I. (2022). Latest Trends in Technical-Tactical Analysis of High-Level Volleyball. Systematic Review. *Retos*, *46*, 874–889.

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.

Mesquita, I., Palao, J. M., Marcelino, R., & Afonso, J. (2013). Indoor volleyball and beach volleyball. In Routledge handbook of sports performance analysis (pp. 385-397). Routledge.

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

Moral-Muñoz, J.A.,Herrera-Viedma, E., Santisteban-Espejo, A., Cobo, M. J., (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. *El profesional de la informa-ción*, v. 29, n. 1, e290103.

Niebles Nuñez, W. A., Sanabria Navarro, J. R., & Silveira Pérez, Y. (2023). Systemic analysis of the world context of sports management: significant contributions of the retos review. *Retos*, *48*, 481–493. https://doi.org/10.47197/retos.v48.96951

Palazon, M. A., Ortega, E., & Garcia-Angulo, A. (2015). Bibliometric analysis of scientific production in futsal. *Sport Tk-Revista Euroamericana De Ciencias Del Deporte*, 4(2), 19-23.

Price, D. J. D. S. (1963). Little science, big science. Columbia University Press.

Silva, M., Marcelino, R., Lacerda, D., & Vicente João, P. (2016). Match Analysis in Volleyball: a systematic review. Montenegrin Journal of Sports Science and Medicine, 5(1), 35-46

Stankovic, M., Ruiz-Llamas, G., PeriĆ, D., & Quiroga-Escudero, M.E. (2019). Point-scoring plays related to level of set win and in-game role during volleyball rules testing. *Journal of Human Sport and Exercise*, 14(1), 86-98.

Van Eck,N.J., & Waltman,L., (2010). Software survey: VOSviewer, a computer program for bibliometric mapping . *Scientometrics*, v. 84, n. 2, pp. 523-538.

Wright, C., Atkins, S., & Jones, B. (2012). An analysis of elite coaches' engagement with performance analysis services (match, notational analysis and technique analysis). *International Journal of Performance Analysis in Sport*, 12(2), 436-451.

6.2 Artigo 2

Technical-tactical performance difference between winning and losing teams in a women's beach volleyball tie break

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Abstract

The aim of this study was to compare the technical-tactical indicators between winning and losing teams of tiebreak according to their final point difference in high-level women's beach volleyball. Game actions in all tie breaks sets (n = 31) played in equal-quality team matches during the 2019 and 2022 World Championships were observed using video match analysis. Cluster analysis established three types of tie breaks based on the final point difference. The analyzed indicators were: number of points in each game complex; number of points and errors by game action in each phase and complex; 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). Inferential analysis with practical significance indicated indicators of differences between tiebreak outcomes. The results showed different patterns between winners and losers, which a change for each tiebreak type. Most changes for winning teams were related to counterattack actions in KII and happened during maximum and medium points. Serve stood out for only winning in the medium score. Attack side-out efficacy is the main difference for winners in minimum score. The article emphasizes the need to consider an integrative approach to prepare proper strategies according to the set result, match period, and status.

Keywords: sand sports**,** match analysis, performance indicators, situational variables, match status, game phase.

Introduction

The tie break is the third set in the playing format of best-of-three sets under the rally points system in beach volleyball matches. It is played when the teams are tied 1-1 in regular sets to determine the winner of the match (FIVB, 2023). This often occurs in matches between equally strong opposing teams in women's FIVB beach volleyball tournaments (LILICH et al., 2023). In this competitive scenario, a third set is won by the team that first scores 15 points, with a two-point lead required at the end of the set by official rules. It is consequently observed that there are notable differences in the final score between teams throughout competitions (GIATSIS, 2023). In turn, this score line balance has an instantaneous effect on the continuous interaction between the two opposing teams (DRIKOS et al., 2018), a situation which might affect the scoring of points (KNIGHT; O'DONOGHUE, 2012) during this game period.

As a last and decisive set, the tiebreak is considered a critical moment in the game in which athletes' ability to give their best is tested when it is most important (Carlstedt, 2004). Because of this, it can affect the players' behavior, especially in controlling physical and psychological stress and influencing performance in points played (O'DONOGHUE, 2001). Moreover, the critical level can fluctuate dynamically, depending on changing conditions (CARLSTEDT, 2004).

Players' behavior during rallies can vary drastically according to dynamic situations, such as the current state of the set (SHENG et al., 2022). The closer the score-line between teams is at the end of a set, the greater the importance of the points played by each team due to the increase in the critical level (DRIKOS et al., 2018), which can place great physiological, psychological, and cognitive loads on players (GHOSH, 2008; ALCOCK; CABLE, 2009; ALDER et al., 2019). Doubtless, the psychological pressure that some players deal with better than others is a factor associated with the importance of points (O'DONOGHUE; SIMMONDS, 2019). Therefore, players' behavior at this moment can determine technical-tactical performance (MARCELINO, SAMPAIO, MESQUITA, 2012).

It is observed that technical and tactical performance levels are related to team success in beach volleyball (PALAO; ORTEGA, 2015). Different types of indicators are used to characterize the winning team patterns, including single-

point actions (e.g., attack, serve, and block), point actions by game phase (i.e. attack side-out or counterattack) or complex (e.g., I,II, III, or IV), as well as the performance coefficients of serve, reception, setting, attack, block, and dig in their respective game phases (i.e. side-out or counterattack) (GIATSIS; ZAHARIADIS, 2008; MEDEIROS et al., 2017; GIATSIS et al., 2023). Some of these indicators have a great influence on winning in beach volleyball, and their importance may vary depending on the game level or set level (KUMAR et al.,2021; GIATSIS, 2023).

Previous research regarding match analysis in beach volleyball has observed that winning in the match can be attributed to more points in attacking, blocking, and serving (KUMAR et al., 2021), and more points in the counterattack phase in Complex II (MEDEIROS et al., 2017). Additionally, attack efficacy in the side-out phase with more points and fewer errors is an important indicator of winning a match (PALAO; ORTEGA, 2015). Attack is also an important indicator of the success of both the men's and women's teams at the set level, both in regular (21 points) and tie break (15 points) formats (GIATISIS, 2023). The margin of the final points difference for regular sets between the teams changed the significant indicators of winning according to their balance. Winners only earned more points in blocks and opponent attack errors than losers in unbalanced regular sets (GIATIS et al., 2023). Specifically, regarding the tie break, block points per set point contribute equally with attack to the probability of winning this decisive set. On the other hand, no studies found an integrative approach between the result of the tie break set, the tie break margin of the final point difference, and the important indicators for winning in women's beach volleyball.

Beach volleyball research is still in its early stages, with few studies having been conducted on match context-related variables (e.g., result, point difference, and game period) and game situations (i.e., game phase) (Lima et al., 2023). However, the impact of these variables on players' match behaviors has been extensively discussed in other sports (GÓMEZ-RUANO et al., 2013; GARCIA-DE-ALCARAZ; USERO, 2019), like basketball, badminton, and volleyball (DRIKOS et al., 2018; ZHANG et al., 2019; GÓMEZ-RUANO et al., 2021). In these sports, the number of significant performance indices in women's teams decreases as the difference in final points in the set between

two challenging teams decreases. Furthermore, researchers emphasize the importance of considering other indicators in addition to single-point elements to avoid error conclusions, especially if final set scores are close or differ largely (RODRIGUEZ-RUIZ et al., 2011). For these reasons, using different game actions and phases can provide different perspectives on the game and more accurately report key performance indicators (DRIKOS et al., 2018).

Thus, it is crucial to evaluate tiebreaker winners based on their final status in the score line using different technical-tactical indicators, avoiding an analysis bias in a dynamic critical moment. Based on the literature, it can be assumed that more indicators differentiate winners and losers in tie breaks in general than in each type of score. Also, the closer the final score is, the fewer indicators differentiate winners and losers in the tie break, with indicators per game phase being more representative than elements of single points. Therefore, the aim of this study was to compare technical-tactical indicators between winning and losing teams in the tie break according to the final point difference in high-level women's beach volleyball.

2. Methods

2.1. Sample

The sample included 31 tie break sets (from 31 balanced matches) played by 44 teams (80 players) collected from the 2019 (n=17) and the 2022 (n=14) FIVB Women's Beach Volleyball World Championships, the most important world women's beach volleyball competition of the Olympic Games. All the tiebreaks performed in balanced games (level1 vs. level 1, level 2 vs. level 2 and level 3 vs. level 3) were observed (figure 1). A balanced game is considered when the quality of both teams is similar (i.e. equality in play levels between opposing teams) (GARCIA-DE-ALCARAZ; MARCELINO, 2017). Players performed a total of 4,872 actions (840 serves, 682 attacks in side-out, 428 attacks in counterattack, 574 blocks, 716 receptions, 646 sets in side-out, 428 sets in counterattack, and 558 digs).

The teams' competitive levels were established through a two-step cluster analysis technique, with the number of clusters fixed in three (distance

measure: log-likelihood; clustering criterion: Schwarz's Bayesian criterion) (TAYLOR et al., 2008). The variables used for the calculation were: the total number of matches, sets, and points lost and won at the end of the competition. These variables composed the team classification criteria during the world championships and some of them have been used in previous studies (Marcelino et al., 2011; Medeiros et al., 2014). The study followed the guidelines stated in the Declaration of Helsinki and was approved by the Institutional Research Ethics Committee.

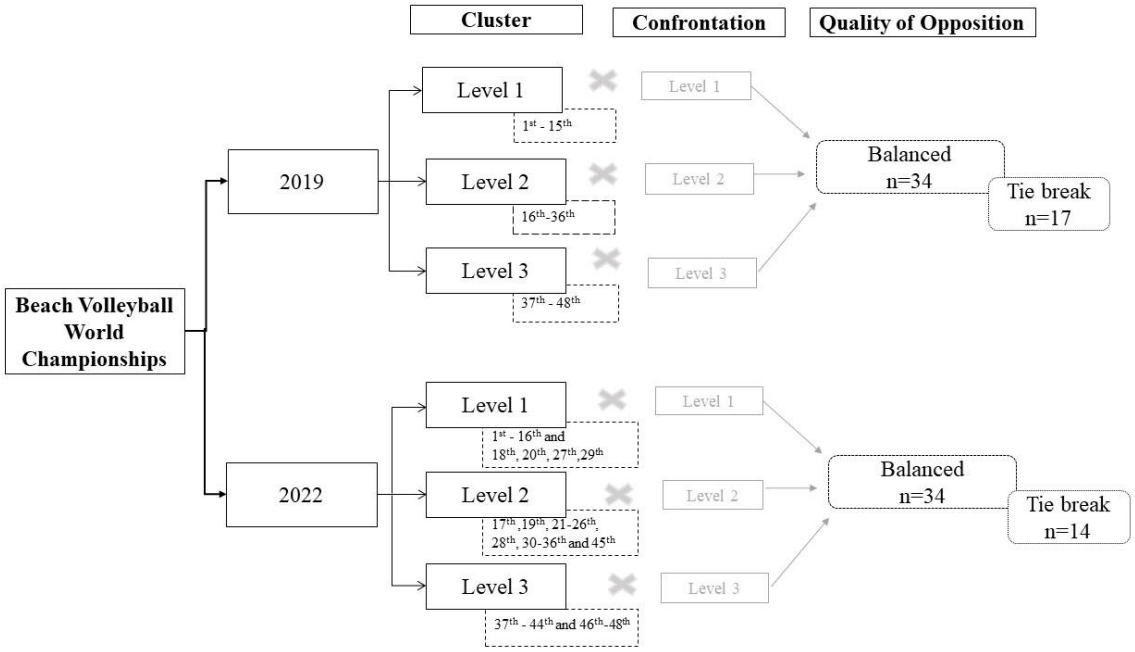

Figure 1. Sample division according to the tournament and the quality of opposition.

2.2 Variables and procedures

Each team's performance was classified according to tie break result (win or loss) and tie break type (minimum, medium or maximum point differences). Tie break type categorization was statistically accomplished through k-means clustering (NORUSIS, 2006) and produced three clusters with the best possible distinction according to tie break final score difference: a) 2

points (minimum point difference sets), b) 3-4 points (medium point difference sets), and c) over 5 points (maximum point difference sets).

Technical-tactical performance indicators were selected following previous studies (PALAO et al., 2015, MEDEIROS et al.,2017). The assessed variables were:

a) total number of points won by game phase (KI KII, KII and KIV). The KI starts when the team receives the serve and is composed by reception, set and attack, while the KII game phase describes the situation of the opposing team in serve, block, dig, set and attack in the counterattack. The KIII and KIV game phases are designated to all subsequent plays, depending on whether the team started the rally in KI or in KII, respectively (Palao & Manzanares, 2009; Palao et al.,2015).
b) total number of points and errors by game action. Total attack (KI+KII+KIII+KIV), attack in side-out (KI), attack in counterattack (KII+KIII+KIV), attack on each complex in the counterattack, total block (KII+KIII+KIV), block on each complex in the counterattack, serve, other errors);
c) performance coefficient of game actions by game phases (serve, attack in side-out (K1), attack in counterattack (K2 + K3 + K4), block, reception, set in side-out (K1), set in counterattack (K2 + K3 + K4) and dig. The serves, attacks and blocks were evaluated with a five-level scale to categorize the performance: error (0), maximum opponent attack options (1), opponent limited attack options or team limited attack options (2), no opponent attack options (3) and points (4). The reception, set and dig were evaluated with a scale of four levels to categorize the performance: error (0), no attack options (1), limited attack options (2) and maximum team attack options (3). The performance coefficient for each action was calculated as the sum of the intents from each category multiplied by the value of each category and divided by the total number of intents (COLEMAN et al.,1969; MEDEIROS et al., 2017; PALAO et al., 2019).

The tiebreaks were recorded in video with a digital camera positioned in the grandstand for a full court frontal view (approximately 10-metre distance from the baseline). All of the observed data were organized in spreadsheets. The main observer was a Sports Training postgraduate, with academic training

in beach volleyball and experience as a beach volleyball player. The main observer (well-trained, following Anguera's (2003) criteria for three two-hour sessions) reanalyzed random sets (over 10% of the total analyzed sets) (TABACHINICK; FIDELL, 2014) after a three-week period of original observations in order to guarantee observation reliability to prevent any learning effect. Aiming inter-observer reliability testing, two experts (more than ten years of experience in beach volleyball match analysis) observed the same sets. Intra- and inter-observer agreements were assessed through the Cohen's Kappa values over 0.85 elucidated a great agreement in both test (FLEISS; COHEN 1973, MCHUGH, 2012). The reliability values obtained were considered acceptable for all recorded variables.

2.3. Statistical analysis

Descriptive statistics were used to characterize the technical-tactical performance indicators according to tie break result in general and the final score difference. The Shapiro-Wilk test was used to assess the normality of distribution. The independent samples T-test was used to the compare the technical-tactical performance indicators between winners and losers in the tie break in all types of tie breaks (score differences). Due to the non-normal distribution of some variables, homogeneity of variance test was considered in the independent samples t-test. When the data violated the assumption of homogeneity of variance, t statistics for unequal variations procedures were used. The alpha-level was set at 0.05. Statistical analyses were performed using the SPSS 22.0® program (Statistical Package for the Social Sciences, SPSS Inc).

Effect sizes (ES) at 95% confidence intervals (CI) using standardized differences in means (SDMs) were calculated for the magnitude of change in the performance for each beach volleyball skill, which was labeled as: d (.01) = very small, d (.2) = small, d (.5) = medium, d (.8) = large, d (1.2) = very large, and d (2.0) = huge (SAWILOWSKY, 2009). The different versions of effect size measures in the d family were used (LAKENS, 2013). The ES were reported using Glass' Δ for unequal variances, Cohen's d for equal variances and Hedges apply correction (Hedge's g) to correct bias in small samples in the tie break score final difference groups. The common language effect size, also

called the probability of superiority, was reported in addition to Cohen's d or Hedge's g to facilitate the interpretation of the effect size. ES were performed in a Microsoft Excel® supplementary spreadsheet by Lakens (2013).

3. Results

Table 1 shows the significant differences between teams who won and teams who lost the tie break sets for the total number of points won in the game phases, total number of points and errors, and team performance coefficients. Winning teams performed better in the KII (very large effect) and KV (medium effect) compared to losing teams in tiebreak sets. Teams that won scored significantly more points in attack in KII, blocking in KII, and attack in KIV, whereas losing teams performed more errors in blocking. For the performance coefficient of game actions, winning teams had significantly higher coefficients of efficacy for blocking, attack side-out, and counterattack. The common language effect size indicates that a team from tie break winners has a 73.5%, 66.9%, and 64.8% higher probability of efficacy than a team from tie break losers in attack side-out, block, and attack counterattack performance, respectively.

Table 1. Descriptive and inferential analysis of technical-tactical performance indicators for the factor tiebreak result (loss vs. win).

		Loss	Win				
		M ± SD		*p*-value	ES	95% CI	
Number of points per game phases	KI	5.4 ± 1.7	5.5 ± 2.1	.792	0.07 ɖ	-0.43	0.57
	KII	1.6 ± 1.2	3.4 ± 1.8	.000**	1.47 ɖ	0.91	2.03
	KIII	1.4 ± 1,9	1.3 ± 0.9	.801	0.07 ɖ	-0.43	0.57
	KIV	0.4 ± 0,7	0.7 ± 0.8	.058	0.49 ɖ	-0.02	0.99
Number of points and errors	Serve aces	0.4 ± 0.7	0.5 ± 0.7	.708	0.10 ɖ	-0.40	0.59
	Serve errors	2.0 ± 1.3	1.4 ± 1.3	.072	0.46 ɖ	-0.04	0.97
	Attack points (side-out)	5.4 ± 1.7	5.5 ± 2.1	.792	0.07 ɖ	-0.43	0.57
	Attack errors (side-out)	1.2 ± 1.3	0.8 ± 0,9	.196	0.33 ɖ	-0.17	0.83
	Attack points (counterattack)	2.1 ± 1.4	3.4 ±1.4	.001**	0.92 ɖ	0.40	1.45
	Attack points KII	0.7 ± 0.7	1.6 ± 1.1	.000**	1.18 Δ	0.64	1.72
	Attack points KIII	1.1 ± 1.0	1.2 ± 0.8	.790	0.07 ɖ	-0.43	0.57
	Attack points KIV	0.3 ± 0.5	0,7±0,8	.044*	0.67 Δ	0.16	1.18
	Attack errors (counterattack)	2.0 ± 1.5	1.4 ± 1.1	.068	0.29 ɖ	-0.21	0.79
	Attack errors KII	0.3 ± 0.5	0.3 ± 0.5	1.000	0.00 ɖ	-0.50	0.50
	Attack errors KIII	0.4 ± 0.7	0.1 ± 0.3	.044*	0.97 Δ	0.44	1.49
	Attack errors KIV	0,1 ± 0.3	0,1 ± 0.3	.399	0.22 ɖ	-0.28	0.72
	Block points	0.7± 0.7	1.4 ± 1,3	.015*	0.64 ɖ	0.13	1.15
	Block points KII	0.4 ± 0.6	1.1 ± 1,0	.001**	0.92 ɖ	0.40	1.44
	Block points KIII	0.2 ± 0.5	0.1 ± 0,3	.375	0.23 ɖ	-0.27	0.73

	Block points KIV	0.1 ± 0.3	0.1 ± 0,3	1.000	0.00 ɖ	-0.50	0.50
	Block errors	0.6 ± 0.8	0.2 ± 0,5	.027*	0.78Δ	0.26	1.29
	Block errors KII	0.5 ± 0,8	0,2 ± 0,5	.062	0.78 Δ	0.26	1.29
	Block errors KIII	0.1 ± 0.2	0.0 ± 0.1	.561	0.15 Δ	-0.35	0.65
	Block errors KIV	0.0 ± 0.1	0.0 ± 0.1	1.00	0.00 ɖ	-0.50	0.50
	Other errors	2.5± 2.0	2.0 ± 1,6	.318	0.26 ɖ	-0.24	0.76
Performance Coefficients	Serve	1.4 ± 0.3	1.5±0.2	.134	0.39 ɖ	-0.12	0.89
	Reception_	1.8 ±0.5	1.9±0.5	.437	0.20 ɖ	-0.30	0.70
	Set (side-out)	2.5±0.2	2.5±0.2	.683	0.10 ɖ	-0.39	0.60
	Attack (side-out)	2.5±0.4	2.9±0.4	.001**	0.89 ɖ	0.37	1.41
	Block	2.1 ±0.4	2.4± 0.4	.018*	0.62 ɖ	0.11	1.13
	Dig	1.7±0,4	1.9±0,4	.078	0.46 ɖ	-0.05	0.96
	Set (counterattack)	2.2±0.3	2.2±0.3	.739	0.08 ɖ	-0.41	0.58
	Attack (counterattack)	2.3±0.6	2.6±0.6	.039*	0.54 ɖ	0.03	1.04

M±SD: Mean ± Standard Deviation; ES: effect size; CI: confidence interval; ** $p < 0.05$; **$p < 0.01$;* ɖ Cohen's; Δ Glass' Effect size: .001-.04 = small effect, .05-.07 = medium effect, .08-1.1 = large effect. ≥1.2 = very large effect.

Table 2 presents the descriptive (mean ± standard deviation and percentages) of total number of points won in the game phases, total number of points and errors, and team performance coefficients, according to tie break result (set won vs. set lost) for the three types of tie breakers by final score difference (minimum, medium and maximum point differences). Figures 2, 3, and 4 presents the effect size with the 95%CI for these variables.

In the tie break with the smallest difference in the final score (2 points), tie break winners performed more points in KI and KII compared with tie break losers. In addition, winning teams achieved more points in total actions of attack (side-out + counterattack) and block compared to losing teams. Among these, the results show that attack points significantly impacted the outcome, with a large effect (Figure 3(a)) and a higher probability of 78.8% for the winners. The attack points in side-outs and block points in KII had a medium effect on teams winning the tiebreak. Considering the efficacy coefficient of the actions (Figure 4(a)), winning teams were significantly different, with a large effect on the losers only for attack in side-out. The winning team's performance in side-out efficacy is 78.3% higher than that of the losing team.

The winning teams for tie break sets which finished with a medium score difference (3–4 points) outperformed the losing teams in KII (large effect), scoring more points from blocks (very large effect), and in KIV (large effect) with more attack points (Figure 2, 3(b)). Also, more points with the opponent's serve error (a very large difference) were scored for tiebreaker winners. In terms of performance coefficient, the winning team showed significantly higher values with a very large effect on serve and block actions (Figure 4(b)). The common

language effect size suggests that a team from tie break winners has a higher performance coefficient of serve than a team from tie break losers in 84% of the cases.

Regarding tie break sets with a maximum score difference (>5 points), winning teams performed better in KII (very large effect) and KIV (medium differences) compared to losing teams (Figure 2). Moreover, winners scored more attack points in counterattack, attack in KII, and block II, and fewer errors in total actions in attack and block (Table 2). As in the previous types of tie break sets, points and error variables were found to have large and very large effects (Figure 3(c)). The winning teams showed better serve, attack, block, and dig efficacy in the performance coefficient. Attack side-out and counterattack were statistically significant, with very large differences and a probability of superiority in effect size of 83.30% and 81.2%, respectively.

Table 2. Descriptive analysis of technical-tactical performance indicators for the factor tiebreak results in all types of tiebreaks.

	2 points difference		3-4 points difference		>5 points difference	
	Loss n=11	Win n=11	Loss n=9	Win n=9	Loss n=11	Win n=11
	M ± SD		M ± SD		M ± SD	
Points per game phases						
KI	5.8 ± 1.8	7.4 ± 2.3	5.9 ± 2.0	4.7 ± 1.0	4.5 ± 1.0	4.3 ± 1.0
KII	2.3 ± 1.4	3.5 ± 1.5	1.3 ± 0.7	2.4 ± 1.3*	1.1 ± 1.1	4.0 ± 2.1**
KIII	1.4 ± 1.2	1.6 ± 1.2	1.4 ± 1.3	1.2 ± 0.7	1.4 ± 0.8	1.1 ± 0.7
KIV	0.6 ± 0.8	0.5 ± 0.5	0.0 ± 0.0	0.8 ±0.7**	0.5 ± 0.7	1.0 ± 1.0
Points and errors per single- action						
Serve aces	0.6 ± 0.8	0.4 ± 0.5	0.3 ± 0.5	0.3 ± 0.5	0.4 ± 0.7	0.8± 0.9
Serve errors	1.6 ± 1.4	2.0 ± 1.7	3.2 ± 1.0	1.2 ±0.8**	1.6 ± 0.8	1.0 ± 1.1
Attack points (total)	8.4 ± 1.8	10.6±2.2*	8.2 ± 1.6	7.78 ± 1.9	6.0±1.0	8.1 ± 1.7**
Attack points (side-out)	5.8 ± 1.8	7.4 ± 2.3	5.9 ± 2.0	4.7 ± 1.0	4.5 ± 1.0	4.3 ± 1.0
Attack errors (side-out)	1.4 ± 1.4	1.3 ± 1.0	0.9 ± 1.1	0.9 ± 1.1	1.4 ± 1.5*	0.4 ± 0.7
Attack points (counterattack)	2.5 ± 1.8	3.3 ± 1.3	2.3 ± 1.4	3.1 ± 1.5	1.5 ± 0.8	3.8 ± 1.4**
Attack points KII	0.8 ± 1.0	1.5 ± 0.8	0.9 ± 0.3	1.1 ± 1.2	0.5 ± 0.7	2.0 ± 1.2**
Attack errors (counterattack)	0.5 ± 0.5	0.5 ± 0.5	0.9 ± 1.2	0.8 ± 0.8	1.0 ± 0.9	0.5 ± 0.7
Block points	1.1 ± 0.7	1.9 ± 1.7	0.1 ± 0.3	0.8 ± 0.7*	0.8 ± 0.8	1.5 ± 1.4
Block points KII	0.8 ± 0.8	1.5 ± 1.2	0.1 ± 0.3	0.8±0.73*	0.2 ± 0.4	1.2 ± 1.2*
Block errors	0.5 ± 0.5	0.3 ± 0.6	0.6 ± 0.7	0.3 ± 0.5	0.8 ± 1.1	0.1 ± 0.3*
Ohter errors	2.7 ± 2.3	2.4 ± 2.0	2.7 ± 1.7	2.2 ± 1.2	2.1 ± 1.8	1.5 ± 1.3
Performance Coefficients						
Serve	1.5 ± 0.2	1.4 ± 0,2	1.3 ± 0.3	1.6 ± 0.2*	1.6 ± 0.3	1.6 ± 0.2
Reception	1.8 ± 0.5	2.0 ± 0.5	1.7 ± 0.4	1.9 ± 0.7	1.9 ± 0.5	1.8 ± 0.5
Set (side-out)	2.6 ± 0.1	2.4 ± 0.2	2.5 ± 0.1	2.7 ± 0.3	2.4 ± 0.2	2.5 ± 0.2

Attack (side-out)	2.5 ± 0.3	2.8±0.2**	2,7 ± 0.5	2.9 ± 0.5	2.4 ± 0.5	3.0 ± 0.4**
Block	2.3 ± 0.5	2.5 ± 0.5	1.9 ± 0.2	2.2 ±0.2**	2.1 ± 0.4	2.3 ± 0.3
Dig	1.7 ± 0.4	1.9 ± 0.5	1.6 ± 0.4	1.7 ± 0.3	1.7 ± 0.3	1.8 ± 0.2
Set (counterattack)	2.3 ± 0.4	2.3 ± 0.3	2.2 ± 0.2	2.1 ± 0.4	2.3 ± 0.3	2.2 ± 0.3
Attack(counterattack)	2.4 ± 0.8	2.7 ± 0.4	2.3 ± 0.6	2.4 ± 0.8	2.2 ± 0.4	2.7 ± 0.4 **

M±SD: Mean ± Standard Deviation; ** p < 0.05; **p < 0.01.*

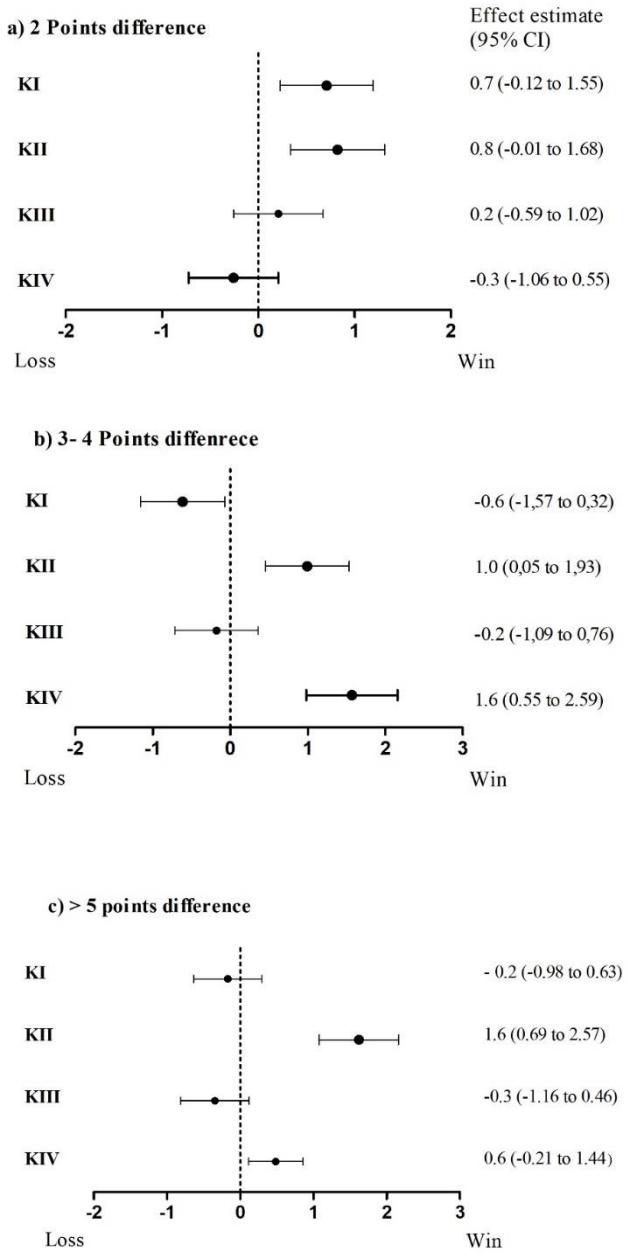

Figure 2. Effect estimates assessing the number of points obtained in team game phases for of all types of tiebreaks for the factor tie break result. Effect size: .001-.04 = small effect, .05-.07 = medium effect, .08-1.1 = large effect. ≥.12 = very large.

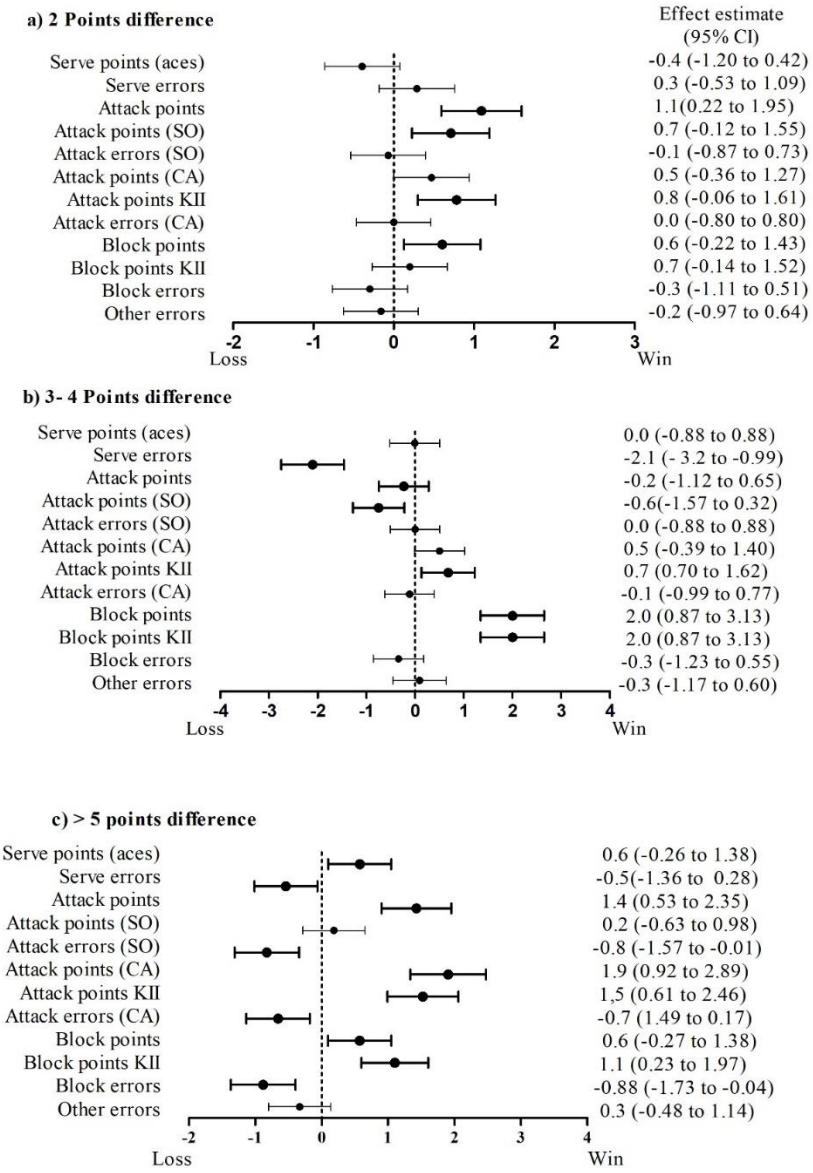

Figure 3. Effect estimates assessing teams' total number of points and errors for of all types of tiebreaks for the factor tie break result. Effect size: .001-.04 = small effect, .05-.07 = medium effect, .08-1.1 = large effect. ≥.12 = very large.

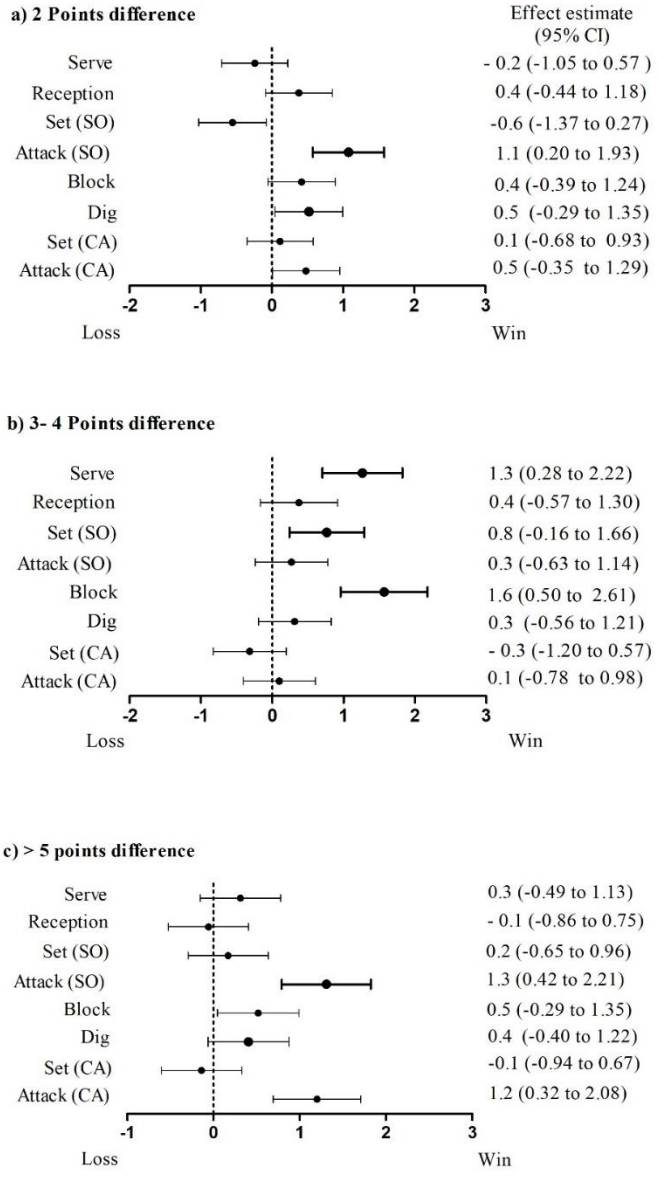

Figure 4. Effect estimates assessing team performance coefficients for all types of tiebreaks for the tie break result factor. Effect size: .001-.04 = small effect, .05-.07 = medium effect, .08-1.1 = large effect. ≥.12 = very large.

Discussion

The present study evaluates the technical-tactical indicators from different perspectives in order to get a more complete picture of the difference between winning and losing teams. Actions were quantified in the total and per

phase and/or complex of the game and analyzed for tie break set performance in both a general way and based on their final score difference.

From a general perspective, the results show that winning teams have more points scored in KII and KIV, in attack and block actions, fewer block errors, and higher efficacy values for block, side-out attack, and counterattack attacks. When considering only these results, attack, block, and counterattack (KII) are crucial actions and a crucial game phase for success in the tie break in high-level women's beach volleyball. Losing teams make more mistakes and have less side-out attack efficacy, allowing winning teams more counterattack options and points in this phase. These findings corroborate the literature on the importance of side-out attacks (GIATSIS; TETZIS, 2003; GIATSIS; PANAGIOTIS, 2008; MICHALOPOULU et al., 2005; RONGLAN; GRYDELAND, 2006), block, and counterattack attacks in winning men's and women's beach volleyball sets (PALAO et al., 2015; MEDEIROS et al., 2017; KULMAR et al., 2021; GIATSIS et al., 2023). Specifically, Giatsis et al. (2023) showed that the block points per set point contribute equally to the attack in the probability of winning the tie break set.

Contrary to previous studies, this study found no significant difference in serve aces between tiebreak sets won or lost in beach volleyball. This may be due to the adaptation of high-level teams' receivers throughout the game, the quality of balanced opposition in the sample, and the critical moment of the decisive set. High-level teams are increasingly familiar with the opponent's serve during matches (PALAO et al., 2015), allowing them to maximize their performance in the side-out and the win (MARTINEZ ABREU et al., 2003; GARCIA et al., 2015). According to Loesch (2003), the uniformity of the teams makes the serve more decisive, creating an imbalance in the opposing team's offensive structure. It is observed that the tactical role of the serve reinforces the efficiency of the block. Furthermore, game-critical situations with high mental stress influence players' serve performance (O'DONOGHUE, 2017). Players earn fewer serving points when facing critical situations (MEFFERT et al., 2018).

Based on the final score difference of the tie break sets won and lost, our results showed that winning teams in tie break sets with a two-point score difference showed limited differences compared to losing teams in side-out

attacks, points won in KI and KII, total attack, and total blocks. Moreover, winning teams' performance in a three-four-point score difference tie break is also characterized by more points in KII and blocking, as well as KIV points, fewer serve errors, and more efficacy of serving and blocking actions than the losing teams. However, the winning teams in unbalanced tie breaks (>5 points) were superior to the losers in several indicators, such as points gained in KII, total counterattack, blocking in KII, total blocking, opponent errors (attack and block), and the efficiency of side-out attacks and counterattacks. As a general trend, blocks are important for winning in a tiebreak, regardless of the final score difference. This highlights the importance of blocks in top-level team performance indicators, where players must master blocks to balance attack advantages with defensive systems. As in Drikos et al. (2018) for volleyball, we also observed that the number of significant performance indices in women's beach volleyball is reduced as the difference in points between the two challenging teams' decreases.

Blocks and attacks are crucial in equal sets. Giatsis et al. (2023) found that beach volleyball winners' block points in balanced sets are comparable to the minimum difference needed to win a balanced set. This performance can be attributed to the fact that the elite female teams are more experienced and can have a better "read" of the game (GIATIS et al., 2023). Moreover, skilled decision-making also contributes to better performance in terms of the efficacy of side-out attacks and attack points for winning a tiebreak with a two-point difference. The more difficult the set, the more decisive the team's ability to apply attack actions.

The serve plays a crucial role in tiebreak sets with medium final difference scores, with service errors and lower serve efficacy facilitating the opponent's side-out. In addition, the winner's more efficient serve assists in block efficacy and contributes to the final set victory. showed that a reduction in serve errors increases the probability of winning the set. The team behind the score often tries to reduce the score difference by risking a harder serve, but then ending up with more errors. Momentary equilibrium on the tiebreak score line can involve high-pressure situations, leading athletes to make unusual errors (ZHENG et al., 2011). Thus, strategically executing serves can restrain the opponent's offense (KUMAR et al., 2021) and favor counterattack actions by

winning teams (PALAO et al., 2015). According to Rodrigues et al. (2011), the scoreboard should be balanced by precision in the attack. The side-out attack follows a different pattern than close and unbalanced sets, with the team losing the set typically scoring more points.

Winning a tie break with a comfortable margin (>5 points) necessitates added points due to the opponent's errors in blocking and errors in K1 and K3 attacks. Furthermore, less efficiency in the attack allows for better counterattacking by the opposing team, and more points in the attack count increase the advantage of final points for the winning team. These findings corroborate those of Drikos et al. (2011) and confirm the importance of the winners making fewer mistakes in side-out actions and having a better attack side-out and block efficacy than in other studies (PALAO et al., 2015; KUMAR et al., 2021). Along this line, GIATSIS et al. (2023) pointed out that attacking is the most important skill for winning beach volleyball in all types of sets.

The data found allows us to better understand the game dynamics in beach volleyball tiebreak sets. The number of indicators that differentiate winners from losers increases with the increase in the score difference. Winning teams achieve solid and efficient side-outs and could execute more counterattacks when there is a smaller final point difference from their opponent, while the losing teams make more mistakes in serving, blocks, and attacks as the differences in scores increase. When the difference in the score is small, the game must be played "safely" from the server's position, transferring the probability of making an unforced error to the receiving team in their three touches of the ball. This approach based on the score difference in a tie break seeks to expand the applicability of this type of research.

Regarding the possible application of the data, the results can be used as reference values to monitor, guide, or carry out goal-setting interventions in the studied population. For example, coaches should offer several offensive scenarios to enhance players' attack potential, prepare them for gaining points from this skill, and balance tie break sets. They should also provide various game scenarios to enhance block efficacy, given that players must master blocking to reduce attacking advantage in relation to the defensive system and decide the tie break set. Furthermore, they should consider different ways of expressing the performance, especially for attacking, in order to properly

establish the criteria to use as a reference in their analysis. If a coach is going to monitor the efficacy, data show that the best option is to monitor side-out actions. However, if we are going to monitor the number of points obtained, the data show that the best option is to monitor the block and counter-attack points together (complex II) or individually.

Conclusion

The tactical-technical performance of winning teams is generally characterized by greater efficiency in counterattacks, obtaining more points in blocking and attacking, and limiting the opponent's attack. They make fewer serving errors and have better side-out attack efficacy. The data show that monitoring the number of points and errors obtained, specifying counterattack actions with or without possession of the ball, provides a more dynamic view of the game. This study can serve as a reference for coaches and performance analysts. Future studies should take the periods of the set period, specifically the final period ≥+10, into consideration when studying the importance of the different skills on the result of the tiebreak. Therefore, more studies that combine other contextual variables at critical moments are needed to understand beach volleyball game patterns.

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References

Anguera, M. (2003). Observational methods (general). In R. Fernández-Ballestores (Ed.), Encyclopedia of Psychological Assessment (Vol. 2, pp. 632–637). London: Sage.

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

Drikos, S., Angelonidis, Y., & Sobonis, G. (2018). The role of skills in winning in different types of set in women's volleyball. *International Journal of Performance Analysis in Sport*, *18*(6), 950-960.

Drikos, S., Sotiropoulos, K., Barzouka, K., & Angelonidis, Y. (2020). The contribution of skills in the interpretation of a volleyball set result with minimum score difference across genders. *International Journal of Sports Science & Coaching*, 15(4), 542-551.

Federation Internationale de Volleyball. (2023). *FIVB official volleyball rules 2013–2016*. Retrieved July 10, 2023.

Fleiss, J. L., & Cohen, J. (1973). The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. Educational and psychological measurement, 33(3), 613-619.

García-de-Alcaraz, A., & Marcelino, R. (2017). Influence of match quality on men's volleyball performance at different competition levels. *International Journal of Performance Analysis in Sport*, *17*(4), 394-405.

Giatsis, G. (2023). Beach volleyball performance benchmarks in men's high level. *Journal of Human Sport and Exercise, in press*. https://doi.org/10.14198/jhse.2023.182.15

Giatsis, G., Lola, A., Drikos, S., Lopez-Martinez, A. B., & Turpin-Pérez, J. A. (2023). Beach volleyball set and technical performance indicators for elite women's teams. *Journal of Human Sport and Exercise, in press.*

Giatsis, G., & Zahariadis, P. (2008). Statistical analysis of men's FIVB beach volleyball team performance. *International Journal of Performance Analysis in Sport*, *8*(1), 31-43.

Kumar, G., Shukla, A., Chhoker, A., & Thapa, R. K. (2021). Identification of Factors Determining Winning in Men's and Women's Beach Volleyball: a Logistical Regression Approach. *Physical Education Theory and Methodology*, *21*(1), 26-35.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Frontiers in psychology*, *4*, 863.

Lillich, L., Schweizer, G., & Nießner, M. (2023). Searching for the Effects of Momentum in Beach Volleyball. *Zeitschrift für Sportpsychologie*. 10.1026/1612-5010/a000393

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

Marcelino, R., Mesquita, I., & Sampaio, J. (2011). Effects of quality of opposition and match status on technical and tactical performances in elite volleyball. *Journal of sports sciences*, *29*(7), 733-741.

McHugh, M. L. (2012). Interrater reliability: the kappa statistic. Biochemia medica, 22(3), 276-282.

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. *Journal of sports science & medicine*, *13*(3), 658.

Medeiros, A. I., Marcelino, R., Mesquita, I. M., & Palao, J. M. (2017). Performance differences between winning and losing under-19, under-21 and senior teams in men's beach volleyball. *International Journal of Performance Analysis in Sport*, *17*(1-2), 96-108.

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.

Norušis, M. J. (2006). *SPSS 14.0 guide to data analysis*. Upper Saddle River, NJ: prentice hall.

O'Donoghue, P., & Simmonds, E. (2019). Probability of winning and match length in Tiebreak Ten tennis. *International Journal of Performance Analysis in Sport*, *19*(3), 402-416. DOI: 10.1080/24748668.2019.1615296.

Palao, J. M., Lopez-Martinez, A., Valades, D., & Hernandez, E. (2019). Manner of Execution and Efficacy of Reception in Men's Beach Volleyball. *Montenegrin Journal of Sports Science and Medicine*, *8*(2), 21.

Palao, J. M., & Manzanares, P. (2009). Manual for observation instrument of techniques and efficacy in beach-volleyball. Murcia: Author.

Palao, J. M., Manzanares López, P., & Ortega, E. (2015). Design and validation of an observational instrument for technical and tactical actions in beach volleyball. *Motriz: Revista de Educação Física*, *21*, 137-147.

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

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).

Sawilowsky, S. S. (2009). New effect size rules of thumb. *Journal of modern applied statistical methods*, *8*(2), 26.

Stankovic, M., Ruiz Llamas, G., Peric, D., & Quiroga Escudero, M. E. (2019). Point-scoring plays related to level of set win and in-game role during volleyball rules testing. *Journal of Human Sport and Exercise*.

Taylor, J., Mellalieu, S., James, N. and 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: 885–895.

5.3 Artigo 3

Technical-tactical performance indicators to be explored in each tiebreak period to win elite women's beach volleyball matches.

Abstract

The aim of the present study was to examine winning and losing teams' performances during the three different periods (initial, intermediate, and final) in women's beach volleyball tie breaks. The performance indicators (number of points and errors and performance coefficients) of both sideout and counterattack actions were gathered from 31 tiebreaks of the World Championship equality matches. Statistically significant differences via GEE were observed between winning and losing teams in the intermediate and final periods for sideout attack points. Also, statistically significant differences in the final period were observed for winning teams in block and dig efficacy. Besides, in the final period block, sideout and counterattack attack efficiency increase the chances of winning a tie break. On the other hand, serve, block, and sideout attack errors in the final period decrease the chances of winning the tie break. The result suggested that beach volleyball tie breaks presented different profiles depending on the tie break period. The final period showed the largest number of different and relevant indicators. Considering the margin of victory in the final period, fewer errors in the sideout attack, more blocking points, and counterattack points by the winners reduce the chances of a tight tie break ending. These findings can be used to simulate different tie break scenarios and control key performance indicators along the tie break.

Key words: performance analysis, logistic models, match context, team sports.

Introduction

A sports team's performance depends on multiple factors, including technical, tactical, or even contextual variables (GAIZER, 2015). Researchers, sport analysts, and coaches of beach volleyball usually study the game in official matches to know which performance technical-tactical indicators influence team wins and losses in both the set and match (PALAO; ORTEGA, 2015, KUMAR et al., 2021). These dados reveal performance through statistical information about efficacy coefficients, points, and errors for the serve, receive, set, attack, block, and dig actions performed by teams during the side-out or counterattack game phases (MEDEIROS et al., 2017). The information obtained from these investigations makes it possible to improve coaches' decision-

making during competitions and when preparing training sessions (O'DONOGHUE, 2015, GARCÍA-DE-ALCARAZ; USERO, 2019). For this, elite coaches emphasize the need for comprehensive analysis of performance in competitions that considers the nature of a dynamic game like this and its context (LÓPEZ-SERRANO et al., 2022). This approach is based on how opposing teams act and react when facing "momentum" or critical situations that are context-dependent and can affect player behaviors (GOMEZ et al., 2020), thereby disrupting the technical-tactical performance of both teams throughout the entire match (JIMEZ-OLMEDO; PENICHET-TOMAS, 2016).

Among the events that occur during a beach volleyball game, the set is one of the most important contextual variables that can influence team performance (GIATIS et al., 2023). The effects of a set on performance are based both on its temporais sequence (the first, second, and final sets) along with the effects of different moments within each set (initial period, intermediate and final period) (Marcelino et al., 2010) and its decisive fact for winning (RAMOS et al., 2011). The first and second sets are played to 21 points, while the third set is a tiebreak set played to 15 points (FIVB, 2023). The tie break is considered decisive because it is the last opportunity to win a match (MARCELINO et al., 2009) structured in best-of-three sets (FIVB, 2023).

Emotional charge and changes in the rules of a set tie break represent a critical situation during the game that influence the technical-tactical performance of winning and losing teams differently (O'DONOGHUE, 2007). When it comes to how the period affects performance in beach volleyball, previous studies have shown that main changes in the serve, block, and dig types occur between the initial and final periods for men's teams (JIMENEZ-OLMEDO et al., 2012, JIMENEZ-OLMEDO; PENICHET-TOMAS 2017a, 2017b).This shows how performance trends change over time and the importance of modeling performance profiles based on match constraints (GÓMEZ et al., 2021). However, no study to our knowledge has examined the relationship between period and technical-tactical performance according to tiebreak results in women's beach volleyball.

Win or loss in the tiebreaker set can be investigated in two ways: how the points were scored throughout the set or how many points were scored in the set. In the first case, it will be necessary to analyze the points scored by the

teams in each period (RODRIGUES et al., 2011). Under this viewpoint, volleyball literature points out that points in the early (first 5 points) and final periods (>10 points) are the most valuable for the result of the set (RAYMOND et al., 2020). Additionally, the impact of the final set moments would be conditioned by tight scoreboards (DÁVILA-ROMERO; GARCÍA-HERMOSO, 2015). According to this interactive effect, it was previously demonstrated in beach volleyball that the closer the teams' scoring line is to the end of the tiebreaker, the number of technical-tactical indicators that differentiate the winning teams from the losing teams decreases and can be different (DRIKOS et al., 2018). However, it has not yet been demonstrated how the relationship between actions within the game phase in the final period increases the chances of winning in the tiebreaker considering the score differences in beach volleyball. The analysis of tiebreak periods, especially the last one (>10 points), is important because it provides information that can show differences in the parameters leading to a match win (LOPEZ et al., 2022). In addition, the analysis of the difference in the final score may provide new insights into performance dynamics that keep the close scores in the final of the tie break.

Beach volleyball research in match analysis has increased in the last few decades, updating knowledge on the technical and tactical dimensions of high-level competitions. However, few studies have focused on the different contexts that affect these actions (LIMA et al.,2023). In the current study, the analysis of technical-tactic and contextual-related variables is innovative, making it possible to identify critical scenarios and relate them to specific performance trends. Therefore, this specific information may be used to modulate the tactics of players towards a better understanding of how game-play dynamics change. It is expected that there is a difference in the performance of serve, attack, block, reception, set and dig actions depending on the side-out or countattack phase of the game throughout the periods to win a tie break. The aim of the present study was to: (i) examine winning and losing teams’ technical-tactical performances during the three different tie break periods in equally high-level beach volleyball matches’; (ii) establish the relationships between performance indicators in each period and tie break result; and (iii) analyze the relationship between performance indicators by the game phases in the final period in winning and losing teams' and the margin of victory.

2.Methods

2.1. *Sample and data collection*

The sample consisted of matches from the 2019 and 2022 FIVB Women's Beach Volleyball World Championships. Altogether, 31 tie breaks sets from 68 matches that met the inclusion criteria were selected. Matches between teams of the same performance level (level 1 vs. level 1, level 2 vs. level 2, and level 3 vs. level 3), i.e., played by two teams of similar quality (GARCIA-DE-ALCARAZ; MARCELINO, 2017), based on cluster analysis, were included in the sample (see Fig. 1). A two-step analysis technique with three fixed clusters (Schwartz's Bayesian) was used to determine team levels (Taylor et al., 2008) and included, as variables, the total number of matches, sets, and points lost and won at the end of the competition (Medeiros et al., 2014). The study should control in team quality due to the fact that teams perform differently when facing equal teams than when facing teams with different levels (Marcelino, Sampaio, & Mesquita, 2011). All tiebreaks from these selected matches were considered for each team separately, giving a total of 62 (31 sets x 2 teams) tie break sets, 186 (93 x 2 teams) tiebreak set periods, and 4.872 actions for analysis. These actions were performed by 44 players, including 840 serves, 682 attacks on side-out, 428 attacks on counterattack, 574 blocks, 716 receptions, 646 sets on side-out, 428 sets on counterattack, and 558 digs. The study followed the Declaration of Helsinki guidelines and was approved by the Institutional Research Ethics Committee.

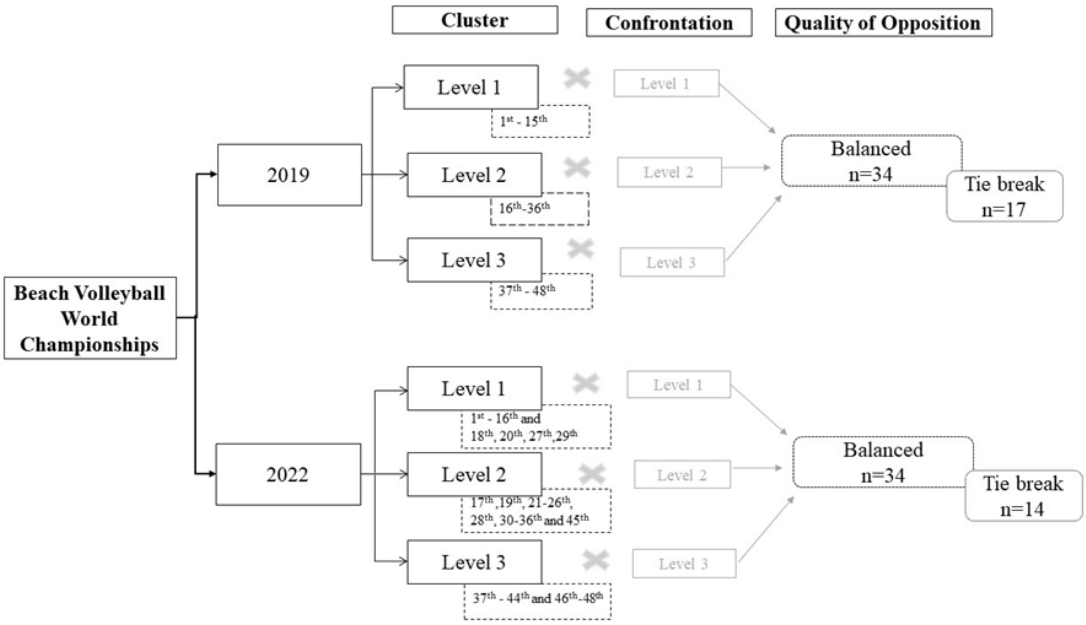

Figure 1. Sample division according to the tournament, the quality of opposition

The data gathering was done via match analysis by an observer (a performance analyst with five years' experience in beach volleyball match analysis) trained for this task. Match observation was conducted using Kinovea video analysis software and an observation instrument designed by Palao e Manzanares (2009). The observer's training process followed the stages described by Anguera's (2003): (i) the basic training stage with coaches and analysts in order to learn the key performance indicators (units of observation) from the observation instrument and how to proceed with the observational practice; (ii) the applied training stage, including the final observational tool and instrument using the Kinovea software; and (iii) the maintenance stage, guaranteeing that inter- and intra-reliability values for all the performance indicators reach acceptable levels. Accordingly, the data reliability was tested for inter- and intra-observer match analyzes with a very good Cohen's Kappa >0.81 (MCHUGH, 2012) for all variables using a random selection of 15% of the total analyzed sets (TABACHINICK; FIDELL, 2014). Also, two experienced observers (with more than ten years of experience in beach volleyball match analysis) conducted the inter- observer reliability analysis. Data on observation actions was organized in spreadsheets and merged into a single matrix, including contextual variables like tie break period, result, and type.

Variables

The variables analyzed were the following: tie break result (win, loss), tie break period (initial, intermediate, final), margin of win in the tie break final period (2 points, 3-4 points, >5 points), and performance technical-tactical indicators.

The *tie break period* variable was established according to Jimez-Olmedo, Pueo, & Penichet-Tomas (2017) in three periods: the initial period from 1 to 5 points; the intermediate period from 6 to 10 points; and the final period from 11 to 15, or the end of the tie break set. The point range for each period is determined by the team leading it. This allows for the observation of evolution's performance along the tie break, depending on the period when the action was carried out (JIMEZ-OLMEDO; PENICHET-TOMAS, 2017).

Categorization for *margin of win* was accomplished for the tie break sets using k-means clustering (NORUSIS, 2005), and three distinct clusters were generated based on the final point set difference: (i) closed (2 points); (b) closed safe (3-4 points); (c) large (5 or over points) tie break sets.

The *performance technical-tactical indicators* were evaluated by analyzing points and errors in terminal actions (serve, attack, and block) and the performance coefficients of serve, reception, set, attack, and block for both teams. The efficacy of actions was analyzed according to their effect on the rally (point or excellent, continuity, and error (PALAO; MANZANARES, 2009). Also, a performance coefficient was computed for these actions, according to Coleman (1969). In addition, these variables were analyzed per rally-game phase. The rally is categorized based on standardized action sequences. The side-out phase consists of the action sequences reception, set, and attack, whereas the counter-attack phase consists of the action sequences service, block, dig, and counterattack attack. The selection of these variables was based on the available research that considered them to be good predictors of a team’s success (PALAO et al., 2015; MEDEIROS et al., 2017; GIATISIS, 2022).

Statistical analysis

All statistical analyses were performed using IBM SPSS statistics for Windows, version 20.0 (SPSS Inc., Chicago, IL), and statistical significance was

set at p<.05. Descriptive analysis was performed to present the mean and standard deviation of the performance indicators over the three tiebreak periods for the teams that won and lost these tiebreakers. The normality assumptions were tested for each variable using the Shapiro-Wilks test. As the data mostly did not meet normal distribution, a repeated-measures version of the generalized linear model (GLM) known as generalized estimation equations (GEE) (Nelder & Wedderburn) was used to analyze the influence tie break result, tie break period, and their interaction on changes in performance indicators over time (three periods). For these analyses, GEE, assuming a negative binomial distribution, and the log link function were used for points and errors, and the gamma distribution and the identity link function were used for performance coefficients. Goodness of fit statistics based on the smallest Quasi Likelihood Under Independence Model Criterion (QIC) value The Wald test was used to analyze significant main and interaction effects. When significant interactions were found (i.e., p< 0.05), pairwise comparisons were made using Bonferroni adjustment.

Secondly, a logistic regression version of the GEE was constructed to estimate the relationships between performance indicator variables for three measure groups (number of points and errors, performance cofficients for the side out phase, and performance coefficients for the counterattack phase) and tie break periods on win probability in the tie break for the team. A binomial logistic regression by GEE was carried out, and the family was set binomial (win (1) or loss (0)). As suggested by Crawley (2007), model simplification (parsimonious) was performed by backward selection of variables from each full model and establishing one model for each group performance indicator (number of points and errors, performance coefficients for the side out phase, and performance coefficients for the counterattack phase). Model selection was based on the smallest QIC, as indicated by Neider and Lee (1992). The statistical significance of the fixed effects associated with the covariates included in the model was assessed using the Wald test. We checked the correlation and the main possible interactions among the covariates in the final model. There is no evidence of heteroscedasticity in the residuals. The relationships were determined by the odds ratio (OR) and their 95% confidence intervals (CI).

Finally, the regression logistic ordinals version of GLM was then used to determine the associations between points or errors in the third period of the tie break (wins and losses) and the winning margin in the tie break. For these analyses, proportional odds and the absence of multicollinearity was verified through the level of tolerance and variance inflation factor (VIF). The relationships were determined by the OR and their 95% CI.

The GEE approach is an advanced statistical method developed by Liang and Zeger (1986) to produce more efficient and unbiased regression estimates when analyzing longitudinal or repeated measures research designs with non-normal response variables. This feature can greatly benefit studies in which the distribution of data is difficult to verify due to a small sample size. It is particularly useful in situations that take into account the correlations between repeated measures on the same group (ZEGER; LIANG, 1986). Further, GEE has been shown to show higher classification accuracy in comparison to methods such as logistic regression in such instances (ÖNDER, 2015). The method models the mean response as a linear function of covariates of interest via a transformation or link function. To accommodate various types of outcomes that are not necessarily normally distributed, different link functions are employed, modeling the relationship between outcome and covariates (NASERI et al., 2016). Further, the method of GEE was employed to construct a model explaining match outcomes as a function of the feature set for the performance indicators (ROBERSON; GUPTA; MCINTOSH 2016; ROBERTSONB; URNETT; GUPTA, 2014).

Results

The descriptive results for all analyzed variables are presented for three periods of tie break in Table 1 and 2. The median comparisons between winning and losing teams showed statistically significant differences in period intermediate in points of side out attack and in period final in points of side out attack, block, and dig efficacy ($p = 0.02$). There were non-significant differences between winning and losing teams in the rest of the periods for all variables studied ($p > 0.05$). In addition, the results differentiating the repeated measures (among periods) for each team showed significant differences in side-out attack

points among winning teams (p <0.05), with the final period being the most differentiated from the other periods of the tiebreak (all pairwise comparisons p < 0.05). Besides, the winning teams also showed significant differences between periods in dig and counterattack attack efficacy (p = 0.021), with the final period being different from the intermediate periods (lower values) (p < 0.05). Losing teams also showed significant results among periods for side-out attack points (p > 0.05), with the initial period being different from other periods (lower values) (p<0.05). On the other hand, block efficacy (p > 0.05) showed significant differences for losing teams with a final period different from the intermediate period (lower values) (p < 0.05).

Table 1. Descriptive and inferential data of points and errors according to tie break result and tie brek period.

	Loss	Win			
Number of points and errors	M ± SD		Contex	W	*p*-value
Serve aces					
Initial period	0.16±0.45	0.19±0.47	Result	0.026	0.89
Intermediate period	0.19±0.40	0.16±0.45	Period	0.218	0.87
Final period	0.16±0.37	0.19±0.40	R*P	0.218	0.88
Serve erros					
Initial period	0.54 ±0.76	0.54±0.67	Result	2.553	0.11
Intermediate period	1.0±0.85	0.41±0.58	Period	2.067	0.35
Final period	0.51±0.67	0.45±0.67	R*P	5.834	0.05
Attack points (side-out)					
Initial period	1.3±0.97	1.90±1.01	Result	0.125	0.72
Intermediate period	2.16±1.01	1.41±0.95	Period	5.544	0.06
Final period	1.90±1.01	2.16±1.53	R*P	13.49	0.001*
Attack errors (side-out)					
Initial period	0.25±0.51	0.38±0.61	Result	1.670	0.19
Intermediate period	0.38±0.55	0.25±0.51	Period	0.035	0.98
Final period	0.58±1.02	0.19±0.47	R*P	4.937	0.08
Attack points (counterattack)					
Initial period	0.80 ±1.14	1.03± 0.75	Result	11.27	0.001*
Intermediate period	0.71 0.86	0.93±0.77	Period	0.636	0.72
Final period	0.64± 0.75	1.41±1.25	R*P	2.529	0.28
Attack errors (counterattack)					.
Initial period	0.0± 0.0	0.13± 0.40	Result	0.860	0.35
Intermediate period	0.23 ± 0.50	0.16 ± 0.37	Period	1.294	0.52
Final period	0.19 ± 0.40	0.07± 0.25	R*P	0.913	0.63
Block points					
Initial period	0.19± 0.48	0.51 ± 0.72	Result	7.882	0.005*
Intermediate period	0.32± 0.45	0.48 ± 0.68	Period	1.114	0.57
Final period	0. 19± 0.48	0.45± 0.72	R*P	1.136	0.56
Block erros					
Initial period	0.13±0.43	0.032±0.18	Result	5.011	0.02*
Intermediate period	0.61±0.37	0.032±0.18	Period	7.528	0.02*
Final period	0.32±0.54	0.13±0.34	R*P	0.506	0.776

M±SD: Mean ± Standard Deviation; ** p < 0.05;*

Table 2. Performance coefficients according to tie break result and tie break period.

	Loss	Win			
	M ± SD	M ± SD	Context	W	*p*-value
Performance Coefficients					
Serve					
Initial period	1.45 ±0.57	1.43 ±0.83	Result	1.081	0.29
Intermediate period	1.25 ±0.75	1.49 ±0.53	Period	0.764	0.68
Final period	1.41 ±0.52	1.45 ±0.46	R*P	0.818	0.66
Reception_					
Initial period	2.18 ±0.73	2.28±0.48	Result	0.558	0.45
Intermediate period	2.32 ± 0.48	2.32± 0.40	Period	0.166	0.92
Final period	2.39 ± 0.44	2.29± 0.37	R*P	0.482	0.78
Set (side-out)					
Initial period	2.65±0.50	2.68±0.40	Result	0.096	0.75
Intermediate period	2.55±0.42	2.48±0.39	Period	4.17	0.12
Final period	2.52±0.38	2.50±0.47	R*P	0.32	0.84
Attack (side-out)					
Initial period	3.31±0.97	3.52±0.77	Result	2.745	0.09
Intermediate period	3.57±1.00	3.47±1.02	Period	0.927	0.62
Final period	3.22±1.19	3.70±0.65	R*P	0.677	0.71
Block					
Initial period	2.01±1.05	2.62±0.87	Result	4.230	0.04*
Intermediate period	2.45±1.12	2.51±0.78	Period	5.301	0.07
Final period	1.63±0.98	2.55±0.79	R*P	7.658	0.02*
Dig					
Initial period	1.75 ± 0.90	1.89 ±0.94	Result	5.380	0.02*
Intermediate period	1.64 ±0.95	1.40 ±0.84	Period	0.666	0.71
Final period	1.40±0.92	1.99 ±0.81	R*P	6.812	0.03*
Set (counterattack)					
Initial period	2.40±0.52	2.21±0.47	Result	1.266	0.26
Intermediate period	2.10±0.84	2.22±0.62	Period	1.963	0.37
Final period	2.29±0.79	2.41±0.58	R*P	0.592	0.74
Attack(counterattack)					
Initial period	3.23±1.42	3.25±1.39	Result	3.655	0.05
Intermediate period	2.68 ±1.67	3.39±1.12	Period	0.457	0.79
Final period	2.76±1.57	3.38±1.36	R*P	1.374	0.50

M±SD: Mean ± Standard Deviation; * $p < 0.05$;

GEE models were used to analyze the number of points and errors (Table 3) and performance coefficients of both side out and counterattack phases (Table 4) in the tie break periods associated with winning in this set. It included parameter estimates and odds ratios with their 95% confidence limits for interaction between points, errors, and performance coefficients of actions and tie break period.

Regarding the number of points and errors, points increase the odds of winning the tiebreak, while errors decrease these odds. This study found significant differences in counterattack attack points in the final period (OR = 2.151; 95% CI: 1.264–3.660), block points in the intermediate (OR = 3.136; 95% CI: 1.024–9.600), and final (OR = 3.753; 95% CI: 1.147–12.274) periods. Serve errors in the intermediate (OR = 0.376; 95% CI: 0.150–0.947) and final (OR = 0.219; 95% CI: 0.070–0.690) periods, attack side-out errors (OR = 0.263; 95% CI: 0.108–0.643), and block errors (OR = 0.166; 95% CI: 0.033–0.829) in the final period also showed significant differences, ceteris paribus all the other variables of this group.

Table 3. Association between points and errors and each tie break period with the tiebreak win.

Actions		**Points**				**Errors**			
	Periods of tiebrek	*p*-value	OR	95% CI for OR		*p*-value	OR	95% CI for OR	
				Lower	Upper			Lower	Upper
Serve	Initial	.512	.661	.191	2.282	.250	.672	.342	1.323
	Intermediate	.980	.984	.281	3.452	.038*	.376	.150	.947
	Final	.912	1.113	.167	7.415	.009*	.219	.070	.690
Attack (side-out)	Initial	.124	1.463	.901	2.376	.996	1.003	.367	2.738
	Intermediate	.981	1.006	.619	1.636	.956	.973	.378	2.506
	Final	.145	1.482	.873	2.517	.003*	.263	.108	.643
Attack (counter attack)	Initial	.882	1.038	.633	1.704	.954	.966	.297	3.145
	Intermediate	.058	1.859	.980	3.529	.190	.518	.193	1.387
	Final	.005*	2.151	1.264	3.660	.184	.351	.075	1.644
Block	Initial	.108	2.207	.840	5.800	.062	.239	.053	1.076
	Intermediate	.045*	3.136	1.024	9.600	.315	.280	.024	3.343
	Final	.029*	3.753	1.147	12.274	.029*	.166	.033	.829

OR=Odds Ratios

Considering the performance coefficients of reception, set, and attack in the sideout phase, only attack in the sideout in the final period of the tiebreak increased the teams' chances of victory by 1.621 (95% CI, 1.012 – 2.599). As for the performance coefficients of the counterattack phase, better dig and block efficacy in the initial period increase the chances of winning the tiebreak by 4.927 (95% CI, 1.556 – 4.232) and 15.172 (95% CI, 2.341–98.345), respectively. Only counterattack attack efficacy increased the chances of

winning in the intermediate period by 2.087 (95% CI, 1.048 – 4.156). In addition, better block efficacy and counterattack attack efficacy in the final period increase the odds by 3.383 (95% CI, 1.204 – 9.506) and 2.296 (95% CI, 1.142 – 4.618), respectively, all other variables being equal.

Table 4. Association between performance coefficients of actions by game phase and each tie break period with the tiebreak win.

Performance Coefficients	**Side-out phase**					**Counterattack phase**			
	Periods of tiebrek	*p*-value	OR	95% CI for OR		*p*-value	OR	95% CI for OR	
				Lower	Upper			Lower	Upper
Serve efficacy	Initial	-	-	-	-	.746	.856	.333	2.199
	Intermediate	-	-	-	-	.817	1.165	.320	4.242
	Final	-	-	-	-	.158	3.216	.635	16.291
Reception or Dig efficacy	Initial	.501	.733	.296	1.813	.048*	4.927	1.017	23.869
	Intermediate	.951	1.032	.378	2.818	.604	.629	.109	3.621
	Final	.461	.627	.181	2.170	.064	3.041	.939	9.853
Set efficacy	Initial	.452	1.309	.649	2.637	.092	.163	.020	1.344
	Intermediate	.981	.991	.480	2.048	.845	1.150	.282	4.686
	Final	.984	1.012	.306	3.348	.007*	.099	.018	.538
Attack efficacy	Initial	.346	1.275	.769	2.114	.278	.687	.349	1.354
	Intermediate	.660	1.142	.631	2.068	.036*	2.087	1.048	4.156
	Final	.045*	1.621	1.012	2.599	.020*	2.296	1.142	4.618
Block efficacy	Initial	-	-	-	-	.004*	15.172	2.341	98.345
	Intermediate	-	-	-	-	.528	1.413	.483	4.134
	Final	-	-	-	-	.021*	3.383	1.204	9.506

OR=Odds Ratios

Table 5 presents the results of ordinal logistic regression via GLM for the points and errors of winning and losing teams in the final tie break period associated with the margin of victory. The results identified only the serve in both teams had no association with the margin of victory. On the other hand, more points in the block, more points and fewer errors in the counterattack, fewer side out errors scored by the winning teams, as well as fewer attack points in the side out and counterattack, and more errors in the side out attack by losing teams, reduce the chances of a final score with a minimum difference. In other words, these indicators help to establish a safer margin of victory.

Table 5. Interaction between statistics in the final period of the tiebreak and the result of the tie break associated with the victory making.

Points and errors in period final	**Points**					**Errors**			
	Tiebreak Result	*p*-value	OR	95% CI for OR		*p*-value	OR	95% CI for OR	
				Lower	Upper			Lower	Upper

tiebreak									
Serve	Loss	.502	2.946	.126	69.014	.906	.917	.220	3.826
	Win	.769	1.487	.106	20.952	.051	8.048	.995	65.071
Attack (side-out)	Loss	.001*	.173	.061	.485	.011*	.222	.070	.708
	Win	.449	.769	.390	1.518	.005*	.046	.005	.398
Attack (counterattack)	Loss	.001*	.055	.009	.328	.246	3.019	.467	19.509
	Win	.002*	.230	.092	.572	.012*	.040	.003	.490
Block	Loss	.108	9.840	.604	160.417	.897	.883	.132	5.885
	Win	.006*	.095	.018	.503	.408	3.287	.196	55.025

OR=Odds Ratios

Discussion

The aim of the current study was to examine how winning and losing teams performed during the three different tie break periods in elite women's beach volleyball matches. As it was hypothesized, different patterns of relations between teams occur during different tie break periods. In particular, winning and losing teams show different performance trends on technical-tactical indicators during the intermediate and final tie break periods, while initial periods show more equal trends. The approach of this study highlights the importance of interaction between match-contextual variables, such as the period and result. According to Sarmento et al. (2022), more integrated holistic analyses of team sports performance by considering technical, tactical, and contextual aspects will bridge the gap between theory and practice.

Although most comparisons between the two teams in the initial period did not show significant differences, better performers in block (more points and few errors) and in dig increased the chances of winning a tie break. A less efficient side out attack by the losing teams in this period may have contributed to the better efficacy of these defensive actions for the winners since the serve remained the same. This reflects the importance of teams executing the side-out attack efficiently and, thus, preventing the opposing team from scoring points in defensive actions that increase their chances of winning the game. JIMENEZ et al. (2017a, 2017b) also found the greatest number of defenses and blocks to be more effective in the initial period of the set. Therefore, players need to manage the risk according to their attack skills to increase the score advantage as soon as possible (MARCELLINO et al., 2011). At the same time, consistent blocking action hinders the attack of the opposing team (CASTRO et

al., 2011). It was clear in the literature the importance of attack and blocked ball in the outcome of beach volleyball matches (GIATIS et al., 2023).

During the last two periods, teams seemed to change dominance between each other in terms of points of side out attack and serve and defense efficiency. For example, the pattern of play in the side out attack of the winning teams decreases in the intermediate period in relation to the initial period, while the losing teams improve their pattern of play in the side out attack in the intermediate period. This fact may be related to a more offensive serve performed by the losing team and their better block performance in the intermediate period when compared to the initial period. Previous research has suggested that winning teams may underperform after leading and then decrease their effort in trying to keep this difference score (KONEFAŁ et al., 2019).

Moreover, the increased serve errors may be justified by the need for an advantage, even taking high risks, when playing against high-quality opponents. In the serve action, there is no direct interference with any other player; this condition ensures that only situational variables could be affecting its effectiveness (MARCELINO; SAMPAIO; MESQUITA, 2012). In theory, a tactical serve with less risk of making mistakes helps the winning team maintain points in the block in the intermediate period. Block performance can be influenced by decision-making depending on the game's time and the advantageous or disadvantageous situation in which players find themselves (MARCELINO, MESQUITA; SAMPAIO, 2011). Players understand that not all points are equally important for winning matches, and the best players exert more physical and mental effort on important points while relaxing on unimportant ones (BARNETT, 2010).

When the tie break sets are moving toward their end (final period), the side-out attack point, counterattack attack, and dig efficacy of winning teams increase, while the side-out attack point and block efficacy of losing teams decrease. High performance in serve, block, reception, and set remains for winners, while losers' serve efficiency improves in relation to the intermediate period. Errors in serve, attack, and block reduce the chances of winning, leading to teams avoiding mistakes and adopting safer strategies. This could somehow explain why high-level players use different serve strategies

depending on the period of the set; in the last rallies, they have refrained from taking risks (MARCELINO; SAMPAIO; MESQUITA, 2012). Jimenez et al. (2012) saw a decrease in the use of a serve with jump power while floating in the final period of beach volleyball matches. On the other hand, within this opposition level, a weak service allows for a well-organized attack by the opponent team (MORAS et al., 2008). Moreover, Giatsis et al. (2023) found that block points per set significantly increased the probability of winning a tiebreak in women's beach volleyball. Teams that show a better interpretation and reading of the opponent's game as well as a sample of better physical preparations that guarantee the defensive player’s responses in the digger’s and blocker's performance set the final period (JIMENEZ-OLMEDO;PENICHET-TOMAS, 2017a, 2017b). According to Gomez et al. (2022), the final period of a match corresponds to a period of higher exploration and variation in dynamic relations teams compared to other periods.

Still in the final tie break period, when the winning teams make fewer errors in side-out attacks, as well as more block points and counterattack attacks, points reduce the chances of a tie break with a minimum point difference. Negative momentum in the final period may occur due to errors and reduce the team's performance in a critical way (O'DONOGHUE, 2001). That's why it is crucial to manage the negative moment and come back to perform well in decisive indicators to win in the final period (REDWOOD-BROWN, 2008). In particular, the teams that are losing try to overcome the adversity by increasing their performance to get back in the match (GOMEZ et al., 2020). However, if the teams do not score or err more, they can lose motivation, and then the negative momentum leads to a dramatic drop in performance (GOMEZ et al., 2021). Winning teams may perceive crucial points at the end of the set, allowing them to concentrate on decisive rallies (MARCELINO; SAMPAIO; MESQUITA, 2012). Final set periods can be considered critical moments that differentiate team expertise levels (RAMOS et al. 2017).

Winning teams performed better during the final and initial periods than during the intermediate periods in attack, serve, and dig (lower values in the intermediate period), while other indicators remained more constant. On the other hand, losing teams performed better for these indicators during the intermediate period than during the initial and final periods. However, during the

final period, the losing teams faced a drop in performance compared to the winning teams. A similar number of serving receptions and setting per team was achieved in each period, increasing the balance between teams and the pressure on attack performance.

The current study has some limitations that need to be considered in further studies. Firstly, only tie breaks of matches with similar quality of opposition were considered in the study; further research could account for others' quality of opposition (e.g., level 1 x level 2). Secondly, due to the study only accounting for the final difference score in the final period, future research should analyze the difference score in other final periods. Thirdly, further research could account for match status, such as periods of alternative scorelines (e.g., advantage, draw, disadvantage). Lastly, future research could integrate more analysis into the final period, which could provide interesting insights into performance, especially during close tie breaks or comebacks in the tie breaks.

Practical Applications

The study emphasizes the importance of an integrative approach to sports performance, considering technical, tactical, and match-context variables and providing practical applications that can be controlled during training and matches. The specific information about the impact of intermediate periods (better performances of losing teams) and final periods (better performances for winning teams) in a tie break can be used to account for specific training drills and competitive scenarios anticipating positive and negative variations (i.e., behavioral momentum) of the point and errors scored that stress the need to perform at the highest level, particularly at the end. Analysis of technical-tactical performances allowed a characterization of the initial, intermediate, and final periods of the tiebreak and helped to reveal the need to explore the dynamics of side-out and counterattack phases. Specifically, identified trends obtained for block, serve, and attack can feed coaches to minimize failure by adapting training drills (using specific constraints) according to the tie break period scenarios. For example, specific training drills can be created focused on tasks

at the end of the training sessions with induced fatigue and in a specific context: i) perform attack in side-out play immediately after a block received or make a mistake in the attack; ii) players perform reception and attack side-out after scoring a serve error or a block received with a close scoreline at the end of a tie break; or iii) defensive players must perform several actions in combination with both cognitive and physical demands.

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References

Anguera, M. (2003). Observational methods (general). In R. Fernández-Ballestores (Ed.), Encyclopedia of Psychological Assessment (Vol. 2, pp. 632–637). London: Sage.

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

Dávila Romero, C., & García-Hermoso, A. (2015). Close set in volleyball. Differences and discriminatory power of final game actions in formative stages. Rev. Int. Med. Cienc. Act. Física Deporte, 21, 67-70.

Drikos, S., Angelonidis, Y., & Sobonis, G. (2018). The role of skills in winning in different types of set in women's volleyball. *International Journal of Performance Analysis in Sport*, *18*(6), 950-960.

Drikos, S., Sotiropoulos, K., Barzouka, K., & Angelonidis, Y. (2020). The contribution of skills in the interpretation of a volleyball set result with minimum score difference across genders. *International Journal of Sports Science & Coaching*, 15(4), 542-551.

Drikos, S., Barzouka, K., Balasas, D. G., & Sotiropoulos, K. (2022). Effect of quality of opposition on game performance indicators in elite male volleyball. International Journal of Sports Science & Coaching, 17(1), 169-177.

Federation Internationale de Volleyball. (2023). *FIVB official volleyball rules 2013–2016*. Retrieved July 10, 2023.

Fleiss, J. L., & Cohen, J. (1973). The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. Educational and psychological measurement, 33(3), 613-619.

García-de-Alcaraz, A., & Marcelino, R. (2017). Influence of match quality on men's volleyball performance at different competition levels. *International Journal of Performance Analysis in Sport*, *17*(4), 394-405.

García-de-Alcaraz, P. A., & Usero, L. (2019). Influence of contextual variables on performance of the libero player in Top-Level women's volleyball. Journal of human kinetics, 70, 199.

Giatsis, G. (2022). Beach volleyball performance benchmarks in men's high level. *Journal of Human Sport and Exercise, in press*. https://doi.org/10.14198/jhse.2023.182.15

Giatsis, G., Lola, A., Drikos, S., Lopez-Martinez, A. B., & Turpin-Pérez, J. A. (2023). Beach volleyball set and technical performance indicators for elite women's teams. *Journal of Human Sport and Exercise, in press.*

Giatsis, G., & Zahariadis, P. (2008). Statistical analysis of men's FIVB beach volleyball team performance. *International Journal of Performance Analysis in Sport*, *8*(1), 31-43.

Gomez, M. A., Reus, M., Parmar, N., & Travassos, B. (2020). Exploring elite soccer teams' performances during different match-status periods of close matches' comebacks. Chaos, Solitons & Fractals, 132, 109566.

Gómez, M. A., Cid, A., Rivas, F., Barreira, J., Chiminazzo, J. G. C., & Prieto, J. (2021). Dynamic analysis of scoring performance in elite men's badminton according to contextual-related variables. Chaos, Solitons & Fractals, 151, 111295.

Jimenez-Olmedo, J. M., Penichet-Tomas, A., Saiz Colomina, S., Carbonell Martínez, J. A., & Jove Tossi, M. (2012). Serve analysis of professional players in beach volleyball.

Jimenez-Olmedo, J. M., & Penichet-Tomás, A. (2017). Digger's activity at men's European beach volleyball university championship.

Jimenez-Olmedo, J. M., & Penichet-Tomas, A. (2017). Blocker's activity at men's european beach volleyball university championship. Retos. Nuevas Tendencias En Educacion Física, Deporte y Recreación, (32), 252-255.

Kumar, G., Shukla, A., Chhoker, A., & Thapa, R. K. (2021). Identification of Factors Determining Winning in Men's and Women's Beach Volleyball: a Logistical Regression Approach. *Physical Education Theory and Methodology*, *21*(1), 26-35.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Frontiers in psychology*, *4*, 863.

Liang, K.-Y., & Zeger, S. L. (1986). Longitudinal data analysis using Generalized Linear Models. Biometrika, 73, 13–22.

Lima, V. S., Rocha, F. B. F., Diniz, I. B., Garcia-de-Alcaraz , A. S. Palao, J. M.; Costa, G. C., ... & Batista, G. R. (2023). Status of Match Analysis Research in Indoor and Beach Volleyball: A bibliometric analysis. Retos: nuevas tendencias en educación física, deporte y recreación, (50), 838-848.

López-Serrano, C., Moreno Arroyo, M. P., Mon-López, D., & Molina Martín, J. J. (2022). In the Opinion of Elite Volleyball Coaches, How Do Contextual Variables Influence Individual Volleyball Performance in Competitions? Sports, 10(10), 156.

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

Marcelino, R., Mesquita, I., & Sampaio, J. (2011). Effects of quality of opposition and match status on technical and tactical performances in elite volleyball. *Journal of sports sciences*, *29*(7), 733-741.

McHugh, M. L. (2012). Interrater reliability: the kappa statistic. Biochemia medica, 22(3), 276-282.

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. *Journal of sports science & medicine*, *13*(3), 658.

Medeiros, A. I., Marcelino, R., Mesquita, I. M., & Palao, J. M. (2017). Performance differences between winning and losing under-19, under-21 and senior teams in men's beach volleyball. *International Journal of Performance Analysis in Sport*, *17*(1-2), 96-108.

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.

Naseri, P., Majd, H. A., Kariman, N., & Sourtiji, A. (2016). Comparison of generalized estimating equations (GEE), mixed effects models (MEM) and repeated measures ANOVA in analysis of menorrhagia data. Archives of Advances in Biosciences, 7(1), 32-40.

Norušis, M. J. (2006). *SPSS 14.0 guide to data analysis*. Upper Saddle River, NJ: prentice hall.

Önder, H. (2015). Comparative study of generalised estimating equations and logistic regressions on different sample sizes and correlation levels. Communications in Statistics-Simulation and Computation.

O'Donoghue, P. (2015). An introduction to performance analysis of sport. Routledge.

O'Donoghue, P., & Simmonds, E. (2019). Probability of winning and match length in Tiebreak Ten tennis. *International Journal of Performance Analysis in Sport*, *19*(3), 402-416. DOI: 10.1080/24748668.2019.1615296.

Palao, J. M., Lopez-Martinez, A., Valades, D., & Hernandez, E. (2019). Manner of Execution and Efficacy of Reception in Men's Beach Volleyball. *Montenegrin Journal of Sports Science and Medicine*, *8*(2), 21.

Palao, J. M., & Manzanares, P. (2009). Manual for observation instrument of techniques and efficacy in beach-volleyball. Murcia: Author.

Palao, J. M., Manzanares López, P., & Ortega, E. (2015). Design and validation of an observational instrument for technical and tactical actions in beach volleyball. *Motriz: Revista de Educação Física*, *21*, 137-147.

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

Ramos, A., Coutinho, P., Silva, P., Davids, K., & Mesquita, I. (2017). How players exploit variability and regularity of game actions in female volleyball teams. European Journal of Sport Science, 17(4), 473-481.

Raymond, B., Izkowicz, A., Lebedew, M., & Dietz, J. (2020). The Value of Points in Volleyball. Science Untangled. Available online: https://untan.gl/point-value.html (accessed on October 2023).

Redwood-Brown, A. (2008). Passing patterns before and after goal scoring in FA Premier League Soccer. International Journal of Performance Analysis in Sport, 8(3), 172-182.

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).

Sarmento, H., Clemente, F. M., Afonso, J., Araújo, D., Fachada, M., Nobre, P., & Davids, K. (2022). Match analysis in team ball sports: an umbrella review of systematic reviews and meta-analyses. Sports Medicine-Open, 8(1), 66.

Sam Robertson, Angus F. Burnett & Ritu Gupta (2014) Two tests of approach-iron golf skill and their ability to predict tournament performance, Journal of Sports Sciences, 32:14, 1341-1349.

Sam Robertson, Ritu Gupta & Sam McIntosh (2016): A method to assess the influence of individual player performance distribution on match outcome in team sports, Journal of Sports Sciences.

Sawilowsky, S. S. (2009). New effect size rules of thumb. *Journal of modern applied statistical methods*, *8*(2), 26.

Stankovic, M., Ruiz Llamas, G., Peric, D., & Quiroga Escudero, M. E. (2019). Point-scoring plays related to level of set win and in-game role during volleyball rules testing. *Journal of Human Sport and Exercise*.

Taylor, J., Mellalieu, S., James, N. and 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: 885–895.

Zeger, S. L., & Liang, K. Y. (1986). Longitudinal data analysis for discrete and continuous outcomes. Biometrics, 121-130.

Zeger, S. L., Liang, K.-Y., & Albert, P. S. (1988). Models for longitudinal data: A generalized estimating equation approach. Biometrics, 44, 1049–1060.

Ziegler, A., & Vens, M. (2010). Generalized estimating equations. Methods of Information in Medicine, 49, 421–425

6. CONSIDERAÇÕES FINAIS

De um modo geral, os resultados do presente estudo permitiram inferir que:

- As variáveis contexuais do jogo e estatisticas das ações técnico e taticas durante o jogo estão entre os principais tópicos de tendência no interesse da comunidade cientica relacionada a análise do jogo no voleibol de praia
- Os conntextos de jogo estudados (*tie-break*, resultado do *tie-break*, periodos do *tie-break*) influenciaram no comportamento do desempenho tatico-tecnico das equipes em jogos de igual qualidade de oposicão no voleibol de praia feminino.
- A performance técnico e tático das times vencedoras no set *tie-break* é geralmente caracterizado por maior número de indicadores quanto maior a diferença de pontos finais, com maior eficiência nos contra-ataques, mais pontos no bloqueio e no ataque, menos erros de saque e melhor eficácia de ataque em side-out (mais pontos e menos erros).
- Os times vencedores do tie break realizaram mais às ações de contra-ataque no KII para vencerem com média e máxima diferença de pontos. O saque fez differença para vencer apenas nos sets *tie break* finalizados com media diferenca de pontos no placar final. Nas vitórias com a mínima diferença no placar apenas a equicácia de ataque em side-out parece diferenciar os vencedores e perdedores.
- As equipes vencedoras tiveram melhor desempenho nos períodos final e inicial do que nos períodos intermediários no ataque, saque e defesa (valores mais baixos no período intermediário), enquanto outros indicadores permaneceram mais constante nos tres peridos do *tie-break*.
- A melhor eficiência do bloqueio, do ataque de side-out e do ataque contra-ataque no período final *do tie-break* aumentam as chances de vencer o *tie-break*, inclusive com uma margem de pontos maiores.

REFERÊNCIAS

ANGUERA, M., T. Observational methods (general). **Encyclopedia of psychological assessment**, v. 2, p. 632-637, 2003.

ATKINSON, G.; NEVILL, A. M. Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. **Sports Medicine**, v. 26, n. 4, p. 217–238, 1998.

BARRIS, S.; BUTTON, C. A review of vision-based motion analysis in sport. **Sports Medicine**, v. 38, n. 12, p. 1025-1043, 2008

BAR-YAM, Y. Complex systems insights to building effective teams. **International Journal of Computer Science in Sport**, v. 2, n. 2, p. 8-15, 2003.

BATTERHAM, A., HOPKINS, W. The case for magnitude-based inference. **Med Sci Sports Exercise**, v. 47, n. 4, p.885, 2015.

BUSCÁ, 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. **Journal of Sports Sciences**, v. 30, n. 3, p. 269–272, 2012.

CARLSTEDT, R., A. **Critical moments during competition: A mind-body model of sport performance when it counts the most**. Psychology Press, 2004.

COHEN, J. Weighted kappa: Nominal scale agreement provision for scaled disagreement or partial credit. **Psychological bulletin**, v. 70, n. 4, p. 213, 1968.

COLEMAN, J. E.; NEVILLE, B.; GORDON, B. A statistical system for volleyball and its use in Chicago Women's Association. International Volleyball Review, v. 17, p. 72-73, 1969.

CONFEDERAÇÃO BRASILEIRA DE VOLEIBOL DE PRAIA. **Regras oficiais de vôlei de praia 2013-2016.** Disponível em: www.cbv.com.br.Acesso em: 10 de junho de 2017.

CHINCHILLA-MIRA, J.J et al. Offensive zones in beach volleyball: differences by gender. **Journal of Human Sport and Exercise**, v. 7, n. 3, p. 727-732, 2012.

DÁVILA ROMERO, C.; GARCÍA-HERMOSO, A. Close set in volleyball. Differences and discriminatory power of final game actions in formative stages. **Rev. Int. Med. Cienc. Act. Física Deporte**, 21, 67-70, 2015.

DRIKOS, S.; ANGELONIDIS, Y.; SOBONIS, G. The role of skills in winning in different types of set in women's volleyball**. International Journal of Performance Analysis in Sport**, v. 18, n. 6, p. 950-960, 2018.

DRIKOS, S.; SOTIROPOULOS, K.; BARZOUKA, K.; ANGELONIDIS, Y. The contribution of skills in the interpretation of a volleyball set result with minimum score difference across genders**. International Journal of Sports Science & Coaching**, v. 15, n. 4, p. 542-551, 2020.

DRIKOS, S.; BARZOUKA, K.; BALASAS, D. G.; SOTIROPOULOS, K. Effect of quality of opposition on game performance indicators in elite male volleyball. **International Journal of Sports Science & Coaching**, v. 17, n. 1, p. 169-177, 2022.

FEDERATION INTERNATIONALE DE VOLLEYBALL (FIVB). **FIVB official volleyball rules 2013–2016**. Published by **FIVB** in 2012. Disponivel em: www.fivb.org.

FLEISS, J.L.; COHEN, J. The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. **Educational and psychological measurement**, v. 33, n. 3, p. 613-619, 1973.

GARCÍA-DE-ALCARAZ, A.; MARCELINO, R. Influence of match quality on men's volleyball performance at different competition levels. **International Journal of Performance Analysis in Sport**, v. 17, n. 4, p. 394-405, 2017.

GARCÍA-DE-ALCARAZ, P. A.; USERO, L. Influence of contextual variables on performance of the libero player in Top-Level women's volleyball. **Journal of human kinetics**, v. 70, p. 199, 2019.

GARCÍA, G. M. G.; MARTÍN, J. J. M. Analysis of the second defensive line in female beach volleyball depending on the level of play. **Apunts. Educacion Fisica y Deportes**, v. 115, n. 1, p. 54–60, 2014.

GARGANTA, J. A análise da performance nos jogos desportivos. Revisão acerca da análise do jogo. **Revista Portuguesa de Ciências do Desporto**, v. 2001, n. 1, p. 57–64, 2001.

GEA, G. M. G.; MOLINA, J. J. M. Relationship between sport level competition and serving skill in female beach volleyball. **Revista Internacional de Medicina y Ciencias de la Actividad Fisica y del Deporte**, v. 15, n. 59, p. 433–448, 2015.

GEA, G. M.; MOLINA, J. J. Revista internacional de ciencias del deporte. 2013.

GIATSIS, G. The effect of changing the rules on score fluctuation and match duration in the FIVB women's beach volleyball. **International Journal of Performance Analysis in Sport**, v. 3, n. 1, p. 57–64, 2003.

GIATSIS, G.; ZAHARIADIS, P. Statistical Analysis of Men's FIVB Beach Volleyball Team Performance. **International Journal of Performance Analysis in Sport**, v. 8, n. 1, p. 31–43, 2008.

GIATSIS, G.; TILI, M.; ZETOU, E. The height of the women's winners FIVB Beach Volleyball in relation to specialization and court dimensions. **Journal of Human Sport and Exercise**, v. 6, n. 3, p. 497–503, 2011.

GIATSIS, G.; TZETZIS, G. Comparison of performance for winning and losing beach volleyball teams on different court dimensions. **International Journal of Performance Analysis in Sport**, v. 3, n. 1, p. 65–74,2003.

GIATSIS, G. Beach volleyball performance benchmarks in men's high level. **Journal of Human Sport and Exercise, in press***,* 2023.

GIATSIS, G.; LOLA, A.; DRIKOS, S.; LOPEZ-MARTINEZ, A. B; TURPIN-PÉREZ, J. A. Beach volleyball set and technical performance indicators for elite women's teams**. Journal of Human Sport and Exercise, in press***,* 2023.

GOMEZ, M. A.; REUS, M.; PARMAR, N.; TRAVASSOS, B. Exploring elite soccer teams' performances during different match-status periods of close matches' comebacks. **Chaos, Solitons & Fractals**, v. 132, p. 109566, 2020.

GÓMEZ, M. A.; CID, A.; RIVAS, F.; BARREIRA, J.; CHIMINAZZO, J. G. C.; PRIETO, J. Dynamic analysis of scoring performance in elite men's badminton according to contextual-related variables. **Chaos, Solitons & Fractals**, v. 151, p. 111295, 2021.

GRGANTOV, Z.; KATIĆ, R.; MARELIĆ, N. Effect of new rules on the correlation between situation parameters and performance in beach volleyball. **Collegium Antropologicum**, v. 29, n. 2, p. 717–722, 2005.

HANK, M. et al. Evaluation of the horizontal movement distance of elite female beach volleyball players during an official match. **International Journal of Performance Analysis in Sport**, v. 16, n. 3, p. 1087–1101, 2016.

HÄYRINEN, M.; TAMPOURATZIS, K. **Technical and tactical game analysis of elite female beach volleyball**. Jyväskylä, KIHU: Research Institute for Olympic Sports, 2012.

HUGHES, M. D.; BARTLETT, R. M. The use of performance indicators in performance analysis. **Journal of Sports Sciences**, v. 20, n. 10, p. 739–754, 2002.

HUGHES, M.; FRANKS, I. M. (Ed.). **Notational analysis of sport**: Systems for better coaching and performance in sport. Routledge,2004.

JAMES, N.; TAYLOR, J.; STANLEY, S. Reliability procedures for categorical data in Performance Analysis. **International Journal of Performance Analysis in Sport**, v. 7, n. 1, p. 1–11, jan. 2007.

JEON, G.; PARK, J**.** Characterizing patterns of scoring and ties in competitive sports. **Physica A: Statistical Mechanics and its Applications**, v. 565, p. 125544, 2020.

JIMÉNEZ-OLMEDO, J. M. et al. Serve analysis of professional players in beach volleyball. **Journal of Human Sport and Exercise**, v. 7, n. 3, p. 706–713, 2012.

JIMENEZ-OLMEDO, J. M. et al. Análisis del saque en jugadoras femeninas profesionales de vóley playa. **Retos: nuevas tendencias en educación física, deporte y recreación**, n. 25, p. 77-79, 2014.

JIMENEZ-OLMEDO, J. M; PENICHET-TOMAS, A. Blocker's activity at men's european beach volleyball university championship. **RETOS. Nuevas Tendencias en Educación Física, Deporte y Recreación**, n. 32, p. 252-255, 2017a.

JIMENEZ-OLMEDO, J. M.; PENICHET-TOMAS, A. Digger's activity at men's European beach volleyball university championship. **Journal of Physical Education and Sport**, v. 17, n. 3, p. 2043–2048, 2017b.

JIMENEZ-OLMEDO, J. M.; PUEO, B.; PENICHET-TOMÁS, A. Defensive systems during the men's European university beach volleyball championship. **Journal of Physical Education and Sport**, v. 16, n. 3, p. 945–950, 2016.

JONES, M. V.; BRAY, S. R.; OLIVIER, S. Game location and aggression in rugby league. **Journal of Sports Sciences**, v. 23, n. 4, p. 387–393, abr. 2005.

KOCH, C.; TILP, M. Beach volleyball techniques and tactics: A comparison of male and female playing characteristics. **Kinesiology**, v. 41, n. 1, p. 52–59, 2009.

KUMAR, G.; SHUKLA, A.; CHHOKER, A.; THAPA, R. K. Identification of Factors Determining Winning in Men's and Women's Beach Volleyball: a Logistical Regression Approach. **Physical Education Theory and Methodology**, v. 21, n. 1, p. 26-35, 2021.

LAMES, M. Modelling the interaction in game sports - Relative phase and moving correlations. **Journal of sports science & medicine**, v. 5, n. 4, p. 556, 2006.

LAKENS, D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. **Frontiers in psychology,** v. 4, p. 863, 2013.

LIANG, K-Y; ZEGER, S. L. Longitudinal data analysis using generalized linear models. **Biometrika**, v. 73, n. 1, p. 13-22, 1986.

LILLICH, L.; SCHWEIZER, G.; NIEßNER, M. Searching for the Effects of Momentum in Beach Volleyball. **Zeitschrift für Sportpsychologie**, 2023.

LIMA, V. S.; ROCHA, F. B. F.; DINIZ, I. B.; GARCIA- DE - ACARAZ, A. S., PALAO, J. M..; COSTA, G. C.; MEDEIROS, A. A.; BATISTA, G.R. Status of Match Analysis Research in Indoor and Beach Volleyball: A bibliometric **analysis. Retos: nuevas tendencias en educación física, deporte y recreación**, n. 50, p. 838-848, 2023.

LINK, D.; WENNINGER, S. Performance streaks in elite beach volleyball - does failure in one sideout affect attacking in the next? **Frontiers in Psychology**, v. 10, 2019.

LÓPEZ-SERRANO, C.; MORENO ARROYO, M. P.; MON-LÓPEZ, D., & MOLINA MARTÍN, J. J. In the Opinion of Elite Volleyball Coaches, How Do Contextual Variables Influence Individual Volleyball Performance in Competitions?. **Sports**, v. 10, n. 10, p. 156, 2022.

LUSHER, D.;ROBINS, G.;, KREMER, P. The application of social network analysis to team sports. **Measurement in physical education and exercise science**, v. 14, n. 4, p. 211-224, 2010.

MARCELINO, R.; MESQUITA, I..; ANDRÉS, J. M. P.; SAMPAIO, J. Home advantage in high-level volleyball varies according to set number. **Journal of Sports Science & Medicine**, v. 8, n. 3, p. 352, 2009.

MARCELINO, R.; SAMPAIO, J.; MESQUITA, I. Investigação centrada na análise do jogo: da modelação estática à modelação dinâmica. In Portuguese. **Revista Portuguesa de Ciências do Desporto,** v. 11, n. 1, p. 481-499, 2011.

MARCELINO, R., O.; SAMPAIO, J., E.; MESQUITA, I., M. Attack and serve performances according to the match period and quality of opposition in elite volleyball matches. **The Journal of Strength & Conditioning Research**, v. 26, n. 12, p. 3385-3391, 2012.

MARCELINO, R.; MESQUITA, I.; SAMPAIO, J. Effects of quality of opposition and match status on technical and tactical performances in elite volleyball. **Journal of sports sciences**, v. 29, n. 7, p. 733-741, 2011.

MARTINS, J. B, MESQUITA I, MENDES A, SANTOS L, AFONSO J. Current understanding of critical game scenarios in team sports: systematic review. **Human Movement**, v. 23, n. 2, p. 1-11, 2022.

MCGARRY, T. Applied and theoretical perspectives of performance analysis in sport: Scientific issues and challenges. **International Journal of Performance Analysis in Sport**, v. 9, n. 1, p. 128–140, 2009.

MCHUGH, Mary L. Interrater reliability: the kappa statistic. **Biochemia medica**, v. 22, n. 3, p. 276-282, 2012.

MEDEIROS, A. et al. Physical and temporal characteristics of Under 19, Under 21 and senior male beach volleyball players. **Journal of Sports Science and Medicine**, v. 13, n. 3, p. 658–665, 2014a.

MEDEIROS, A. I. A. et al. Revisão sistemática sobre a performance desportiva no voleibol de praia a partir da análise do jogo. **Revista Brasileira de Cineantropometria e Desempenho Humano**, v. 16, n. 6, p. 698–708, 2014b.

MEDEIROS, A. I. A. et al. Effects of technique, age and player's role on serve and attack efficacy in high level beach volleyball players. **International Journal of Performance Analysis in Sport**, v. 14, n. 3, p. 680–691, 2014c.

MEDEIROS, A. I. A. et al. Performance differences between winning and losing under-19, under-21 and senior teams in men's beach volleyball. **International Journal of Performance Analysis in Sport**, v. 17, n. 1–2, p. 96–108, 2017.

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. **Revista Brasileira de Ciências do Esporte**, v. 26, n. 1, 2004.

MICHALOPOULOU, M.; PAPADIMITRIOU, K.; LIGNOS, N.; TAXILDARIS, K., ANTONIOU, P. Computer analysis of the technical and tactical effectiveness in Greek Beach Volleyball. **International Journal of Performance Analysis in Sport**, v. 5, n. 1, p. 41–50, jun. 2005.

NATALI, S. et al. Physical and technical demands of elite beach volleyball according to playing position and gender. **Journal of Sports Medicine and Physical Fitness**, v. 59, n. 1, p. 6–9, 1 jan. 2019.

NASERI, P.; MAJD, H. A.; KARIMAN, N.; SOURTIJI, A. Comparison of generalized estimating equations (GEE), mixed effects models (MEM) and repeated measures ANOVA in analysis of menorrhagia data. **Archives of Advances in Biosciences**, v. 7, n. 1, p. 32-40, 2016.

NORUŠIS, M.J. **SPSS 14.0 guide to data analysis**. Upper Saddle River, NJ: prentice hall, 2006.

O'DONOGHUE, P., G. The most important points in grand slam singles tennis. **Research quarterly for exercise and sport**, v. 72, n. 2, p. 125-131, 2001.

O'DONOGHUE, P. Normative Profiles of Sports Performance. **International Journal of Performance Analysis in Sport**, v. 5, n. 1, p. 104–119, 2005.

O'DONOGHUE, P. Interacting Performances Theory. **International Journal of Performance Analysis in Sport**, v. 9, n. 1, p. 26–46, abr. 2009.

O'DONOGHUE, P. (2015). **An introduction to performance analysis of sport**. Routledge.

O'DONOGHUE, P; SIMMONDS, E. Probability of winning and match length in Tiebreak Ten tennis. **International Journal of Performance Analysis in Sport**, v. 19, n. 3, p. 402-416, 2019.

ÖNDER, H. Comparative study of generalized estimating equations and logistic regressions on different sample sizes and correlation levels. **Communications in Statistics-Simulation and Computation**, v. 45, n. 10, p. 3528-3533, 2016.

PALAO, J. M.; MANZANARES, P. **Manual del instrumento de observación de las técnicas y la eficacia en voleibol** (TEVOL) VERSIÓN 1.0. Publisher: Authors. Murcia: Spain., 2009.

PALAO, J. M.; MANZANARES LÓPEZ, P.; ORTEGA, E. Design and validation of an observational instrument for technical and tactical actions in beach volleyball. Motriz: Revista de Educação Física, v. 21, p. 137-147, 2015.

PALAO, J.M.; VALADÉS, D.; MANZANARES, P.; ORTEGA, E. Physical actions and work-rest time in men' s beach volleyball. **Motriz**, p. 257–261, 2014.

PALAO, J. M; LÓPEZ-MARTÍNEZ, A. B.; VALADÉS, D.; ORTEGA, E. Physical actions and work-rest time in women's beach volleyball. **International Journal of Performance Analysis in Sport**, v. 15, n. 1, p. 424–429, 2015.

PALAO, J. M.; LOPEZ-MARTINEZ, A.; VALADES, D.; HERNANDEZ, E. Manner of Execution and Efficacy of Reception in Men's Beach Volleyball. **Montenegrin Journal of Sports Science and Medicine**, v. 8, n. 2, p. 21, 2019.

PALAO, J. M.; ORTEGA, E. Skill efficacy in men's beach volleyball. **International Journal of Performance Analysis in Sport**, v. 15, n. 1, p. 125–134, 2015.

PALAO, J. M.; VALADES, D.; ORTEGA, E. Match duration and number of rallies in men´s and women´s 2000-2010 FIVB world tour beach volleyball. **Journal of Human Kinetics**, v. 34, n. 1, p. 99–104, 1 out. 2012.

PAPADOPOULOU, S.; GIATSIS, G.; BAKIRTZOGLOU, P. Comparative analysis of the technical-tactical elements of elite men ' s beach volleyball teams. **Sport Science**, v. 13, n. IKEEART-2020-130, p. 59-66, 2020.

PÉREZ-TURPIN, J. A. et al. Performance Indicators in Young Elite Beach Volleyball Players. **Frontiers in Psychology,** v. 10, n. December 2019.

RAMOS, A.; COUTINHO, P.; SILVA, P.; DAVIDS, K.; MESQUITA, I. How players exploit variability and regularity of game actions in female volleyball teams. **European Journal of Sport Science**, v. 17, n. 4, p. 473-481, 2017.

RAYMOND, B. IZKOWICZ, A.; LEBEDEW, M.; DIETZ, J. **The Value of Points in Volleyball.** Science Untangled, 2020. Disponível em: https://untan.gl/point-value.html. Acesso em: outubro, 2023.

REDWOOD-BROWN, A. Passing patterns before and after goal scoring in FA Premier League Soccer. **International Journal of Performance Analysis in Sport**, v. 8, n. 3, p. 172-182, 2008.

RODRIGUEZ-RUIZ, D.; QUIROGA, M. E.; MIRALLES, J. A.; SARMIENTO, S.; DE SAÁ, Y.; GARCÍA-MANSO, J. M. 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**, v. 7, n. 1, 2011.

ŠIMAC, M.; GRGANTOV, Z.; MILIĆ, M. Situational efficacy of top Croatian senior beach volleyball players. **Acta Kinesiologica**, v. 11, n. 2, p. 35–39, 2017.

SARMENTO, H.; CLEMENTE, F. M.; AFONSO, J.; ARAÚJO, D.; FACHADA, M.; NOBRE, P.; DAVIDS, K. Match analysis in team ball sports: an umbrella review of systematic reviews and meta-analyses. **Sports Medicine-Open**, v. 8, n. 1, p. 66, 2022.

SAM ROBERTSON, ANGUS F. BURNETT.; RITU GUPTA. Two tests of approach-iron golf skill and their ability to predict tournament performance. **Journal of Sports Sciences**, v. 32, n. 14, p. 1341-1349, 2014.

SAM ROBERTSON.; RITU GUPTA.; SAM MCINTOSH. A method to assess the influence of individual player performance distribution on match outcome in team sports. **Journal of sports sciences**, v. 34, n. 19, p. 1893-1900, 2016.

SAWILOWSKY, S.S. New effect size rules of thumb. **Journal of modern applied statistical methods**, v. 8, n. 2, p. 26, 2009.

SU-LIN, G.; TUGGLE, C. A.; MITROOK, M. A.; COUSSEMENT, S. H.; ZILLMANN, D. The thrill of a close game: Who enjoys it and who doesn't?. **Journal of Sport and Social Issues**, v. 21, n. 1, p. 53-64, 1997.

STANKOVIC, M.; RUIZ LLAMAS, G.; PERIC, D.; QUIROGA ESCUDERO, M. E. Point-scoring plays related to level of set win and in-game role during volleyball rules testing. **Journal of Human Sport and Exercise**, 2019.

TABACHNICK, B.G.; FIDELL, L.S.; ULLMAN, J.B. **Using multivariate statistics**. Boston, MA: Pearson, 2007.

TAYLOR, J.; MELLALIEU, S.; JAMES, N.; SHEARER, D. The influence of match location, quality of opposition, and match status on technical performance in professional association football. **Journal of sports sciences**, v. 26, n. 9, p. 885-895, 2008.

WASSERMAN S, FAUST K. **Social network analysis**: Methods and applications: Cambridge university press; 1994

YIANNIS, L. 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**, v. 8, n. 3, p. 130–137, 10 nov. 2008.

ZEGER, S. L.; LIANG, K. Y. Longitudinal data analysis for discrete and continuous outcomes. **Biometrics**, p. 121-130, 1986.

ZEGER, S. L., LIANG, K.-Y.; ALBERT, P. S. Models for longitudinal data: a generalized estimating equation approach. **Biometrics**, p. 1049-1060, 1988.

ZIEGLER, A.; VENS, M. Generalized estimating equations. **Methods of information in medicine**, v. 49, n. 05, p. 421-425, 2010.