

Evolution of the documents related to the study of taekwondo sports performance: a bibliometric review

Evolución de los documentos relacionados con el estudio del rendimiento deportivo en taekwondo: una revisión bibliométrica

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Abstract. Taekwondo is a Korean martial art, combat sport, and Olympic discipline. Taekwondo competition is characterized as an individual sport (1X1), single elimination tournament and repechage system. The aim goal of this study was to conduct a bibliometric review regarding the item's "Taekwondo" and "Performance", through identified and published papers on the Web of Science (WOS) database by December 31, 2022. The bibliometric analysis was used to analyze a data set of 460 WOS-indexed papers published between 1992 and 2022. Descriptive analysis, citation, authorships, countries, institutions, and keywords co-occurrence analyses were conducted on Taekwondo sports performance. The papers found in the WOS database are inserted into the categories: "Sports Science" ($n = 229$), "Hospitality Leisure Sport Tourism" ($n = 48$), and "Physiology" ($n = 32$). The authors Kazemi et al. (2006), Matsushigue et al. (2009), and Paillard (2017) are the most published and cited researchers. The countries with the highest number of published papers with the objective of this study are Brazil ($n = 83$), South Korea ($n = 57$), and Spain ($n = 52$). We found also, five collaboration networks between authors and institutions, finding a gap in the thematic relevant researchers. The authors should have highlighted Franchini, E., ($n = 42$), and Falco, C., ($n = 20$). It is recommended to carry out multidimensional research on Taekwondo sports performance to establish collaborations within groups, institutions, and countries. In this way, the productivity, effectiveness, and quality of research would be increased, as well as international collaboration networks.

Keywords: bibliometric, analysis, skills, sport, individual

Resumen. El taekwondo es un arte marcial coreano, deporte de combate y disciplina olímpica. La competición de taekwondo se caracteriza por ser un deporte individual (1X1), torneo de eliminación simple y sistema de repesca. El objetivo de este estudio es la realización de una revisión bibliométrica sobre el tema "Taekwondo" y "Performance", a través de manuscritos identificados y publicados en la base de datos Web of Science (WOS) hasta el 31 de diciembre de 2022. El análisis bibliométrico se utilizó para analizar un conjunto de datos de 460 manuscritos indexados en WOS publicados entre 1992 y 2022. Se realizaron análisis descriptivos, de citas, autorías, países, institucionales y de co-ocurrencia de palabras clave en el rendimiento deportivo del taekwondo. Los manuscritos fundados en la base de datos WOS se insertan en las categorías: "Sports Science" ($n = 229$), "Hospitality Leisure Sport Tourism" ($n = 48$), y "Physiology" ($n = 32$). Los autores Kazemi et al. (2006), Matsushigue et al. (2009) y Paillard (2017) son los investigadores más publicados y citados. Los países con mayor número de manuscritos publicados con el objetivo de este estudio son Brasil ($n = 83$), Corea del Sur ($n = 57$) y España ($n = 52$). Encontramos también, cinco redes de colaboración entre autores e instituciones, encontrando un vacío de los investigadores temáticamente relevantes. Los autores deberían haber destacado Franchini, E., ($n = 42$), y Falco, C., ($n = 20$). Se recomienda realizar investigaciones multidimensionales sobre el rendimiento deportivo del Taekwondo con el objetivo de establecer colaboraciones dentro de los grupos, instituciones y países. De este modo, aumentaría la productividad, la eficacia y la calidad de la investigación, así como las redes de colaboración internacional.

Palabras clave: bibliometría, análisis, habilidades, deporte, individual

Fecha recepción: 27-03-24. Fecha de aceptación: 16-08-24

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Introduction

Taekwondo is an ancient Korean martial art without weapons and sport combat (Wasik & Shan, 2015), its goal is strengthening the body, mind, and spirit, through self-defence practice. Besides, it helps to integrate development, and even to obtain better inclusion and quality of life (Kim et al., 2011; Morales et al., 2018). Equally, it is recognized as an international sport modality, and it is practised all over the world by kids, young people, and adults (Janiszewska & Przybyłowicz, 2015). A Taekwondo competition is characterized by three two-minute rounds and one minute rest between rounds (Prado et al., 2011). The athlete performs fantastic and spectacular kick techniques. Likewise, there is a panoply of kick varieties (Chagi), in the Taekwondo system, such as: An-chagi, Ap-chagi, Bakat-

chagi, Bandal-chagi, Dollyo-chagi, Furyo-chagi, Miro-chagi, Nako-chagi, Neryo-chagi, Dwit-chagi, Yop-chagi, Mondollyo Furyo-chagi y Mondollyo Nako-chagi, Mondollyo Yop-chagi, Mondollyo Dwit-chagi, etc. (Falco et al., 2009; Sant'Ana et al., 2014; Sousa et al., 2022). In the same way, defensive gestures and the use of fists are of vital importance in the development of Taekwondo attacks and defence actions. That's why complex technical processes are used, and the kick technique can be performed dynamically, with powerful acrobatic, jumping and explosive movements (Menescardi et al., 2020). Therefore, in Taekwondo, where the athlete fights against an opponent, technical and tactical control is required, as well as recognizing the opponent's qualities to win the fight (Menescardi et al., 2020). Likewise, the control of stress, emotions and motivation are variables which influence directly in the

sports performance. Therefore, good group cohesion should be developed, as well as the promotion of the control of mental abilities (Chicaiza et al., 2024).

In scientific literature, a wide variety of studies related to Taekwondo exist. For instance: body mass characterization (Baek et al., 2021; Cular et al., 2021; Ojeda-Aravena et al., 2020), physical capabilities (Ros-Saura, 2022), main physiological adjustments during competition (Santos et al., 2020), and effects of Taekwondo practice on the health and well-being of practitioners (Linhares et al., 2022; Nam & Lim, 2019). There are also investigations related to the level of motivation during training periods (Olmedilla et al., 2021), and comparison studies between boxing and Taekwondo (Sanchez Rodríguez & Bohórquez Aldana, 2020). Also, papers related to the benefits of using video in Taekwondo learning processes (Bernal-Torres et al., 2020; Cui & Hu, 2022; Rosendahl et al., 2022), and sensors for sportswear (Ma et al., 2021). There are studies related to the most common sports injuries in Taekwondo practitioners (Jeong et al., 2021; Son et al., 2020; Tulendiyeva et al., 2021). Thus, a wide variety of investigations into Taekwondo.

Theoretical studies on Taekwondo are focused on specific themes, and papers related to sports performance indicators in Taekwondo are scarce (Muñoz Alemán et al., 2022; Sousa et al., 2022) and emerging. Thus, in a short time, it has gained popularity as a concept among sports professional researchers (Drust, 2010). Understanding sports performance indicators as a method of recording data and analyzing the sports context (Hughes & Franks, 2004), with the purpose of giving optimal quantitative and qualitative feedback, as well as providing relevant data on the sport analyzed (Hughes & Franks, 2008). Also, the main objective is to identify strengths that can be developed in training, and weaknesses that can be improved before the competition (Hughes & Bartlett, 2002; Lago Peñas, 2022).

In this way, and due to the importance of evaluating and identifying performance in different sports modalities, to implement improvements in skills, and specific techniques in each discipline, the objective of this study was to analyze the evolution of the documents related to the study of performance in Taekwondo, from its origins to the present (2022).

Materials and Methods

Study Design

According to Montero and León (2007) criteria, the present study is predominantly theoretical, to analyze the evolution of documents related to performance analysis in Taekwondo through a literature bibliometric review, based on past events. Therefore, it is classified as an ex post facto retrospective study (Ato et al., 2013). Likewise, by analyzing the evolution of papers related to the researched topic, it will allow researchers to know the state-of-the-art regarding a specific topic and identify future underdeveloped lines of research (Cabo, Hernández-Beltrán, Gamonales,

Parraca, et al., 2024; Hernández-Beltrán, Espada, Santos, et al., 2023). Furthermore, considering the main objective of the study, a review of the literature has been developed, based on a systematic and bibliometric analysis of the data obtained (Munn et al., 2023).

Data extraction

To search for papers, the Web of Science (WoS) database was used, since it is one of the databases which is most used and with a great deal of impact on the preparation of bibliometric reviews (Gámez-Calvo et al., 2024; Gutiérrez-Hellín et al., 2023; Hernández-Beltrán, Espada, Muñoz-Jiménez, et al., 2023). Likewise, the WoS database presents the largest number of indexed documents (Herrera & de las Heras-Rosas, 2020). For data extraction, the guidelines, and laws of bibliometrics have been taken (Bookstein, 1980). Therefore, this database allows extracting information from the papers related to Title, Summary, Keywords, Author(s), Collaborating Institutions and Countries. Also, it will allow the authors to analyze and identify the influence, and relationship with the scientific field, as well as its growth in the number of publications (Hernández-Torrano & Ho, 2021).

On the other hand, a phases series proposed by Arksey and O'Malley (2005) has been used: a) identify and establish the research question and objectives; b) identify the most relevant studies related to the research topic; c) select the most relevant studies taking into account the established inclusion criteria; d) extract the data to prepare the figures, and identify the relationships established between them, and; e) identify, summarize and establish the main findings obtained after carrying out the study. These phases allow the authors to identify and include the most relevant documents according to the study's aim and extract relevant conclusions to increase the scientific knowledge (Cabo, Hernández-Beltrán, Gamonales, Fernandes, et al., 2024).

Search strategy

The keywords "*Performance*" and "*Taekwondo*" were used to search and identify the papers, by using the "*Topic*" filter. Therefore, the search phrase was "*Performance*" and "*Taekwondo*", using the Boolean operator "AND" to increase the number of documents related to the topic. This fact will allow to select those documents that present the key terms in the Title, Summary and Keywords, identifying papers with great relevance and relationship with the selected topic. Furthermore, to identify the greatest number of documents related to the research topic, the search was carried out by two of the investigators (VHB and JMG). Subsequently, the results were reviewed and corroborated by a third and fourth researchers (SJI and JLS). In this way, bias in the results is reduced. After this analysis step, a total of 533 documents were identified, and 73 were eliminated for not meeting the inclusion criteria. The final sample of the study was made up of a total of 460 documents (Figure 1).

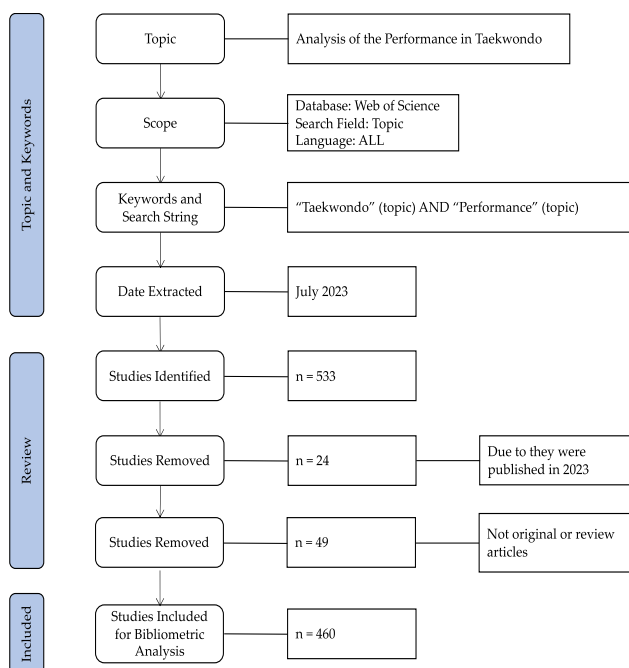


Figure 1. PRIMA flow diagram by identification, screening, eligibility and included sources process.

Inclusion criteria

For the inclusion of documents in the bibliometric analysis, these had to meet a series of established inclusion criteria established at the beginning of the research by the authors: 1) *the documents had to be related to Taekwondo performance analysis*; 2) *be written in Spanish, English, or Portuguese, or, failing that, present the possibility of being translated into English*; 3) *the full text or summary be available for analysis*, and; 4) *be published before December 31, 2022, once the year 2023 has not yet been completed*. For this reason, studies related to Taekwondo from the year 2023 are not included in the analysis.

Data analysis

For data extraction and subsequent analysis, the main laws of bibliometrics have been taken as reference (Donthu et al., 2021; Mukherjee et al., 2022). For data analysis, the following established laws have been used: Law of Price, Lotka (Hirsch, 2005), and Zipf (Vega-Muñoz et al., 2022). Also, to carry out the analysis of the papers, the metadata of the studies were downloaded in two formats, Plain text, and Excel. Subsequently, by using VOSViewer (Center for Science and Technology Studies, Netherlands), and Microsoft Excel (2006 version: Microsoft Corporation, Redmond, WA, USA), the visualization and data analysis processes were carried out. In the VOSViewer application, a fragmentation analysis was used with a value of 3 for attraction and -3 for repulsion.

Results

Number of publications evolution

After the analysis of the study sample, it is shown as the

first study related to the research topic, published in 1992, and analyzed the influence of competitive anxiety on the performance of athletes (Finkenberg et al., 1992). In 1995, the second article was published, to analyze the influence of the presence of injuries before the competition, being an influential factor in the control and regulation of athletes and coaches (Feehan & Waller, 1995).

After making these publications, no continuity is identified in the publication of studies until 2004, the year in which a minimum of one article is published to date. From 2004 to nowadays, the sample is divided into those documents published between 2004 to 2013 ($n = 83$), and from 2013 to the present date (2022) ($n = 275$), presenting an increase of 90.7% in the number of publications. Furthermore, the years 2021 and 2022 are the periods with the highest number of publications ($n = 66$) (Figure 2).

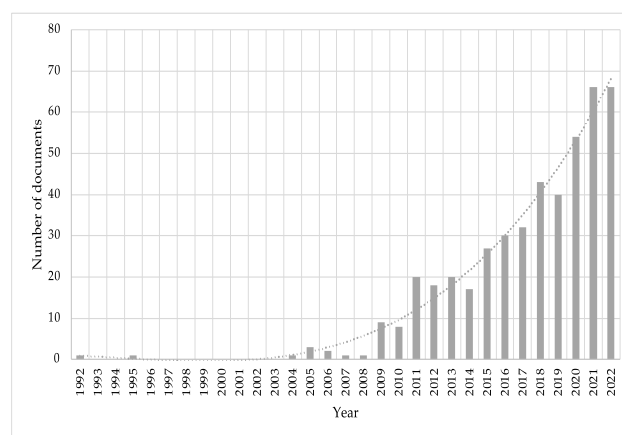


Figure 2. Evolution of the number of documents

WOS Category

Table 1 shows the results related to the categories established by the WOS. It is also observed that the most predominant category is "Sports Science", with a total of 229 documents, corresponding to almost 50% of the selected sample. Behind her, and with a considerably smaller number, are "Hospitality Leisure Sport Tourism" ($n = 48$), and "Physiology" ($n = 32$). Thus, the authors focus their interests on areas related to Sports Sciences, whose objective is the analysis of performance, and the factors that thereby influence.

Table 1.

Distribution of documents based on WoS category.

| WoS Category | Documents | % of 460 |
|--|-----------|----------|
| Sport Sciences | 229 | 49.78 |
| Hospitality Leisure Sport Tourism | 48 | 10.43 |
| Physiology | 32 | 6.95 |
| Nutrition Dietetics | 27 | 5.87 |
| Public Environmental Occupational Health | 23 | 5.00 |
| Environmental Sciences | 18 | 3.91 |
| Rehabilitation | 18 | 3.91 |
| Medicine General Internal | 15 | 3.26 |
| Multidisciplinary Sciences | 14 | 3.04 |
| Psychology Experimental | 14 | 3.04 |

Publication journal

Considering the journal in charge of publishing the arti-

cles, it is noted that “*Archives of Budo*”, has the largest number ($n = 61$). Also, the impact Factor of the journal has been identified based on the score awarded by the Journal Citation Reports for the year 2022. It is observed that the journals with an impact index greater than 3 are: “*Plos One*” with 11 published documents, “*International Journal of Sports Physiology and Performance*” with 9 documents, and “*Journal of Strength and Conditioning Research*”, with a total of 23 studies

(Table 2). On the contrary, “*Plos One*” is the Journal with the highest Impact Factor (3.7), followed by “*International Journal of Sports Physiology and Performance*” and “*Journal of Strength and Conditioning Research*” with 3.3 and 3.2, respectively. In this line, “*Journal of Strength and Conditioning Research*” is the journal with the highest number of documents published and an Impact Factor upper than 3.

Table 2.

Most relevant journals by IF.

| Publication title | Doc's | % of 460 | IF* | Editorial |
|---|-------|----------|-----|------------------------------------|
| Plos One | 11 | 2.39 | 3.7 | Public Library Science |
| International Journal of Sports Physiology and Performance | 9 | 1.95 | 3.3 | Human Kinetics Publ Inc |
| Journal of Strength and Conditioning Research | 23 | 5.00 | 3.2 | Lippincott Williams & Wilkins |
| Archives of Budo | 31 | 6.73 | 2.1 | Int Scientific Information, Inc |
| Journal of Exercise Rehabilitation | 8 | 1.73 | 1.9 | Korean Soc Exercise Rehabilitation |
| Perceptual and Motor Skills | 12 | 2.60 | 1.6 | Sage Publications Inc |
| Journal of Sports Medicine and Physical Fitness | 9 | 1.95 | 1.7 | Edizioni Minerva Medica |
| Revista de Artes Marciales Asiáticas | 9 | 1.95 | N/A | Universidad de León |
| Ido Movement for Culture Journal of Martial and Anthropology | 22 | 4.8 | N/A | Idokan Poland Assoc. |
| International Journal of Environmental Research and Public Health | 18 | 3.91 | N/A | Mdpi |

*IF – Impact Factor of Journal Citation Reports 2022; Doc's - Documents

Most cited documents

Table 3 shows the Top 10 cited documents about the study of sports performance in Taekwondo. In addition, the journal in which it has been published is identified, as well

as the average number of citations per year from its publication to the present (time cited in the WOS). It can be seen how the study prepared by Kazemi et al. (2006), it is the one that has received the greatest number of citations since its publication (2006).

Table 3.

High-cited documents, authors, journal, and average per year.

| Title | Authors | Journal | Year of publication | Total of citations | Average per year |
|---|----------------------------|--|---------------------|--------------------|------------------|
| Plasticity Of The Postural Function To Sport And/Or Motor Experience | Paillard (2017) | Neuroscience And Biobehavioral Reviews | 2017 | 104 | 14,86 |
| Taekwondo: Physiological Responses And Match Analysis | Matsushigue et al. (2009) | Journal Of Strength and Conditioning Research | 2009 | 108 | 7,2 |
| Practices Of Weight Regulation Among Elite Athletes In Combat Sports: A Matter Of Mental Advantage? | Pettersson et al. (2013) | Journal of Athletic Training | 2013 | 78 | 7,09 |
| A Review Of Time-Motion Analysis And Combat Development In Mixed Martial Arts Matches At Regional Level Tournaments | Del Vecchio et al. (2011) | Perceptual And Motor Skills | 2011 | 91 | 7 |
| Caffeine Reduces Reaction Time And Improves Performance In Simulated-Contest Of Taekwondo | Santos et al. (2014) | Nutrients | 2014 | 66 | 6,6 |
| Physiological Responses And Perceived Exertion During International Taekwondo Competition | Bridge et al. (2009) | International Journal of Sports Physiology and Performance | 2009 | 96 | 6,4 |
| A Profile Of Olympic Taekwondo Competitors | Kazemi et al. (2006) | Journal Of Sports Science and Medicine | 2006 | 114 | 6,33 |
| Stress-Related Hormonal And Psychological Changes To Official Youth Taekwondo Competitions | Chiodo et al. (2011) | Scandinavian Journal of Medicine & Science in Sports | 2011 | 74 | 5,69 |
| Making Weight In Combat Sports | Langan-Evans et al. (2011) | Strength And Conditioning Journal | 2011 | 70 | 5,38 |
| Fitness Profile Of Elite Croatian Female Taekwondo Athletes | Markovic et al. (2005) | Collegium Antropologicum | 2005 | 100 | 5,26 |

H-Index

Figure 3 shows the minimum of documents depending on the H-Index of the sample ($n = 40$). Therefore, in this study, we can affirm that there is a minimum of 40 documents

that present a minimum of 40 citations. After carrying out a thorough analysis of the documents, it is shown that there are a total of 4 documents with a number equal to or greater than 100 citations, with 114, 108, 104 and 100 respectively.

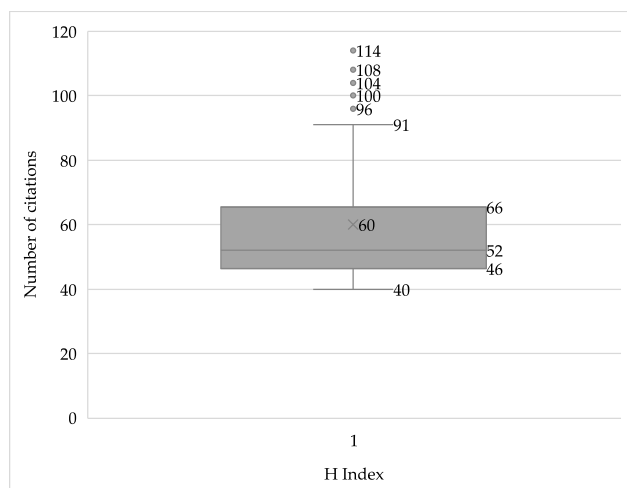


Figure 3. Number of citations depending on the H-Index of the sample.

Below, Figure 4 shows the number of documents and citations received in total, per year. The year of 2021 shows the highest number of citations: 719, with a total of 20 published documents. In contrast, the years after 2020 are the one with the greatest number of documents produced. However, the number of citations decreases considerably.

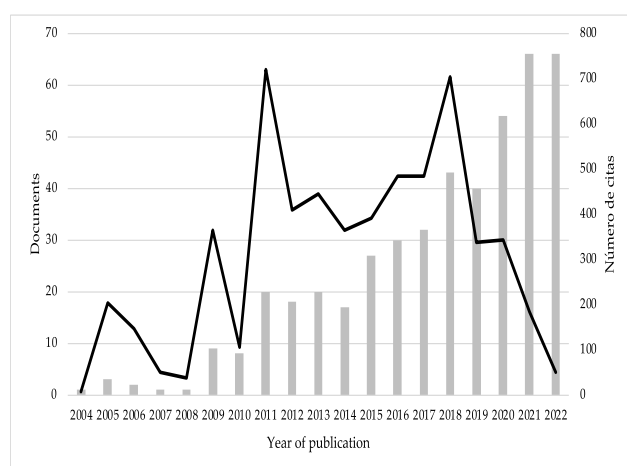


Figure 4. Numbers of documents and citation evolution in Taekwondo sports performance.

Publications by countries

After the extracting procedure of the countries that have contributed to the preparation of the documents, there is a total of 62 regions of the 35 countries present a minimum of 3 documents, and 20 countries present a minimum of 7 documents produced. For the analysis of co-authorship of the countries, all of them have been included ($n = 62$). Only 51 of them have a connection. Beyond that, it is observed that Brazil ($n = 83$), South Korea ($n = 57$), and Spain ($n = 52$) are the countries with the highest number of publications. Taking the number of citations received as a reference, Brazil, Italy, and England have the highest number, with 1264, 622 and 604, respectively. Spain is identified in fourth place with a total of 589 citations (Figure 5).

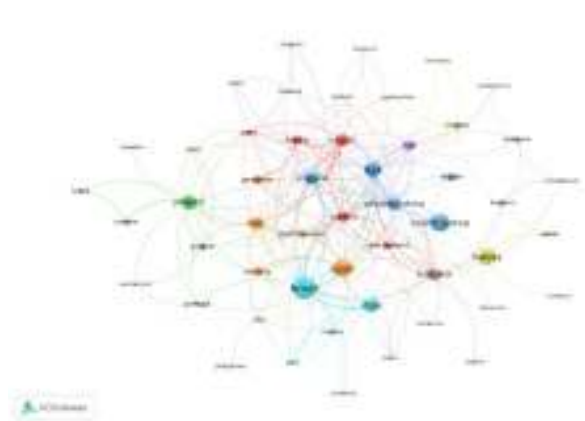


Figure 5. Co-authorships of countries based on the number of documents.

Figure 5 also identifies the Co-authorships of the countries map, by using the VOSviewer, seven clusters representing the network between the countries. The size of the bubbles indicates the co-authorship frequency. Light blue cluster leadership by Brazil indicates the most published documents related to the Taekwondo sports performance, followed by blue cluster leadership by South Korea, and the orange cluster represents the network lead by Spain.

Figure 6 shows the existing relationships between the collaborating countries, depending on the temporality of the publication of the documents. Once again, the blue cluster, leadership by Brazil, is the biggest, but nowadays the yellow cluster (such as Japan, Nepal, Thailand, Lithuania, Peru, and Cuba) are the countries with the largest number of studies published in a temporal perspective. Studies published in these temporal co-authorships of the countries cluster highlighted that these countries are, nowadays, interested in the topic of this study.

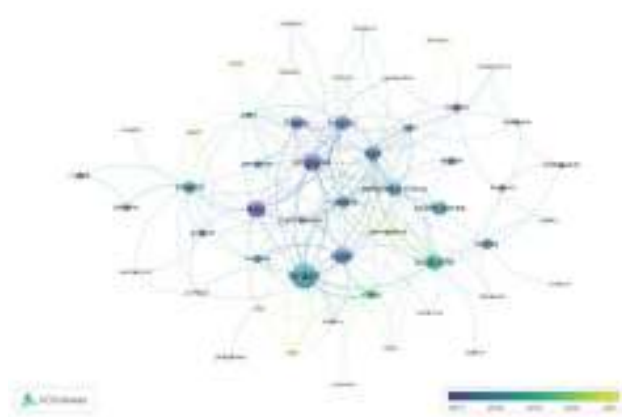


Figure 6. Co-authorships of the countries based on temporality.

Publications regarding the Organisations

Table 4 shows those institutions that present the greatest number of studies carried out. It is observed that the University of São Paulo (Brazil) is one of the most active in the development of studies related to the analysis of performance in Taekwondo ($n = 46$).

Table 4.

Most prolific institutions in the preparation of documents.

| Affiliations | Registers number | % of 460 |
|--|------------------|----------|
| Universidade de São Paulo | 46 | 10.00 |
| Universidad de Santiago de Chile | 21 | 4.56 |
| Centre National de la Medecine Sciences des Sports | 16 | 3.47 |
| Universidad de Manouba | 16 | 3.47 |
| Universidad de Valencia | 15 | 3.26 |

In the below Figure 7, a fragmentation analysis has been carried out (attraction: 3 and Repulsion: -3), to know the co-authorship of the identified organizations. In the first instance, a total of 728 institutions have been identified, of which only 46 present a minimum of 5 documents. To identify the relationships between those most prolific institutions, a total of 31 have been included, those that presented a minimum of 6 documents, of which only 24 have related each other.

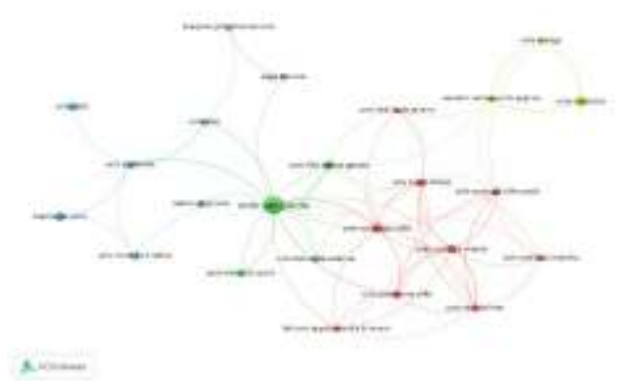


Figure 7. Co-authorship of the organizations depending on the number of documents.

The co-work map, regarding the organizations analysis, was generated in VOSviewer revealed five top cluster institutions involved in Taekwondo sports performance studies from 1992 to 2022.

The biggest bubbles organizations are *Universidade de São Paulo* (Brazil) (green cluster), followed by *Universidad de Santiago de Chile* (Chile) (red cluster), then *Universidad de Valencia* (Spain) (yellow cluster), *Manouba University* (Tunis)

Table 5.

Highly numbers of paper and H-Index by authors.

| Authors | Documents | H-Index | Affiliation |
|------------------------|-----------|---------|--|
| Franchini, E. | 42 | 50 | University of São Paulo |
| Falco, C. | 20 | 14 | Western Norway University of Applied Sciences |
| Herrera-Valenzuela, T. | 18 | 11 | Universidad de Santiago de Chile |
| Valdés-Badilla, P. | 14 | 11 | Universidad Católica del Maule |
| Estevan, I. | 13 | 17 | University of Valencia |
| Da Silva Santos, J.F. | 13 | 5 | Universidade Federal dos Vales do Jequitinhonha e Mucuri |
| Chaouachi, A. | 11 | 49 | Centre National de la Medecine Sciences des Sports |
| Capranica, L. | 10 | 40 | Foro Italico University of Rome |
| Chiodo, S. | 8 | 9 | University of Catanzaro |
| Song, J.K. | 8 | 10 | Kyung Hee University |

(blue cluster), and finally *Liverpool John Moores University* (England) (purple cluster).

Network between authors

Of the total selected network authors ($n = 1485$), only 62 have been included in the analysis, since it is the closest value to 38, square root of 1485. In this manner, the most prolific authors of the research topic have been selected. In addition, those authors who presented a minimum of 4 completed documents have been included.

Figure 8 illustrates the network map by using the VOSviewer showing six cluster acts with the most prolific authors and their co-authorships analysis. Leadership by Franchini, E. (red cluster), then Falco, C. (purple cluster), Chaouachi, A. (green cluster), Capranica, L. (yellow cluster), Oergui, I. (blue cluster), and Miarka, B. (light blue cluster).

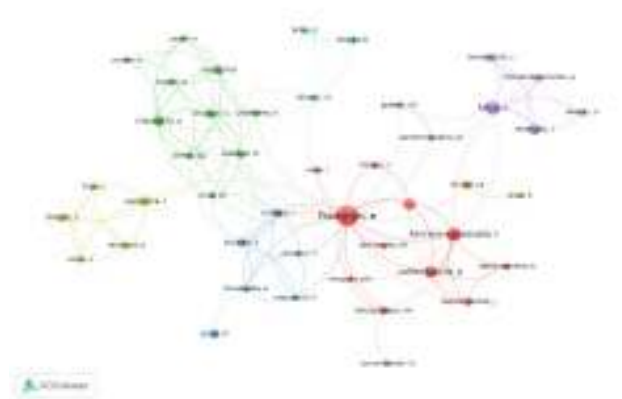


Figure 8. Most prolific authors and their co-authorships

Table 5 shows the top 10 cluster study authors with the highest number of documents produced, as well as the H-Index of each of them, extracted from the researcher profile of the WOS database. It should be noted that the authors Franchini, E., and Chaouai, A., present an H-Index much higher than the others with a value of 50 and 49, respectively. Followed by Capranica, L., who present values of 40 H-Index. This being a value that expresses the level of significance which they present within the scientific community.

Keywords used by authors

About the keywords used by the authors in their different studies, a total of 1128 keywords have been identified, of which only 40 terms had a minimum occurrence of 5. It is observed that the co-work analysis identified the most frequently used by the authors are “*Taekwondo*” ($n = 110$), “*Martial arts*” ($n = 94$), “*Combat sports*” ($n = 58$), “*Performance*” ($n = 33$), and “*Athletes*” ($n = 18$) (Figure 9). The findings suggested that the sports performance information system and taekwondo keywords appear in every analysis linked by other sports (e.g., judo, karate, boxing, and wrestling) and in a generical point analyse “*Combat sport*”. Also, in relationship with the keywords co-occurrence analyses by balance, isokinetic strength, postural control, vertical jump, and training

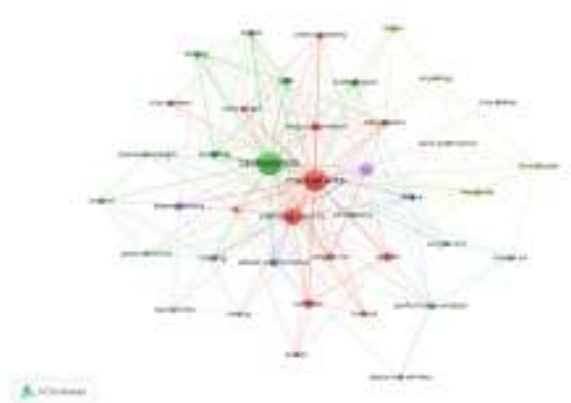


Figure 9. Most used keywords

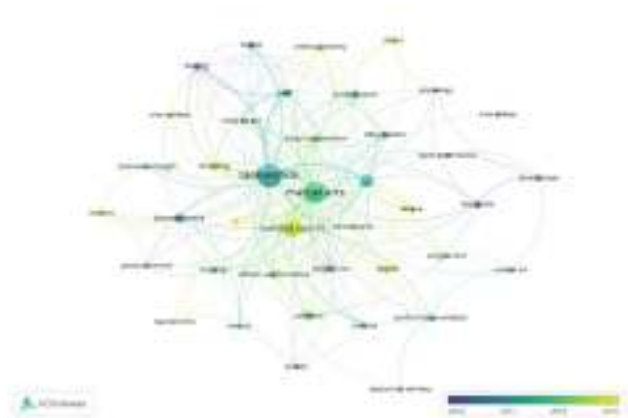


Figure 10. Keywords depending on temporality.

On the opposite, depending on the temporality (Figure 10), the keywords map shows a clear trend in the use of terms focused on the analysis of factors that influence the performance of athletes such as “*Stress*”, “*Fatigue*” or “*Reaction time*”. These terms are related to the new research lines which are focused on the analysis of those factors and their influence on sports performance. Also, the “*reaction time*” is one of the most important factors in Taekwondo in order to avoid the opponent’s kicks.

The last step, a temporal keywords analysis map was generated in VOSviewer. According to the bubble map results, the keyword “*combat sports*” information system is

related with the cluster “*Sports*”, and “*Elite athletes*”. These findings confirm that the recent published works are connected to Taekwondo sports performance and psychological issue. These is the focus and recent interesting topic for majority of the authors and co-authors.

Discussion

The main objective of the present theoretical study was to carry out a comprehensive analysis of the papers related to sports performance in Taekwondo through the development of a bibliometric review. The results show the existence of 460 WOS-indexed papers included in this bibliometric review and related to the topic under study between 1992 and 2022. Almost 50% of the documents are related to the WOS category: “*Sports Science*” ($n = 229$). These results stand out from previous work, which presents the life science categories as the most developed, with sub-areas such as biomechanics, sports medicine or physiology being the most studied (Pérez-Gutiérrez et al., 2017). Furthermore, the largest number of papers are published in the journal “*Archives of Budo*” ($n = 31$). Likewise, publications related to sports performance in Taekwondo from 2013 to nowadays present an increase of 90.7%. Therefore, bibliometric reviews allow us to obtain a global and effective perspective in relation to the object of study (Hernández-Beltrán et al., 2024; Gamonales et al., 2024).

The results related to the evolution in the number of publications show that the first published document related to Taekwondo sports performance occurred in the year of 1992 and analyzed the influence of competitive anxiety on sports performance (Finkenberg et al., 1992). Currently, sports performance indicators related to psychology are focused on behaviors and psychological processes in the sports context (Ursino et al., 2020). Besides, the first line of research in psychology and sports performance in Taekwondo is still valid today. Regarding the second published article, which analyzes Taekwondo athlete injuries before competition (Feehan & Waller, 1995), it is an emerging field of research, since any type of injury that occurs before, during or after training or competition can influence the sports performance of athletes. On the other hand, research related to sports performance in Taekwondo from 2013 to the present ($n = 375$), presents an increase of 90.7% in the number of publications because of the boom in the field of Sports Sciences, and the need to innovate in studies. Likewise, the authors of this papers are expanding the knowledge related to the object of study, and it is a variant of systematic literature reviews (Lim et al., 2022). It can also serve as a starting point and complement for research. In relation to the WOS categories, the main categories are: “*Sports Science*” ($n = 229$), “*Hospitality Leisure Sport Tourism*” ($n = 48$), and “*Physiology*” ($n = 32$). The first three categories add up to 67.16% of published documents. In the scientific literature, there are no papers that corroborate the results obtained. The publication journal, “*Archives of Budo*”, is presented with the highest number ($n = 61$;

FI=2.1). However, the journals with an impact index greater than 3 are: “*Plos One*” ($n = 11$; FI=3.7), “*International Journal of Sports Physiology and Performance*” ($n = 9$; FI=3.3), and “*Journal of Strength and Conditioning Research*” ($n = 23$; FI=3.2). Therefore, researchers focus their interests on areas related to Sports Sciences, to analyze sports performance in Taekwondo, allowing them to create a performance profile, which must be present in the sporting activity to achieve performance and can be used to predict the future of sporting activities (O'Donoghue, 2010). The bibliometric review related to Taekwondo sports performance allows us to determine which are the main categories where researchers publish. The results related to the most cited documents show how the study prepared by Kazemi et al. (2006), it is the papers that has received the highest number of citations since its publication (2006). The study carried out by Paillar (2017), is the document that has received a total of 14.86 citations per year since its publication (2014). In addition, they are recent and interesting studies for Taekwondo coaches and athletes, since they allow the profiles of the Olympic Champions and other competitors who participated in the Sydney 2000 Olympic Games to be identified, as well as knowing the effects of caffeine on reaction time during a specific Taekwondo task and Sports Performance during a simulated competition. The others TOP 10 documents allow us to determine the time structure and physiological response during competitions between winners and losers (Matsushigue et al., 2009). The study by Markovic et al. (2005), allows to know the physical condition profile of elite Taekwondo Croatian athletes, determines what physical, and physiological (Bridge et al., 2009), and motor performance characteristics differences between the winners and losers. On the other hand, there is a study that compares different martial arts such as Judo, Wrestling, Karate and Taekwondo to quantify the effort-pause relationship and identify the number of actions performed per round in each sport modality analyzed (del Vecchio et al., 2011). Besides, there is a great diversity of studies related to Taekwondo as a sports and Olympic discipline. That's why it is recommended to carry out multidisciplinary research to increase the quality of the work.

About the H-Index, there is a minimum of 40 documents that present a minimum of 40 citations. Only a total of 4 documents present a number equal to or greater than 100 citations (Kazemi et al., 2006; Marković et al., 2005; Matsushigue et al., 2009; Paillard, 2017). This centralization of citations in only 40 papers out of the totality of those selected is due to the concern and interest of researchers in high-quality scientific papers, focusing on those primary papers. The year 2011 is the year with the highest number of citations, 719 with a total of 20 published documents. However, in the years after 2020, a greater number of documents related to Taekwondo sports performance have been published, but they present a considerably lower number of citations. Taekwondo research has increased considerably in recent years. Therefore, the present bibliometric study reveals the increase in publications related to

Taekwondo sports performance, and shows the main journals where researchers publish. Bibliometric research must go beyond reporting the results of the performance analysis and scientific mapping generated by scientific databases (e.g., Web of Science), and software (e.g., CiteSpace, Gephi, Leximancer, and VOSviewer) (Mukherjee et al., 2022). It is insufficient to describe the main contributors, (e.g., main authors, institutions, and countries), and the topics (for example, most cited articles and top keywords) in each field. Therefore, bibliometric reviews should be complementary to systematic reviews or meta-analyses. Furthermore, researchers should focus on underexplored topics to increase knowledge.

Results related to Publications considering countries: 35 countries present a minimum of 3 documents and 20 countries show a minimum of 7 documents produced. The countries with the highest number of publications are Brazil ($n = 83$), South Korea ($n = 57$), and Spain ($n = 52$). On the opposite, the countries with the highest number of citations received are Brazil ($n = 1264$), Italy ($n = 622$), and England ($n = 604$). Currently, the countries with the highest number of publications depending on the temporal perspective are Japan, Nepal, Thailand, Lithuania, Peru, and Cuba. The country's density map shows a bigger spread on the implicated countries. Once again, we found that in the scientific literature, there are no studies that corroborate the results obtained. So, the present bibliometric review allows providing relevant information on the topic under investigation and helps researchers establish new relationships, as well as find more relevant authors and articles (Denche-Zamorano et al., 2023).

The results related to the Publications regarding the Organizations show how the *Universidade de São Paulo* is one of the most active in carrying out research related to the analysis of performance in Taekwondo ($n = 46$). The *Universidad de Santiago de Chile* ($n = 21$), and the *Centre National de la Medecine Sciences des Sports de Cité Khadra* ($n = 16$), stand out in the production of scientific documents. There is a diversity of Institutions and countries dedicated to research into Taekwondo sports performance. Researchers need to establish new contacts to design and develop quality research.

Concerning the network between authors, the most relevant researchers based on the number of published documents are Franchini, E. (H-Index=50), Falco, C. (H-Index=14), and Herrera-Valenzuela, T. (H-Index=11). The Top-3 articles on Taekwondo sports performance finding, in accordance with (Millet et al., 2021), are Kazemi et al. (2006), Matsushigue et al. (2009), and Falco et al. (2009). The authors Franchini, E., ($n = 42$), and Falco, C., ($n = 20$), should be highlighted. However, the authors Franchini, E., and Chaouai, A., present an H-Index much higher than all research with a value of 50 and 49 respectively, and have fewer published papers. It is assumed that it is due to the quality of the papers. Therefore, it is essential to establish relationships with authors from other institutions to improve research (Gamonal et al., 2023; Hernández-Beltrán, Espada, Muñoz-Jiménez et al., 2023).

These networks of different authors may be interesting for the rest of the researchers to establish future lines of research related to Taekwondo sports performance. Therefore, bibliometric studies offer unique opportunities to contribute to theory and practice (Mukherjee et al., 2022), as well as meet the main authors on a specific topic. Bibliometric review studies are essential to know the main research lines and the cooperation between different factors (authors, countries, organizations, and keywords). Similarly, this document provides a general and exclusive description of Taekwondo sports performance.

Regarding the results related to the Keywords used by the authors, it is shown that the authors most frequently use the following terms: “*Taekwondo*” ($n = 110$), “*Martial arts*” ($n = 94$), “*Combat sport*” ($n = 58$), “*Performance*” ($n = 33$), and “*Athletes*” ($n = 18$). However, depending on the temporal issue, a clear trend is observed in the use of terms focused on the analysis of factors that influence the athlete’s performance such as “*Stress*”, “*Fatigue*”, or “*Reaction time*”. Keywords results show that related subject to Taekwondo sports performance is directed. “*Stress*” and “*Fatigue*” is a psychobiological state that impairs sports performance in healthy athletes (Habay et al., 2021). The bubble map results reflect that the combat sports information system is an emerging theme on the topic of this paper related to the temporal keywords co-occurrence analysis. And the most recent topics in the WOS database are the cluster “*Sports*” and “*Elite athletes*”. This bibliometric review may provide the future readers with a state-of-the-art understanding of the topics, help identify gaps and recognize signal future research (Paul & Criado, 2020).

Coaches must work on the psychological aspects of athletes to improve their sports performance. Finally, the results of this bibliometric review allow us to analyze the documents in the WOS-indexed papers database in a general way on research on Taekwondo sports performance. In future papers, these findings results can be used to analyze the temporal dimension and evolution of the academic environment. The development of bibliometric studies makes it possible to know the relationships produced between different factors or items specific to scientific work. Therefore, after learning this information, as future lines of study, it is recommended to analyse the different factors that affect the performance of sportsmen and women. As well as identifying new thematic lines that have been little studied or analysed, such as the influence of stress, fatigue or reaction time. In the same way, analyzing different psychological and emotional factors, as well as their influence on performance, is of vital importance, as it allows the identification of the most influential psychological aspects, and how athletes manage the pressure before, during and after competitions.

Limitations

This study has some limitations and must be acknowledged, firstly, the Taekwondo sports performance scope of this bibliometric review is limited to the objective of this paper. In the worldwide bibliometric review, researchers

tend not to focus on a particular subject of Taekwondo but to provide a Taekwondo as a global trend of sport. This work focused on the Taekwondo sport performance to provide specific knowledge by interesting authors. Secondly, the bibliometric review method can’t replace other review methods like the systematic review and/or meta-analysis approach. Thirdly, this review was conducted only on the articles indexed in the WOS database. This might be a significant limitation because there are several articles published on the KCI – Korean Citation Index, KISS – Korean-Studies Information Service System, and RISS – Research Information Sharing Service, and most of the papers are written in the native language of Korea. A systematic review and meta-analysis of randomized controlled trials shows that in twelve included studies only two (16%) were writing in English (other language than Korean) (Jeong et al., 2023).

Conclusions

To the best of our knowledge, this bibliometric analysis of Taekwondo related to sport and performance is the first paper contribution to understanding the main goal of this study. Using science mapping, exploring, and analyzing by VOSviewer tool the literature provides novel insights and crucial information into the Taekwondo sports performance theme.

The results, of this bibliometric review, show the existence of 460 WOS-indexed papers published between 1992 and 2022. The mainly papers found in the WOS categories are: “*Sports Science*” ($n = 229$), “*Hospitality Leisure Sport Tourism*” ($n = 48$), and “*Physiology*” ($n = 32$). The most notable documents related to Taekwondo sports performance, from the authors are: Kazemi et al. (2006), Matsushigue et al. (2009), and Paillard (2017). The authors Franchini, E., ($n = 42$), and Falco, C., ($n = 20$) should be highlighted. The countries with the highest number of publications made in line with the main study are Brazil ($n = 83$), South Korea ($n = 57$), and Spain ($n = 52$). There are five collaboration networks between different authors and academia dimensions, with an absence of the most relevant researchers in this bibliometric study. It is recommended to carry out multidisciplinary research on the Taekwondo Olympic discipline to establish collaborations between groups, institutions, and countries. In this way, the productivity, effectiveness, and quality of research will increase, as well as collaboration networks will be international relationships. The bibliometric review is a relevant and reliable source of knowledge since it allows to know the main advances in research related to Taekwondo sports performance and to know the relationships between the authors and main institutions.

Author Contributions

Conceptualization, J.L.S., V.H.B., and J.M.G.; methodology, J.L.S., V.H.B. and J.M.G.; formal analysis, J.L.S., H.L., V.H.B. and J.M.G.; investigation, J.L.S., H.L., V.H.B. and J.M.G.; data collection, J.L.S., V.H.B. and

J.M.G.; writing: original draft preparation, J.L.S., V.H.B. and J.M.G. Writing: review and editing, H.L. and J.M.G.; funding acquisition, J.M.G. All authors have read and agreed to the published version of the papers.

Funding

This research was partially funded by the GOERD of the University of Extremadura and the Research Vice-rectory of the Universidad Nacional. This study has been partially supported by the funding for research groups (GR21149) granted by the Government of Extremadura (Employment and Infrastructure Office - Consejería de Empleo e Infraestructuras), with the contribution of the European Union through the European Regional Development Fund (ERDF) by the Optimisation of Training and Sports Performance Research Group (GOERD) of the Faculty of Sports Sciences of the University of Extremadura. Also, the author José M. Gamonales was supported by a grant from the Requalification Program of the Spanish University System, Field of Knowledge: Biomedical (MS-18).

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Acknowledgements

This study has been developed within the Optimization of Training and Sports Performance Group Research (GOERD) of the Faculty of Sports Sciences of the University of Extremadura. All authors have contributed to the papers, and we certify that it has not been published and is not under consideration for publication in another journal.

Conflicts of Interest

The authors declare no conflict of interest.

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