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Science Mapping for Nutrition Education in Sports Recovery Research: A Bibliometric Analysis

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Abstract

This study aims to conduct a bibliometric analysis of the literature on sports nutrition as recovery published between 1964 and 2022. This study illustrates the structure and trends in sports nutrition publications by using scientific mapping and analyzing publication performance. This study identified the contributions of authors, journals, countries, and widely cited articles. While there was no massive expansion in the first year of publication, the results show that high growth emerged in the 2010s. Several countries have made significant contributions to recovery research in sports nutrition. European countries account for the majority of publications on this subject. Latin American and Asian countries are also keeping an eye on the study's growth. Another finding is that various multidisciplinary publishers publish articles about sports nutrition. The International Journal of Sports Nutrition and Exercise Metabolism, on the other hand, is the journal that publishes the most articles. Burke L.M. has established himself as a prolific writer in this field, producing many documents and total citations. Several keywords have large nodes associated with their frequency of occurrence. The keyword relationship provides information about the relationship between keywords frequently appearing in one study. Visualizations of research trends are presented to provide an up-to-date reference guide for academics, revealing critical research gaps and potential research avenues for future studies to advance the discipline's consolidation.

Introduction

The application of nutrition in sports has become more common as technology and information in sports have advanced. Sports nutrition is one of the most rapidly growing and developing sports and exercise disciplines (Close et al., 2019). In sports nutrition, well-established ergogenic aids in modulating performance, recovery, training adaptation, body composition, and immunity have emerged (Oliveira et al., 2021). Sports nutrition can be divided into several categories (Dorofeeva, 2018): (1) high-carbohydrate foods and drinks to create and maintain glycogen in muscles for energy; (2) protein-fortified foods to increase protein synthesis in muscles and

adapt to exercise; and (3) micronutrients (vitamins, minerals, biologically active substances) in various forms; and isotonic solutions for rehydration and supplemental energy supply.

Maintaining adequate energy intake is an essential first step for any athlete who wishes to achieve peak performance. Energy intake should be sufficient to ensure that the required fuel is delivered effectively during periods of energy-consuming exercise and during the necessary recovery periods (Kerksick & Kulovitz, 2014). Furthermore, optimal nutrition will create the conditions for peak physical performance, increase the body's resistance to stress and unfavorable factors, and reduce the risk of chronic diseases (Dorofeeva, 2018).

The importance of ensuring adequate nutrition for endurance athletes has been extensively researched to maintain energy substrates during exercise, as well as for mental function and muscle contraction, among other things (Tiller et al., 2019). According to previous research, coaches should pay close attention to the supplementation of endurance athletes to ensure they perform at their best (Junaidi et al., 2020). In contrast to endurance athletes, strength athletes have a much more difficult time determining their caloric intake because of the variability in burst and high-intensity strength, the varying lengths of recovery time between training and competition petitions, and the significant contribution of eccentric contractions to their performance known to cause increased muscle breakdown and impaired recovery in athletes (Laursen & Buchheit, 2019). Strength-power athletes' training nutrition is vital in three areas: fueling sport-specific and strength-training sessions, recovering from these sessions, and promoting training adaptations such as skeletal muscle hypertrophy (G. Slater et al., 2014)

As physical exercise increases, sports nutrition becomes more popular. In particular, when the use of nutrition began to develop in the early 2000s, anti-doping regulations were established, and athlete supplementation was given more attention than ever before. (Petroczi & Naughton, 2008). Not only that but there have been regulations regarding nutritional consumption for athletes in place for the past five years (Gunina & Dmitriev, 2020). It provides an opportunity for academics to research and conduct additional research in this field as time permits. Furthermore, the public's desire to obtain information on sports and nutrition recommendations is still insufficient (Junaidi et al., 2020). Bibliometrics is a cross-disciplinary science that employs mathematical and statistical methods to conduct quantitative analyses of all knowledge carriers (Merigó et al., 2015) and identify knowledge transmission patterns. In order to identify developments in a specific field, this technique is commonly used by researchers (Železnik et al., 2017).

This study aims to use bibliometric methods to understand sports nutrition's scientific structure and dynamics as recovery. In addition, academics, coaches, and researchers can use these results as a reference for the topic of sports nutrition as recovery. The findings will enable researchers to answer the following questions:

- RQ 1. What about recovery publications on sports nutrition?
- RQ 2. What countries are involved in the advancement of this science?
- RQ 3. Which journals are involved in sports nutrition as recovery publications?
- RQ 4. Who contributed the most, and how did the authors contribute?
- RQ 5. What keywords are the most popular and relevant in this field?
- RQ 6. What are the latest keyword research trends in sports nutrition as a means of recovery?

Method

The records corresponding to these results were analyzed using bibliometric analysis. According to Noyons et al. (Noyons et al., 1999), bibliometrics combines two main procedures: performance analysis and science mapping. Bibliometric performance analysis uses many techniques, including word frequency analysis, citation analysis, and counting publications by country, university, research group, or authors (Thelwall, 2008). As shown in Figure 1, three phases were taken: source identification, data extraction, and data analysis. These steps are briefly explained here.

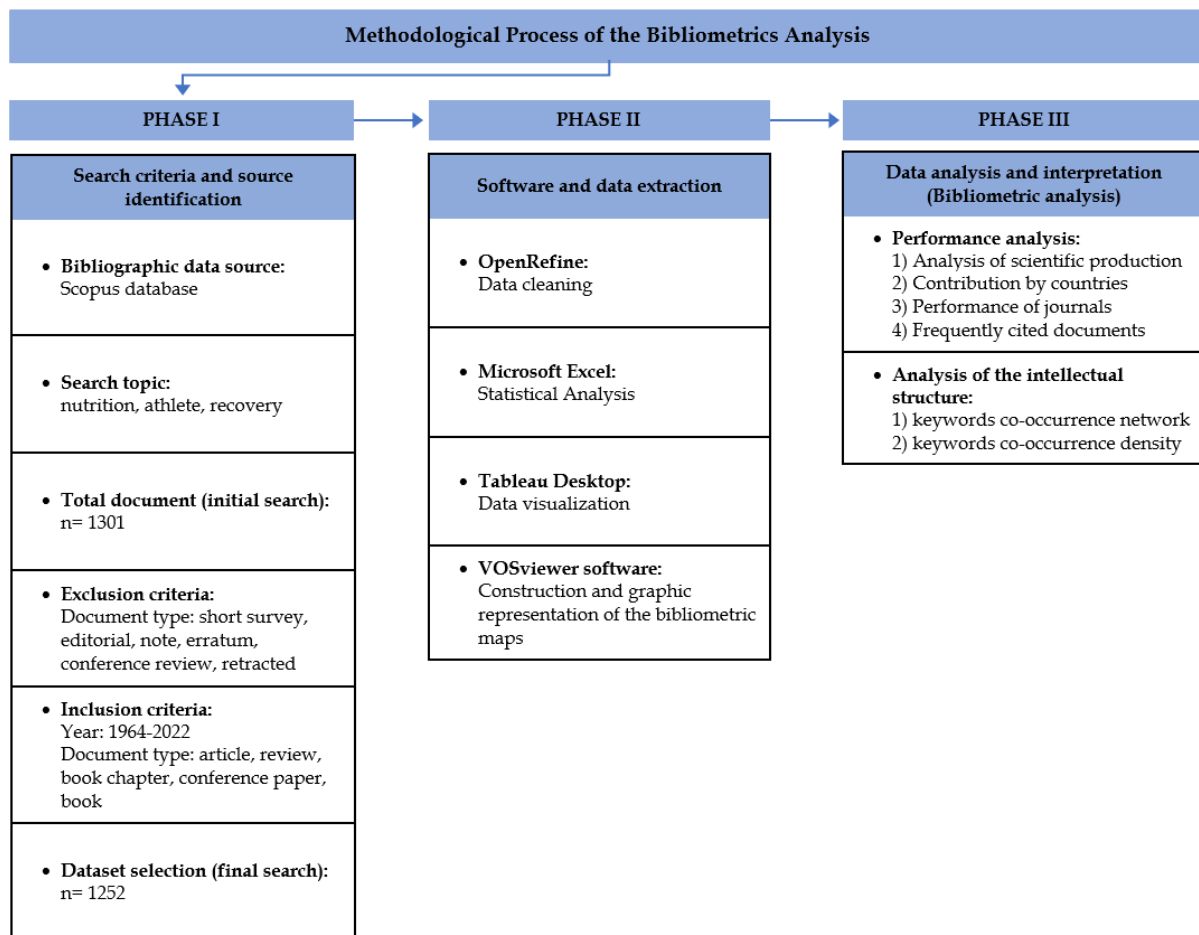


Figure 1. Methodology Stage Design of the Bibliometric Analysis

Source of Data

Researchers that want to evaluate publication trends would benefit from bibliometric analysis, which may be used to analyze research outcomes in practically any discipline (AlRyalat et al., 2019). As a result, selecting appropriate database sources to filter articles for each subject becomes increasingly critical (Aghaei Chadegani et al., 2013). The Scopus database was used in our search for this particular study. A multidisciplinary bibliographic database, Scopus, was chosen since it contains information that is perhaps the most extensive citation and abstract database of peer-reviewed scientific publications (Kulkarni et al., 2009). Additional reasons for using Scopus include that

it is easy to use and has a database that contains more (Burnham, 2006). The Scopus database is frequently used in bibliometric studies.

Defining Keywords

In order to maximize the accuracy of the findings, it is critical to select acceptable and relevant keywords (Zupic & Čater, 2015). Keyword selection also directly impacts the findings of bibliometric research (Chabowski et al., 2013). In order to search, the keywords chosen must be used to filter information. The keyword criteria used in this study were derived from research that identified sports nutrition as an essential component of athlete rehabilitation. Several researchers have attempted to categorize sports nutrition as a critical component of staying healthy and fit and enhancing athlete performance (Vázquez-Espino et al., 2022). Aside from that, sports recovery is seen as being extremely significant because it helps a person's performance to return to normal after engaging in physical exercise or participating in sporting activities (Latief et al., 2022)

The previously described concepts in Nutrition literature are used as keywords when searching for bibliographic records in the Scopus database. In this way, the Boolean operator (OR & AND), command of the quotation marks and asterisk are used to search the following keywords in a single search: nutrition ("nutrition*"), sport ("sport*"), athlete ("athlete*"), recovery ("recovery"), rehab ("rehab*"), restoration ("restoration*"). The following keywords are searched through Scopus database:

(TITLE-ABS-KEY ("nutrition*") AND TITLE-ABS-KEY ("sport*" OR "athlete*") AND TITLE-ABS-KEY ("recovery" OR "rehab*" OR "restoration"))

Inclusion and Exclusion Criteria

In order to ensure that the results acquired were as accurate as possible, several steps were taken during the literature search to reduce the likelihood of inconsistent findings. A review of the literature on nutrition as a means of recovery in sports and among athletes was carried out. Following an evaluation by all authors of the initial search strategy, it was decided that the literature drawn would cover the years 1964 to 2022 to ensure that all relevant keywords were included and that the first paper on nutrition as recovery in exercise was identified because the first paper on sleep in athletes was published in 1964 and because the first paper on nutrition as recovery in exercise was identified in 1964. Only items classified as articles, reviews, book chapters, conference papers, and books were included in the analysis. Because it is necessary to cover all relevant literature, the subject area, and the language are not considered constraints. However, as a final article, all of the literature must be included.

Data Analysis

In this study, data for articles were retrieved directly from the Scopus database on February 17, 2022, as CSV (comma-separated values) files, and the results were evaluated using Microsoft Excel 2013 and the VOSViewer software (<https://www.vosviewer.com/>). The data was cleaned first using OpenRefine (<https://openrefine.org/>), and then it was put into the analysis. It is critical to clean the data in order to obtain reliable results. Despite the

that most of the bibliometric data is correct, the cited references may contain numerous copies of the same article (Zupic & Čater, 2015). The research findings are presented in the form of graphs, tables, and network visualization maps. A bibliometric study is performed based on the frequency of publications by country, journal, author, and most cited articles. Additionally, keyword network analysis and density analysis were established to determine the most crucial research domains and the most popular themes. VOSViewer was used to do a network analysis of the relationships between the article keywords. The findings are displayed as a network graph consisting of nodes (i.e., keywords) and the network lines that connect those nodes. The greater the frequency of occurrence of a keyword, the larger the node size. The close association between keywords is displayed by a line representing a shared keyword quote, and the thickness of the network reflects the close relationship between keywords. Because the proximity or distance between nodes influences how frequently they are linked, it is possible to be in close vicinity to the nodes at any time. Nodes with a high density of relationships between them are differentiated by the color of the nodes around them (clusters). Following that, a density analysis was performed between the primary study domains identified. It allows the researchers to identify the research topic's trending research subjects.

Findings and Discussion

A bibliometric analysis was performed on the records after completing the other steps in the process. Bjork et al. (2014) demonstrated that the value of bibliometric analysis lies in the ability to obtain an overall picture of a specific field of study. It is the application of various methods to ascertain qualitative and quantitative changes in the subject of scientific research, the establishment of a publication profile for a specific subject, and the identification of structural and trend aspects within a discipline that is the subject of bibliometrics (Huertas-Valdivia et al., 2020). The bibliometric technique is divided into performance analysis and scientific chart mapping, also known as bibliometric mapping. Performance analysis is the first part of the technique (Noyons et al., 1999)

Type of Documents and Publication Trends

After going through the inclusion and exclusion criteria, 1,252 documents were used and analyzed. The highest number of papers by type is Article (774), Review (336), Book Chapter (75), Conference Paper (44), and Book (23) (see Table 1).

Table 1. Type of Document on Nutrition Research in Athlete Recovery

Type of Document	Frequency	Proportion
Article	774	61,8
Review	336	26,8
Book Chapter	75	6,0
Conference Paper	44	3,5
Book	23	1,8
Total	1252	100

As seen in Figure 2, research on nutrition for athletes and recuperation was published in 1964 by M. Nezu and S. Obata in *The Japanese Journal of Genetics*. The first ten years of publication saw slight growth, with only three papers published. Beginning around 1980, publications on this subject gradually increased in number. While the publication trend is upward, the data indicate inconsistent findings. In 2006, published papers increased significantly. In that year, the growth of sports nutrition expanded to several sports, including cycling (Kuipers, 2006), football (Balasekaran et al., 2021; Hawley et al., 1995; Peake et al., 2017), rowing (G. J. Slater et al., 2005), basketball (Calleja-González et al., 2019), athletics (She, 2004), and dance (Motta-Valencia, 2006). Following that, the trend toward constant improvement began. A significant increase was observed in 2018 when the IOC Consensus established regulations on several aspects of nutrition and dietary supplements for athletes (Maughan et al., 2018). It illustrates that the publication trend has continued to grow up to the current year.

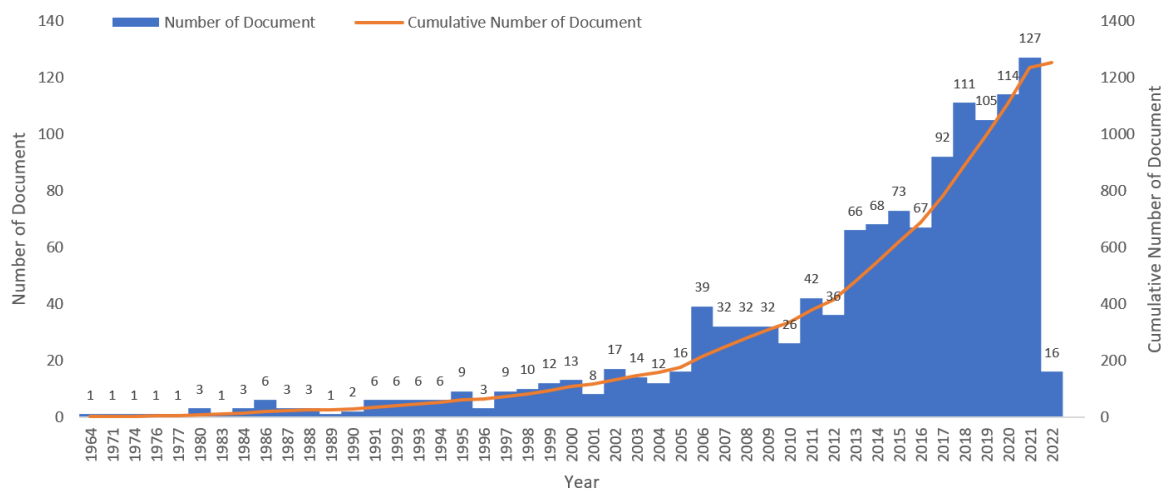


Figure 2. Sports Nutrition Publication Trends

Countries' Contribution to Sports Nutrition Research

Among the 76 countries identified, both developed and developing countries published research related to work in sports nutrition as long as the publication is identified. According to the findings, European countries contribute more than 60% (753 out of 1252) of the nutrition as recovery articles, indicating Europe's academic field's leading position in this sector. However, developed countries made up most of the top ten countries, with China and Brazil among the list's developing countries. The United States is the most significant contributor, representing 29% (370 documents) of all articles published, followed by the United Kingdom (211; 16%), Australia (143; 11%), Canada (98; 7.8%), and Spain (87; 6.9%) (see Figure 3).

Since they are the core main publisher countries, accounting for most of the primary authors, journals, and most-cited articles, the US, UK, and Australia are the leaders in the scientific landscape in producing knowledge related to work in sports nutrition. Furthermore, China is the Asian country with the most publications on sports nutrition, with 63 articles, more than any other country. South Africa also has the most publications in its region, which is Africa. However, South Africa does not make it into the top ten with this figure.

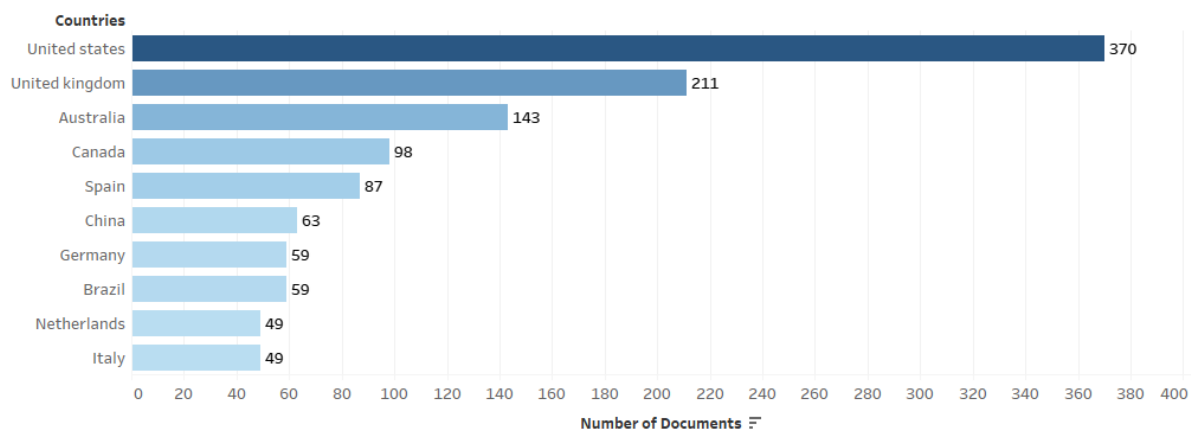


Figure 3. Top 10 Countries on Sports Nutrition Research

Developed and developing countries contribute to research differently among the most crucial research domains identified in our results. Developed countries produce scientific knowledge because they dominate major publishers and publications (the USA, European countries, and Australia). While developing countries are frequently identified as data providers due to empirical research or database analysis (Malanski et al., 2021). A small proportion of articles, authors, or journals in the top 10 originate in developing countries. In Latin America and Asia, only Brazil, China, and India have been identified as both primary publishers and data providers. Previous research has shown that European countries have developed an interest in nutrition (Hughes, 2003), consistent with this finding.

Publisher Contribution to Sports Nutrition Research

Various journals publish sports nutrition and recovery articles, including the Journal of Sports Medicine. This field has multiplied, and as a result, there is a large structure of academic resources, including specialty journals, available to researchers. Aside from that, theoretical frameworks in sports nutrition and recovery research are increasingly being used to explain specific phenomena, such as individual sports (Sygo et al., 2019) and team sports (Jenner et al., 2019). For this reason, articles on sports nutrition and recovery were published in various nutrition and exercise journals to explain the phenomena observed in their studies. Figure 4 depicts the ten most productive and influential journals in these fields, which can be used to categorize journals and their publications. The journal data is arranged in an order based on their productivity.

It was found that 1,252 articles related to the topic were published in 478 journals. The most productive journal is found to be "International Journal of sports nutrition and exercise metabolism" which published 11.53% of articles of the collected sample, followed by "Nutrients" (11.03%), "Journal of the International Society of Sports Nutrition" (8.85%), "Sports medicine" (7.56%) and "Medicine in sport and exercise" (7.26%). These are expected to be the top journals and high-ranking sports nutrition publishers in the recovery field (see Figure 4). The International Journal of Sports Nutrition and Exercise Metabolism is where most of these articles are published, which may reflect the specifics of the journal chosen by each author to publish their work. On the other hand, some prefer the journal Nutrients, which publishes articles in various multidisciplinary fields of science.

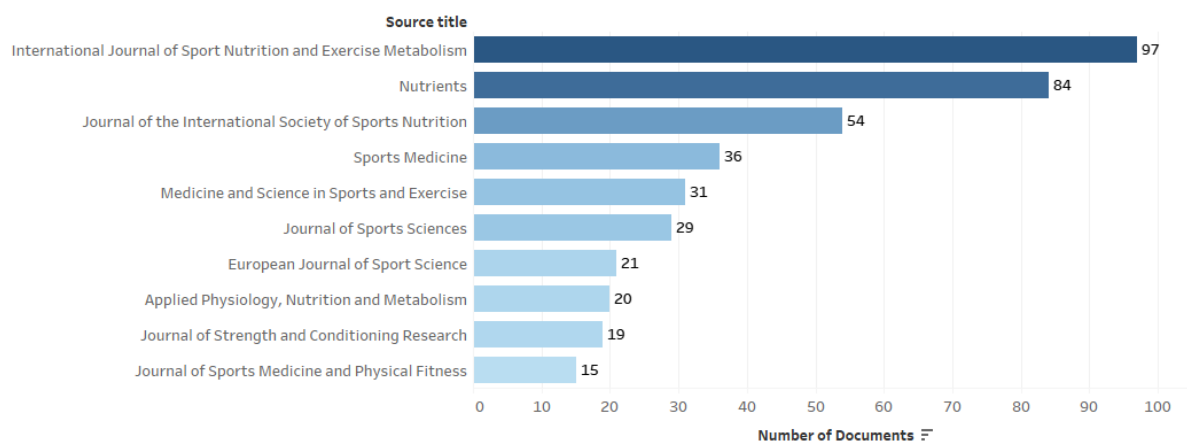


Figure 4. Top 10 Source Title/publisher in Sports Nutrition Research

Authors' Contribution to Sports Nutrition Research

According to an analysis of sports nutrition as recovery-related articles published between 1964 and 2022, and concerning the number of documents published by an author, it can be observed that there are apparent differences between the authors and that Burke L.M. is an influential and productive author in the field of sports nutrition as recovery research.

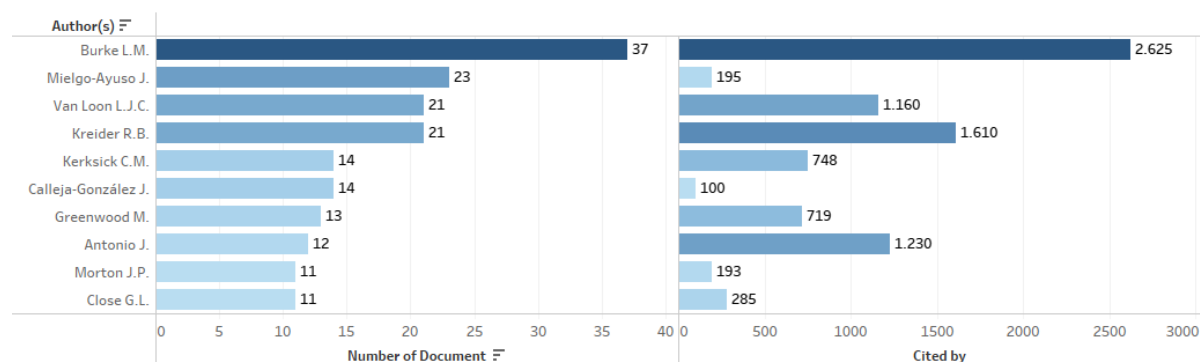


Figure 5. Top 10 Authors Publish on Sports Nutrition Research

Among the 37 articles Burke L.M. has published, the most notable is 2,625 citations, which is far more than any other author in this field. After Mielgo-Ayuso, Van Loon, and Keider, the trend continued, with all three authors publishing more than 20 documents in a single year. An interesting finding is that Mielgo-Ayuso J., who has the second-highest number of publications, has the lowest number of citations (195 citations) when compared to Van Loon L.J.C. (1,160 citations) and Keider R.B. (1,610). However, he has more publications than the other two authors (see Figure 5).

The Most Cited Articles in Sports Nutrition Research

Several influential articles on sports nutrition as a means of recovery have been published in various journals over years of research. One method of identifying them is to classify publications based on the number of citations they

have received (Merigó et al., 2015), which is a method that has been used in the past. The number of citations a paper receives reflects the amount of influence, popularity, and attention it has received from the scientific community. According to Scopus, we looked at the most cited articles in the field as part of our sports nutrition as a recovery research study. Table 2 contains the necessary information.

As shown in the table, the five most cited and influential articles have received more than 500 citations. Luepker, R.V., 1996; Thompson, P.D., 2007; American Dietetic Association Dietitians of Canada, 2009; Bangsbo, J., 2006; American Dietetic Association Dietitians of Canada, 2015. Luepker, R.V., 1996; Thompson, P.D., 2007; American Dietetic Association Dietitians of Canada, 2015. The article "Physical activity and cardiovascular health," written by Luepker (1996) and published in the Journal of the American Medical Association, received the most significant number of citations. With 729 citations, this article is the most widely referenced. In addition, Burke L.M. possessed two documents included in the list of the 15 documents cited in the article cited. These documents have received more citations than Luepker, who has received a smaller number (1996). In this regard, it is essential to point out that some of the writings of Burke L.M. are considered to be the foundation of this research area. Kreider R.B. is another author with two documents on the list, and he is also a prolific writer.

Table 2. Top 10 Influential Articles in Sports Nutrition as Recovery Research

Cited by	First Author	Title	Year	Source title
729	Luepker R.V.,	Physical activity and cardiovascular health	1996	Journal of the American Medical Association
686	Thompson P.D.	Exercise and acute cardiovascular events: Placing the risks into perspective, a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism and the Council on Clinical Cardiology	2007	Circulation
684	American Dietetic Association Dietitians of Canada	Nutrition and athletic performance	2009	Medicine and Science in Sports and Exercise
614	Bangsbo J.	Physical and metabolic demands of training and match-play in the elite football player	2006	Journal of Sports Sciences
529	American Dietetic Association	Nutrition and Athletic Performance	2016	Medicine and Science in Sports and Exercise

Cited by	First Author	Title	Year	Source title
		Dietitians of Canada		
482	Burke L.M.	Carbohydrates for training and competition	2011	Journal of Sports Sciences
472	Thomas D.T.	Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance	2016	Journal of the Academy of Nutrition and Dietetics
418	Rodriguez N.R.	Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance.	2009	Journal of the American Dietetic Association
400	Kenttä G.	Overtraining and recovery. A conceptual model	1998	Sports Medicine
358	Kreider R.B.,	Effects of creatine supplementation on body composition, strength, and sprint performance	1998	Medicine and Science in Sports and Exercise
314	Nieman D.C.	Exercise and immune function. Recent developments	1999	Sports Medicine
273	Burke L.M.	Carbohydrates and fat for training and recovery	2004	Journal of Sports Sciences
272	Reilly T.	Energetics of high-intensity exercise (soccer) with particular reference to fatigue	1997	Journal of Sports Sciences
253	Kreider R.B.	ISSN exercise and sport nutrition review: Research and recommendations	2010	Journal of the International Society of Sports Nutrition
227	Frisch R.E.	Body fat, menarche, fitness and fertility	1987	Human Reproduction

The Most Used Keywords in Studies

In this section, we analyze content by looking at the distribution of keywords. An interactive co-occurrence map, the top 5 keywords in sports nutrition as recovery publications, a keyword density visualization map, and a keyword timeline view will be presented. Co-occurrence keywords can effectively reflect research hotspots in a discipline area, thereby providing additional support for scientific study (Gong et al., 2021). This approach is

commonly used to determine the relevance of publications based on the relationships between citations or between words in the publications (Eck & Waltman, 2014). The VOSviewer software generated the co-occurrence network of athlete recovery nutrition keywords (see Figure 6) by analyzing the data. We obtained a total of 2148 keywords from all 1252 publications that were related to sports nutrition as a recovery strategy. 1147 keywords appeared only once, and 1932 keywords appeared at least ten times. Only 54 keywords related to and displayed in the image appear when a minimum of ten documents appear.

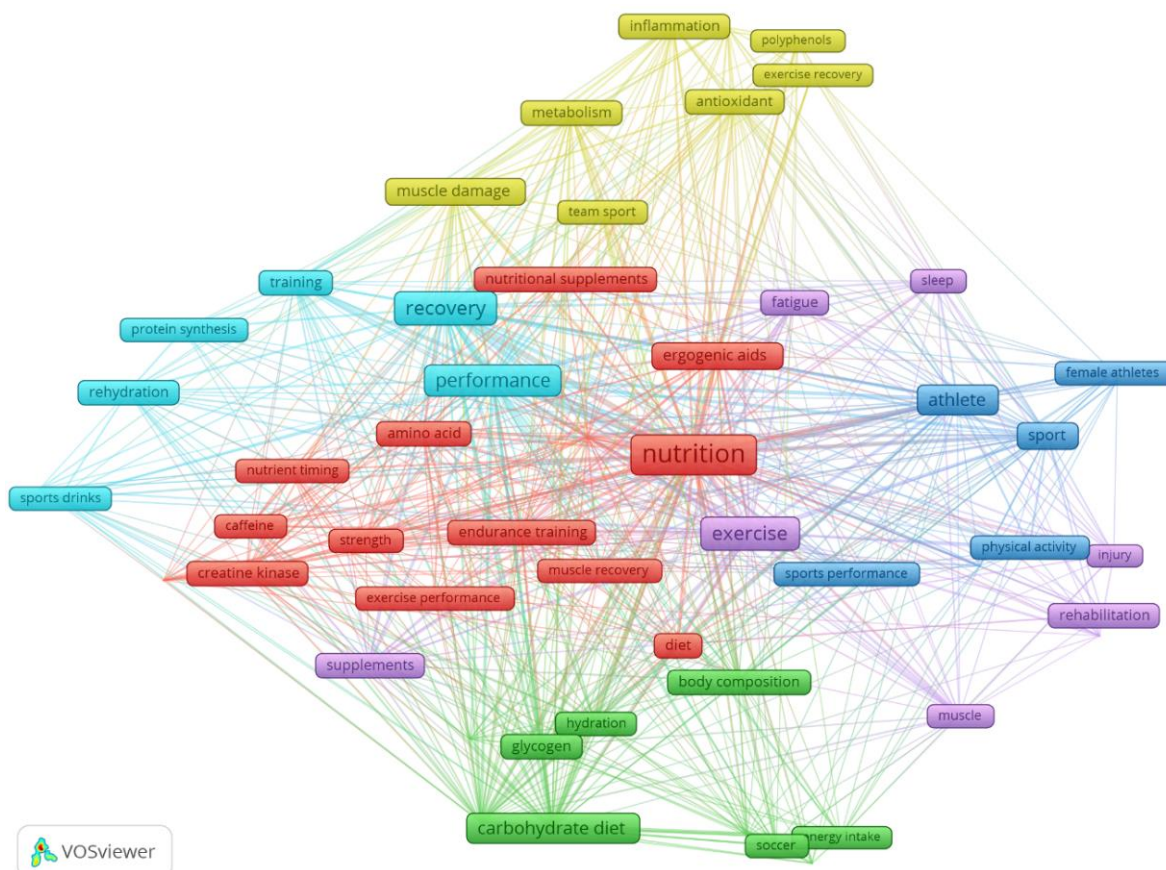


Figure 6. Network Visualization of Keywords (Minimum of 11 Documents to get 54 Related Keywords)

The weights of the nodes are represented by the size of the nodes and the words in the image. The weight is proportional to the size of the knot and the word (Zhang et al., 2021). The strength of a relationship between two nodes is reflected in their distance, and relationships with shorter distances are more likely to be stronger. The line that connects the two keywords denotes that they first appeared together. The thicker the line, the more likely it appears in a group (Hernández-Torrano & Ibrayeva, 2020). A cluster is made up of nodes that are the same color. The publication keywords related to athlete recovery nutrition are divided into six clusters by VOSviewer.

The keyword "Nutrition" was the most frequently used, with 297 occurrences. Others that appeared frequently were "recovery" (138 times), exercise (124 times), performance (116 times), and athlete (87 times), among others (see Table 3.). The three most essential keywords describe the field of the study observed. Furthermore, recovery and performance also have a high frequency in sports nutrition research. The frequency of co-occurrence between two nodes is represented by the strength of the link between them.

Table 3. Clusters of Keywords in Sports Nutrition as Recovery Research

Thematic cluster with central keyword	Main keywords (number of occurrences)
Cluster no 1. (red) <i>Nutrition</i> (in total: 15 keywords)	nutrition (297), supplementation (57), ergogenic aids (45), creatine kinase (33), endurance training (33), amino acid (25), diet (25), nutritional supplements (24), exercise performance (16), caffeine (15), muscle recovery (15), strength (15), nutrient timing (12), power (12), skeletal muscle (12)
Cluster no 2. (green) <i>Carbohydrate Diet</i> (in total: 10 keywords)	carbohydrate diet (76), protein (53), glycogen (28), body composition (27), hydration (22), soccer (19), energy expenditure (13), energy intake (11), football (10), glycemic index (10)
Cluster no 3. (blue) <i>Athlete</i> (in total: 8 keywords)	athlete (87), sport (51), female athletes (21), physical activity (16), sports performance (15), health (12), adolescents (11), eating disorders (11)
Cluster no 4. (yellow) <i>Muscle Damage</i> (in total: 8 keywords)	muscle damage (41), antioxidant (31), inflammation (31), metabolism (30), oxidative stress (21), team sport (12), exercise recovery (11), polyphenols (11)
Cluster no 5. (purple) <i>Exercise</i> (in total: 8 keywords)	exercise (124), supplements (32), fatigue (30), rehabilitation (23), muscle (19), sleep (17), sports medicine (15), injury (11)
Cluster no 6. (aqua) <i>Recovery</i> (in total: 7 keywords)	recovery (128), performance (116), training (31), rehydration (30), sports drinks (16), protein synthesis (12), whey protein (11)

In order to describe the relationship between two nodes, it can be used as a quantitative indicator (Pinto, 2014). An individual node's total link strength can be calculated by summing the link strengths of that node and all other nodes. In Figure 5, there is a thicker line around the node "nutrition," which includes the words: "recovery" (53), "exercise" (48), "performance" (46), "athlete" (30), and "ergogenic aids" (22). The following are all nodes with a link strength more significant than 20. The strong relationship between "nutrition," "recovery," and "performance" implies that nutrition is not only crucial for recovery but also has a strong relationship with athlete performance, which implies that nutrition is closely integrated with performance.

Trends Keywords in Studies

VOSViewer analyzes the most frequently occurring keywords from the publication year. We can see the keywords trend over the period analyzed (1964-2022). The node's color indicates the average number of publications per year with the node (Eck & Waltman, 2014). Blueness nodes correspond to keywords used mainly at the beginning of our study period. At the same time, more yellow nodes correspond to keywords that have appeared more recently. Classifying the most frequently used keywords enables the determination of which topics are most frequently discussed and which are not.

Referring to Figure 7, muscle recovery, polyphenols, health, injury, sleep, inflammation, oxidative stress, skeletal muscles, sports medicine, and sports performance are some of the newer areas of research in the field of exercise management that have been discovered by looking at high-frequency keywords from the most recent publication dates (2017-2019). Based on the topics mentioned above, it can be assumed that there is no common knowledge about sports nutrition, which currently intersects with variables related to health and other sports.

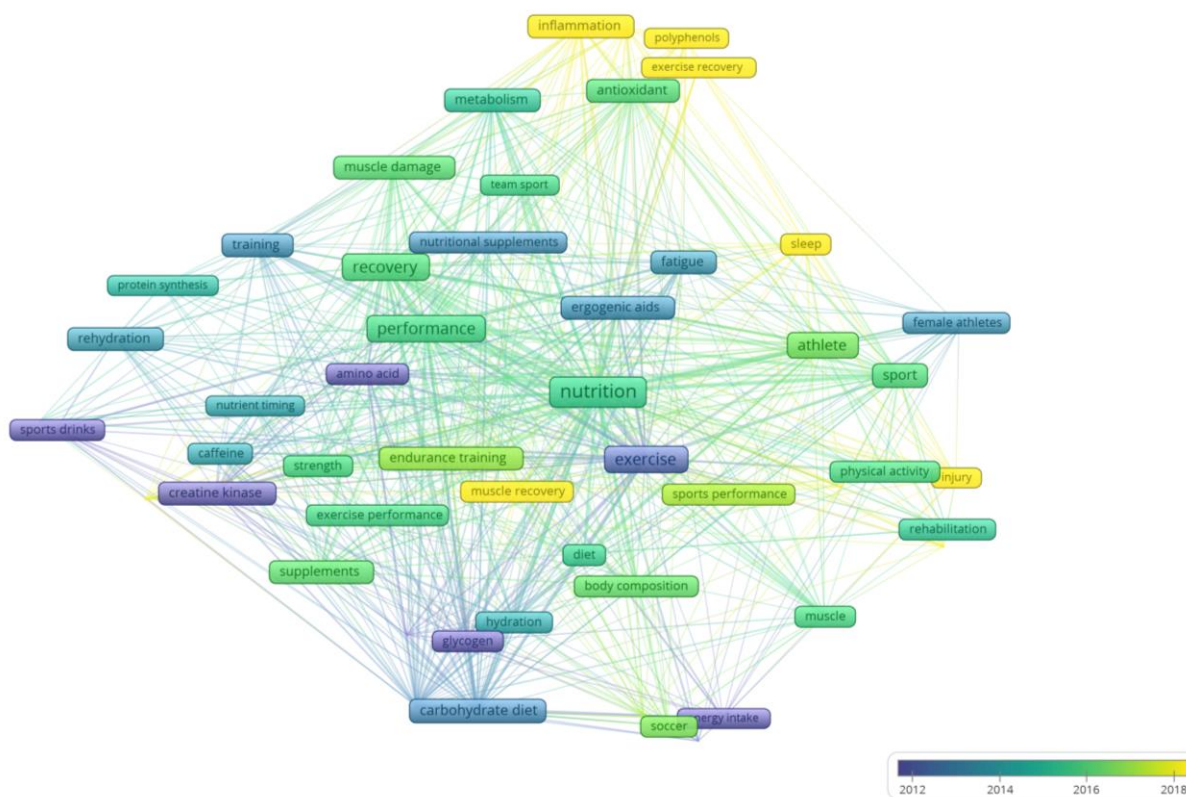


Figure 7. Keyword Trends

Conclusion

A bibliometric analysis of sports nutrition as recovery revealed that global research trends emerged during this study. The most relevant papers from the Scopus database were extracted using keywords in this study. In total, 1252 documents were obtained relevant to this discussion topic. The development of sports nutrition publications began in 1964 and saw a steady and rapid increase in the 2010s. According to the findings, the United States, the United Kingdom, Australia, Canada, and Spain are the most productive countries in this research, with the highest number of published papers worldwide. Many publishers publish articles on sports nutrition as recovery, with the "International Journal of Sports Nutrition and Exercise Metabolism" publishing the most in this field. According to an analysis of all the widely cited papers, 372 authors have published at least two papers in this field. In addition, four authors have published more than 20 documents and are considered influential authors in this field.

Furthermore, the author's keyword analysis reveals six clusters, indicating that there are six interrelated groups of keywords. Each cluster was represented by the keywords "nutrition," "carbohydrate diet," "athlete," "muscle

damage," "exercise," and "recovery." In the current year of publication, there are several new and emerging keywords, indicating that these topics are new to sports nutrition. The findings of this study are relevant to the global sports nutrition research landscape and can be used to guide further research into the most relevant fields and research areas at any time. They reaffirm that these findings can assist academics, coaches, and researchers discover critical information about sports nutrition as recovery research.

Limitations and Recommendations

There are several limitations to our study. First, the Scopus database is the sole source of literature relevant to our research. Even though Scopus is one of the most comprehensive databases, some research in this field may be indexed in other databases or not at all. Consequently, another database is required to supplement and expand the research literature. Second, the author's needs are considered when determining the threshold in the VOSViewer analysis, and it only organizes but does not fully represent the writer's needs. Third, data cleaning relies solely on the application and assumes all is well.

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