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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

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-

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.

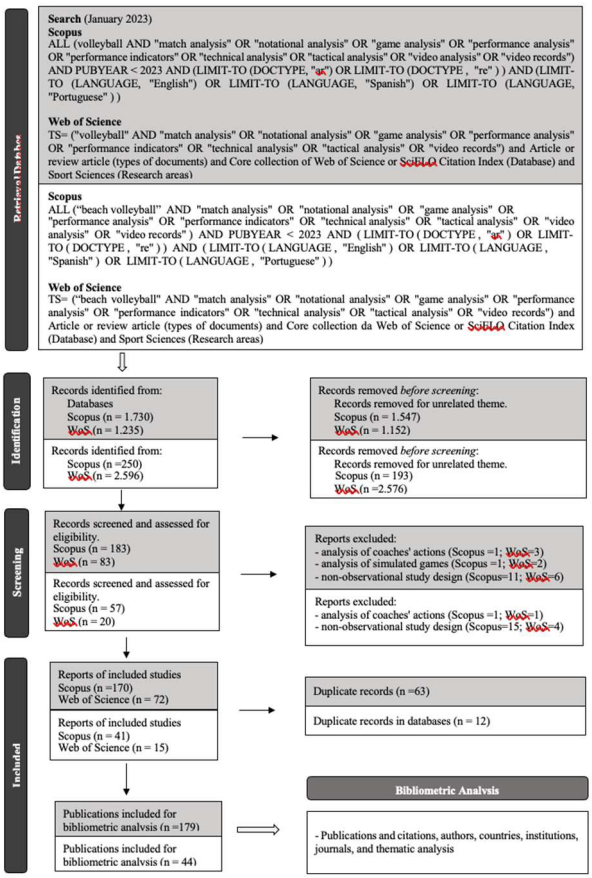

Figure 1. Flow diagram of research strategy and article selection of bibliometric study in indoor and beach volleyball. Gray and white colours refer to indoor and beach volleyball (respectively).

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.

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.

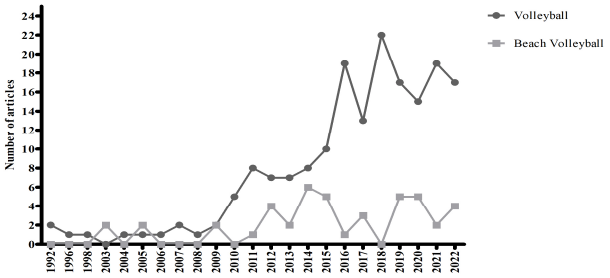

Figure 2. Number of articles published per year in indoor and beach Volleyball. Years without publications were removed.

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.

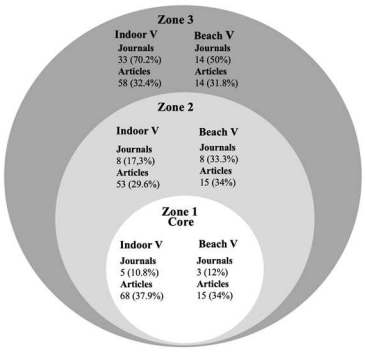

Figure 3. Dispersion of scientific production in Bradford rings related to match analysis in indoor (V) and beach volleyball (V).

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

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.

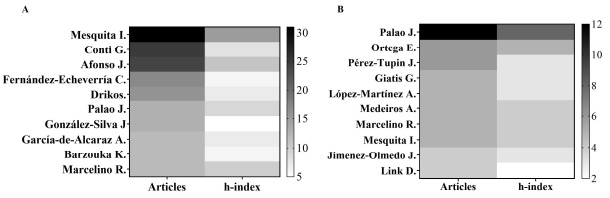

Figure 4. Top-ten most productive (number of articles) authors and h-index in (A)indoor and (B) beach volleyball match analysis.

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.

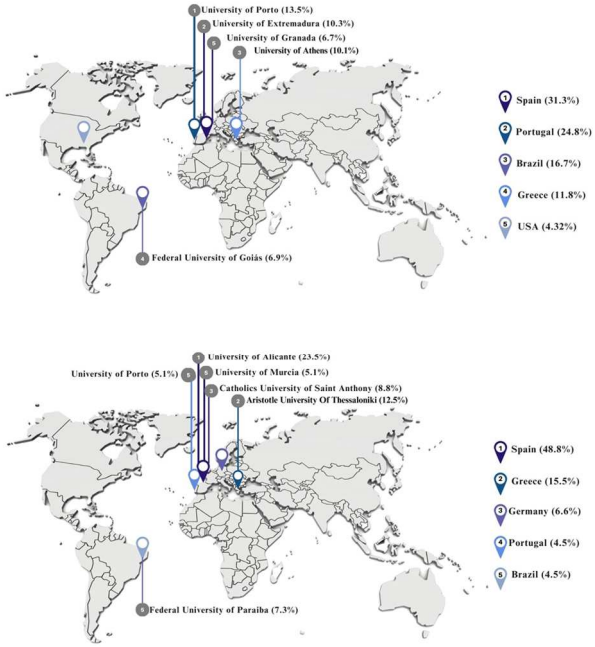

Figure 5. Top-five most productive countries and institutions in indoor (upper panel) and beach volleyball (lower panel) match analysis.

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.

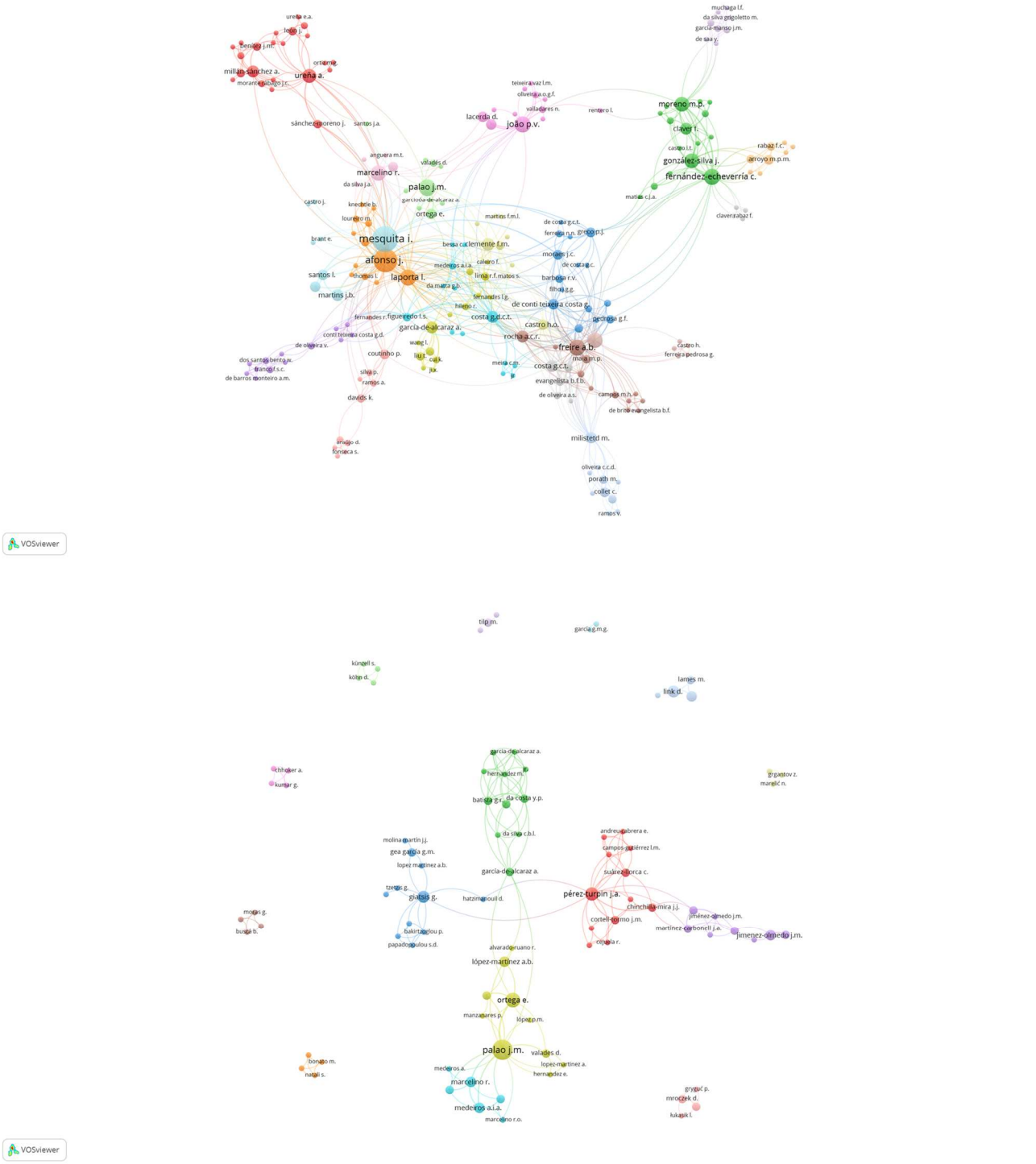

Figure 6. Network visualization map of author documents with more than one contribution in indoor volleyball (upper panel) and beach volleyball (lower panel).

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.

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

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

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).

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.

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