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Research trends in swimming and diving: A five-year bibliometric analysis (2019-2023)

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ABSTRACT

Background Problems: The field of sports research has experienced varying degrees of development, with certain areas, such as swimming and diving, showing slower progress in publication trends over recent years. **Research Objectives**: This study aims to provide a comprehensive overview of research trends in swimming and diving over the past five years (2019-2023) using bibliometric analysis. **Methods**: This study examined 389 Scopus-indexed swimming and diving papers published between 2019 and 2023. Researchers conducted co-word analysis and text mining using VOSviewer to identify key research trends. **Finding/Results**: The analysis reveals a consistent increase in research trends in swimming and diving, with the United States leading the way in terms of publication output and Indonesia ranking 13th. Influential authors such as Lippmann, John M., Schipke, Jochen D., and Koch, Andreas Edmund, made significant contributions to the field. The majority of publications focus on the sport of swimming, highlighting the research gap in the sport of diving. **Conclusion**: This bibliometric analysis provides valuable insights in the development of research in the field of swimming and diving, emphasising the need for further research to optimise training methods and improve athlete performance in these sports.

Keywords: Bibliometric analysis; swimming; diving

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INTRODUCTION

The increasing number of sports-related publications poses specific challenges, particularly in ensuring a balanced development across various sports disciplines. While sports such as football, basketball, and tennis dominate the research landscape (Rincón et al., 2023). Other sports like swimming and diving receive comparatively less attention, indicating a gap in research and knowledge development in these areas. Swimming is widely recognised as a lifelong physical activity that is accessible to various age groups, from children to adults (Apriyanty et al., 2021; Arhesa & Badriah, 2021; Özkadi et al., 2022; Sin & Hudayani, 2020). Even infants can be introduced to swimming, demonstrating its broad appeal and adaptability (Sofyan et al., 2022). On the other hand, diving, though increasingly popular as a sport, presents more physical

challenges and risks; such as the impact of increased underwater pressure on the body (Fachrianto, 2016). Diving is an underwater activity that is now widely enjoyed as a sport. Diving is not without risk, as divers descend deeper into the seabed, the lungs will be exposed to increased O_2 pressure. The more often a person dives, the greater the risk of pulmonary abnormalities that may occur (Dwipayana et al., 2017). This sport is played in swimming pools and open water (such as the sea or lakes) (Erzhuo, 2022).

Swimming and diving present significant opportunities for research collaboration between scholars and coaches, aimed at enhancing athlete development and optimising training methodologies. Coaches are crucial in this process, as they design and implement training strategies that align with the latest developments in sports science, thereby directly influencing athletes' performance and interest. Despite the potential benefits, coaches often face challenges in integrating new technologies into training environments, largely due to limited access and understanding of technological advancements (Susilawati et al., 2023). Developing strategies to enhance coaches' technological competencies is essential for advancing both education and sports training.

In this review, the researchers present a comprehensive bibliometric analysis that builds on previous studies and our investigation of existing bibliometric analyses. As an example, Chen (2023) looked at research hotspots and trends in synchronised swimming in the 21st century. Özkadi et al. (2022) did a bibliometric analysis of swimming publications in sports science from a medical point of view. Rincón et al. (2023) did a study on artistic swimming. Huang et al. (2024) did an in-depth analysis and visualisation of freestyle swimming biomechanics research from 1984 to 2023. Erzhuo (2022) looked at trends in competitive swimming from 1998 to 2022. Despite these efforts, there is a notable gap in the literature: the absence of bibliometric analyses focused on diving. A review of previous bibliometric studies highlights a limited focus on swimming and a complete lack of analysis on diving. To address this gap, our study will examine the research trends in both swimming and diving. This approach will not only broaden our understanding of developments in swimming research, but it will also fill a critical void by providing the first comprehensive analysis of diving research.

This paper gives a far-reaching outline of the present status and patterns of exploration in swimming and diving. We report a bibliometric examination of swimming and diving distributions distributed somewhere in the range of 2019 and 2023. The purpose of this study is to assess the current state of research on swimming and diving using bibliometric analysis. The research questions to be answered include: **RQ1**. What is the current state of research on swimming and diving from day to day? **RQ2**. In which country are there the most studies on swimming and diving? **RQ3**. Which author has made the most contributions about swimming and diving? **RQ4**. What is the subject or topic area that appears in the swimming and diving research? Through answering these questions and achieving the research goal, it is anticipated that this study will provide valuable insights into current conditions and research directions related to swimming and diving.

METHOD

The study of publication trends in swimming and diving used bibiometric methodology. Bibliometric studies highlight the emerging science and technology in a particular field while helping researchers to make priority and meaningful decisions for future research (Donthu et al., 2021; Mejia et al., 2021) by finding opportunities and updates to contribute more (Blegur et al., 2023; Marmoah et al., 2022), such as examining publication patterns such as subject area, author, citation, title, and other factors. Bibliometric analysis aims to facilitate a comprehensive understanding of the research area, map its boundaries, identify influential authors, and provide new directions for future research (Donthu et al., 2020; Endriani et al., 2024; Xue et al., 2018). In In this study, sample articles taken in *CSV format from Scopus were processed using VOS viewer software to help visualise and identify trends (Susilawati et al., 2022), such as country and topic area visualization. The VOS viewer can likewise be utilized to assess all types of bibliometric network information, remembering connections between distributions or diaries for terms of references, joint effort among researchers, and connections regarding co-events between logical papers (Strozzi et al., 2017). The use of the VOS viewer for bibliometric studies is carried out using various approaches and analyses including bibliographic coupling and co-citation analysis. This combined analysis is used to measure the similarity of

sources cited by two documents, while cocitation is used to measure the similarity of citations. These two analyses can complement each other (Novia et al., 2022).

Search Strategies

The documents were retrieved from established research sources in the Scopus database. The keywords used in Boolean expression form (AND, OR) were ("swimming" OR "aquatics") AND ("diving" OR "underwater sport"). The search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Swartz, 2011).

Eligibility Criteria

Eligibility criteria for studies included in this study included studies exploring the concept of swimming and diving. The data considered for this study were collected on February 12, 2024, and the analysis was conducted for the period covering 2019 to 2023. This time frame ensures a comprehensive picture of the evolution and trends in the field of swimming and diving research over the past decade.

Database Abstraction

During the publication identification and screening stage, a total of 1879 documents were extracted from the Scopus database. Then, the researcher reviewed the publications based on title, abstract, and keyword, still a total of 1879 documents. Next, the year of publication of the documents was filtered, limited from 2019 to 2023, so that 1490 documents were removed. After being removed, the final data used for this study amounted to 389 documents. A field of study must have more than 300 documents to qualify for bibliometric analysis (Donthu et al., 2021). Because it has met the requirements, it is analysed using a bibliometric approach, as can be seen in **Figure 1**.

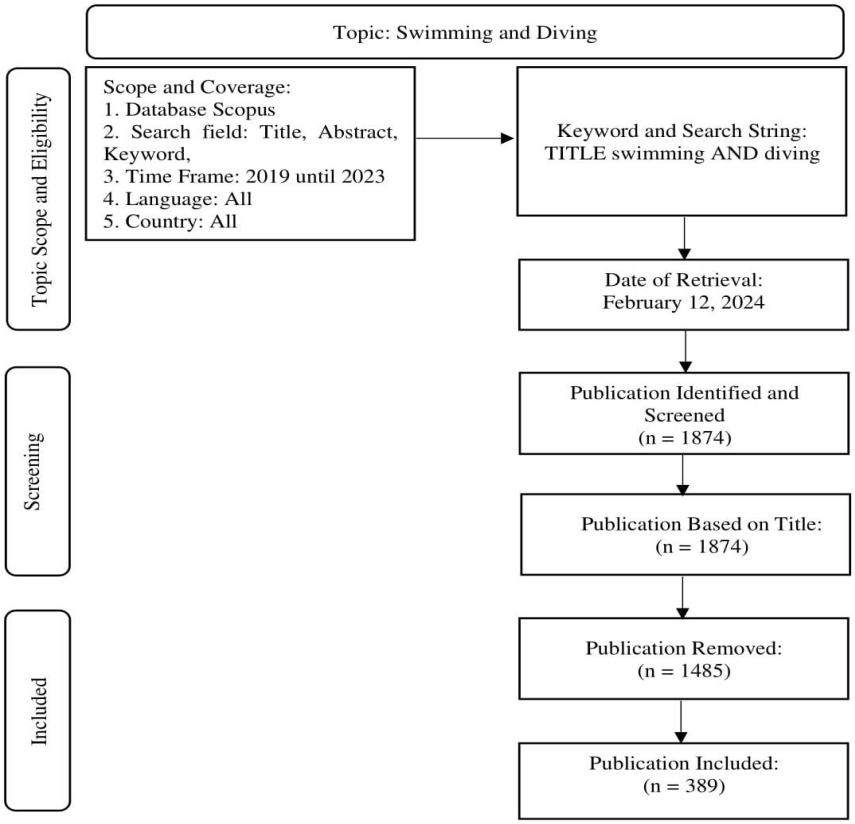

Figure 1. Search Design Method of Publication Documents from Scopus Database

RESULTS AND DISCUSSION

The smallest number of terms used in the research studied, according to Scopus. After analysis, there are 4 categories, namely based on year, country, author, and field of study.

RQ1. What is the current state of research on swimming and diving from day to day?

The first stage in this study was to organise documents based on the year of publication. The results of the research trend analysis show significant developments in research on swimming and diving over time. From 2019 to 2023, there was a consistent increase in the number of documents discussing this topic. At the beginning of the period, namely 2019, the number of articles published was 65 papers. However, over time, there was a significant decrease, especially in 2020, when the number of papers was only 56. Furthermore, although there was a decrease in 2020, there was an increase in 2021, namely 90 papers. Then there was another decrease in 2022, namely 75 papers. Furthermore, in 2023, there was an increase from the previous year in the number of articles published, reaching 103 papers. Thus, the research trend on swimming and diving shows consistent and increasing growth over time, indicating the interest of researchers to continue exploring this topic and the awareness of the importance of this sport in athlete development and training strategies. It is likely that the number of studies on swimming and diving will continue to increase because swimming and diving are sports that are very popular with many people. Several research results have been carried out as an effort to apply and understand swimming and diving in the field of sports. Can be seen in **Figure 2** below.

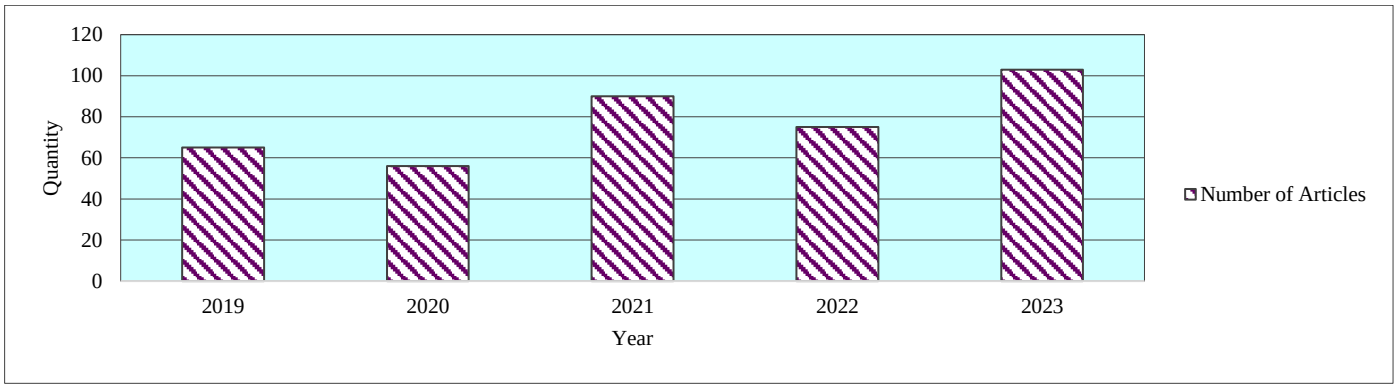

Figure 2. Research Trends on Swimming and Diving in 2019-2023

RQ2. In which country are there the most studies on swimming and diving?

If calculated by country for the keyword "swimming AND diving," there are 10 largest countries that have publications about swimming and diving. These countries are the United States with 134 papers, Australia with 39 papers, Germany with 35 papers, England with 35 papers, China with 34 papers, Canada with 23 papers, Spain with 21 papers, France with 19 papers, Italy with 18 papers, and Japan with 17 papers. The United States is the country that publishes the most papers discussing swimming and diving. The second country is Australia, then Germany is the third. These opportunities related to research on swimming and diving are still very few. The US has the most papers discussing swimming and diving, and they have networked with other countries. **Figure 3** presents the top ten countries in terms of swimming and diving research.

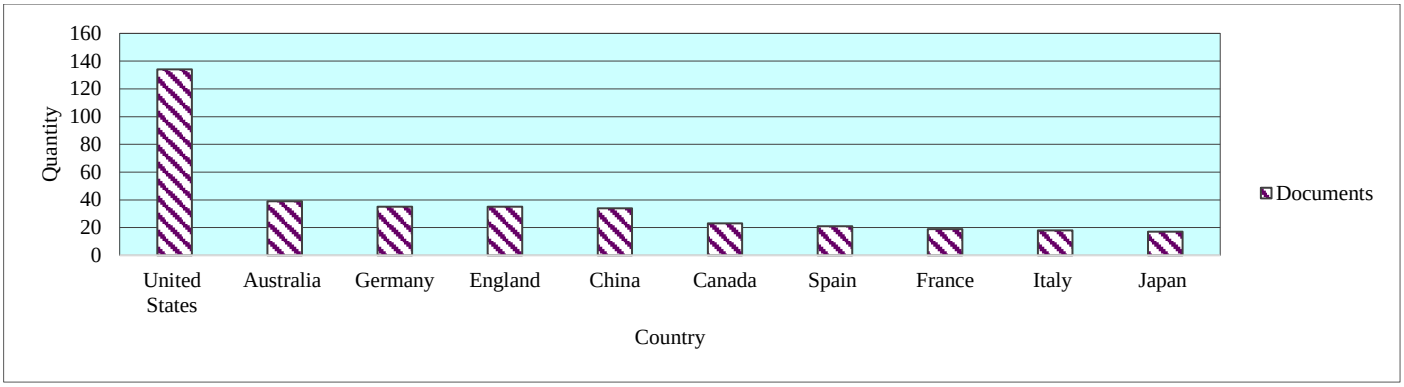

Figure 3. Top Ten Countries on Swimming and Diving Research

RQ3. Which author has made the most contributions about swimming and diving?

Based on the analysis of the search results of the top 10 authors on the topic of swimming and diving from 2019 to 2023, there are 40 documents that have been cited 275 times. The most influential author is Lippmann, John M., with a total of 5 documents related to this topic, which have been cited 23 times. Then by Schipke, Jochen D., with 5 documents that have been cited 6 times, and Koch, Andreas Edmund., with 5 documents that have been cited 3 times. Followed by Davis, Randal William., with 4 documents that have been cited 43 times, then Bosco, Gerardo M., with 4 documents that have been cited 34 times, then Hoffmann, Uwe., with 4 documents that have been cited 15 times, and Möller, Fabian N., with 4 documents that have been cited 15 times too. Furthermore, some other authors who also have significant contributions to the literature on swimming and diving are Boltz, Adrian J., with 3 documents that have been cited 60 times; Chandran, Avinash., with 3 documents that have been cited 60 times; and Afonso, Pedro., with 3 documents that have been cited 16 times. This shows that these authors have a great impact on the development and dissemination of knowledge about swimming and diving and strengthen their role as opinion leaders in this field. These results can be seen in **Figure 4**.

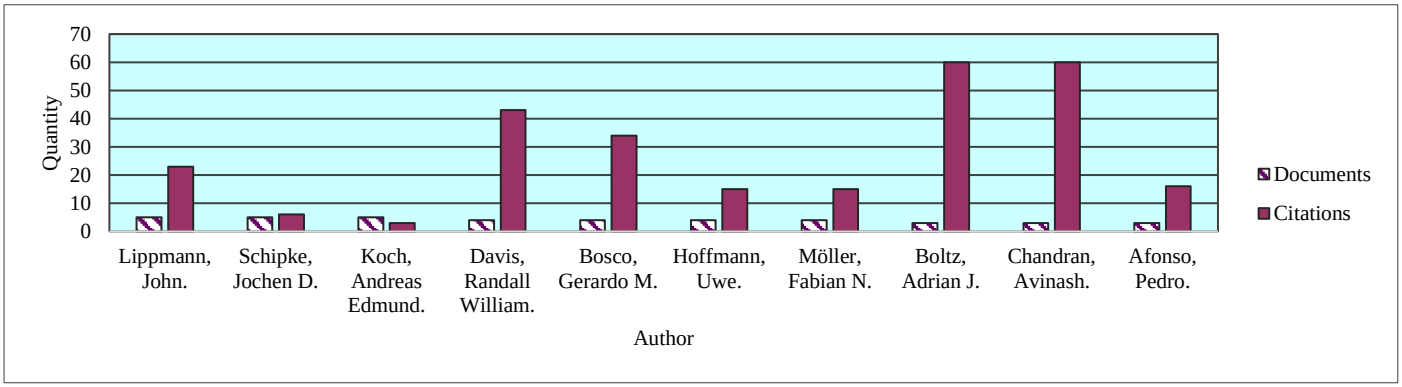

Figure 4. Top 10 Authors with Publications and Citations on Swimming and Diving

RQ4. What is the subject or topic area that appears in the swimming and diving research?

This section presents the results of an analysis of keywords in publications, which helps explain the main research themes and research trends on swimming and diving. Keywords are considered "descriptors of content at a macroscopic level, and topics in a field can be described by keywords from relevant publications (Susilawati et al., 2023). **Figures 5** and **6** and **7** show 224 items connected to swimming and diving. Which are divided into 4 clusters; the first cluster has 80 items, the second has 77 items, then the third has 66 items, and the fourth has 1 item. The VOS viewer can display bibliometric mappings in different visualizations. The results of data analysis are then tabulated and presented in tables, diagrams, and curves. The results are based on swimming and diving keywords; 224 terms were obtained in total (see Figure 5). However, if you want to show the most common themes regarding swimming and diving, this is shown in **Figure 6**. The research topics that are most closely related are several terms, namely swimming, diving, human, animal, man, female, and

adult. As shown in **Figure 7**, the ten largest fields of study are medicine (21.8%), agricultural and biological sciences (15%), biochemistry, genetics, and molecular biology (8.5%), environmental sciences (7.6%), engineering (7), health professions (6.7%), earth and planetary sciences (5%), computer science (4%), social sciences (3.4%), and multidisciplinary (3.3%). Swimming and diving are the most interesting topics, which have relevant characteristics to be developed in the world of education and sports, especially being introduced and given to students and athletes. In this way, they can plan and implement swimming and diving lessons and training.

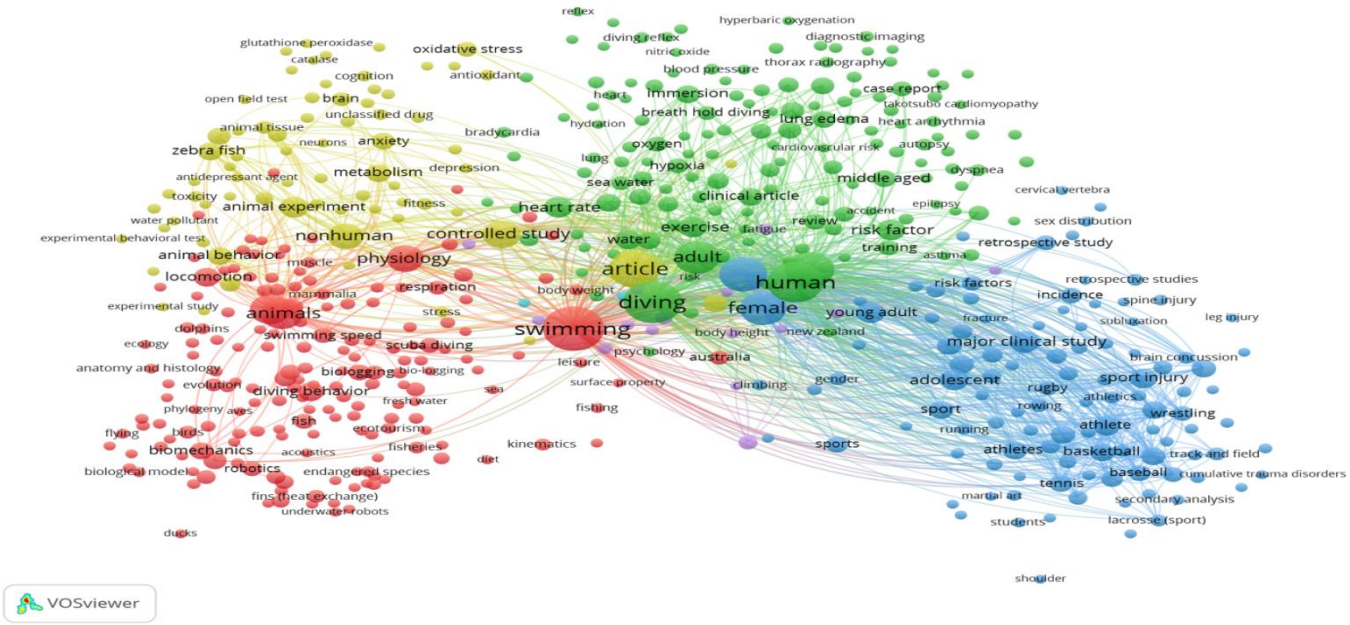

Figure 5. Topic Area Visualization Using VOS Viewer Using Network Visualization

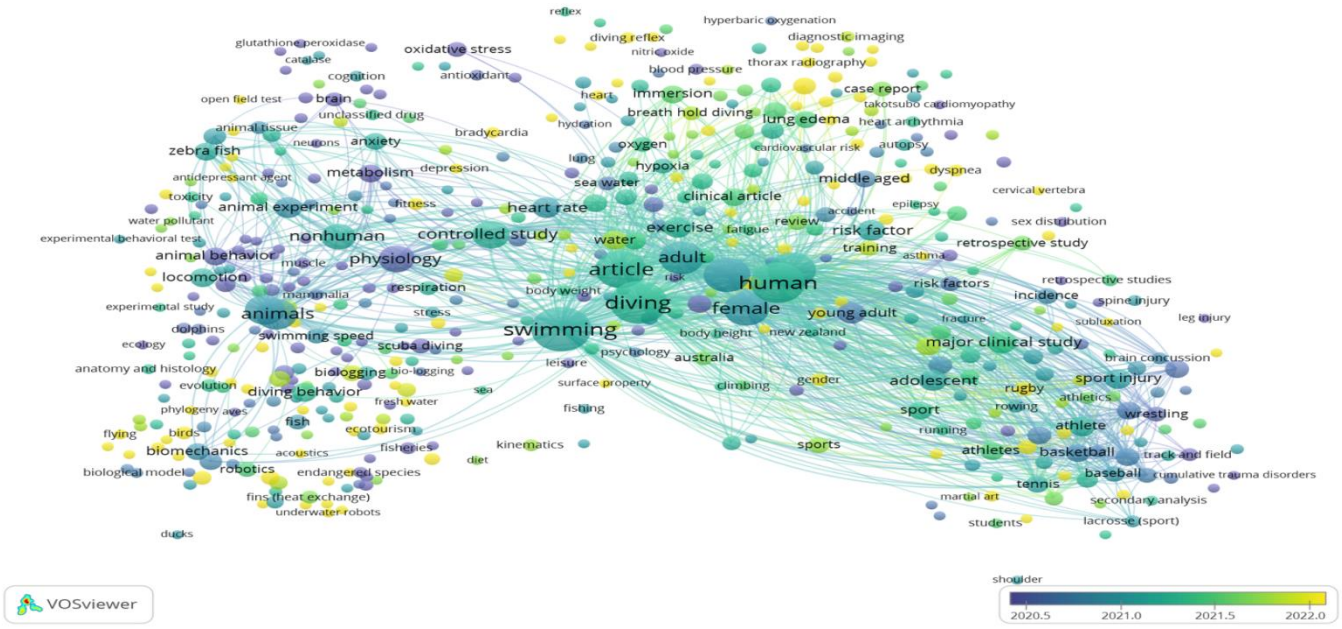

Figure 6. Visualization of Topic Areas Using VOS ViewerUsing Overlay Visualization

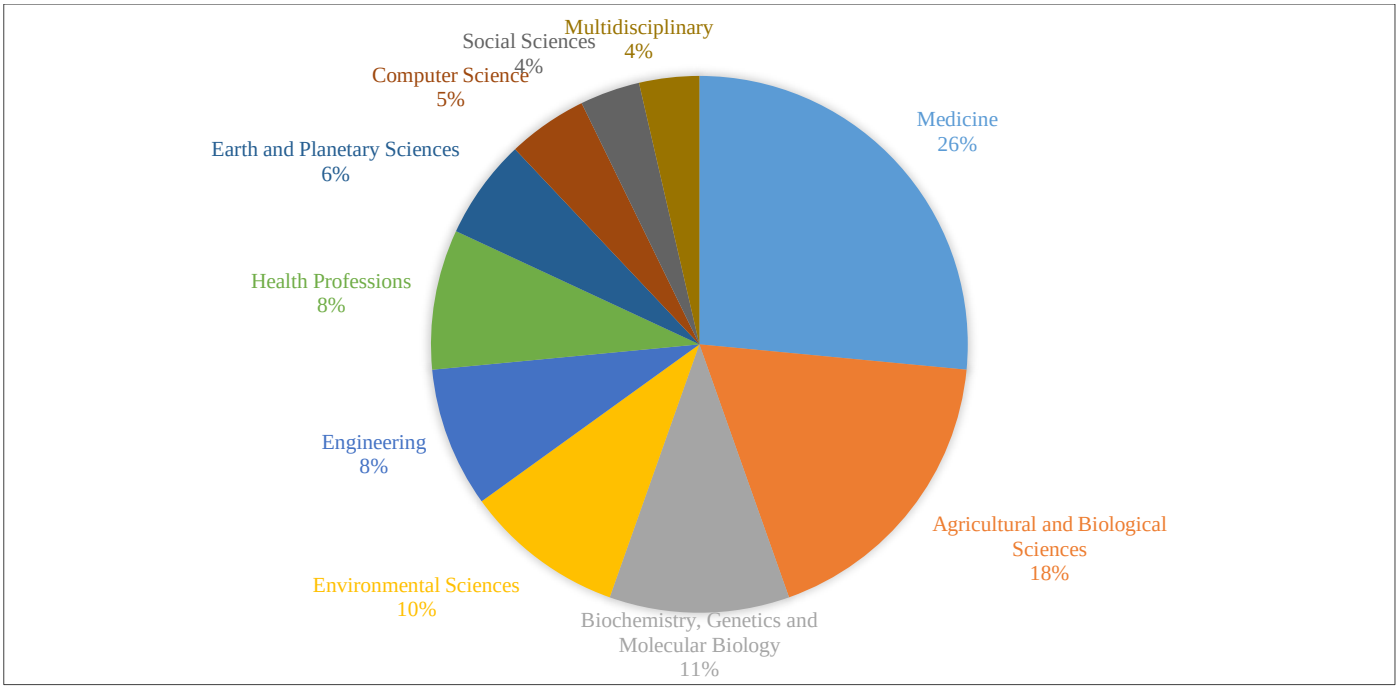

Figure 7. Subject Areas of Scopus Analysis

This study analyses academic research published in Scopus on swimming and diving from 2019-2023. Based on the results of this bibliometric analysis, the discussion based on the research questions is explained. The publication trend on the topic of swimming and diving has an upward and downward trend. A significant increase occurred in 2023 with 103 articles, while a drastic decrease occurred in 2020 with 56 articles. This decrease may be due to the impact of the COVID-19 pandemic, and many researchers in various countries have difficulty conducting research (Perdima et al., 2022), including swimming and diving. Then in 2022 there was also a decline from the previous year with 75 articles; it is likely that there will be many more publications for the following months because swimming is a sport that is in great demand by all groups, as explained by Esih and Pramono (2021). Meanwhile, there are not many people interested in diving because the level of danger is very high, usually causing ear and nose problem (Koesdianasari, 2019).

The country with the most articles published about swimming and diving is the United States with a total of 134 articles, and the second place is Australia with only 39 articles, much different from the United States. While the researcher's country, Indonesia, is ranked 13th with 12 published papers on swimming and diving, relevant topics include an article entitled "Swimming exercise model policy using straps as aid for beginners" (Umanailo et al., 2021), which discusses the changes that occur in the implementation of the swimming method using ropes as an aid, namely that students who initially could not swim were finally able to swim. In addition, testing the characteristics of male athletes' performance in 35 different sports branches, including swimming and diving (Nuryadin et al., 2023). Looking at the results of publications from Indonesia, they are still very few compared to the United States because in terms of facilities and human resources, swimming and diving are better, and even sports there are made into a sports industry (Priyono, 2012).

The names of the authors who made the most contributions are Lippmann, John M., Schipke, Jochen D., and Koch, Andreas Edmund, with 5 published articles. While the most cited is Lippmann, John M., with 23 times, of the 5 most cited articles in 2020, 10 times with the title "Scuba diving fatalities in Australia 2001 to 2013: Chain of Events" (Lippmann & Taylor, 2020). Lippman, John M., is one of the Chief Executive Officers of the Australasian Diving Safety Foundation, so his published articles are mostly related to diving. Meanwhile, the most citations were 60 citations by Boltz, Adrian J., and Chandran, Avinash., with 3 published articles each, the most in 2022 with 41 citations with the article title, namely "Epidemiology of Concussions in National Collegiate Athletic Association (NCAA) Sports: 2014/15-2018/19" (Chandran et al., 2022). So, even though there are many published articles, it is not necessarily that there are many citations.

Furthermore, the results are based on swimming and diving keywords; 224 terms were obtained in total. The research topics that are most closely related are several terms, namely swimming, diving, human, animal, man, female, and adult. From the emergence of these keywords, the topic of swimming and diving is an interesting thing to discuss because swimming is one of the sports that is of interest to many people, from children to the elderly (Nur'aeni et al., 2023). Meanwhile, diving is still underdeveloped, and many are interested because the risk is higher than swimming. In addition, the most subject areas are about medicine (21.8%), then agricultural and biological sciences (15%), biochemistry, genetics, and molecular biology (8.5%), environmental sciences (7.6%), engineering (7%), health professions (6.7%), earth and planetary sciences (5%), computer science (4%), social sciences (3.4%), and multidisciplinary (3.3%). The fields of study related to swimming and diving are more about health or medicine because of the publications that are widely discussed in terms of the risks of the sport, such as lung disorders (Sukbar et al., 2016), hearing disorders (Koesdianasari, 2019), and the risk of accidents (Dwiyanti et al., 2020).

CONCLUSION

From the analysis of research trends, countries involved, influential authors, general publication types, and topic areas in the context of swimming and diving, it can be concluded that the trend of swimming and diving research from 2019 to 2023 has experienced an increase that fluctuates, with the most publications in 2021 with 90 documents and in 2023 with 103 documents. This is due to global events that have an impact, such as the COVID-19 pandemic that occurred in 2019 to 2020. The most influential authors and those with the largest number of publications are Lippmann, John M., Schipke, Jochen D., and Koch, Andreas Edmund. Based on the results of swimming and diving research obtained, it is still very low because it can be seen from inadequate resources and facilities, and only a few countries have studied it, the most being the United States. In addition, the relationship between swimming, diving, and other research subjects is still very shallow, which indicates the need for further research to explore the relationship between this sport and other fields of study such as health, biology, and technology. Thus, based on the results of this bibliometric analysis, it provides a very large contribution to the development of swimming and diving and emphasises the importance of further research to continue optimising the potential of this training method in supporting athlete development and training strategies with better resources and adequate facilities.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest in writing this article.

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