

Global Trends in Patellofemoral Osteoarthritis Related Researches from 2001 to 2020: A Bibliometric and Visualized Study

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Abstract: *Purpose:* Patellofemoral osteoarthritis (PFOA) is a severe disease which is one of the leading causes of body dysfunction as well as anterior knee pain. In recent years, multiple researches have occurred in this area. However, worldwide research on this disease is not well displayed. The purpose of our study is to explore the research hotspot and direction of PFOA-related diseases. *Methods:* Publications on PFOA-related diseases from 2001 to 2020 were retrieved from Web of Science (WoS) database. Then the bibliometric method was used to analyze the data. In terms of visualization research, the VOS viewer was used to generate bibliographic coupling for co-occurrence analysis and further simulate the publishing trends in PFOA related fields. A total of 283 keywords met the threshold and were selected for co-occurrence analysis. *Results:* A total of 3215 publications were included. The number of publications is increasing every year. The United States is at the forefront of the world in this area, with the number and quality of publications (measured by the H index) ranking first in the world. The journal “Knee Surgery, Sports Traumatology, Arthroscopy” has published the most manuscripts, the University of California system has contributed the most studies among all the institutions, while the researcher Crossley KM is the most prolific author in this field. The PFOA-related studies could be divided into four clusters: “Dynamics, symptomatology and rehabilitation study”, “Imaging and basic experimental study”, “Alignment and functional study” and “Perioperative management study”. *Conclusions:* According to the analysis of current global trends, publications on PFOA-related research will continue to increase. The United States is now the leading country in this field, with both the largest number and the highest quality of researches. Among the four groups of studies related to PFOA, “Dynamics, symptomatology and rehabilitation study”, “Perioperative management study” and “Alignment and functional study” are considered as the current popular research directions in the PFOA-related studies.

Keywords: Patellofemoral Osteoarthritis, Global Trends, Hotspots

1. Introduction

As a part of knee osteoarthritis, patellofemoral osteoarthritis is an important cause of knee joint pain and loss of physical function [1, 2], leads to a significant impact on the health outcomes, social economic burden as well as reduced quality of life [3]. It is reported that the imaging

manifestations of PFOA exists in 17.1–34% of women and 18.5–19% of men [4]. Studies estimated the annual incidence of radiographic PFOA is about 5% in population level and 3% in knee level [5], indicating an urgent need for attention and way of solutions.

As far as we know, the global research trend on PFOA-related studies has not been well studied. In recent years, there are more and more researches on PFOA, involving interdisciplinary cooperation. Therefore, it is necessary to investigate the current global status of PFOA related research by bibliometric analysis, a common method for qualitative and quantitative prediction of research development trend by comparing the research results of main authors, published journals, affiliations and different countries and regions [6], which can help us have a macro understanding on the importance of a certain research field. In addition, bibliometric analysis of different diseases makes scientific research in different fields more transparent and intuitive, and makes great contributions to the development and update of clinical decision-making and guidelines [7, 8].

2. Methods

2.1. Data Sources

Although databases such as Scopus, Google Scholar and Sci Finder could certainly meet the requirement for evaluation research at a global level, we chose the Science Citation Index-Expanded (SCIE) of Web of Science (WoS) for the analysis of this study, which provides coverage back to 1900, overlapping a number of over 12,000 international scientific journals [9, 10].

2.2. Retrieval Methods

There are some similar expressions about patellofemoral osteoarthritis. Our retrieving methods were as follow: (Theme = patellofemoral osteoarthritis or Theme = patella osteoarthritis or Theme = patellar osteoarthritis) AND (Language = English) AND (Document type = Articles OR Reviews). The publication time was focused on the last 20 years from January 1, 2001 to December 31, 2020.

2.3. Data Collection

We searched the titles, keywords and abstracts of the

publications according to the theme, the publication year, authors and affiliations, nationalities, journals were recorded then by two authors independently in Microsoft Excel software (version 2016, Redmond, WA).

2.4. Bibliometric and Visualized Analysis

We use the retrieval function of WoS to analyze the basic characteristics of the targetted publications. At the same time, the H-index was displayed to evaluate the quantity and quality of the publications as well as their authors, affiliations or countries, which shows that h publications have been cited at least h times by other publications [11].

Vos viewer (version 1.6.12; Leiden University Center for Science and Technology Studies, Leiden, Netherlands) is a software tool for constructing and visualizing bibliometric networks [12], which can analyze bibliographic coupling, co-authorship relation, co-citation and co-occurrence.

3. Results

3.1. Number of Global Publications

The change of the quantities and qualities of publications is an important indicator in showing the development trend in a certain field. According to our retrieval criteria, a total of 3215 articles from January 1, 2001 to December 31, 2020 were retrieved from the WoS database. Over the past 20 years, the volume of publications has shown an obvious upward trend (see in Figure 1A).

A total of 72 countries and regions have published PFOA related publications, while the USA (1077, 33.50%) with the most number of publications was regarded as the centers of PFOA control and prevention, followed by Australia (391, 12.16%), Germany (319, 9.92%), England (313, 9.74%) and China (250, 7.78%). All the countries and regions who has published PFOA-related researches were shown in Figure 1B, the darker the color, the more numbers of the publications. According to publications quantities, the top 20 countries were shown in Figure 2A.

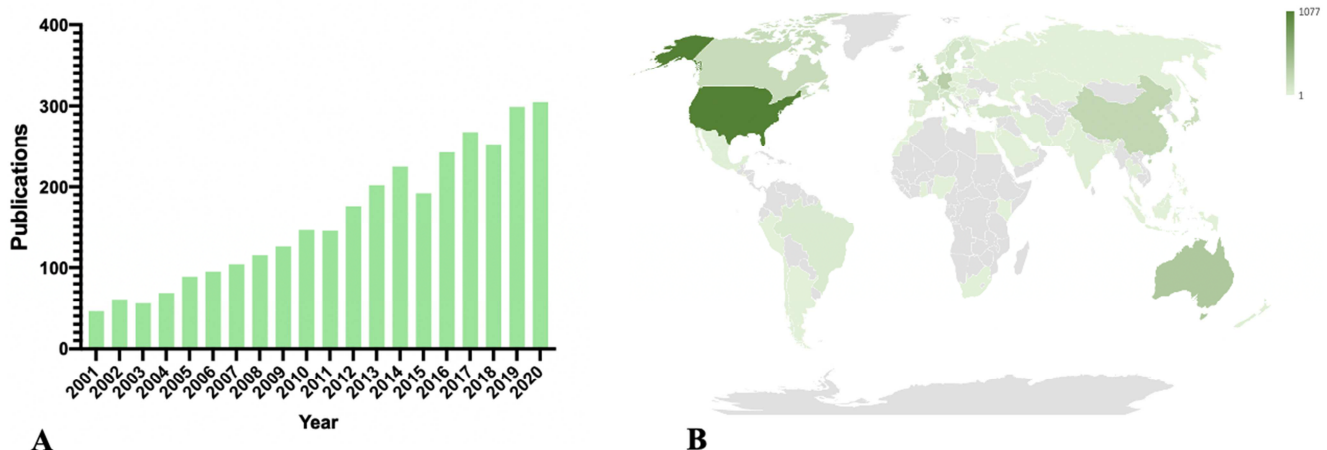


Figure 1. (A) Global publication numbers of PFOA related research. (B) The distribution world map of PFOA-related research.

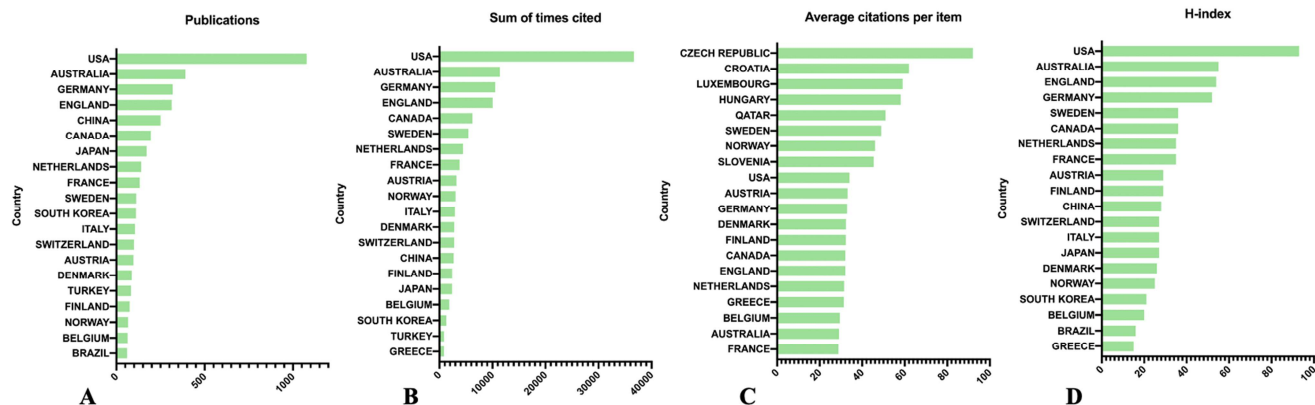


Figure 2. (A) The top 20 countries of total publications. (B) The top 20 countries of total citations. (C) The top 20 countries of average citations (countries/regions with publications \geq were included in analysis). (D) The top 20 countries of H-index.

3.2. Quality of the Publications of Different Countries/Regions

In the aspect of WOS database analysis, we counted the total/average citations and H-index of 72 countries/regions (Figure 2 A-C). When come to total citation frequency, the USA (36,684) ranked the first place among all the countries/regions, followed by Australia (11,390), Germany (10,508), England (10,030) and Canada (6,253). When come to average citation frequency, Czech Republic (92) ranked the first place, followed by Croatia (62), Luxembourg (59), Hungary (58.14) and Qatar (51), the

country/region were included in the ranking analysis only when the number of published articles is more than or equal to two. While the top 5 countries in H-index were the USA (93), Australia (55), England (54), Germany (52), Canada and Sweden tied for fifth place (36).

3.3. Analysis of Global Publications

When it comes to the most research orientations (Figure 3A), journals (Figure 3B), authors (Figure 3C) and institutions (Figure 3D), the top 20 ranking from WOS database were as followed respectively.

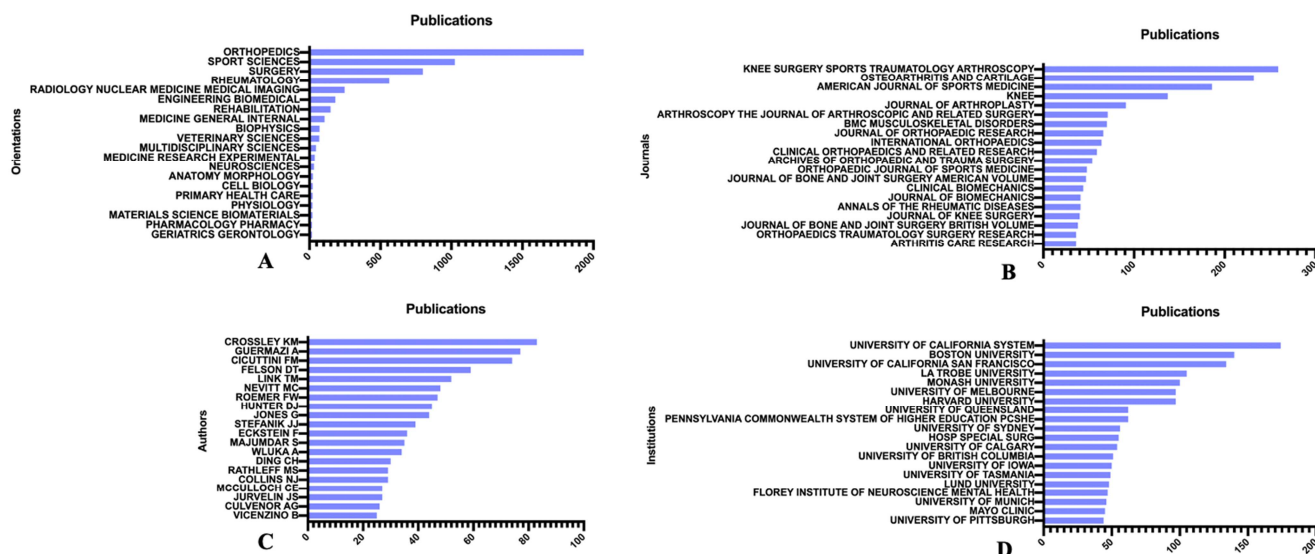


Figure 3. (A) The top 20 research orientations of total publications. (B) The top 20 journals of total publications. (C) The top 20 authors of total publications. (D) The top 20 institutions of total publications.

3.3.1. Research Orientation

The top 5 area that published the most articles/reviews belong to the field of orthopedics (1932 publications), sport science (1024 publications), surgery (799 publications), rheumatology (563 publications), radiology nuclear medicine medical imaging (248 publications), respectively. The top 20 orientations published the most studies were presented in Figure 3A.

3.3.2. Journals

The journal “Knee Surgery, Sports Traumatology, Arthroscopy” published 259 manuscripts, outnumbering other journals. “Osteoarthritis and Cartilage” with 232 publications ranked the second place, followed by “The American Journal of Sports Medicine” with 186 publications, “The Knee” with 137 publications, and “The Journal of Arthroplasty” with 91 publications. The top 20 journals published the most manuscripts

were presented in Figure 3B.

3.3.3. Authors

The top 20 authors with the largest number of publications on PFOA related studies were listed in Figure 3C, these authors, alone or in collaboration with each other, published 440 manuscripts during the last two decades. Among them, Crossley KM from Australia published 83 manuscripts, ranking the first place in the PFOA related area, followed by Guermazi A from the USA with 77 manuscripts, Cicuttini FM from Australia with 74 manuscripts, Felson DT from the USA with 59 manuscripts, and Link TM from the USA with 52 manuscripts. It is worth noting that we took a subject into analysis as long as he/she appears in the author list, regardless of the relative contribution of the author towards a study.

3.3.4. Institution Output

The top 20 institutions with the most PFOA related publications were listed in Figure 3D, the University of California system published the most articles/reviews in this field, with a total of 174 publications, followed by the Boston university (140 publications), University of California San Francisco (134 publications), La Trobe University (105 publications), Monash University (100 publications). It should be noted that the university system and its branches school were not distinguished in the analysis.

3.4. Bibliographic Coupling Analysis

Bibliographic coupling analysis is a method for grouping technical and scientific documents, first introduced by Kessler [13], facilitating scientific information provision and

document retrieval, helps to establish the similarity relationship between documents based on the number of references shared [14]. In this study, VOS viewer was used to demonstrate the collaboration network among different journals, institutions, countries/regions in PFOA related research (see in Figure 4). Each sphere in the picture represents a different item, the size of which represents the number of publications. The curve line between different sphere represented the strength of associations, the larger the width of the line, the closer the connection. A total of 105 journals were counted into analysis when the minimum number of papers were set up as 5, shown in Figure 4(A). The top five journals with the highest total link strength (TLS) were as follows: Knee Surgery, Sports Traumatology, Arthroscopy (TLS = 122,591 times); The American Journal of Sports Medicine (TLS = 106,548 times); Osteoarthritis and Cartilage (TLS = 98,651 times); The Knee (TLS = 55,958 times); Arthroscopy: The Journal of Arthroscopic & Related Surgery (TLS = 33,422 times). There were 321 institutions shown in Figure 4(B) based on publications with the minimum number was over 5. The Boston University ranked the first place with a TLS of 232,528 times, followed by University of California San Francisco (TLS = 186,447 times), La Trobe University (TLS = 177,464 times), and the University of Melbourne (TLS = 155,836 times), Monash University (TLS = 139,964 times). When comes to different countries and regions, a number of 46 countries/regions were counted into analysis. The USA ranked the first (TLS = 629,895 times), then followed by Australia (TLS = 339,480 times), Germany (TLS = 257,135 times), England (TLS = 211,281 times), and Canada (TLS = 160,466 times).

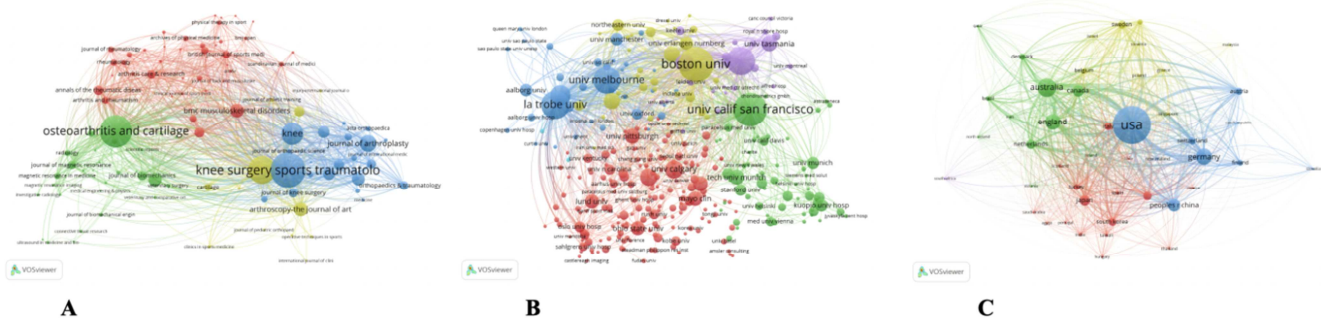


Figure 4. Bibliographic coupling analysis of global research about PFOA related study. (A) Mapping of the 105 identified journals on PFOA related study. (B) Mapping of the 321 institutions on PFOA related study. (C) Mapping of the 46 countries/regions on PFOA related study.

3.5. Co-occurrence Analysis

The purpose of co-occurrence analysis is to illustrate the popular topics in research and monitoring the development in scientific areas, helping researchers to well understand and grasp hot spots in a certain area [15]. A number of 283 keywords were picked up by setting the threshold as 20 times via VOS viewer.

After analysis, all the keywords were classified into approximately 4 clusters (Figure 5A): “Dynamics, symptomatology and rehabilitation study (marked in red)”,

“Imaging and basic experimental study (marked in green)”, “Alignment and functional study (marked in yellow)” and “Perioperative management study (marked in blue)”. The most common used keywords were “osteoarthritis”, “knee”, “follow up”, “cartilage”, “articular-cartilage”, “knee osteoarthritis”, “joint”, “MRI”, “anterior cruciate ligament” and “pain”, with the top 10 highest TLS.

As shown in Figure 5B, keywords were marked with different colors based on the frequency of their appearance in the retrieved studies. The blue color indicated the earlier appearance, while the red color stood for the later appearance.

Before 2012, most studies were focusing on “articular-cartilage”, “volume and thickness” and “degradation”. While “prevalence”, “anterior knee pain” and “outcomes” seems to be the most popular ongoing area of PFOA related after 2016. Also, recent trends showed diversified in the other three clusters.

As shown in Figure 5C, the occurrence frequency of keywords was defined as the color of the surrounding area

in the density visualization map, the higher the frequency, the warmer the color is. The color blue corresponds to the lowest density of keywords frequencies, and red corresponds to the highest density of keywords frequencies. The yellow area contained the keywords bellow: pain, articular-cartilage, joint, epidemiology, replacement, follow-up, anterior cruciate ligament, patellar tendon, MRI, and progression.

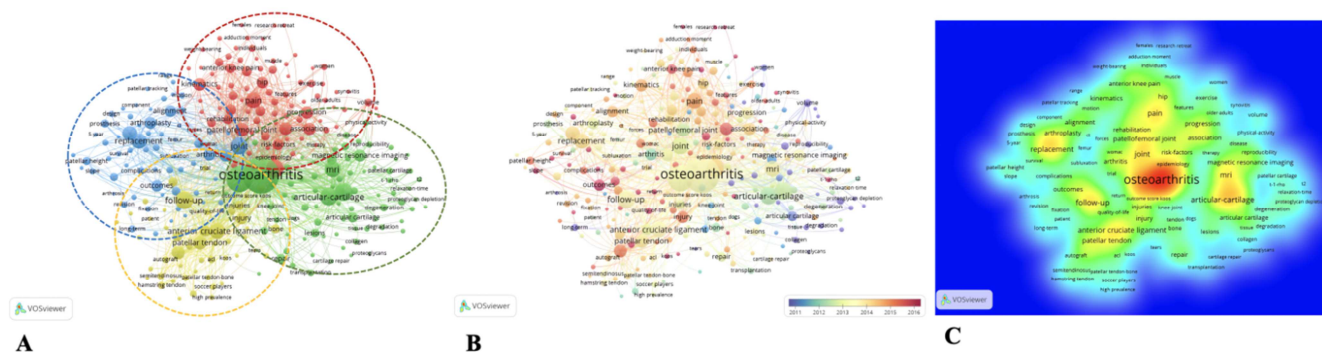


Figure 5. Co-occurrence analysis of PFOA related study. (A) Network visualization map: mapping of keywords on PFOA related study. The size of the dots indicates the frequency of the keywords, which are divided into 4 clusters and marked in red, green, yellow and blue, respectively. (B) Overlay visualization map: mapping of the distribution of keywords on PFOA related study according to the frequency of appearance. (C) Keywords density visualization map: the frequency of keywords was defined as the color of the region, the higher the frequency, the warmer the color is.

4. Discussion

This is the first bibliometric and visualized study demonstrating the global trends of PFOA related research in the past two decades. It can be seen clearly that papers on PFOA showed a significant increasing trend with the growth of years, indicating that more and more studies are involved in the field of PFOA. A total of 72 countries and regions have been counted into analysis, the most productive countries are either economically developed countries or countries that have been developing rapidly in medical science, especially in the treatment of functional disorders. According to our data, it is not difficult to see that there will be more and more PFOA related and in-depth studies in the future, further promoting the better control of PFOA worldwide.

Quantity and quality of publications were combined together to reflect the contribution of each country. The quality of articles was assessed from three dimensions: total of times cited, average citations, and H-index. The USA has far more articles published than other countries, ranking the first in the world in terms of total citations and H-index. Although the average citations per publication of the USA is not the highest in the world. Among the countries whose average citations per publication were above the USA, only Sweden has more than 10% of the number of publications produced by the USA. The results of the data analysis show that the USA is still the leading country in the research of PFOA up to now. Without exception, the publication number of the countries (Czech Republic, Croatia, Luxembourg, Hungary, and Qatar) with the top five average citations per publication is less than ten, indicating the related studies of those countries is not

enough, though the quality of their articles may be tremendous. Australia, Germany and England are in the top 5 in terms of the number and quality of publications, while China ranks the fifth in terms of the number of papers, but the quality is relatively weak compared with other countries, which indicates that there are a lot of related studies in China according to the high incidence of PFOA recent years, but the core value and contribution of the studies are still insufficient, which need to be further improved in the follow-up researches. It is worth mentioning that the average citation per publication of Sweden and Norway is higher than the USA, the two countries rank in the top 20 in terms of number of publications and H-index, indicating that these two countries play an important role in this field, and their research contributions cannot be ignored. Sweden, with a population of about 10 million [16], in particular, ranks 10th in the world in terms of number of articles and 5th in terms of H-index.

Orthopedics, sport sciences, surgery, rheumatology and imaging were the main orientation of PFOA studies. The proportion of basic medicine and laboratory research in PFOA related studies is not dominant, which fully shows that more and more research and people's attention are urgently needed in the field of basic medicine in this direction. In terms of authors and institution rankings, the USA and Australia were at the top of the list, suggesting that study directions led by certain researchers have been formed, distinct and upward trends in those institutions have been well established. As for journals, “Knee Surgery, Sports Traumatology, Arthroscopy”, “Osteoarthritis and Cartilage”, and “the American Journal of Sports Medicine” made great contributions, and it is still possible for these magazines to be the leaders in the field in the next few years. The researches of these journals need to be

pay attention to, in order to grasp the latest research advancements of PFOA.

In this study, bibliographic coupling analysis was performed to interpret the relationship of similarity among different studies by using bibliographic indicators such as journals, authors, institutions and countries [17]. It occurs when two different studies contain common citations in the bibliographies. According to our analysis, “Knee Surgery, Sports Traumatology, Arthroscopy”, “the American Journal of Sports Medicine”, and “Osteoarthritis and Cartilage” was the most relevant journal which is more likely to report the latest development in PFOA related studies. The Boston University was the most cooperative institution, followed by the University of California San Francisco and the La Trobe University, which could be considered as the landmark research centers about the PFOA research. Almost all the included countries and regions have cooperation with the USA more or less, which has laid an indispensable position for the USA in PFOA studies. Countries and countries together, promoting rapid development in this field.

Based on the co-occurrence analysis, which is commonly used to predict the current research trends and focus of this field according to keywords, PFOA related studies could be divided into four clusters. Each cluster stood for a research area (Figure 5B), helping us to catch sight of different research directions in various fields intuitively. Apart from the colors of the lines and spheres, there is no difference between the co-occurrence map and the overlay visualization map. The color of the latter reflects the relevant time of the corresponding study, which could monitor the research popularity more precisely. Overlay and density visualization map combined together, we can see that the keywords: “pain”, “epidemiology”, “patellar tendon” and “replacement” were focused in the past five years with a relatively high frequency of occurrence, indicating that epidemiology, symptomatology and surgery are more likely to be the ongoing and next research hot-spots.

As far as we know, this is the first bibliometric and visualized analysis on PFOA research, which illustrate the research distribution and cooperation relationship among different countries, authors and institutions, and makes a comprehensive analysis and prediction on the research status and development direction of PFOA. Also, there are still limitations in our study. Firstly, we only searched articles through the WOS database, and some non-English publications were excluded from the analysis, which may cause ignorance of some papers, though the included publications were adequate enough [18]. Secondly, we did not analyze the papers published in 2000 and before. This part contains about 200 articles, which may affect the judgment of influence of some countries, authors and institutions. Thirdly, there are different expressions of the author's name sometimes, which may cause deviation to the results. Last, but not the least, there are inherent differences between the results of bibliometric analysis and the results of real-world research, some of the latest publications may not get the general attention due to the short time or in the early stage of research.

5. Conclusions

According to the analysis of current global trends, the quantity and quality of publications on PFOA related research will continue to increase in the future. The United States is currently the leading country in this field, with the largest number of research and the highest quality of research, but other countries still have a certain trend of catching up. There are many journals and institutions that attach great interests and importance to PFOA-related researches. Among directions of PFOA related studies, “Dynamics, symptomatology and rehabilitation study”, “Perioperative management study” and “Alignment and functional study” are considered to be the current popular research directions. While “pain”, “epidemiology”, “patellar tendon” and “replacement” may be the current hot spots, it can be predicted that in the next few years, relevant articles will focus on these aspects. It can be seen that new areas will be gradually explored, and more and more research will help reduce the incidence rate of PFOA patients and improve their quality of life.

Foundations

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