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Original Article

Sports Medicine: Scientometric of 10 Years of Global Scientific Productions

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Abstract

Background: Sport Medicine maintains an active lifestyle and reduces or inhibits countless age-related changes in physical and physiological function by substituting sports methods for people. Improving the scientific situation in sports medicine over time will lead to progress in the field of prevention and reduction of mortality. This study aimed to analyze sports medicine research in the world in terms of scientometric indicators using the Scopus database.

Methods: This is a bibilometric study. The study population consisted of all articles indexed in the Scopus citation database in the field of sports medicine, registered by researchers from 2011 to 2020. They used SciVal analytical tool as a bibliometric tool that allows the analysis of publications in various parameters, and VOSviewer and Excel software as drawing all citation maps.

Results: The highest increase in scientific production of sports medicine was in 2015. Overall, 1,695 articles were published, which received an average of 13 citations per article. The highest rate of scientific production is related to the United States with 41%, followed by the United Kingdom with 16% and Australia with 9%, with a significant difference in the second and third which indicates the high quality and impact of this group of studies. The British Journal of Sports Medicine has contributed the most to the publication of highly cited articles. The most commonly used terms include "Head Impact", "Athletes", and "Sport Injury"

Conclusion: Considering the importance of sports medicine in the prevention, control and treatment of many diseases, as well as the growth of the elderly population, it is necessary to develop research in this area. By identifying the features of highly cited articles in this field, a clear view of the top authors and publications and widely used topics was provided.

Keywords: Sports medicine; Scientometric; Global scientific productions; Sport

Introduction

The gradual decline in human physical and physiological function is a major risk factor for most non-communicable diseases. Therefore, the use of preventive measures is clinically important because they can reduce age-related physical and physiological function and also reduce the risk factors for chronic diseases (1). Sports science is one of the broad, complex and interdisciplinary

subject areas. It is one of the most important and influential fields in the world of research that deals with topics related to health, hygiene, physical activity, disease, medicine and lifestyle (2). Sports medicine is one of the most important and attractive branches in sports science research. In recent years, it has attracted more and more international attention. Sports medicine maintains an active lifestyle and reduces or inhibits countless age-related changes in physical and physiological function by substituting sports methods for people. This medicine incorporates new habits into accepted practice to achieve maximum clinical benefits for patients (3).

On the other hand, scientometric indicators (number of citations, impact factor (IF), H-index, etc.) are becoming more and more important due to determining the effectiveness of scientists' activities in various scientific fields. In scientometric studies, the latest developments in research activities in each scientific trend and the factors affecting its growth have been evaluated. This branch explains the process of science production and the efficiency of scientific research by examining variables by providing an appropriate combination of indicators based on them (4). Due to the popularity of this category, studies at various levels and from micro to macro, governments and educational centers take scientific measures to inform their decisions and formulate policies related to ranking, position, budget, impact, vision and future plans. Institutions, countries and scientists can be evaluated using reliable scientometric indicators which are significant tools in the study of disciplines. Scientometrics is also used to determine the future of academic disciplines (5). As much as it has been used in scientific disciplines, it has been used sparingly in sports sciences, including sports medicine.

Owing to the importance of sport in managing important social and health problems, investing in this field is a valuable resource that requires various policies for economic and social support. The review analysis also showed a significant lack of contributions in this regard, which in fact reveals an interesting starting point for future research work (6). Therefore, it is time for this research to be evaluated in the mirror of scientometric techniques to provide a clear and comprehensive picture of the general situation to present the process of scientific production and exchanges in this field. Given that any planning and policy-making requires knowledge of scientific competencies, reviewing sports medicine products and collaborations will tell policymakers how to empower researchers to compete globally. Improving the scientific situation in sports medicine over time will lead to progress in the field of prevention and reduction of mortality. The purpose of this study was to analyze sports medicine research in the world in terms of scientometric indicators using the Scopus database. To achieve this goal, this study seeks to answer the following questions:

- What is the process of scientific productions in sports medicine in the Scopus database?
- Which countries in the world do sports medicine researchers have the most cooperation with? And what is the international cooperation network like?
- Who are the world's top researchers in Sports Medicine based on the H-index?
- What are the world's top journals based on 1st quarter to 4th quarter in Sports Medicine?

Materials and Methods

The study population consisted of all articles indexed in the Scopus citation database in the field of sports medicine, registered by researchers from 2011 to 2020. The research community was examined in general. The reason for choosing the Scopus citation index is that it is one of the largest international citation databases with extensive coverage in Elsevier. It also has the ability to use SciVal analytical tool as a bibliometric tool that allows the analysis of publications in various parameters. The Scopus search was conducted on July 5, 2021. The query field created in the ad-

vanced search form was based on the main title or SUBJMAIN of sports medicine and the subtitle of the ASJC (field code -SUBJMAIN) classification subject. This search was limited to 10 years, as articles related to 2021 have not yet all been indexed in the Scopus database.

Research Findings

In the ten-year period (2011-2020), 1695 records in sports medicine were indexed in Scopus database. As shown in Table 1, during these 10 years, sports medicine research has had an intermittent trend, so that the number of research in this field had increased from 2011 to 2015. It has been on a downward trend from 2015 to 2018, and since then has shown a slight increase. In 2015, the most research was conducted in this field, which numbered about 210 studies. The gradual decline until 2020, when this number has reached 160 studies, shows that over time, researchers have paid less attention to studies in this field. Preliminary data analysis showed that 1695 articles under review received a total of 22298 citations, with an average of 13 citations per article. This is a significant amount. 250 (14.7%) of these articles were in the top 10% of the most cited articles in the world. About 41.7% of these articles are in the top 10% of most-cited journals. The American Medical Society for sports medicine position statement: concussion in sport, published in 2013 in the British Journal of sports medicine, is the most cited article among all sports medicine research in Scopus. As of the time of data collection in this study, this article alone has 639 citations in Scopus. Sports Medicine articles have been published in various journals, and the British Journal of sports medicine, with 359 articles, has contributed the most to the publication of articles in this field in the last 10 years.

Table 1: Top 10 Journals in Sports Medicine

Scopus source	*Scholarly Output*	*Citations*	*Authors*	*CiteScore2020*
British journal of Sports Medicine	359	7689	1000	19.2
Current Sports Medicine Reports	125	344	268	2.3
Journal of athletic Training	98	909	283	4.0
Clinics in sport medicine	50	887	94	3.8
American journal of sports medicine	44	969	146	9.6
Clinical journal of sport medicine	33	427	164	4.6
Physician and sportmedicine	27	272	101	3.0
Journal of science and medicine in sport	26	180	81	6.6
Sports medicine	25	853	113	17.7
International journal of sports physiology and performance	21	182	23	6.6

Top researchers in Sports Medicine in terms of number of articles, number of citations and H-index

Different scientometric indicators are used to evaluate the research performance of researchers. The most important of which are the index of article number, number of citations received and H-index. In this part of sports medicine research, these three indicators were examined.

Preliminary analysis of the data indicates that a total of 4217 authors were involved in compiling 1695 articles in sports medicine. The average number of authors per article is 2.4. Among all sports medicine research, Drezner, Jonathan Adam is the most active sports medicine researcher in the world with 27 articles. Finch, C.F. and Engerbretsen, Lars are in second and third places with 23 and 21 articles, respectively. According to the data of the most cited researchers, Harmon, Kimberty G with 19 articles in sports medicine and received 1816 citations, with a relatively large difference compared to other researchers, is the most cited researcher in sports medicine in Scopus. And Drezner, Jonathan Adam and Herring

Stanley A are in second and third place with 1603 and 1361 citations. As mentioned, information on the top 15 researchers in terms of the number of articles is presented in Table 2.

Table 2: Top 15 Researchers in Sports Medicine

Name	*Scholarly Output*	*Most recent publication*	*Citations*	*Citations per Publication*	*Field-Weighted Citation Impact*	*H-index*
Drezner, Jonathan Adam	27	2020	1603	59.4	4.74	45
Finch, C. F.	23	2020	628	27.3	4.95	53
Engebretsen, Lars	21	2020	822	39.1	5.63	94
Meeuwisse, Willem H.	20	2020	890	44.5	6.63	68
Putukian, Margot	20	2020	1343	67.2	5.46	47
Asif, Irfan M.	19	2020	428	22.5	2.24	23
Harmon, Kimberly G.	19	2019	1816	95.6	7.04	38
Börjesson, Mats Å.	17	2020	870	51.2	4.67	42
Herring, Stanley A.	17	2020	1361	80.1	7.07	33
Dvorak J	17	2020	688	40.5	7.23	88
Sharma, Sanjay Sanjay	17	2020	1023	60.2	4.97	65
Ardern, Clare L.	16	2020	168	10.5	2.94	29
Verhagen, Evert	16	2020	326	20.4	7.3	40
McCrory, Paul	16	2020	637	39.8	4.62	70
Asplund, Chad A.	15	2020	771	51.4	4.11	21
McNamee, Mike John	15	2020	195	13	1.08	21
Roberts, William O.	15	2020	896	59.7	5.02	31

One of the most common criteria used to identify influential researchers in a field is the h-index, which indicates the cumulative impact of researchers' research output. And it is used in many rankings. The H-index has the ability to take into account two important indicators, the number of articles and the number of citations at the same time, and thus evaluate the effectiveness of a researcher. In this part of the research, according to the number of researchers' articles and also the number of citations for each article, the H-index was calculated and ranked. Ackerman, Micheal John with h-index 113 has the highest H-index among all sports medicine researchers. Maffulli Nicola is in second place with h-index 100 and Thiene Eaetana is in third place with h-index 96. As mentioned, information on the top 5 researchers in terms of h-index is presented in Table 3.

International Cooperation Network for Sports Medicine Research

Another issue that was examined in this study was the level of research cooperation of sports medicine researchers with their counterparts at international, national, institutional and individual levels. The most research collaborations in sports medicine at the national level was 30.9%. 21% of studies are based on international research collaborations, 20% are institutional collaborations and 28% of research in this field is done individually.

Table 3: Top 5 researchers in terms of H-index

Name	*Scholarly Output*	*Most recent publication*	*Citations*	*Citations per Publication*	*Field-Weighted Citation Impact*	*H-index*
Ackerman, Michael John	6	2019	727	121.2	9.23	113
Maffulli, Nicola	6	2019	52	8.7	1.15	100
Thiene, Gaetano	4	2016	106	26.5	1.39	96
Engebretsen, Lars	21	2020	822	39.1	5.63	94
Rivara, Frederick Peter	4	2020	137	34.3	2.34	91
Van Mechelen, Willem	3	2018	129	43	2.47	89

The collaboration of studies at the international level had the greatest impact of 2.37 compared to other studies. In fact, these studies have received the highest citation rate of 20.5 compared to other studies at different levels (Fig.1).

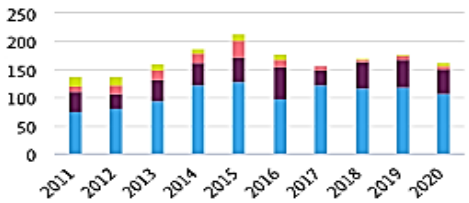
Out of 1695 published articles in sports medicine, 51% of the articles were written based on group and academic collaborations, which had a greater impact than non-group and non-academic articles. And for each article, approximately 21.5% of citations have been received.

Metric		Scholarly Output	Citations	Citations per Publication	Field-Weighted Citation Impact
International collaboration	21.0%	345	7,058	20.5	2.37
Only national collaboration	30.9%	507	7,939	15.7	1.46
Only institutional collaboration	20.0%	328	5,031	15.3	1.24
Single authorship (no collaboration)	28.0%	460	1,701	3.7	0.61

Fig. 1: Percentage of international sports medicine research cooperation network

Articles based on quarterly journals

The study of research conducted in sports medicine in terms of articles written in quarters 1 to 4 of journals was another item that was considered in this study. Most articles in the first and second quarters of journals are 1069 and 405 articles, respectively. 87.4% of these articles were of high quality and were published in this category of journals. In this study, 95.2% of the articles are in the first to third quarters, which indicates the high quality and impact of this group of studies (Fig. 2).



Quartiles	Publications	Publication share (%)
Q1 (top 25%)	1,069	63.4
Q2 (26% - 50%)	405	24.0
Q3 (51% - 75%)	132	7.8
Q4 (76% - 100%)	81	4.8

Cumulative shares	Publications	Publication share (%)
Q1 to Q2 (top 50%)	1,474	87.4
Q1 to Q3 (top 75%)	1,606	95.2

Fig. 2: Percentage of sports medicine articles based on quarterly journals

Analysis of patents cited in Sports Medicine research

Analysis the citations of research conducted in sports medicine based on the number of patents showed that 17 inventions were registered based on scientific research published in sports medicine, which was the highest number of patents in sports medicine in 2016. Nine articles have been cited in patents in sports medicine. On average, for every 1000 articles in medical medicine, 10 inventions have been registered based on these articles, which shows the economic value of articles in medical medicine.

Evaluation of observations of Sports Medicine research.

The number of times the research is viewed actually indicates the usage impact, and the high number of times viewed an article indicates that this article has received more attention and use. Sports medicine articles have been viewed 43438 times in Scopus database. Overall, 265 publications are among the 10% of the most viewed sports medicine publications in the world. An average of 25.6 per journal of sports medicine has been viewed. The field-weighted views impact index averages 1.23, which is an adjusted index for the same age, the same sex and the same subject cases, calculated for articles. And indicates that each article has been viewed an average of 1.23 times in sports medicine (Fig. 3).

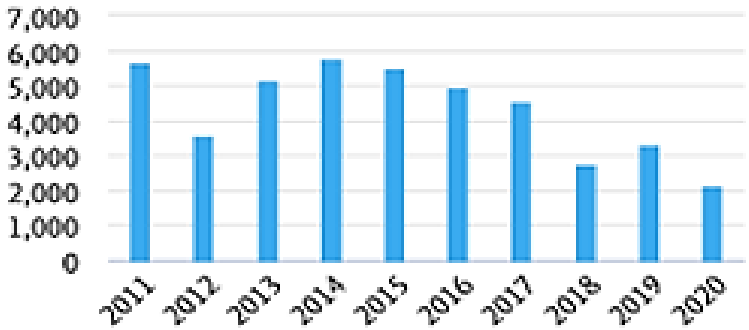


Fig. 3: Number of views of articles in the field of sports medicine

Frequent Article Words Related to Sports Medicine

In Fig. 4, the frequent words in the "article titles, abstracts and their keywords" are retrieved and displayed based on the search strategy. According to the researchers, "COVID-19" and "Physical Activity Level" were removed from the chart due to their repetition.

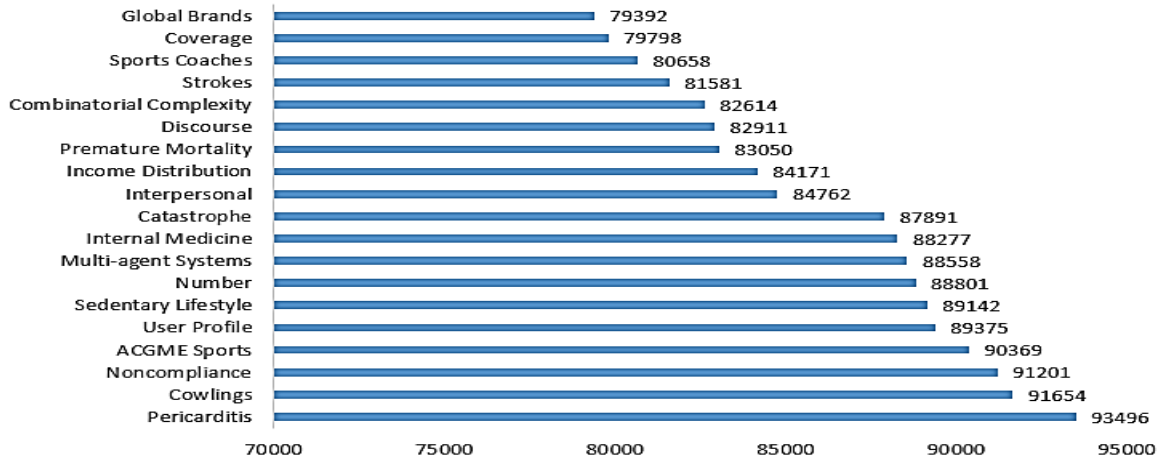


Fig. 4: Twenty repetitive words in retrieved sports medicine articles

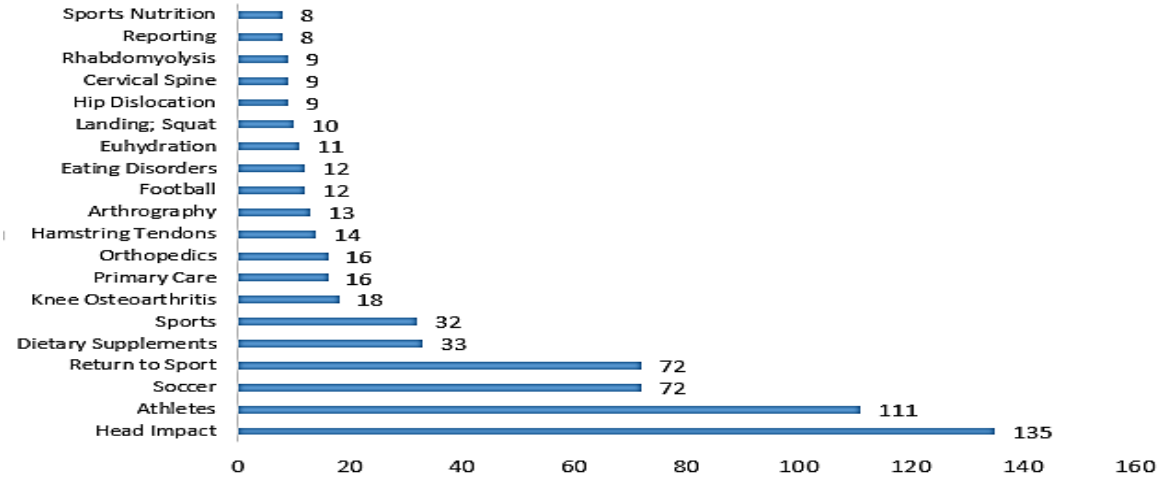


Fig. 5: Twenty words have more frequency in retrieved sports medicine articles

According to SciVal, "Pericarditis" with 93496 repetitions, "Cowlings" with 91654 repetitions, "Noncompliance" with 91201 repetitions are the most repeated phrases among the most frequently retrieved 1695 articles in the field of sports medicine (Fig. 5).

Based on the output of the SciVal tool, the phrase "Head Impact" with a frequency of (135) times, the phrase "Athletes" with a frequency of (111) times, the phrase "Sport Injury" with a frequency of (72) times are among the phrases with the highest frequency among 1695 retrieved articles in the field of sports medicine. Table 4 also lists thematic classifications based on 10 high-frequency thematic areas that are considered by default for related documents.

Table 4: The division of subject areas in sports medicine based on the frequency of events

Subject areas	*Frequency*
Postconcussion Syndrome; Brain Concussion; Head Impact	135
Sudden Cardiac Death; Polymorphic Catecholergic Ventricular Tachycardia; Athletes	111
Accident Prevention; Soccer; Sport Injury;	72
Sports Medicine; National Football League; Return to Sport	72
Nutrition Knowledge; Athletes; Dietary Supplements	33
Training Devices; Intercollegiate Athletics; Sports	32
Platelet-Rich Plasma; Tendinitis; Knee Osteoarthritis	18
Counseling; Exercise; Primary Care	16
Arterial Stiffness; Pulse Wave Analysis; Orthopedics	16
Anterior Cruciate Ligament Reconstruction; Hamstring Tendons; Return to Sport	14

Drawing a thematic map of highly cited articles in the field of sports medicine

Based on the scientific map of articles related to sports medicine in VOS viewer software, after summarizing and considering all the cases, with regard to the drawn pattern and the opinion of researchers, six important clusters in the field of sports medicine studies in the world were identified. The process of segregation is based on the repetition and frequency of topics, participation in publications, and the weighted citation effect, and the emergence of the so-called "cluster shape" (Fig. 6).

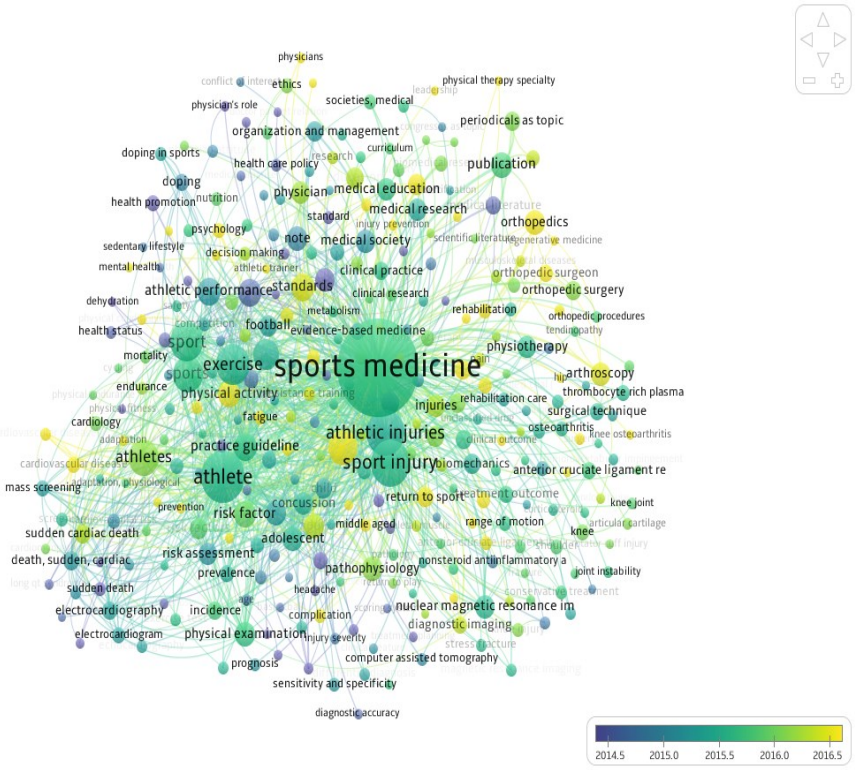


Fig. 6: Drawing a scientific map of the field of sports medicine 2020-2011

The five major sports medicine clusters recovered from Scopus articles between 2020-2011 include topics such as: The first cluster includes Achill tendon, animals, ankle injuries, anterior cruciate ligament, arthroscopic, articular cartilage, and the second cluster includes athletic topics. Trainer, chronic disease, biomedical research, clinical competence, clinical practice and the third cluster including adaptation, athletic performance, biological maker, body mass, cognition, and the fourth cluster including anamnesis, athletics, cardiology, cardiomyopathy, cardio vascular disease and the fifth cluster including accident prevention, adolescent, age factor, athletic injuries, attitude. The issues that have been done in recent years have been highlighted in a lighter color.

Discussion

This study provides an overview of the world's scientific productions in sports medicine in the Scopus citation database. Despite the ups and downs, the process of publishing articles has been growing over the last two years. These results are similar to the findings of González-Serrano Research in Sports Entrepreneurship Research (7), Chang-Yeon Kim Scientific Writing Trends in Orthopedic Sports Medicine by Gender (8), Belfiore in Sports Education and Management (9), Yaminfirooz in Sports Science (10), Archambault in Middle East Scientific Production (11). In 2015, the highest rate of rise was experienced in the scientific productions of sports medicine. The amount of scientific production in this field in 2011 was 162 articles, decreased by 30 compared to the maximum number of 214 articles in 2015, during these ten years. Overall, 1695 articles were published between 2011 and 2020, which received 22298 citations, with an average of 13 citations per article, which is a significant amount.

In terms of scientometrics, more citations and the subsequent increase in the h-index do not necessarily mean higher value and quality of work. The H-index has been widely criticized up to now for its weaknesses and inability to diagnose correctly. In this study, the top and most productive sports medicine scientists do not have the highest h-index or citation. In fact, the H-Index is a common indicator for evaluation, but it does not determine the level of the author, because it easily increases with the amount of self-citation (12). The best sports medicine authors in the world are from the United States. Drezner, Jonathan Adam from the University of Washington in the United States has the most publications or production with 1603 citations and h-index 45 in 2020. The most citations are devoted to Harmon, Kimberly G. from the same university with 1816 citations for 19 articles in 2019 with an h-index of 38. The highest h-index in this field was assigned to the American author Ackerman, Michael John with 113, with the publication of 6 articles.

The highest rate of scientific production is related to the United States with 1458 degrees England and Australia are in the second and third ranks with 589 and 319 degrees, respectively. Most of the scientific productions are related to Harvard University and the University of Washington. The United States, England, and Australia ranked 34154, 16930, and 6541, respectively, with the highest number of citations in the world. Other studies also confirm that these countries are at the forefront of scientific production (10, 13). The study of Eagle et al. also confirms the high activity of these two universities in the top ten institutes in sports medicine (14).

Among all sports medicine research, Drezner, Jonathan Adam is the most active sports medicine researcher in the world by writing and participating in 27 articles. Finch, C.F. and Engerbretsen, Lars are in second and third place with 23 and 21 articles. Information on the most cited researchers shows that Harmon, Kimberty G is the most cited researcher in sports medicine in Scopus with 19 articles in sports medicine and 1816 citations with a relatively large difference compared to other researchers. The highest citation rate for an article entitled American Medical

Society for Sports Medicine position statement: concussion in sport, which helps physicians evaluate and manage concussion using sports medicine by providing a summary of best evidence-based practices (15).

The present study showed that sports medicine articles have been published in various journals. Three journals: British Journal of Sports Medicine, Current Sports Medicine Reports and Journal of Athletic Training have the largest share of articles in sports medicine. The Eagle study also confirms the presence of these journals in the top ten journals in sports medicine (14).

Other findings of this study show that researchers in this field have a favorable tendency for scientific collaboration and joint writing at the national and institutional levels, so that in the years under review, only 28% of published articles had a single author. Regarding the collaboration in joint scientific productions, Abramo and Murgia believe that collaboration at the national and institutional levels can have a positive impact on research productivity (16). This participation in the writing leads to the qualitative and quantitative improvement of the article, the use of expertise and skills, and learning from other authors. Also, leading organizations with higher rates of contributory articles, resource allocation and highly cited products are known as valuable assets of sharing experiences (17).

The present study has the most articles in the first and second quarters of 1069 and 405 articles. 87.4% of these articles were of high quality and were published in this category of journals. In this study, 95.2% of the articles are in the first to third quarters, which indicate the high quality and impact of this group of studies. In another study, most articles are in the third quarter (18).

The limitations of this scientometric study are significant. This study was limited to research published in 2011-2021, so the findings presented here do not reflect pre-arrival sports medicine research. This study also deals with the scientific products of sports medicine in the Scopus citation database.

Conclusion

Considering the importance of sports medicine in the prevention, control and treatment of many diseases, as well as the growth of the elderly population, it is necessary to develop research in this area. By identifying the features of highly cited articles in this field, a clear view of the top authors and publications and widely used topics was provided.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Conflict of interest

The authors declare that there is no conflict of interests.

References

1. Luo H, Newton RU, Ma'ayah F, Galvão DA, Taaffe DR (2018). Recreational soccer as sport medicine for middle-aged and older adults: a systematic review. *BMJ Open Sport Exerc Med,* 4(1): e000336.
2. Pyne D (2014). Improving the practice of sports science research. *Int J Sports Physiol Perform*, 9(6): 899.
3. Della Villa F, Hägglund M, Della Villa S, Ekstrand J, Waldén M (2021). High rate of second ACL injury following ACL reconstruction in male professional footballers: an updated longitudinal analysis from 118 players in the UEFA Elite Club Injury Study. *Br J Sports Med*, 55(23): 1350-1357.
4. Blümel C, Schniedermann A (2020). Studying review articles in scientometrics and beyond: a research agenda. *Scientometrics*, 124(1): 711-728.
5. Sooryamoorthy R (2020). Scientometrics for the study of sociology. *Int Sociol,* 35(5): 461-79.

6. Cassese FP, Raiola G (2017). The importance of sport in disability management. *Sport Sci*, 10 (Suppl. 1): 7-11.
7. Huertas González-Serrano M, Jones P, Llanos-Contrera O (2020). An overview of sport entrepreneurship field: a bibliometric analysis of the articles published in the Web of Science. *Sport Soc*, 23(2): 296-314.
8. Kim CY, Sivasundaram L, Trivedi NN, et al (2019). A 46-year analysis of gender trends in academic authorship in orthopaedic sports medicine. *J Am Acad Orthop Surg*, 27(13): 493-501.
9. Belfiore P, Iovino S, Tafuri D (2019). Sport management and educational management: a bibliometric analysis. *Sport Sci*, 12(1): 61-64.
10. Yaminfirooz M, Siamian H, Jahani MA, Yaminifirouz M (2014). Scientific production of sports science in Iran: A scientometric analysis. *Acta Inform Med*, 22(3): 195-8.
11. Archambault E (2010). 30 years in science: Secular movements in knowledge creation. *Science-Metrix*, (30): 1-12.
12. Hirsch JE (2019). h α: An index to quantify an individual's scientific leadership. *Scientometrics*, 118(2): 673-686.
13. Gümüs H, Gençoglu C, Sahin T (2020). Physical Education and Sports: Bibliometric Analysis of the ERIC Database. *Int Online J Educ Teach*, 7(4): 1823-1837.
14. Eagle SR, Kontos AP, Collins MW, Connaboy C, Flanagan SD (2021). Network Analysis of Sport-related Concussion Research during the Past Decade (2010–2019). *J Athl Train*, 56(4): 396-403.
15. Harmon KG, Clugston JR, Dec K, Hainline B, Herring S, Kane SF, Roberts WO (2019). American Medical Society for Sports Medicine position statement on concussion in sport. *Br J Sports Med*, 53(4): 213-225.
16. Abramo G, D'Angelo AC, Murgia G (2017). The relationship among research productivity, research collaboration, and their determinants. *J Informetr*, 11(4): 1016-1030.
17. Keshtkar AA, Djalalinia SH, Khashayar P, Peykari N, Mohammdi Z, Larijani B (2013). Iranian Health Research Networks and vision of Iran by 2025: a case of Virtual Health Network in EMRI. *Iran J Public Health*, 42(Supple1): 78-83.
18. Smolina SG, Khafizov DM, Erlikh VV (2020). Bibliometric analysis of the publication activity of Russian scientific institutions in sports science for 2008-2018. *J Phys Educ Sport,* 20(2): 783-790.