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## **Bibliometric Analysis of the Impact of COVID-19 on Athlete Performance: Publication Trends and Implications for Future Research**

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**Abstract:** The COVID-19 pandemic has significantly affected various sectors, including the realm of sports. The importance of researching the impact of COVID-19 on athlete performance lies in the urgency to prevent similar repercussions in the future. Therefore, this study aims to explore publication trends related to the influence of COVID-19 on athlete performance from 2020 to 2023, using bibliometric analysis methods. In this analysis, VOSviewer software and the bibliometric analysis application biblioshiny were utilized to analyze bibliographic data. From the Scopus database, a total of 977 documents were analyzed after undergoing the screening process. The results indicate fluctuations in publication trends, with the International Journal of Environmental Research and Public Health being the highest contributor with 87 documents. The United States ranks first in the number of documents, with a primary focus on athlete performance, totaling 907. Semmelweis University emerged as the most productive affiliation with 25 documents. Research findings highlight contributions from 19 Indonesian researchers, with the highest number of authors originating from the United States with 14 documents. The most globally cited document, published in the British Journal of Sports Medicine, has reached 387 citations. Visualization of research trends reveals popular topics aligning with the research, including "human," "Covid-19," "male," "female," "athlete," "adult," and "pandemic." The implications of these findings provide significant benefits to researchers by offering guidance for future analysis and serving as considerations in determining research themes. Furthermore, this supports global efforts to enhance understanding of the pandemic's impact on athlete performance and design more effective strategies to protect their health and well-being in the future.

**Keyword:** Bibliometric analysis, Covid-19, Athlete performance

### **Introduction**

The COVID-19 outbreak has changed the way people engage in physical activity, making it difficult for many to meet recommended levels due to major changes in their lifestyles. (Ha & Dauenhauer, 2020). The importance of physical activity in preventing and treating COVID-19, as well as improving psychological well-being, has been clearly proven (Yang et al., 2022). Especially in the middle of the quarantine phase, the interrelationship

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between physical activity and mental health becomes more pronounced (Khosravi, 2020). Therefore, it is important to find methods to maintain physical activity levels during the pandemic for the general well-being.

Throughout this pandemic, athletes have faced many obstacles in maintaining their performance. Home workouts during lockdown have resulted in irregular changes in physical performance and decreased motivation, especially among elite athletes. (Paludo et al., 2022). The performance of the top 10 athletes has changed due to a significant decrease in their performance levels. (Schipman J., 2022). The financial side of the sports industry has also suffered, adding to the difficulties experienced by athletes (Wiltshire et al., 2022). However, retraining has shown effectiveness in mitigating the adverse impact of the pandemic on the performance load and performance of elite athletes, with performance returning to normal levels within a period of time (Valenzuela et al., 2021).

The psychological impact of COVID-19 on athletes deserves attention. Research shows that athletes who contract the virus tend to face increased levels of depression, anxiety, and stress, especially those who are losing income and belong to certain age groups. (Sanborn et al., 2021: Factors such as age, having children, and smoking are also associated with a higher risk of virus transmission among athletes (Lopes et al., 2021). Therefore, elite athletes are advised to undergo regular RT-PCR tests to monitor and curb the spread of the virus. (Rankin et al., 2021).

Studies on the impact of COVID-19 on athlete performance show significant variations. Some studies find that athletes experience various symptoms, with women and those experiencing severe symptoms tending to experience exercise disturbances (Kim et al., 2023). There are also reports of inconsistent effects from home training during lockdowns, with significant decreases in motivation and perceived effort (Paludo et al., 2022). However, there are also interesting findings that the vertical jump performance of volleyball players can improve even when they are infected with COVID-19, highlighting the complexity of the pandemic's impact on athlete performance (Orscelik et al., 2022).

The primary aim of this study is to conduct a thorough examination of how the COVID-19 pandemic has affected athlete performance, with a specific focus on various aspects such as publication trends, international collaboration, document sources, and research dissemination. By delving into these areas, we aim to gain a comprehensive understanding of the impact of COVID-19 on athletes and the broader research landscape surrounding this topic.

To achieve this overarching goal, we have formulated a series of research questions that will guide our investigation:

1. **Understanding Publication Productivity Trends:** Through the utilization of VOSviewer analysis, we seek to unravel the trends in publication productivity pertaining to the impact of COVID-19 on athlete performance. By employing this method, we aim to discern how research output in this area has evolved over time and identify any notable patterns or fluctuations.
2. **Analyzing Publication Trajectories:** By analyzing publication trajectories spanning the past decade, we aim to uncover patterns and fluctuations in the number of publications related to the impact of COVID-19 on athletes. This analysis will provide insights into the trajectory of research in this field and highlight any significant shifts in focus or intensity over time.
3. **Insights into International Collaboration and Knowledge Dissemination:** We aim to explore the dynamics of international collaboration and the dissemination of knowledge among the global research community in COVID-19 impact research. By examining collaboration patterns and knowledge-sharing networks, we seek to understand how researchers from different countries collaborate and disseminate their findings in this field.
4. **Examining Document Sources and Journal Contributions:** Our study will delve into the document sources and journal contributions in analyzing athlete performance amid the COVID-19 pandemic. Through this examination, we aim to identify the key sources of research and assess the contributions of different journals to the advancement of knowledge in this area.
5. **Dispersal of Research across Disciplines:** We will investigate the dispersal of research on the impact of COVID-19 on athletes across various disciplines. This analysis will provide insights into the interdisciplinary nature of research in this field and shed light on the diverse perspectives and methodologies employed by researchers.
6. **Identifying Leading Countries and Institutions:** Our study aims to identify the leading countries and institutions in analyzing the impact of COVID-19 on athletes and assess their contributions to the research.

By identifying the most prolific countries and institutions, we aim to understand the global distribution of research activity in this field.

7. **Key Authors and Their Contributions:** We will map the landscape of COVID-19 impact research on athletes by identifying key authors and assessing their contributions. This analysis will highlight the pivotal role played by individual researchers in shaping the direction and progress of research in this area.
8. **Network Visualization and Cluster Analysis:** Through network visualization and cluster analysis, we aim to gain a deeper understanding of research focuses and trends in the field of COVID-19 impact on athletes. By visualizing the connections between key terms and concepts, we seek to uncover underlying patterns and thematic clusters within the research literature.
9. **Overlay and Density Visualizations:** We will track the evolution of research focuses and trends using overlay and density visualizations. These visualizations will enable us to identify changes in research interests over time and track the emergence of new areas of focus within the field.
10. **Utilizing VOSviewer for Research Planning and Identifying Future Directions:** Finally, we will explore how VOSviewer can be utilized for research planning and identifying future directions in the study of COVID-19 impact on athletes. By leveraging this tool, we aim to identify gaps in the existing literature and pinpoint areas that warrant further investigation.

Through a comprehensive exploration of these research questions, we seek to contribute to a deeper understanding of the impact of COVID-19 on athlete performance and provide valuable insights for future research directions in this rapidly evolving field.

## Method

### Data Source

A structured literature review is an important instrument for identifying gaps in knowledge as well as research needs. (García-Peñalvo, 2022). When conducting a bibliometric review, it is important to outline precisely the scope of the study and describe the methods used to monitor related sources. The current investigation extracted bibliometric information from the Scopus database, which is known for its wide coverage of scientific journal articles, including abstracts and citations. (Mongeon & Paul-Hus, 2016 ; Sweileh, 2020 ; Kussainova et al., 2024). Traditionally, Scopus and Web of Science are the two databases most commonly utilized for bibliometric analysis. (Singh et al., 2021).

Bibliometric analysis techniques are employed to condense bibliographic datasets. This approach reveals the structural, social, and author networks, along with the prevailing analytical focuses within particular research domains. (Alsolbi et al., 2022; Öztürk et al., 2024 ; Donthu et al., 2021; (Sweileh, 2020). Through examination of citation patterns, publication trends, and co-authoring networks, bibliometric analysis offers valuable insights into the research landscape and knowledge dissemination. (Oliveira et al., 2019). This helps in finding lead authors, important papers, and new research directions, as well as areas of literature that require further study. (Alsolbi et al., 2022) In addition, bibliometric analysis can evaluate the influence and prominence of research by analyzing the number of citations and publication metrics. This helps in assessing authors, institutions, and funding bodies. (Alsolbi et al., 2022) . Figure 1 illustrates the implementation of these five steps, emphasizing bibliometric methods

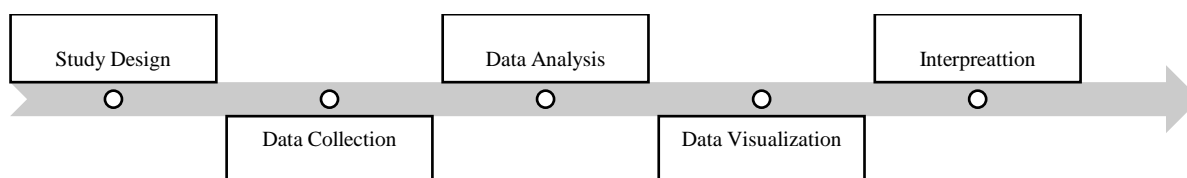


Figure 1. Bibliometric methodology

### Study Design

The study was structured by creating research inquiries and choosing relevant keywords and databases. It focused on six key aspects: yearly publication patterns, document origins, subject fields, and countries; institutional affiliations; leading authors; contributions from Indonesian specialists; extensively referenced articles; and potential future research directions.

### Data Collection

The search approach employed the title keywords "COVID 19" AND "ATHLETE" within the timeframe of 2020-2023 to gather data from the Scopus database. This yielded 977 documents meeting the criteria, all in their final publication stage and written in English. Additionally, the documents were downloaded in both Comma-Separated Values (CSV) and Research Information System (RIS) formats to capture article titles, author names, references, and keywords.

### Data Analysis

The data analysis commenced by importing CSV and RIS data retrieved from the Scopus database into Microsoft Excel and VOSviewer. This step was pivotal for facilitating subsequent data manipulation. The analysis aimed to uncover trends and patterns, such as publication characteristics, document origins, country affiliations, institutional distributions, subject category breakdowns, and prominent authors and citations. This data was meticulously dissected and comprehensively examined to gain deeper insights into the prevailing research landscape, specifically concentrating on the timeframe spanning from 2020 to 2023.

### Data Visualization

Following data processing and analysis, the subsequent stage involved data visualization. Visualization was carried out utilizing VOSviewer and Microsoft Excel. With VOSviewer, the processed RIS metadata was transformed into network visualizations, overlays, and densities. Meanwhile, Microsoft Excel was utilized to present the data in tables and diagrams, aiming to offer a more straightforward and comprehensible overview of the identified research patterns.

### Interpretation

Ultimately, the data visualized through VOSviewer underwent additional analysis and interpretation. This process entailed examining the quantity of formed clusters, charting both past and recent studies, and scrutinizing densities to unveil insights regarding saturation levels and potential future research avenues. Diligent interpretation of these visualization outcomes was essential for extracting profound insights into the patterns and trajectories of research within the field.

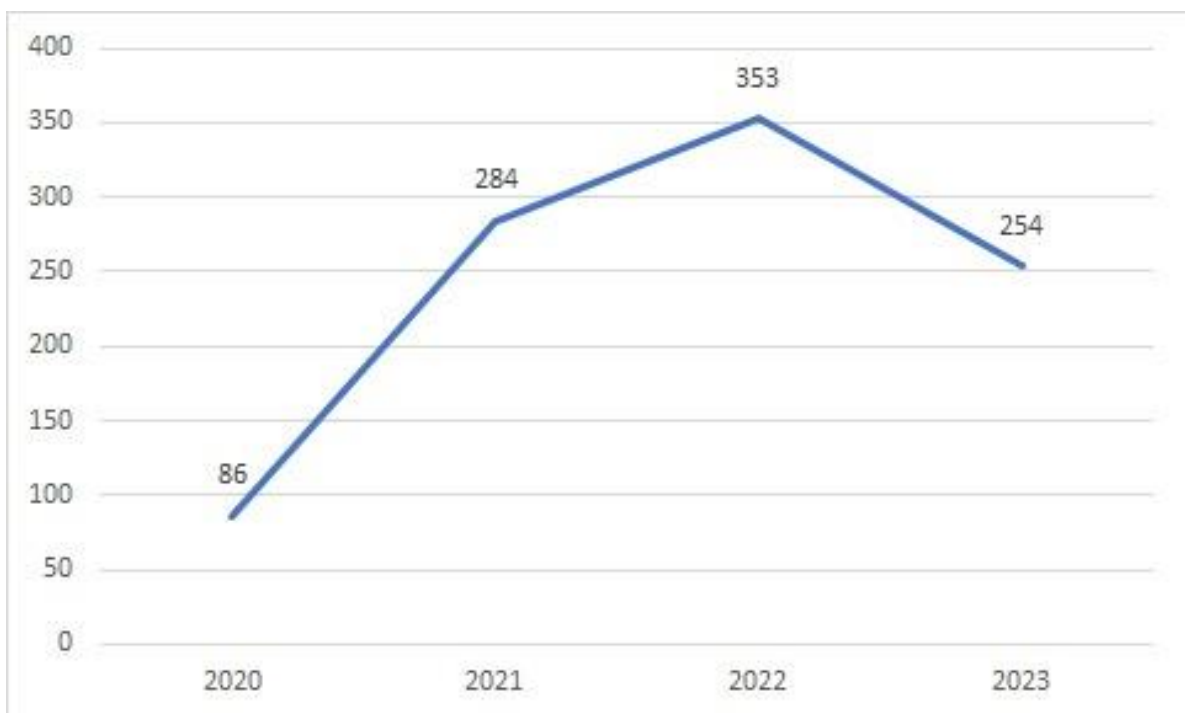


Figure 2. Annual publication trends for the period 2020-2023

## Results

The pattern of publication output over a three-year period (2020-2023), as indicated by the Scopus database, reveals notable fluctuations. Specifically, the analytical trend concerning the impact of COVID-19 on athlete performance across different disciplines exhibited variations over this timeframe. This is evidenced by the rise in the number of publications in 2020, 2021, 2022, and 2023, with 86, 284, and 353 publications respectively, followed by a decrease in 2023 with 254 publications. Figure 2 depicts the annual publication trends.

### Main Source Document

The articles were sourced from academic journals, with a predominant focus on examining the influence of COVID-19 on athlete performance across diverse disciplines such as environmental science, engineering, energy, and social sciences. Table 1 showcases the ten most prolific journals in publishing articles concerning the impact of COVID-19 on athlete performance.

Table 1. Distribution of documents by related sources from 2020-2023

SOURCES	ARTICLES	SJR INDEX (SCIMAGOJR 2022)
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	87	0.83 (Q2)
FRONTIERS IN PSYCHOLOGY	50	0.89 (Q2)
FRONTIERS IN SPORTS AND ACTIVE LIVING	28	0.62 (Q1)
BRITISH JOURNAL OF SPORTS MEDICINE	23	4.76 (Q1)
JOURNAL OF SPORTS MEDICINE AND PHYSICAL FITNESS	18	0.5 (Q2)
PLOS ONE	16	0.89 (Q1)
ORTHOPAEDIC JOURNAL OF SPORTS MEDICINE	15	1.11 (Q1)
JOURNAL OF ATHLETIC TRAINING	13	1.43 (Q1)
SUSTAINABILITY (SWITZERLAND)	13	0.66 (Q1)
JOURNAL OF PHYSICAL EDUCATION AND SPORT	11	0.31 (Q3)

### Top Publications by Country

According to country categorization, 977 documents were distributed among different nations, with the majority originating from the USA, Italy, United Kingdom, Spain, and Brazil, with 907, 360, 257, 221, and 182 articles respectively. Figure 4 provides a visual representation of the top 5 countries contributing to publications on the impact of COVID-19 on athlete performance.

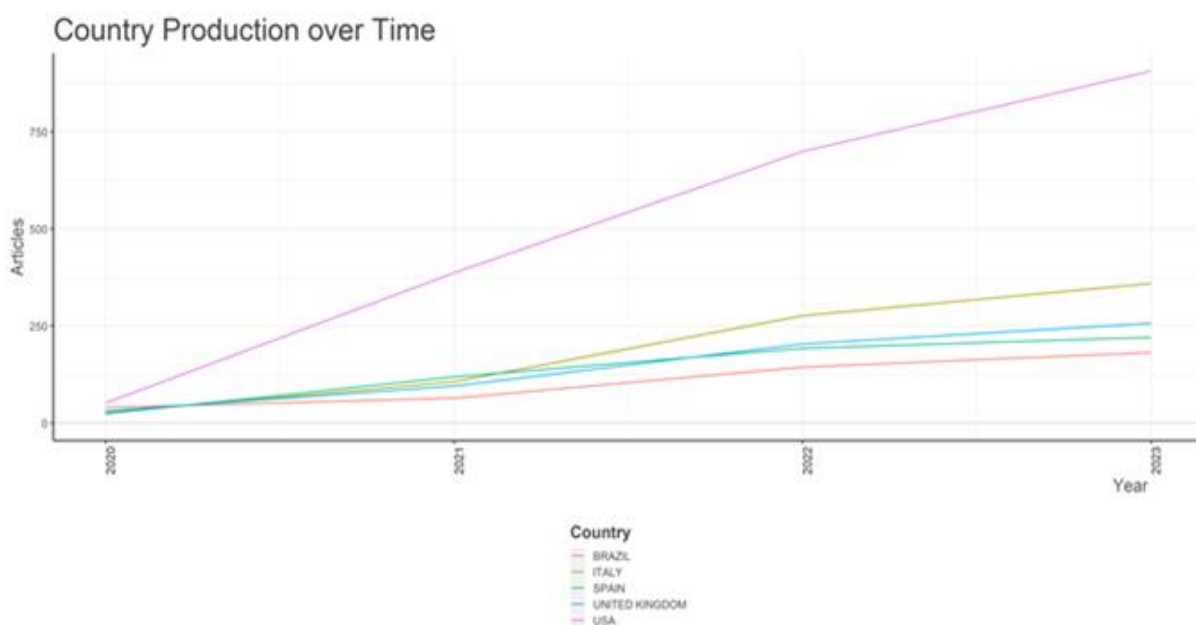


Figure 3. Country production over time

### University Affiliation

Figure 5 depicts the distribution of the top 5 university affiliations, highlighting their analytical focus on the impact of COVID-19 on athletes. The publication distribution originates from various university affiliations, namely: Semmelweis University, University of Wisconsin, University of Wisconsin-Madison, University of Calgary, and University of Washington. Among these, Semmelweis University emerges as the most prolific institution, with 25 documents published in the Scopus database. It is followed by the University of Wisconsin and University of Wisconsin-Madison, each with 21 articles, and the University of Calgary and University of Washington, both contributing 20 articles each.

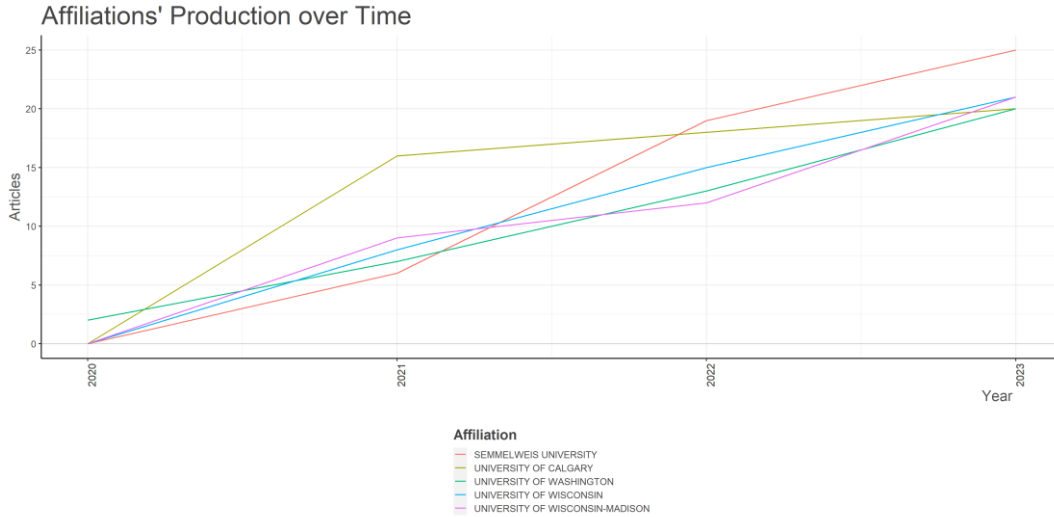


Figure 4. Most relevant Affiliation

Among the most significant authors in this field, Baggish AI and Washif Ja are notable, each contributing 14 documents. They are closely followed by Ammar A, Chamari K, Drezner Ja, and Trabelsi K, with 12 documents each. Furthermore, Farooq A, Harmon KG, and Mujika I each have 11 documents, while Chtourou H has 10 documents, as depicted in Figure 6

### Document Citation

According to data extracted from Scopus, the top 10 most frequently cited documents per year are as follows: Daniels CJ leads the list with a total citation count (TC) of 203, closely followed by Martinez MW with a TC of 182. Miljoen H's research in Heal Sci Rep ranks third with a TC of 178, while Starekova J's contribution in Jama. Cardiol holds the fourth position with a TC of 152. Abbasi J's study follows with a TC of 35, while Dixon BC's work in Jama Netw OpeN and Tsao J's contribution have TCs of 13 and 10, respectively. Schultz EA's research has a TC of 5, and both Hamburger RF's document in Clin Cardiol and Kasashi K's work in Jaccp Jam Coll Clin Pharm have a TC of 0.

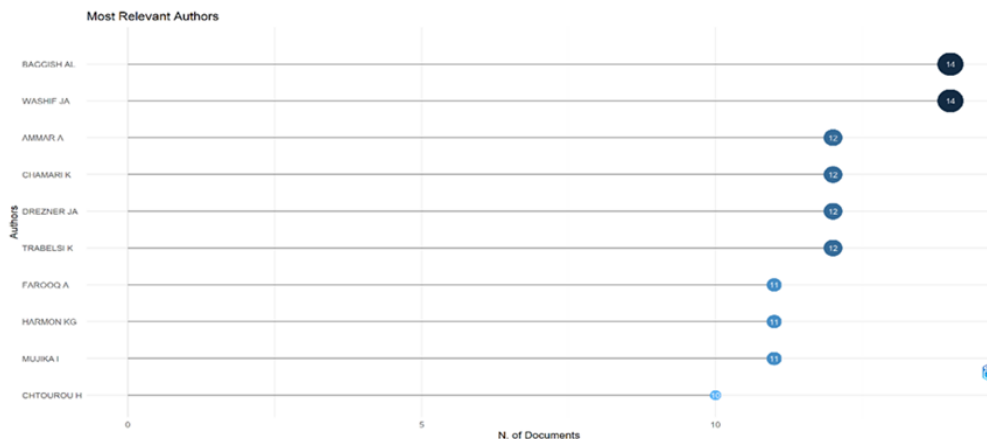


Figure 5. Top 10 authors









Density visualization plays a crucial role in assessing the concentration of a topic, where red, blue, yellow, and green colors denote unexplored, rarely studied, and highly researched areas, respectively. Brighter colors in the image signify more frequent usage of the analyzed terms in relevant studies. Additionally, keyword density distribution illustrates the frequency of research topics. (Hoang et al., 2020). For instance, COVID-19 and humans are frequently examined analytically, whereas terms related to athletic performance are less commonly studied. Figure 8 illustrates the visualization of the density of decision-making and problem-solving skills based on keyword indices.

## **Discussion**

The utilization of VOSviewer for bibliometric analysis has proven to be an invaluable tool for exploring research trends and contributions in the realm of Impact of COVID-19 on Athlete Performance. This approach allows us to delve deeper into understanding the evolution of publication productivity over the past decade, spanning from 2020 to 2023. Through this analysis, notable fluctuations in publication numbers from year to year become evident. Certain years exhibit an uptick in publication productivity, notably observed during the period from 2020 to 2022. These increases may signify a growing interest and research emphasis on the analytical impact of COVID-19 during those intervals. Factors such as the development of novel technologies or emerging environmental concerns could contribute to heightened research activity in this domain. However, there is also a decline in the number of publications noted in 2023. While this decline may seem unexpected, it's essential to recognize that this dataset only encompasses the early months of 2024. Therefore, this decrease might reflect early-year trends and may not accurately represent the overall publication trajectory for that year. It is imperative to scrutinize these trends more comprehensively and gather additional data to ascertain whether this decline is enduring or transitory.

Moreover, bibliometric analysis enables us to explore the contributions of different countries and institutions in this field of research. By identifying leading countries and academic institutions, we gain insights into international collaboration dynamics and knowledge dissemination among research communities. In essence, bibliometric analysis using VOSviewer offers a comprehensive overview of research trends and contributions in analyzing the impact of COVID-19 on athletes. It aids in understanding the evolution of research in this area over time and provides valuable guidance for future research planning and identifying areas requiring further investigation. Notably, the primary sources of documents predominantly originate from scientific journals, indicating a robust scientific foundation for research in this domain. These journals cover diverse fields such as environmental science, engineering, and energy. Table 2, which outlines the top twenty sources, offers a clear representation of these journals' contributions to advancing knowledge in analyzing the impact of COVID-19 on athletes.

Moreover, examination by fields of study reveals that this research is extensively dispersed across different disciplines, encompassing areas such as environmental and social sciences. This indicates that the analytical impact of COVID-19 on athletes is a prominent area of interest across multiple fields. Visualizing document distribution by fields of study offers a nuanced perspective of research dispersion across diverse disciplines. Notably, when scrutinizing contributions by specific countries, it becomes apparent that nations in the Americas and Spain have made substantial contributions to this research. This underscores the significance of the analytical impact of COVID-19 in those regions.

In terms of university affiliations, we observe significant participation from institutions across various countries in this research. Numerous leading universities from these nations actively contribute to publications regarding the analytical impact of COVID-19 on athletes. The table detailing the top university affiliations offers a more comprehensive understanding of these institutions' involvement in this research. It is evident that collaborative efforts spanning countries and institutions greatly propel knowledge advancement in this field. Furthermore, notable contributions are also observed from top authors in this area. Authors hailing from diverse countries such as Brazil, Italy, Spain, and the United Kingdom are actively engaged in research pertaining to the impact of COVID-19 on athletes. The visual representation provided by the graph underscores the substantial contributions of these authors to the advancement of knowledge in this domain. This analysis also underscores the significance of the most frequently cited publications, indicating the broad influence of specific research in this field. Several researchers and authors play pivotal roles in shaping the trajectory and progress of this research. VOSviewer network visualization is an extremely useful tool in understanding the structure and relationships between the most frequently occurring keywords in research. Using cluster analysis techniques, VOSviewer helps us identify groups of keywords that often appear together in literature. This provides valuable insights into the main focuses and research trends in the field of the analytical impact of COVID-19 on athletes.

Overlay and density visualizations also provide additional information about experimental trends and ongoing research focuses. By using different colors to highlight annual trends and density levels, we can see how research interests evolve over time and where research centers are located. For example, an increase in yellow color may indicate increased interest in specific topics in recent research. Meanwhile, the blue color may indicate that the topic is less studied. This information is crucial for planning future research. By understanding existing research trends and focuses, researchers can identify extensively studied areas and areas that require further attention. For example, if we see that there are underexplored keyword groups, this may provide opportunities for researchers to further explore these topics and make meaningful contributions to scientific literature. Thus, network, overlay, and density visualizations provide a holistic view of research trends and directions in the field of the analytical impact of COVID-19 on athletes.

## **Conclusion**

The utilization of VOSviewer for bibliometric analysis has emerged as a very useful tool for exploring research trends and contributions in the domain of COVID-19's impact on athlete performance. This analysis facilitates a deeper comprehension of how publication productivity has evolved over the past decade, spanning from 2020 to 2023, revealing noticeable fluctuations in publication numbers from year to year. While certain years exhibit an upsurge in publication productivity, particularly observed during the period from 2020 to 2022, a decline is observed in 2023. However, it's essential to acknowledge that this dataset only covers the early months of 2024, suggesting that this decrease may reflect early-year trends and might not accurately represent the overall publication trajectory for that year.

Moreover, bibliometric analysis enables the examination of contributions from various countries and institutions in this research, underscoring the crucial role of cross-country and cross-institutional collaborations in advancing knowledge within this domain. Additionally, this analysis identifies contributions from top authors and the most frequently cited publications, offering insights into the structure and relationships between the most recurrently occurring keywords in literature. Such insights aid in planning future research endeavors by comprehending existing trends and focal points. Thus, bibliometric analysis utilizing VOSviewer offers a comprehensive overview of research trends and contributions in the field of analyzing the impact of COVID-19 on athletes, furnishing valuable insights for future research planning and pinpointing areas warranting further attention.

## **Scientific Ethics Declaration**

The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the authors.

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