2024, Retos, 60, 129-139

Analysis of badminton research trend in the last three decades: bibliographic analysis of Scopus journal database

Análisis de la tendencia de la investigación en bádminton en las tres últimas décadas: análisis bibliográfico de la base de datos de revistas Scopus

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Abstract. Badminton has become a sport that has grown rapidly in the last few decades. The goal of the study is to examine how badminton research has evolved over the past 30 years. The Bibliometric Analysis and Systematic Review method was applied in this study. A thorough approach was used to scan SCOPUS research journal databases for articles. The term "Badminton" was utilized. Furthermore, journals published within the last 30 years starting in 2023 were excluded from consideration. On October 17th, 2023, 1,053 items from Scopus were extracted. As a result, 217 articles were chosen for additional examination using the VOS viewer computer program. The study's findings demonstrated that over the past 20 years, there has been a notable increase in interest in badminton research. China, Spain, England, and Japan have contributed the most to this research. English dominates in scientific publications about badminton, although several other languages also contribute. Research subjects include athlete physiology, injuries, and health, as well as differences in playing styles and athlete rankings. Several studies have also highlighted the use of technology in-game analysis and athlete training. Research on badminton is an important part of the development of this sport and can support athletes' performance and health. In the next few decades, multidisciplinary research involving different languages and countries may be the key to a more comprehensive understanding of the sport of badminton.
Keywords: Badminton, VOS Viewer, Bibliometric, Sport Science

Resumen. El bádminton se ha convertido en un deporte que ha crecido rápidamente en las últimas décadas. La investigación tiene como objetivo analizar el desarrollo de la investigación en bádminton en los últimos 30 años. Esta investigación utilizó el método de Análisis Bibliométrico y Revisión Sistemática. Las búsquedas de artículos se llevaron a cabo utilizando una estrategia integral en las bases de datos de revistas de investigación SCOPUS. La palabra clave utilizada fue "Bádminton". Además, los criterios de exclusión fueron revistas publicadas en los últimos 30 años a partir de 2023. Hubo 1.053 artículos de Scopus que se extrajeron el 17 de octubre de 2023. Por lo tanto, se seleccionaron 217 artículos para un análisis más detallado utilizando el software de visualización VOS. Los resultados de la investigación mostraron que el interés en la investigación del bádminton ha experimentado un crecimiento significativo en las últimas dos décadas. China, España, Inglaterra y Japón son los que más han contribuido a esta investigación. El inglés domina las publicaciones científicas sobre bádminton, aunque también contribuyen varios otros idiomas. Los temas de investigación incluyen la fisiología, las lesiones y la salud de los atletas, así como las diferencias en los estilos de juego y las clasificaciones de los atletas. Varios estudios también han destacado el uso de la tecnología en el análisis del juego y en el entrenamiento de los atletas. La investigación sobre el bádminton es una parte importante del desarrollo de este deporte y puede favorecer el rendimiento y la salud de los deportistas. En las próximas décadas, la investigación multidisciplinaria que involucre diferentes idiomas y países puede ser la clave para una comprensión más completa del deporte del bádminton.
Palabras clave: Bádminton, VOS Viewer, Bibliométrica, Ciencias del Deporte

Fecha recepción: 12-11-23. Fecha de aceptación: 08-08-24
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Introduction

Badminton has grown rapidly in the last few decades (Wang et al., 2023). In 1972, badminton became an exhibition sport in the Olympics, but it took quite a while before it became an official part of the Olympic Games (Lim & Aman, 2017a). In 1992, badminton finally became part of the Olympics Games in Barcelona, Spain, and has become a populer Olympic sport (Möllers, 2006). Badminton is not only a globally popular sport, but it is also the focus of increasing research in the fields of sport and exercise science (Manrique& González-Badillo, 2003). Research in badminton has provided valuable insight into athlete performance (Lin et al., 2023), game techniques (González-Peño et al., 2023), strategy (Hastie et al., 2009), psychology (Dakhil et al., 2022), biomechanics (Wiriawan et al., 2024), and the health aspects related to this sport (Sutula et al., 2021). One of the most prominent aspects in the development of badminton is the development of playing techniques (Lin et al., 2021). Remarkable badminton players have elevated the game with creative strategies through improvised decision making in competition (Everhart et al., 1999), particularly those from China, Indonesia, Malaysia, and Denmark. Accurate and more powered overhead shots were among the advancements in playing technique (Li & Kong, 2023), a more sophisticated defensive strategy (Yaguang, 2017), in addition to more strategic playing methods (Ma et al., 2024). Rackets and equipment evolved along with playing techniques. Stronger strings, lighter, longer-lasting rackets, and customized footwear and apparel have all helped athletes perform better on the court (McErlain-Naylor et al., 2020). As technology advances, movement monitoring has also grown in importance as a tool for game analysis and training (Rusdiana, 2021). The "rally point" scoring system was implemented by the Badminton World Federation (BWF) in 2006. Under this system, players can gain

points each time when an opponent makes a mistake on a shot and when the opponent fails to receive the shuttlecock and it lands within the legal area (Pearce, 2002). Players and viewers have responded well to these adjustments, which are intended to make the game more competitive and exciting (Wang et al., 2014). Additionally, modifications to competition forms and game rules have impacted badminton's evolution (Ivan et al., 2015). Additionally, regulations surrounding equipment, clothing, and playing rules have evolved over time (Mack, 2011). This includes stricter enforcement of anti-doping regulations to ensure fair play in competitions (Hallward & Duncan, 2019).

Over the past few decades, badminton has gained significant popularity throughout the world (Tan et al., 2017). Countries such as China, Indonesia, Malaysia, Korea, India, and Spain have become bases for leading badminton athletes who have achieved success at the international level (Kaldau et al., 2021). The country of Spain also achieved success with Carolina Marin becoming the youngest player to win gold at the 2014 BWF World Championships (Rodríguez et al., 2022). In addition, professional badminton leagues such as "BWF Super Series" and "All England Championships" have attracted the attention of the global public (Lim & Aman, 2017b). It is a platform for the world's top players to compete in high-quality competitions and chase big prizes. However, the development of badminton in the field of research has not yet been systematically mapped. This bibliometric research and systematic review aimed to look at the development of badminton research trends in the last 30 years with the following research questions:

1. To analyze badminton research trends in the last 30 years.
2. To evaluate the most countries contributed badminton research in the last 30 years.
3. To analyze the language-related badminton research in the last 30 years
4. To discover the subject areas related to badminton research in the last 30 years.
5. To analyze the keyword trends of badminton research in the last 30 years.
6. To analyze the top 10 cited publications in badminton research in the last 30 years.

Method

This type of research is a Bibliometric Analysis and Systematic Review. Article searches were carried out using a comprehensive strategy on SCOPUS research journal databases. The keyword used was "Badminton". Furthermore, the inclusion criteria were journals published in the last 30 years from 2023. There were 1,053 2,136 articles from Scopus that were mined on October 17th, 2023. Therefore, 217 648 articles were selected for further analysis by using VOS viewer computer software. There were 10 articles selected as the most cited articles which were selected for this systematic review. For standard operationalization, this study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

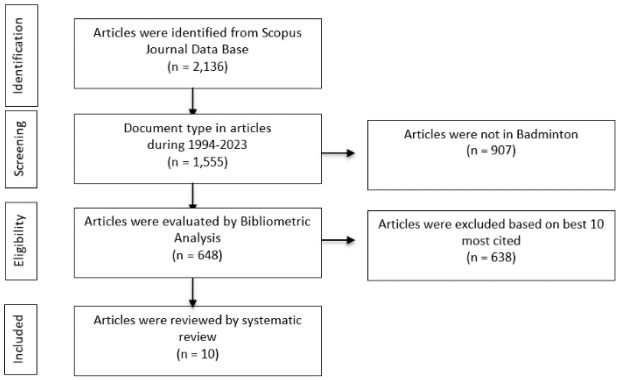

Figure 1. PRISMA flowchart of the article selection process

Results

Badminton Research Trends in the Last 30 Years

There are several trends and patterns that can be identified in badminton publications in the last 30 years. At the start of the period, around 1994 to 1999, the number of badminton publications was low, with 1997 being a year with a significant increase in the number of publications, reaching 4 publications. Furthermore, in 2006, there was a significant spike in the number of publications, reaching 7 publications, which was then followed by a consistent increase until 2018. This shows that interest in badminton research has experienced significant growth in the last two decades

Table 1.
Document of Badminton Research in the Last 30 Years

Year	*f*		Total Cited	Average Cited
1994	0		0	0.00
1995	1		63	32.00
1996	0		0	0.00
1997	4		101	52.50
1998	0	11	0	0.00
1999	1		7	4.00
2000	0		0	0.00
2001	0		0	0.00
2002	2		56	29.00
2003	3		171	87.00
2004	2		13	7.50
2005	2		5	3.50
2006	7		193	100.00
2007	4		130	67.00
2008	4	61	43	23.50
2009	9		704	356.50
2010	5		62	33.50
2011	6		84	45.00
2012	9		262	135.50
2013	13		247	130.00
2014	22		300	161.00
2015	34		423	228.50
2016	29		376	202.50
2017	46		548	297.00
2018	59	546	609	334.00
2019	57		412	234.50
2020	69		452	260.50
2021	77		321	199.00
2022	83		141	112.00
2023	88		39	63.50
Total	636		5762	3199.00

The data from 2009, reflecting an average of 356.50 citations per publication, marks a substantial peak, signaling an increasing acknowledgment of the significance of badminton-related studies within the scientific community. This surge continued until 2018, maintaining a robust average of 334.00 citations per publication. This prolonged period of high citation rates underscores the sustained relevance and influence of badminton research during these years. However, a notable shift in this trend emerges in the more recent period from 2021 to 2023.

There has been a discernible decline both in the overall number of publications and the average citations per publication during these years. This downturn suggests a potential alteration in the dynamics of badminton research, raising questions about the factors contributing to this shift. Plausible explanations may include evolving research trends, changes in the academic landscape, or external factors such as the global COVID-19 pandemic, which could have influenced the frequency and focus of badminton-related studies.

In summary, the trajectory of badminton research over the last 30 years reflects a noteworthy growth, particularly in the past two decades where there was a concerted effort to enhance the quality and impact of publications. However, the recent decline in both publication numbers and average citations per publication prompts a closer examination of the evolving dynamics in badminton research, underlining the need for continued exploration and adaptation within this scientific domain.

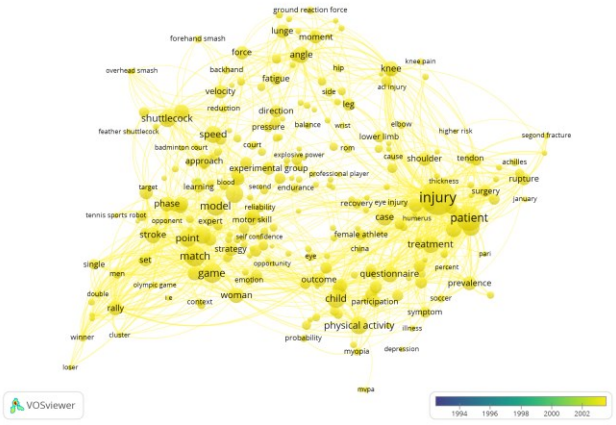

Figure 2. Badminton Research Trend in 1994-2003

During the period from 1994 to 2003, there was a noticeable dearth of research publications focusing on the physical capacity aspects of badminton. There were 11 publications dedicated to this specific facet of the sport, it is evident that the scientific exploration of badminton during this era predominantly centered around other dimensions, such as technical skills, tactics, and game strategies. The limited attention given to the physical capacity of badminton players during this timeframe may have been influenced by the prevailing research trends of the period, which possibly prioritized other elements of player performance.

The scarcity of research on the physical capacity of badminton players during 1994-2003 also raises questions about the overall emphasis on holistic athlete development within the sport during that time. The apparent gap in scientific inquiry into the physical demands, fitness requirements, and conditioning strategies specific to badminton suggests that the research community and sports practitioners may not have fully recognized or prioritized the importance of physical capacity in optimizing player performance. Future scholars may be able to take advantage of this gap in the literature to further explore the physical components of badminton, providing insight into the particular conditioning and training plans required of players to succeed in this fast-paced, dynamic sport.

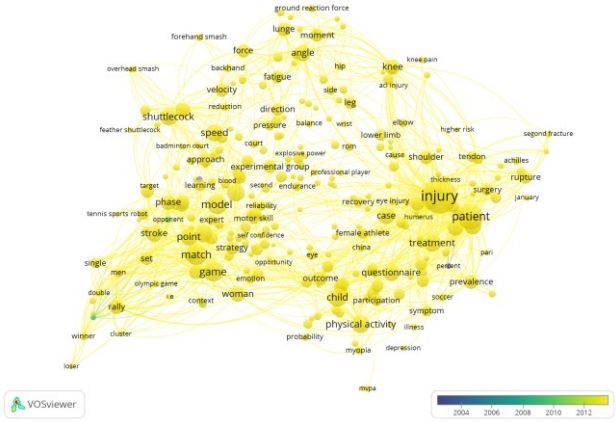

Figure 3. Badminton Research Trend in 2004-2013

Between 2004 and 2013, there was a concentrated trend in badminton research, with 61 papers focusing on the examination of unintentional mistakes made during play. This focused endeavor demonstrated a strong interest in comprehending the mechanics of player errors throughout games and how they can affect performance as a whole. The subtleties of unforced errors were examined by researchers as they investigated the effects of this variable on shot execution, rally games, and the complex dynamics of single men's and women's badminton. During this time, unforced errors were given more attention, indicating an awareness of their crucial significance in determining match results and the necessity of a more complex understanding of the technical and psychological factors that contribute to badminton faults.

The way that unintentional mistakes are related to certain other factors highlighted how intricate the game is. Scholars examined the connection between unintentional mistakes and shot execution, realizing that the psychological effects of mistakes might affect a shot's accuracy and precision. Furthermore, the analysis of unintentional mistakes within the framework of rally games and various gender classifications offered a comprehensive perspective on the variables influencing match results. Between 2004 and 2013, a concentrated research trend added a great deal to

the body of knowledge on badminton by providing insightful analyses of the subtle facets of player performance and methods for reducing mistakes in this fiercely competitive sport.

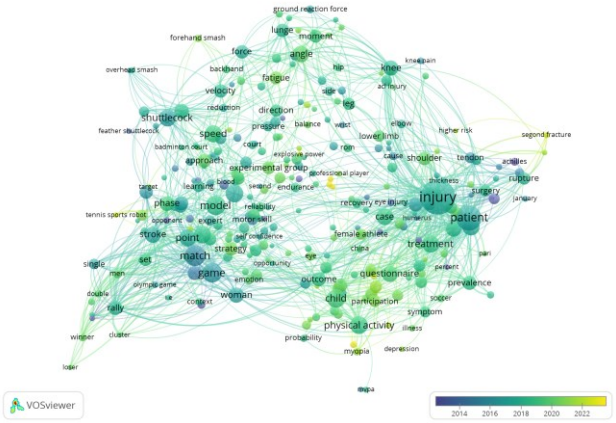

Figure 4. Badminton Research Trend in 2014 - 2023

Between 2014 and 2023, there was a notable increase in the amount of research published on badminton, with 564 publications that mostly addressed different facets of the game. Unlike the earlier period, the recent decade displayed a diversified research interest, with a significant emphasis on analyzing badminton matches, understanding player injuries, and delving into the intricacies of physical activity, especially in the context of elite athletes during the COVID-19 pandemic. This broad spectrum of research signifies a comprehensive approach to badminton science, indicating a recognition of the multifaceted nature of the sport, where technical, physiological, and contextual factors all play pivotal roles in shaping player performance.

A noteworthy trend during this timeframe is the heightened attention on the impact of the COVID-19 pandemic on elite badminton athletes. With a total of 564 publications, researchers engaged in a systematic exploration of how the global health crisis affected training regimens, competition dynamics, and the overall physical well-being of high-level badminton players. This demonstrates the agility of the sports science community in responding to contemporary challenges, using empirical evidence to inform strategies for athlete management and performance optimization in unprecedented circumstances. The rich body of literature produced during this period serves as a valuable resource for coaches, athletes, and sports scientists, providing insights into adapting training methodologies and injury prevention protocols to navigate the unique challenges posed by the pandemic in the context of elite badminton.

Country Contributed to Badminton Research in the Last 30 Years

Data on the number of badminton publications by country in the last 30 years, there are several interesting trends that can be identified. China is the most dominant country in badminton research contributions, with a total of 141 publications, a total of 987 citations, and an average citation per publication of around 564,00. This shows China's high focus and contribution to badminton research, which may be related to their superior position in the sport.

Apart from China, there are several other countries that have made significant contributions to badminton research. Spain, the United Kingdom, and Japan are among the countries with the highest contributions. Spain has 61 publications with a total of 776 citations and an average citation of around 418.50. United Kingdom with 52 publications, total citations 628, and average citations around 340.00, shows the active role of institutions and researchers there in contributing to the scientific literature on badminton.

Table 2.
Top 10 Countries Contributed to Badminton Research in the Last 30 Years

Country	*f*	Total Cited	Average Cited
China	141	987	564.00
Spain	61	776	418.50
United Kingdom	52	628	340.00
Japan	39	253	146.00
United States	37	504	270.50
Germany	35	509	272.00
Malaysia	31	282	156.50
Indonesia	30	85	57.50
Taiwan	28	324	176.00
India	28	98	63.00
Total	482	4446	2464.00

It's crucial to remember that even though China leads the world in both total citations and publication count, articles from other nations still have value and contribution to provide. Every nation has contributed something unusual and distinctive to the advancement of badminton expertise. As time goes on, more and more nations are actively undertaking studies and adding to the body of knowledge about badminton in science. However, variables including resources, research regulations, centers of excellence, and patterns in the growth of particular sports in particular places might have an impact on variations in the quantity of publications and citations among nations.

Nevertheless, international collaboration and information sharing can be extremely beneficial to the development of badminton knowledge by facilitating the fusion of many points of view and methodologies. To sum up, worldwide cooperation in badminton research might be essential to achieving a deeper and more thorough comprehension of this game.

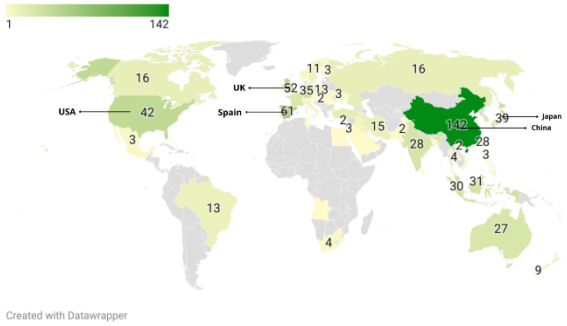

Figure 5. Nations that have made contributions to sport biomechanics research over the past 30 years.

Badminton Research Language in the Last 30 Years

There is a clear tendency in the usage of English in scientific papers, according to data on the quantity of badminton publications over the past 30 years according on language utilized. With 603 articles, 1208 citations, and an average of almost 905.50 citations per publication, English is the most used language in badminton-related publications. This demonstrates the overwhelming dominance of English in the dissemination of badminton-related scientific knowledge.

Even while English is the most widely used language in badminton research, a study in various other languages is also conducted, but on a considerably smaller scale. Though they are far behind the number of English publications, French, Russian, Spanish, and Chinese all have substantial publications. Less is known about the contributions made by speakers of Japanese, German, Slovak, Portuguese, Ukrainian, Korean, and Arabic to the body of scientific badminton literature.

Table 3.
Badminton Research Language in the Last 30 Years

Country	*f*	Total Cited	Average Cited
English	603	1208	905.50
French	11	30	20.50
Russian	10	4	7.00
Spanish	9	26	17.50
Chinese	5	5	5.00
Japanese	4	2	3.00
German	3	15	9.00
Slovak	2	5	3.50
Portuguese	2	3	2.50
Ukrainian	1	1	1.00
Korea	1	0	0.50
Arabic	1	0	0.50
Total	652	1299	975.50

It is evident that the number of publications by language and the preceding table, which displays the number of publications by nation, are related. The predominant language in contributions from other countries as well as in general scientific publications is English. English-speaking nations, like the United States and the United Kingdom, have regularly produced major contributions to the body of scientific literature on badminton. It is noteworthy, although, that many non-English speaking nations, including China and Japan, also made contributions in their own tongues, albeit in smaller quantities than those seen in English-language periodicals.

Numerous factors, such as research regulations, resource capacities, and author preferences when it comes to publication language choice, can be used to explain the relationship between language and nation. It does, however, highlight how crucial cross-linguistic and cross-cultural cooperation is to badminton research. Regardless of the language used in publications, international collaboration can broaden the interchange of ideas and expand current perspectives.

Cooperation across national boundaries involving different languages and nations will be highly advantageous for the advancement of badminton knowledge. Even though English predominates in scientific publications, multilingual collaboration may be essential to developing a more inclusive and comprehensive understanding of the sport. In conclusion, while English dominates in the scientific literature on badminton, cross-language collaboration can enrich insights and pave the way for more inclusive and comprehensive research.

Source Title in Badminton Research Trend in the Last 30 Years.

Based on data on the number of badminton publications from the Top 10 article publishers in the last 30 years, it can be seen that there are significant variations in contributions from various scientific journals. The International Journal of Environmental Research and Public Health is the publisher with the largest number of publications in the badminton context, with 22 publications, a total of 88 citations, and an average citation per publication of around 55.00. This journal shows considerable attention to health and environmental aspects in the context of badminton.

Furthermore, Revista Brasileira De Medicina Do Esporte, Plos One, and Journal of Sports Sciences also have significant contributions in publications about badminton. These journals have rather high citation averages, despite the fact that the quantity of publications varies, suggesting their importance in the badminton scientific field. Other journals that have contributed to badminton research include Physician and Sports Medicine, Journal of Clinical Medicine, Frontiers in Psychology, Science and Sports, International Journal of Human Movement and Sports Sciences, and Physician and Sports Analysis in Sport. These periodicals all cover many facets of the sport, from performance analysis to psychological and clinical elements associated to badminton, despite variations in the quantity of publications and citations.

Table 4.
Source Title in Badminton Research Trend in the Last 30 Years

Source Title	*f*	Total Cited	Average Cited
International Journal of Environmental Research and Public Health	22	88	55.00
Revista Brasileira De Medicina Do Esporte	17	1	9.00
Plos One	14	117	65.50
Journal of Sports Sciences	14	308	161.00
International Journal of Performance Analysis in Sport	10	189	99.50
Frontiers in Psychology	8	58	33.00
Science and Sports	7	24	15.50
Physician and Sportsmedicine	7	20	13.50
Journal of Clinical Medicine	7	66	36.50
International Journal of Human Movement and Sports Sciences	7	7	7.00
Total	113	878	495.50

The unique focus of each journal, such as health, performance analysis, psychology, or environmental concerns, may have an impact on variations in the quantity of publications and citations between these journals. Nonetheless, there is a direct correlation between the variety of topics covered in badminton research and these periodicals. The body of knowledge about badminton is growing thanks to partnerships with numerous scientific journals that focus on

environmental, psychological, sports, and health-related issues. In conclusion, the growth of the scientific literature about badminton is significantly influenced by the role that different publishers play in spreading knowledge about the sport from a variety of viewpoints.

Subject Areas Related to Badminton Research in the Last 30 Years

Several significant patterns may be seen based on data regarding the quantity of badminton publications in the previous 30 years based on the Top 10 relevant Subject Areas. With 406 publications, 1189 citations overall, and an average of almost 797.50 citations per publication, the discipline of medicine (medicine) is the one with the greatest connections to badminton research. This demonstrates the growing interest in badminton-related health and medical issues. A noteworthy contribution is also demonstrated by the field of health professions, which has 222 articles, 1109 citations overall, and an average citation average of almost 665.50. This suggests that the primary focus of badminton-related research is also on health-related topics, such as physical training, injury recovery, and clinical issues. The scientific literature on badminton has benefited greatly from the contributions of the disciplines of Engineering, Psychology, Genetics, and Molecular Biology in addition to Biochemistry and Genetics. These contributions demonstrate the range and diversity of aspects of study relevant to this sport, even though they may not be as numerous in terms of publications. On a smaller scale, it is evident that the domains of Neuroscience, Environmental Science, and Agricultural and Biological Sciences also make contributions to the realm of badminton expertise.

Table 5.
The Top 10 Badminton Research Topics in the Past 30 Years

Subject Areas	*f*	Total Cited	Average Cited
Medicine	406	1189	797.50
Health Professions	222	1109	665.50
Biochemistry, Genetics, and Molecular Biology	77	368	222.50
Engineering	75	205	140.00
Social Sciences	72	182	127.00
Psychology	47	278	162.50
Computer Science	41	212	126.50
Neuroscience	32	405	218.50
Environmental Science	28	143	85.50
Agricultural and Biological Sciences	19	69	44.00
Total	1019	4160	2589.50

The connections between these topics emphasize how crucial it is to take a multidisciplinary approach to comprehending and learning more about badminton as a sport. The variety and complexity of the elements involved in this sport are demonstrated by the existence of numerous associated fields of study. This highlights how crucial it is to collaborate across disciplines in order to gain a deeper understanding of badminton from a variety of angles.

Scientists with different backgrounds working together to better understand and develop badminton as a sport is essential. We can obtain a more thorough understanding of the technical, psychological, health, and other scientific components of this sport by integrating knowledge from diverse domains. In conclusion, multidisciplinary is key to developing knowledge about badminton, which includes health, scientific, technical, and social aspects of this sport.

Top 10 Cited Publications of Badminton Research in the Last 30 Years

Table 6.
Top 10 Cited Publications of Badminton Research in the Last 30 Years

No	Author	Total Cited	Research purposes	Methods	Results
1	(Manrique & González-Badillo, 2003)	163	To characterize the characteristics of badminton in order to identify the energy requirements, the temporal structure of the game and the actions that indicate a player's level of performance, and to use the results to make more accurate training plans.	Descriptive and comparative studies.	With a maximum heart rate of 190.5 beats per minute and an average of 173.5 beats per minute over 28 minutes of competition, as well as 6.4 seconds of performance intervals and 12.9 seconds of rest between exchanges, the results confirm the intense demands of the sport.
2	(Jiménez et al., 2012)	90	Provide evidence from sporting events that supports the biosocial concept of dominance and status.	Correlational study.	The results suggest that testosterone levels in badminton players of both sexes rise and fall after wins and losses, but at lower levels in women.
3	(Hastie et al., 2009)	89	This study sought to determine whether a particular curriculum intervention would improve students' tactics and skills.	Experimental study.	The results of this study show that students' performance in badminton skills tests, their competence in playing the game and their tactical knowledge can all improve during a unit designed according to the principles of physical education, provided that they are given sufficient time to practice and play.
4	(Shariff et al., 2009)	83	The aim of this study was to investigate the pattern of musculoskeletal injuries in Malaysian badminton players.	Retrospective case notes review.	Overuse, mostly to the knee, was the main cause of injury to badminton players in this study. Most injuries that occurred during training/practice sessions were diagnosed in younger players. The frequency and types of injuries did not differ according to gender.
5	(Ooi et al., 2009)	81	The aim of this study was to identify the physical and physiological	Comparative studies.	However, the test battery did not allow us to distinguish between elite and sub-elite players,

Table 6.
Top 10 Cited Publications of Badminton Research in the Last 30 Years

No	Author	Total Cited	Research purposes	Methods	Results
			characteristics of elite and sub-elite male badminton players from Malaysia and to investigate whether these characteristics could be used to differentiate elite players from sub-elite players.		suggesting that psychological preparation, technical ability and tactical understanding may be more important at the elite level.
6	(Abian-Vicen et al., 2013)	69	The aim of the study was to analyze the temporal and notational patterns of men's and women's singles (MS and WS) games and matches of the best badminton players in the world today.	Comparative studies.	When comparing men's and women's badminton singles, there were differences in the temporal and notational structure of the game.
7	(Boesen et al., 2006)	66	The lower extremities, particularly the Achilles tendon, are the most common area of injury for badminton players.	Cohort study (prevalence); Level of Evidence, 3.	Doppler flow was detected in the majority of players before the game and in every player after the game, suggesting that it may in part be a physiological response to exertion.
8	(Chin et al., 1995)	63	The aim of this study was to investigate the physiological responses of professional badminton players to a sport-specific fitness test.	Correlation studies.	The results also show that measurements using exercises that are substantially similar to the type of exercise required for the sport in question can be used to determine fitness.
9	(Hong et al., 2014)	52	The sample for this study wears two different types of badminton shoes and the study examines the external and internal load responses of four different types of badminton lunges: right-forward, left-forward, right-back and left-back.	Comparative studies.	The left-forward lunge would typically produce higher ground reaction forces and peak plantar pressures on the dominant leg of badminton players during heel strike than the other lunge directions tested, according to the most recent external ground reaction force and in-shoe plantar pressure data.
10	(Abianet al., 2015)	47	This study looked at how well professional badminton players performed physically and during matches using a caffeinated energy drink.	Experimental study	The results suggest that the use of caffeine-containing energy drinks may be a useful dietary supplement to improve jump performance and game-related activity patterns in professional badminton players.

Knowledge about badminton continues ~~grow~~ growing. A deeper understanding of the sport can be attained by concentrating on physiological elements, health, athlete rankings, and tactics. This can help athletes, coaches, and medical professionals enhance their performance and well-being in the badminton globe. The three primary themes of Athlete Physiology and Performance, Injuries and Health, and Variations in Playing Style and Athlete Rankings can be used to summarize the 10 Cited Publications of Badminton Research in the Last 30 Years.

The physiological features and physical activity of badminton athletes, as well as the ways in which different elements might affect their performance and physical condition (Manrique & González-Badillo, 2003; Chin et al., 1995). The study's findings shed light on the physiological reactions, heart activity, and fitness levels of competitors. Research of this nature is critical to the creation of more precise training schedules and to the comprehension of how athletes might enhance their performance.

Shariff et al., (2009) and Boesen et al., (2006), attempted to comprehend the health effects of the injury patterns that badminton players face. This study sheds light on the most frequent injuries, the body parts that are most susceptible, and the risk factors that go along with them. Better techniques for badminton players' injury prevention and care can be developed with this knowledge.

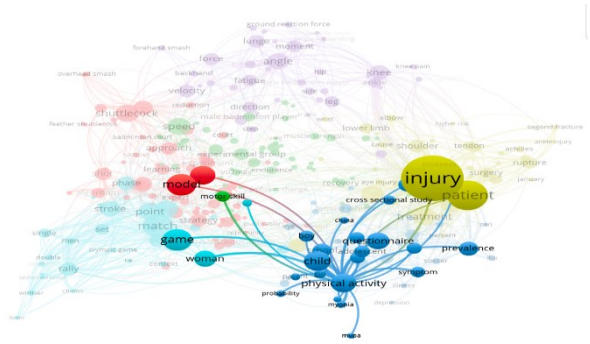

Figure 6. Keywords Interaction of Physical Activity in Badminton Research

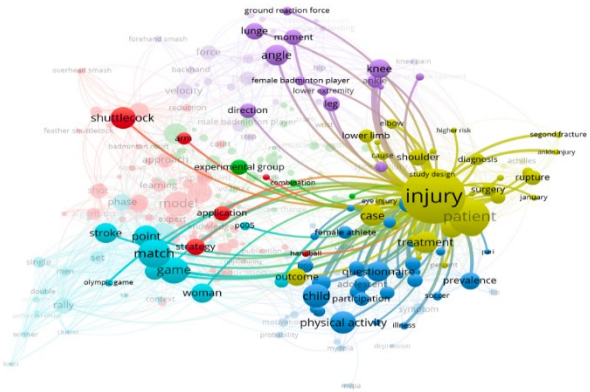

Figure 7. Keywords Interaction of "Injury" in Badminton Research

Popular subjects in the sport of badminton include variations in playing techniques, strategies, and player rankings. The goal of the studies (Abian-Vicen et al., 2013; Ooi et al., 2009) was to shed light on the differences between physical performance, strategy, and technical knowledge between elite and sub-elite athletes. This information can help with the creation of better training programs for badminton players who want to compete at the highest levels.

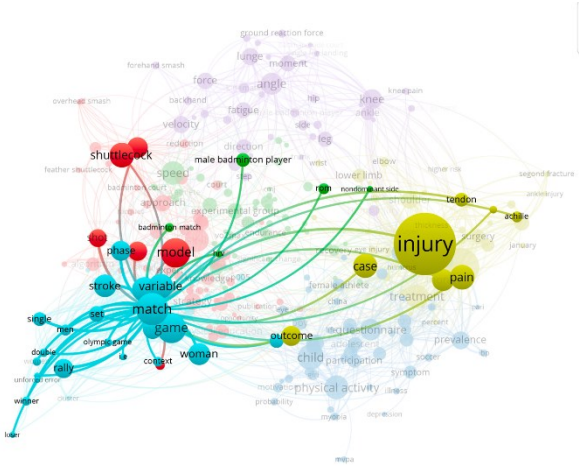

Figure 7. Keywords Interaction of "Match" in Badminton Research

Discussion

Research has been essential to raising athlete performance in badminton (Galeano et al., 2022). Over the past three decades, there has been a more profound comprehension of the game's strategies (Roberts et al., 2019), activity in the field (Yong et al., 2009), and tactics that have provided sportsmen with a notable edge (Qi & Fu, 2017). The findings of this study have altered training regimens and preparation strategies for badminton players worldwide. Sporting badminton necessitates quick movements and frequent direction changes (Ihsan et al., 2023). This increases the risk of injury for athletes (Jamali et al., 2022). Sports biomechanics research has shed light on common badminton injuries and how to create safe training methods (Guo & Wang, 2017).

In badminton, strategy is crucial (Yang et al., 2021). Over the last three decades, studies have investigated efficient playing techniques, encompassing doubles, singles, and mixed doubles approaches (Paup & Fernhall, 2017). This is crucial for young players' growth as well as for elite contests (Johan & Ghani, 2018). In a time when technology is becoming more sophisticated, game analysis has quickly incorporated technology (González-Peño et al., 2023). Technologies such as movement monitoring, video analysis, and health monitoring devices have become important tools in the training and development of badminton athletes (Yang, 2018).

Badminton research also has an impact on the health of the public (Chang et al., 2022). Badminton is a sport that is accessible to various age groups (Saragaglia et al., 2023). This research helps in understanding the benefits of this sport for general health and fitness. Apart from that, along with increasing competition, ethical and doping issues have also emerged in badminton. Research has helped in developing better doping detection methods and in promoting fair play.

Conclusion

Badminton has experienced tremendous development in recent decades since it was officially played in the Summer Olympic Games in 1992. The development is including in terms of playing techniques, competition regulations, global popularity, professional leagues, and its impact on public health. Badminton continues to develop and becomes increasingly attractive to players and spectators around the world. Badminton's rich history and continuous development make it one of the most popular sports in the world of sports. With all its achievements and future potential, the sport of badminton continues to inspire further research and development, which will help maintain its appeal in the future.

Conflict of interested

Authors declare that they have no conflict of interest.

Authors' contributions

Authors contributed equally to the research and preparation of the paper.

Funding

This research uses private funds.

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